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ABSTRACT

of the dissertation for the degree
of Doctor of Philosophy

SPECIES COMPOSITION AND ECOPHYSIOLOGY OF FUNGI INVOLVED IN THE FORMATION OF MYCOBIOTA OF BIOTOPES EXPOSED TO ANTHROPOGENIC IMPACT

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APPLICANT: **Emilya Mizandar Safaraliyeva**

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The dissertation work was carried out in the laboratories of Microbiological biotechnology and experimental mycology of the Institute of Microbiology of ANAS.

Scientific supervisor: Doctor of Biological Sciences,
Associate Prof.
Konul F. Bakhshaliyeva

Official opponents: Doctor of Biological Sciences, Prof.
Mirmusa Mirish Jafarov

PhD on Biology, Associate Prof.
Nizami Rza Namazov

PhD on Biology
Mehriban Rauf Yusifova

Dissertation council FD 1.07 of Supreme Attestation Commission under the President of the Republic of Azerbaijan operating at the Institute of Microbiology of ANAS

Chairman of the
Dissertation Council: Doctor of Biological Sciences, Prof., Academician
Mammad Ahad Salmanov

Scientific Secretary of the
Dissertation Council: PhD on Biology, Associate Prof.
Anar Teyyub Huseynov

Chairman of the
scientific seminar: Doctor of Biological Sciences,
Associate Prof.
Samira Imamyar Nadjafova

INTRODUCTION

Relevance and level of elaboration of the topic. Recent periods are characterized by an increase in the burden of anthropogenic impact on the environment, which is reflected in environmental pollution and deterioration of the environmental situation. Against the background of all this, environmental problems of a global nature inevitably arise, the solution of which is already one of the most important issues of our time. So the negative aspects of this problem concern all living things, primarily the people themselves. For this reason, a comprehensive study of ecosystems that have been subjected to anthropogenic impact is one of the most targeted areas of research in recent years. In the studies related to this, first of all, an assessment of the general state of ecosystems is carried out, for which various methods and approaches are used.

It should be noted that the assessment of the effect of anthropogenic impact on a particular ecosystem is possible on the basis of a number of indicators. According to modern views, if we take into account the fact that the soil is a biological and biochemical system, then the use of soil microorganisms in the mentioned issues will not cause any doubt. Soil microorganisms are primarily bacteria, fungi, and protozoa. All of them are characterized by high quantitative indicators, both by type and quantity. In addition, primarily bacteria and fungi are also considered to be creatures that play an important role in the processes. such as the degradation of plant residues, in the synthesis and degradation of humus, in the formation of the phytosanitary state of the soil, in the collection of biologically active substances in the soil, in the fixation of atmospheric nitrogen, etc. The vital activity of microorganisms, including fungi, has a certain influence on the interaction between soil and plants, the formation of potential and effective soil fertility. Biological processes take place in the soil continuously, and the quantitative and qualitative ratio of plant nutrients changes due to the decomposition of the remains of dead organisms. In this case, the chemical analysis of the soil alone is not enough to determine the speed of the biological cycle of chemical elements, and in this case it is necessary to find out the microbiological processes that determine the dynamics of the transformation of organic matter. The explanation of these issues begins with the characterization of living creatures belonging to a particular ecosystem in accordance with their species composition, studying the nature of their relationship with the environment in which they live.

Each of the soil micro-organisms has different ecological functions, and their study has long been the subject of research in various aspects. Just as soil micro-organisms differ in number, species diversity, and the nature of the ecological functions they perform, so do their levels of study.

Thus, although the role of bacteria has been widely studied in research up to date, there is not enough research material to consider the study of fungi in this aspect at the desired level. If we add that most of the lands of the Republic of Azerbaijan as a small part of the world are used for various purposes, primarily in agriculture, there is no systematic research on the mycological assessment of these lands, there is no doubt that the research is relevant.

Goals and objectives. The purpose of this work is to assess the gray-brown soils of the Absheron Peninsula, which are subject to various anthropogenic impacts on the species composition of fungal biota, the forms of specialization of species involved in the formation of the mycocomplex, in terms of ecological and trophic relationships, ecophysiology, and the reaction of fungi to anthropogenic influences.

To achieve this goal it was considered appropriate to perform the following tasks:

1. Selection of the same type of soil affected by various anthropogenic impacts, and determination of some physical and chemical parameters of soils;
2. Assessment of individual anthropogenic affected land plots by the number and species composition of fungal biota;
3. Characteristics of species involved in the formation of mycobiota of individual land plots, according to ecological and trophic relations and ecophysiological features;
4. Assessment of fungi by species and physiological groups in response to anthropogenic impacts.

Methods of research. The accuracy of the obtained results is confirmed by numerous experiments conducted using both mycological and biochemical methods that meet modern standards. The purity of the reagents used for analysis and the accuracy of the instruments were also at the required level. On the other hand, the fact that the equipment used is intended for use in research in this field, the repetition of experiments allows for their statistical processing, and the fact that the standard deviation is within the acceptable limit ($P \leq 0.05$) allows us to note the accuracy of the results.

The thesis provisions are submitted for defense.

1. The diversity of the nature of anthropogenic impact also leads to different changes in the physical and chemical parameters of the same type of soil;
2. Although all anthropogenic impacts lead to a decrease in the species composition of the fungal biota of any area belonging to the same soil type, each cenosis also in some sense leads to the formation of a specific mycocomplex;
3. Although there is no clear relationship between the cultivation temperature, initial pH, oxygen availability, etc., which is necessary for the growth of fungi with various anthropogenic influences, anthropogenic influences also change the ecological and trophic structure of the mycobiota of a particular biotope;
4. Grouping fungi by their response to anthropogenic impacts is a convenient approach for assessing the ecological state of biotopes that are subject to a particular anthropogenic impact.

Scientific novelty of the research. The studies comprehensively studied physico-chemical parameters of the Absheron Peninsula, the abundance and species composition of mycobiota gray-brown soils of differing character of anthropogenic impact, ecological and trophic relationships of the fungi involved in the formation of mycobiota, as well as the reaction of fungi to human impact.

From the results, it became clear that 81 species of fungi are involved in the formation of mycobiota in certain areas of research, and in all cases, the number of registered species of fungi leads to a decrease in the species composition of mycobacteria, characteristic of relatively clean soils.

Despite the fact that in all cases, anthropogenic impacts depends on the typical composition micobiota in the formation micobiota, along with the general types in the formation micobiota each territory involved specific types, the number of which varies from 2 to 7 species for each biotope, that is, each territory is explored from anthropogenic impacts, characterized by microcomplexed wearing in a certain sense a sign of specificity.

It was found that depending on the anthropogenic impacts there is a change in the ecological-trophic structure of each biotope-specific ecocomplex, which manifests itself in reducing the proportion of saprotrophic in bicomplexes relatively clean soils and increase polytrope. A similar situation is observed with respect to toxins, which are manifestations of ecological and trophic specialization.

No special differences are recorded when the fungi recorded in the research were characterized by soil moisture in nature. However, the specific weight of individual groups of mycocomplex due to moisture, which is characteristic of relatively clean soils, may vary to some extent due to hydrophils and mesohydrophils. A similar situation is observed at the temperature and initial pH characteristic. Thus, most of the registered fungi are mesophilic in relation to temperature, and a small number are thermotolerant, and among the registered fungi, psychrophiles and true thermophiles are not found. Although a pH of 4.9-6.0 is considered optimal for all registered fungi, among the registered fungi are such alkotolerants as *Aspergillus fumigatus, A. ochraceus, Mucor hiemalis* and *Ulocladium botrytis*.

In the course of determining the response to the effects of fungi involved in the formation of the mycobiota of soils exposed to various anthropogenic influences, it became clear that no induction-activated species are found on relatively clean soils, and no sensitive species (inhibitory group) are found on oil-polluted soils.

Theoretical and practical significance of the research. The obtained results can be successfully used in assessing the ecological state of the corresponding soils as a species and numerical composition of mycobiota of the gray-brown type of Absheron soils, which are affected by various anthropogenic impacts, ecological and trophic relationships, as well as the actual material that characterizes the response to anthropogenic impacts.

The information obtained on the fungal biota of grey-brown Absheron soils with varying degrees of degradation can be useful as a basis for restoring soils that generally meet this characteristic, as well as for preparing preventive measures to improve the phytosanitary condition of such soils.

Approbation and application of publications and dissertations. 12 dissertations were published, the results of which were presented at the international scientific and practical conference "Actual problems of virology, microbiology, hygiene, epidemiology and Immunobiology" (Kazakhstan, R., Almaty, 2012), at the international scientific conference "Current state, development trends, effective use and protection of biological diversity of the plant world" (Belarus, R., Minsk, 2014), at the Republican scientific conference "Modern problems of biology" (Sumgait, 2018).

Structure and volume of dissertation. The dissertation work consists of an introductory and 4 chapters, a final analysis of the research, results, a list of references, additions and a list of abbreviations used in the dissertation. The dissertation consists of 143 pages, including a table and images, as well as a list of references, which is a total of 235540 signs.

CHAPTER I
ECOPHYSIOLOGICAL ASPECTS OF MYCOBIOTA FORMATION OF BIOTOPES AFFECTED BY VARIOUS ANTHROPOGENIC IMPACTS

Section 1.1 of the dissertation analyzes the literature on anthropogenic environments and sources of their pollution, noting that environmental pollution is a complex problem that poses a threat to future generations.

Section 1.2 of the dissertation analyzes the characteristic features of mycobiotic formation in the anthropogenic environment, as well as changes in mycocomplexes formed by fungi from anthropogenic influences.

Section 1.3 of the dissertation analyzes research on the ecophysiology of fungi involved in the formation of mycobiota in natural and anthropogenic environments, and shows the importance of assessing the functions of fungi in the soil from an ecophysiological point of view.

CHAPTER II
MATERIALS AND METHODS

Studies were conducted in the districts of Baku and near Sumgayit, samples were taken from gray-brown soils that were contaminated from various sources. For this purpose, 7 (Land contaminated with industrial products - LCIP, Irrigated land - IL, Land contaminated with oil and petroleum products - LCOP, Areas contaminated with motor transport - ACMT, Urban land - UL, Areas used for waste disposal - LWD and Relatively clean land-RCL) stationary experimental zones of 100x100 m in size were used in each zone. Samples were taken from 8-10 locations in each field. Sampling, preparation for laboratory analysis, release into pure culture, quantitative assessment, identification of species, study of ecophysiological characteristics, etc.was carried out in accordance with the methods and approaches adopted in Microbiology.

During the study, all experiments were performed in 5 repetitions, the results were statistically processed, and the results corresponding to the formula P (student's criterion) ≤ 0.05 were used.

CHAPTER III
CHARACTERISTICS OF MYCOBIOTA OF THE ANTHROPOGENIC ENVIRONMENT BY THEIR NUMERICAL AND TYPICAL COMPOSITION, ECOLOGICAL-TROPHIC RELATIONS, AND ACCORDING TO THE FREQUENCY OF OCCURRENCE SPECIFICATION

1.1. Selection of research areas affected by various anthropogenic impacts, and determination of some physical and chemical parameters of soils

Samples from 7 areas exposed to various anthropogenic impacts were first analyzed for some physical and chemical properties. It was found that the indicators of 6 land plots exposed to various types of impacts differ from the indicators defined for relatively clean soils (table 3.1). As you can see, the amount of humus in all sources of pollution is relatively low compared to some control soils.

Table 3.1.

Characteristics of selected soils by some indicators

№	Source of pollution	Sampling depth(SD)	pH	Soil moisture (%)	Amount of humus (%)
1	LCIP	0-20	7,2	19	1,52
2	IL	0-20	7,4	22	1,64
3	LCOP	0-20	7,5	20	1,28
4	ACMT	0-20	7,2	21	1,43
5	UL	0-20	7,0	23	1,41
6	LWD	0-20	7,2	22	1,62
7	RCL	0-20	7,1	20	1,74

3.2-3.5. Assessment of fungi involved in the formation of mycobiota in the anthropogenic environment, depending on the number and species composition, ecological and trophic relationships and frequency of occurrence, as well as an annotated list of registered fungi

The distribution of 81 species of true fungi (Mycota) was determined from approximately 800 samples taken from 7 different areas with the same soil type, of which 10 species belonged to *Zygomycota* and 71 species to *Ascomycota* branches. The number of species from 41 registered genera ranged from 1 to 14. In addition, it became clear from the results that in all cases the number of recorded fungal species leads to a decrease in the micro-diversity of species compared to the species composition, which is manifested in the highest levels of oil-contaminated soils (table 3.2). Although the species composition of mycobiota is weakened in all cases due to anthropogenic influences, in addition to the usual species, specific species participate in the formation of mycobiota in each area, the number of which varies from 2 to 7 depending on the biotopes characterized by a microcomplex. Thus, such fungi are found in gray-brown soils 3 (*Absida caerulea, Thysanophora penicillioides* and *Ulocladium atrum*), 2 in irrigated soils (*Epicoccum nigrum* and *Sporothrix fungorum*), 3 in soils contaminated with oil and petroleum products (*Humicola gricea, herbarum* and *Verticillium alboatrum*), 3 in areas polluted by motor transport (*Botryotrichum piluliferum, Myrothecium roridum* and *Scopulariopsis Brevicaulis*), 4 in urban areas (*Acremonium atrogriseum, Gliomastix murorum, Talaromyces rugulosus* and *Trichophyton terrestre*), 3 in areas used for waste disposal (*Coniothyrium olivaceum, Geotrichum Candidum* and *Trichocladium polysporum*) and relatively clean soils are represented by 7 species (*Actinomucor elegans, Alternaria chlamydospora, Chaetomium cellulolyticum, Chrysosporinum merdanum, Gliocladium roseum, Trichoderma hamatum* and *T. harzianum*).

Table 3.2

Quantitative characteristics of the distribution of registered fungi on various anthropogenic affected soils

Sources of pollution	The distribution of fungi by taxon				
	Division	Type	Sequence	Family	Genera (type)
LCIP	3	4	5	8	22(39)
IL	3	5	7	12	21(47)
LCOP	3	4	5	8	17(26)
ACMT	3	4	5	8	18(34)
UL	3	4	5	8	16(37)
LWD	3	4	6	11	21(42)
RCL	3	6	9	16	25(51)
TOTAL	3	7	12	21	38(81)

When studying the numerical composition of mycobiota in the selected areas, it was found that the specificity of relatively clean soil is higher in all cases (table 3.3), i.e. anthropogenic impact leads to a decrease in the number of mycobiota.

Table 3.3

Characteristics of the number of fungi involved in the formation of mycobiota in soils affected by various anthropogenic impacts

№	Sources of pollution	The quantitative composition (at the average rate for the year MNU / g)
1	LCIP	$3,2x10^3$
2	IL	$4,8x10^3$
3	LCOP	$2,2x10^3$
4	ACMT	$3,2x10^3$
5	UL	$8,7x10^2$
6	LWD	$4,2x10^3$
7	RCL	$5,7x10^3$

When describing the registered species of fungi in accordance with their ecological and trophic relationships, it was found that the relative number of polytrophic (biotrophic and saprotrophic) fungi prevails over the land used for control, in soils that are more or less subject to anthropogenic influence and biotrophs were not detected at all (table 3.4). As it can be seen, the number of saprotrophs little compared to polytropon, but they are also quite common.

Table 3.4

Quantitative composition of ecological and trophic belonging of fungi registered in different sources of pollution

№	Sources of pollution	Ecological and trophic affiliation (%)		
		Saprotroph	Polytropic	Biotrophic
1	LCIP	29	71	0
2	IL	32	68	0
3	LCOP	17	83	0
4	ACMT	25	75	0
5	UL	28	72	0
6	LWD	26	74	0
7	RCL	35	65	0

It should be noted that in recent mycological studies, fungi have been described as indicators of ecological and trophic specialization. Toxicity, allergenicity and opportunism are considered as indicators. When describing the fungi registered in the course of research, it is clear that in any case, the background level of relatively clean soils increases to some extent depending on the nature of anthropogenic impact, that is, anthropogenic impact also changes the structure of ecological and trophic specialization of mycobiota. In all cases, these changes are negative (for example, increased background levels of toxins) (table 3.5). As you can see, fungi that do not meet the indicators indicated as manifestations of ecological and trophic specialization are also found. These fungi can also be described as those whose status is unknown today. Thus, there is no literature confirming their allergenicity, toxigenicity, opportunism, and other features. In short, these fungi can also be characterized as objects that are currently open for research.

Table 3.5

Characteristic of fungi registered in various sources of pollution according to the manifestation form of eco-trophic specialization

№	Sources of pollution	The specific gravity of the manifestations of the ecological and trophic specialization (%)			Incompa-tible
		Allergens	Toxins	Opportunists	
1	LCIP	59,7	58,4	40,8	17,9
2	IL	56,4	50,2	38 ,3	25,1
3	LCOP	54,5	62,3	43,4	14,5
4	ACMT	58,4	54,1	41,2	18,4
5	UL	57,5	52,0	38,9	21,3
6	LWD	60,4	55,2	46,2	20,2
7	RCL	54,9	47,1	37,3	27,5

Fungi, one of the stable components of the heterotrophic block of any ecosystem, actively participate in all the processes that occur there. The frequency of occurrence of fungi (RT) is also used as a quantitative expression of this activity. In this regard, it was found that only 3 species are characterized by RT, which is dominant for all the selected areas, including species such as A. niger, M. mucedo, and P. chryzogenum. Thus, their RT coefficient is 53.4%, 51.1% and 50.1%, respectively. Of the 81 species recorded in the study, 35 were described as common (FO (frequency of occurrence) = 12.4-36.4%), and 43 as accidental and rare (FO = 0.08 - 7.6%).

The relatively small number of dominants in soils belonging to the same type of soil in the presented work is due to the nature of anthropogenic influences affecting them. Thus, the number of dominant species involved in mycobiota formation in different regions varies from 5 to 8 (table 3.6).

It should be noted that an annotated list of microorganisms, including fungi, registered in such studies is usually included. We also considered it appropriate to follow this study and compiled a similar list for 81 species of registered fungi.

Table 3.6

Quantitative characteristics of the dominant mycobiota species in certain areas studied

№	Sources of pollution	Number of dominant species (FO, %)
1	LCIP	5(51,2-63,2)
2	IL	6(50,2-57,8)
3	LCOP	5(51,1-62,1)
4	ACMT	5(52,4-55,6)
5	UL	5(50,2-55,4)
6	LWD	8(50,2-61,3)
7	RCL	6(50,2-57,5)

CHAPTER IV
ASSESSMENT OF ECOPHYSIOLOGICAL CHARACTERISTICS OF FUNGI INVOLVED IN THE FORMATION OF MICROBIOTA OF ANTHROPOGENIC ENVIRONMENTS

4.1. Environmental factors affecting the formation of the anthropogenic environment and their impact on fungi

Due to the large diversity of fungi in the formation of mycobiotics in areas with the same soil type and subject to various anthropogenic influences, it was considered appropriate to clarify how this affects the ecophysiological characteristics of fungi at the next stage of research. In this regard, some studies were conducted in natural conditions (humidity and molecular oxygen), and the rest in the laboratory.

Moisture. When describing the registered fungi in terms of soil moisture in nature, it was found that most of the registered fungi belong to xerohydrophils and do not change depending on anthropogenic influences (table 4.1). However, depending on the anthropogenic impact, there are also differences in the ratio of fungi to moisture, since the specific weight of individual groups of mycocomplex, characteristic of relatively clean soils, varies depending on hydrophils and mesohydrophils.

When grouping the fungi registered in the selected areas according to the sources of contamination, it was found that the hydrophilic group was even higher in most of the irrigated and used landfills than in the control soils. The smallest amount was in samples contaminated with petroleum products. Fungi belonging to the xerohydrophilic group are most often found in areas used for waste disposal, and less often in areas contaminated with industrial products, and in all cases this indicator was lower than the control one. As mentioned above, most of the registered fungi belonged to xerohydrophiles. As for mesohydrophils, we can say that the number of mesohydrophils registered in samples taken from areas polluted by vehicles and plants planted there, as well as areas used for garbage collection, was lower than the control one, but other sources of pollution were higher than the control one.

Table 4.1

Grouping of fungi that are affected by various anthropogenic influences, in their relation to moisture

№	Sources of pollution	Groups related to the attitude to moisture (%)		
		Hydrophils	Xerohydrophytes	Mesohydrophiles
1	LCIP	8,7	52,9	38,4
2	IL	15,5	53,4	34,1
3	LCOP	6,7	54,3	39,0
4	ACMT	7,9	54 ,3	28,3
5	UL	8,7	54.7	36,5
6	LWD	12,2	55.1	32,7
7	RCL	10,4	56,5	33,1

From the information given in table 4.1, it is worth noting that the specific weight of hydrophiles in all cases is lower than in other groups. The reason for this fact is that the fungi belong to aerophiles. Because in places with high humidity, air circulation is difficult, which is unfavorable for aerobes.

Temperature. Studies have shown that among the registered fungi there are no species with psychrophilic and true thermophilic characteristics (table 4.2). As you can see, regardless of the source of contamination, mesophiles make up about 90% of the fungi recorded in the temperature study. This suggests that the temperature factor plays an important role in the life of fungi, and the climatic conditions of our Republic are very favorable for the spread of mesophiles.

PH of the medium. In this regard, it is clear from the research that there are no sharp differences in the nature of anthropogenic impact (table 4.3). Because of the initial acidity of the medium, a pH of 4.9-5.9 is considered optimal for all fungi recorded in all habitats, which is a range known to all fungi known to science in general.

Table 4.2

Temperature characteristics of registered fungi

№	Sources of pollution	Groups related to the attitude to temperature (%)			
		Psychro philes	Mesophi les	Thermophiles, including	
				Thermotole-rants	True thermophiles
1	LCIP	0	89,7	10,3	0
2	IL	0	89,4	10,6	0
3	LCOP	0	88,5	11,5	0
4	ACMT	0	88,2	11,8	0
5	UL	0	86,5	13,5	0
6	LWD	0	88,1	11,9	0
7	RCL	0	90,2	9,8	0

Table 4.3

Generalized characteristics of registered fungi in relation to the initial pH of the medium

№	Sources of pollution	The relation to the primary acidity		
		Minimal	Optimal	Maximum
1	LCIP (39 növ)	2,9-3,1	5,2-5,9	7,8-8,3
2	IL(47 növ)	3,0-3,2	5,0-5,9	8,3 -8,9
3	LCOP(26 növ)	2,9-3,0	5,0-5,8	8,3-8,7
4	ACMT(34 növ)	2,8-3,1	4,9-5,6	8,1 -8,3
5	UL(37 növ)	3,0-3,2	5,3-5,8	7,9-8,4
6	LWD(42 növ)	2,8-3,0	5,4-5,8	7,9-8,6
7	RCL(51 növ)	2,9-3,1	5,0-5,8	7,9 -8,5

In addition, the study examined the effect of the initial pH of the environment on the growth of all strains of the fungus on all soils subject to anthropogenic pollution, as well as on relatively clean soils. For this purpose, the laboratory used fungi such as *Aspergillus niger*, *A. versicolor*, *Paecilomyces variotii* and *Pencillium* *chrysogenum*. From the results, it became clear that there is no significant difference in the growth of fungal strains from different regions, which usually depends on the nature of anthropogenic impact, since the optimal temperature for the growth of different strains of the same species is the same. However, depending on the nature of anthropogenic impacts, there are some differences, which are mainly related to strains of the genus *Aspergillus*. Thus, the minimum pH value for the survival of strains of this genus is from 3.0 to 3.3. Comparing this result with the specific pH of soils, it becomes clear that the beginning of growth of strains isolated from soils contaminated with oil and petroleum products has a relatively high acidity (pH = 3.3) and lower in strains isolated from urban soils (pH = 3)., 0) begins with a pointer. In other words, there is a small correlation between the pH of the medium in which the fungi are isolated and, in a sense, the determination of the initial acidity that begins to grow in fungi of the genus *Aspergillus*.

An alkaline environment is not considered as suitable for fungi, and hence, as can be seen, the growth of fungi in an alkaline medium, or rather their vitality that is only possible if pH is 8.9. Fungi that remain viable in the environment can also be called resistant to alcohol, and fungi which retain their ability to grow in an environment with more accurate pH≥8, such as *Aspergillus fumigatus*, *A. ochraceus*, *Mucor hiemalis* and *Ulocladium botrytis.*

Relation to molecular oxygen. To determine the effect of pollution on the oxygen factor and the distribution of fungi depending on it in the selected areas, samples were taken from different depths of relatively clean and two different sources of pollution, and the distribution of fungi was characterized by quantity (table 4.4). As can be seen, the number of fungi was higher on the upper surface of all three soils than in the deeper layers, and was most pronounced on these relatively clean soils. Comparing these numbers between two polluted soils, it was found that the number of fungi decreases faster on irrigated soils. Even in samples taken from a depth of 40-70 cm, the number of fungi in irrigated soils was 11 MNU / g, in areas polluted by traffic, it was 34 MNUU / g, and in relatively clean soils, it was 36 MNU / g.in deeper layers, fungi are almost absent from polluted soils.

Only relatively small (0-3) fungal colonies are found in relatively clean soils. When determining the species composition of fungi at such depths, it was found that they consist of fungi such as *Actinomucor elegans, Mucor mucedo* and *Trichoderma hamatum.* These fungi can also be described as facultative anaerobes.

Table 4.4

Changes in the numerical composition of fungi on different wet soils depending on the depth

Depth, cm	Relatively clean soils	Irrigated lands	Areas contaminated by the impact of motor transport and plants grown there
0-20	$5,4x10^3$	$4,6x10^3$	$3,0x10^3$
20-40	$2,1x10^2$	$1,7x10^2$	$1,6x10^2$
40-70	36	11	34
80-100	0-3	0	0

4.2. General assessment of fungi in response to anthropogenic impact

As a result of research, the reaction of various fungi involved in the formation of mycobiotics of soils subject to various anthropogenic influences on their impact was determined. The response of fungi to pollutants was evaluated according to a distribution based on the following 4 groups:

1. Inhibitors (this refers to more susceptible fungal species that either dominate or are more common in clean soils, i.e. in background soils);
2. Neutral (resistant fungal species that include both dominant and common species of both polluted and clean soils);
3. Activators (Including fungi whose growth is accelerated by the presence of xenobiotics or polutants in the soil);
4. Activated by induction (Induced species that include fungi that are not known to spread in clean soils, but are prevalent in polluted soils or are common).

When describing the fungi registered in these studies, it was found that in oil-contaminated soils those belonging to group I *Actinomucor elegans, Alternaria chlamydospora, Chaetomium cellulolyticum, Chrysosporinum merdanum, Gliocladium roseum, Trichoderma asperellum, T. harzianum* and in relatively clean soils to group IV fungi (*Aspergillus flavus, Botrytis cinerea, Chaetomium globosum, Cladosporium herbarum, Fusarium moniliforme, F. Solani, Humicola gricea, Mucor hiemalis, Penicillium brevicompactum, P.cyclopium, P.oxalicum, Stachybotrys chartarum, Torula herbarum, Verticillium alboatrum*) were not found (table 4.5). In General, in the number of fungi from the soils affected by anthropegenic impacts compared those from relatively clean soils some increase was observed from group II (*Aspergillus candidus, A. niger, A. ochraceus, A. versicolor, Aureobasidium pullulans, Circinella circinans, Cladosporium cladosopides, M. mucedo, P. chrysogenum, Rhisobus Stachybotrys chartarum, Trichothecium roseum* etc. total of 25 species) in the direction of group III (*Absida caerulea, Acremonium atrogriseum, Alternaria alternata, Botryotrichum piluliferum, Candida alpicans, Coniothyrium olivaceum, Epicoccum nigrum, Geotrichrichum glum, Candium, Candida) brevicaulis, Sporothrix fungorum, Talaromyces rugulosus, Trichocladium polysporum, Trichophyton Terrestre, Ulocladium chartarum*, etc. 37 species in total).

Table 4.5

Characteristics of mycobiota of the studied biotopes in response to pollution

Biotopes	The number of species belonging to groups			
	I	II	III	IV
LCIP	4	13	17	5
IL	4	18	21	4
LCOP	0	5	14	7
ACMT	1	11	16	6
UL	2	15	15	5
LWD	3	17	18	4
RCL	8	24	19	0

As a result of these studies, it can be concluded that the components of these identified reactions consist of individual micromycetes, the identification of which can be useful in assessing soils that have been subjected to anthropogenic influence.

FINAL ANALYSIS OF RESULTS

Due to the varying degrees of sensitivity of living creatures, their use for evaluating processes occurring in the soil is already a common approach in experimental biology and its various fields. However, the results obtained due to the fact that the natural soil and climate conditions of the area have specific shades are not universal, which was confirmed in studies conducted in different areas.

In the economy of the Republic of Azerbaijan, which has a rich and diverse nature, both industrial and agrarian sectors have a significant place, which has led to the presence of sufficient area with anthropogenic impact on its territory. Studies on the evaluation of these areas from a mycological point of view are of both small and episodic nature. Taking this into account, it was considered expedient to carry out research in this direction in the presented work, and the research in the Absheron peninsula was expedient for the following reasons:

The Absheron Peninsula, one of the most arid regions in the Caucasus, is usually a "critical zone with serious geo-ecological complex problems".

Land pollution is one of the main problems of the Absheron Peninsula, and solving these problems is one of the tasks that is still relevant today. Thus, the total area of unused land on the Absheron Peninsula with a total area of 222,000 hectares is 33.3 thousand hectares, including the area of oil-contaminated land reaches 10,000 hectares.

The city of Baku, which is characterized as a metropolis of Azerbaijan, and Sumgayit, one of the largest cities of the country, is located in Absheron where urbanization is going fast. As a result of these increasingly focused on the urban goals of the territory, the

Absheron peninsula has become an “anthropogenic” territory. If the processes go at such a pace, in the near decades, Absheron may have to face more acute ecological problems.

In the course of the Study, some physical and chemical parameters of the same type of soil on the Absheron Peninsula, which were affected by various anthropogenic impacts, were first studied, and it was found that the characteristics of the selected 6 land plots differ from those defined for relatively clean soils. More precisely, different anthropogenic influences create such different changes in the same type of soil, which is manifested in changes in the physical and chemical parameters of the soil.

Subsequent studies have shown that the observed differences are manifested in both the species and the number of mycobiota, as well as in the ecological and trophic structure of mycobacter. Thus, in approximately 800 samples taken from 7 areas of the same soil type that are subject to various anthropogenic influences, a total of 81 species of fungi were cultured and identified, each of which belongs to the true fungus (Mycota). In all cases, the number of recorded fungal species reduces the micro-diversity characteristic of relative soils, which is evident in the highest levels of oil-contaminated soils. However, in all cases, due to anthropogenic influences, the species composition of mycobiota weakens, but in addition to the usual species, specific species also participate in the formation of mycobiota in each area. The number of species that match this characteristic, i.e. the number of species found only in a certain area during research, varies from 3 to 7 species. This, in turn, allows us to note that each area studied by anthropogenic impacts is characterized by a microcomplex with a certain degree of specificity. It is interesting to note that the research confirmed differences between registereded fungi in frequency of occurrence, ecological-trophic relationships, as well as manifestations of ecological-trophic specialization. Although these changes are often negative, they are important information for elucidating the role of fungi in certain cenoses.

Mycobiota of areas affected by various anthropogenic impacts is characterized by differences in species composition, ecological and trophic relations and forms of its manifestations used in the modern era. How this affects the ecophysiological characteristics of fungi registereded in research is of interest both from a scientific and practical point of view and is currently insufficiently studied in many places, including in Azerbaijan. Therefore, these questions were clarified in the study. First, the registereded fungi were characterized by their prevalence in nature, or rather by the moisture content of the selected soils, and it was found that most of the fungi belonged to xerohydrophiles. Although this does not lead to significant changes due to anthropogenic influences, the specific weight of different groups of mycocomplex due to moisture characteristic of relatively clean soils, to some extent changes due to hydrophils and mesohydrophils. A similar situation is observed with the temperature and initial pH, which are favorable for the growth of pure fungal cultures, i.e. there are no sharp differences in the nature of anthropogenic impacts or pronounced dependence. Thus, most of the registereded fungi are mesophilic in relation to temperature, and a small number are thermotolerant, and among the registereded fungi, psychrophiles and true thermophiles are not found. Although the pH of the medium is considered optimal for all registered fungi, among the registereded fungi are alkotolerants such as *Aspergillus fumigatus, A. ochraceus, M. hiemalis* and *Ulocladium chartarum* and this occurs when the initial acidity of the medium for their growth is up to 10.

When determining the reaction of fungi involved in the formation of mycobiotics in soils affected by various anthropogenic impacts, it was found that there are no group I (inhibiting) fungi in oil-contaminated soils and no group IV (induced activated) fungi in relatively clean soils. On the other hand, compared to relatively clean soils, only 25 group II species (neutral reactors) and 37 group III species (activators) are present in the number of soils with anthropogenic impact.

The latter, as well as the above, are important information for the assessment of anthropogenic-affected lands and the direction of processes occurring there, which should be expressed as a result of the following 6 points.

RESULTS

1. 81 species of fungi take part in the formation of the mycobiota of the Absheron land plots, which differ in physical and chemical parameters and the nature of anthropogenic impact. In all cases, the number of recorded fungal species leads to a decrease in the typical composition of mycoplankton characteristic of relative soils, which is most evident in oil-contaminated soils [5, 9, 12, 14].

2. Although the species composition of mycobiota is weakened in all cases due to anthropogenic impacts, in addition to general species, specific species are involved in the formation of mycobiota in each area, the number of which varies from 4 to 7 species for each biotope, i.e. each area studied characterized by a mycocomplex bearing specific features [5, 9, 14].

3. It is defined that, depending on the anthropogenic impacts is changing ecological-trophic structure of the mycocomplex, inherent in each biotope, which is manifested in a decrease in the specific weight of saprotroph in the mycocomplex of relatively clean soils and in an increase in polytrophy. A similar situation is repeated with respect to toxigens, which are forms of manifestation of ecological and trophic specialization [1, 3, 5, 7-8, 13].

4. Characteristising the fungi registered in the studies by the moisture content of the soils on which they are common in nature, it became clear that the majority of the registered fungi belong to xerohydrophiles, and although this circumstance does not cause significant changes depending on the anthropogenic impact, the specific weight of individual groups of mycocomplexes in terms of humidity, inherent in relatively clean soils, depending on the anthropogenic impact, changes due to hydrophiles and mesohydrophiles. [9].

5. When characterizing pure fungal cultures registered in the studied biotopes, there are no sharp differences in temperature and initial pH, which are favorable for their growth, resulting from the nature of anthropogenic influences. Thus, most of the registered fungi are mesophilic in relation to temperature, a small part are

thermotolerant, and psychrophiles and true thermophiles are not found among the registered fungi. Although the pH of the medium in the range of 4.9-5.9 is considered optimal for all registered fungi, among the registered fungi are also included alkotolerants such as *Aspergillus fumigatus, A. ochraceus, M. hiemalis* and *Ulocladium chartarum* [9].

6. In the course of determining the response to the effects of fungi involved in the formation of the mycobiota of soils exposed to various anthropogenic influences, it became clear that no induction-activated species are found on relatively clean soils, and no sensitive species (inhibitory group) are found on oil-polluted soils. [4, 11].

THE LIST

of published works on the topic of the dissertation

1. Muradov P. Z., Ibragimov E. A., Mamedova F. R., Akhmedova F.R., Yusifova A. A., Safaralieva E. M. Mycological assessment of technogenically polluted gray-brown soils of Absheron. /"Actual problems of virology, microbiology, hygiene, epidemiology and immunobiology”. Almaty, 2012, pp. 135-136.
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Address: AZ1004, Baku city, M.Mushfig street 103

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