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ABSTRACT

of the dissertation presented for the degree of Doctor of Philosophy

MYCOBIOTA OF TROPICAL PLANTS CULTIVATED IN COVERED CONDITIONS AND THE ECOBIOLOGY OF THEIR PATHOGENIC SPECIESs

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INTRODUCTION

Relevance of the topic and degree of development. Mushrooms are an integral component of natural ecosystems and agrophytocenoses. Mushrooms are also widely spread in Azerbaijan, which seriously affects the rich flora and fauna formed in different ecological conditions in the not so large territory of our country**.** The introduction of plants is one of the most important factors affecting the biodiversity, including mycodiversity, of a certain region. Thus increasing the number of introduced plant species and varieties can lead to an increase in the number of both mushroom and host plant species. On the other hand, abiotic and biotic factors that can cause stress for introduced plants affect the population of saprotrophic micromycetes and phytopathogens at the initial stage of introduction. By and large "*the formation of the general mycobiota of the indroducent first takes place due to the mushrooms that spread in local conditions. The activity of mushroom species that come with introduced plants and are new to local conditions occurs later, and their activity, revealing their phytopathological qualities, in many cases leads to the emergence of undesirable situations.*"[1,2,3] For this reason, the species composition of the mycobiota of the plants introduced in specific conditions, the species composition of their host plants and the study of the phytopathogenic properties of the recorded mushrooms are among selected issues.

Until today, "*although a large number of scientific data have been collected about plants introduced from foreign countries used in*

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[1] Belanova A.P., Banaev E.V., Tomoshevich M.A., Chindyaeva L.N. Condition of woody plants in different ecological zones of a Siberian city // Proceedings of the Samara Scientific Center of the Russian Academy of Sciences. – 2016. - T. 18, №2(2), - p. 292-296.

[2] Koropachinsky I.Yu., Vstovskaya T.N., Tomoshevich M.A. Modern problems of the introduction of woody plants in Siberia. - Novosibirsk: Academic publishing house "Geo", 2013. - 91 p.

[3] Lankau E.W., Lankau R.A. Plant species capacity to drive soil fungal communities contributes to differential impacts of plant-soil legacies. Ecology. 2014; 95: 3221-3228.

the enrichment of cultivated flora, research materials related to conducting systematic research on tropical plants"[4,5] cultivated in covered conditions and their mycobiota are extremely few, more precisely, it can be said there is no.

As mentioned, introduced plants can also be a new food source where native pathogens can successfully populate and significantly influence the introduction process. In addition, "*plants transferred to new environmental conditions*"[6,7] are a potential source in terms of introduction of new phytopathogenic species. Pathogens accidentally introduced to the region or following the host plant can pose a serious threat to both the introducers themselves and closely related native plants, it has been confirmed in numerous studies.

Botanical gardens can be important not only as a *"plant introduction and acclimatization center*"[8] but also as a scientific experiment base for studying the adaptation mechanism of phytopathogenic organisms. The study of this problem makes it very relevant to study the aboriginal and introduced plant species for the greening of cities and towns, and at the same time, the additional impact of the urboecosystem on the plant-pathogen system, especially during the cultivation of tropical plants under cover. The study of this problem makes very topical to study the aboriginal and introduced plant species for the greening of cities and towns, and at the same time, the additional impact of the urboecosystem on the plant-

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[4] Bayramov, A.A. Botanical and geographical analysis of plants introduced from the Central Asian flora in the conditions of dry subtropics // Scientific works of the Institute of Botany of ANAS, // ,2010. t. XXX, p.232-234.

[5] Bayramov, A.A. Botanical and geographical analysis of plants from the North American flora in the dry subtropics of Azerbaijan // Works of the Central Botanical Garden, 2011. T. IX, p. 16-21.

[6] Desprez-Loustau M.L., Robin C., Buee M. et al. The fungal dimension of biological invasions. //Trends in Ecology & Evolution., 2007, v.22(9), p.472-480

[7] Tomoshevich M.A. Micromycetes - causative agents of diseases of woody plants. // In the book. Dynamics of ecosystems of the Novosibirsk Akademgorodok / ed. ed. I.F. Zhimulev. - Novosibirsk: Publishing House of the Siberian Branch of the Russian Academy of Sciences, 2013., p.184-199.

[8] Chen G., Sun W. The role of botanical gardens in scientific research, conservation, and citizen science. // Plant Divers., 2018, v. 25;40(4), p.181-188.

pathogen system, especially during the cultivation of tropical plants grown indoors.

In general, the works dedicated to the pathogenic mycobiota of trees and shrubs used in the greening of cities and towns located in Azerbaijan and also in the Absheron peninsula with a dry subtropical climate, mainly refer to "*the description of the taxonomic composition of micromycetes and their eco-trophic relations*"[9,10] At this time, in most cases, researchers were satisfied with only fragmentary observations on pathogens. However, the composition of pathogens of plants of different geographical zones has its own characteristics which depends on the gene pool of different introducers, composition of aboriginal flora, soil and climate conditions and etc. In this regard, it is necessary to assess the potential damage caused by the disease, to develop measures to combat pathogens, and to carry out an inventory of parasitic fungi, analysis of developmental biology, and complex studies of the ways of pathocomplex formation in specific ecological and geographical conditions. These works can serve as a basis for solving practical issues in the field of introduction, greening and plant protection.

Objectives and tasks of the research. The purpose of the work is to study the mycobiota of tropical plants grown indoor in Absheron according to their species composition, host-plant distribution, prevalence of diseases caused by pathogens and ecobiology.

In order to achieve the set goal, it is planned to solve the following tasks:

1. Study of the mycobiota of tropical plants grown indoors in Absheron according to species composition and taxonomic structure;

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[9] Muradov P., Abdullayeva Sh., Akhmedov Yu, Makhmudova S., Jabrayilzade S. Species composition of plants used in landscaping cities of Azerbaijan and their mycobiota. / XV International Conference "Biological Diversity of the Caucasus and South of Russia". Makhachkala, 2013, p.67-69

[10] Muradov P.Z., Gasimova G.Ch., Namazov N.R. et al. Comparatıve Study Of Mycobıota Of Some Relıct Plants Included To The Flora Of Azerbaıjan. // J Complement Med Res (USA)., 2020, 11(2): 227-231

2. Determination of distribution and seasonal development dynamics of recorded mushroom on tropical plant species;
3. Evaluation of host-plant relationship with phytopathogens, organotropic specialization of micromycetes and resistance of tropical plants to pathogens;
4. Preparation of measures to combat diseases caused by pathogenic micromycetes in tropical plants.

Research methods. The methodology for a comprehensive study of the ecobiology of tropical plant mycobiota and pathogenic species is based on the principle of their comprehensive study. Microscopic analysis of the fungi was performed using MBS-9 and OMAX 40X-2500X LED Digital Lab Trinocular Compound Microscope microscopes. During the research, the identification of fungi was studied by general mycological methods adopted in this field, as well as wet chamber, assessment of the degree of infection of plants and methods of mathematical statistical processing of data were applied.

The main provisions of the defense:

1. The species composition of tropical plants, as well as the adaptability of invasive pathogens and the acquisition of new areas by aboriginal fungi are crucial in the formation of pathogen complexes.
2. Abiotic factors of the place where the introducers are kept cause certain changes in the morphology, development cycles and pathogenesis of the mushroom involved in the formation of their mycobiota.
3. In Absheron micromycetes, which cause staining and ash (flour dew) disease in plants, are more prevalent in the formation of a similar structure in the pathogen complexes of tropical plants used in indoor conditions (greenhouses) and production, greening the interiors of public buildings.
4. Introductors-plants are more resistant to pathogenic micromycetes than aboriginal species

Scientific novelty of the research.The mycobiota of tropical plants grown indoors in Absheron was comprehensively studied according to their species composition, taxonomic structure, host-plant

distribution, seasonal development dynamics, prevalence and ecobiology of diseases caused by pathogens observed in tropical plants.

It was determined that 126 species participate in the formation of the mycobiota of 166 species of tropical introducers belonging to 91 genera, and 10.3% of it belongs to mushroom-like organisms *(Chromista)*, and 89.7% to true mushroom *(Mycota or Fungi)*.

It was determined that the distribution of mushroom such as *Alternaria cinerariae Hori & Enjoji, Cladosporium colocasiae Sawada, Stemphylium solani G.F.Weber, Septoria anthurii Kotthoff and S.elasticae Koord* was recorded for the first time in Azerbaijan.

It has become clear that the distribution of mushrooms both among plants and among individual taxa is different. Thus, 9 plant families with 10 or more pathogenic micromycetes found on one plant family *(Arecaceae* - 10 species, *Orchidaceae* - 50 species, *Araceae* - 22 species, *Asteraceae* - 12 species, *Cactaceae* - 13 species, E*uphorbiaceae* - 10 species, *Rutaceae* - 11 species, *Polypodiaceae* - 10 species, *Musaceae*- 10 species) and 4 fungal families (*Mycosphaerellaceae* - 14 species; *Nectriaceae* - 13 species; *Botryosphaeriaceae* - 12 species; *Glomerellaceae* - 10 species) were identified. The number of species varies from 1 to 9 for the rest of the mushroom and plant families.

Based on the study of multi-year dynamics of pathogens of various types of diseases found in covered conditions in Absheron, it was determined that covered conditions significantly affect the morphology, development cycles and pathogenesis of mushrooms in a number of cases.

The tolerance of 50 species of tropical plants to spotting disease was evaluated under indoor conditions, and 8 species of them had more than 50% damage to the leaf surface (*Euphorbia splendens, E. pulcherrima, Alocasia odora, Cineraria hybrida, Fittonia verschaffeltii, Fuchsia hybrida, Begonia semperflorens, Zantedeschia aethiopica*), 9 resistant species (1-10%), 18 mildly damaged species (11-25%) and 15 moderately damaged species (26-50%) were identified.

Theoretical and practical significance of the research. The information obtained on the developmental biology of pathogenic

micromycetes of tropical plants grown indoors (greenhouses) in Absheron can be a theoretical and practical basis fo r the development of measures to increase the endurance of tropical plants used in landscaping of residential, industrial and public buildings. Original information on the morphology, distribution, pathogenesis, biology of pathogenic micromycetes can be the basis for the preparation of an atlas of pathogenic micromycetes of tropical plants grown indoors. Based on the evidence obtained during the study, it is possible to identify tropical plant species that are resistant to pathogenic fungi. Identification of sources, ways and factors contributing to the formation of mycobiota of tropical plants grown indoors in Absheron allows to solve some important issues in the field of landscaping and plant protection.

The obtained materials can be used in the biology faculties of universities in the courses of tropical plants, indoor plant growing, phytopathology and mycology.

Publication, dissertation approval and application. 11 scientific works related to the dissertation topic have been published. The main results of the work were reported at the All-Russian Conference (Moscow, 2014), at the III International Mycological Forum "Современная микология в России" (Moscow, 2015) and at the XV Congress of the Ukrainian Society of Microbiologists (Odessa, 2017), at the scientific-practical conference on "Actual Problems of Modern Biology" (Baku , 2019).

Name of the organization where the dissertation work was performed. Dissertation work was performed at the Institute of Microbiology of Azerbaijan Republic Science and Education Ministry.The collection of tropical plants of the laboratory "Cultivated plants under covered conditions" of the Central Botanical Garden of the former ANAS was used for sampling.

The structure and content of the dissertation. The dissertation consists of an introduction, literature review (Chapter I), description of research materials and methods (Chapter II), presentation of obtained results and their interpretation (Chapters III-IV), results, list of used literature. In total, the dissertation consists of (315500 marks).

CHAPTER I
THE MYCOBIOTA OF ORNAMENTAL PLANTS AND ANALYSIS OF THE STUDY OF THEIR PATHOGENIC SPECIES

In this chapter of the dissertation, the scientific works dedicated to the history of the study of the mycobiota of plants, especially the taxonomy, systematics, development, ecobiology of pathogenic micromycetes of decorative plants and the formation of the world of mushrooms in general, were analyzed in chronological order and the level of study of the problem to be solved was evaluated.

CHAPTER II
CONDITION, OBJECT AND METHODOLOGY OF THE RESEARCH.

Samples for the study were taken from **166** species of tropical plants cultivated in the orangeries and greenhouses of the Central Botanical Garden of ANAS located on the Absheron Peninsula since 2014, as well as recently spontaneously brought to the country from foreign countries for business purposes. In general, about 1,000 samples were taken during the research, and **"**well-known methods and approaches"[11,12] accepted in mycology and phytopathology were used. The taken samples were analyzed by widely used methods in this field in accordance with the set goal.

The scientific names of tropical plants infected with micromycetes are given according to "*Cherevchenko T.M. and."*[13], *"Golovkin B.N., Chekanova V.N., Shakhova G.I. an d others* "[14] .

Observations on plants in the collection were made every ten

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[11] Головин, П.Н.; Арсеньева, М.В.; Тропова, А.Т. Практикум по общей фитопатологии. - СПб: Лань, 2002, 288с.

[12] Дудка И.А., Вассер С.П., Элланская И.А. и др. Методы экспериментальной микологии. Справочник. К. Наукова думка, 1982, 550 с..

[13]Тропические и субтропические растения закрытого грунта: Справочник / Т.М. Черевченко [и др.]. - Киев: Наукова думка, - 1988. - 412 с.

[14]Комнатные растения: Справочник / Б.Н. Головкин, В.Н. Чеканова, Г.И. Шахова [и др.] - Москва: Лесная промышленность, - 1989. - 431 с.

days during the growing season, from March- April to November-December. Live infected plants were collected, as well as herbarium materials were analyzed (described, characteristic symptoms of the disease were noted). The duration of the symptoms of the disease and the dynamics of its development are noted.

Analysis of micromycetes was carried out by standard methods. Plants with signs of disease infection were placed in a wet chamber for 3-6 days and of the growing mushrooms was observed through a microscope. Analysis of mycobiota of germinated seeds was carried out after stratification after long-term storage at -15^0C temperature in the refrigerator. Microscopic analysis of the objects was carried out using MBS-9, "OMAX 40X-2500X LED Digital Lab Trinocular Compound Microscope" microscopes. The identification of micromycetes was carried out according to the "known determinants"[15,16,17,18,19] compiled by different authors according to the cultural-morphological and physiological characteristics of mushrooms . Detection and recording of diseases of flowering and decorative plants were also carried out using "known determinants"[20,21,22].

Systematics of micromycetes and clarification of their names

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[15] Азбукина З.М. Порядок Ржавчинные. 1. Семейства Пукциниастровые, Кронарциевые, Мелампсоровые, Факоспоровые, Чакониевые, Микронегериевые. Владивосток: Дальнаука, 2015. 281 с.

[16] Саттон Д. И др. Определитель патогенных и условно-патогенных грибов -М.: Мир, 2001, 486с.

[17]Kirk P. M. et al. Dictionary of the fungi. - UK, -2008, -747 p.

[18] Ellis, M.B., Ellis J.P. Microfungi on Land Plants. An Identification Handbook The Richmond Publishing Co. Ltd., Slough. - 1997. - 176 p.

[19] Seifert, K.A. The genera of Hyphomycetes./K.A.Seiferi. -Utrecht:CBS-KNAW Fungal Biodiversity Centre, 2011. -997 p.

[20] Прутенская, М.Д. Атлас болезней цветочно-декоративных растений / М.Д. Прутенская - К.: Наук. думка, - 1982. - 84 с.

[21] Митрофанова, О.В. Методические указания по диагностике болезней цветочных культур и мерам борьбы с ними / О.В. Митрофанова, А.С. Кольцова - Ялта, - 1977. - 23 с.

[22] Кулибаба, Ю.Ф. Методические указания по выявлению и учету болезней цветочных культур / Ю.Ф. Кулибаба, М.А. Примаковская - М.: Колос, - 1974. - С. 19-26.

are provided on the *"official website"*[23] of the International Mycological Association and on the basis of the information provided by "*Index fungorum*"[24].

The degree of infection is assessed on a 5-point scale: 0 points – no symptoms of infection; 1 point – very small spots or rare pustules infect up to 10% of the leaf surface; 2 points – the surface of the leaf is infected from 11 to 25%; 3 points – from 26 to 50% are infected; 4 points – more than 50% of the plant surface is infected.

The intensity of disease development (%) was used as a criterion for assessing disease persistence and was determined by the following formula: R=S(axb)xi00/N*K.

Here, S(axb) is the sum of the number of plants multiplied by the infection score corresponding to them; N - the total amount of registered plants; K - the number of points on the accounting scale.

During the acquisition of quantitative data, the experiments were carried out at least 4 times, and the obtained data were "statistically" processed.

CHAPTER III
TAXONOMIC STRUCTURE OF MYCOBIOTA OF DECORATIVE TROPICAL PLANTS CULTIVATED IN COVERED CONDITIONS

3.1. General characteristics of mushrooms involved in the formation of the mycobiota of studied tropical plants

As a result of the analysis of the samples taken from the collection of tropical plants grown indoors in Absheron, it was determined that 126 species belonging to 63 genera are involved in the formation of their mycobiota (Table 1). Apparently, the vast majority of recorded mushrooms (113 species) belong to true mushrooms *(Mycota),* and some (13 species) belong to mushrooms like organisms *(Chromista)*.

[23] http://www.mycobank.org/MycoTaxo.aspx
[24] https://www.indexfungorum.org

Although most of the registered mushrooms were recorded in other studies conducted in Azerbaijan, as well as in Absheron, this opinion cannot be said about species such as *Alternaria cinerariae* Hori & Enjoji, *Cladosporium colocasiae* Sawada, *Stemphylium solani* G.F. Weber, *Septoria anthurii* Kotthoff *and S.elasticae* Koord. So, there is no literature information about the distribution of these species not only in Absheron, but even in Azerbaijan.

Table 1.

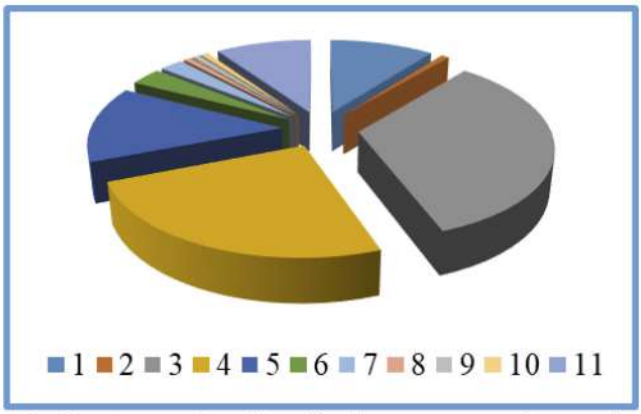
Quantitative characterization of the taxonomic structure of fungi found in tropical plants

№	Class	Row	Season	Gender	Species
1.	*Chromista*	1	2	2	5(13)
2.	*Mycota or Fungi*	10	22	37	58(113)
Total:		11	24	39	63(126)

It became clear from the observations made in the studies about the influence of the factors of the conditions in which the plants were kept on the settlement of the mushrooms on the plants, their observed signs and the formation of their cultural-morphological characteristics, that in a number of cases there were certain changes in the morphology, development cycle, and pathogenic activity of this or that type of mushrooms.

3.2. General characteristics of the taxon distribution of the mycobiota of tropical plants

As a result of our research on the distribution of mushroom discovered during observations on tropical plants included in the collection, it became clear that in the collection of tropical plants, the *Oomycetes* class of mushroom-like organisms *(Chromista)* was represented by 13 species belonging to 2 orders *(Peronosporales, Pythiales).* Assigned species of the class *Oomycetes* constitute 10.3% of the total mushroom recorded in the studies (Fig. 1).



Picture 1. Reciprocal ratio of micromycete classes found in tropical plants

1 - Oomycetes - 10.3%; 2 - Mucormycotina - 0.8%;
3 - Dothideomycetes - 33.3%; 4 - Sordariomycetes - 24.6%;
5 - Leotiomycetes - 13.5%; 6 - Agaricomycetes - 3.2%;
7 - Eurotiomycetes - 2.4%; 8 - Exobasidiomycetes - 0.8%;
9 - Chytridiomycetes - 0.8%; 10 - Ascomycote - 0.8%;
11 - Pucciniomycetes - 9.5%

The *Mucormycetes* class of the *Mucormycotina* subdivision of the *Mucormycota* division of the *Mucormyceta* subworld of the *Fungi* world was represented by 1 species belonging to one order *(Mucorales)* and 1 genus *(Mucor).* Representatives of this class make up 0.8% of the total number of mushroom species found in the collection.

The *Dothideomycetes* class of *the Pesisomycotina* subdivision of the *Ascomycota* division of the *Dikaria* suborder of the *Fungi* kingdom represented with 42 species belonging to three orders *(Pleosporales, Capnodiales, Botryosphaeriales).*

Representatives of this class make up 33.3% of the detected pathogenic mycobiota, and it can be said that most of them are powdery mildew mushroom.

Sordariomycetes class was represented by 31 species belonging to 7 orders (Sordariomycetidae, Hypocreales, Meliolales, Magnaporthales, Microascales, Xylariales, Diaporthales). Representatives of this class make up 24.6% of the detected pathogenic

mycobiota.

The Leotiomycetes class consists of 17 species represented by 4 orders (Helotiales, Phacidiales, Erysiphales, Incertae sedis). Almost 13.5% of the detected pathogenic mycobiota belongs to the micromycetes that make up the Leotiomycetes class.

In the collection of tropical plants, there are representatives of 2 genera belonging to 2 orders of the Agaricomycetes class (Cantharellales, Agaricales). In total, 4 types of mushrooms included in this class were found. These detected fungi constitute about 3.2% of the total pathogenic mycobiota.

3 species of the Penicillium genus of the Eurotiales order of the Eurotiomycetes class were found in the collection. Representatives of this class make up 2.4% of the detected total pathogenic mycobiota .

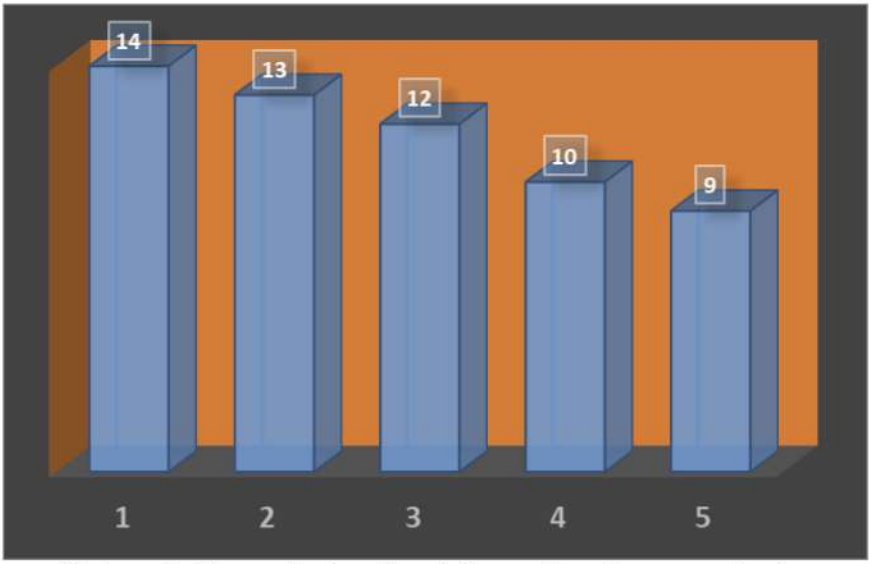
The genus Fumago which belongs to the Incertae sedis order of the Ascomycota division, was represented by one species. It constitutes 0.79% of the total pathogenic mycobiota.

A species of the genus Olpidium of the order Spizellomycetales of the class Chytridiomycetes (Fungi, Chytridiomyceta, Chhydridiomycotina) was found. Representatives of both classes make up 0.8% of the total pathogenic mycobiota.

In the collection, the Pucciniomycetes (Fungi, Dikaria, Basidiomycota, Pucciniomycotina) class was represented by the following genera belonging to the Pucciniales order: Coleosporium - 1 species, Pucciniastrum - 1 species, Melampsora - 2 species, Cronartium - 1 species, Hemileia - 2 species, Puccinia - 1 species. , Uredo – 4 types. These genera make up 9.5% of the total mycobiota detected.

Among the 39 families determined during the research, Mycosphaerellaceae, Nectriaceae, Botryosphaeriaceae, Glomerellaceae, Dermataceae families are very rich in species composition (up to 10 or more species) and make up 46.0% of the total found mycobiota (fig. 2).

The family Mycosphaerellaceae is the richest in terms of species composition compared to other found families. This family includes 14 species belonging to 6 genera, which makes up almost 11.11% of the total amount of detected micromycetes (table 2).



Picture 2. **Numerical ratio of the main micromycetes by species:**

1 – Mycosphaerellaceae, 2 – Nectriaceae, 3 - Botryosphaeriaceae, 4- Glomerellaceae, 5 - Dermataceae .

Table 2.

Absolute and relative number of micromycete species in the main family

Chapters	Number of species	
	Definitely, ed.	Relative,%
Mycosphaerellaceae	14	11,2
Nectriaceae	13	10,3
Botryosphaeriaceae	12	9,5
Glomerellaceae	10	7,9
Dermataceae	9	7,1
total	58	46,0

The species are distributed as follows among the mushrooms genera found in the collection of tropical plants of CBG: *Gloeosporium* – 9 species, *Colletotrichum* – 8 species, *Fusarium* – 8

species, *Phytophthora* – 6 species, *Septoria* – 5 species, *Phyllosticta* – 5 species, *Cercospora* – 4 species, *Uredo* – 4 species.

It should be noted that the species composition of the pathogenic mycobiota found in the collection of decorative tropical plants cultivated indoors of CBG is not stable. So, as a result of new decorative plants entering the collection from different regions of the world, the species composition of the existing mycobiota is constantly changing.

3.3. Distribution of mushroom on host plants involved in the formation of the mycobiota of tropical plants

From the studies conducted on the distribution of recorded mushrom species on host plants, it became clear that mushrom genera consisting of 10 or more species were recorded in 9 families of tropical plants: *Arecaceae* - 10 species of micromycetes, *Orchidaceae* - 50 species, *Araceae* - 22 species, *Asteraceae* - 12 species, *Cactaceae* – 13 species, *Euphorbiaceae* – 10 species, *Rutaceae* – 11 species, *Polypodiaceae* – 10 species, *Musaceae* – 10 species. In the plants of ten families, 6-7 species of micronisetes were recorded: *Asparagaceae* - 6 species, *Bromeliaceae* - 7 species, *Acanthaceae* - 7 species, *Crassulaceae* - 6 species, *Cyperaceae* - 6 species, *Liliaceae* - 7 species, *Strelitziaceae* - 6 species, *Geraniaceae* - 6. species, *Begoniaceae* – 7 species, *Gesneriaceae* -6 species. 3-5 species of micromycetes were found in decorative plants of five families: *Amaryllidaceae* - 4 species, *Calceolariaceae* - 4 species, *Lauraceae* - 3 species, *Onagraceae* - 5 species, *Moraceae* - 4 species. 1-2 species of micromycetes were found in decorative plants of the remaining 7 families*:* *Commelinaceae* - 2 species, *Piperaceae* - 1 species, *Vitaceae* - 1 species, *Davalliaceae* - 1 species, *Hydrangeaceae* - 1 species, *Malvaceae* - 1 species, *Agavaceae* - 1 species.

3.4. Ecobiological characteristics of pathogenic species involved in the formation of mycobiota of tropical plants

The mass introduction of decorative tropical plants has led to the formation of new populations of phytophages and pathogens, and the expansion of the distribution area of aboriginal and introduced pathogenic species that feed on plants has been created.

Table 3 presents the results of the analysis of the composition of the mycobiota adapted to different organs of the plant. As can be seen from the table, 69 species of micromycetes inhabiting the phylloplane (leaves) of ornamental tropical plants account for approximately 54.76% of the identified mycobiota. Stem diseases are caused by 26 species of micromycetes, accounting for almost 20.63% of the detected mycobiota. 29 species of micromycetes, accounting for about 23.01% of the mycobiota, damage flowers and fruits. In the underground organs, 41 species were recorded, making up about 32,53% of the detected mycobiota.

3.4.1. Agents of leaf spot disease

Most of the 55 species of micromycetes that live in the phylloplane of decorative tropical plants and cause spotting disease are pathogenic mushroom belonging to the classes *Dothideomycetes* (25 species) and *Sordariomycetes* (13 species). These fungi cause mottling of leaves and other organs in plants of 35 tropical species of 20 genera belonging to 14 families.

In the collection of tropical plants cultivated under indoor conditions of CBG, the most common pathogenic mushroom species, after representatives of the class *Dothideomycetes*, which cause leaf spot disease of plants, belong to the class *Sordariomycetes*.

9 species of the genus *Gloeosporium* were recorded in the collection of tropical plants grown indoors of the *Leotiomycetes* class of the class *Leotiomycetes*, which causes spotting disease on the leaves and stems of tropical plants: *Gloeosporium opuntiae*, *Gl. physalosporae*, *Gl. affine, Gl. elasticae, Gl. coelogynes, Gl. epidendri, Gl. orchidearum, Gl. oncidii, Gl. Beyrodtii.*

3 types of micromycetes belonging to one genus *(Pythium splendens, P. debaryanum, P. ultimum)* were found on the leaves of decorative tropical plants of the class *Oomycetes*.

During the research conducted in the collection, 3 types of micromycetes belonging to the *Pucciniomycetes* class were discovered: *Melampsora orchidis-repentis, M. euphorbiae, Cronartium eupatorium*. These micromycetes cause leaf spot disease of plants.

Table 3.

Organotropic specialization of some micromycetes

Micromycetes		Substrat							
Class	Number of species	Leaf		Stem		Carrot		Flowers, fruits	
		A	B	A	B	A	B	A	B
Oomycetes	13	6	4,76	5	3,97	11	8,73	2	1,58
Mucormycotina	1	-	-	1	0,79	1	0,79	-	-
Dothideomycetes	42	25	19,84	8	6,35	2	1,58	4	3,17
Sordariomycetes	31	13	10,32	4	3,17	20	15,87	10	7,94
Leotiomycetes	17	11	8,73	3	2,38	1	0,79	7	5,56
Agaricomycetes	4	3	2,38	2	1,58	6	4,76	2	1,58
Eurotiomycetes	3	-	-	1	0,79	-	-	2	1,58
Exobasidiomycetes	1	1	0,79	-	-	-	-	-	-
Chytridiomycetes	1	-	-	1	0,79	-	-	-	-
Ascomycota	1	-	-	1	0,79	-	-	-	-
Pucciniomycetes	12	10	7,94	-	-	-	-	2	1,58
Total	126	69	54,76	26	20,63	41	32,53	29	23,01

Note. "A" - absolute number, "B" - relative number, %

Thus 55 species of micromycetes, including 25 species of *Dothideomycetes*, 13 species of *Sordariomycetes*,11 species of *Leotiomycetes,* 3 species of *Oomycetes*,3 species of *Pucciniomycetes*, damage the leaves of ornamental tropical plants, causing leaf spotting, deformation, decay, scaly thin layer and pustule formation.

In CBG tropical plants introduced to covered conditions were evaluated for their resistance to spotting disease caused by a complex of pathogenic agents.A total of 50 species of plants were assessed for resistance to the spotting disease, of which 8 species with more than 50% damage to the surface of the leaf blade were removed from the collection. In addition, 9 resistant,18 weakly damaged and 15 moderately damaged species were identified.

3.4.2. Causes of body diseases

24 species of micromycetes belonging to 18 genera causing stem diseases in decorative tropical plants have been recorded. 2 species of the *Phytophthora* genus of the *Oomycetes* class *(Phytophthora palmivora, Ph. omnivora)* parasitize the stems of tropical plants. 3 species of the genus *Pythium (P. debaryanum, P. splendens, P. ultimum)* were found on the trunks of tropical plants.

The mushrooms *Mucor* attenuatus from the class *Mucormycotina* causes rotting dark brown or black spots on the stem of the plant.

During the research period, 8 species belonging to 7 genera of Dothideomycetes class infecting the trunk of tropical plants were found: *Alternaria senecionis,A.tenuis, Stemphylium solani, Deuterophoma tracheiphila, Coniothyrium euphorbiae, Diplodia notalensis, Macrophoma mantegazziana, Cladosporium colocasiae.* The mentioned species of mushroom were found on 12 types of tropical plants.

Three types of pathogenic micromycetes belonging to the *Leotiomycetes* class, which cause disease in the trunks of decorative tropical plants, were found - *Gloeosporium physalosporae, Sporotrichum tropicale and Botrytis cinerea*.

4 types of micromycetes belonging to 3 genera of the *Sordariomycetes* class causing disease were found in the stems of plants: *Fusarium oxysporum, F. moniliforme, Phomopsis arecae, Melanconium strelitziae*.

1 species of the *Eurotiomycetes* class was found on the stem - *Penicillium italicum*. Rotting dark brown or black spots are formed on the stem infected by this micromycete.

2 species of *Agaricomycetes* class *(Rhizoctonia aderholdii, Rh. solani)* were found on the stem.

Thus 24 types of micromycetes belonging to 18 genera were found in the trunks of decorative tropical plants, among which there are mushrooms that cause dangerous diseases.These diseases include: wilting and drying of plants, falling of seedlings, dry rotting of the rhizome, the part of the stem above the root and the root tuber and at the same time, the stem becomes moldy and covered with a thin film-like layer.

3.4.3. Pathogens of flowers and fruits

Pathogenic mushroom found in flowers and fruits usually grow on a wide variety of plant substrates, including soil. Many soil saprotrophs can cause some diseases in conditions of plant weakening.

Micromycetes *Colletotrichum orchiderum, C. roseolum, C. orthianum, Gloeosporium affine, G. coelogynes, G. epidendri, G. orchidearum, G. oncidii and G. beyrodtii* cause brown spots on the flowers of species belonging to the *Orchidaceae* family.

Micromycetes *Ascochyta cinerariae, Septoria anthurii, Vermicularia cacti, Pestalotia guepini, Colletotrichum gloeosporioides* and *Phyllosticta* begoniae form brown spots of various sizes and shapes on flowers and stems of plants.

Hyphomycetes which have certain pathogenic properties, form the basis of the mycobiota found in the fruit of decorative tropical plants.

Thus 29 types of mushrooms are found in the generative organs of decorative tropical plants, of which 17 types were found in flower stalks and flowers and 12 types were found in fruits. Most of the micromycetes that develop on the flower and fruit are representatives of the *Sordariomycetes* class - 10 species. This is approximately 7.94% of the identified mycobiota. Representatives of *Leotiomycetes* class represented by 7 species or 5.56%, *Dothideomycetes* class by 4 species or 3.17%, remaining 4 classes *Eurotiomycetes, Agaricomycetes, Oomycetes* and *Pucciniomycetes* with 2 species each corresponding to approximately 1 of the total mycobiota they make up 58 %.

CHAPTER IV
DISEASE CONTROL MEASURES IN COLLECTION OF TROPICAL PLANTS OF THE CENTRAL BOTANICAL GARDEN IN CONCERNED WITH DISEASE CAUSED BY MICROMYCETES

4.1. Diseases observed in tropical plants and their general characteristics of the measures to fight them

Micromycetes cause various diseases on tropical plants. Some micromycetes are pathogens of common or rare ornamental tropical plants, infecting host-plants in a narrow area, often limited to one species of plant on which they feed. The number of micromycetes found in one type of plant was 55 species. This facilitates to a certain extent the development of protective measures during the transfer of such plants to culture. Other micromycetes are polygamous. For example, *F.oxysporum* infected 39 species belonging to 15 families, and *Botrytis* cinerea infected 30 species of tropical plants belonging to 11 families.

During the conducted studies, it was determined that 41 species of registered micromycetes infect different species of several plant families cultivated in the collection. Another 22 species of micromycetes were recorded on plants of one genus belonging to the same family.

In the conducted researches, experimental data were also obtained regarding the observed forms of diseases observed in the tropical plants included in the collection, their symptoms and the limitation of the activities of mushrooms causing disease. Obtained experimental data and effective control measures for the prevention of diseases caused by mushrooms are proposed.

4.2. General characteristics of the distribution of diseases observed in tropical plants by plant taxa

As a result of conducted mycological studies, it was determined that 6 species belonging to 3 genera of the *Asteraceae* family have pathogenic mushroom disease. It was determined that these diseases are caused by 13 types of fungi: *Oidium cinerariae, Peronospora gangliformis, P. sparsa, Bremia lactucae,*

Coleosporium senecionis, Alternaria senecionis, Ascochyta cinerariae, Phytophthora parasitica, Ph. cinnamomi, Ph. omnivora, Fusarium oxysporum, Pseudocercospora eupatorii-formosani, Cronartium eupatorium. Among these fungi, representatives of the *Oomycetes* class dominate with 6 species.

7 types of pathogenic fungi *(Stagonospora curtisii, Colletotrichum crassipes, Fusarium oxysporum, Ceratocystis paradoka, Pythium debarianum, Rhizoctonia aderholdii, Olpidium brassicae)* are found in 15 of the 49 species of the *Bromeliaceae* family in the collection. 3 of the detected micromycetes *(Colletotrichum crassipes, Fusarium oxysporum, Ceratocystis paradoxa)* belong to the *Sordariomycetes* class.

Among the detected micromycetes, 3 species damage the leaves, 5 species cause stem diseas and 2 species infect the root. Micromycete species infecting bromeliad species - *Rhizoctonia aderholdii, Olpidium brassicae*, *Stagonospora* curtisii and *Ceratocystis paradoxa* - were observed for the first time in the collection of tropical plants cultivated indoors of CBG. Of these, *Fusarium oxysporum* fungus is considered to be the cause of the most harmful disease fusarium. Common diseases of bromeliads are caused by black leg disease, *Pythium debarianum, Rhizoctonia aderholdii, Olpidium brassicae, Ceratocystis paradoxa*, and anthracnose is caused by *Colletotrichum crassipes* fungi.

During the research period, observations were made on 61 species belonging to 23 genera to study the mycobiota of the *Cactaceae family*. 12 types of pathogenic fungi were recorded in 44 of the observed plant species. Among these fungi, 1 species belongs to *Oomycetes*, 6 species to *Dothideomycetes*, 3 species to *Sordariomycetes* and 1 species to *Leotiomycetes* class.

The taxonomic composition of detected micromycetes consists of the following fungal species: *Phytophthora cactorum, Alternaria senecionis, Helminthosporium cactivorum, Ascochyta cinerariae, A. hydrangeae, Septoria selenophomoides, Diplodia natalensis, Colletotrichum crassipes, C. gloeosporioides, Fusarium oxysporum, Pestalotia guepini, Gloeosporium opuntiae.* These types of fungi were found in the old and young trunks,

roots, leaves and flowers of cacti.

Helminthosporium cactivorum fungus was found for the first time under the cover of cactus species - *Gymnocalycium saglionis, Opuntia humifusa, Parodia mammulosa and P.erinacea.* As a result of the infection of this fungus *Helmintosporiosis* wet rot disease is formed at the base of the plant stem.

Hyphomycetes form the basis of mycobiota identified in sprouts, seedlings and young plants of cacti.

19 species of pathogenic fungi included in 6 classes were found during the mycological studies on 17 species belonging to 10 genera of the *Araceae* family cultivated in the collection. Among these fungi, 5 species of *Oomycetes,* 5 species of *Dothideomycetes,* 6 species of Sordariomycetes, 1 species of Leotiomycetes, 1 species of *Agaricomycetes* and 1 species belong to the class of *Eurotiomycetes*.

47 pathogenic species belonging to 6 classes of fungi are found in 15 species and hybrids of the orchid family. Recorded pathogenic fungal species cause various diseases in above-ground and underground organs: black rot, phytophthora, root rot, spot, anthracnose, fusarium rot, leaf rot, bulb rot, gray rot, southern sclerotia rot, rust. Among the recorded fungi, the class *Sordariomycetes* with 12 species and the class *Dothideomycetes* with 11 species predominate over other fungal classes.

5 species of *Oomycetes*, 8 species of *Leotiomycetes* and 3 species of *Agaricomycetes* were found in the plants of *Orchidacea*e family.

8 species of fungi of the *Pucciniomycetes* class causing leaf rust were recorded on species of the *Orchidaceae* family. Golden-yellow powdery pustules appear on the lower and upper sides of leaves infected with these fungi.

CONCLUSION

1. In this research Mycobiota of 166 species of tropical plants grown indoors in Absheron was studied for the first time according to the species composition and ecological-trophic

relations and it has been identified that 126 species were involved in the formation of their mycobiota. Of the registered fungi, 13 species belong to the fungus-like organisms (*Chromista*) and 113 species belong to the true fungus (*Mycota*) [1-3, 5, 8, 10-11].

2. Not only the covered conditions of Absheron, but also the territory of the Republic of Azerbaijan in general is a new area for such species as *Alternaria cinerariae* Hori & Enjoji, *Cladosporium colocasiae* Sawada, *Stemphylium solani* G.F.Weber, *Septoria anthurii* Kotthoff and *S.elasticae* Koord distribution of which was determined in the studies [9].
3. It became clear that the distribution of recorded fungi by individual taxa is uneven, so that the Oomycetes class - 13 species (10.3%), *Mucormycetes* - 1 species (0.8%), *Dothideomycetes* - 42 species (33.3%), *Sordariomycetes* class - 31 species (24.6%), *Leotiomycetes* class - 17 species (13.5%), *Agaricomycetes* class - 4 species (3.17%), *Eurotiomycetes* class - 3 species (2 ,4%), *Exobasidiomycetes* class - 1 species (0.8%), *Chytridiomycetes* class - 1 species (0.8%), *Ascomycote* (Incertae sedis) - 1 species (0.8%), *Pucciniomycetes* class - 12 species (9.5%) [3, 5, 8, 10-11].
4. It was determined that the distribution of fungi on plants is different. Thus, the number of plant families with 10 or more pathogenic micromycetes on one plant family is equal to 9: *Arecaceae* - 10 species, *Orchidaceae* - 50 species, *Araceae* - 22 species, *Asteraceae* - 12 species, *Cactaceae* - 13 species, *Euphorbiaceae* - 10 species, *Rutaceae* – 11 species, *Polypodiaceae* – 10 species, *Musaceae* – 10 species. The number of species for the rest of the plant families varies from 1 to 9 [5, 8].
5. During the study of the distribution of the recorded micromycetes on different organs of tropical plants, it became clear that the fungi have the ability to cause pathology most in the leaves (54.7% of the total mycobiota) and least in the stem (20.6%). A similar situation is 32.5% for underground organs, and 23.0% for flowers and fruits [4, 7, 10].

6. The resistance of 50 species of tropical plants to spotting disease was evaluated under indoor conditions, and 8 species of which the surface of the leaf surface was damaged by more than 50% (*Euphorbia splendens, E. pulcherrima, Alocasia odora, Cineraria hybrida, Fittonia verschaffeltii, Fuchsia hybrida, Begonia semperflorens, Zantedeschia aethiopica*), 9 resistant species (1-10%), 18 mildly damaged species (11-25%) and 15 moderately damaged species (26-50%) were identified [6-7].

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