Dothideomycetes of the Botanical Gardens and Arboreta of the Steppe Zone of Ukraine

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Abstract. As a result of mycological studies it was found the species diversity of fungi (Dothideomycetes), which includes 74 species from 30 genera, 18 families, 5 orders, 2 subclasses. Analysis of the taxonomic structure of the investigated mycobiota shows that its core consists of representatives of the order Pleosporales comprising 48 species (65%). In the ecological structure it was established the dominance of saprotrophic xylotrophs (63%). Identified species of micromycetes have consortial association with 67 species of the introduced plants. Ontogenetic features of certain species of pleomorphic Dothideomycetes are considered.

Keywords: *Dothideomycetes, species diversity, introduced plants, Steppe zone*

Introduction. Botanical gardens and arboreta are cultural phytocoenoses that are in the process of constant change. By definition, these are unstable communities, since they are mainly anthropogenic and are subject to further anthropogenic transformation. Some of the indispensable constituents of the biocoenosis are Dothideomycetes, which have strong trophic association with the introduced plants. These microscopic fungi make up a significant proportion of the artificial plant communities, being an additional influencing factor on the phytosanitary state of the plants. Thus, the study of species diversity and patterns of the loculoascomycete mycobiota establishment during introduction of plants is an important subject of research.

Overview of the publications. In Ukraine, still in the middle of the 20th century, well researched mycobiota of botanical gardens and arboretums in Polissia, Forest-Steppe, Southern Crimea, in particular fungi of O.V. Fomin Botanical Garden, Nikitsky Botanical Gardens – National Scientific Centre of National Academy of Agrarian Sciences of Ukraine, arboretums "Trostianets", "Sofiivka", "Oleksandriia" [1]. Phytopathogenic mycobiota of the Donetsk Botanical Garden National Academy of Sciences of Ukraine and Arboretum Biosphere Reserve "Askania-Nova" is the most studied in the steppe zone [2-5]. In our previous works considered the ascomycetes and anamorphic fungi of Botanical Garden of Kherson State University and the Botanical Garden of Odessa I. Mechnikov National University [6, 7]. However, the study Dothideomycetes in these territories before our research not was conducted [8-10].

Purpose. The purpose of the research was study the species diversity of Dothideomycetes (Ascomycota) in botanical gardens and arboretums at Steppe zone of Ukraine, to identify the taxonomic and ecological characteristics of the studied mycobiota.

Materials and methods. Materials for this research are mycological specimens collected during expeditions and from the stationary experimental plots established during 2002-2013 years at Botanical Garden of Odessa I.I. Mechnikov National University, Botanical Garden of Kherson State University, Zaporizhia City Children's Botanical Garden, Kriviy Rig Botanical Garden of the National Academy of Sciences of Ukraine, Botanical Garden of Poltava V.G. Korolenko National Pedagogical University, Arboretum of Biosphere Reserve «Askania-Nova», Arboretum of Mykolayiv Zoo and several local arboreta. Collection and preservation of mycological samples was performed according to the method described earlier [6]. Species were identified using light microscopy methods for the study of anatomical and morphological structure, using the relevant handbooks and monographs [11-14]. Species names of vascular plants correspond to the manual "Catalogue of Ukraine's dendroflora" [15] and species names of fungi are given in accordance with the international taxonomy database of fungi "Index Fungorum" [16]. The composition of class Dothideomycetes is given according to the 10th edition of the Ainsworth & Bisby's Dictionary of the Fungi [17].

Results and discussion. Analyzing our data, literature sources, and herbaria, collected from the territory of 8 botanical gardens and arboreta of the Steppe zone of Ukraine, we determined the species diversity of Dothideomycetes, which includes 74 species from 30 genera, 18 families, 5 orders of subclasses Pleosporomycetidae and Dothideomycetidae (Tab. 1).

Analysis of the taxonomic structure of the investigated mycobiota shows that its majority consists of representatives of the order Pleosporales comprising 48 species (65%). We found that quantitatively dominate species from families Botryosphaeriaceae, Lophiostomataceae, Pleosporaceae, Cucurbitariaceae, and from genera Otthia, Cucurbitaria, and Pleospora (Tab. 1).

The species diversity indicator of genera is quite low, 2.5 which is typical for the allochtonic mycrobiota. In addition, a relatively high the frequency of occurrence of phytotrophic Dothideomycetes on the territory of Zaporizhia City Children's Botanical Garden); the smallest occurrence was observed on the area of the Biosphere Reserve «Askania-Nova»). Presented figures are largely due to the influence of climatic and microclimatic factors necessary for the development of micromycetes.

We compared the species composition of the Dothideomycetes using Jacquard's Index (Kj) [18]. It was found that species composition of Botanical Garden of Kherson State University is close to the composition of that of Botanical Garden of Odessa I.I.Mechnikov National University, and the Arboretum of Biosphere Reserve «Askania-Nova» to the highest level of similarity (Kj 0.58 and 0.64 correspondingly). The level of similarity is high due to the large number cosmopolitan species. The low degree of similarity was found in the species composition of Arboretum of Mykolayiv Zoo and Botanical Garden of Poltava V.G. Korolenko National Pedagogical University, Kriviy Rig Botanical Garden (Kj from 0.16 to 0.28).

We found that in the ecological structure of the inves-

Table 1. Quantitative taxa distribution of Dothideomycetes from botanical gardens and arboreta of Steppe zone of Ukraine

Orders	Families	Genera	Total number of species, pcs	Total number of species, %
1	2	3	4	5
Subclass Dothideomycetidae				
Dothideales	Dothideaceae	Dothidea	2	2.7
	Dothioraceae	Dothiora	4	5.4
Capnodiales	Mycosphaerellaceae	Mycosphaerella	5	6.7
		Sphaerulina	1	1.4
Subclass Pleosporomycetidae				
Pleosporales	Cucurbitariaceae	Cucurbitaria	6	8.0
	Didymosphaeriaceae	Didymosphaeria	4	5.4
	Fenestellaceae	Fenestella	1	1.4
	Leptosphaeriaceae	Leptosphaeria	4	5.4
	Lophiostomataceae	Cilioplea	1	1.4
		Lophiostoma	4	5.4
		Lophiotrema	3	4.0
	Massarinaceae	Massarina	2	2.7
	Melanommataceae	Melanomma	1	1.4
	Montagnulaceae	Kalmusia	1	1.4
	Mytilinidiaceae	Lophium	1	1.4
	Pleomassariaceae	Splanchnonema	2	2.7
		Trematosphaeria	3	4.0
	Pleosporaceae	Pleospora	6	8.0
		Pyrenophora	2	2.7
	Venturiaceae	Venturia	2	2.7
		Platychora	1	1.4
	Incertae sedis	Didymella	3	4.0
		Herpotrichia	1	1.4
Dothideomycetes, incertae sedis				
Botryosphaeriales	Botryosphaeriaceae	Botryosphaeria	3	4.0
		Guignardia	1	1.4
		Otthia	7	9.5
Hysteriales	Hysteriaceae	Hysterium	1	1.4
		Hysterographium	1	1.4
Incertae sedis	–	Thyridaria	1	1.4
Total	18	30	74	100.0

tigated species the species composition of Dothideomycetes it characterized by the dominance of saprotrophic xylotrophs, 46 species (63%), somewhat lower number of hemibiotrophs, 24 species (33%), and biotrophs are represented by just 3 species (4%).

Identified species of Dothideomycetes have consortial association with 67 species of the introduced plants from 53 genera of 20 families. Majority of the cultivated plants of the artificially created communities which are associated with Dothideomycetes belong to the family Rosaceae and Fabaceae (Fig 1.).

We analyzed distribution of Dothideomycetes on the host plant species and found that family Rosaceae and Fabaceae have higher number of associated species of phytotrophic Dothideomycetes (70% of all the plant substrates). The other investigated families show significantly fewer number of consortial micromycetes (Fig 1.).

According to criteria of distribution, genera Sorbus, and Cotoneaster from family Rosaceae have the highest number of species of fungi (5 and 4, respectively). Genera Amelanchier, Spiraea, Prunus and others have fewer number fungi species (one or two). The maximum number of fungal species was found on Sorbus domestica L., Cotoneaster salicifolius Franchet, and Amelanchier ovalis Medic. Most frequently on Rosaceae plants were found Dothideomycetes of genus Otthia. Phylogenetic specialization was confirmed for Dothiora sorbi Fr. and Otthia spiraeae (Fuckel) Fuckel.

Within the family Fabaceae, the stable consortial relationships with Dothideomycetes demonstrate plants of genera Chamaecytisus, Styphynolobium, Colutea. The largest number of these fungi are associated with Colutea arborescens L. and Styphynolobium japonica L. The most common consortial loculoascomycetae were species of genera Cucurbitaria (Cucurbitariaceae) and Pleospora (Pleosporaceae). In general, Cucurbitaria caraganae P. Karst., C. elongata (Fr.) Grev., and C. laburni (Pers.) De Not. were frequently found on plants of family Fabaceae. Phylogenetic specialization was observed for species C.coluteae (Rabenh.) Auersw., C. spartii (Nees ex Fr.) Ces. & De Not., Pleospora cytisi Fuckel.

Phytotrophic fungi as a nutrient substrate utilise living and dead parts of plants. Phytotrophic Dothideomycetes often develop on vegetative organs, mainly on the shoots and their structural components. We propose introduction of fungi localisation criteria dependily on the location on the plant organism (vegetative body), namely caulophilic, phyllophilic and radixophilic consortia, given that micromycetes associated with the plants have not only trophic, but topical characteristics. Caulophilic and radixophilic consortia involving loculoascomycetes and woody plants by trophic specificities are represented by cortexotrophic and lignotrophic species and phyllophilic consortia – phyllotrophic species. In the investigated microbiota caulophilic consortia dominate (62 species, 86%), phyllophylic and radixophilic consortia are represented by fewer species.

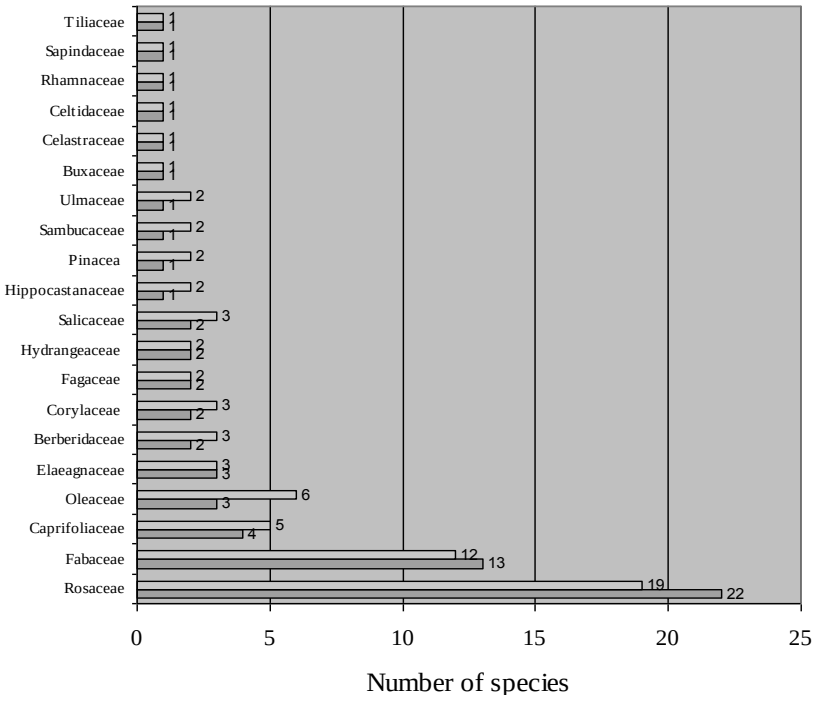

Fig 1. Quantitative distribution of loculoascomycete species on the plants from different families

Saprotrophic loculoascomycetes which mostly form caulophilic consortia, develop on the dried-out branches, dead and rotting wood, bark of the studied species. These include Botryosphaeria prunicola Rehm., Dothidea pyrenophora Fr. Dothiora sphaeroides (Pers.) Fr., Lophium mytilinum (Pers.) Fr., Trematosphaeria pertusa (Pers.) Fuckel, ect. The development of these fungi does not cause significant damage to the core plant of the consortium, therefore the consortium may be regarded as as positive [19].

Phytopathogenic Dothideomycetes (hemibiotrophs and biotrophs) in the investigated areas are involved in the formation of mostly indifferent caulophilic and phyllophilic consortia. Depending on the stage of the life cycle these fungi develop on living or dead plant organs, and usually affected are no more than 30-40% of the plant population. Among the hemibiotrophs the most frequently are found species: O.spiraeae and C. elongata and among biotrophs are found potentially dangerous pathogens Guignardia aesculi (Peck) V.B. Stewart, Herpotrichia juniperi (Duby) Petr., Platychora ulmi (Schleich.) Petr.

In the studied ecotopes we noted the marked dominance of the indifferent consortia involving Dothideomycetes, however negative as well as antagonistic consortia have not been identified.

On plants at the stage of initial introduction, as well as sick and injured individuals the caulophilic sinusia with mitosporic and loculoascomycetous fungi were found which grow on semidry and dried-out branches of woody plants. The greatest quantity of components was found in mycosinusia formed by the introduced species of North American Elaeagnus commutata Bernh. ex Rydb. (species of fungi C. caraganae, Camarosporium elaeagni Potebnia, Coniothyrium montagnei Castagne, Cytospora elaeagni Allesch, Diplodia elaeagni Pass.) and Robinia pseudoacacia L. (C. elongata, Camarosporium pseodoacaciae Brunaud, Cytospora robiniae Schwein., Dothiorella robiniae Prill.). We found certain constancy on of mycosinusian groups for majority of the studied species of vascular plants, and the analysis of the studied sinusia indicates the relative constancy of their taxonomic composition. Concorent development of micromycetes both within the mycosinusia and ontogeneticaly linked, to some extent serves as a debilitating factor for plants [20].

The study of ontogenetic succession of pleomorphic loculoascomycetes can serve as an effective diagnostic tool for determination of the sanitary condition of the plant and the basis for phytopathological prognosis. Distinctiveness of the life cycles of pleomorphic species is represented by a natural alternation of sexual and asexual stages of different types, which often develop in the adjacent fruit bodies and pseudostromata.

A large number of anamorphs of the picnidial type was found for the genus Otthia, which taxonomically belong to 18 species of 7 genera of the family Sphaerioidaceae order Sphaeropsidales class Coelomycetes. These species are assigned to genera Diplodia (8 species), Microdiplodia (3), Camarosporium (2), Sphaeropsis (2), Dichomera, Hendersonia, Phoma (1 species resp.).

The largest number of anamorphs in the ontogenetic succession were observed for the pleomorphic species O. spiraeae. During monitoring in vivo on the branches of Amelanchier ovalis a consistent development of anamorphs Phoma crataegi Sacc., Diplodia crataegi Fuckel, Hendersonia sp., Camarosporium kirchneri Staritz. was observed. Similar successions were found on Sibiraea altaiensis (Laxm.) Schneid. but with the following species M. rosarum and D. rosarum, and on Rhodotypos kerrioides Sieb. Ex Zucc., Sorbus domestica, the genera Spiraea, and Cotoneaster we found Sphaeropsis syringae (Fr.) Peck & Cooke and D. pruni. In terms of ecological and biological characteristics of the anamorphs of Diplodia-type and Microdiplodia-type thus cause drying of branches [21], and the next conidial stage and teleomorpha develop on dried-out branches. Other investigated species of pleomorphic loculoascomysetes have essentially similar pattern of dynamics of the phytopathological activity. Thus, the specificity of the detection and study of

consortia of pleomorphic species is due to the fact that in certain stages of the life cycle of these fungi, they often develop in different organs or on different plants, and the degree of their pathogenicity varies. Species diversity of the collections of introduced plants in this case can help expand the spectrum of lesions and trophic preferences of these fungi, and consequently, the formation of new consortial relationships.

Conclusions

1. The species diversity of Dothideomycetes of the Botanical Gardens and Arboreta of the Steppe Zone of Ukraine includes 74 species from 30 genera, 18 families, 5 orders of subclasses Pleosporomycetidae and Dothideomycetidae.

2. In the taxonomic structure of the investigated species composition of Dothideomycetes quantitatively dominate species of the order Pleosporales (48 species, 65%), of the families Botryosphaeriaceae, Lophiostomataceae, Pleosporaceae and Cucurbitariaceae, as well as genera Otthia, Cucurbitaria and Pleospora.

3. In the ecological structure of the investigated species composition of Dothideomycetes it was established the dominance of saprotrophic xylotrophs (46 species, 63%); somewhat lower member of hemibiotrophs (24 species, 33%); biotrophs are represented by 3 species (4%).

4. Identified species of Dothideomycetes form consortive association with 67 species of the introduced plants from 53 genera of 20 families. Majority of the cultivated plants of the artificially created communities which are associated with Dothideomycetes belong to the family Rosaceae and Fabaceae (70% of all the plant substrates). In the investigated microbiota caulophilic consortia dominate (62 species, 86%).

5. In the studied ecotopes the marked dominance of indifferent consortia involving Dothideomycetes was noted, however negative and antagonistic consortia have not been identified. This indicates a relative balance in populations of fungi reflecting stability of mycocomplexes and the constancy of relationships between the introduced plants and their consortial micromycetes.

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