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Original Contribution

LARGER FUNGI – INDICATOR SPECIES FOR XEROTHERMIC GRASSLANDS OF PROTECTED AREA "SHEEP HILLS" THRACIAN LOWLAND (BULGARIA)

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ABSTRACT

In the Protected Area "Sheep Hills", xerothermic grasslands are semi-natural habitats developed on old volcanic and limestone hills. Xerothermic grassland belongs to the class *Thero-Brachypodietea*, and the alliances *Thero-Brachypodion* and *Astragalo-Poion bulbosae*. The xerothermic grasslands have their own characteristic mycota, as following steppe, xerothermic, and thermophilous fungi deserve special attention: *Agaricus bernardii, A. comtulus, A. maleolens, Crinipellis mauretanica, Entoloma incanum, Hygrocybe virginea, H. persistens, Lepiota erminea, Leucopaxillus lepistoides, Tulostoma fimbriatum,* and *T. volvulatum.* The studyfound the occurrence of 6 fungi included in the Bulgarian Red List of fungi and the Red Data Book in the Republic of Bulgaria – *Amanita vittadinii, Crinipellis mauretanica, Geastrum melanocephalum, Myriostoma coliforme, Tulostoma fimbriatum,* and *T. volvulatum.* The main factors threatening xerothermic grasslands of the Sheep Hills area, among others, the devastation and disappearance of natural habitats, often as a result of in appropriate land management as well as the pollution of air, water, and soil.

The aim of the paper is to enrich the information about larger fungi indicator species for xerothermic grasslands in this protected area and the country.

Key words: Protected Area "Sheep Hills", xerothermic grasslands, larger fungi, semi-natural habitats, *Thero-Brachypodietea*, steppe fungi, xerothermic fungi

INTRODUCTION

The Protected Area "Sheep Hills" is situated in the Thracian Lowland region, in the land of village of Ovchepoltsi, Pazardzhik municipality, Plovdiv distr., close to the Pazardzhik town. The climate is transitional continental (1). Summers are warm and winters are mild and moderately cold, without lasting snow cover and withsmall temperature amplitudes.

According to the physical and geographical regionalisation, the mountain is situated within the Thrace region (2, 3). The highest peak in the Sheep Hills is mainly constitutes of old and e site and volcanic rocks, with some limestone out crops. Soil cover in the Protected Area is represented by shallow leached and podzolized cinnamon-forest soils. The predominant soil types are cinnamon-podzolic soils (4).

The protected area is included in the national Natura 2000 Network, with the sole purpose of protecting the natural habitat and maintain representative ecosystem for eastern sub-Mediterranean dry grasslands, eastern forests of *Quercus pubescens* and pseudo-steppe with grasses and annuals of the *Thero-Brachypodietea*; (BG0000365, Protected area according to Directive 92/43/EECfor conservation of natural habitats and of wild fauna and flora). This is the first mycological study conducted on the territory of this interesting area. Data from this study in the Sheep Hills provide information on the fungi – indicator species in the xerothermic grasslands in Bulgaria.

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The Protected Area "Sheep Hills" can be characterized by the presence of volcanic and limestone hills. Xerothermic grasslands developed on slopes of these hills are semi-natural habitats. The development of xerothermic grasslands was strictly connected with agricultural and pastoral farming of man. Typical representatives of the herbaceous plants are *Aegilops neglecta, A. geniculata, Bromus fasciculatus, B. madritensis, B. intermedius, Bothriochloa ischaemum, Brachypodium distachyon, Chrysopogon gryllus, Cynodon dactylon, Cynosurus echinatus, Dactylis glomerata, Dichanthium ischaemum, Eryngium campestre, Knautia orientalis, Medicago minima, M. rigidula, Poa bulbosa, Salvia viridis, Trifolium echinatum, T. purpureum, T. subterraneum, Xeranthemum annuum,* etc.). These grasses belong to the class *Thero-Brachypodietea* and the alliances *Thero Brachypodion, Astragalo-Poion bulbosae, Trachynion distachya* and *Xeranthemion annui*.

The larger fungi in xerothermic grasslands in Bulgaria are poorly known. A summary over view of macromycetes in Mediterranean and sub-Mediterranean plant communities in the country provides (5). The importance of this problem stems from the fact that knowledge and literature on fungi associated with thermophilous and xerothermic grasslands in Europe and Bulgaria are still very inadequate (5-22).

In recent years, many changes in the xerothermic grassland communities of the Protected Area "Sheep Hills" have been observed. These changes may lead to the disappearance of rare plants as well as whole phytocoenoses of an extreme interest.

The xerothermic grasslands have their own mycota characteristic for them. The aim of the investigations was to identify resources of larger fungi growing in the xerothermic grasslands ofthe study area and to distinguish indicator species for them. The collected scientific information will be used for analysis and planning activities on the conservation and management of the biodiversity in the protected territory in the future.

MATERIALS AND METHODS

The current research is based on observationsand collection of larger fungi in the xerothermic grasslands of the Protected Area "Sheep Hills" between 2010-2012. The study was carried out in 12 permanent plots with size 1000 m^2 each distributedin the communities belonging to the class *Thero-Brachypodietea.* Collection of fruit bodies was carried out each year from April-October. Furthermore, fungi were also collected outside the permanent study plots, using so-called the itinerary method, which allowed us to enrich observations and to gather data concerning the composition of larger fungi species growing in the xerothermic grasslands.

To illustrate the floristic composition and existing phytosociological relationships in the investigated phytocoenoses, phytosociological study were performe dusing the (23) method. The nomenclature for fungi is according to (24), vascular plants according to (25), and plant communities according to (26) and (27). The author's names of the fungal taxa are abbreviated according to (28). Identification and nomenclature of the specimens was performed according to (29-45). The conservation status is indicated according to the Red List of fungi in Bulgaria (46).

Studied specimens are kept in the Agricultural University (SOA) in Plovdiv; their accession numbers are given in brackets atthe end of each record. Specimens were collected by the author, unless other wise stated.

The identification of the collected material was done in two stages. In the first stage, if it was possible, fruit bodies were identified in fresh samples, while during the second stage identification was performed after fruit bodies had been dried. Microscopic features are observed and measured in lactophenol under an Amplival ML light microscope, with magnification ×1000.

RESULTS AND DISCUSSION

Changes taking place in the plant communities have a strong influence on the species composition of fungi (11, 22).

During the course of the investigations on the mycobiota of the Sheep Hills xerothermic grasslands, the occurrence of more than 46 species of larger fungi belonging to the classes Agaricomycetes was established. From among this group, 36 species were selected which were identified, based on their general distribution and habitat requirements, to be distinctly connected with the xerothermic grasslands. These species can be considered to be indicative of this type of habitats **(Table 1).**

Table 1. *List of larger fungi species from xerothermic grasslands in the Protection Area "Sheep Hills"*

Species of larger fungi	**Plant alliances in which the occurrence of larger fungi was confirmed**
Agaricus arvensis Schaeff.	*Astragalo-Poion bulbosae, Trachynion distachya*
A. bernardii Quél.	*Astragalo-Poion bulbosae*
A. comtulus Fr.	*Astragalo-Poion bulbosae, Trachynion distachya*
A. cupreobrunneus (F.H. Møller) Pilát	*Astragalo-Poion bulbosae*
A. campestris L. : Fr.	*Thero-Brachypodion, Trachynion distachya*
A. maleolens F.H. Møller	*Astragalo-Poion bulbosae*
A. xanthodermus Genev.	*Thero-Brachypodion, Trachynion distachya*
Agrocybe molesta (Lasch) Singer	*Astragalo-Poion bulbosae*
Amanita vittadinii (Moretti) Vittad.	*Astragalo-Poion bulbosae, Trachynion distachya*
Bovista plumbea Pers. : Pers.	*Thero-Brachypodion, Trachynion distachya*
Conocybe apala (Fr. : Fr.) Arnolds	*Astragalo-Poion bulbosae*
Coprinus comatus (O.F. Müll. : Fr.) Pers.	*Thero-Brachypodion, Trachynion distachya*
*Crinipellis mauretanica*Maire	*Thero-Brachypodion*
C. scabella (Alb. & Schwein. : Fr.) Murrill	*Thero-Brachypodion*
Cyathus olla (Batsch. : Pers) Pers	*Astragalo-Poion bulbosae, Trachynion distachya*
Entholoma incanum (Fr. : Fr.) Hesler	*Thero-Brachypodion*
Geastrum fornicatum (Huds.) Hook.	*Thero-Brachypodion, Trachynion distachya*
G. melanocephalum (Czern.) V.J. Staněk	*Thero-Brachypodion*
G. rufescens Pers. : Pers.	*Thero-Brachypodion*
Hygrocybe miniata (Fr. : Fr.) P. Kumm.	*Astragalo-Poion bulbosae*
H. persistens (Britzelm.) Singer	*Thero-Brachypodion*
H. virginea (Wulfen : Fr.) P.D. Orton & Watling	*Astragalo-Poion bulbosae, Trachynion distachya*
Leucopaxillus lepistoides (Maire) Singer	*Thero-Brachypodion*
Lepiota erminea (Fr. : Fr.) P. Kumm.	*Thero-Brachypodion, Trachynion distachya*
Marasmius oreades (Bolton : Fr.) Fr.	*Thero-Brachypodion, Trachynion distachya*
Macrolepiota excoriata (Schaeff. : Fr.) Wasser	*Astragalo-Poion bulbosae,Trachynion distachya*
M. procera (Scop. : Fr.) Singer	*Thero-Brachypodion*
Panaeolus sphinctrinus (Fr.) Quél.	*Thero-Brachypodion, Trachynion distachya*
Pleurotus eryngii (DC. : Fr.) Quél.	*Thero-Brachypodion, Trachynion distachya*
Stropharia coronilla (Bull. : Fr.) Fr.	*Thero-Brachypodion, Trachynion distachya*
S. semiglobata (Batsch. : Fr.) Qéll.	*Astragalo-Poion bulbosae*
Tulostoma brumale Pers. : Pers.	*Thero-Brachypodion, Trachynion distachya*
T. fimbriatum Fr.	*Thero-Brachypodion*
T. volvulatum I.G. Borshch.	*Thero-Brachypodion*
Vascellum pratense (Pers. : Pers.) Kreisel	*Thero-Brachypodion, Trachynion distachya*

The analysis of the macromycetes species composition of the studied grasslands belonging to the class *Thero-Brachypodietea* reveals its uniqueness. Of particular importance are the steppe, xerothermic, and thermophilous fungi whose presence underline the mycological relationship with the plant communities belongingto the alliance *Thero-Brachypodion*, and these are as follows: *Entoloma incanum*, *Hygrocybe persistens*, *Lepiota alba*, and *Leucopaxillus lepistoides*, although latter has the most out standing features considered to be a typical steppe species (10, 11, 19, 22). The occurrence of typical steppic species of macromycetes is very rare in Bulgaria. Additionally, other interesting fungi connected with the *Astragalo-Poion bulbosae* grasslands are *Agaricus bernardii*, *A. cupreobrunneus*, and *Hygrocybe virginea* (22, 47). A characteristic feature of the grassland mycobiota in this area is the occurrence of calciphilous fungi that include, among others *Bovista plumbea*, *Entoloma incanum*, *Lepiota alba*, *Leucopaxillus lepistoides*, *Geastrum minimum*, and *Tulostoma fimbriatum*, which can beconsidered to be a characteristic species for the xerothermic grasslands (11, 30).

Equally interesting and rare is *Agaricus maleolens*, a species that is associated with xerothermic grasslands (30). Basidiomata of *Crinipellis mauretanica* develop on rotten sticks in grassy placesand of *Crinipellis scabella* occuron a largely degree on dry grass blades (21, 48-50). Fruit bodies of *Stropharia coronilla*, *Marasmius oreades*, *Pleurotus eryngii* and *Vascellum pratense* also occur in vast numbers**.** These are fungi with a wide range of occurrence, mostly in the grasslandsin question, but also in psammophilous grassland, and in dry pine forests (11, 22).

The fungi associated with dry and warm habitats are the most interesting. These fungi belong to extremely specialised thermophilous and calciphilous organisms whose development is possibleonly in deforested and open xerothermic communities (22). A separate group comprises of fungi more often growing in the meadows and pastures, including among others *Agaricus arvensis*, *A. campestris*,*A. xanthodermus*, *Cyathus olla*, *Hygrocybe virginea*, *Macrolepiota excoriata* and *M. procera* which are also present intoxerothermic grasslands. Were observed and some mushrooms developing on excrement, namely *Coprinus comatus*, *Panaeolus sphinctrinus*, and *Stropharia semiglobata*.

The habitats of the Sheep Hills xerothermic grasslands are the place of occurrence of many interesting macromycetes species, some of which are consideredas rare and threatened both in Bulgaria and Europe. The study found the occurrence of 6 fungi being on the Bulgarian Red List of fungi (46) and Red Data Book in the Republic of Bulgaria (51) which are as follows: *Amanita vittadinii*, *Crinipellis mauretanica*, *Geastrum melanocephalum*, *Myriostoma coliforme*, *Tulostoma fimbriatum*, and *T. volvulatum*.

CONCLUSION

The effective protection of many plant species and macromycetes is only possible by protecting their entire semi-natural habitats, and not only their single components.

The achieved results have a significant importance for the identification of macromycetes biota growing in rare ecosystems in the communities belonging to the class *Thero-Brachypodietea* withinthe investigated area. The knowledge of selected fungi, which can be considered to have diagnostic features, allows us to use these organisms for bioindication of their habitats. This is of particularly great significance during the preparation of conservations plans for nature reserves and protected areas as well as during the evaluation of negative impacts on the environment.

Hope that this study will enrich information about fungal diversity of the Protected Area “Sheep Hills” as well as for the fungal diversity to xerothermic grasslands in Bulgaria, on the whole.

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