FUNGI IN FOREST CONSERVATION OF THE ALA-ARCHA NATIONAL PARK

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Mountain systems of Tien Shan within Kyrgyz Republic have fragile ecosystems, which are notable for their biodiversity. The research on the biodiversity of mushrooms in Kyrgyz Republic becomes important not only for preservation of this valuable component of ecosystems, but also in supporting the national strategy of this newly independent state, which highly depends on forestry and tourism for future development. Many species of fungi are of economic importance and play the crucial role in the forest ecosystems health through their mycorrhizal connections. There are 60 species of mushrooms in Kyrgyzstan which are symbionts of trees and shrubs. The deterioration of socio-economic situation in Kyrgyzstan, especially in the remote countryside, drives the local population toward often barbaric use of plant resources, thus diminishing the biodiversity of edible mushrooms and damaging such valuable resource as conifer forests.

Importance of biodiversity databases with the references to the digital maps that will use Global Positioning System (GPS) coordinates as well as Internet access to such databases was recently emphasized by many researchers [1]. This study demonstrates how the use of georeferncing techniques supports a regional biodiversity study of macrofungi.

Ala-Archa National Park, where the survey was conducted, is located in central portion of the northern macroslope of Kyrgyz Range of Tien Shan Mountains, which stretches from east to west for 450 km. The Ala-Archa Valley is located in the highest part of the mountain range, Semenov-Tien-Shansky Peak, is 4875 m above sea level. The National Park territory includes meadow-steppe, forest-meadow, subalpine and alpine vegetation zones. Vegetation is represented by eight types and 22 formations [2]. A representative altitudinal profile of mountain habitats was studied in the summer of 2002. When sampling locations of fungi were geo-referenced with a GPS unit, and ecological characteristics of forest and desert habitats were described using relative abundance measurements. As a result of vegetation classification, four major vegetation types were described for the sampling points at Ala-Archa (Table 1). They are as follows:

1. **Spruce forest – junipers and shrubs**: Dominant *Picea shrenkiana* with co-dominant *Lonicera hispida, Lonicera stenanta, Rosa albertii*, *Ribes meyeri, Cotoneaster melanocarpa, Juniperus turkestanica.* These spruce forests are mixed with two different species of junupers (dwarf juniper, *Juniperus turkestanica* and regular *Juniperus semiglobosa*).

2. **Birch – Juniper-shrubs**. Juniper-birch forest in association with numerous and diverse shrubs is another category. Dominant species are: *Juniperus semiglobosa*, *Betula tianschanica*, with co-dominant *Berberis intermedia, Berberis heteropoda, Potentilla orientalis, Juniperus turkestanica, Salix tianschanica, Myricaria squammosa, Polygonum songoricum, Epilobium palustris.*

Table 1. Vegetation types of Ala-Archa national Park.

Dominants, co-dominants	Conifer forests		Broad leaf forests	Steppe
	Spruce forests-shrubs	Dwarf juniper-juniper	Birch-Willow-shrubs	Sagebrush and fescue
Picea schrenkiana	dominant	dominant	co-dominant	—
Juniperus semiglobosa	co-dominant	dominant	co-dominant	—
Juniperus sibirica	—	—	co-dominant	—
Juniperus turkestanica	—	co-dominant	—	—
Salix tianschanica	—	—	dominant	—
Myricaria squammosa	—	—	co-dominant	—
Lonicera hispida	—	—	co-dominant	—
Lonicera stenantha	—	—	co-dominant	—
Rosa fedtschenkoana	co-dominant	—	co-dominant	—
Hyppophaë rhamnoides	—	—	доминант	—
Cotoneaster melanocarpa	—	—	co-dominant	—
Betula tianschanica	co-dominant	—	доминант	—
Berberis heteropoda	—	dominant	co-dominant	—
Sorbus tianschanica	—	—	co-dominant	—
Poa pratensis	—	—	—	co-dominant
Festuca valesiaca	—	—	—	dominant
Carex turkestanica	co-dominant	co-dominant	co-dominant	co-dominant
Fragaria vesca	co-dominant	—	co-dominant	—
Phlomoides oreophila	—	—	co-dominant	—
Artemisia santalonifolia	—	—	co-dominant	dominant
Artemisia dracunculus	—	co-dominant	—	—
Ziziphora clinopodioides	—	co-dominant	—	—
Stipa capillata	—	—	—	co-dominant
Achillea setacea	co-dominant	—	—	co-dominant
Origanum vulgare	—	co-dominant	—	—

3. **Dwarf Juniper- Juniper and shrubs**:
Dominants are *Juniperus turkestanica, Juniperus semiglobosa*, *Sorbus tianschanica,* with codominant *Rosa albertii*, *Rosa spinosissima, Cotoneaster melanocarpa, Lonicera stenanta, Lonicera tatarica, Phlomis areolata, Gallium verum, Thalictrum minus, Aconitum songoricum.*
4. **"Steppe":** arid grassland with fescue grass and sagebrush species. Dominant are *Festuca valesiaca, Artemisia vulgaris,* with co-dominant *Artemisia dracunculus*.

During the survey, we collected and identified 43 species of macromycetes belonging to 17 families and 28 genera. Some species are connected to a certain symbiont tree species, others can be connected to both deciduous and coniferous trees. Based on literature data [3-7], we separated 12 species of mycorrhiza-forming mushrooms for the following tree species: spruce (7 species of mushrooms), juniper (1), birch (6), willow (4), honeysuckle (2), and pine (2). The distribution of macromycete fungi is determined by ecological conditions, mainly by substrate, humidity, temperature, light regime.

Table 2. Sample of the fungi data survey.

Sampling points	Elevation	GPS coordinates	Fungi species	Vegetation types
1.	2157 м	42°33'12"N 74°29'03,7"E	Russula vesca (D.) Russula heterophylla (D.) Lactarius deliciosus Leccinum scabrum Russula grisca Coprinus atramentarius Hebeloma crustiliniforme Agaricus silvaticus Hygrocybe conica Bovista vassjagiana Sarcodon imbricatus	Conifer forest with shrubs: Juniperus semiglobosa, Betula tianschanica, Rosa fedtschenkoana, Achillea setacea, Carex turkestanica.
4.	2204 м	42°33'38,1"N 74°28'52,2"E	Russula vesca (D.) Russula heterophylla (D.) Leccinum scabrum (D.) Lactarius deliciosus Hebeloma crustiliniforme Hygrocybe conica Agaricus silvaticus Bovista plumbea Mycena sp.	Broad leaf forest with shrubs: Betula tianschanica, Salix tianschanica, Juniperus semiglobosa, Juniperus sibirica, Juniperus turkestanica, Hyppophaë rhamnoides, Rosa spinosissima, Phlomoides orophila, Artemisia santalinifolia.

Plant communities of Ala-Archa National Park differ considerably in their structure, which determines variable systematic and ecological composition of mushrooms. In dense spruce forests, among mushrooms dominate *Lactarius deliciosus*, *Russula vesca, R. heterophulla,* and *Sarcodon imbricatus*, while at the clearings, one finds *Clitocybe dealbata, Agaricus compestris, A. silvaticus, Lycoperdon perlatum,* and *Bovista plumbea*. Steppe comunities lack forst mycorrhyzal fungi but are dominated by steppe and semidesert fungi species such as *Lepista saeva, Coprinus contatus, C. micaceus, Calvatia lilacina, C. lepidifolia,* and *Phallus imbricatus*.

For constructing our database [8], we used 27 species of fungi with 137 data point locations recorded with GPS. The studied types of vegetation are recognizable in the process of imagery analysis with ER Mapper 6.0 and ArcGIS 8.2 and served as ground proof points for digital mapping [1, 8, 9]. Higher resolution satellite imagery (USGS, Landsat 7 +ETM, 2002) was used for classification; it allowed for spatial analysis that provides correlation between species and habitats. Each sampling point in different types of coniferous forests and semi-desert environments was described and georeferenced with a GPS unit. Description included lists of identified fungi species for each location point. Microsoft Access was used for spreadsheet inclusion of data sets and supported by GPS references. These formats could be accessed by a standard web browser.

Fig. 1. Fragment of the digital map of forest types of Ala-Archa with fungi sampling point.

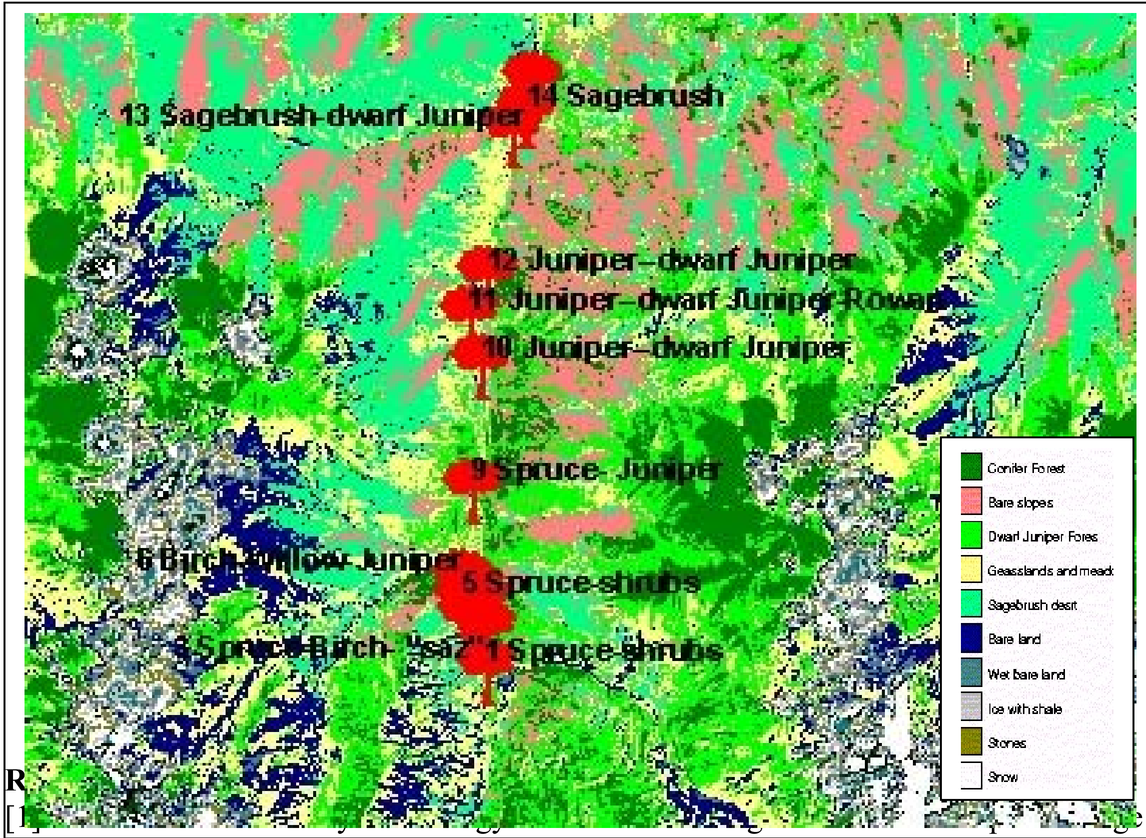

Image processing classification techniques such as ISOCLASS with ER Mapper software provided an opportunity for compute classification of the forest community types. Using image processing, we were able to outline compatible habitats in the forest communities. As a result, map representation of forest types distribution was obtained. Data registration and conversion included the following procedures: coordinates were imported into Excel spreadsheet, Landsat 7 +ETM imagery band combination overlay was performed with ER Mapper, image classification conducted and displayed, image enhancements improved the sharpness and intensity, and a legend produced with custom color selection. Satellite imagery of 30 m resolution (red, green, blue, bands 3, 2, 1) was data fused with intensity layer (band 8) of 15 m resolution.

The techniques that were used provide an opportunity for biodiversity mapping and evaluating forest community types. This study sets an example of GIS-linked biodiversity databases. Species descriptions and photographs were posted on a website, www.kyrgyzfungi.com. Further GIS-based studies will be directed toward mapping of the ranges of main types of forest communities and their fungal species. The studies of mycorrhizal fungi will contribute to the practical application for the forest plantations as well as for the study of the health of the natural forests. database to analyze relationships between ground-based inventories of mycorrhizal fungi and forest canopy structure.

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