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Phytodiversity and Lichenodiversity in the Conditions of Agricultural Landscapes In Southern Ukraine

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Abstract. The article presents the results of investigations of vascular plants, mosses and lichens diversity on the agricultural landscapes of southern Ukraine. Flora species of bryophytes agrolandscapes include anthotserotophytes, marshantyophytes and bryophytes. Bryophytes are dominant and include species of the family Pottiaceae (50,0 % of all the species composition) and Bryaceae (22,5 %). The vegetation is represented by the classes *Stellarietea mediae, Polygono arenastri–Poëtea annua, Agropyretea repentis, Chenopodietea*, including Red rare species – *Anacamptis picta* (Loisel.) R.M. Bateman, *Lepidium pumilum* Boiss. et Balansa and others. There are 944 species of weeds on agricultural landscapes in the south of Ukraine that grow spontaneously. The most common among them are 130–150 species, 500 species are adventive. The methods of rare diversity conservation and measures to fight weed infestation were proposed.

Keywords: *phytodiversity, lichenodiversity, agricultural landscapes, southern Ukraine*

Introduction. Agricultural landscapes are complex systems that were formed by the different elements of agroecosystems, with all chains of farming systems, with infrastructure and protective measures for consistent. The basis of agricultural landscapes are: agricultural land – arable land in the whole, fields of one-year crops, hays, pastures, fields of perennial grasses; artificial forest plantations – belts, artificial forests of various purposes with the tree and shrub components; transformed natural communities – the remnants of natural forests, natural meadows, natural steppe areas, marshes, wetlands, peatlands. The components of agricultural landscapes are also located in their territories erosion waterworks of different types, limits and rotation fields, country roads, hydrographic network, paved roads, various communication lines of high-power, gas distribution stations, building structures for various purposes, etc. [12; 15].

Agricultural landscapes of southern Ukraine are ecosystems that were formed as a result of agrarian transformation of steppe, ravine gully, river-valley, psamophytic, sea salt and over-firth coenoses and coenoses of rock outcrops.

Under the influence of irrigation agricultural landscapes has been degrading in southern Ukraine; southern black and brown soils as well as biota (primarily rare phytobiota and lichen biota) appeared to be very sensitive to high humidity [4]. The fundamental problem is the study of the current state of rare phytodiversity of southern Ukraine agricultural landscapes and strategies of its conservation and management, detection of rare phytodiversity state components, including vascular plants, bryophytes and lichens in order to develop strategies for their conservation and sustainable use based on autphytsozological index, index of rarity and synanthropisation index.

A brief literature review. In the scientific world there are a number of works on rare phytodiversity of agricultural landscapes (Beymer, Klopatek, 1991, Evans, Ehleringer, 1993; Eldridge, Kinnell, 1997; Belnap, Gardner, 1993; Harper, Belnap, 2001; De Falko et al., 2001; Maestre, 2003; D. Moon, 2009; M.Wingreen, 2010). Fragmented researches on rarity of phyto- lichen diversity of certain habitats were held in Ukraine (Бойко, 1988; Бойко та ін., 1984; Ходосовцев, 1999; Дідух та ін., 2009; Кагало 2010; Мойсієнко, 2010; Остапко, 2011; Перегрим, 2011). This indicates the relevance and necessity of our studies.

The purpose of research. The aim of the research was to establish the state of phyto- and lichen diversity of the agricultural landscapes of southern Ukraine – namely, the diversity of higher vascular plant, of non-vascular plants – mosses, and lichen diversity.

Materials and methods. Results are based on materials obtained during the research expedition in 2012–2014. We used conventional methods for botanical research: route-exploratory method and establishing of trial and sampling areas. During cameral processing of materials aimed to determine the species temporary microscopic preparations were used, which had been studied on binocular microscopes MBS-2 and MICMED-2. Materials were worked out in the laboratory of biodiversity and environmental monitoring named after J.K. Pachoski placed in the Department of Botany (Kherson State University).

Results and discussion. Results of integrated study of rare phytodiversity of agricultural landscapes, which enable to develop a strategy of management, conservation and protection, are given.

Bryophytes as phytodiversity components are common components of surface soil in agricultural landscapes with varying degrees of disturbance. To some extent, they perform stabilization role in agricultural landscapes, they are very sensitive to antropopression in general, especially in the steppe zone. Therefore, they can be used as indicators of digression and demutation of colorful kuazinatural and disturbed ecosystems of the steppe zone. According to our observationsaaaa bryophytes as elements of steppe zone phytodiversity, are components of the soil surface on agricultural landscapes of various degrees of disturbance.

Bryophyte flora on the south of Ukraine has 31 species of bryophytes. Division Anthocerotophyta is represented by one species – *Phaeoceros laevis* (L.) Prosk. of family Anthocerotaceae (3,2 % of species composition), Division

Marchantiophyta – by 3 species of following families: Ricciaceae (6,5 %) and Cephaloziellaceae (3,2 %), Division Bryophyta – by 27 species of 14 genera of 5 families. Among bryophytes there are dominant species: of the genus *Bryum* (7 species, 22,5 %) genera *Pleuridium, Acaulon, Microbryum, Phascum, Pterygoneur*um and *Tortula* are represented by 2 species. Among the dominant species of the family Pottiaceae (50,0 % of all the species composition) and Bryaceae (22,5 %), Funariaceae and Ditrichaceae are represented by 3 species, Ricciaceae – by two, Dicranaceae and Cephaloziellaceae – by just one. Most families are represented by 1-3 species. This is natural, since agricultural landscapes in their ecotope and general physiographic features are not species arena of shaping but of migration [2; 3]. On agricultural landscapes only upper sporogonium mosses are marked.

Best adapted to subsistence farming land are species with loose sod; there are 24 species of them. Wide areal species are dominat. They have holarctic, bipolar and cosmopolite ranges of 21 species. In relation to the prevailing humidity ecohydromorfes of mezoxerophytes and xerophytes are prevailing by reference to light of habitats – ecoheliomorpha of heliophytes, they are 27 species; by reference to the chemistry of the substrate incertophyles dominate with 18 species and Calcicole with 8 species; in relation to the substrate trophicity by mezotrophes (18 species) and mezoevtrophes by 6 species. As for sex structure, the mezoevtrophes and dioecious species are almost identical – 16 and 14 species, respectively, and inactive and less active species prevail – 15 and 5, which is not due to the formation of communities of farmland.

A number of key causes that prevent the increase lichen species diversity number in these areas was defined. The positive dynamics of increasing diversity of species were observed for only epiphytic species and species that grow in a dusty area. Concrete slabs of channels and arica, concrete floors of agricultural facilities of agronomy and zootechnical character building with limestone dust of crushed stone roads create some special conditions which lead to the spread of such species. It is the concrete slabs of irrigation canals where we had found a new species to science – lichen *Caloplaca wucuricola* and lichenicolous fungus *Prouectria caloplacae*, which grew at *Caloplaca austrocitrina* [16, 18]. A number of species such as *Collemopsidium augermanicum, Staurothele ambrosiana, Caloplaca soralifera* were defined for the first time in Ukraine [14, 15]. The dominant species on concreted slabs are *Candelariella aurella, Caloplaca flavocitrina, C. teicholyta, C. crenulatella, Verrucaria nigrescens*.

Lichens that grow on the bark of trees can be used as bioindicators on nitrates. Lihenobyota belts are represented by 41 species of lichens and lichenicolous fungi. There are the most common species *Amandinea punctata, Lecanora hagenii, L. saligna, L. carpinea, Lecidella elaeochroma, Pleurosticta acetabulum, Parmelia sulcata, Melanelixia subuarifera, Evernia prunastri, Scoliciosporum sarotamnii* and others [13].

Forest belts located in the coastal zone contain significant amounts of bushy lichens, including *Ramalina fastigiata, R. pollinaria, R. fraxinea, Anaptychia ciliaris*.

Ravines and gullies remained almost the only refuge steppe vegetation among the agricultural landscapes of southern Ukraine. Interestingly enough in lichenologic respect is complex ravine and gully systems where natural areas were preserved as a narrow strip along the right bank of the Lower Dnieper. At the territory of investigated gullies there is an architectural monument – XVIII century bridge. On the concrete of the bridge 12 species of lichens were found, including conventional species *Lecanora albescens* (Hoffm.) Branth & Rostr., *L. dispersa* (Pers.) Sommerf., *Caloplaca saxicola* (Hoffm.) Nordin, *Candelariella aurella* (Hoffm.) Zahlbr. Also other species were found such as *Caloplaca concrecicola* Vondrak & Khodosovtsev, *C. coronata* (Köerb.) J. Steiner, *C. teicholyta* (Ach.) J. Steiner. – on the covered bridge's surface; *C. decipiens* (Arnold) Blomb. & Forssell, *C. flavocitrina* (Nyl.) H. Oliver, *Lecania inundata* (Hepp ex Körber) M. Mayrhofer, L. turicensis (Hepp) Müll. Arg. – on the vertical shaded surfaces; *Lecanora crenulata* Hook. – on the horizontal surfaces of the bridge, *Staurothele ambrosiana* (A. Massal.) Zsch., which has previously been found on southern Ukraine anthropogenic substrates [8]. Concrete slabs of a dam were studied and the following species of *Caloplaca* have been found there: *Caloplaca concreticola* Vondrák & Khodos., *C. crenulatella* (Nyl.), *C. decipiens* (Arnold) Blomb. & Forssell, C. flavocitrina (Nyl.), *C. saxicola* (Hoffm.) [9].

To study the flora of vascular plants we laid the model sites that were selected taking into account geobotanic units in the south of Ukraine –subzone desert wormwood-grass steppes.Vegetation is represented by steppe, halophytic and psamophytic: wormwood-fescue-grass vegetation of sandy steppes (dominants are *Festuca valesiaca* Gaudin, *Stipa lessingiana* Trin. & Rupr., *Stipa ucrainica* P.A. Smirn., *Artemisia austriaca* Jacq. Agrophytocenoses on their place in conjunction with halophytic groups); saline meadows and psamophytic groups (*Alopecurus pratensis* L., *Elytrigia pseudocaesia* (Pacz.) Prokudin, *Puccinellia fominii* Bilyk (fragments) and agrophytocenoses in their place). Vegetation of investigated area is characterized by high halophytization and the average percentage of the area of natural lands [9].

Ruderal vegetation is confined mostly to the roads and roadsides belts. Vegetation of roads and roadsides belts is represented by *Artemisia absinthium* L., *Euphorbia seguierana* Neck, *Polygonum novoascaniucum* Klokov, *Sysimbrium loeselii* L., *Xanthium albinum* (Widd.) H. Scholz. Woody vegetation is represented by *Elaeagnus angustifolia* L., *Robinia pseudoacacia* L., *Salix alba* L. and *Quercus robur* L., shrub vegetation – by *Swida alba* (L.) Opiz. A class Stellarietea mediae representatives are: *Ambrosia artemisiifolia* L., *Chenopodium album* L., *Elytrigia repens* (L.) Nevski, *Erodium cicutarium* (L.) L`Her., *Polygonum aviculare* L. s.str., P. *novoascaniucum* Klokov mainly grow in belts. Grouping class Polygono arenastri-Poëtea annua with the dominance of *Polygonum aviculare, P. novoascanicum* and *Plantago lanceolata* confined to roadsides, and are characterized by soil disturbance. Also characteristic types of the roads are representatives of class Agropyretea repentis – *Convolvulus arvensis* L. and *Elytrigia repens* (L.) Nevski., *Anisantha tectorum* (L.) Nevski, *Artemisia austriaca* Jacq. and *Bromus squarrosus* L. Dominants that grow along the roads and in fallow, in forest belts are: *Conyza canadensis* (L.) Cronqist, *Secale sylvestre* Host, *Sysimbrium loeselii* L., *Berteroa incana* (L.) DC. The vegetation consists mainly of Chenopodietea class groups with

dominating of *Atriplex tatarica* L., *A. sagittata* Borkh, *Chenopodium album* L. and *Bromus squarrosus* L. on abandoned pastures. *Xanthium albinum* (Widd.) H.Scholz (representative of the class Bidentea riparii) occurs as sporadic and forms thickets monospecies brushwood [11].

An analysis of the species composition of belts and road verges vegetation found indigenous rare species of higher vascular plants (rare for these elements of agricultural landscapes): *Agropyron pectinatum* (M.Bieb.) P. Beauv., *Dianthus guttatus* M. Bieb., *Koeleria cristata* (L.) Pers., *Linaria biebersteinii* Besser, *Salvia nemorosa* L., *Salvia aethiopis* L. All these endangered species by Belgrade's xenomorphes are stepanties which are typical for the area where which the study was conducted [1]. Examples of measures to increase the number of indigenous species and further species diversity in forest belts and along roadsides within the band of wormwood-grass steppes are seeding the caryopsides of turf grasses such as *Agropyron pectinatum* and *Koeleria cristata*, various species of *Stipa* genus.

Another type is fallow agricultural landscapes. Depending on the age and distance to natural species diversity fallow cells can serve as an example of successful self-healing. In areas with high level of halophytization of vegetation fallows were investigated, where extensive grazing is observed during the last decade. At the investigational tract "Dolyna Kurganiv" (designed Regional Landscape Park) in 2014 more than 400 species were recorded such as *Anacamptis picta* (Loisel.) R.M. Bateman (on an area of 80 square meters), which is protected by the Red Data Book of Ukraine, Berne Convention and CITIES. Within this investigational tract wet salt marshes population *Lepidium pumilum* Boiss. et Balansa was described, which is listed in the European Red List on an area of about 1 km, the average density of individuals per 1m² was 15 [10].

So in areas with a relatively large area with decreasing anthropogenic pressure the reduction processes take place in species composition. Such elements of agricultural landscapes surrounding the natural reserve can serve as an additional buffer zone.

The high proportion of arable land causes a threat to the conservation of floristic diversity of agricultural landscapes [14]. Agricultural landscapes are the arena for the development of segetal phytobiota Agricultural landscapes in the south of Ukraine contain spontaneously growing 944 species of weeds [5], more than 500 species of them are adventive, they occupy ruderal places and plant crops. They cause great harm in new regions through intensive expansion. Adventive plants, getting into new territory, primarily colonize ruderal habitat, but then settle in plant crops. They can bring great harm because they don't have new deterrent mechanisms of spreading (such as diseases and pests which occur on their home area) and can carry out expansion.

As a result of our research (2013–2014) Agrophytocenoses massively clogged the following adventitious species: a) segetal – *Amaranthus albus* L., *A. blitoides* S. Watson, *A. powellii* S. Watson, *A. retroflexus* L., *Brassica campestris* L ., *Capsella bursa-pastoris* (L.) Medic., *Chenopodium suecicum* J. Murr., *Conyza canadensis* (L.) Cronq., *Descurania sophia* (L.) Webb. ex Prantl,, *Echinochloa crus-galli* (L.) P. Beauv., *Galeopsis ladanum* L., *Galinsoga parviflora* Cav., *G. urticifolia* (Kunth) Benth., *Papaver rhoeas* L., *Portulaca oleracea* L .., *Raphanus raphanistrum* L ., *Sinapsis arvensis* L., *Sisymbrium loeselii* L., *Sonchus arvensis* L., *S. asper* (L.) Hill., *S. oleraceus* L., *Tripleurospermum inodorum* (L ..) Sch. Bip., *Xanthium albinum* (Widd.) H. Scholz, etc .; b) pasture – *Anisantha tectorum* (L.) Nevski, *Carduus acanthoides* L., *Phalacroloma annuum* (L.) Dumort, *Peganum harmala* L., *Xanthium albinum* etc .; c) ruderal – *Artemisia absinthium* L., *Conium maculatum* L., *Lepidium ruderale* L., *Malva neglecta* Wallr., *M. pusilla* Smith et al.

We offer one of the measures to combat the invasion of weeds, including their distribution of agrophytocenoses in Southern Ukraine. This method applies to biological methods and lies in the formation of peculiar culturesphytocoenoses on the edges of agrophytocenoses. In natural phytocenoses which were not affected by human activities, real weed almost never happens, although soil samples of virgin land plowing their weed seeds are usually found. This is the ultimate saturation, isolation and inaccessibility of natural plant communities to settle adventive species.

The observations argue that the best anti-weeds (especially perennials root shoots) are turf grasses: *Stipa capillata* L., *Stipa lessingiana* Trin. et Rupr., *Stipa ucrainica* P. Smim., *Festuca valesiaca* Gaud. – in black and brown soils. In the impurity different species of grasses can be used – *Phlomis hybrida* Zelen., *P. pungens* Willd., *Salvia nutans* L. If agrophytocenoses are located on sandy soils (eg fighting *Cenchrus pauciflorus* Benth.) in this case the following seed can be used: *Stipa borysthenica* Klokov ex Prokud. and *Agropyron dasyanthum* Ledeb. Crops of cultivated crops (eg. sunflower), which ripen in autumn are recommended to plant with shrubs *Caragana scytica* (Kom.) Pojrk around. It will delay the evil weed seeds such as *Ambrosia artemisiifolia* – species, whose expansion in the steppe zone led to its mass participation in segetal, ruderal and natural vegetation communities.

Conclusions. Agricultural landscapes are characterized by specific phyto and lihenodiversity. Lihenodiversity is best represented in agricultural landscapes on such elements as concrete slabs channels and Arica, concrete floors of agricultural facilities, zootechnical building with limestone dust of crushed stone roads. Flora of vascular plants found to be indigenous rare (rare for these elements of agricultural landscapes): *Agropyron pectinatum, Dianthus guttatus, Koeleria cristata, Linaria biebersteinii, Salvia nemorosa, Salvia aethiopis*. Non-vascular plant flora include the following species: antotserotophytes marshantsyophytes and bryophytes. Dominated bryophytes include species of the family Pottiaceae (50,0 % of all the species composition) and Bryaceae (22,5 %). Vegetation species of agricultural landscapes are represented by classes *Stellarietea mediae, Polygono arenastri-Poëtea annua, Agropyretea repentis, Chenopodietea*, including Red rare species – *Anacamptis picta* (Loisel.) R.M. Bateman, *Lepidium pumilum* Boiss. et Balansa and others. There are 944 species of weeds on agricultural landscapes in the south of Ukraine that grow spontaneously, more than 500 species are adventive. The methods of rare diversity conservation and measures to fight weed infestation were proposed.

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Бойко М.Ф., Ходосовцев О.Є., Гавриленко Л. М., Мельник Р.П., Клименко В.М., Шапошникова А.О. Фиторазнообразие и лихеноразнообразие в условиях агроландшафтов юга Украины

Аннотация. В статье подаются результаты исследований разнообразия сосудистых растений, мохообразных и лишайников агроланшафтов юга Украины. Флору мохообразных агроландшафтов составляют виды антоцеротофитов, маршанциофитов и бриофитов. Доминируют бриофиты, среди которых види семейства Pottiaceae (50,0 % всого видового состава) и Bryaceae (22,5 %). Растительность представлена видами классов *Stellarietea mediae, Polygono arenastri-Poëtea annua, Agropyretea repentis, Chenopodietea,* в т.ч. редкими краснокнижными видами – *Anacamptis picta* (Loisel.) R.M. Bateman, *Lepidium pumilum* Boiss. et Balansa и др. В агроландшафтах юга Украины спонтанно произрастают 944 виды сорняков. Наиболее распространенными среди них считаются 130–150 видов, свыше 500 видов являються адвентивными. Предложены методы охраны раритетного биоразнообразия и мероприятия борьбы с инвазией сорняков.

Ключевые слова*: *фиторазнообразие, лихеноразнообразие, агроландшафты, юг Украины