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Grasslands and coastal habitats of Southern Ukraine: First results from the 15th EDGG Field Workshop

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Abstract: The 15th EDGG Field Workshop took place from 24 May to 3 June 2021 in Southern Ukraine (Kherson and Mykolaiv administrative regions). Over 10 days, we sampled different types of grasslands, mainly focusing on dry grasslands of the classes *Festuco-Brometea, Koelerio-Corynephoretea canescentis*, and *Festuco-Puccinellietea* (steppic, sandy and saline, respectively) but also taking into account other open habitats, such as mesic grasslands and dunes. In total, we sampled 50 nested-plot series with 7–8 grain sizes from 1 cm2 to 100 m2 and, in some cases, up to 1000 m2 ("EDGG Biodiversity Plots"), plus 74 additional normal plots of 10 m2 . We comprehensively sampled vascular plants as well as terricolous bryophytes and lichens, and, for the first time also Sciaridae (Diptera, Insecta). One vascular plant species (*Torilis pseudonodosa*), as well as two lichen species (*Cladonia conista* and *Endocarpon loscosii*), were recorded for the first time from Ukraine. Two species of moss (*Rhynchostegium megapolitanum* and *Ptychostomum torquescens*) and three species of lichen (*Cladonia cervicornis, C. symphycarpa*, and *Involucropyrenium breussi*) were reported for the first time for the Kherson region. We summarize the scale-dependent richness values and compare them with those from other studies. The report concludes with a photo diary with impressions from the Field Workshop.

Keywords: biodiversity; bryophyte; coastal habitat; grassland; lichen; nested plot; sandy grassland; species richness; steppe; syntaxonomy; Ukraine; vascular plant.

Nomenclature: Euro+Med (2006-2021) for vascular plants, Boiko (2014) for bryophytes, Kondratyuk et al. (2021) for lichens and lichenicolous fungi; Mucina et al. (2016) for syntaxa.

Abbreviations: EDGG = Eurasian Dry Grassland Group; FW = Field Workshop; NNP = National Nature Park; RLP = Regional Landscape Park.

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Introduction

One of the most prominent activities of the Eurasian Dry Grassland Group (EDGG) are Field Workshops (FWs). These are research expeditions that aim to collect high-quality phytodiversity data in different types of grasslands and other open habitats throughout the Palaearctic, applying the standard EDGG methodology, including nested-plot sampling (Dengler et al. 2016, 2021). They take place in different countries once or twice per year. Since the first FW in Transylvania (Romania) in 2009 (Dengler et al. 2012), and up until 2020, the EDGG has organized 14 of these events. A series of papers has already been published based on the results of the FWs. Among them, there are regional syntaxonomical surveys (Dengler et al. 2012; Pedashenko et al. 2013; Kuzemko et al. 2014; García-Mijangos et al. 2021; Magnes et al. 2021) and regional studies of patterns and drivers of plant diversity (Turtureanu et al. 2014; Kuzemko et al. 2016; Polyakova et al. 2016; Dembicz et al. 2021b). Additionally, data from the FWs represent a relevant part of the "GrassPlot" database (Dengler et al. 2018; Biurrun et al. 2019) and have been used for several overarching papers dealing with alpha and beta diversity on the continental scale (Dengler et al. 2020a; Biurrun et al. 2021; Dembicz et al. 2021a, 2021c; Zhang et al. 2021).

In 2021, two more Field Workshops were held aiming to sample grasslands in Southern Ukraine (15th FW) and alpine habitats in Switzerland (16th FW). The 15th was the second FW organized in Ukraine. The first was in 2010 in Central Podolia, Vinnytsia region, which is located in the Forest-Steppe zone (Barbarych 1977). The main focus then was on dry grasslands, mainly meadow steppes and rocky grasslands (Kuzemko et al. 2014, 2016). During the second Ukrainian FW, we conducted sampling in the southern part of the steppe zone (Kherson and Mykolaiv regions), focusing mainly on dry grasslands (desert steppes, bunchgrass steppes, saline and sandy grasslands), but other vegetation types - mesic grasslands, dunes and saline communities - were also included in our survey:. For the first time in the history of the EDGG FWs, we sampled a few 1000-m² plots in addition to the seven standard grain sizes of 0.0001–100 m², as recommended in the second amendment of the standardized EDGG sampling methodology (Dengler et al. 2021). Also, for the first time, Sciaridae (Diptera, Insecta) were recorded during the event.

In this report, we give an overview of the sampling and present initial data on first records for species and scale-dependent biodiversity values. The report concludes with an extensive photo diary summarizing the impressions.

The 15th EDGG Field Workshop

The Field Workshop was attended by 20 participants from four countries (Ukraine, Italy, Poland and Switzerland) (Fig. 1). The majority of the participants had experience of vegetation sampling. In addition, our team included experts in the taxonomy of the genus *Festuca*, lichens, bryophytes, and also of the family Sciaridae (Diptera). Along with nested -plot series, we sampled so-called "normal" vegetation plots of 10 m2. In each 10-m2 plot (i.e., normal plots + subplots of nested series), several environmental and structural parameters were recorded including cover of vegetation layers and of litter, slope, aspect, inclination, maximum microrelief, soil depth, etc. In addition, we also sampled soil and above-ground biomass of four fractions: necromass, living

Fig. 1. Above: Participants of the 15th EDGG Field Workshop during the first day in meadows dominated by *Ventenata dubia* ("Chorna Dolyna'' steppe depression). Photo: J. Dengler. Below: Participants of the Field Workshop near Syvash Lake. Photo: D. Vynokurov.

bryophytes and lichens, living herbs and living woody species using a circle-shaped frame of 0.25 m2.

During the Field Workshop, the so-called "dark-winged fungus gnats" (family Sciaridae, order Diptera, class Insecta) were collected inside the plots and their surroundings within the same habitat by non-accounting sweep-netting. Sciarid imagos were picked with an aspirator, killed in ethyl acetate vapor, transferred into 5 ml vials and stored in 70% ethanol. In the laboratory, male specimens were dehydrated in absolute ethanol and mounted on slides in Euparal.

During 10 days of intensive sampling, we studied different types of grasslands in two administrative regions of Ukraine, i.e., Kherson and Mykolaiv oblasts (Fig. 2, Table 1). Except in a few cases, we worked in nature protected areas: Black Sea Biosphere Reserve, and five national nature parks (NNP): Azov-Syvash, Dzharylgach, Biloberezhzhia Sviatoslava, Oleshkivski Pisky and Kamians'ka Sich.

This area is situated in the central-southern part of the Black Sea Lowlands in the southern part of the steppe zone of Ukraine, within two geobotanical belts using the national classification system (Barbarych 1977); namely sagebrush-fescue-steppes (or desert steppes) and fescue-feathergrass-steppes (or bunchgrass steppes). The climate of the study area is characterized by hot summers with a long dry period and short mild winters with little snow cover. The average annual precipitation is about 380 mm. The average temperature of the warmest month (July) is 23–24°C (maximum 39°C; the average temperature of the coldest month (January) ranges from -1 to -4°C (minimum -31°C) (Marynych & Shyshchenko 2005). In the belt of the desert steppes, the soils are mainly dark kastanozems occurring in in combination with saline soils. In the belt of bunchgrass steppes, they are southern chernozems with low amounts of humus and alluvium of the sand terraces of the new and older riverbeds of the Dnipro River (Skliar & Hil'chenko 1969).

In total, we sampled 50 nested-plot series (EDGG Biodiversity Plots) with 7 grain sizes from 1 cm^2 to 100 m^2, in 16 cases with an 8th grain size of 1000 m^2, and 74 additional "normal" plots of 10 m^2. When the 10-m^2 subplots from the nested-plot series are included, a total of 174 10-m^2 plots were sampled. Compared to the previous EDGG Field Workshops, this makes the 15th Field Workshop the most productive in terms of the number of EDGG biodiversity plots recorded, followed by the ones in Khakassia, Russia (39) and Navarra, Spain (35). Moreover, this year's event ranks second with respect to the number of 10-m^2 plots sampled, after the 2nd Field Workshop in Central Podolia, Ukraine (226) and followed by 12th Field Workshop in Switzerland (142).

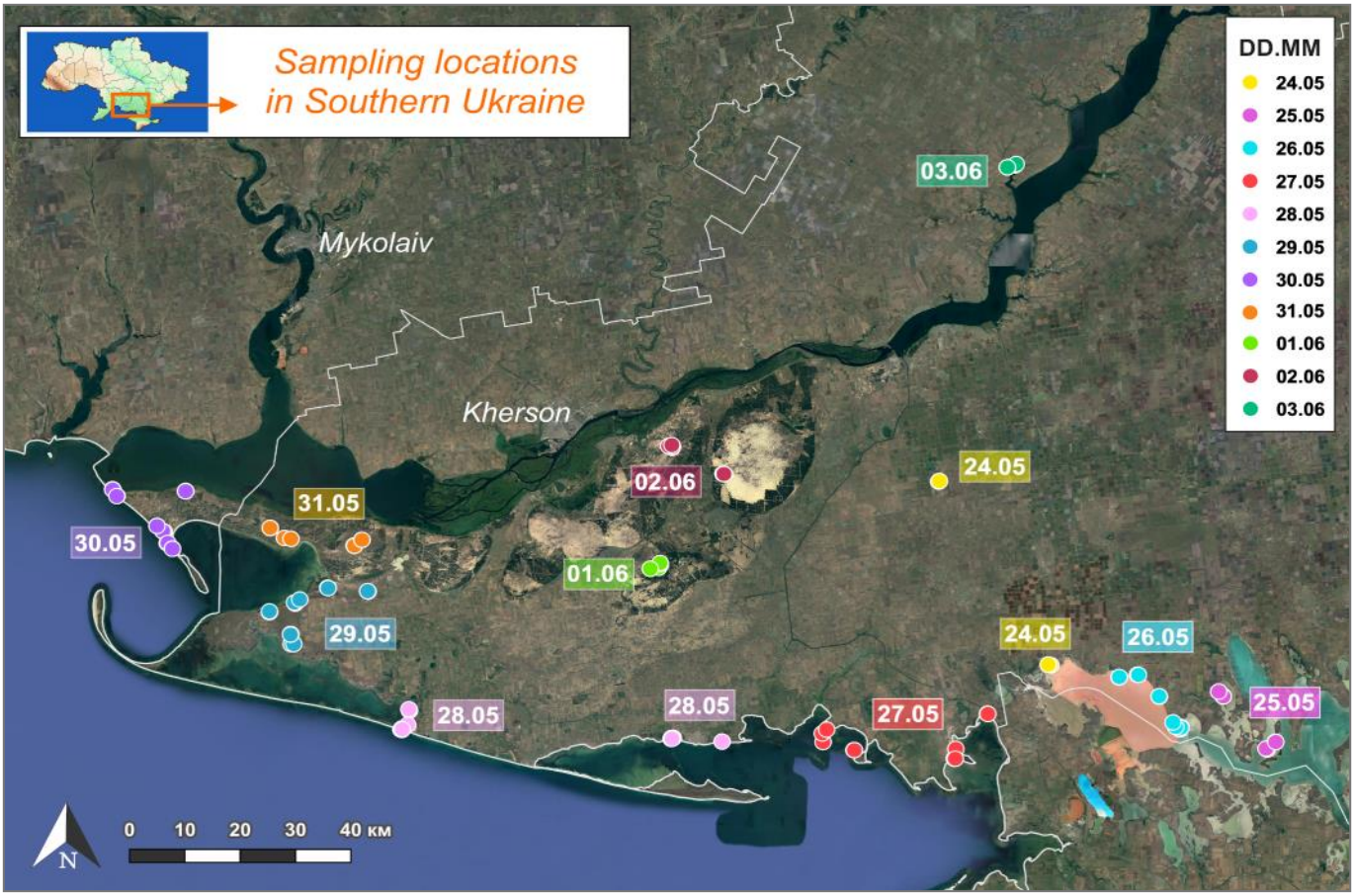

Fig. 2. Map of the study region showing sampling localities. Base map: ©2021 Google (satellite image) and ©www.minregion.gov.ua (administrative boundaries). Prepared by D. Shyriaieva.

Table 1. Sampling sites studied during the 15th EDGG Field Workshop 2021 in Ukraine (A – number of EDGG Biodiversity Plots, B – number of additional 10-m² plots, C – total number of 10-m² plots considering those from biodiversity series, D - number of 1000 m² plots). The location of the sites is shown in Fig. 2. NPP - National Nature Park. Protected areas marked with an asterisk (*) are projected.

Date	Region (oblast)	Protected area	Site location	Vegetation type	A	B	C	D
24 May	Kherson	"Chorna Dolyna" Landscape Reserve (*)	Pid "Chorna Dolyna"	Steppe depression (pody)	2	0	4	1
24 May	Kherson	"Western Syvash" Landscape Reserve (*)	Pershokostyantynivka	Desert steppe	2	2	6	1
25 May	Kherson	Azovo-Syvash NNP	Churiuk Island	Desert steppe, bunchgrass steppe	2	4	8	1
25 May	Kherson	-	Vasylivka, Zelenovsky Island	Desert steppe, bunchgrass steppe	3	1	7	0
26 May	Kherson	"Western Syvash" Landscape Reserve (*)	Vasylivka, Kutara Cape	Desert steppe	3	6	12	1
26 May	Kherson	"Western Syvash" Landscape Reserve (*)	Ivanivka, Berezina Cape	Desert steppe, saline grassland	2	4	8	0
27 May	Kherson	"Peninsula Mala Kosa" Landscape Reserve (*)	Oleksandrivka, Mala Kosa, Stavky	Bunchgrass steppe	2	1	5	0
27 May	Kherson	"Sofia`s Steppe" Landscape Reserve (*)	Khorly Peninsula	Bunchgrass steppe	1	4	6	0
27 May	Kherson	"Karadai" Landscape Reserve (*)	Karadai Peninsula	Bunchgrass steppe, subsaline steppe	1	2	4	1
28 May	Kherson	Dzharylhach NNP	Skadovs'k	Subsaline steppe, desert steppe	2	5	9	1
28 May	Kherson	Black Sea Biosphere Reserve	Potiivska site	Subsaline steppe, dune and saline grassland	3	6	12	1
29 May	Kherson	"Yagorlyts`kyi Step" Zoological Reserve (*)	Yagorlytsky Kut, Yagorlyk Polygon	Subsaline steppe, bunchgrass steppe, dune vegetation	3	8	14	1
29 May	Kherson	Valley of Kurgans NNP (*)	Valley of Kurgans	Subsaline steppe, saline grassland	2	4	8	2
30 May	Mykolaiv	Kinburn Spit RLP	Kinburn Peninsula, Pokrovska spit	Sand steppe, dune vegetation, saline grassland	7	4	18	1
30 May	Mykolaiv	Black Sea Biosphere Reserve	Kinburn Peninsula, Volyzhyn Forest	Sand steppe	1	3	5	1
30 May	Mykolaiv	Biloberezhzhia Sviatoslava NNP	Kinburn Spit	Saline grassland, dune vegetation	1	5	7	0
31 May	Kherson	Black Sea Biosphere Reserve	Solonoozerna Dacha	Sand steppe	3	2	8	2
31 May	Kherson	Black Sea Biosphere Reserve	Ivano-Rybal'chanska Dacha	Sand steppe	2	2	6	0
01 Jun	Kherson	Oleshkivski Pisky NNP	Burkuty	Sand steppe, mesic sandy grassland, hemipsammophitic steppe	2	5	9	1
02 Jun	Kherson	Oleshkivski Pisky NNP	Radensk	Sand steppe	2	2	6	0
02 Jun	Kherson	"Sahy"Landscape Reserve	Sahy	Sand steppe	2	4	8	1
03 Jun	Kherson	Kamianska Sich NNP	Mylove	Bunchgrass steppe, calcareous rocky grassland	2	0	4	0

Initial results and discussion

Floristic composition and species of special interest

Vascular plants

According to preliminary results, 502 vascular plant species were recorded across all vegetation plots. After final checking, the number may be slightly amended.

We recorded many rare and endangered vascular plant species, according to the Red Data Book of Ukraine (Didukh 2009) and regional red lists of Kherson and Mykolaiv regions (Andriyenko & Peregrym 2012), in different habitat types as described below:

- white dunes: *Crambe maritima, Eryngium maritimum, Odontarrhena borzaeana, Polygonum euxinum, P. mesembricum*;
- psammophitic dry grasslands: *Agropyron dasyanthum, Centaurea breviceps, Odontarrhena tortuosa* subsp. *savranica, Stipa borysthenica*;
- steppe depressions: *Elytrigia repens* subsp. *pseudocaesia*;
- bunchgrass steppes: *Caragana scythica, Ephedra distachya, Stipa capillata, S. lessingiana, S. ucrainica*;
- desert steppes: *Goniolimon rubellum, Limonium tschurjukiense*;
- mesic sandy grasslands: *Anacamptis coriophora, A. morio* subsp. *picta, A. palustris, Schoenus nigricans*, etc.

We also recorded a new vascular species for Ukraine – *Torilis pseudonodosa*. It was discovered on May 28, 2021 in the territory of the Potiivska site of the Black Sea Biosphere Reserve in the EDGG Biodiversity Plot UAS20. A scientific paper on this topic has been published (Moysiyenko et al. 2022).

Narrow-leaved fescues

During the Field Workshop, Iryna Bednarska, our specialist on the genus *Festuca*, sampled 39 populations of narrow-leaved fescues that belong to the critical taxa of *Festuca valesiaca* agg. (F. *valesiaca, F. stricta* subsp. *sulcata* and a number of taxa related to *F. callieri*) and to F. *beckeri*. The total number of samples was around 1,000. Preliminary analysis of anatomical and morphological features, as well as chromosome number analysis, allowed us to outline that the large majority of the studied samples/populations belong to *Festuca callieri* and related taxa. Populations of *F. stricta* subsp. *sulcata* were only confirmed from the Kamianska Sich NNP (last day of the expedition). F. *valesiaca* s.str is also rare. So far, only two localities of the latter species were confirmed: in the vicinity of the village Vasylivka on the shore of Syvash Lake (plot UAS09) and in the Karaday Peninsula (plot UAS70R). Such results are surprising, as until now, it has been generally accepted that the two species – *Festuca rupicola* Heuff. (*Festuca stricta* subsp. *sulcata* according to Euro+Med) and *F. valesiaca* – are the main dominants of dry grasslands in the steppe zone of Ukraine. At the same time, F. *callieri* s.str. to date, has only been known from Ukraine from the Crimea. Thus, the widespread distribution of the species and related taxa in southern Ukraine was discovered for the first time. The data show significant heterogeneity within the group of *Festuca callieri* and possibly include a new species to science. Based on the morphological features, our provisional conclusion is that hybrids between the species related to F. *callieri* (4x) and *F. beckeri* (2x) are present in the "Oleshkivski Pisky" NNP and in the "Sahy" reserve which would be a novel discovery. However, this needs to be confirmed by flow cytometry and sequencing of both the assumed hybrids and their tentative parent species.

Bryophytes

We collected more than 200 herbarium specimens of bryophytes during the Field Workshop. Three liverwort species (*Riccia lamellosa, R. pseudopapillosa* and *Cephaloziella divaricata*) and 37 moss species were identified. The moss layer most often consisted of *Syntrichia ruralis, S. ruraliformis* and *Ceratodon purpureus*, with admixtures of ephemeral *Tortula* and *Pterygoneurum* species. Combinations of different *Bryum* species were also observed. In areas with dense grass cover, a combination of *Syntrichia ruraliformis* with pleurocarpous mosses of the family Brachytheciaceae were found. Two species were reported for the first time for the Kherson region namely *Rhynchostegium megapolitanum* and *Ptychostomum torquescens*. Other moss species were typical representatives of the European steppe zone (Boiko 1999), together with *Microbryum curvicollum* and *Weissia levieri*, which are included in the Red Data Book of European bryophytes (Stewart et al. 1995). The list of species will be updated after finalizing the identification of some specimens of *Bryum* that were in a sterile and partly necrotized state at the time of collection.

Lichens

In the sampled plots, we registered 44 lichens and lichenicolous fungi in different grassland types, among them 33 species growing on soil, and nine species on shrubs and plant debris, while two species were lichenicolous fungi. Only terricolous lichens were counted for the species richness values so as to be consistent with the EDGG standardized sampling methodology. The lichens *Cladonia conista* and *Endocarpon loscosii* were recorded for the first time from Ukraine. The foliose lichens *Cladonia cervicornis* and *C. symphycarpa*, as well as the inconspicuous crustose lichen Involucropyrenium breussi recorded from the desert steppes, are new records for the Kherson region. The latter was described recently and its locality in the Kherson region is only the second known site worldwide apart from the type locality in the Kharkiv region (Gromakova & Kondratyuk 2017). Surprisingly, immersed in soil we found the fruiting bodies of the ephemeral lichen *Thelocarpon imperceptum*, that has few records worldwide (Khodosovtsev et al. 2010). Moreo-

ver, further studies may lead to the description of a lichen (Megasporaceae) new to science, which was collected in the "Sahy" Landscape Reserve. Among the rare species, the Red Data book lichens *Agrestia hispida* and *Xanthoparmelia camtschadales* were recorded in plots of desert steppe vegetation. The richest cover of lichens was observed in sandy grasslands of Black Sea Reserve. There, *Cladonia foliacea, C. mitis, C. rangiformis* and *C. furcata* had up to 30% cover in the plots. Moreover, strange forms of *Cladonia rangiformis*, which had strongly-branched podetia with a dark brown exposed side and a marble dot-white bottom side (typical for the species) and a K+ yellow reaction, were found in open places in the Black Sea Reserve. The cyanolichens *Enchylium tenax* and *Blennothallia crispa* were frequently found in semi-desert steppes along Syvash Lake. Sometimes, in vegetation plots, twigs (of *Kochia, Halocnemum* and *Artemisia*) hosted small, corticolous lichens, such as *Caloplaca sterilis, Fominiella skii, Rinodina pyrina, Seawardiella lobulata, Xanthocarpia raesaenenii, Xanthoria parietina*, etc.

Sciaridae

During the expedition, we collected 17 ethanol samples in which 320 female and 62 male imagos were found. Female imagos were left in the samples because identification to species is impossible. Males were mounted on slides and studied using a PZO "Biolar" microscope. All of the studied material is kept in Andriy Babytskiy's private collection, Kyiv (PABK) – specimens No 3628 – 3689. Among the mounted material, we identified 14 sciarid species from six genera (examples: Fig. 3). Apparently, all of these species are new for Ukraine but their identification needs additional confirmation.

Vegetation

We can preliminarily assign the sampled plots to eight vegetation classes (Table 2). Zonal vegetation was represented by steppe communities of the *Festuco-Brometea*: bunchgrass steppes with dominance of narrow-leaved turf grass species, such as taxa of *Festuca valesiaca* agg., *Stipa spp*., and desert steppes, characterized by higher proportion of subshrubs, namely *Artemisia taurica, A. lerchiana, Salsola laricina, Camphorosma monspeliaca* and *Bassia prostrata* (Fig. 4E). We sampled these vegetation types on the northern shore of Syvash Lake (Fig. 5) and along the Black Sea coast. During the last day of the expedition, we sampled two EDGG Biodiversity Plots in calcareous rocky grasslands which also belong to the *Festuco-Brometea* vegetation class. In some areas, due to higher salinity, zonal communities were replaced by subsaline steppes, with *Limonium gmelinii, Artemisia santonicum* and *Halimione verrucifera*, which are assigned to the class *Festuco-Puccinellietea* within the alliance *Diantho guttati-Milion vernalis* (Fig. 4D). We sampled such communities mainly in the territory of the Black Sea Biosphere Reserve (Potiivka and Yahorlytsky Kut sites), but also along the sea coast. Among the non-zonal herbaceous vegetation types, the most common were saline (mostly *Festuco-Puccinellietea*, occasionally Juncetea *maritimi*) and sandy grasslands (*Koelerio-Corynephoretea canescentis*). The former was common along the seacoast; the latter is widely spread on the vast alluvial deposits of the Dnipro River (Fig. 4F), as well as on the dune system of the Black Sea (*Cakiletea maritimae* and *Ammophiletea*) (Figs. 4B, 5). Mesic grassland communities were not common in the study region. They occupied temporarily-flooded steppe depressions with Planosol soils (so called 'pody') and are classified within the *Molinio-Arrhenatheretea* vegetation

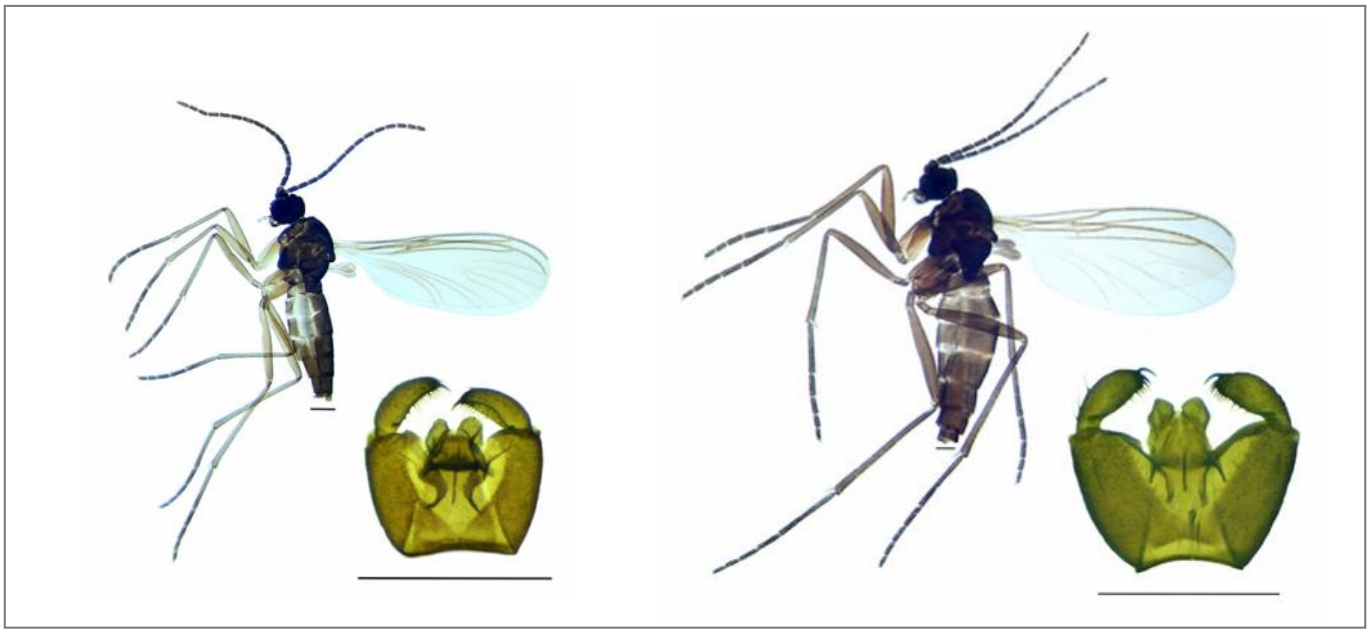

Fig. 3. Sciaridae specimens collected during the Field Workshop: male imago and terminalia (scale bars 0.2 mm). A - *Lycoriella sp*., B - *Bradysia sp*.

Fig. 4. Different grassland types sampled during the Field Workshop. A - steppe depression (pody) vegetation with *Ventenata dubia* and *Anthemis ruthenica*; B - white dunes with *Leymus racemosus* subsp. *sabulosus*, *Odontarrhena borzaeana* and *Carex colchica*; C - sandy mesic grasslands with *Scirpoides holoschoenus* and *Anacamptis palustris*; D - subsaline steppes with *Festuca callieri* agg. and *Limonium gmelinii*; E - desert steppes with *Artemisia taurica*, *A. lerchiana* and *Tanacetum achilleifolium*; F - sand steppe with *Stipa borysthenica, Koeleria glauca* subsp. *sabuletorum* and *Artemisia campestris* subsp. *inodora.* Photos: A-C - I. Dembicz, D - D. Shyriaieva, E-F - J. Dengler.

Table 2. Preliminary syntaxonomical assignment of plots to the class level.

Vegetation type	Vegetation class	Number of biodiversity plots	Number of additional normal plots
Bunchgrass steppes	*Festuco-Brometea*	7	11
Desert steppes	*Festuco-Brometea*	6	11
Calcareous rocky grasslands	*Festuco-Brometea*	2	0
Subsaline steppes	*Festuco-Puccinellietea*	9	18
Saline grasslands	*Festuco-Puccinellietea, Juncetea maritimi*	4	6
Sandy dry grasslands	*Koelerio-Corynephoretea canescentis*	11	17
Sandy mesic grasslands	*Koelerio-Corynephoretea canescentis or Molinio-Arrhenatheretea*	4	2
Coastal dune vegetation	*Cakiletea maritimae* and *Ammophiletea*	4	6
Steppe depressions (pody)	*Molinio-Arrhenatheretea*	2	0
Hemipsammophitic steppes	*Festuco-Brometea or Koelerio-Corynephoretea canescentis*	1	3

class (Shapoval & Kuzemko 2021) (Fig. 4A). They also occurred in sandy depressions in Burkuty and Kinburn spit sites (Fig. 4C).

Species richness patterns

Richness values of the different taxonomic groups (complete vegetation, vascular plants, bryophytes, lichens) are shown in Tables 3 and 4. Mean total species richness increased from 2.6 species in the smallest grain size (1 cm^2) to 56.8 species in the largest grain size (1000 m^2). When our results were compared to those from previous EDGG FWs, we found generally lower mean richness values, especially in the larger grain sizes. For example, at the grain size 10 m^2, mean species richness value was 28.1 species for complete vegetation (24.3 for only vascular plants) in comparison with the mean richness obtained in the FWs in Armenia: 51.3 (48.7) (Aleksanyan et al. 2020), Austria: 41.5 (34.1) (Magnes et al. 2020), Switzerland: 34.4 (28.9) (Dengler et al. 2020b), Siberia: 48.5 (43.9) (Polyakova et al. 2016), Bulgaria: 38.5 (34.1) (Dembicz et al. 2021b), Romania: 60.5 (57.2) (Turtureanu et al. 2014).

This is mainly due to the fact that on this occasion, we recorded many more plots of sparse vegetation such as sandy dry grasslands, that, as shown in Biurrun et al. (2021) are relatively species-poor vegetation types. The richest plot at 1000 m^2 was located in a desert steppe (complete vegetation: 84 species; vascular plants: 78 species), at 100 m^2, 10 m^2 and 1 m^2 – in a bunchgrass steppe (complete vegetation: 80, 59 and 42 species respectively; vascular plants: 69, 50 and 35 species respectively). Mean values of the richness patterns of complete vegetation across vegetation types are shown in Table 4, where the highest mean value per grain size is highlighted in bold. Our first biodiversity plot in the steppe depression "Chorna Dolyna" supporting mesic grasslands appeared to be the richest plot at the smallest grain sizes – 0.01 m^2, 0.001 m^2 and 0.0001 m^2 (complete vegetation: 17, 14 and 11 species respectively; vascular plants: 15, 11 and 9 species). The published world record at the grain size 0.0001 m^2 is 10 species for complete vegetation and 11 species for vascular plants (Biurrun et al. 2021). Thus, our plot shares the world record for the number of species at the grain size 0.0001 m^2.

Mean species richness for bryophytes and lichens increased from 0.3 species in the smallest grain size to 3.6 and 3.3 species in the largest grain size, respectively. Comparing the results to those obtained from previous EDGG FWs (Armenia (Aleksanyan et al. 2020), Austria (Magnes et al. 2020), Switzerland (Dengler et al. 2020b), Russia (Polyakova et al. 2016), Bulgaria (Dembicz et al. 2021b) and Romania (Turtureanu et al. 2014), mean number of bryophytes in this FW was generally lower, especially for the larger grain sizes. For example, for 100 m^2, the number of bryophytes was on

Table 3. Descriptive statistics of the scale-dependent richness patterns across all sampled plots from the 15th EDGG Field Workshop in Southern Ukraine.

Area (m^2)	n	All species			Vascular plants			Bryophytes			Lichens		
		mean	min	max	mean	min	max	mean	min	max	mean	min	max
0.0001	100	2.6	0	11	2	0	9	0.3	0	3	0.3	0	3
0.001	100	4.1	0	14	3.3	0	11	0.4	0	4	0.4	0	4
0.01	100	7	1	17	5.8	0	15	0.6	0	6	0.6	0	4
0.1	100	12.5	2	28	10.6	0	26	1	0	6	1	0	6
1	100	18.9	3	42	16.1	2	35	1.5	0	9	1.4	0	6
10	174	28.1	4	59	24.3	3	50	2.1	0	9	1.8	0	8
100	50	43	11	80	36.8	8	69	3.3	0	13	2.8	0	10
1000	16	56.8	16	84	49.9	13	78	3.6	1	6	3.3	0	12

average 3.3 species, whereas in all other mentioned FWs it was higher. Interestingly, mean richness values for lichens for the smaller grain sizes in general were the highest in the Ukrainian FW, whereas in the larger grain sizes the mean richness of lichens obtained in some other FW were higher. For example, for 0.1 m^2, the mean richness value for lichens was 1.0 in Ukrainian FW; in Armenia: 0.3, Austria: 0.8, Switzerland: 0.5, Siberia: 0.6, Bulgaria: 0.4, Romania: 0.2.

Most of the richest plots for bryophytes were recorded in desert steppes (1, 10, 100 m^2 with 9, 9 and 13 species, respectively) and bunchgrass steppes (0.001, 0.01, 0.1, and 1000 m^2 with 4, 6, 6 and 6 species). The maximal number of lichens was recorded in sand steppes for the majority of the grain sizes: for 0.0001 m2 – 3 species, 0.001 m^2 – 4, 0.01 m2 – 4, 1 m^2 – 6, 10 m^2 – 8, 100 m2 – 10 and 1000 m^2 – 12 species. Only at the grain size 0.1 m^2 was the maximum recorded in desert steppes with 6 species.

Nature conservation

Almost all the localities studied during the FW belong to existing or projected nature protection areas (Table 1). We sampled vegetation in nine existing protected areas: Black Sea Biosphere Reserve, Azovo-Syvash NNP, Biloberezhzhia Sviatoslava NNP, Dzharylhach NNP, Oleshkivski Pisky NNP, Kamianska Sich NNP, Kinburn Spit RLP, "Karadai" Landscape Reserve and "Sahy" Landscape Reserve. Six other areas have high conservation value and were recently proposed as new nature protected objects (Moysiyenko et al. 2020): "Valley of Kurgans" NPP, "Chorna Dolyna" Landscape Reserve, "Western Syvash" Landscape Reserve, "Peninsula Mala Kosa" Landscape Reserve, Landscape Reserve "Sofia`s Steppe" and "Yagorlyts`kyi Step" Zoological Reserve.

Highly valuable pieces of land have been transferred from government ownership to private hands during the administrative-territorial reform which has been conducted over the last few years in Ukraine. Some areas have been ploughed out in part causing irreparable damage to the nature value of these territories, for example, 700 hectares of the "Valley of Kurgans" in 2020 and 69.7 hectares of the "Chorna Dolyna" in 2021. The last case happened after the FW, and in particular, our sampling localities were destroyed. The preliminary results from our expedition confirmed the high conservation value of these areas. Therefore, we support the formal adoption of the above mentioned six projected nature protection territories.

Conclusions and outlook

The initial results of the FW in Southern Ukraine are very promising and have already shown that the joint efforts of its participants greatly improved the knowledge of the biodiversity of Southern Ukraine.

The importance of the data from the Field Workshop is that it helps to improve the classification of grasslands in Ukraine, as it describes underrepresented grassland types. The data can also assist in refining the European vegetation classification. Interestingly, the high-quality biodiversity data of dry grasslands in Southern Ukraine show much lower richness across all scales especially for the bigger grain sizes. However, at the same time, we had relatively high maximal richness values for the lower grain sizes compared to other regions in Europe, including a new world record for a 1 cm2 plot. These data will make a major contribution to the development of models of patterns and drivers of scale- and taxon-dependent plant diversity of grasslands across the Palaearctic biogeographic realm (Dengler et al. 2018, 2020a).

We have already finalized the identification of the collected specimens of bryophytes, lichens and vascular plants, except for specimens of the genus *Festuca*. The determination of numerous samples of *Festuca* genus is being undertaken by Iryna Bednarska, an expert on this genus and a participant in our FW. A combination of analytical methods are

Table 4. Descriptive statistics of the scale-dependent richness patterns of complete vegetation differentiated according to the main vegetation types. The highest richness value per grain size is highlighted in bold.

Area (m^2)	All vegetation types		Desert steppes		Bunchgrass steppes		Steppe depressions (pody)		Subsaline steppes		Sand steppes		Sandy mesic grasslands		Saline grasslands		Hemipsammophytic steppes		Coastal dune vegetation		Calcareous rocky grasslands	
	n	mean	n	mean	n	mean	n	mean	n	mean	n	mean	n	mean	n	mean	n	mean	n	mean	n	mean
0.0001	100	2.6	12	2.1	14	2.8	4	**5.8**	18	3.2	22	2.4	8	3.5	8	1.4	2	2	8	0.9	4	2.3
0.001	100	4.1	12	3.4	14	4.9	4	**8.3**	18	5	22	3.5	8	5.3	8	2.4	2	4.5	8	1.4	4	3.5
0.01	100	7	12	6.1	14	9.6	4	**11.3**	18	8.7	22	5.7	8	9.9	8	3.6	2	7	8	2	4	6
0.1	100	12.5	12	14.4	14	**17.4**	4	15.3	18	13.5	22	11.3	8	17.3	8	5.9	2	13.5	8	3.8	4	10.5
1	100	18.9	12	24.2	14	**27.4**	4	19.8	18	17.9	22	18	8	23.3	8	7.8	2	20	8	6.4	4	19
10	174	28.1	**23**	**33.5**	**25**	**39.4**	4	26.8	36	26.4	39	29.2	10	33.1	14	14.9	5	31	14	9	4	29.8
100	50	43	**6**	**56**	**7**	59.4	2	46.5	9	36.2	11	42.7	4	52.8	4	18.8	1	**63**	4	14.5	2	51
1000	16	56.8	**1**	**84**	**2**	77.5	1	55	4	42	5	54.6	1	77	1	16	1	81	0	NA	0	NA

being used, in particular cytometry, microanatomy and morphology. Various parameters of the soil samples are currently being analyzed in the "Podillia-Agrochimservis" Agrochemical Laboratory using EDGG protocols (Dengler et al. 2021), and the biomass samples have already been weighted. We intend to use our comprehensive dataset to prepare two main publications, one on syntaxonomy of the studied dry grasslands and one on biodiversity patterns and their drivers. Where appropriate, we will include some additional plots sampled by I.M. and colleagues using similar methods (e.g. research project NFDU 2020-2021 leaded by A. Kuzemko). The first manuscript resulting from the FW, is a short communication concerning *Torilis pseudonodosa* as a new species for the Ukrainian flora. This has already been completed and submitted to a scientific journal. The preparation of a manuscript describing a new species for science of the lichen genus *Aspicilia* has also recently commenced.

As soon as the vegetation data are ready, they will be integrated into the GrassPlot database (Dengler et al. 2018; Biurrun et al. 2019) and the Ukrainian Grassland Database (Kuzemko 2012) and subsequently via these to the European Vegetation Archive (EVA; Chytrý et al. 2016) and the global vegetation plot database "sPlot" (Bruelheide et al. 2019) to ensure their best possible use. Moreover, the floristic information will be fed into the worldwide GBIF database.

Fig. 5. Above: sampling a desert steppe with *Artemisia lerchiana*. Below: EDGG biodiversity plot on the northern shore of Syvash Lake, near Vasylivka village, Kherson Region. Photo: D. Shyriaieva.

Author contributions

I.M., D.V., D.Sh., N.S., A.Kh organized the Field Workshop, I.D. coordinated the organization, all co-authors participated in the field sampling. I.B. collected and determined *Festuca* specimens, A.B. determined dark-winged fungus gnats; A.Kh. identified lichens, N.Z. bryophytes. I.M. and D.V. led the writing of the report, D.S prepared the map; the photo diary was compiled by D.Sh., O.B., O.Ch., K.K. All authors checked, improved and approved the manuscript.

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Bunchgrass steppe near Stavky village.

Appendix: Photo diary of the 15th EDGG Field Workshop

Compiled by Dariia Shyriaieva, Olesia Bezsmertna, Olha Chusova and Kateryna Kalashnik.

With photos by Iryna Bednarska, Olesia Bezsmertna, Olha Chusova, Iwona Dembicz, Jürgen Dengler, Riccardo Guarino, Kateryna Kalashnik, Oleksander Khodosovtsev, Vitalii Kolomiichuk, Oksana Kucher, Anna Kuzemko, Ivan Moysiyenko, Dariia Shyriaieva, Olga Umanets, Denys Vynokurov & Natalia Zagorodniuk.

When the Field Workshop "Ukrainian steppes along climatic gradients" was officially postponed to 2022, we decided to attempt to organize an alternative Field Workshop in Southern Ukraine in the spring of 2021. Following the restrictions associated with Covid-19, we limited the study area to remote and sparsely populated corners of the Kherson region. The team consisted of Ukrainian scientists and several foreign guests - those who had received the vaccine and were thus able to come to Ukraine. After a year of quarantine restrictions, this expedition was a breath of fresh air for us – in fact the brackish air of the southern Ukrainian steppes! We would like to share with you the spirit of our scientific discoveries and travel adventures by introducing this diary.

Day 1 (May 24, 2021)

Our field workshop started in Kherson city, where we met in the morning. Unlike other EDGG Field Workshops, most of the participants in this expedition were local Ukrainians. Therefore, we used the participants' own cars for transporting everyone, plus luggage and equipment. On the road to the south, we made a stop for sampling in the steppe depression (pid) known as "Chorna Dolyna". At this stop, our group was joined by Viktor Shapoval, a botanist from the Askania-Nova Nature Reserve, who has studied steppe depressions for over 20 years. Such steppe depressions are termed "pody" in Ukrainian (plural, in singular – "pid") and occur in the south of the country. They are characterised by an abrupt change in the nature of the vegetation, which is influenced by the humidity in different years and seasons: from dry to mesic, wet, moist and even aquatic. We set out the first two biodiversity plots of our expedition in mesic areas dominated by *Ventenata dubia*. These plots were the first biodiversity plots ever sampled in steppe depressions.

After lunch, we drove to the shore of Sivash Lake in the southernmost part of the Kherson region. There we sampled desert steppes which were remarkable and characterised by various dwarf shrubs, such as *Artemisia lerchiana, A. taurica*, and *Caragana scythica*. In the evening, we arrived at the small hotel "Hostynnyi dvir", owned by local people in the village of Grygorivka. This was one of the few opportunities to find accommodation in this remote and unpopulated region, and the hosts were surprised to see such a large and diverse group of scientists in their courtyard.

Left: The beginning of our expedition - meeting of the participants at the gas station. Right: The first rain in the first plot! Southern spring greeted us with changeable weather.

Biodiversity plot in the steppe depression (pid) "Chorna Dolyna" - aerial view.

Left: Remarkable formations in the soil – iron-manganese nodules (beans), characteristic of steppe depressions. Right: Mesic grasslands in the steppe depression "Chorna Dolyna", dominated by *Ventenata dubia* and *Carex melanostachya*.

Semi-desert steppes at the shore of Sivash Lake, warmed by the southern sun and swept by salty winds.

Common shelduck (*Tadorna tadorna*) and black-winged stilt (*Himantopus himantopus*) in shallow water. Sivash Lake is designated as a Wetland of International Importance under the Ramsar Convention and is home to thousands of birds.

Way to Zelenovsky Island

Day 2 (May 25, 2021)

In the morning, we visited Churiuk Island, which is a part of the Azov-Syvash National Park. Vitalii Kolomiichuk, the National Park botanist, was our guide through the territory and its flora. We sampled charming southern bunchgrass steppes dominated by feather grasses and fescues. The vegetation was remarkable for the occurrence of many central -asiatic (eastern steppic) species at the western edge of their distribution range, such as *Ferula caspica, Goniolimon rubellum, Limonium suffruticosum, Prangos odontalgica*, and *Salsola laricina*. For lunch, we visited the house of local rangers (island guards), and nearby we saw a reintroduced population of bobak marmots or steppe marmots (*Marmota bobak*). In the afternoon, the bravest participants crossed the shallow, muddy-bottomed bay to reach Zelenovsky Island. The second part of the group remained to work on the shore and from time to time watched their friends walking in the wild, against the wind and across the mud.

Steppe marmot (*Marmota bobak*)

Bunchgrass steppes with *Stipa ucrainica* and *Stipa lessingiana* at Churiuk Island.

Sampling at Churiuk Island.

Zelenovsky Island: walking through the saline and muddy lake (above), view from the top (below).

A working session in the evening: plant identification on the terrace and the fescue herbarium.

Day 3 (May 26, 2021)

On the third day, we continued working in the Azov-Syvash National Park. Our groups sampled desert steppes and saline grasslands near Vasylivka village (Kutara Cape) and Ivanivka (Berezina Cape). We spent all day near the saltiest part of Lake Sivash which is famous for its pink water.

The shades of pink changed during the day, which was very surreal. In the evening, we said goodbye to the hosts of our first hotel. They prepared a barbecue for us, and then we spent a nice evening engaged in pleasant conversation, eating delicious food and singing Ukrainian and Italian songs.

Sampling desert steppes at Kutara Cape.

Lunch time: car repair (left) and the lunch spot in the shade (right).

Berezina Cape near Ivanivka village in the evening, view from the top. Believe it or not, the unreal pinkish color on the left side is water!



The last evening in "Hostynnyi dvir", from left to right: barbecue; our landlord Volodymyr playing his harmonica (accordion); and the landlady Natalia looking at plant samples with a binocular microscope.

Day 4 (May 27, 2021)

The fourth day was full of various impressions and incidents, but – looking ahead – we must assure you that everything ended well. In the morning, we divided between three different locations - Oleksandrivka, Mala Kosa and Stavky. Bunchgrass steppes delighted us with feather-grasses and wonderful sunny weather. For lunch, we visited a very interesting place in the Khorly village. This was a small hotel "Pomistia" situated in a historic building that was formerly built and owned by Sofia Falz-Fein (mother of Friedrich Falz-Fein, establisher of Askania-Nova Nature Reserve). Anton Petrosovych Hukasian, the current owner of the hotel, was very hospitable and prepared a table with various dishes which resulted in an extended lunch! In the afternoon, we worked in two groups on Khorly Peninsula and Karaday Peninsula. The work was completed at sunset, but we still had to get to the next hotel. It was a long and eventful day… Unfortunately, one of the cars needed repairing on the way resulting in an additional delay. Finally though, we all arrived at our new hotel "Galychanochka" in Zaliznyi Port. We were very tired, but happy that we were together again. Our kind hosts kept their kitchen open until our late arrival and served us a delicious dinner.


Above: Feather grass in front of a windturbine, near Stavky village. Below: During sampling in species-poor saline meadows we were diligent in looking out for diminutive plants.

Malabaila graveolens **– a plant with a very specific smell which is very attractive to flies, but unpleasant to those in the sampling spot…**

Lunch in Khorly village: our hospitable friends Anton Petrosovich Hukasian and Vyacheslav Volodimirovich Rolland.

North-facing slope with mesophilous dry grasslands at Khorly Peninsula. This habitat supported the most species-rich biodiversity plot of the expedition (complete vegetation per 100 m^2: 80 species).

Above: Fescue-woman Iryna Bednarska - the superhero of our expedition in the process of collecting population herbariums of *Festuca* species. Below: Unexpected delay on the road: car repair in progress.

Day 5 (May 28, 2021)

After a rest and a delicious breakfast, we were ready for adventures again!

During the first half of the day, we sampled subsaline and desert steppes, as well as psammophilous grasslands near Skadovs'k. For lunch, we arrived at the area of the Black Sea Biosphere Reserve known as Potiivska dilianka. The local botanist Olga Umanets, a scientist of the Biosphere Reserve, joined us in our work for this day, as well as for the next three days. In the afternoon at Potiivska dilianka, we sampled subsaline steppes, dune and saline vegetation. It was a great pleasure to work on the seashore and many participants took the opportunity to swim in the Black Sea.

In the evening, we witnessed an incredible sunset over the sea and Tendrivska Spit (one of the largest sand spits - 78 km long!). During our dinner, we organized a session of "short talks" by each of the participants. Each talk covered their work, hobbies and involvement with EDGG.

Sampling spot within the meso-xeric psammophilous grasslands near Skadovsk.

The caravan of our cars, looking for the right road and attractive sampling locations.

Happy moments of rest and sampling in the coastal zone, Black Sea Biosphere Reserve (Potiivska dilianka).

A sunset over the sea and Tendrivska Spit.

Evening in the hotel: interesting conversations and productive work with samples.

Day 6 (May 29, 2021)

On this day, we moved to our next location - Kinburn Spit. However, on the way, we visited many interesting places and did a lot of work sampling five biodiversity plots and 12 normal plots of subsaline steppes, bunchgrass steppes, halophytic vegetation, and coastal dunes. For the first half of the day, we worked at Yagorlytsky Kut and Yagorlyk Polygon, which are parts of the Black Sea Biosphere Reserve. After lunch at the sandy beach, we moved to a new location. It was the Valley of Kurgans, a coastal saline plain with a large number of kurgans (kurgan – a tumulus constructed over a grave, widespread in the Pontic–Caspian steppes).

There are a total of 308 kurgans of various sizes in the Valley of Kurgans. The territory between kurgans is subsaline steppe that is periodically-flooded with seawater under the influence of strong winds. After sampling, we had a long drive to the village Pokrovka on Kinburn Spit. On the way, we were surrounded by seemingly boundless areas of sandy grasslands dominated by the feather grass *Stipa borysthenica* which shone with silver and gold at sunset. In the evening, we arrived at our new accommodation – the cozy hotel Larina Dacha with very hospitable hosts and local-grown food.

Packing luggage when moving to a new hotel was like "Tetris": all items should match and fit!

Sampling in Yagorlytsky Kut and Yagorlyk Polygon: we are ready for sampling biomass with wire circles (left); biodiversity plot in a saline grassland (right).

Sampling in the Valley of Kurgans: side view of the kurgan with a small human silhouette (left); intensive work in a 1000 m^2 plot (right).

Moments of teamwork in the Valley of Kurgans.

Psammophytic grassland dominated by *Stipa borysthenica*, a sunset photo taken during a short stop on the road to the Kinburn Spit.

Day 7 (May 30, 2021)

Our morning started with orchids - we found pretty meadows with *Anacamptis palustris* right next to our house. Then one part of the group using two cars spent the day sampling sandy grasslands in the Pokrovka village and its surroundings. The other team in the all-terrain car drove along sandy roads to remote parts of the Kinburn spit – the so-called "Tip of the Kinburn spit" and "Volyzhyn Forest". It was very surprising for us to see a forest oasis among the sand dunes of the Kinburn Spit. In the 4th century BC, large primary forests in the lower reaches of the Dnieper River were described by Herodotus as "Gilea''. Volyzhyn Forest is the only part of Gilea that now remains. One of the many interesting moments of this day was swimming in the sea between sampling relevés in the coastal zone. The journey back did not pass without incident either as one of the cars got stuck in the sand. However, in the end, we all returned to the hotel safe and sound. The most active and energetic members of the team arranged dancing after dinner, while others preferred to relax on the evening terrace, answering urgent emails while sampling a variety of beverages.

Left: breakfast on the terrace. Right: photo hunt for the orchids, behind a barbed wire fence near our hotel.

Natural boundaries Volyzhyn Forest (right) and Kovalivska Saha (left) a wetland oasis with alder trees and oaks among the sand dunes of the Kinburn Spit.

Open sandy communities with *Odontarrhena borzaeana*, in the vicinity of Pokrovka village.

The steppe-runner lizard (*Eremias arguta*).

Moments of relaxation after productive work.

Left: The unreliable roads of the Kinburn Spit. Here it was easy to get stuck in the sand! Right: Evening moments of rest and work on the hotel's terrace.

Day 8 (May 31, 2021)

We spent this day sampling sandy grasslands in a new remote area - Solonoozerna Dilianka and Ivano-Rybal'chanska Dacha, which are parts of the Black Sea Biosphere Reserve. Not all of our cars were able to drive along the sandy roads in this part of the reserve, so the administration of the Biloberezhzhia Sviatoslava National Park helped us with transport. An old, all-terrain car with open seats became our "Ukrainian safari car", and on the way, we enjoyed the views of psammophytic steppes on the hills and oak-birch forests in the depressions. For lunch, we visited the so-called "kordon", a remote house with a backyard in the wilderness where the ranger of the reserve and his family live. There we were met by very kind and friendly people who prepared local food for us and provided tasty milk from their cows. At the end of the day, we arrived in Kherson and stayed at the hostel of the Kherson State University.

The best way to travel across the sand dunes was in our Ukrainian "safari car", an old all-terrain car with an open cabin.

Left: Sampling psammophytic grasslands. Right: Biomass collection requires a large number of participants in order to collect each gram of biomass!

Oak-birch forests in the depressions between sandy dunes.

Lunch at the ranger's house in the reserve (“kordon”), with delicious pies and pancakes.

Revision of data forms and checking plant specimens in the evening at the Kherson State University dormitory.

Day 9 (June 1, 2021)

The weather on the ninth day was extreme due to very low temperatures and intensive rainfall. It rained heavily, almost without stopping. However, we tried to keep working notwithstanding the unfavourable conditions and established and sampled two biodiversity plots and five normal plots at the Burkuty site (National Park Oleshkivski Pisky). After lunch in the shelter, a special hide for birdwatching, we said goodbye to several participants of our expedition party, who then left us in one car.

Then, totally wet and tired of the rain, we decided to return to Kherson and work with our samples at the Kherson State University. The Botany Department welcomed us and provided a warm room, hot tea and the necessary environment for the work.

Working in the rain, where everything was wet and cold… not the most pleasant time, but we all did our best!

Raincoats and umbrellas helped us. But, at one moment, the rain was so hard and the wind was so strong, that even good equipment was not enough.

Our team in the birdwatching hide during lunch.

Photo session of the best "penetrometer operators" among the group.

We spent the second half of the day working with samples and materials in the Botany Department at the Kherson State University.

Day 10 (June 2, 2021)

On the last official day of the expedition, we sampled the sandy vegetation of the lower reaches of the Dnipro River. One group went to the part of National Nature Park known as Oleshkivski Pisky with the informal name "Oleshky desert". There we sampled vegetation of recently disturbed sandy dunes which resemble a real desert. Another group visited the "Sagy" landscape reserve. The most remarkable finding of the day was a strange lichen from the family Megasporaceae, which preliminary investigations indicate may be a new lichen species to science! In the evening, we had the farewell dinner in a restaurant in Kherson. The participants shared their impressions of the 10-day expedition in the remote corners of Southern Ukraine. We were happy to be together during the 15th EDGG Field Workshop and we hope to meet again this year in the FW "Ukrainian steppes along climatic gradients"!

Exploring "Oleshky desert", which is a territory with recently-disturbed sandy dunes. It looks like a real desert!

In “Oleshky desert”, we even met a camel!

Sampling in the “Sagy” landscape reserve.

Psammophytic grasslands in the “Sagy” landscape reserve.


The farewell dinner of the 15th EDGG Field Workshop "Grasslands of Southern Ukraine".

Day 11 (June 3, 2021)

After the official completion of the workshop and the departure of most of the participants, the remaining group undertook a short post-excursion and spent one day in the National Park. There we sampled bunchgrass steppe and calcareous rocky grassland vegetation.


Post-excursion with sampling of bunchgrass steppes in the Kamyanska Sich National Park.

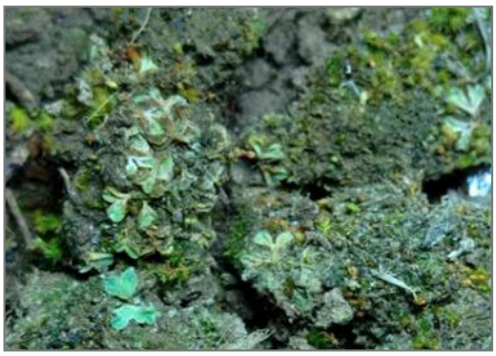

Left: Steppe gulley near Milove village in the Kamyanska Sich National Park.
Right: A "strawberry prize" - for those who joined the post-excursion day!

Selected pictures of bryophytes

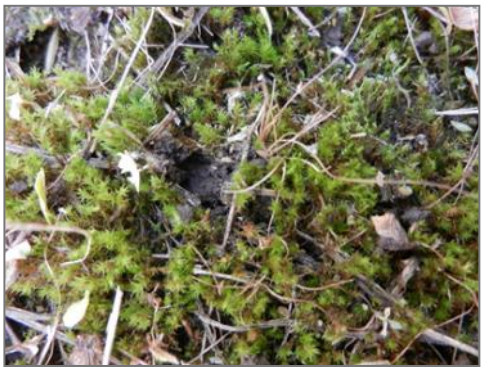
Polytrichum piliferum

Syntrichia ruralis

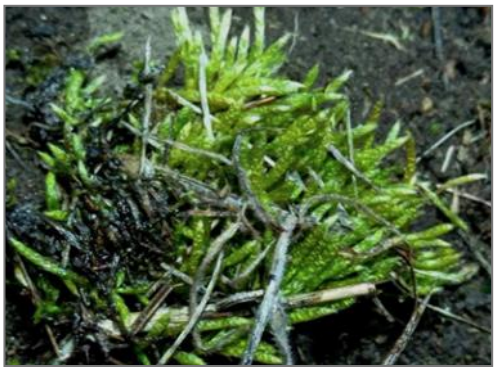
Brachythecium mildeanum



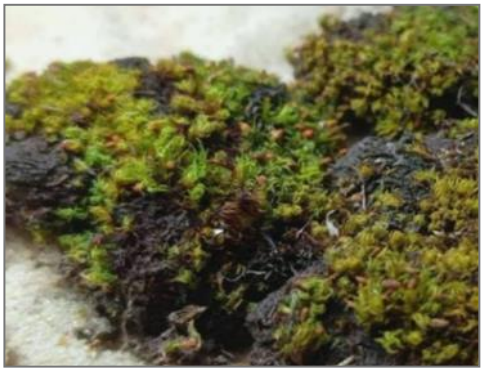
Riccia lamellosa



Ceratodon purpureus



Brachythecium albicans



Weissia levieri

Mycrobryum curvicollum

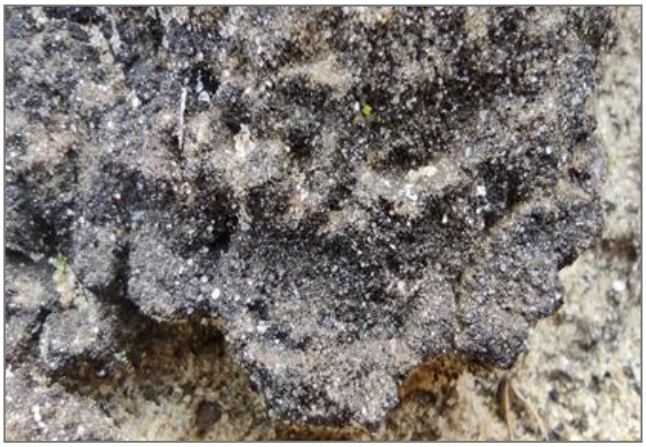
Selected pictures of lichens

Toninia sedifolia

Xanthoparmelia pockornyi

Cetraria aculeata

Diploschistes muscorum



***Placynthiella uliginosa* s.l.**

Cladonia foliacea

Selected pictures of vascular plants

Trifolium subterraneum, Astragalus asper, Astragalus reduncus, Trifolium angulatum

Eremopyrum orientale, Allium regelianum, Rhinanthus borbasii, Anacamptis palustris

Trifolium diffusum, Carduus pycnocephalus* subsp. *marmoratus, Cytisus borysthenicus, Petrosimonia brachiata

Caragana scythica

Onosma arenaria

Prangos odontalgica

Odontarrhena borzaeana

Artemisia lercheana

Agropyron dasyanthum

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