Scientific Report

DOI: 10.21570/EDGG.PG.46.12-51

Biodiversity of dry grasslands in Armenia: First results from the 13th EDGG Field Workshop in Armenia

Alla Aleksanyan[1,2], Idoia Biurrun[3], Elena Belonovskaya[4], Beata Cykowska-Marzencka[5], Asun Berastegi[6], Andreas Hilpold[7], Philipp Kirschner[8], Helmut Mayrhofer[9], Dariia Shyriaieva[10], Denys Vynokurov[10], Thomas Becker[11], Ute Becker[12], Iwona Dembicz[13,14], George Fayvush[1], Dieter Frank[15], Martin Magnes[9], Itziar García-Mijangos[3], Marine Oganesian[16], Salza Palpurina[17], Aslan Ünal[18], Yuliia Vasheniak[19] & Jürgen Dengler[13,20,21]*

[1]Department of Geobotany and Plant Eco-Physiology, Institute of Botany after A.L. Takhtajyan, NAS RA, Acharyan 1, 0040, Yerevan, Armenia; alla.alexanyan@gmail.com; gfayvush@yahoo.com

[2]Chair of Biology and Biotechnology, Armenian National Agrarian University, Teryan 74, 0009, Yerevan, Armenia

[3]Department of Plant Biology and Ecology, University of the Basque Country UPV/EHU, P.O. Box 644, 48080 Bilbao, Spain; idoia.biurrun@ehu.es; itziar.garcia@ehu.es

[4]Department of Biogeography, Institute of Geography, Russian Academy of Sciences, Staromonetny per. 29, 119017 Moscow, Russia; ebelonovskaya.0709@gmail.com

[5]Department of Mycology, W. Szafer Institute of Botany, Polish Academy of Sciences, Lubicz 46, 31-512 Kraków, Poland; b.cykowska@botany.pl

[6]Department of Biodiversity, Environmental Management of Navarre, Padre Adoain 219 Bajo, 31015 Pamplona, Spain; aberastg@gan-nik.es

[7]Institute for Alpine Environment, Drususallee 1/VialeDruso 1, 39100 Bozen-Bolzano, Italy; andreas.hilpold@eurac.edu

[8]Department of Botany, University of Innsbruck, Sternwartestraße 15, Innsbruck, Austria; philipp.kirschner@gmail.com

[9]Division of Plant Sciences, Institute of Biology, Karl-Franzens-University of Graz, Holteigasse 6, 8010 Graz, Austria; helmut.mayrhofer@uni-graz.at; martin.magnes@uni-graz.at

[10]Geobotany and Ecology Department, M.G. Kholodny Institute of Botany, NAS of Ukraine, Tereshchenkivska str. 2, 01601 Kyiv, Ukraine; darshyr@gmail.com; denys.vynokurov@gmail.com

[11]Department of Geobotany, University of Trier, Behringstr. 21, 54296 Trier, Germany; beckerth@uni-trier.de

[12]Green School in the Botanic Garden, Johannes Gutenberg University Mainz, Anselm-Franz-von-Bentzel-Weg 9 b, 55128 Mainz, Germany; beckeru@uni-mainz.de

[13]Vegetation Ecology, Institute of Natural Resource Sciences (IUNR), Zurich University of Applied Sciences (ZHAW), Grüentalstr. 14, 8820 Wädenswil, Switzerland; i.dembicz@gmail.com; juergen.dengler@uni-bayreuth.de

[14]Department of Plant Ecology and Environmental Conservation, Faculty of Biology, University of Warsaw, ul. Zwirki I Wigury 101, 02-089 Warsaw, Poland

[15]Saxony-Anhalt Environment Agency, Reideburger Str. 47, Halle 06116, Germany; dieter.frank@lau.mlu.sachsen-anhalt.de

[16]Department of Taxonomy and Geography of Higher Plants, Institute of Botany aft. A.L. Takhtajyan, NAS RA, Acharyan 1, 0040, Yerevan, Armenia; oganesianm@yahoo.com

[17]National Museum of Natural History, 1 Tsar Osvoboditel Blvd, 1000 Sofia, Bulgaria; salza.palpurina@gmail.com

[18]Am Schießrain 10 , 79219 Staufen, Germany; auenal@mail.ru

[19]Department of Biology, Chemistry and Biotechnologies, Vasyl' Stus Donetsk National University, 600-richya str. 21021, Vinnytsia, 21, Ukraine; arrhenatherum@gmail.com

[20]Plant Ecology, Bayreuth Center of Ecology and Environmental Research (BayCEER), Universitätsstr. 30, 95447 Bayreuth, Germany

[21]German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig, DeutscherPlatz 5e, 04103 Leipzig, Germany

*) corresponding author

Palaearctic Grasslands 46 (2020): 12-51

Abstract: The 13th EDGG Field Workshop was conducted from the 26 June to 6 July 2019 in Armenia. The Field Workshop had two main aims: (a) to analyse the biodiversity patterns of the Armenian grasslands across multiple taxonomic groups and grain sizes, and (b) to study the syntaxonomic position of these grasslands in a general European context. We conducted our sampling in 16 sites that ensured good geographical coverage across the country. In total, we sampled 29 EDGG Biodiversity Plots (nested-plot series of 0.0001 to 100 m²) and 53 additional 10-m² plots. Data of orthopteroid insects (*Orthoptera* and *Mantodea*) were recorded in 42 100-m² plots. We found mean total species richness values of the vegetation of 7.5 species in 0.01 m², 31.9 species in 1 m² and 51.3 species in 10 m². The richest grasslands for vascular plants were meso-xeric grasslands with up to 35 species in 0.1 m² and 80 in 10 m². Maximum orthopteroid richness in 100 m² was 14. Syntaxonomically, the majority of stands appear to belong to the class *Festuco-Brometea*, with the orders *Brachypodietalia pinnati* (meso-xeric), *Festucetalia valesiacae* (xeric, non-rocky) and an unknown order of rocky dry grasslands. By contrast, the thorn-cushion communities (probably *Onobrychidetea cornutae*), the scree communities and the dry grasslands of lower elevations rich in annuals and chamaephytes (probably largely *Astragalo-Brometea*), do not fit to any vegetation class described in Europe. We found two species new to Armenia – the moss *Syntrichia papillosissima* and the lichen *Aspicilia hispida*. Our data demonstrate that Armenia is one of the Palaearctic hotspots of fine grain plant diversity. Both diversity patterns and syntaxonomy warrant in-depth studies, which are now possible with our comprehensive dataset.

Keywords: Armenia; biodiversity; bryophyte, dry grassland; lichen; *Mantodea*; nested plot; *Orthoptera*; species richness; syntaxonomy; vascular plant.

Nomenclature: Euro+Med (2020) for vascular plants, Hill et al. (2006) for mosses, Söderström et al. (2016) for liverworts, Nimis et al. (2018) for lichens and Heller et al. (2016) for orthopteroid insects.

Abbreviations: EDGG = Eurasian Dry Grassland Group.

Submitted: 9 June 2020; first decision: 10 June 2020; accepted: 16 June 2020

Scientific Editor: Riccardo Guarino

Linguistic Editor: Richard Jefferson

Introduction

Palaearctic grasslands are known for their outstanding biodiversity in many taxonomic groups (Dengler et al. 2014; 2020a). For vascular plants, most of the world records of species richness at fine spatial grains across any habitat type worldwide come from Palaearctic semi-dry grasslands, but bryophytes, lichens and many invertebrate groups can also be quite diverse (Dengler et al. 2020a). Despite numerous studies, there is still no conclusive knowledge as to which factors are mainly responsible for this fine-grain diversity and why, in some regions, exceptionally rich grasslands occur and in others not (Dengler et al. 2014).

Armenia is known to have diverse grasslands (Fayvush & Aleksanyan 2016; Dengler et al. 2019; Ambarlı et al. 2020) and a very rich vascular plant flora. However, detailed data on fine-grain plant diversity are lacking and, as such, this would be valuable for pan-Palaearctic studies of patterns and drivers of grassland diversity, such as Dengler et al. (2020c). While Armenia has a typology of habitats (Fayvush & Aleksanyan 2016), there are only few phytosociological studies from the country. Therefore, its community types cannot readily be aligned with the well-established syntaxonomic system of Europe (Mucina et al. 2016). Due to a lack of vegetation-lot data, Armenian vegetation has not been included in the broad-scale consistent classification of Palaearctic dry grasslands, either with supervised (Schaminée et al. 2016) or semi-supervised methods (Willner et al. 2017).

Since 2009, the Eurasian Dry Grassland Group (EDGG) has been conducting annual Field Workshops, with the main aim of obtaining high-quality biodiversity data of grassland vegetation in Palaearctic areas that have been under-sampled in the past (Dengler et al. 2019). Sampling is conducted with a standardised multi-scale method (Dengler et al. 2016a; based on Dengler 2009). Using data from these expeditions, a series of regional studies on phytosociological classification have been developed (Dengler et al. 2012; Pedashenko et al. 2013; Kuzemko et al. 2014). Studies of patterns and drivers of plant diversity (Turtureanu et al. 2014; Kuzemko et al. 2016; Polyakova et al. 2016) and also comparative overviews on mean and maximum richness values of Palaearctic grasslands have been obtained from these data (Dengler et al. 2016b). All the multi-scale vegetation plot data produced in the EDGG Field Workshops have been incorporated into the "GrassPlot" database of EDGG (Dengler et al. 2018; Biurrun et al. 2019) to facilitate their utilization for scientific studies. Several ongoing projects related to alpha and beta diversity are taking advantage of this, including a study on species-area relationships in Palaeartic grasslands (Dengler et al. 2020c). While vascular plants, bryophytes and lichens are the principal objective of the EDGG Field Workshops, specialists in other taxonomic groups such as spiders (Biurrun et al. 2014) and leafhoppers (Filibeck et al. 2018), have taken part in some expeditions. This interdisciplinary collaboration has been translated into some specific publications (Polchaninova et al. 2018).

In 2019, EDGG organised two Field Workshops: the 12th in Switzerland (Dengler et al. 2020b), which continued the survey of central dry valleys of the Alps started in Austria by the 11th Field Workshop (Magnes et al. 2020), and the 13th in Armenia. The latter was conducted from the 26 June to the 6 July 2019, and this was the second time that EDGG conducted a Field Workshop in Asia, the other being based in Khakassia, Russia (see Polyakova et al. 2016). The main aims of the workshop were (a) to analyse the biodiversity patterns of the Armenian grasslands across multiple taxonomic groups and grain sizes and (b) to study the syntaxonomic position of these grasslands within the Palaearctic context. In this paper, we present some initial findings concerning the species diversity and composition of vascular plants, bryophytes, lichens and orthopteroid insects of these grasslands. Moreover, we have also provided some visual impressions with photographs of the Armenian grasslands, their diversity and biota.

The 13th EDGG Field Workshop

Nineteen scientists from nine countries (Armenia, Austria, Bulgaria, Germany, Italy, Russia, Spain, Switzerland and Ukraine) participated in the Field Workshop. Most of them were botanists, but two zoologists specialized in orthopteroid insects also joined the Field Workshop (Fig. 1). Subsequently, two cryptogam specialists helped with the determination of bryophytes and lichens.

Based on several pre-excursions, our Armenian hosts selected an itinerary that covered a wide variety of dry grassland types in Armenia (Fig. 2, Table 1). We sampled plots in five

Fig. 1. Group photo at the Selim Pass on 2 July 2019.

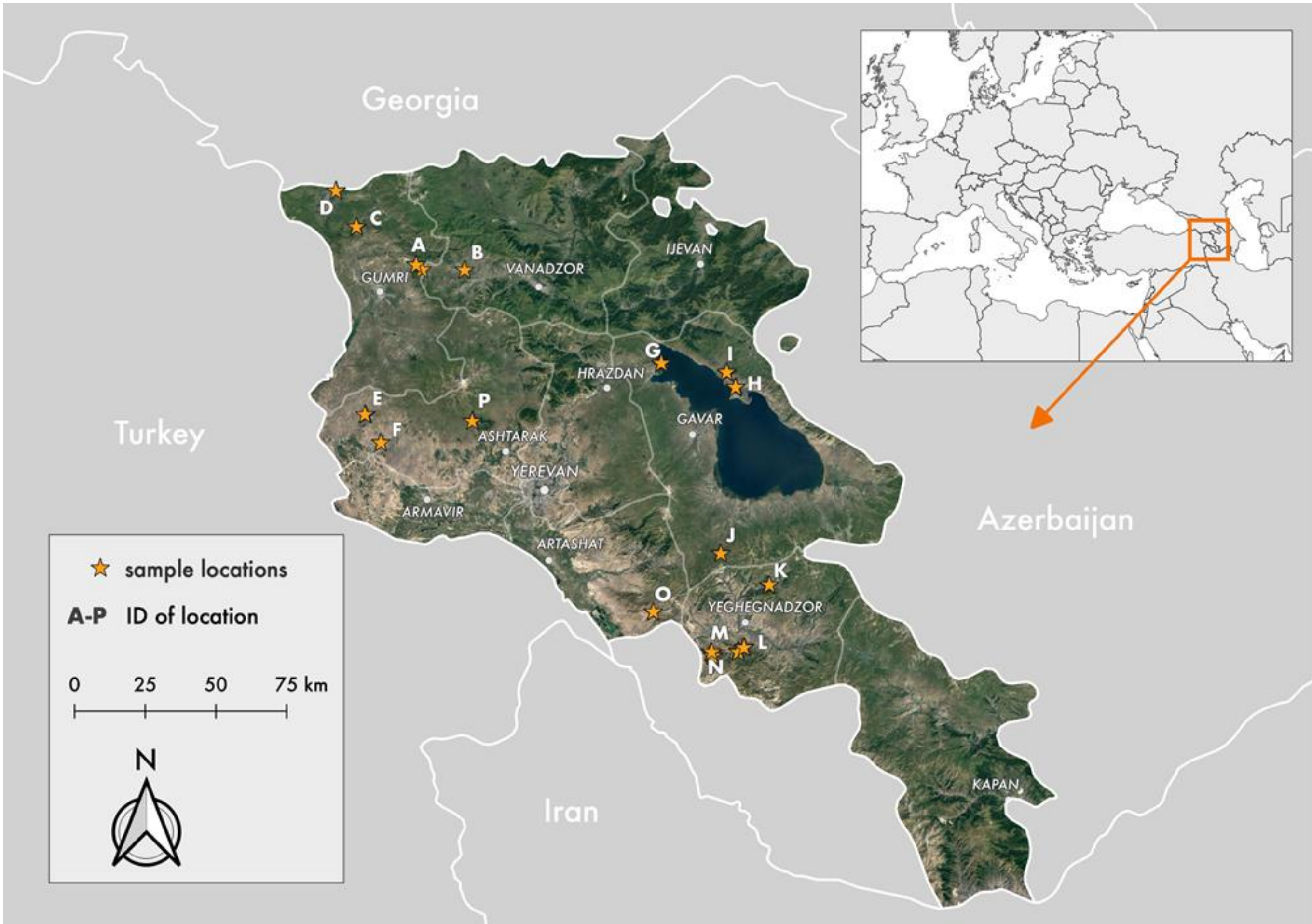


Fig. 2. Sites sampled during the 13th EDGG Field Workshop in Armenia. Further information on the sites is provided in Table 1. The selected sites were distributed from 39.66 to 44.00° N, 40.88 to 45.43° E, and at 1338 to 2400 m a.s.l. Base map: ©2020 Google (satellite image) and @Natural Earth (administrative boundaries).

Table 1. Overview of the grassland sites studied during the 13th EDGG Field Workshop 2019 in Armenia. The location of the sites is shown in Fig. 1.

Site ID	Date	Administrative region	Floristic region	Site location	# biodiversity plots	# normal plots	Total # of 10-m² plots
A	27 June 2019	Shirak	Shirak	Jajur pass	1	4	6
B	27 June 2019	Shirak	Shirak	Vicinity of Shirakamut village	1	3	5
C	28 June 2019	Shirak	Verin Akhuryan	Vicinity of Amasia town	2	2	6
D	28 June 2019	Shirak	Verin Akhuryan	Vicinity of Zorakert village	1	4	6
E	29 June 2019	Aragatsotn	Shirak	Vicinity of Tatool village	2	2	6
F	29 June 2019	Aragatsotn	Shirak	Vicinity of Dashtadem village	1	5	7
G	30 June 2019	Gegharkunik	Sevan	Vicinity of Sevan town	3	0	6
H	01 July 2019	Gegharkunik	Areguni	Ardanish	1	5	7
I	01 July 2019	Gegharkunik	Areguni	Shorja	2	2	6
J	02 July 2019	Gegharkunik	Darelegis	Selim pass	3	2	8
K	02 July 2019	Vayots dzor	Darelegis	Hermon	0	3	3
L	03 July 2019	Vayots dzor	Darelegis	Vicinity of Gnishik village	5	6	16
M	04 July 2019	Vayots dzor	Darelegis	Between Khachik and Areni villages	2	4	8
N	04 July 2019	Vayots dzor	Darelegis	Vicinity of Khachik village	2	6	10
O	05 July 2019	Ararat	Yerevan	Vicinity of Tigranashen village	2	2	6
P	06 July 2019	Aragatsotn	Aparan	Near Amberd fortress	1	3	5

administrative regions and this included seven of the 12 floristic regions of the country (Tamanyan & Fayvush 2009): Verin Akhuryan, Shirak, Sevan, Areguni, Aparan, Yerevan and Darelegis. Our itinerary comprised two national parks (Arpi Lake and Sevan) and the Gnishik Community-Managed Protected Area.

Over ten days, we collected vascular plant, bryophyte and lichen data in 29 EDGG Biodiversity Plots (= nested-plot series of 0.0001 to 100 m²; see Dengler et al. 2016a and Fig. 3) and 53 additional 10-m² plots. Orthopteroid insects were sampled in 42 100-m² (28 EDGG Biodiversity Plots and 14 enlarged 10-m²-vegetation plots; for method, see Hilpold et al. 2020). After the Field Workshop, a set of soil parameters were determined in the laboratory from mixed soil samples that were collected in the field from the uppermost 15 cm of the soil. The identification of bryophytes and lichens has been completed. However, determination of vascular plants is still ongoing and, therefore, minor modifications to the richness data might be required in the future.

Preliminary results and discussion

Site conditions and vegetation structure

Our sampling covered an elevational gradient from 1338 to 2400 m a.s.l. (Table 2). Thus, only the lowest areas and the alpine grasslands were not sampled, the former due to the season already being too advanced. The alpine grasslands were visited on the last day (see Appendix) but not sampled. Dry grasslands occurred in all aspects, from South to North, from nearly flat areas to steep slopes (Table 2). The majority of soils were skeletal (on average more than 40% cover of rocks, stones and gravel on the surface) and rather shallow with a mean soil depth of less than 20 cm (Table 2). Soil reaction was mostly alkaline, with only a few soils having a pH below 7 (Table 2).

Composition of the vegetation

The most frequent graminoids were *Dactylis glomerata* (31.2%), *Poa bulbosa* (31.2%), *Elytrigia intermedia* (20.7%),

Fig. 3. Sampling the EDGG Biodiversity Plot No. 5 in the vicinity of Zorakert village. Photo: T. Becker.

Poa angustifolia (17.7%), *Koeleria macrantha* (14.4%) and *Phleum phleoides* (14.4%), i.e. all species that are widespread in the xerothermic regions of the Western Palaearctic. We found 14 taxa of *Stipa*, with *S. capillata* (8.8%) and *S. pulcherrima* (8.4%) being the most frequent ones. Apart from the common Central and Eastern European species such as *S. capillata*, *S. lessingiana*, *S. pennata*, *S. pulcherrima* and *S. tirsa*, we also found Caucasian and Minor Asian ones, such as *S. sareptana* subsp. *anisotricha*, *S. arabica*, *S. araxensis*, *S. canescens*, *S. hohenackeriana*, *S. ehrenbergiana* and others. The narrow-leaved fescue species were mainly represented by *Festuca valesiaca* (13.5%), but additionally, also rare occurrences of *F. stricta* subsp. *sulcata*, *F. brunnescens* and *F. woronowii*. The most widespread forbs were *Galium verum* (36.0%), *Medicago sativa* agg. (34.0%), *Teucrium capitatum* (28.1%), *Thymus kotschyanus* (27.7%), *Stachys recta* (24.4%), *Scutellaria orientalis* (with various subspecies: 20.2%), *Convolvulus lineatus* (19.1%), *Lotus corniculatus* (18.8%) and *Scabiosa bipinnata* (17.0%). While our samples still need final confirmation, it appears that we recorded for the first time from Armenia (see Euro+Med 2020), *Festuca stricta* subsp. *sulcata* (= *S. rupicola*; in regional keys seemingly included in the polymorphic *F. brunnescens*) and *Rhinanthus angustifolius* (quite widespread but according to the key in the Armenian flora one would determine it as *R. minor*).

In the Armenian dry grasslands we investigated, 43 moss taxa were found. Among them, ground mosses of the *Pottiaceae* family predominated, especially *Syntrichia ruralis* var. *ruralis*, *S. ruralis* var. *ruraliformis* and *Weissia brachycarpa*. On areas of bare ground and plant debris, common mosses such as *Bryum argenteum*, *B. caespiticium*, *B. capillare*, *Ceratodon purpureus*, *Hypnum cupressiforme* and *Pohlia nutans* frequently occurred. On more alkaline sites, typical mosses of base-rich grasslands were found: *Abietinella abietina*, *Campyliadelphus chrysophyllus*, *Encalypta vulgaris*, *Homalothecium lutescens*, *Rhytidium rugosum*. On rocky ground (gravel, stones and the margins of rocks) *Grimmia laevigata*, *G. pulvinata*, and *Schistidium crassipilum* were noted. During our study, only one species of liverwort was found, namely *Lophocolea heterophylla*. The moss species *Syntrichia papillosissima* (*Pottiaceae*) was found new for Armenia.

Lichens were generally rare in the dry grasslands of Armenia, with *Collema* spp. div. (12.3%), *Placidium* spp. div. (2.3%), *Aspicilia hispida* (syn. *Agrestia hispida, Circinaria hispida, Sphaerothallia hispida*) (2.3%) and *Cladonia foliacea* (1.9%) being the most frequent taxa. Most remarkable were the records of the small manna lichen (*Aspicilia hispida*) from three Biodiversity Plots (AM08, AM16, AM32) in sites B and O (see Table 1), which is new for Armenia. The thallus

Table 2. Overview of site, soil and structural parameters of the conditions found in the 111 10-m² plots. Soil chemical variables refer to a mixed sample of the uppermost 15 cm; "standard height herb layer" refers to the "disc method" of Dengler et al. (2016a).

	Min.	Max.	Mean	SD
Location				
Latitude [°]	39.66	41.10	40.23	0.50
Longitude [°]	43.40	45.43	44.73	0.66
Elevation [m a.s.l.]	1338	2400	1931	251
Topography				
Southing	-1.00	1.00	0.08	0.67
Inclination [°]	4	53	21	12
Microrelief (maximum) [cm]	2	72	13	11
Soil physical				
Cover stones and rocks [%]	0	70	12	14
Cover gravel [%]	0	99	28	28
Cover fine soil [%]	1	100	61	32
Soil depth mean [cm]	2.3	100.0	18.6	15.6
Soil depth SD [cm]	0.0	35.0	6.5	5.2
Soil depth CV [%]	0	135	43	25
Soil chemical				
pH (H_2O)	5.90	8.10	7.35	0.60
Electrical conductivity [$\mu S\ cm^{-1}$]	100	780	277	147
Organic C [%]	0.60	6.81	3.82	1.50
Humus [%]	1.03	11.74	6.58	2.58
N [%]	0.05	0.92	0.43	0.19
C/N	5.1	15.1	9.4	2.4
Vegetation cover				
Total vegetation cover [%]	20	95	67	19
Cover shrub layer [%]	0	11	0	2
Cover herb layer [%]	20	95	66	19
Cover cryptogam layer [%]	0	80	3	9
Cover litter [%]	0	100	28	30
Cover dead wood [%]	0	1	0	0
Vegetation height				
Maximum height shrub layer	NA	173	9	29
Maximum height herb layer	24	150	75	22
Standard height herb layer	4	57	15	8
Standard height herb layer SD	1	25	7	5

of this species forms tiny, bushy, more or less *Cladonia*-like branches with black apices at the tip of branchlets. It initially grows on soil and later becomes vagrant. Vagrant forms accumulate in wind-deposited drifts (Sohrabi et al. 2013). The species is rare in Europe and is only known from the most continental parts of the Iberian Peninsula, the maritime Alps of France, the western Alps of Piemonte in Italy, the Parnassus mountain in Greece and the Crimean Peninsula. It is more widely distributed in the steppes of the Near East, Middle and Central Asia (Nimis 2016; Sohrabi et al. 2013).

Diversity of the vegetation

Mean total richness of the vegetation increases from 2.0 species in 1 cm² via 31.9 species in 1 m² to 51.3 species in 10 m² (Table 3). Data for the 100-m² plots have yet to be fully analysed, but the raw data suggest that our richest plot (Fig. 4) contains approximately 145 species, of which 130 are vascular plants. Bryophytes and lichens mostly not only had very low cover with 3% on average (Table 3), but they also contributed only a rather small fraction to the total richness of the dry grasslands, decreasing from about 10% in the smallest grain sizes to only 5% in 10 m². Accordingly, mean vascular plant species richness values were only slightly lower than that of the total vegetation (Table 3). Maximum values for vascular plant species richness were 7 in 1 cm², 51 in 1 m² and 80 in 10 m². Particularly high values of vascular plants were, without exception, a feature of the meso-xeric grasslands, such as the example shown in Fig. 4.

While the richness values for non-vascular species and the contribution of these groups to overall richness of the vegetation were below average for Palaearctic grasslands (Dengler et al. 2016a), the small-scale diversity of vascular plants was outstanding. With a mean of 48.7 vascular plant species in 10 m², the values were only minimally below those in Transylvania (49.7), which is the record for the EDGG Field Workshops held to date (Dengler et al. 2016a). By contrast, values were much lower in other Field Workshop areas that included xeric valleys and high mountains, such as Navarre (41.9; see Dengler et al. 2016a) and the central-alpine valleys of Switzerland (28.9; Dengler et al. 2020b). This extreme fine-grain vascular plant species richness in the Armenian dry grasslands is all the more astonishing as plots sampled in meso-xeric grasslands were only a relatively small fraction of the total. As is the case all over the Palaearctic (Dengler et al. 2020a), the Armenian meso-xeric (basiphilous) grasslands were by far the richest type. With up to 80 vascular plant species in 10 m², they exceed the maxima known in most regions of the Palaearctic. Only from Eastern Europe (98 species) and Western Europe (86 species) have higher maxima been reported, but taking into account our small sample size, one can assume that equally rich plots could also be found in Armenia. Also 35 vascular plants in 0.1 m² (Table 3) is only slightly below the Palaearctic (and world) record of 43 (Wilson et al. 2012; Dengler et al. 2020a).

Table 3. Overview of scale-dependent species richness of vascular plants, terricolous bryophytes and lichens in Armenian dry grasslands using the shoot presence method. The data for vascular plants are preliminary as the determination of herbarium specimens has not been yet finalised. However, for grain sizes below 100 m² only minor changes are now likely. Species richness values for vascular plants and complete vegetation in the 100-m² plots are not provided here because they may change substantially once the alignment of plant nomenclature between the subplot series of the two corners is completed.

		Total richness		Vascular plants		Bryophytes		Lichens	
Area [m²]	***n***	**Mean**	**Range**	**Mean**	**Range**	**Mean**	**Range**	**Mean**	**Range**
0.0001	58	2.0	0–10	1.8	0–7	0.2	0–3	0.0	0–0
0.001	58	3.4	0–12	3.1	0–9	0.3	0–4	0.1	0–2
0.01	58	7.5	2–24	6.7	2–22	0.6	0–7	0.1	0–3
0.1	58	16.6	7–35	15.4	6–35	0.9	0–7	0.3	0–3
1	58	31.9	15–56	29.6	15–51	1.9	0–11	0.4	0–3
10	111	51.3	22–91	48.7	22–80	1.9	0–11	0.6	0–5
100	29	NA	NA	NA	NA	3.8	0–12	1.3	0–7

Fig. 4. The most species-rich plot at 10 m² and 100 m² recorded during the 13th EDGG Field Workshop, a meso-xeric grassland in Ardanish (site H, Biodiversity Plot AM22), with 91 species in 10 m² (among them 80 vascular plants) and approx. 145 species (among them approx. 130 vascular plants) in 100 m² (raw number: 159 species; final number not yet fixed as a cross-check of species determination between subplots is incomplete). Typical species visible in the photo include *Trifolium alpestre* (red), *Psephellus dealbatus* (pink), *Campanula glomerata* (blue), *Lotus corniculatus* (yellow) and *Cephalaria gigantea* (non-flowering tall forb in the foreground). Photo: J. Dengler.

Vegetation types and syntaxonomy

In the absence of a syntaxonomic overview of Armenia and prior to proper classification of the relevés, we can provide only a brief characterisation of the main vegetation types encountered among the dry grasslands of the country:

Widespread across all study regions (except the lowest elevations), we found meso-xeric grasslands, xeric grasslands and rocky grasslands, all three often juxtaposed, but on slopes with different aspects and rockiness (Figs. 5 and 6). These three main types were floristically and physiognomically clearly distinct, as well as in their colour during sampling time (Fig. 5). Given their dominating species (see in section "Composition of the vegetation" above), all three types probably should be included in the class *Festuco-Brometea*, which comprises the basiphilous dry grasslands dominated by perennial species in Europe (see Mucina et al. 2016). In the case of the meso-xeric and xeric types, the high floristic similarity to stands in Eastern and Eastern Central Europe suggests that they might be included in the widespread orders *Brachypodietalia pinnati* and *Festucetalia valesiacae*, respectively (see Mucina et al. 2016), but in both cases probably in a vicariant alliance of the Caucasus. This finding is particularly interesting (and possibly for many readers astonishing) in the case of the *Brachypodietalia pinnati*. However, by overlaying distribution maps of diagnostic species of this order, Dengler (2003) already predicted an isolated outpost of this order in the Caucasus. By contrast, the rocky dry grasslands apparently do not belong to any of the described orders (*Stipo pulcherrimae-Festucetalia pallentis*, *Thymo cretacei-Hyssopetalia cretacei*, *Scorzoneretalia villosae* in the sense of Mucina et al. 2016) and thus might represent a new order.

The other three main physiognomic-ecological types (Fig. 7) might largely belong to other classes than the *Festuco-Brometea*. The thorn-cushion communities of Iran and neighbouring countries have been described as *Onobrychidetea cornutae* and the scree communities might partly belong to the class *Prangetea ulopterae* (see Ambarlı et al. 2017), partly perhaps still to the *Festuco-Brometea* (e.g. Fig. 7C). Xeric grasslands with Minor-Asian species, such as *Astracantha microcephala*, *Dianthus crinitus*, *Helichrysum plicatum*, *Leontodon asperrimus*, *Taeniatherum caput-medusae* subsp. *crinitum*, *Stipa holosericea* are classified within the class *Astragalo-Brometea* which represents

Fig. 5. South-facing (left) and north-facing (right) slopes were often inhabited by contrasting plant communities, i.e. xeric vs. meso-xeric types, with their distinct flora as here in site M. Photo: J. Dengler.

Fig. 6. Examples I of main vegetation types sampled during the EDGG Field Workshop in Armenia. (A) and (B): meso-xeric grasslands sometimes had many Caucasus-specific species as *Stachys macrantha*, *Polygonum alpinum* and *Rhinanthus* cf. *angustifolius* in site C (A), sometimes had a species composition almost identical to stands in Eastern Central Europe, with *Campanula sibirica*, *Plantago media, Briza media* and *Onobrychis transcaucasica* in site G (B). (C) and (D): xeric grasslands on deeper soils occurred in various types as (C) with *Koeleria macrantha*, *Salvia nemorosa* and *Teucrium capitatum* in site B or (D) with *Stipa* spp. in site L. (E) and (F): rocky grassland also occurred in various types as (E) in site E or (F) with *Echium vulgare* in site G. Photos: J. Dengler.

Fig. 7. Examples II of main vegetation types sampled during the EDGG Field Workshop in Armenia. (A) and (B): Thorn-cushion communities typically also contained grassland elements as (A) with *Onobrychis cornuta*, *Asphodeline taurica* and *Carex humilis* in site A or (B) with *Onobrychis cornuta*, *Stipa pulcherrima* and *Galium verum* in site I. (C) and (D): Xerothermic scree communities were diverse and contained many Caucasus-specific species as (C) with *Michauxia laevigata* and *Euphorbia sequieriana* in site K or (D) with *Stipa araxensis* in site L. (E) and (F): Dry grasslands of the lower elevations were rich in annuals and dwarf shrubs as (E) with *Artemisia fragrans*, *Taeniatherum caput-medusae* subsp. *crinitum* and *Aegilops cylindrica* in site F or (F) with *Gypsophila aretioides*, *Helianthemum ledifolium* and *Chardinia orientalis* in site O. Photos: J. Dengler.

Iranian and Anatolian steppes (Kenar et al. 2020). Whether all xeric grasslands of the lower elevations, rich in annuals and dwarf shrubs and containing Irano-Turanian elements, should be included in *Astragalo-Brometea*, is still an open question that needs further elaboration.

Composition and diversity of the orthopteroid insects

During the 13th EDGG Field Workshop in Armenia, we were able to test a new, standardized method to survey orthopteroid insects (Hilpold et al. 2020). Within the group "orthopteroid insects" we considered grasshoppers (*Caelifera*), bush and field crickets (*Ensifera*) and mantids (*Mantodea*). In summary, this method is conducted on the full extent of the EDGG biodiversity plots and combines sweep-netting along a transect and an exhaustive species search. This combination enables the surveyor to assess both absolute and relative species abundance, and also provides a representative picture of the total species richness.

We applied and tested the method on 42 EDGG vegetation survey plots (14 “normal plots“, 28 EDGG Biodiversity Plots). By doing so, a total of approximately 40 species of orthopteroid insects have been identified so far, while additional species that have been collected await identification. We observed a maximum of 14 species per 100 m² in the vicinity of the village of Gnishik, which is situated within a landscape that consists of dry pastures, hay meadows and shrubland (see day 8 in the Photo Diary in the Appendix). Orthopteroid insects were present in all the sampled plots with the lowest species number of 3 species per 100 m² plot. Among these species, we found many characteristic elements of mesic grasslands of the western Palaearctic, for example *Stauroderus scalaris* and *Chorthippus apricarius* – species that also occur in Central and Western Europe. In addition, we found widespread Eurasian steppe elements that are limited to isolated dry habitats in Central Europe, such as *Omocestus petraeus* and *Stenobothrus nigromaculatus*. Also, Mediterranean elements, such as *Tylopsis liliifolia* and *Platycleis affinis* were frequently recorded. The group of species that was biogeographically most interesting to the authors comprised species that have their main distribution in Southwestern Asia, such as *Notostaurus anatolicus*, *Psorodonotus* sp., *Paradrymadusa* sp. or *Ramburiella turcomana*. Finally, a small number of species were recorded that are endemic to the Caucasus and Trans-Caucasus area, for example *Euchorthippus transcaucasicus* and *Bradyporus dilatatus* (Fig. 8-left), the latter, a huge cricket exceeding 5 cm in length. The latter was one of the orthopterological highlights of the field workshop and was present in large numbers in the meso-xeric grasslands of Lake Arpi National Park.

For the authors , the excursion was a unique chance to get an impression of the diverse *Orthoptera* fauna of the Trans-Caucasus, and to acquire familiarity with many new species of grasshoppers and bush crickets. However, species identification was not always straightforward. The identification key we mainly relied on was qualitatively very good, but comprised the *Orthoptera* fauna of the whole former Soviet Union and dates back to 1951 (Bei-Bienko & Mishchenko 1964). This lack of recent, and more region-specific taxonomic literature became challenging at times, mostly when we encountered genera that appear rather exotic to the Central European orthopterologist. This was for example the case for several species belonging to the *Pamphagidae*, a family that is uncommon in Central Europe. These very attractive grasshoppers were another orthopterological highlight of the Field Workshop (Fig. 8-right).

Conclusions and outlook

The 13th EDGG Field Workshop provided the participants with a wonderful insight into the diversity of the dry grasslands of Armenia. In addition, and for the first time, standardised and comprehensive biodiversity sampling of four important grassland taxa (vascular plants, bryophytes, lichens, orthopteroid insects) have been undertaken in this country. Meanwhile, data have been entered, soils have been analysed and bryophytes, lichens, *Orthoptera* and *Festuca* samples have been determined. Thus, all that remains to be completed is the identification of vascular

Fig. 8. Two *Orthoptera* species that are particularly interesting from a European perspective. Left: *Bradyporus dilatatus* at Lake Arpi National Park, the largest *Orthoptera* species found during the Field Workshop in Armenia. Photo: T. Becker. Right: *Pamphagidae* sp. Photo: P. Kirschner.

plants. The current incomplete data have already provided several valuable insights, including:

First records from Armenia of two species of cryptogams (*Syntrichia papillosissima* and *Aspicilia hispida*) and possibly two more vascular plant species.

Very high fine-grain species richness of vascular plants, only slightly below the current world records (despite our relatively small sample size). Armenia can in this respect now be mentioned together with well-known places in Transylvania and the White Carpathians as a global hotspot.

Dominant vegetation types seem to fit into the European class *Festuco-Brometea* and here into the orders *Brachypodietalia pinnati*, *Festucetalia valesiacae* and probably a new order of Caucasian rocky grasslands.

By contrast, the other vegetation types (thorn cushion communities, scree vegetation and dry grasslands of lower elevations rich in annuals and chamaephytes) do not fit into any of the European classes.

The new method for sampling orthopteroid insects (Hilpold et al. 2020) designed to be conducted in conjunction with EDGG Biodiversity Plots of vegetation (Dengler et al. 2016a) proved to be efficient and informative.

As next steps, we plan to finalise the determination of the sampled vascular plants and *Mantodea* species. Then we aim to prepare at least two papers dealing with (a) the combined analysis of the scale- and taxon-dependent biodiversity patterns and their drivers and (b) the syntaxonomy of the Armenian dry grasslands in a Palaearctic context. Meanwhile, the plots sampled during the expedition have already been fed into the GrassPlot database (Dengler et al. 2018; Biurrun et al. 2019) and will, from now on, provide high-quality biodiversity data for macroecological studies such as Dengler et al. (2020c). In conclusion, the Field Workshop has contributed to filling important information gaps both in biodiversity analyses and syntaxonomy both from a national and from a Palaearctic perspective.

Author contributions

A.A. organised the Field Workshop together with G.F. and M.O., while J.D. and I.B. led the writing of the text. D.V. and E.B. compiled the Photo Diary. All authors, except B.C.-M., I.D. and H.M., were involved in the field sampling. P.K and A.H. sampled the orthopteroid insects and wrote the corresponding section. B.C.-M. H.M. and I.D. determined bryophytes, lichens and *Festuca* species, respectively, and wrote the corresponding sections. A.B. contributed to the Introduction, D.V. to the text on *Stipa* and syntaxonomy, and D.S. prepared the map. A.B., D.S and I.V. entered the data and I.B and I.D. contributed to “data cleaning”. Many authors contributed photos (see captions). All authors read and approved the manuscript.

Acknowledgments

We are grateful to the IAVS and EDGG for providing travel grants to some participants and the administration of the Institute of Botany after A.L. Takhtajyan of the National Academy of Science of the Republic of Armenia for support in the organization of the Field Workshop. We are grateful to Richard Jefferson for fast and thorough linguistic editing.

References

Ambarlı, D., Vrahnakis, V., Burrascano, S., Naqinezhad, A. & Pulido, M. 2017. Grasslands in the Mediterranean Basin and the Middle East. In: Squires, V.R., Dengler, J., Feng, H. & Hua, L. (eds.) *Grassland of the world: diversity, management and conservation*, pp. 89–112. CRC Press, Boca Raton, US.

Ambarlı, D., Naqinezhad, A. & Aleksanyan, A. 2020. Grasslands and shrublands of the Middle East and the Caucasus. In: Goldstein, M.I. & DellaSala, D.A. (eds.) *Encyclopedia of the world’s biomes*, pp. 714-724. Elsevier, Amsterdam, NL.

Bei-Bienko, G. & Mishchenko, L.L. 1964. *Locusts and grasshoppers of the U.S.S.R. and adjacent countries* (English edition). National Science Foundation, Washington D.C., US.

Biurrun, I., García-Mijangos, I., Berastegi, A., Ambarlı, D., Dembicz, I., Filibeck, G., Jandt, U., Janišová, M., Jaunatre, R., (…) & Dengler, J. 2014. Diversity of dry grasslands in Navarre (Spain). Experiences from the 7th EDGG Field Workshop, 15-24 June 2014. *Bulletin of the European Dry Grassland Group* 24/25: 4–21.

Biurrun, I., Burrascano, S., Dembicz, I., Guarino, R., Kapfer, J., Pielech, R., García-Mijangos, I., Wagner, V., Palpurina, S., (…) & Dengler, J. 2019. GrassPlot v. 2.00 – first update on the database of multi-scale plant diversity in Palaearctic grasslands. *Palaearctic Grasslands* 44: 26–47.

Dengler, J. 2003. Entwicklung und Bewertung neuer Ansätze in der Pflanzensoziologie unter besonderer Berücksichtigung der Vegetationsklassifikation. *Archiv naturwissenschaftlicher Dissertationen* 14: 1–297.

Dengler, J. 2009. A flexible multi-scale approach for standardised recording of plant species richness patterns. *Ecological Indicators* 9: 1169–1178.

Dengler, J., Becker, T., Ruprecht, E., Szabó, A., Becker, U., Beldean, M., Biţă-Nicolae, C., Dolnik, C., Goia, I., (…) & Uğurlu, E. 2012. *Festuco-Brometea* communities of the Transylvanian Plateau (Romania) – a preliminary overview on syntaxonomy, ecology, and biodiversity. *Tuexenia* 32: 319–359.

Dengler, J., Janišová, M., Török, P. & Wellstein, C. 2014. Biodiversity of Palaearctic grasslands: a synthesis. *Agriculture, Ecosystems & Environment* 182: 1–14.

Dengler, J., Boch, S., Filibeck, G., Chiarucci, A., Dembicz, I., Guarino, R., Henneberg, B., Janišová, M., Marcenò, C., (…) & Biurrun, I. 2016a. Assessing plant diversity and composition in grasslands across spatial scales: the standardised EDGG sampling methodology. *Bulletin of the Eurasian Grassland Group* 32: 13–30.

Dengler, J., Biurrun, I., Apostolova, I., Baumann, E., Becker, T., Berastegi, A., Boch, S., Cancellieri, L., Dembicz, I., (…) & Weiser, F. 2016b. Scale-dependent plant diversity in Palaearctic grasslands: a comparative overview. *Bulletin of the Eurasian Dry Grassland Group* 31: 12–26.

Dengler, J., Wagner. V., Dembicz, I., García-Mijangos, I., Naqinezhad, A., Boch, S. Chiarucci, A., Conradi, T., Filibeck, G., (…) & Biurrun, I. 2018. GrassPlot – a database of multi-scale plant diversity in Palaearctic grasslands. *Phytocoenologia* 48: 331–347.

Dengler, J., Gehler, J., Aleksanyan, A., Fayvush, G. & Biurrun, I. 2019. EDGG Field Workshops 2019 – the international research expeditions to study grassland diversity across multiple scales and taxa: Call for participation. *Palaearctic Grasslands* 41: 9–22.

Dengler, J., Biurrun, I., Boch, S., Dembicz, I. & Török, P. 2020a. Grasslands of the Palaearctic biogeographic realm: introduction and synthesis. In: Goldstein, M.I. & DellaSala, D.A. (eds.) *Encyclopedia of the world's biomes*, pp. 617-637. Elsevier, Amsterdam, NL.

Dengler, J., Guarino, R., Moyisyenko, I., Vynokurov, D., Boch, S., Cykowska-Marzencka, B., Babbi, M., Catalano, C., Eggenberg, S., (…) & Dembicz, I. 2020b. On the trails of Josias Braun-Blanquet II: First Results from the 12th EDGG Field Workshop studying the dry grasslands of the inneralpine dry valleys of Switzerland. *Palaearctic Grasslands* 45: 59–88.

Dengler, J., Matthews, T.J., Steinbauer, M.J., Wolfrum, S., Boch, S., Chiarucci, A., Conradi, T., Dembicz, I., Marcenò, C., (…) & Biurrun, I. 2020c. Species-area relationships in continuous vegetation: Evidence from Palaearctic grasslands. *Journal of Biogeography* 47: 72–86.

Euro+Med 2020. *Euro+Med PlantBase – the information resource for Euro-Mediterranean plant diversity*. URL: http://ww2.bgbm.org/EuroPlusMed/ [accessed on 9 June 2020].

Fayvush, G. & Aleksanyan, A. 2016. *Habitats of Armenia*. Institute of Botany NAS RA, Yerevan, AM.

Filibeck, G., Cancellieri, L., Sperandii, M.G., Belonovskaya, E., Sobolev, N., Tsarevskaya, N., Becker, T., Berastegi, A., Bückle, C. (…) & Biurrun, I. 2018. Biodiversity patterns of dry grasslands in the Central Apennines (Italy) along a precipitation gradient: experiences from the 10th EDGG Field Workshop. *Bulletin of the Eurasian Grassland Group* 36: 25–41.

Heller, K-G., Bohn, H., Haas, F., Willemse, F. & de Jong, Y. 2016. Fauna Europaea – Orthopteroid orders. *Biodiversity Data Journal* 4: e8905.

Hill, M.O., Bell, N., Bruggeman-Nannenga, M.A., Brugués, M., Cano, M.J., Enroth, J., Flatberg, K.K., Frahm, J.-P., Gallego, M.T., (…) & Söderström, L. 2006. An annotated ckecklist of the mosses of Europe and Macaronesia. *Journal of Bryology* 28: 198–267.

Hilpold, A., Kirschner, P. & Dengler, J. 2020. Proposal of a standardized EDGG surveying methodology for orthopteroid insects. *Palaearctic Grasslands* 46: 52–57.

Kenar, N., Şekerciler, F. & Çoban, S. 2020. The phytosociology, ecology, and plant diversity of new plant communities in Central Anatolia (Turkey). *Hacquetia* 19: 1–22.

Kuzemko, A., Becker, T., Didukh, Y.P., Ardelean, I.V., Becker, U., Beldean, M., Dolnik, C., Jeschke, M., Naqinezhad, A., (…) & Dengler, J. 2014. Dry grassland vegetation of central Podolia (Ukraine) – A preliminary overview of its syntaxonomy, ecology and biodiversity. *Tuexenia* 34: 391–430.

Kuzemko, A., Steinbauer, M.J., Becker, T., Didukh, Y.P., Dolnik, C., Jeschke, M., Naqinezhad, A., Uğurlu, E., Vassilev, K. & Dengler, J. 2016. Patterns and drivers of phytodiversity in steppe grasslands of Central Podolia (Ukraine). *Biodiversity and Conservation* 25: 2233–2250.

Magnes, M., Kirschner, P., Janišová, M., Mayrhofer, H., Berg, C., Mora, A., Afif, E., Willner, W., Belonovoskaya, E., (…) & Dengler, J. 2020. On the trails of Josias Braun-Blanquet – changes in the grasslands of the inneralpine dry valleys during the last 70 years. First results from the 11th EDGG Field Workshop in Austria. *Palaearctic Grasslands* 45: 34–58.

Mucina, L., Bültmann, H., Dierßen, K., Theurillat, J.-P., Raus, T., Čarni, A., Šumberová, K., Willner, W., Dengler, J., (…) & Tichý, L. 2016. Vegetation of Europe: Hierarchical floristic classification system of vascular plant, bryophyte, lichen, and algal communities. *Applied Vegetation Science* 19, Suppl. 1: 3−264.

Nimis, P.L. 2016. *The lichens of Italy. A second annotated catalogue*. EUT – Edizioni Università di Trieste, Trieste, IT.

Nimis, P.L., Hafellner, J., Roux, C., Clerc, P., Mayrhofer, H., Martellos, S. & Bilovitz, P.O. 2018. The lichens of the Alps – an annotated checklist. *MycoKeys* 31: 1–634.

Pedashenko, H., Apostolova, I., Boch, S., Ganeva, A., Janišová, M., Sopotlieva, D., Todorova, S., Ünal, A., Vassilev, K., (…) & Dengler, J. 2013. Dry grasslands of NW Bulgarian mountains: first insights into diversity, ecology and syntaxonomy. *Tuexenia* 33: 309–346.

Polchaninova, N., García-Mijangos, I., Berastegi, A., Dengler, J. & Biurrun, I. 2018. New data on the spider fauna (*Araneae*) of Navarre, Spain: results from the 7th EDGG Field Workshop. *Arachnology Letters* 56: 17–23.

Polyakova, M.A., Dembicz, I., Becker, T., Becker, U., Demina, O.N., Ermakov, N., Filibeck, G., Guarino, R., Janišová, M., (…) & Dengler, J. 2016. Scale- and taxon-dependent patterns of plant diversity in steppes of Khakassia, South Siberia (Russia). *Biodiversity and Conservation* 25: 2251–2273.

Schaminée, J.H.J., Chytrý, M., Dengler, J., Hennekens, S.M., Janssen, J.A.M., Jiménez-Alfaro, B., Knollová, I., Landucci, F., Marcenò, C., (…) & Tichý, L. 2016. *Development of distribution maps of grassland habitats of EUNIS habitat classification*. European Environment Agency [Report EEA/NSS/16/005], Copenhagen, DK.

Söderström, L., Hagborg, A., von Konrat, M., Bartholomew-Began, S., Bell, D., Briscoe, L., Brown, E., Cargill, D.C., Pinheiro da Costa, D., (…) & Zhu, R.-L. 2016. World checklist of hornworts and liverworts. *PhytoKeys* 59: 1–821.

Sohrabi, M., Stenroos, S., Myllys, L., Søchting, U., Athi, T. & Hyvönen, J. 2013. Phylogeny and taxonomy of the 'manna lichens'. *Mycological Progress* 12: 231–269.

Tamanyan, K.G. & Fayvush, G.M. 2009. On the problem of floristic regions of Armenia. *Flora, Vegetation and Plant Resources of Armenia* 17: 73–78.

Turtureanu, P.D., Palpurina, S., Becker, T., Dolnik, C., Ruprecht, E., Sutcliffe, L.M.E., Szabó, A. & Dengler, J. 2014. Scale- and taxon-dependent biodiversity patterns of dry grassland vegetation in Transylvania. *Agriculture, Ecosystems & Environment* 182: 15–24.

Willner, W., Kuzemko, A., Dengler, J., Chytrý, M., Bauer, N., Becker, T., Biţă-Nicolae, C., Botta-Dukát, Z., Čarni, A., (…) & Janišová, M. 2017. A higher-level classification of the Pannonian and western Pontic steppe grasslands (Central and Eastern Europe). *Applied Vegetation Science* 20: 143−158.

Wilson, J.B., Peet, R.K., Dengler, J. & Pärtel, M. 2012. Plant species richness: the world records. *Journal of Vegetation Science* 23: 796–802.

Appendix: Photo diary of the 13th EDGG Field Workshop in Armenia

Compiled by Elena Belonovskaya, Denys Vynokurov and Idoia Biurrun

With photos by Elena Belonovskaya, Asun Berastegi, Idoia Biurrun, Jürgen Dengler, Dieter Frank, Itziar García-Mijangos, Andreas Hilpold, Philipp Kirschner, Martin Magnes, Salza Palpurina, Dariia Shyriaieva & Denys Vynokurov

Day 1 - June 26, Yerevan-Gyumri

The meeting point for the group was at the Yerevan Botanical Garden. Everyone was very glad to see colleagues again. We started at 3 PM and the outdoor temperature was 40˚C. Our first trip was to Gyumri. We crossed Yerevan city and made our way to the North-West.

During our journey, we had a short unexpected stop near a small village. For most of us it was our first acquaintance with the desert steppe community with *Artemisia fragrans, Capparis sicula* subsp. *herbacea, Taeniatherum caput-medusae* subsp. *crinitum,* etc.

We arrived at Gyumri in the evening and, after checking in the hotel, we went for dinner. We sat outdoors on the terrace and tasted traditional Armenian dinner with several national dishes: dolma, shashlik, apjapsandal and lavash. Then back in the hotel, we assembled our equipment in readiness for our first sampling the next day.

Left: Gathering in the Yerevan Botanical Garden. Right: Our driver Aram loads our luggage into the bus that will take us through Armenia.

Capparis sicula* subsp. *herbacea.

Traditional Armenian dinner.

Traditional equipment ready for the next day.

Day 2 - June 27, Gyumri-Jajur, Jajur-Shirakamut

On this day we travelled to the region of Jajur pass. We sampled several plots of the rare thorn cushion and shrub steppe with *Onobrychis cornuta, Asphodeline taurica* and *Prangos ferulacea* in a narrow valley with rather steep stony slopes. While we were working, the weather changed rapidly. The sky was becoming more and more cloudy. Nevertheless, we managed to finish our work on the plots, run down the scree slopes and get into the car before the heavy rain began. We drove through the rain and when the sun appeared again, we found a place for a nice picnic lunch near the river under the trees.

This was our leaflet detailing the sampling instructions.

In the afternoon, we drove eastwards towards the Lory area and stopped near Shirakamut village. This area has a long, well-documented land use history and is known for its Palaeo- and Neolithic settlements. We saw several caves preserved by archaeologists for further researches. We sampled plots of the mountain feather-grass steppes on the relatively flat surfaces. Most of these habitats were previously arable fields. In the evening, we had dinner in the famous fish restaurant “Cherkezi Dzor” where fresh fish was caught from the artificial ponds within the restaurant grounds. Later the same evening, at the hotel, we identified the plants collected during the day.

Our first EDGG Biodiversity Plot in Armenia.


Thorn cushions of *Onobrychis cornuta* in the Jajur pass.


Left: Picnic by the stream. Right: After lunch, we are quite enthusiastic and have the energy to sample more plots.


Afternoon work near the Shirakamut village.


Left: Aragats mountain behind Gyumri city. Right: Plant determination in the evening.

Day 3 - June 28, Gyumri-Amasia, Amasia-Zorakert

Early in the morning, our direction was to the North-West, towards the town of Amasia. Our bus drove for a long time and, after crossing the pass, we found ourselves on a flat plateau. We passed villages and rivers in deep canyons and then stopped opposite a partly ruined abandoned settlement. There, we sampled mainly former arable fields. At midday, our picnic was by the roadside ("Roadside Picnic" or "Extraterrestrial Picnic" was the name of a famous novel by the Strugatsky brothers). Sometimes in our Field Workshops we also feel the presence of aliens in our surroundings ☺.

Then we drove further for a long time, and near the lake Arpi and Aghvorik village, turned into a valley with a spring near Zorakert village. We crossed the spring and sampled plots on the steep slopes. The weather started to deteriorate. Dark clouds were gathering over us. However, again, we were lucky - we managed to finish our work, return to the bus, and at the moment it started moving, a severe storm with thunder and lightning, rain and hail began.

Late in the evening, we returned to Gyumri. On this evening, we had our dinner in the tavern of Georgian Armenians named "Avlabar" ("Avlabar" is the Armenian quarter in Tbilisi, Georgia) where they serve mainly Georgian dishes: khinkali, lobbio, pkhali.

Colourful grasslands and meadow steppe with *Stipa tirsa* and *Pontechium maculatum* were the focus of our morning sampling.

Left: Sampling meadow steppes. Right: Picnic by the roadside with Armenian bread – lavash.

Landscapes of the Lake Arpi National Park.

Afternoon sampling in the Lake Arpi National Park, near Zorakert village.

Left: Working moments in the evening. Right: examples of some of the identified plant species.

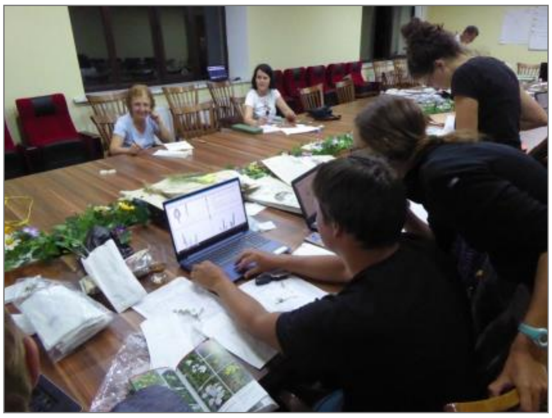
Day 4 - June 29, Gyumri-Talin

In the morning, after breakfast, we made our way to the South, towards Talin town. The bus drove on a flat plateau and far away we saw mountains. We sampled plots in the secondary grasslands restored from former arable fields near Tatool and Dashtadem villages. Some of these steppe grasslands were very dry and we ended up with a large amount of the sharp fruits of grasses in our socks and shoes. As is usual in this region, it became cloudy in the afternoon and, when we were already in the bus, heavy rain began. On the way back to Gyumri, we started learning the song "Garun-Garun" which we had heard in the tavern the day before. We liked this song so much that it became the musical talisman for our team.

On this evening, we had our dinner in the restaurant run by Syrian Armenians "Nor Allepo" which means "New Aleppo". We tasted the delicious western Asian cuisine: hummus, pita, pilaf… Meanwhile in the hotel, that days plant collection was awaiting identification. Our taxonomic work lasted long into the night!

Dry landscape near Talin town.

Sampling moments.



Left: Local gas station on the way back. Right: Plant identification in the evening.

Day 5 - June 30, Gyumri-Sevan pass, Sevan pass-Sevan town

In the morning, we left hospitable Gyumri and made our way to the East, towards Sevan lake. We passed Spitak town (sadly known for the destructive earthquake), Vanadzor town, several Molokanian villages with Russian names (for example Lermontovo, Fioletovo; Molokans are members of a Russian religious sect), Dilijan town, and reached the Argatsin monastery founded between 11-13th century. Everybody was amazed with the ensemble of the ancient monastery. Of course, as botanists we also enjoyed the visit to the Oriental beech (*Fagus orientalis*) forest surrounding Argatsin.

Everyone is packed and ready at Gyumri before we travel to our next accommodation in Sevan.

After sightseeing, we continued on our way, crossed Sevan pass and soon had a first glance at Sevan lake. Upon reaching Sevan town, our first visit was to the Sevan Botanical Garden. This has been maintained and is open to the public only thanks to the enthusiasm of the local specialists. We enjoyed the hospitality of our Sevanian colleagues and had our lunch there. After the lunch, we drank hot tea and coffee served Armenian style. Then, following Armenian tradition, we tried to read out future from the coffee grounds. Of course, they told us that everything would be all right.

Then we sampled plots near Sevan town in front of the Sevanavank monastery. After finishing our sampling, we sat on our bus and as usual, the rain began. For several days, we were due to stay in the "Noyland" resort (Noyland = land of Noy or Noah, whose ark navigated the sea near Ararat in Armenia, according to the Bible). After check-in, we had our dinner in a restaurant on the shore of the lake. The weather at Sevan lake was severe but our dinner was very tasty. We tasted ishkhan (endemic of Sevan - subspecies of brook trout) and various "underfoot exotics": aveluk (*Rumex crispus*), shushan (*Chaerophyllum* spp.).

After a heavy dinner and a long working day, nobody objected to putting off plant identification until another time!


Left: *Fagus orientalis* forest in the Dilijan National Park. Right: Argatsin monastery.


Lunch in the Sevan Botanical Garden.


Sampling with a view of the Sevan Lake.


Severe Sevan Lake weather and warm atmosphere.

Day 6 - July 1, Ardanish peninsula, vicinity of Shorja village
In the morning the sun shined brightly, Sevan was calm and blue. Some of us had their breakfast in the rooms, and others preferred to have morning tea on the balcony. Some of us – people with spirit – swam in the Sevan.
We went along the northern shore of the lake towards Ardanish peninsula and sampled plots in a very nice valley near Chembarak village. Here we sampled the most species-rich plot in Armenia.
After lunch, we moved a little bit and studied tragacanth communities near Shorja village.
After dinner, we continued with the usual business of plant identification, which lasted nearly until early morning, at least for some of us!!

Astonishing view of Sevan Lake.

Left: Biodiversity plot in the diverse meso-xeric grassland near Chembarak village, in Ardanish. Right: Sampling of more xeric communities on the opposite slope.


Botanical and zoological sampling.

Vegetation with *Onobrychis cornuta.*


Left: Plant identification has already begun in the car. Right: Photo session before dinner.

Day 7 - July 2, Sevan-Selim pass-Hermon

On a sunny morning, we said goodbye to the "Noyland" and drove along the southern shore of the lake. Within two days, we had made a full circle around Sevan. After Chkalovka, we stopped in a fantastic valley with flowering meadows, where we stayed all the morning and sampled several plots. Then we continued our journey and after a while reached the Selim pass. We were delighted with the fantastic view from the pass. There was also an ancient caravanserai. This proves that this road was a part of the Great Silk Road. After some quick sightseeing, we returned to the bus and along the serpentine, came across the fantastic valley.

After a short time, we arrived at the fairy garden of our pension "Lyusi-tour" in Hermon. In the afternoon, we had some free time, which some of us chose to spend sampling on the nearby slope whereas others chose to relax in the swimming pool. After dinner, we gathered in the very comfortable large hall to process the collected soil and plant samples. A short piano concerto brought variety to our work.

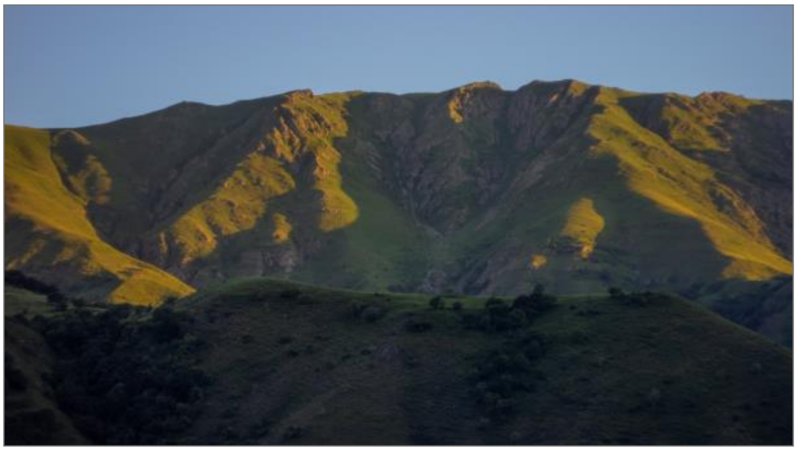
Attracted by the nice advertisement, people took the opportunity to buy a drink for the picnic.

Sampling the rocky grasslands with *Papaver orientale* near Selim pass.

Just in case, resting people hide their faces for posterity ☺ .

Breathtaking view from the Selim pass.

Caravanserai in Selim pass



Lyusi-tour – our home for the next two days and the nearby slopes in the Yeghegis valley.

Dried *Rumex crispus* (aveluk) ready for the soup.

Our evening studies: plant identification (left) and work with orthopterans (right).

Day 8 - July 3, Yeghegnadzor-Gnishik

After breakfast, we drove into Yeghegnadzor – a little town with fruit trees in the streets and storks on the roofs. Then our route was to the south to the Gnishik landscape sanctuary. The bus was climbing up to the mountains and the "valley of reeds" (Yeghegnadzor) was left far below.

On this day, we sampled plots mainly of hedgehog communities situated on the strongly rugged terrain. Therefore, it was not easy to reach some places with these interesting communities. We had lunch near an old small chapel. In this spot, we had a magnificent view of Mount Ararat.

In the evening after dinner, we had a small meeting to organize work after expedition.

Diverse landscape with the highest orthopteran richness near Gnishik village.

Left: Sampling rocky feather-grass steppes. Right: Sampling a *Brachypodietalia pinnati* community on the Northern slopes.

Sampling the *Stipa araxensis* community.

Ancient geological formations.

Magnificent Mount Ararat.

Cold beer is the best for bumps! Itziar recovers after she hit her head on the door of the small chapel in Gnishik. We hope that she did not totally destroy it!

Day 9 - July 4, Yeghegnadzor-Areni, Areni-Khachik

On this day our destination was the karst region near the villages of Areni and Khachik. On the dry slopes we sampled plots of thorny cushion communities. The 'hedgehogs' were formed by *Onobrochis cornuta, Acantholimon caryophyllaceum* and three species of *Astracantha*. All day long, we worked on the very warm slopes under the open sun. At midday, we gathered near the specially equipped picnic point. We rested a little while near a freshwater spring and under the shade of a tree.

Thorn cushion communities with *Acantholimon caryophyllaceum.*

Sampling in progress during the hot day.

We were surrounded by spectacular mountains.

Day 10 - July 5, Yeghegnadzor- Tigranashen, Tigranashen-Yerevan

In the morning, we said good-bye to the corner of paradise where we had lived during the last two days and took the route via the M-2 for Yerevan.

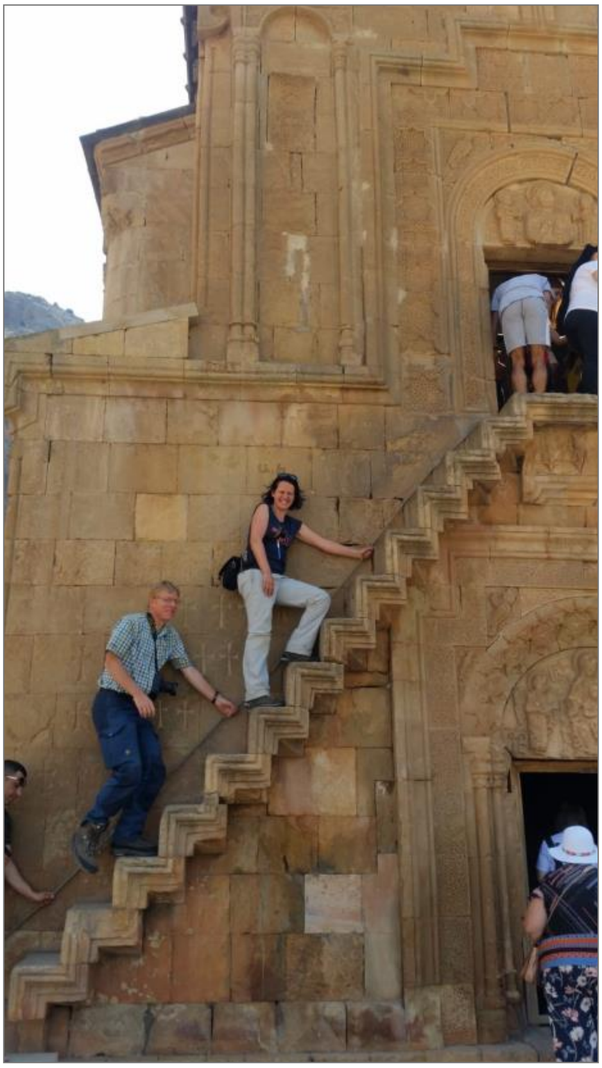
On the way, we visited Noravank, a 13-14th century monastery. All of us, with great pleasure, admired its remarkable architecture. Then, we stopped near Areni winery, tasting the wine followed by an excursion to the nearby "bodega". After the excursion, we continued on our way singing our famous song "Garun-Garun".

We stopped near Tigranashen in a rocky place and sampled plots in tragacanthoid communities with the rare *Gypsophila aretioides*.

In the evening, after checking in the Yerevan hotel, we went to the restaurant for dinner. Before dinner, we strolled along the main streets in the center of Yerevan. There were many people, illuminated streets as well as dancing fountains. Armenians were celebrating the Constitution Day. We also sampled the various attractions and crossed through the fountains' tunnel.

The evening was very nice. We enjoyed the delicious Armenian dishes and also the folk music, songs and dancing.

Noravank monastery.



Asun is creating a queue on the steps at Noravank.

Rocky grasslands with *Gypsophila aretioides*.

Fieldwork near Tigranashen.

Dining table (left) and working table (right).

Day 11 - July 6, Yerevan-Kari lake, Kari lake-Amberd fortress

The last day was devoted to travelling to the Mount Aragats massif. We drove through several small towns: Proshyan, Ashtarak, Byurakan and, at the elevation of 3,300 m a.s.l., we reached the Aragats Cosmic Ray Station (former Byurokan observatory). Near to the Station, we enjoyed the small Kari Lake, glaciers on the slopes above it and the surrounding colourful alpine meadows.

Then we descended to the subalpine belt and near the 10-13th century Amberd fortress, we sampled plots in the subalpine forb meadows. It was our last sampling of the year and fittingly marked the end of a beautiful and successful expedition. We thanked our Armenian colleagues for organising such an interesting and well-executed Field Workshop. We presented subalpine flowers to Alla, George and Aram.

The farewell party was in the restaurant Yerevan. The firework on the cake celebrated the 10-year Jubilee of the EDGG Field Workshops, and successful ending of the 13th Field Workshop in Armenia.


Alpine meadows on Mount Aragats.


Kari Lake.

Traditional lunch and our greetings with thanks to Alla, George and Aram.

Left: The last sampling of the expedition has just finished and we celebrate with *Prangos*-fireworks. Right: Gorge near the Amberd fortress.

Closing ceremony of the Field Workshop and the farewell words.

Selected pictures of plants

Asphodeline taurica

Centaurea macrocephala

Michauxia laevigata

Astragalus lagopoides

Pontechium maculatum

Ephedra major subsp. *procera*

Taeniatherum caput-medusae subsp. *crinitum*

Odontites aucheri

Psephellus dealbatus

Astracantha vedica

Phlomis orientalis

Scutellaria orientalis

Acantholimon caryophyllaceum

Phelypaea coccinea

Stachys macrantha

Prunus incana

Teucrium orientale

Thalictrum foetidum

Vicia canescens subsp. variegata

Gypsophila aretioides

Astracantha microcephala

Crupina vulgaris

Lomelosia rotata

Onobrychis cornuta

Salvia hydrangea

Astragalus alopecurus

Delphinium buschianum

Selected pictures of orthopterans

Empusa sp. (Mantodea)

***Bradyporus dilatatus* group (*Ensifera*)**

Predatory Bush Cricket (*Saga pedo*); *Saga natoliae*, both *Ensifera*

Arcyptera microptera;* Cone-headed grasshopper (*Acrida* sp.), both *Caelifera

Other invertebrates

Mylabris **sp.**

Chazara **sp. (*Nymphalidae*, *Lepidoptera*)**

Easter burnet (*Zygaena carniolica; Zygaenidae*, *Lepidoptera*)

Privet hawk moth *(Sphinx ligustri)*

Libelloides macaronius

Nemoptera sinuata **(both *Neuroptera*)**

Lycosa praegrandis

Rhagodes caucasicus **(sun spiders / *Solifugae*)**

Vertebrates

Caucasian agama (*Paralaudakia caucasia*)

Caucasus emerald lizard *(Lacerta strigata)*

Western black-eared wheatear *(Oenanthe hispanica)*

White stork (*Ciconia ciconia*)

Marsh frog (*Pelophylax ridibundus*)

Participants of the 13th EDGG Field Workshop in Armenia


Martin Magnes


Salza Palpurina


Thomas Becker


Dariia Shyriaieva


Asun Berastegi


Ute Becker


Jürgen Dengler


Aslan Unal


Idoia Biurrun


Iuliia Vasheniak


Elena Belonovskaya


Dieter Frank


Philipp Kirschner


Andreas Hilpold


Alla Aleksanyan


Itziar García-Mijangos


Denys Vynokurov


George Fayvush, Marine Oganesian