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The Romanian Grassland Database (RGD): historical background, current status and future perspectives

Kiril Vassilev*, Eszter Ruprecht, Valeriu Alexiu, Thomas Becker, Monica Beldean, Claudia Biță-Nicolae, Anna Mária Csergő, Iliana Dzhovanova, Eva Filipova, József Pál Frink, Dan Gafta, Mariya Georgieva, Markus S. Germany, Irina Goia, Media Gumus, Stephan M. Hennekens, Monika Janišová, Ilona Knollová, Viktoriya Koleva, Sofia Kostadinova, Nevena Kuzmanović, Jacqueline Loos, Constantin Mardari, Thomas Michl, Monica Angela Neblea, Roxana Ion Nicoară, Pavel Novák, Kinga Öllerer, Marilena Onete, Salza Palpurina, Inge Paulini, Hristo Pedashenko, Mihai Pușcaș, Anamaria Roman, Jozef Šibík, Culiță Sîrbu, Daniela Stancu, Laura M.E. Sutcliffe, Anna Szabó, Cezar-Valentin Tomescu, Evelin Totev, Borislav Tsvetanov, Pavel Dan Turtureanu, Plamena Vassileva, Nikolay Velev & Jürgen Dengler

*Corresponding author's address: Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences, 23 Acad. G. Bonchev Str., 1113 Sofia, Bulgaria; kiril5914@abv.bg. Complete addresses of all authors can be found at the bottom of the paper.

Running title: Romanian Grassland Database (RGD)

Abstract: This report describes the Romanian Grassland Database (RGD), registered under EU-RO-008 in the Global Index of Vegetation-Plot Databases (GIVD). This collaborative initiative aims to collect all available vegetation-plot data (relevés) of grasslands and other open habitats from the territory of Romania to provide them for science, nationally and internationally, e.g. via the European Vegetation Archive (EVA) and the global database "sPlot". The database mainly contains vegetation-plots from not only wet, mesic, dry, saline, alpine and rocky grasslands, but also other vegetation types like heathlands, mires, ruderal, segetal, aquatic and cryptogam-dominated vegetation. Currently, 21,685 relevés have mainly been digitised from literature sources (90%), while the remainder comes from individual unpublished sources (10%). We report on the background and history of the RGD, explain its "Data Property and Governance Rules" under which data are contributed and retrieved, and outline how the RGD can contribute to research in the fields of vegetation ecology, macroecology and conservation.

Keywords: ecoinformatics; European Vegetation Archive (EVA); grassland vegetation; phytosociology; relevé; Romanian Grassland Database (RGD); sPlot; Turboveg; vegetation classification; vegetation-plot data.

Abbreviations: EVA = European Vegetation Archive; GIVD = Global Index of Vegetation-Plot Databases; RGD = Romanian Grassland Database.

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GIVD Fact Sheet

#Separate file#

Introduction

Vegetation-plot databases provide a powerful source of information for plant community ecology, macroecology and conservation biology as they combine fine-grain co-occurrence data of plant species across large spatial extents (Dengler et al. 2011; Chytrý et al. 2016). Europe, due to its strong phytosociological tradition (Braun-Blanquet 1965; Dengler et al. 2008) probably is the continent with the largest number of vegetation-plot records (relevés), totalling several millions (Schaminée et al. 2009; Dengler et al. 2011). Over the last 25 years, in many European countries comprehensive national vegetation-plot databases have emerged (Schaminée et al. 2009), which subsequently gave rise to the integrated European Vegetation Archive (EVA; http://euroveg.org/eva-database; Chytrý et al. 2016) and the global database "sPlot" (https://www.idiv.de/splot; Dengler & sPlot Core Team 2014). Schaminée et al. (2009) estimated that in Romania more than 70,000 relevés exist, although at the time of publication none of these data were digitally available in a database.

Meanwhile, the development of the Global Index of Vegetation-Plot Databases (GIVD; http://www.givd.info/; Dengler et al. 2011) inspired several colleagues to establish and register in GIVD smaller databases with plots from Romania, including the "Vegetation Database of Dry Grasslands in the Southeast Romania" (Biță-Nicolae 2012; EU-RO-001), the "Vegetation Database of the Dry Grasslands from the Transylvanian Basin" (Ruprecht et al. 2012; EU-RO-002) and

"Mesophilic Pastures in Southern Transylvania, Romania" (by L. Sutcliffe; EUR-RO-006). When the EVA was established, its team sought to facilitate the establishment of one or few larger national vegetation databases in Romania that could serve as competent partners for the European initiative. As a result, the three named grassland databases joined to form the Romanian Grassland Database (RGD; EU-RO-008) which aimed to comprise all vegetation types of grasslands and other open habitats from the country. Similarly, several smaller forest databases merged to form the Romanian Forest Database (RGF; EU-RO-007) focusing on forests and shrublands (Indreica et al. in press).

In this article we introduce the RGD, its technical and organisational set-up, report on its current content, and provide a view on future activities and opportunities.

Knowledge of grasslands and other open habitats in Romania

Based on the vast data that have accumulated over time, as a result of field investigations conducted by numerous phytosociologists, a series of syntheses on the vegetation of Romania were published over the past seven decades, at regional (e.g. Soó 1949; Borza 1963; Beldie & Dihoru 1967; Coldea 1991; Chifu et al. 2006) and national levels (e.g. Borza et al. 1960; Pușcaru-Soroceanu et al. 1963; Doniță et al. 1992; Sanda et al. 1998; Coldea 1997, 2012; Chifu 2014). According to Coldea (1997, 2012), the herbaceous vegetation of Romania consists of 461 vascular plant associations, grouped into 115 alliances, 56 orders and 35 classes. Of the total number of associations, ca. 42% (from 48 alliances, 24 orders and 18 classes) are comprised of natural vegetation and 58% (from 67 alliances, 32 orders and 17 classes) of anthropogenic vegetation (including secondary meadows and ruderal vegetation).

This diversity of syntaxa reflects the great variety of vegetation cover in Romania, resulting from the geomorphological and climatic diversity of the country and its location at the intersection of several floristic provinces (Coldea 1997). However, all the current classification schemes in Romania are based on "expert knowledge" only. To date, no classification takes advantage of the large amount of existing vegetation-plot data that would allow the sound delimitation of syntaxa and determination of their diagnostic species with transparent and reproducible (statistical) methods (see De Cáceres et al. 2015).

Emergence and organisation of the Romanian Grassland Database

Unrecognized by the vegetation-plot community outside the country (e.g. Schaminée et al. 2009), 1,467 relevés from dry grassland vegetation types were digitally collected by E. Ruprecht and colleagues in 2002. This later became the "Vegetation Database of the Dry Grasslands from the Transylvanian Basin" (EU-RO-002; Ruprecht et al. 2012). The Romanian Grassland Database (RGD) was created in 2014, via merging the existing Transylvanian database with several smaller datasets of C. Biță-Nicolae, M. Janišová and J. Dengler, resulting in a total of 1,831 relevés. With the establishment of the RGD Data Property and Governance Rules (Supplement S1), we expanded the database to not only include grasslands s.str, but also all vegetation types of open habitats,. This together with an advertising campaign led to dynamic growth of the database content from 7,528 relevés in May 2015 to 21,685 relevés in August 2017.

The RGD is registered in the Global Index of Vegetation-Plot Databases (GIVD; http://www.givd.info; Dengler et al. 2011) under EU-RO-008 (http://www.givd.info/ID/EU-RO-008). This database has contributed its vegetation-plot data to the European Vegetation Archive (EVA; Chytrý et al. 2016), and to the global vegetation-plot database "sPlot"

(http://www.idiv.de/splot; Dengler & sPlot Core Team 2014). Since the spring of 2017, the RGD has maintained a webpage on the Ecoinformatics Portal of the University of Bayreuth (http://bit.ly/2vz0l1u).

The RGD's Data Property and Governance Rules (Supplement S1) doubtlessly contributed much to its attractiveness and success. The document regulates the governance of the database, data provision, type of data availability regimes, data requests and terms of data use, rules for authorship and relationships with other databases like EVA, sPlot and GIVD. These rules are phrased similarly to the EVA Data Property and Governance Rules (http://euroveg.org/download/eva-rules.pdf) and the governance and Data Rules of the sPlot Working Group (http://www.idiv-biodiversity.de/sdiv/workshops/workshops-2013/splot/join/content_815683/sPlot-Rules_approved.pdf). In essence, they show that the RGD is a collaborative, self-governed consortium that elects a Custodian (currently E.R.) and a Deputy-Custodian (currently K.V.) to represent its interests and to coordinate daily business. Currently, the RGD Consortium consists of 50 members of which one half is from Romania and the remainder are people from abroad who study or studied Romanian vegetation.

The basic principle of the RGD that makes becoming a member so attractive is the concept of give-and-take. Only those who contribute data to the RGD, and thus become members of the RGD Consortium, have access to full RGD content and can propose projects making use of it. Likewise, RGD Consortium members are informed whenever there are requests to utilize RGD data, either directly or via EVA or sPlot. When requests are made, one of the RGD Consortium members can opt in as active co-author, while they themselves also can propose EVA and sPlot projects using the whole European or global dataset. Over the last two years, data from the RGD were requested and provided for 30 projects via the EVA and sPlot databases, and some first papers resulting from these cooperations have been published (e.g. Willner et al. 2017).

Technical implementation

The relevés of the RGD are managed and stored with the Turboveg v2.101 software (Hennekens & Schaminée 2001). This facilitates effective data import and handling as well as very easy data provision to EVA and sPlot, which are run under Turboveg v3 that allows the combination of many different Turboveg v2 databases. The database structure is based on the standard header data fields of Turboveg v2, but many new fields have been added, both to allow retaining as much as possible of the original information and to support the coordination and the rights management within and between RGD, EVA and sPlot.

The species list of vascular plants was originally based on *Flora Europaea* (Tutin et al. 1964−1980), and augmented with new taxa when needed. We also entered varieties and forms of species in order to keep the original information from digitized publications. All changes in species nomenclature related to the original literature sources follow the *Flora Europaea* database (http://rbg-web2.rbge.org.uk/FE/fe.html) and the Euro+Med PlantBase (http://www.emplantbase.org/home.html) and are documented in a separate file. Names of bryophytes, lichens and algae are currently stored in their original form and not yet standardized according to uniform checklists.

Author and "biblioreference" popup lists were created during digitization. The list of digitized publications and other sources is provided in Supplement S2. Names of syntaxa were harmonized according to Sanda et al. (2008).

Current content of RGD

According to its Rules, the RGD collects data from all grassland vegetation types (wet, mesic, dry, saline, alpine, rocky), and also other vegetation types, such as heathlands, ruderal and segetal vegetation, mires and aquatic vegetation as well as cryptogam-dominated types from the territory of Romania (Fig. 1). Forests and the majority of shrublands are not considered because they are captured by a parallel effort of the Romanian Forest Database (RFD; EU-RO-007; Indreica et al. in press). However, there is currently some overlap between both national databases, concerning communities dominated by shrubs and dwarf shrubs, mainly from the subalpine zone. Such stands, dominated by *Pinus mugo*, *Juniperus sibirica*, *Alnus viridis, Vaccinium, Salix* and *Rubus* species constitute about 5% of the content of RGD and might partly also be contained in RFD. In addition, some data of wetland vegetation (about 1%) are also included in the WetVegEurope database (EU-00-020; Landucci et al. 2015) and some plots with "standard plot sizes" are shared with the Database of Scale-Dependent Phytodiversity Patterns in Palaearctic Grasslands (GrassPlot; EU-00-003; Dengler et al. 2012). We are cooperating with these other databases to avoid duplication of work in the future and to ensure that each vegetation plot is delivered only once to EVA and sPlot.

The majority of the data in RGD was digitized from published literature sources (90%), while the rest are unpublished relevés from Consortium members (10%). In total, the RGD currently contains data from nearly 500 different sources. There are two periods during which the majority of vegetation plots were recorded (Fig. 1). The first peak (1960−1980) refers to a large number of vegetation studies in different regions of the country, while the second peak (2001−2010) is related to a great number of relevés sampled as a part of PhD or Master theses. The majority of plots are in the semi-restricted data availability regime (87%; for specific definitions for access see the EVA; Chytrý et al. 2016), while few have restricted access (10%) and even fewer have free access (3%).

Geographic coordinates are now available for 99.88% of the relevés (Fig. 2). While most sources (72%) did not contain geographic coordinates, they were geo-referenced *a posteriori* using Google Earth and other available information about the plot localities, which lead to coarse geographic precision (see Fact Sheet). Most of the relevés come from mountainous and semi-mountainous parts of Romania, which are better explored compared to lowland areas (Fig. 2). Traditionally, researchers focused mainly on the most distant, natural areas, whereas agricultural and rural areas were less studied.

To complement the information provided in the Fact Sheet, we summarize the contents of the best-filled header data as follows:

- Plot size ranges from 0.01 to 3,500 m². The most frequently used plot sizes are 100 m² (21.8%), 25 m² (21.0%) and 10 m² (4.3%), while 19.9% of the plots lack such information.
- Data on non-vascular plants are available for 28% of the relevés.
- Elevation ranges from 0 to 2,525 m a.s.l., although 35% of the relevés are lacking this information.
- Aspect and slope are the two most often recorded environmental parameters and are available for 55% and 54% of the relevés, respectively, while land use and soil parameters are unfortunately rather sparse (< 10%) in the current database (see Fact Sheet).
- Cover of vegetation: Total vegetation cover is provided for 31% of the relevés, while availability of individual vegetation strata cover varies from 35% for the tree layer to 8% for the cryptogam layer.

- Syntaxa: 77.6% of the relevés in the RGD are classified into syntaxa of different levels (Table 1; Supplement S1). Non-classified relevés (22.4%) mainly come from unpublished data sources or are cryptogam communities, which are not included in syntaxon popup list.

Summary and outlook

With this Long Database Report we give credit to all of the vegetation scientists who actively contributed to mobilizing Romanian vegetation-plot data, either by providing their own plots or helping with the digitization of data from the literature for the RGD. From now on, we ask that this report be cited when data from the RGD are used.

The RGD has undergone dynamic development during recent years and now nicely complements the Romanian Forest Database (RFD; Indreica et al. in press). We believe the success of the RGD is largely due to our transparent rules that balance the interests of data providers, data managers and data users in a fair manner. The RGD and RFD together currently contain more than 31,000 relevés, which is nearly half the amount of existing relevés from the country as estimated by Schaminée et al. (2009). However, our estimate exceeds Schaminée et al.'s in that there are at least 100,000 relevés alone of open habitats, so in short about 75% still remain to be mobilized. Thus, we hope that this publication together with Indreica et al. (in press) will further stimulate researchers to contribute their data and join one or the other consortium. The RGD has already become the 16th biggest member database of EVA (http://euroveg.org/eva-database-participating-databases). Compared to mid-June 2015 (Chytrý et al. 2016), the two national Romanian databases together have nearly tripled the density of available data from the country from 5.2 plots/100 km² to 13.1 plots/100 km².

The RGD is one of the regional databases established under the umbrella of the Eurasian Dry Grassland Group (EDGG; http://www.edgg.org/; Vrahnakis et al. 2013). Other regional databases include the Balkan Dry Grassland Database (BDGD; EU-00-013; http://bit.ly/2upRrDz), the German GrassVeg.DE (EU-DE-020; http://bit.ly/2qgX208; Dengler et al. 2017), the Nordic-Baltic Grassland Vegetation Database (NBGVD; EU-00-002; http://bit.ly/2vzz3YT) and the multi-scale database GrassPlot for high-quality, standardized data from throughout the Palaearctic biogeographic realm (EU-00-003; http://bit.ly/2qKTQt2). Together these databases make a major contribution to better data availability of grassland data for a multitude of analyses. They thus help to approach the ideal of a broad-scale vegetation classification of Palaearctic grasslands that is data-driven and consistent (Dengler et al. 2013; Janišová et al. 2016). One first such example is the high-rank classification of Pannonian-Pontic *Festuco-Brometea* communities by Willner et al. (2017), which received data for western Romania from the predecessors of the RGD, similarly emerging more detailed studies can now rely on much more extensive data from the current RGD. Also, for the recent re-classification and parameterisation of EUNIS grassland habitats, the Romanian data from the RGD was essential (Schaminée et al. 2016).

Last but not least, we hope this paper contributes to raising the awareness of the RGD as a highly useful source for studies of flora, vegetation and habitats at the national scale, including the development of a national syntaxonomic scheme based on numerical analysis, similar to the achievements of the Czech Republic (Chytrý 2007) and Slovakia (Janišová 2007; Jarolímek & Šibík 2008). Furthermore, the RGD is an excellent source for ecology studies as well, as shown by one of the first data requests from a project intending to evaluate the ecological impact of invasive plant species on Romanian grasslands. The compilation of biodiversity datasets with broad taxonomic and biogeographic extents that the computation of a range of biodiversity indicators is necessary to enable better understanding of

historical processes and to project future biodiversity changes (Hudson et al. 2014). To model the future, we need to examine the past (Griffin 2017) therefore the collection and preservation of digitized data is a huge responsibility. When researchers learn of once-neglected data that have been revived and transformed via modern insight, they themselves are more likely to recognize such hidden opportunities (Griffin 2017). The Romanian vegetation database is one of these projects that not only preserves historical data, but at the same time also offers the opportunity for various broader scientific purposes and activity that will benefit humankind.

Author contributions

K.V. and E.R., Deputy-custodian and Custodian of the RGD, carried out the major part of the data digitalization and standardization, while S.M.H. and I.K. helped with database management. Except the latter two, all authors contributed published or unpublished data in electronic or printed format. This report was drafted by K.V. with major input by E.R. and J.D., while all co-authors checked, improved and approved the manuscript before submission.

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Author addresses

Vassilev, K. (Corresponding author, kiril5914@abv.bg)[1], **Ruprecht, E. (**eszter.ruprecht@ubbcluj.ro)[2], **Alexiu, V.** (alexiuvaleriu@gmail.com)[3], **Becker, T.** (beckerth@uni-trier.de)[4], **Beldean, M.** (beldean.monica@yahoo.com)[2], **Bita-Nicolae, C.** (claudia.bita@ibiol.ro)[5], **Csergő, A.M.** (csergo.anna.maria@gmail.com)[6], **Dzhovanova, I.** (msjovanova@abv.bg)[7], **Filipova, E.** (eveto_filipova@abv.bg)[7], **Frink, J.P.** (jpfrink@gmail.com)[8], **Gafta, D.** (dan.gafta@ubbcluj.ro)[2], **Georgieva, M.** (meri.xai@abv.bg)[9], **Germany, M.S.** (mgermany@ecology.uni-kiel.de)[10,11], **Goia, I.** (igoia@yahoo.com)[2], **Gumus, M.** (med_i@abv.bg)[12], **Hennekens, S.M.** (stephan.hennekens@wur.nl)[13], **Janišová, M.** (monika.janisova@gmail.com)[14], **Knollová, I.** (ikuzel@sci.muni.cz)[15], **Koleva, V.** (vikshan@abv.bg)[9], **Kostadinova, S.** (sofiq_borisova@abv.bg)[9], **Kuzmanović, N.** (nkuzmanovic@bio.bg.ac.rs)[16], **Loos, J.** (jacqueline.loos@agr.uni-goettingen.de)[17], **Mardari, C.** (constantin.mardari@uaic.ro)[18], **Michl, T.** (michl@buero-huck.de)[19], **Neblea, M.A.** (monica_neb@yahoo.com)[3], **Nicoară**, **R.I.** (roxanaion85@gmail.com)[5], **Novák, P.** (pavenow@seznam.cz)[15], **Öllerer, K.** (kinga.ollerer@gmail.com)[5,20], **Onete, M.** (marilena.onete@gmail.com)[5], **Palpurina, S.** (salza.palpurina@gmail.com)[7], **Paulini, I.** (ipaulini@uni-bonn.de)[21], **Pedashenko, H.** (hristo_pedashenko@yahoo.com)[1], **Pușcaș, M.** (mihai.puscas@ubbcluj.ro)[22], **Roman, A.** (anamaria.roman@icbcluj.ro)[23], **Šibík, J.** (jozef.sibik@savba.sk)[14], **Sîrbu**, **C.** (culita69@yahoo.com)[24], **Stancu, D.** (stancuileana@yahoo.com)[25], **Sutcliffe, L.M.E.** (sutcliffe.laura@gmail.com)[26], **Szabó**, **A.** (annuc19@gmail.com)[2], **Tomescu, C.-V.** (tomcezar@yahoo.com)[27], **Totev, E.** (evelintotev@abv.bg)[7], **Tsvetanov, B.** (borislav.tzvetanov@abv.bg)[7], **Turtureanu, P.D.** (pavel.turtureanu@ubbcluj.ro)[22], **Vassileva, P.** (p.plamena@abv.bg)[9], **Velev, N.** (nikolay.velev@abv.bg)[1] & **Dengler, J.** (juergen.dengler@uni-bayreuth.de)[28, 29, 30]

[1] Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences, Acad. G. Bonchev str. 23, 1113 Sofia, Bulgaria

[2] Faculty of Biology and Geology, Babeș–Bolyai University, Republicii str. 42, 400015 Cluj-Napoca, Romania

[3] Faculty of Sciences, Physical Education and Informatics, University of Pitești, Târgul din Vale str. 1, 110040 Pitești, Romania

[4] Faculty of Geography and Geosciences, University of Trier, Behringstr. 21, 54296 Trier, Germany

[5] Institute of Biology Bucharest, Romanian Academy, Splaiul Independenței 296, 060031 Bucharest, Romania

[6] School of Natural Sciences, Trinity College Dublin, College Green, Dublin 2, Dublin, Ireland

[7] Department of Ecology and Environmental Protection, Faculty of Biology, St. Kliment Ohridski University of Sofia, Dragan Tzankov Blvd. 8, 1164 Sofia, Bulgaria

[8] National Institute for Research and Development in Forestry “Marin Drăcea”, Cluj-Napoca Research Branch, Horea str. 65, 400275 Cluj-Napoca, Romania

[9] Faculty of Geology and Geography, University of Sofia “St. Kliment Ohridski”, Tzar Osvoboditel Blvd. 8, 1000 Sofia, Bulgaria

[10] Institut für Spezielle Botanik, Johannes Gutenberg Universität Mainz, 55099 Mainz, Germany

[11] Institute for Ecosystem Research, Christian-Albrechts University of Kiel, Olshausenstr. 75, 24118 Kiel, Germany

[12] Faculty of Biology, University of Plovdiv Paisii Hilendarski, Todor Samodumov str. 2, 4000 Plovdiv, Bulgaria

[13] Alterra, Wageningen UR, P.O. Box 47, 6700AA, Wageningen, Netherlands

[14] Institute of Botany, Plant Science and Biodiversity Center, Slovak Academy of Sciences, Institute of Botany, Dúbravská cesta 9, SK-845 23, Bratislava, Slovakia

[15] Faculty of Science, Department of Botany and Zoology, Masaryk University, Kotlářská 2, 611 37 Brno, Czech Republic

[16] Institute of Botany, Faculty of Biology, University of Belgrade, Takovska 43, 11000 Belgrade, Serbia

[17] Agroecology, University of Göttingen, Grisebachstr. 6, 37077 Göttingen, Germany

[18] Anastasie Fătu Botanic Garden, Alexandru Ioan Cuza University, Dumbrava Roșie str. 7−9, 700487 Iași, Romania

[19] Planungsbüro Dr. Huck, General-Colin-Powell-Str. 4a, 63571 Gelnhausen, Germany

[20] Centre for Ecological Research, Hungarian Academy of Sciences, Alkotmány str. 2–4, 2163 Vácrátót, Hungary

[21] Institute of Crop Science and Resource Conservation, Rheinische Friedrich-Wilhelms-Universität Bonn, Katzenburgweg 1, 53115 Bonn, Germany

[22] Alexandru Borza Botanical Garden, Babeș-Bolyai University, Republicii str. 42, 400015 Cluj-Napoca, Romania

[23] Institute of Biological Research Cluj-Napoca, Branch of the National Institute of Research and Development for Biological Sciences, 48 Republicii str. 48, 400015 Cluj-Napoca, Romania

[24] "Ion Ionescu de la Brad" University of Agricultural Sciences and Veterinary Medicine "Ion Ionescu de la Brad", Mihail Sadoveanu Alley 3, 700490 Iași, Romania

[25] Argeș County Museum, Armand Călinescu str. 44, 110047 Pitești, Romania

[26] Department of Plant Ecology and Ecosystems Research, University of Göttingen, Untere Karspüle 2, 37073 Göttingen, Germany

[27] Faculty of Forestry, "Ștefan cel Mare" University, Universității str. 13, 720229 Suceava, Romania

[28] Vegetation Ecology Research Group, Institute of Natural Resource Sciences (IUNR), Zurich University of Applied Sciences (ZHAW), Grüentalstr. 14, Postfach, 8820 Wädenswil, Switzerland

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

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

Electronic Supplements

Supplementary material associated with this article is embedded in the article´s pdf. The online version of Phytocoenologia is hosted at www.ingentaconnect.com/content/schweiz/phyt and the journal's website www.schweizerbart.com/journals/phyto. The publisher does not bear any liability for the lack of usability or correctness of supplementary material.

Supplement S1: Data Property and Governance Rules of RGD.

Supplement S2: List of publications and other sources currently included in RGD.

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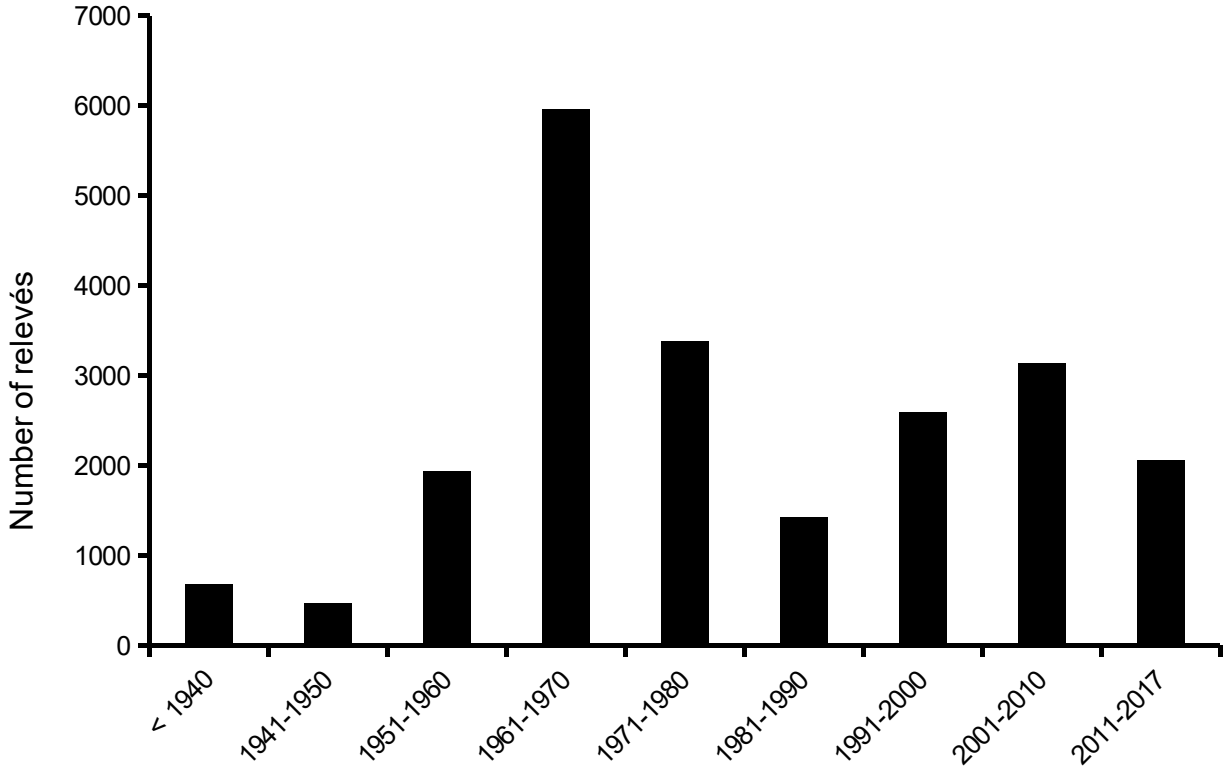

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377 **Fig. 1.** Temporal distribution of relevés currently contained in the Romanian Grassland Database.

Fig. 2. Spatial distribution of the vegetation plots currently contained in the Romanian Grassland Database, shown as density of plots with geographic coordinates in square grids of 100 km².

Table. 1. Frequency of different phytosociological classes among the relevés in the Romanian Grassland Database, grouped into several broad types. Statistics are based on the 17,747 relevés that currently have a phytosociological assignment. The typology of classes follows Sanda et al. (2008).

Code	Class name	Number of orders	Number of alliances	Number of associations & communities	Number of relevés
01	*Lemnetea*	3	4	12	400
02	*Charetea fragilis*	2	5	8	99
04	*Ruppietea maritimae*	-	-	-	4
05	*Potamogenetea pectinati*	2	4	23	560
06	*Littorelletea uniflorae*	1	1	1	12
07	*Isoeto-Nanojuncetea*	2	2	7	59
08	*Phragmito-Magnocaricetea*	5	6	43	1,584
09	*Montio-Cardaminetea*	1	3	7	215
10	*Scheuchzerio-Caricetea nigrae*	3	5	14	574
11	*Oxycocco-Sphagnetea*	1	1	2	71
Total	**Wetland vegetation**	**20**	**31**	**117**	**3,578**
12	*Festucetea vaginatae*	1	3	6	131
13	*Puccinellio-Salicornietea*	3	6	22	566
14	*Juncetea maritimi*	1	2	4	55
16	*Ammophiletea*	1	1	2	11
23	*Nardo-Callunetea*	1	2	4	764
27	*Molinio-Arrhenatheretea*	4	9	38	2,256
28	*Festuco-Brometea*	4	9	46	2,582
29	*Koelerio-Corynephoretea*	3	3	7	125
35	*Trifolio-Geranietea sanguinei*	2	3	4	80
Total	**Grassland vegetation of lowlands**	**20**	**38**	**133**	**6,570**
19	*Asplenietea trichomanis*	3	7	22	569
20	*Thlaspietea rotundifolii*	3	4	16	415
21	*Salicetea herbaceae*	2	3	12	299
22	*Juncetea trifidi*	2	2	8	896
24	*Carici rupestris-Kobresietea bellardi*	1	1	2	44
25	*Seslerietea albicantis*	1	3	13	753
26	*Betulo-Adenostyletea*	1	3	12	321
Total	**Subalpine and alpine vegetation**	**13**	**23**	**85**	**3,297**
15	*Cakiletea maritimae*	2	2	5	43
18	*Bidentetea tripartiti*	1	2	8	142
30	*Stellarietea mediae*	4	13	27	966
31	*Plantaginetea majoris*	1	3	6	180
32	*Artemisietea vulgaris*	3	7	25	449
33	*Galio-Urticetea*	2	5	17	298
34	*Epilobietea angustifolii*	2	3	7	206
Total	**Ruderal and segetal vegetation**	**15**	**35**	**95**	**2,284**
36	*Salicetea purpureae*	2	4	5	22

37	*Alnetea glutinosae*	2	2	2	21
38	*Querco-Fagetea*	1	2	9	82
39	*Querco pubescenti-petreae*	1	3	6	146
40	*Rhamno-Prunetea*	1	2	2	50
41	*Erico-Pinetea*	1	1	1	26
42	*Vaccinio-Piceetea*	5	7	12	764
Total	**Woodland vegetation**	**13**	**21**	**37**	**1,111**
Total	**Cryptogam-dominated vegetation**	**-**	**-**	**-**	**907**
	Grand total	**81**	**148**	**467**	**17,747**

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