Tuexenia 41: 459–466. Göttingen 2021.
doi: 10.14471/2021.41.017, available online at www.tuexenia.de

SHORT COMMUNICATION

Update on maxima of fine-scale vascular plant species richness in a Transylvanian steppe meadow

Neue Maxima des kleinflächigen Gefäßpflanzen-Artenreichtums in einer siebenbürgischen Steppenwiese

Jan Roleček[1, 2 *], Pavel Dřevojan[2], Petra Hájková[1, 2], Irina Goia[3] & Michal Hájek[2]

[1]*Department of Paleoecology, Institute of Botany, The Czech Academy of Sciences, Lidická 25/27, 602 00 Brno, Czech Republic;*
[2]*Department of Botany and Zoology, Faculty of Science, Masaryk University, Kotlářská 267/2, 611 37 Brno, Czech Republic;*
[3]*Department of Taxonomy and Ecology, Faculty of Biology and Geology, Babeş-Bolyai University, Strada Republicii 42, 400015 Cluj-Napoca, Romania*
**Corresponding author, e-mail: honza.rolecek@centrum.cz*

Abstract

We report new maxima of vascular plant species richness ever recorded in 10-m^2 plots (115 and 110 species in two adjacent plots). Both come from a steppe meadow at a well-known site Valea Lui Craiu, located in the Fânaţele Clujului grassland complex close to the city of Cluj in Transylvania, Romania, where maximum values have been observed before. We also correct the previously published maximum of 106 species, which was recorded in a 10.9-m^2 plot due to erroneous plot delimitation. The new maxima, which were recorded by the same research team using the identical sampling methodology, likely reflect successional changes after the transformation of the site from a mown grassland to a medium-intensity sheep pasture. The increase in species richness is largely due to the increased number of ruderal species. We assume that the high species density may be temporary and might decrease over time along with the loss of species that suffer from grazing. We therefore permanently marked the plots belowground, enabling to monitor the effects of grazing on species richness and composition over a longer period.

Keywords: grazing, permanent plot, plant diversity, Romania, species richness, steppe meadow, Transylvania, world record

Erweiterte deutsche Zusammenfassung am Ende des Artikels

1. Introduction

The phenomenon of extremely high fine-scale plant species richness of steppe meadows in the peri-Carpathian region has been recognized in the last decades. To mention some examples, KLIMEŠ (1997) reported 103 species per 24 m^2 from the White Carpathians in the

Manuscript received 18 July 2021, accepted 02 August 2021
Published online 31 October 2021
Co-ordinating Editor: Steffen Boch

Czech Republic, DENGLER et al. (2012) 98 species per 10 m^2 from the Transylvanian Basin in Romania and ROLEČEK et al. (2014) 90 species per 9 m^2 from the Prut-Siret interfluve in the Western Ukraine. WILSON et al. (2012) and BIURRUN et al. (2021) put these values into a broad geographical context and emphasized the exceptional position of the peri-Carpathian grasslands.

In 2018, we visited the record-holding site in Transylvania (Valea Lui Craiu located in the Fânaţele Clujului grassland complex) to film a documentary about peri-Carpathian steppe meadows and show how abandonment of mowing and introduction of sheep grazing can affect species richness and composition. Surprisingly, we recorded even higher species richness of vascular plants than reported before and we permanently marked the plot below-ground (ROLEČEK et al. 2019). After publishing the new maximum species richness values (106 species per 10 m^2), J. Dengler (pers. comm.) draw our attention to the fact that the reported plot size (3.3 m × 3.3 m) is larger than the reported area (10.9 m^2 instead of 10 m^2), meaning that species richness per 10 m^2 is probably slightly lower. Due to COVID-19-related travelling restrictions we were able to revisit the place and verify plot's area only in June 2021. Here, we report recent species richness and composition of vascular plants in the permanent plot and the surrounding grassland and discuss possible causes of its temporal dynamics.

2. Methods

We traced the permanent plot established in 2018 using a GPS and metal detector. We remeasured its dimensions (3.3 m × 3.3 m) and confirmed that its actual area (ca. 10.9 m^2) is larger than erroneously reported by ROLEČEK et al. (2019). We permanently marked a new plot of 3.16 m × 3.16 m (corresponding to an area of 10 m^2) at the same place using a nine-inch nail and a washer in each corner. We also preserved the permanent plot of 3.3 m × 3.3 m to enable comparison with the relevé recorded in 2018. Both plots share the lower left corner (when looking up the slope). Corners of the new, 10-m^2 plot were equipped with two washers so that they can be unequivocally identified. Because the exact position of the plot sampled in 2009 was not known (only GPS coordinates were recorded; DENGLER et al. 2012), we established two additional permanent plots within a radius of 10 m to document the fine-scale variation in species richness and composition (Fig. 1).

We used a standard methodology for phytosociological sampling (DENGLER et al. 2008). We delimited plot boundaries with an inflexible string and recorded the presence of species rooted in the plot. Species abundances were estimated using the extended Braun-Blanquet cover-abundance scale. Two to five researchers participated in species recording, which took up to two hours per plot. The nomenclature and taxonomy of plant taxa follow the Euro+Med PlantBase (EURO+MED 2006–2021), except for *Molinia arundinacea* subsp. *freyi* Dančák (DANČÁK et al. 2012) and the following critical taxa, which were treated as species complexes (aggregates): *Dianthus carthusianorum* agg. (*D. carthusianorum*, *D. giganteiformis*, *D. giganteus*, *D. pontederae*), *Poa pratensis* agg. (*P. angustifolia*, *P. pratensis*), *Rosa canina* agg. (*R. caesia*, *R. canina*, *R. corymbifera*, *R. dumalis*, *R. subcanina*, *R. subcollina*) and *Vicia cracca* agg. (*V. cracca*, *V. tenuifolia*). To evaluate the effects of management change (mown meadow transformed to a sheep-grazed pasture), we compared numbers and summed covers of ruderal species in the relevés recorded in 2009, 2018 and 2021. Ruderal species were defined using the hemeroby variable in the BIOLFLOR database (KLOTZ et al. 2002) as species which may inhabit places completely transformed or intensively managed by human (hemeroby levels "p" or "c") and which at the same time avoid natural sites and sites weakly influenced by human (hemeroby levels "a" and "o"). Out of the species not included in the BIOLFLOR database, *Xeranthemum cylindraceum* was also considered a ruderal species.

Fig. 1. Searching for the marking nails of a permanent plot with the maximum vascular plant species richness in Valea Lui Craiu, Fânaţele Clujului, Transylvania, Romania (Photo: J. Roleček, 19. 06.2021).

Abb. 1. Suche nach der mit Nägeln markierten Dauerfläche des maximalen Gefäßpflanzenartenreichtums im Gebiet Valea Lui Craiu, Fânaţele Clujului, Transsilvanien, Rumänien (Foto: J. Roleček, 19.06.2021).

3. Results

We recorded 118 species of vascular plants in the permanent 10.9-m^2 plot established in 2018 and 115 species in its nested subplot of 10 m^2. We further recorded 110 and 82 vascular plant species in two newly established permanent plots in the surrounding grassland (within a 10-m radius around the original plot). Full relevés with header data are provided in Table 1. In addition, we found a slight increase of richness and summed cover of ruderal species over time in the plots recorded in 2009, 2018 and 2021 (Table 2).

4. Discussion

We showed that despite erroneous delimitation in 2018, our permanent plot in a steppe meadow at Valea Lui Craiu holds the maximum of vascular plant species richness ever recorded in a 10-m^2 plot (BIURRUN et al. 2021). The value of 115 vascular plant species recorded in 2021 in a 10-m^2 plot was considerably higher than the one recorded in 2018 in a 10.9-m^2 plot (106 species). We further recorded 110 vascular plant species in a newly established permanent plot near the original one, indicating that extreme species richness at this site is not confined to a single place. This finding is in agreement with the richness pattern reported from another fine-scale plant diversity hotspot, the White Carpathians in the Czech Republic and Slovakia (HÁJEK et al. 2020). The fact that the 110 species relevé was

Table 1. Full relevé table with species sorted by their mean percentage cover in the presented relevés and then alphabetically. Species recorded only once are listed below the table. Ruderal species (according to BIOLFLOR hemeroby value) are marked with [R]. Relevé 1.1 is nested within relevé 1.2.

Tabelle 1. Aufnahmetabelle mit Reihenfolge der Arten nach ihrem Deckungsgrad und dann alphabetisch. Nur einmal vorkommende Arten sind unten aufgeführt. Ruderalarten (nach BIOLFLOR-Hemeroby-Wert) sind mit [R] gekennzeichnet. Aufnahme 1.1 ist innerhalb Aufnahme 1.2. geschachtelt.

Relevé number	1.1	1.2	2	3
Year	2021	2021	2021	2021
Species richness	115	118	110	83
Plot area [m^2]	10	10.9	10	10
Slope [°]	12		7	16
Aspect [°]	340		345	345
Altitude [m a.s.l.]	540		540	540
Latitude [°]	46.84006		46.84006	46.84008
Longitude [°]	23.65639		23.65650	23.65631
Cover herb layer [%]	75	75	75	70
Cover moss layer [%]	45	45	1	30
Adonis vernalis	2b	2b	1	2b
Festuca stricta subsp. *sulcata*	2a	2a	2a	2b
Brachypodium pinnatum	1	1	2b	+
Thymus pulegioides subsp. *pannonicus*	1	1	1	2a
Carex michelii	2m	2m	1	1
Koeleria macrantha	1	1	+	1
Teucrium chamaedrys	1	1	+	1
Plantago media	2m	2m	1	.
Elytrigia intermedia	+	+	2m	+
Trifolium repens [R]	1	1	+	+
Briza media	+	+	1	+
Carex montana	+	+	1	+
Cyanus triumfettii	+	+	r	+
Euphorbia angulata	+	+	+	r
Filipendula vulgaris	+	+	1	+
Salvia pratensis	+	+	1	+
Stachys officinalis	+	+	1	+
Tephroseris integrifolia	+	+	1	+
Viola hirta	+	+	1	+
Xeranthemum cylindraceum [R]	+	+	+	1
Picris hieracioides	1	1	.	+
Plantago lanceolata	1	1	+	.
Salvia austriaca	1	1	.	+
Schedonorus pratensis	1	1	+	.
Agrimonia eupatoria	+	+	+	+
Ajuga genevensis	+	+	+	+
Anthericum ramosum	+	+	+	+
Asperula cynanchica	+	+	+	+
Cerastium fontanum	+	+	+	+
Clinopodium vulgare	+	+	+	+
Cruciata glabra	+	+	+	+
Dactylis glomerata	+	+	+	+
Dianthus carthusianorum agg.	+	+	+	+
Galium boreale	+	+	+	+
Galium verum	+	+	+	+
Jacobaea vulgaris	+	+	+	+
Lactuca saligna	+	+	+	+
Linum catharticum	+	+	+	+

Relevé number	1.1	1.2	2	3
Lotus corniculatus	+	+	+	+
Mercurialis ovata	+	+	+	+
Noccaea kovatsii	+	+	+	+
Pimpinella saxifraga	+	+	+	+
Prunella vulgaris	+	+	+	+
Tanacetum corymbosum	+	+	+	+
Trifolium campestre	+	+	+	+
Trifolium montanum	+	+	+	+
Veronica arvensis [R]	+	+	+	+
Veronica austriaca	+	+	+	+
Arenaria serpyllifolia	+	+	r	+
Geranium sanguineum	+	+	+	r
Onobrychis arenaria	+	+	r	+
Ranunculus polyanthemos	+	+	+	r
Torilis arvensis [R]	+	+	+	r
Trifolium alpestre	+	+	+	r
Verbascum phoeniceum	+	+	r	+
Calamagrostis epigejos	+	+	1	.
Poa pratensis agg.	+	+	1	.
Achillea millefolium agg.	+	+	.	+
Agrostis vinealis	+	+	+	.
Anthoxanthum odoratum	+	+	+	.
Arabis hirsuta	+	+	.	+
Arrhenatherum elatius	+	+	+	.
Campanula glomerata	+	+	+	.
Danthonia alpina	+	+	+	.
Equisetum ramosissimum	+	+	.	+
Festuca rubra [R]	+	+	+	.
Helictochloa sp.	+	+	+	.
Leucanthemum vulgare agg.	+	+	+	.
Medicago falcata	+	+	.	+
Polygonatum odoratum	+	+	+	.
Primula veris	+	+	+	.
Rumex acetosa	+	+	+	.
Scabiosa ochroleuca	+	+	.	+
Klasea lycopifolia	+	+	+	.
Seseli annuum	+	+	.	+
Valeriana stolonifera	+	+	+	.
Veronica vindobonensis	+	+	+	.
Avenula pubescens	r	+	+	.
Galium album	+	+	.	r
Leontodon hispidus	+	+	.	r
Medicago lupulina [R]	+	+	r	.
Myosotis arvensis [R]	+	+	r	.
Phleum phleoides	+	+	.	r
Potentilla alba	+	+	r	.
Pulmonaria mollis	r	+	+	.
Rosa canina agg.	+	+	r	.
Taraxacum sect. *Taraxacum* [R]	+	+	r	.
Thesium linophyllon	r	+	+	.
Galium glaucum	r	r	+	r
Lathyrus pannonicus	r	r	+	r
Securigera varia	r	r	+	r
Thalictrum aquilegiifolium	r	r	+	r
Trifolium pannonicum	r	r	+	r

Relevé number	1.1	1.2	2	3
Bromus racemosus	+	+	.	.
Capsella bursa-pastoris [R]	+	+	.	.
Erysimum cf. *odoratum*	+	+	.	.
Iris aphylla	+	+	.	.
Lactuca serriola [R]	+	+	.	.
Luzula campestris	+	+	.	.
Nepeta nuda	+	+	+	.
Seseli peucedanoides	+	+	.	.
Stachys recta	+	+	.	.
Viola cf. *mirabilis*	+	+	.	.
Campanula patula	r	r	+	.
Campanula persicifolia	r	r	+	.
Carduus acanthoides [R]	r	r	.	+
Bromopsis erecta	.	.	+	+
Potentilla heptaphylla	r	r	r	r
Carex filiformis	.	r	+	.
Jurinea mollis	.	r	.	+
Vicia cracca agg.	r	+	.	.
Centaurea sp.	r	r	.	.
Clematis integrifolia	r	r	.	.
Crepis praemorsa	r	r	.	.
Daucus carota [R]	r	r	.	.
Knautia arvensis [R]	.	.	r	r
Lappula squarrosa [R]	r	r	.	.
Orobanche cf. *alba*	r	r	.	.
Serratula tinctoria	r	r	.	.

Species recorded only once: relevé 1.2: *Inula hirta/salicina* (r); relevé 2: *Achillea collina* (+), *Agrostis capillaris* (+), *Bromus* cf. *japonicus* [R] (+), *Cirsium eriophorum* (+), *Cirsium pannonicum* (r), *Festuca valesiaca* (+), *Heracleum sphondylium* (r), *Iris graminea* (1), *Lathyrus pratensis* (+), *Linum nervosum* (+), *Molinia arundinacea* subsp. *freyi* (+), *Polygala comosa* (r), *Prunella grandiflora* (r), *Ranunculus auricomus* agg. (+), *Scorzonera hispanica* (r), *Scorzonera purpurea* (+), *Symphytum tuberosum* (r), *Trifolium arvense* (r), *Trisetum flavescens* (+), *Veratrum nigrum* (+), *Vicia tetrasperma* [R] (+); relevé 3: *Cerinthe minor* (r), *Convolvulus arvensis* [R] (+), *Crataegus* sp. (r), *Crepis* sp. (r), cf. *Dipsacus fullonum* [R] (r), *Inula hirta* (r), *Leucanthemum* cf. *adustum* (+), *Phlomis tuberosa* (+), *Pilosella piloselloides* (+), *Pilosella* sp. (+), *Polygala major* (r), *Pontechium maculatum* (+).

Table 2. Number and summed percentage cover of ruderal species in the plots with maximum species richness recorded in 2009, 2018 and 2021.

Tabelle 2. Anzahl und Deckungssumme der Ruderalarten in den Aufnahmeflächen des maximalen Artenreichtums aus den Jahren 2009, 2018 und 2021.

Year	Plot area [m^2]	Species richness	Ruderal species number	Ruderal species cover [%]
2009	10	98	7	2.1
2018	10.9	106	10	14.9
2021	10	115	13	19.9

recorded by only two researchers (compared to five in the world record-holding plot), further shows that extraordinary effort is not needed to record extraordinary species richness in these grasslands.

The new maxima partly result from an increasing number of ruderal species and thus at least partly reflect successional dynamics of the previously mown grassland, following its transformation to a medium-intensity sheep pasture. Among the ruderal species that either increased in abundance or newly appeared are e.g. *Carduus acanthoides*, *Lactuca saligna*, *L. serriola*, *Lappula squarrosa*, *Myosotis arvensis* and *Xeranthemum cylindraceum*, the latter being one of the dominants in the overgrazed places. The observed effect of grazing on species richness is noteworthy, as it has been shown before that extremely high species richness is usually found in mown grasslands in East-Central Europe (MERUNKOVÁ et al. 2012, ROLEČEK et al. 2014, TURTUREANU et al. 2014). We thus assume that the high species density may be temporary and might again decrease over time due to the loss of species that suffer from grazing. We therefore permanently marked the plots belowground to be able to monitor the effects of grazing on species richness and composition over a longer period.

Erweiterte deutsche Zusammenfassung

Einleitung – In den Steppenwiesen der Randkarpaten wurden in den letzten Jahren immer wieder extrem hohe Werte des Pflanzenartenreichtums auf kleinen Flächen gemessen (KLIMEŠ 1997, DENGLER et al. 2012, WILSON et al. 2012, ROLEČEK et al. 2014). Im Jahre 2019 berichteten wir von einem neuen Maximum von 106 Arten auf einer 10 m²-Fläche (ROLEČEK et al. 2019) – dieser Wert muss allerdings wegen fehlerhafter, zugrundeliegender Flächengröße korrigiert werden. Hier präsentieren wir nun den korrekten Wert (für das Jahr 2021) mit seiner Artenkombination. Außerdem präsentieren wir Werte des Pflanzenartenreichtums des angrenzenden Graslands und evaluieren mögliche Gründe für beobachte Veränderungen des Artenreichtums der Flächen.

Methoden – Wir relokalisierten im Jahr 2021 zunächst die im Jahr 2018 angelegte Dauerfläche (Abb. 1) und stellten fest, dass sie mit 10,9 m² tatsächlich größer war als in ROLEČEK et al. (2019) fälschlicherweise angegeben. Innerhalb dieser 10,9 m²-Fläche wurde daraufhin eine neue 10 m²-Fläche eingemessen und zusätzlich wurden im angrenzenden Grasland zwei neue 10 m²-Dauerflächen angelegt. Die pflanzensoziologische Aufnahme erfolgte nach einer Standardmethode: Die Fläche wurde mit einer nicht dehnbaren Schnur abgespannt und alle innerhalb des Plots wurzelten Arten wurden notiert. Die Aufnahme wurde von zwei bis fünf Personen durchgeführt und dauerte etwa zwei Stunden an. Um mögliche Auswirkungen der im Gesamtzeitraum 2009–2021 offenbar stattgefundenen Bewirtschaftungsänderung (von Mahd hin zu Weide) zu evaluieren, wurde der Anteil der Ruderalarten über die Zeit untersucht. Dazu diente neben unseren Aufnahmen aus den Jahren 2018/2021 auch eine Aufnahme aus demselben Gebiet aus dem Jahr 2009 (DENGLER et al. 2012), welche den Rekord des Gefäßpflanzen-Artenreichtums damals hielt.

Ergebnisse und Diskussion – Auf der im Jahre 2018 angelegten 10,9 m²-Dauerfläche wurden nun (in 2021) 118 Gefäßpflanzenarten gezählt; der Artenreichtum der Fläche war also in nur zwei Jahren um 12 Arten angestiegen (Tab. 1). Auf der innerhalb der 10,9 m²-Fläche gelegenen 10 m²-Fläche wurden dagegen 115 Arten gezählt. In den zwei neu angelegten angrenzenden 10 m²-Flächen wurden 110 und 82 Gefäßpflanzenarten gezählt. 115 und 110 Arten stellen die höchsten jemals gemessenen Werte des Gefäßpflanzen-Artenreichtums auf 10 m² dar. Da es sich bei den hinzugekommenen Arten überwiegend um Ruderalarten handelt, die auch ihre Deckung erhöht hatten (Tab. 2), hat es den Anschein, dass die neuen Rekorde zumindest teilweise durch Nutzungsänderung von Mahd auf mittelintensive Schafbeweidung bedingt sind. Wir mutmaßen daher, dass die Zunahme des Artenreichtums ediglich temporär ist. Da wir alle Flächen dauerhaft markiert haben, können wir die Auswirkungen der Nutzungsänderung auf den Artenreichtum und die Artenzusammensetzung der Flächen jetzt besser verfolgen.

Acknowledgements

This study was financed by the Czech Science Foundation (project 20-09895S). Jan Roleček and Petra Hájková were also supported by the long-term developmental project of the Czech Academy of Sciences (RVO 67985939). Our thanks go to Steffen Boch and Jürgen Dengler for useful comments on a previous version of this manuscript, Thomas Becker for the German translation and Constantin Goia for arranging to unlock our car without keys.

Author contributions

J.R. and M.H. conceived the ideas leading to this research. J.R. planned the research, participated in field sampling and led the writing. P.D. approved plant identification and nomenclature, participated in field sampling and writing. M.H., P.H. and I.G. participated in field sampling and writing.

ORCID iDs

Pavel Dřevojan https://orcid.org/0000-0003-0802-3509
Michal Hájek https://orcid.org/0000-0001-9358-0494
Petra Hájková https://orcid.org/0000-0003-1434-7825
Irina Goia https://orcid.org/0000-0001-8270-2214
Jan Roleček https://orcid.org/0000-0002-0023-1111

References

BIURRUN, I., PIELECH, R., DEMBICZ, I. ... DENGLER, J. (2021): Benchmarking plant diversity of Palaearctic grasslands and other open habitats. – J. Veg. Sci. doi: 10.1111/JVS.13050.

DANČÁK, M., DUCHOSLAV, M. & TRÁVNÍČEK, B. (2012): Taxonomy and cytogeography of the *Molinia caerulea* complex in central Europe. – Preslia 84: 351–374.

DENGLER, J., BECKER, T., RUPRECHT, E. ... 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., CHYTRÝ, M. & EWALD, J. (2008): Phytosociology. – In: JØRGENSEN, S.E. & FATH, B.D. (Eds.): Encyclopedia of Ecology. Vol. 4. General Ecology: 2767–2779. Elsevier, Oxford.

EURO+MED (2006–2021): Euro+Med PlantBase – the information resource for Euro-Mediterranean plant diversity. – URL: http://ww2.bgbm.org/EuroPlusMed/ [accessed 2021-07-15].

HÁJEK, M., HÁJKOVÁ, P. & ROLEČEK, J. (2020): A novel dataset of permanent plots in extremely species-rich temperate grasslands. – Folia Geobot. 52: 257–268.

KLIMEŠ, L. (1997): Druhové bohatství luk v Bílých Karpatech (Species richness of meadows in the Bílé Karpaty Mts) [in Czech]. – Sborn. Přírod. Kl. Uherské Hradiště 2: 31–42.

KLOTZ, S., KÜHN, I. & DURKA, W. (2002): BIOLFLOR – Eine Datenbank zu biologischökologischen Merkmalen der Gefäßpflanzen in Deutschland. – Schriftenr. Vegetationskd. 38: 1–334.

MERUNKOVÁ, K., PREISLEROVÁ, Z. & CHYTRÝ, M. (2012): White Carpathian grasslands: can local ecological factors explain their extraordinary species richness? – Preslia 84: 311–325.

ROLEČEK, J., ČORNEJ, I.I. & TOKARJUK, A.I. (2014): Understanding the extreme species richness of semi-dry grasslands in east-central Europe: a comparative approach. – Preslia 86: 5–27.

ROLEČEK, J., DŘEVOJAN, P., HÁJKOVÁ, P. & HÁJEK, M. (2019): Report of new maxima of fine-scale vascular plant species richness recorded in East-Central European semi-dry grasslands. – Tuexenia 39: 423–431.

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. – Agricult. Ecosyst. Environ. 182: 15–24.

WILSON, J.B., PEET, R.K., DENGLER, J. & PÄRTEL, M. (2012): Plant species richness: the world records. – J. Veg. Sci. 23: 796–802.