Acta Societatis Botanicorum Poloniae
Journal homepage: pbsociety.org.pl/journals/index.php/asbp
REVIEW Received: 2011.08.25 Accepted: 2012.05.04 Published electronically: 2012.05.28 Acta Soc Bot Pol 81(2):75-79 DOI: 10.5586/asbp.2012.014

The Polish Vegetation Database: structure, resources and development

Zygmunt Kącki, Michał Śliwiński*
Department of Biodiversity and Plant Cover Protection, University of Wrocław, Kanonia 6/8, 50-328 Wrocław, Poland

Abstract

The phytosociological database Polish Vegetation Database collects relevés of all vegetation types in Poland. The database was established in 2007 and is located at Department of Biodiversity and Plant Cover Protection, University of Wrocław (http://synbiot.uni.wroc.pl). On March 2012, the database included 40000 relevés collected between 1927 and 2011. Most of relevés was taken from published papers and represents almost all types of habitats of Poland. Large groups of relevés represent meadows and pastures (*Molinio-Arrhnehteretrea*), broadleaf forests (*Querco-Fagetea*), arable land communities (*Stellarietea*), coniferous forests (*Vaccinio-Piceetea*) and eutrophic reed communities (*Phragmitetea*). In comparison to other countries in Central Europe, Polish Vegetation Database currently belongs to medium-sized databases, with full functionality and accessibility. The present article describes its development, basic operational information and how it can be used in analysis of vegetation in Poland.

Keywords: database, phytosociology, relevé, vegetetion plot, biodiversity informatics, Poland

Introduction

Databases contain information stored in a specific manner [1]. Colloquially, the term is used both for the data themselves, as well as for the database management systems. The origins of databases go back to the 1960s and now they are an integral component of the world information source. Nowadays, electronic databases are an indispensable resource also in phytosociology. In Europe, the first phytosociological databases appeared in early 1990s, when French SOPHY database appeared and the Netherlands began organizing relevés in a national phytosociological database [2,3]. Other countries followed soon [4,5]. These databases were managed separately, but were soon linked into an international network of data exchange. By 2009, 35 European countries had electronic vegetation databases [6]. Poland was not among them, even though it had a long tradition of vegeatation survey and gathering relevés.

Since almost 100 years, the basic data unit in phytosociological studies is a relevé. It is a list of present plant species together with the information pertaining to their abundance as calculated using appropriate methods [7-12]. Even without having monitoring plots, relevés made over period of many years are an excellent source of information on changes of plant diversity and are exelent tool for vegetation science [13,14]. Effective use of this phytosociological data requires gathering in digital form. Such relevés are a useful basis for valuable phytosociological synthesis of vegetation variability [15-20]. They can also be used in environmental management and help to understand of long-term changes in plant communites [21,22], invasion ecology [23,24], biodiveristy patterns [25] or species composition changes [26]. They have been used to characterize the habitats included in the Natura 2000 network, and can be used to predict climate changes [27,28].

The aim of this article is to present the structure, potential use and dissemination of data stored in Polish Vegetation Database PVD, and compare it with other European databases in order to plan future development of the database and to promote cooperation among local scientists.

Development of vegetation databases in Poland

In Poland, small phytosociological databases had been used in all research facilities for many years. Relevés were stored mostly as hardcopies, only some of them were stored in computers. The total number of digitalized relevés collected in Poland is unknown. This substantial collection of data was stored on separate computers in many science centers throughout the country. Regionally, relevés were collected with use of two programs, PROFIT [29] and FITO [30]. However, the program that was probably most widely used was TURBOVEG [31], which is cited in several papers on plant communities [32-38]. These small databases were created locally for specific purposes, and had not been processed to make them available for other ecological studies. Poland was therefore considered as a country without any electronic vegetation database (Fig. 1a), even though it might possess one of the largest resources of phytosociological relevés in Europe [6]. Compared to other countries in Central Europe, the Polish Vegetation Database belongs now to the medium-sized databases, with full functionality and accessibility (Tab. 1).

* Corresponding author. Email: synbiot@biol.uni.wroc.pl

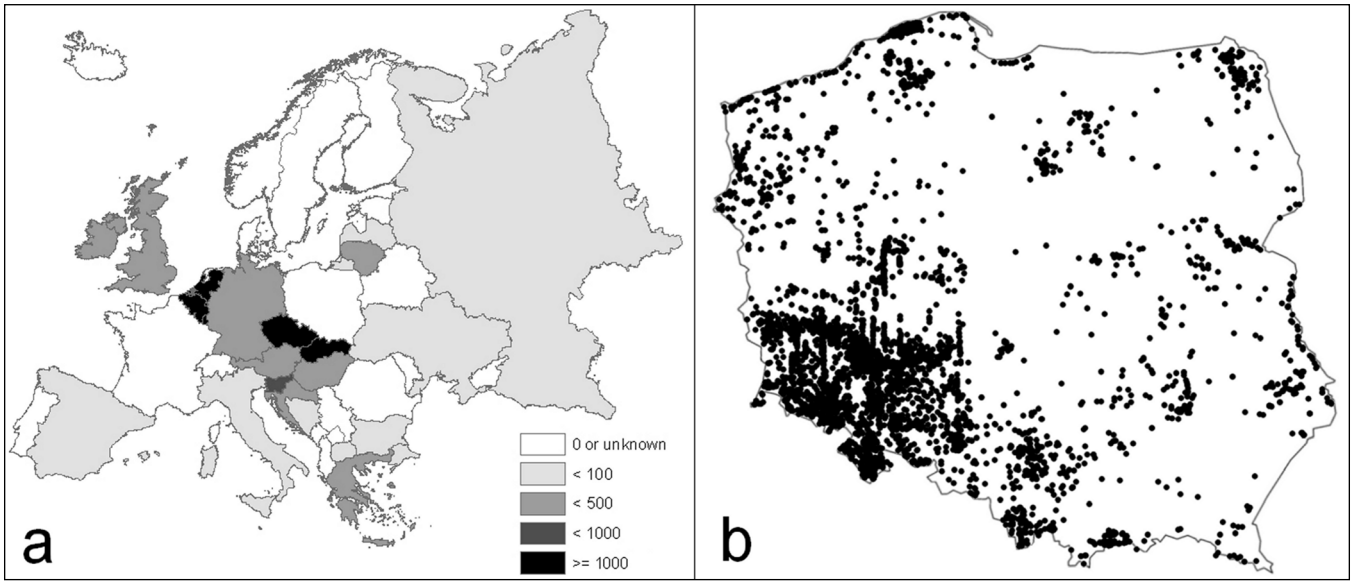

Fig. 1 Computerized resources on vegetation in: **a** Europe, an overview [6]; **b** Polish Vegetation Database, exact distribution of vegetation-plots.

The establishment and structure of Polish Vegetation Database

The national-scale vegetation database PVD was established in 2007 as a project of several research facilities associated with the National Biodiversity Information Network. An easy way to make phytosociological data available in a widely used format is use of the TURBOVEG program [31]. This program was therefore used as a basis for the Polish Vegetation Database. It already contains data from the territory of Poland (Fig. 1b), which describes most types of its vegetation. In the database both published and unpublished phytosociological data are

Tab. 1 Current statistics of the Polish Vegetation Database.

The position of Polish Vegetation Database among other Central European vegetation databases

Country	GIVD ID	Name of Database	Responsible Person	Vegetation Plots
Germany	EU-DE-014	GVRD Vegetation Database Halle	Jandt, Ute	103252
Czech Republic	EU-CZ-001	Czech National Vegetation Database	Chytrý, Milan et al.	98098
Germany	EU-DE-001	VegMV	Jansen, Florian et al.	53842
Slovakia	EU-SK-001	Slovak Vegetation Database	Šibík, Jozef	51581
Austria	EU-AT-001	Austrian Vegetation Database	Willner, Wolfgang	40000
Poland	EU-PL-001	Polish Vegetation Database	Kącki, Zygmunt et al.	38671
Czech Republic	EU-CZ-002	Database of Czech Forest Classification System	Zouhar, Vaclav	32387
Germany	EU-DE-013	VegetWeb	May, Rudolf	26692
Ukraine	EU-UA-001	Ukrainian Grasslands Database	Kuzemko, Anna	3181
Latvia	EU-LV-002	Mires of Latvia	Aunina, Liene	2027

Some of Polish Vegetation Database specifications (http://www.givd.info, state on 3rd of March 2012)

Plot size categories

<1 m²	1-<10 m²	10-<100 m²	100-<1000 m²	1000-<10000 m²	Not specified
1%	9%	51%	26%	1%	12%

Decades

<1919: 0%	1920-1929: 1%	1930-1939: 0%	1940-1949: 0%
1950-1959: 3%	1960-1969: 8%	1970-1979: 17%	1980-1989: 16%
1990-1999: 21%	2000-2009: 22%	2010-2019: 2%	Not specified: 10%

Geographic localisation

GPS coordinates: 2%	Point coordinates, up to 1 km: 76%
Small grid, no more than 10 km: 0%	Political units, more than 10 km: 22%

gathered, which are collected in the country. Stored records are required to use bibliography field, which includes the year of publication and the names of the authors. Because of extensive syntaxonomic synonymy and difficulties with interpretation, some relevés were added to the database as syntaxa of higher ranks following the system proposed by Matuszkiewicz [39]. If an accurate location is known, geographic coordinates are recorded for each relevé. If not, the coordinates of the nearest village are added. Each relevé is required to have a header field, which contains basic environmental characteristics of the vegetation plot.

The database is divided into two sub-databases: temporary and main. Relevés are stored in various formats: XLS, TXT, CSV and XML. In the temporary database, the required information is added together with the geographical coordinates and assignment to syntaxa. Nomenclature is standardized, and the relevés are then transferred to the main database. The main part of database contains 29000 relevés (on March 2012) derived from 320 publications dated from 1927 to 2011 (Tab. 1) and unpublished data collected by employees of the University of Wrocław. Their most important features are date and geographical coordinates in decimal degrees, acquired directly from GPS receiver or from locations found in Google Maps. On March 2012, the total number of relevés in temporary and main databases is 40000. All relevés are available, some of them however, still have not been fully converted to the format of the database (Tab. 2).

Tab. 2 Header data field of Polish Vegetation Database.

No.	Field name	Type	Lenght	No.	Field name	Type	Length
1	RELEVE_NR	N	6	14	COV_SHRUBS	N	3
2	COVERSCALE	C	2	15	COV_HERBS	N	3
3	COUNTRY	C	2	16	COV_MOSSES	N	3
4	REFERENCE	C	6	17	COV_TREEA1	N	3
5	TABLE_NR	C	6	18	COV_TREEA2	N	3
6	NR_IN_TAB	C	3	19	COV_TREEA3	N	3
7	DATE	C	8	20	LATITUDE	N	10 (DEC 7)
8	SYNTAXON	C	7	21	LONGITUDE	N	10 (DEC 7)
9	SURF_AREA	N	7	22	GEO_SOURCE	C	3
10	ALTITUDE	C	4	23	MIEJSCOWOS	C	20
11	EXPOSITION	C	3	24	ODDZ	C	3
12	INCLINATIO	C	2	25	WYDZ	C	3
13	COV_TREES	N	3	26	REMARKS	C	56

Tab. 3 Classified resources of Polish Vegetation Database.

No.	Class of vegetation	Number of relevés
1	*Molinio-Arrhenatheretea*	5624
2	*Querco-Fagetea*	5097
3	*Secalietea*	2612
4	*Vaccinio-Piceetea*	2357
5	*Phragmitetea*	2089
6	*Chenopodietea*	1372
7	*Sedo-Scleranthetea*	1303
8	*Artemisietea*	1242
9	*Festuco-Brometea*	1041
10	*Potametea*	805
11	*Alnetea glutinosae*	640
12	*Scheuchzerio-Caricetea fuscae*	505
13	*Plantaginetea majoris*	413
14	*Trifolio-Geranietea sanguinei*	397
15	*Lemnetea*	356
16	*Nardo-Callunetea*	353
17	*Quercetea robori-petraeae*	325
18	*Rhamno-Prunetea*	254
19	*Bidentetea tripartiti*	220
20	*Betulo-Adenostyletea*	187
21	*Oxycocco-Sphagnetea*	184
22	*Isoeto-Nanojuncetea*	172
23	*Ammophiletea*	156
24	*Asplenietea rupestria*	156
25	*Charetea*	135
26	*Epilobietea angustifolii*	102
27	*Montio-Cardaminetea*	98
28	*Salicetea purpureae*	79
29	*Utricularietea intermedio-minoris*	70
30	*Caricetea curvulae*	65
31	*Elyno-Seslerietea*	39
32	*Salicetea herbaceae*	37
33	*Littorelletea*	28
34	*Erico-Pinetea*	22
35	*Thlaspietea rotundifolii*	18
36	*Asteretea tripolii*	4
37	*Thero-Salicornietea*	4
38	*Cakiletea maritimae*	0
39	*Ruppietea maritimae*	0
40	*Violetea calaminariae*	0
41	*Zosteretea marinae*	0

Most relevés in the database are describing meadow and deciduous forest communities, as well as crop fields, pine forests, wetlands, saum communities and xerothermic grasslands. In total, 37 syntaxa in rank of Classes cover most of communities occurring in the country (Tab. 3).

The use and analysis of data

The data pertain to communities from different habitat types and different time periods. The Polish Vegetation Database therefore constitutes a large pool of data that makes it already possible to conduct numerical analysis on a country-size scale. For example, 1744 relevés were selected on the basis of whether they contained species groups characteristic for Molinion meadows. All relevés were identified in ATPOL 1 × 1 km squares [40]. Using geographical coordinates, a map of sites of Molinion meadows in Poland was created (Fig. 2a). The meadows included on the map are most common in the central lowland belt.

To perform the analysis the data was stratified and resampled. The relevés that had a surface of less than 24 m^2 or greater than 100 m^2 were excluded nad the geographical stratification were carried out to reduce number of relevés from over-sampled regions [41] and randomly maximum of 3 relevés from each of ATPOL squares were taken into account, so that 746 relevés which clearly represented the Molinion alliance were selected. The analyzed set of relevés was divided into five time periods following agriculture development

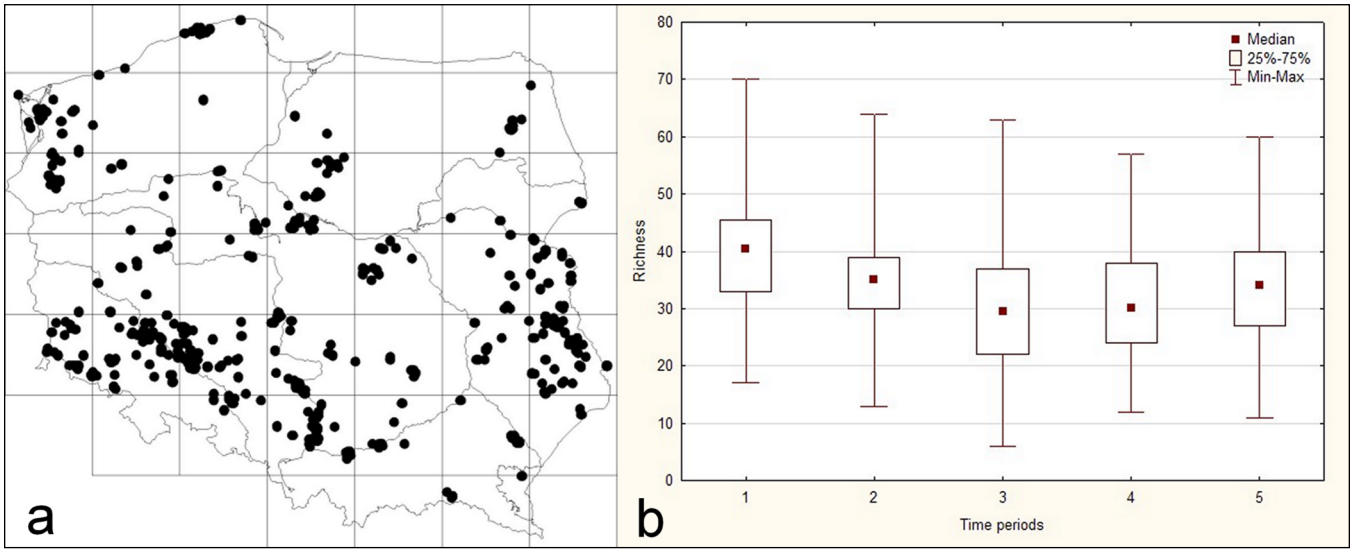

Fig. 2 An example of data use in a study on a country-size scale. **a** The distribution of *Molinion* meadows in Poland. **b** The species richness as a function of time. 1 – 1927 to 1957; 2 – 1958 to 1974; 3 – 1975 to 1994; 4 – 1995 to 2003; 5 – 2004 to 2010.

in order to determine temporal changes in species richness of seminatural *Molinion* grasslands (Fig. 2b). Over the past eighty years, species richness in these meadows has changed. However, identified changes of Molinion vegetation might be also affected by the uneven distribution of the data in database [21,42,43] or due to preferential data sampling by choosing in earlier phytosociological studies well-developed species-rich stands [44]. On the other hand, the diffrences in species diversity of Molinion meadows are also strongly associated with changes in land use and grassland management in Poland [45].

Conclusion

The Polish Vegetation Database PVD has a large collection of data, and is an essential contribution to the study of plant communities in Europe. The data collection system is structurally stable, consistent and flexible, which makes it easy for scientists to use the data. Due to the adoption of universal format for data collection, Polish Vegetation Database already worked well with foreign databases [14,46]. This indicated that further exchange and cooperation on an international scale is now possible. Data can be transferred to PVD in any format (XML, XLS, TXT and even hand-written), and can be retrieved mainly in TURBOVEG XML format. Funding remains a problem, as does the lack of a permanent position for a technical manager of the database and the web page. Nevertheless, the size, rapid development and promotion of the Polish Vegetation Database [47,48] make it an important data source on vegetation of Poland.

References

1. Ullman JD, Jurkiewicz M, Widom J. Podstawowy wykład z systemów baz danych. Warszawa: Wydawnictwa Naukowo-Techniczne; 2000.
2. Brisse H, de Ruffray P, Grandjouan G, Hoff M. The phytosociological database "SOPHY" Part 1: calibration of indicator plants, Part II: socio-ecological classification of the relevés. Ann Bot (Roma). 1995;53:177-223.
3. Schaminée JHJ, Hennekens SM. Update of the installation of TURBOVEG in Europe. Ann Bot (Roma). 1995;53:159-161.
4. Chytrý M, Rafajová M. Czech national phytosociological database: basic statistics of the available vegetation-plot data. Preslia. 2003;75:1-15.
5. Willner W. Austrian Vegetation Database. Biodivers Ecol. 2012;4 (in press).
6. Schaminée JHJ, Hennekens SM, Chytrý M, Rodwell JS. Vegetation-plot data and databases in Europe: an overview. Preslia. 2009;81:173-185.
7. Braun-Blanquet J. Pflanzensoziologie: Grundzüge der Vegetationskunde. Berlin: Springer; 1928.
8. Westhoff V, van der Maarel E. The Braun-Blanquet approach. In: Whittaker RH, editor. Ordination and classification of vegetation. Hague: Dr. W. Junk; 1973. p. 617-726.
9. Mueller-Dombois D, Ellenberg H. Aims and methods of vegetation ecology. New York: Wiley; 1974.
10. Pawłowski B. Skład i budowa zbiorowisk roślinnych oraz metody ich badania. In: Szafer W, Zarzycki K, editors. Szata roślinna Polski. Warszawa: Polish Scientific Publishers PWN; 1972. p. 229-263. (vol 1).
11. Dengler J, Chytrý M, Ewald J. Phytosociology. In: Jørgensen SE, Fath BD, editors. Encyclopedia of ecology. Oxford: Elsevier; 2008. p. 2767-2779. (General Ecology; vol 4).
12. Lososová Z, Chytrý M, Cimalová S, Kropáč Z, Otýpková Z, Pyšek P, et al. Weed vegetation of arable land in Central Europe: gradients of diversity and species composition. J Veg Sci. 2004;15(3):415-422. http://dx.doi.org/10.1111/j.1654-1103.2004.tb02279.x
13. Ewald J. A critique for phytosociology. J Veg Sci. 2003;14(2):291-296. http://dx.doi.org/10.1111/j.1654-1103.2003.tb02154.x
14. Dengler J, Jansen F, Glöckler F, Peet RK, de Cáceres M, Chytrý M, et al. The global index of vegetation-plot databases (GIVD): a new resource for vegetation science. J Veg Sci. 2011;22(4):582-597. http://dx.doi.org/10.1111/j.1654-1103.2011.01265.x
15. Rodwell JS, editor. British plant communities. Woodland and scrub. Cambridge: Cambridge University Press; 1991. (vol 1).

16. Berg C, Dengler J, Abdank A, editors. Die Pflanzengesellschaften Mecklenburg -Vorpommerns und ihre Gefährdung – Text and Tabellenband. Jena: Weissdorn; 2001.
17. Chytrý M, editor. Vegetace Ceské republiky. Vodní a mokřadní vegetace. Prague: Academia; 2011. (vol 1).
18. Chytrý M, editor. Vegetace Ceské republiky. Ruderální, plevelová, skalní a suťová vegetace. Prague: Academia; 2009. (vol 2).
19. Chytrý M, editor. Vegetace Ceské republiky. Ruderální, plevelová, skalní a suťová vegetace. Prague: Academia; 2009. (vol 2).
20. Willner W, Grabherr G, editors. Die Wälder und Gebüsche Österreichs. Munich: Spektrum Akademischer Verlag; 2007.
21. Haveman R, Janssen JAM. The analysis of long-term changes in plant communities using large databases: the effect of stratified resampling. J Veg Sci. 2008;19(3):355-362. http://dx.doi.org/10.3170/2008-8-18375
22. Schaminée JHJ, van Kley JE, Ozinga WA. The analysis of long-term changes in plant communities: case studies from the Netherlands. Phytocoenologia. 2002;32(2):317-335. http://dx.doi.org/10.1127/0340-269X/2002/0032-0317
23. Jansen F, Ewald J, Zerbe S. Ecological preferences of alien plant species in North-Eastern Germany. Biol Invasions. 2011;13(12):2691-2701. http://dx.doi.org/10.1007/s10530-011-9939-4
24. Chytrý M, Pyšek P, Wild J, Pino J, Maskell LC, Vilà M. European map of alien plant invasions based on the quantitative assessment across habitats. Divers Distrib. 2009;15(1):98-107. http://dx.doi.org/10.1111/j.1472-4642.2008.00515.x
25. Lenoir J, Gégout JC, Guisan A, Vittoz P, Wohlgemuth T, Zimmermann NE, et al. Cross-scale analysis of the region effect on vascular plant species diversity in southern and northern European mountain ranges. PLoS ONE. 2010;5(12):e15734. http://dx.doi.org/10.1371/journal.pone.0015734
26. Anioł-Kwiatkowska J, Kącki Z. Species diversity of segetal plant communities in the early-Neolithic settlement area of the Ślęża Landscape Park. Acta Soc Bot Pol. 2006;75(3):257-262.
27. Tanaka N, Matsui T, Shimada K, Yagihashi T, Taoda H. Constructing vegetation databases useful for assessing impact of climate changes in Japan. J Agric Meteorol. 2005;60:433-438.
28. Chytrý M, Kučera T, Kočí M, Grulach V, Luetyk P, editors. Katalog biotopů České republiky. Prague: Agentura ochrany přírody a krajiny ČR; 2010.
29. Balcerkiewicz S, Sławnikowski O. Profit 3.0. Pakiet programów komputerowych do analiz geobotanicznych. Poznań: Profit s.c.; 1998.
30. Zielony R, Konieczny A. Komputerowy program fitosocjologiczny FITO. Wiad Bot. 1994;38(3-4):37-44.
31. Hennekens SM, Schaminée JHJ. TURBOVEG, a comprehensive data base management system for vegetation data. J Veg Sci. 2001;12(4):589-591. http://dx.doi.org/10.2307/3237010
32. Dzwonko Z. Zbiorowiska leśne Gór Słonnych (polskie Karpaty Wschodnie). Fragm Flor Geobot. 1977;23(2-4):161-200.
33. Załuski T. Łąki selernicowe (związek *Cnidion dubii* Bal.-Tul. 1966) w Polsce. Monogr Bot. 1995;77:1-142.
34. Wilczek Z. Zespoły leśne Beskidu Śląskiego i zachodniej części Beskidu Żywieckiego na tle zbiorowisk leśnych Karpat Zachodnich. Katowice: Silesian University Press; 1995.
35. Kącki Z, Michalska-Hejduk D. Assessment of biodiversity in *Molinia* meadows in Kampinoski National Park based on biocenotic indicators. Pol J Environ Stud. 2010;19(2):351-362.
36. Kącki Z. Comprehensive syntaxonomy of *Molinion* meadows in southwestern Poland. Acta Bot Siles Monogr. 2007;2:1-134.
37. Zarzycki J. Roślinność łąkowa pasma Radziejowej (Beskid Sądecki) i czynniki wpływające na jej zróżnicowanie. Zesz Nauk Uniw Roln. 2008;448:1-113.
38. Dajdok Z, Wuczyński A. Alien plants of field margins and fields of southwestern Poland. Biodiv Res Conserv. 2008;9-10:19-33.
39. Matuszkiewicz W. Przewodnik do oznaczania zbiorowisk roślinnych Polski niżowej. Warsaw: Polish Scientific Publishers PWN; 1981.
40. Zając A. Atlas of distribution of vascular plants in Poland (ATPOL). Taxon. 1978;27(5-6):481-484. http://dx.doi.org/10.2307/1219899
41. Hill MO. TWINSPAN: a FORTRAN program for arranging multivariate data in an ordered two-way table by classification of the individuals and attributes. Ithaca NY: Section of Ecology and Systematics, Cornell University; 1979.
42. Knollová I, Chytrý M, Tichý L, Hájek O. Stratified resampling of phytosociological databases: some strategies for obtaining more representative data sets for classification studies. J Veg Sci. 2005;16(4):479-486. http://dx.doi.org/10.1111/j.1654-1103.2005.tb02388.x
43. Holeksa J, Woźniak G. Biased vegetation patterns and detection of vegetation changes using phytosociological databases. A case study in the forests of the Babia Góra National Park (the West Carpathians, Poland). Phytocoenologia. 2005;35(1):1-18. http://dx.doi.org/10.1127/0340-269X/2005/0035-0001
44. Chytrý M. Phytosociological data give biased estimates of species richness. J Veg Sci. 2001;12(3):439. http://dx.doi.org/10.1111/j.1654-1103.2001.tb00190.x
45. Kącki Z. Variability and long-term changes in the species composition of *Molinion* meadows in Poland: a case study using a large data set from the Polish Vegetation Database. Acta Bot Siles Monogr. 2012;7 (in press).
46. Jansen F, Dengler J, Glöckler F, Chytrý M, Ewald J, Oldeland J, et al. Die mitteleuropäischen Datenbanken im Global Index of Vegetation-Plot Databases (GIVD). Tuexenia. 2011;31:351-367.
47. Śliwiński M. Nasza baza danych o roślinności aktywnym węzłem baz europejskich. Przegląd Uniwersytecki. 2011;5:18-19.
48. Śliwiński M, Kącki Z, Swacha G, Czarniecka M. Polish vegetation database. Nowe narzędzie do badań nad roślinnością Polski. Zielona Planeta. 2011;4(97):14-16.