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NEW TRENDS IN BIODIVERSITY INFORMATICS

VegItaly: The Italian collaborative project for a national vegetation database

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Abstract
Two years after its official start, the national vegetation database VegItaly, a collaborative project supported by the Italian scientific community and developed by a large group of scientists, is presented. This article offers a concise overview of the content of the database, currently consisting of 31,100 vegetation plot, including published and unpublished data. Some basic statistics are analysed; for example, data distribution in space and time, represented vegetation types expressed as physiognomic categories. Although rather young and still in progress, VegItaly already contains data from all the Italian regions and stands as an optimal candidate for the development of an Italian national vegetation database. Its main goals, theoretical basis, technical features, functionalities and recent progresses are outlined, showing glimpses of future prospects.

Keywords: *Biodiversity informatics, database, phytosociology, relevé, vegetation plot*

Introduction

In the last decades, with the improvement of the informatics technology, great advancements have been made in the field of databases applied to ecology, nature conservation and environmental science. Regional and national databases have been developed during recent years, and they resulted very useful tools for public and private institutions in obtaining detailed and synthetic information for both scientific research and applied topics management (Michener & Brunt 2000; Schaminée et al. 2011).

In the context of vegetation science, several institutions worldwide developed databases consisting of electronic archives of vegetation plots (Wohlgemuth 1992; Brisse et al. 1995; Ewald 1995, 2001; Font & Ninot 1995; Schaminée & Hennekens 1995; Schaminée & Stortelder 1996; Mucina et al. 2000; Chytrý & Rafajová 2003; Font et al. 2010; Schaminée et al. 2011; Kącki & Śliwiński 2012). Given the important structural and functional role of vegetation in terrestrial ecosystems, vegetation databases represent an important instrument for supporting taxonomic investigation (Raimondo & Spadaro 2008; Castellano et al. 2012; Troia et al. 2012), providing data for the analysis of spatial distribution of species (Parolo et al. 2008; Scarnati et al. 2009b; Guidi & Foggi 2012), assessing the conservation status of species and habitats (Scarnati et al. 2009a; Abeli et al. 2012) and monitoring

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environmental changes, including climate change and the spread of alien species (Celesti-Grapow et al. 2010; Attorre et al. 2011; Jandt et al. 2011; Barni et al. 2012). This is extremely useful even in light of the main international policies for biodiversity conservation (e.g. Kyoto Conference, Rio Conference and the Habitat Directive 92/43/EEC).

In a recent overview about vegetation-plot data and databases, Schaminée et al. (2009) reported more than 4,300,000 vegetation-plot records existing in Europe. At present, the Global Index of Vegetation-Plot Databases (GIVD, Dengler et al. 2011) counts 1,894,272 plots for Europe included in 129 databases. At present, the five largest vegetation databases in Europe are the Dutch national vegetation database (600,000 plots), the French database (SOPHY, 212,244 plots), the Iberian and Macaronesian Vegetation Information System (125,000 plots), the German Vegetation Reference Database (111,928 plots) and the Czech National Phytosociological Database (99,586 plots; data from http://www.givd.info/ on 21 July 2012).

Schaminée et al. (2009) reported for Italy a total amount of 150,000 plots including published and unpublished relevés, with only about 20,000 computerized relevés. They also remarked the absence of an Italian national vegetation database. The total amount of vegetation plots recorded in Italy, in terms of both existing data and data already stored in electronic archives, is at present much higher than in the figure given by Schaminée et al. (2009). Currently, 18 different Italian databases are registered in GIVD for a total amount of 37,243 plots (not considering incidental repetitions), but other important and well-known vegetation databanks existing in some Italian institutions not yet registered in the Global Index should be added to this list. The main problem remains that most of these data are not available for the public, since they are stored in private, often temporary databanks in datasheet format specifically created for syntaxonomical analyses (Venanzoni et al. 2012).

During the last 5 years, the idea of a national vegetation database called VegItaly was developed and proposed to the Italian scientific community (Venanzoni & Panfili 2010; Venanzoni et al. 2012), stimulating a larger and larger group of scientists to join the project. The main aim of this article is to present the state and to discuss the future developments of VegItaly, 2 years after its first presentation as a national project.

A brief history

VegItaly (http://www.vegitaly.it) was founded and developed as a subproject of the open-source project anArchive for Botanical Data (http://www.anarchive.it), a Web geodatabase designed to store, retrieve and analyse floristic and vegetation data (Venanzoni et al. 2012). AnArchive, started in 2000, was a collaborative project at the beginning mainly dedicated to manage *herbaria* and floristic data and involving only three universities, Perugia, Camerino and Siena (Venanzoni et al. 2003; Panfili et al. 2004; Venanzoni & Panfili 2010). During the last 12 years, the project grew up, involving more and more universities, improving its structure and applications in order to offer increasing opportunities to users and to facilitate the research. The subproject dedicated to vegetation data was accurately developed respecting international standards and according to the definition of ''vegetation database'' stated by GIVD (http://www.givd.info/index.php?id=givd-criteria; Schaminée et al. 2009; Dengler et al. 2011).

At the 46th Congress of the Italian Society of Vegetation Science (SISV), held in 2010 in Pavia, VegItaly was proposed for the first time as a standard to collect and manage vegetation data at national scale (Venanzoni & Panfili 2010). During the last 2 years, VegItaly grew both in number of stored vegetation plots and in popularity, at both the national and international scales. The citations of the database increased (Feoli et al. 2011; Landucci et al. 2011; Guarino et al. 2012; Venanzoni et al. 2012) and the project was often promoted in national and international congresses. It has been well acknowledged in Europe becoming a founding partner of the rising European Vegetation Archive (EVA; Chytrý et al. 2012) and the main Southern European reference point for the creation of the European taxonomic standard list for vegetation studies named EuroSL (Dengler et al. 2012).

At present, a large number of researchers from different Italian universities, including the authors of this article (some of which were already managing private databanks), joined VegItaly. The resulting working group aims at bringing together all the small databases scattered across Italy in one large collaborative project. The group has already gone through a trial period, managing data from different origins, collected with different aims and stored by using different systems and programs (such as TURBOVEG, Microsoft ACCESS or spreadsheet software applications). Indeed, one of the first and most important issues faced by the working group concerns a proper data standardization, avoiding the loss of useful information. Practical and technical solutions of this problem have been successfully tested, developing user-friendly tools for importing and managing vegetation plots in a single database structure. Another important issue, still under development, is the serious need of a shared set of formal rules, which allow a wide access to data and still safeguard each data provider's intellectual property.

Main goals of the project

VegItaly can be defined as a collaborative long-term project. It is supported by SISV and Italian Botany Society and involves different universities, public institutions and private users willing to cooperate. Its basic purposes are:

- to build a vegetation database on the national level, which contains historical and current data, both published and unpublished;
- to provide standards for data collecting and archiving according to national and international guidelines;
- to create a robust support for syntaxonomical, synecological and geobotanical researches, in particular large-scale vegetation classifications, statistical data analyses, spatial and temporal analyses of floristic and vegetation data for monitoring environmental changes and ecosystems;
- to create a direct link between bibliographic sources and their data content making use of the system LISY – List of the Syntaxonomic Units of the Italian Vegetation (Bracco & Nola 1995; Biondi et al. 1996, 1997; Bracco 2001; Bracco et al. 2007), a specific tool to manage syntaxonomic literature created by SISV, periodically updated and available online at http://www.scienzadellavegetazione.it/sisv/lisy/index.jsp;
- to facilitate the sharing and comparing of data among European countries and
- to create a Web interface for accessing and disseminating data.

Some of these purposes have already been achieved (at least partially) or are about to be reached. VegItaly is a project which needs of continuous updating, support and collaborations from the scientific community in order to be considered really successful.

Current functionalities and tools

VegItaly uses open-source software to archive, retrieve and publish botanical data on the Web. The Web server application runs on Apache Tomcat(servlet container and stores its data in PostgreSQL(. The client application is written in Java and runs on various platforms such as Linux, Mac OS X and Windows. The Web access and consultation of the database content are free for public data, while the export function is regulated on the ground of the level of data-protection, decided by each data owner. Any recent browser such as Firefox, Chrome, Internet Explorer and Safari can be used to access and manage the data (Venanzoni et al. 2012).

The keystone concept of vegetation plot adopted by VegItaly corresponds to the modern phytosociological relevé derived from the Braun-Blanquet model (Braun-Blanquet 1928; Westhoff & van der Maarel 1973; Mueller-Dombois & Ellenberg 1974; Dengler et al. 2008; Biondi 2011), the most traditionally used approach in collecting vegetation data among European vegetation scientists (Schaminée et al. 2009). However, some variants of this basic concept are also accepted, provided that they respect the ''vegetation-plot'' definition adopted by GIVD (Dengler et al. 2011). For example, plots based on multi-scale design (e.g. plots and subplots), as those used by Chiarucci et al. (2008, 2012), have been entered in the database already from its very beginning. In these data, the presence/absence of species can be obtained for the smaller scales (subplots) and the species frequency in the subplot can be obtained for the larger scale (plot).

The accepted measures of species abundance at present are:

- the original Braun-Blanquet scale (1932, 1964),
- the scale of Braun-Blanquet modified by Barkman et al. (1964),
- the ordinal van der Maarel's scale (1979),
- the scale of Pignatti and Mengarda (1962),
- the cover percentage scale,
- the binary presence/absence scale and
- any frequency scale based on a division of plots into subplots.

A conversion system integrated in VegItaly enables the export, use and comparison of relevés based on different sampling scales, turning each scale into each other through their transformation to percentage values, or reducing to presence/absence data, which are often more informative than abundance data (Wilson, 2012).

Three tools are available to store and manage vegetation data:

(1) ''Archiver'' is the principal and oldest application, created to properly handle floristic and vegetation data; it enables to store, retrieve and modify single vegetation plots or phytosociological relevés, by a user-friendly interface.
(2) ''TabImport'' is a tool to quickly upload multiple vegetation plots organized in tables, in spreadsheet file formats such as .xls, .xlsx and .ods.
(3) ''VegImport'' is the younger application, designed to adapt, standardize and import independent databases and tables in .xml format, such as data from Turboveg (Hennekens & Schaminée 2001).

The data export is possible from the Web interface using queries (e.g. dominant species, localities, syntaxa and projects) and organizing the data in tables containing header and species data. The currently available export formats are .txt, .csv and .ods respecting the compatibility with data analysis and statistical programs such as JUICE (Tichý 2002), SYNTAX (Podani 1995), MATEDIT (Burba et al. 2008) and R Project for Statistical Computing (R Core Team 2012). A simple cluster analysis is also supported via Web.

Geographic information may be imported in metric-based Universal Trasversal Mercator (UTM) system, degree-based systems WGS84, ED50 and Roma40 or using the European Floristic Grid, corresponding to 1/16 of a map in scale 1:50,000 UTM-ED50 (Ehrendorfer & Hamann 1965; Niklfeld 1977).

Two powerful tools make VegItaly more innovative than other databases in Europe. The first one is the constantly updated, synonymized taxonomical list on which the whole database system is founded. The second one concerns the opportunity to cross both floristic and vegetation data in order to facilitate geobotanical investigations (Venanzoni et al. 2012). These functions are available thanks to the close integrated development of the project VegItaly within the anArchive system, which besides vegetation data contains more than 95,000 floristic records from several Italian *Herbaria* (data available on 26 September 2012 at http://www.anarchive.it/anArchive/statistiche.jsp).

The synonymized checklist includes 13,062 cormophytes (25,348 specific and infraspecific names, including accepted names and synonyms), 1198 bryophytes (4181 names including synonyms), 1493 fungi (2308 names including synonyms) and 34 macro-algae (64 names including synonyms). This list is the result of a continuous update based on acknowledged Italian taxonomic checklists (Conti et al. 2005; Onofri et al. 2005; Aleffi et al. 2008; Bazzichelli & Abdelahad 2009) integrated by the most important and recent taxonomical and nomenclatural revisions in Europe. Users may choose to export vegetation data using the original species names recorded by the authors or translating automatically old synonyms of a taxon in the current name, suggested by the system. This function may be particularly useful to manage large data set collected in different times or by different people, who adopted different synonyms to indicate the same taxon. Evidently, the system cannot solve problems such as historically misapplied names or different taxonomic concepts, which should be appropriately evaluated.

A webGIS platform has been developed in order to allow the data visualization through the projection of point and grid data overlaid on a topographic base map. The base maps are supplied by leading providers of online maps such as Google and OpenStreetMaps. The platform allows operations such as navigation, zoom, data exploration, selection and export of selection in different formats such as .gml (geographic markup language) and .kml (keyhole markup language), easily loadable into common Global Information System (GSI) software. The webGIS platform is an integral part of the database management system, which enables the visualization based on SQL query request on the stored data. Actually, this function is active only in the *herbaria* section, because still under construction. So at the moment it is only possible the visualization of species distribution of *herbaria* specimens stored in anArchive. In a next future, this function will be extended to all parts of the system including VegItaly project, and the integrated visualization of species/syntaxa geographic distribution and species distribution model will be possible.

Basic statistics of the database

At present, VegItaly hosts 31,100 vegetation plots, whose large majority derives from published sources (Table I). The total amount is the sum of a number of already existing datasets, which have been merged and might include incidental repetitions.

They are not evenly distributed in the Italian territory (Table II and Figure 1). In general, a higher density of archived plots is evident in Central Italy (Figure 1). The most represented region is Lazio (6,134), due to the large number of research groups operating in that territory, followed by Umbria (3,766) and Toscana (3,131). These three regions together count for more than 40% of the total amount of plots in the database, indicating that a remarkable storage effort was invested up to date in these territories.

When considering the number of stored vegetation plots as a function of their year of publication (distribution per decades, Figure 2), a progressive increase is evident especially with reference to the last 30 years. The oldest relevé dates back to 1923. Obviously, in the starting stages of the upload process, most of the providers gave priority to recent data, including also a remarkable number of unpublished plots. A progressive increase of old data is

Table I. Published, unpublished and total vegetation plots (vp) stored in VegItaly.

	No. of vp	%
Published	22,878	73.56
Unpublished	8,222	26.44
Total	31,100	

Table II. Geographical origin, according to the Italian Regions, of the vegetation plots (vp) currently stored in VegItaly (n.a. = not available).

	No. of vp	%
Lazio	6,134	19.72
Umbria	3,766	12.11
Toscana	3,131	10.07
Sicilia	2,742	8.82
Campania	2,722	8.75
Marche	1,881	6.05
Abruzzo	1,660	5.34
Sardegna	1,488	4.78
Veneto	1,315	4.23
Emilia Romagna	1,032	3.32
Calabria	758	2.44
Lombardia	624	2.01
Basilicata	451	1.45
Molise	434	1.40
Puglia	357	1.15
Friuli Venezia Giulia	288	0.93
Valle d''Aosta	243	0.78
Piemonte	192	0.62
Liguria	164	0.53
Trentino	133	0.43
San Marino Rep.	2	0.01
n.a.	1,583	5.09
Total	31,100	

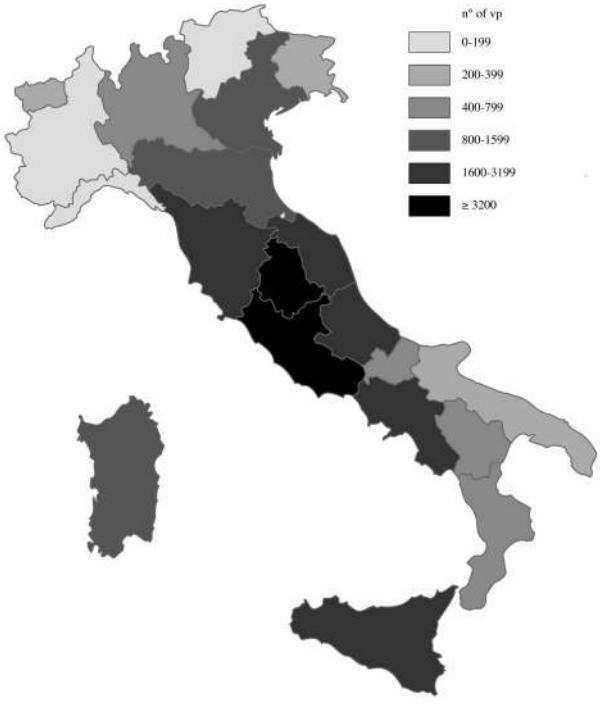

Figure 1. Distribution map of the vegetation plots (vp) stored in VegItaly.

expectable in the next future, although they present a number of intrinsic difficulties, mainly due to the current taxonomic and methodological advances which make them obsolete and often unsuitable for large analyses.

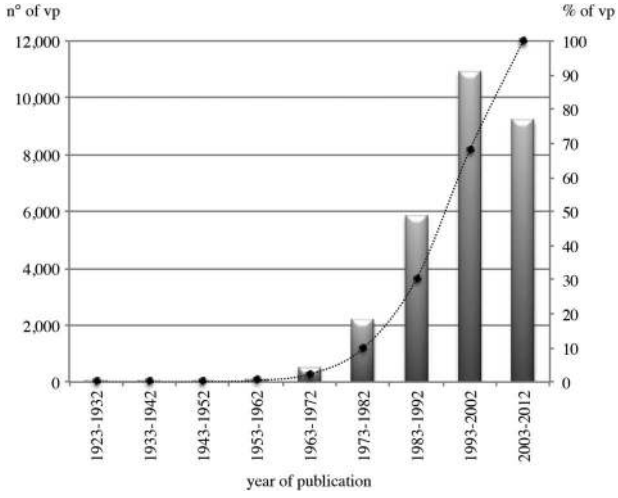

Figure 2. Years of publication of the vegetation-plots (vp) stored in VegItaly, grouped in decades (bars); cumulative frequency distribution of the vp number per decades (dashed line).

A first data screening on the ground of the corresponding vegetation type was possible only using rough categories, mostly based on physiognomy, structure and life form of the dominant species (Table III). More than half (55.59%) of the total amount of stored relevés represents herbaceous vegetation, including in this category also aquatic and amphibious plant communities. More than one-third (34.68%) refers to forest vegetation.

Conclusions and perspectives

The convergence of several private (mainly regional or including few vegetation types) databases into a single national one represents an important milestone for the Italian vegetation science towards the development of national-scale and long-term projects. VegItaly might become one of the most important instruments for large-scale studies in vegetation science and plant ecology, as it already happened for analogous projects in other European countries (e.g. Rodwell 1991–1995; Schaminée & Westhoff 1992; Valachovič 1995–2001; Jarolímek et al. 1997; Chytrý 2007–2011).

Although the number of vegetation plots rapidly increased during the last years, the data at present stored in VegItaly are still far from being considered complete and representative of the whole Italian vegetation biodiversity. Some vegetation types are better represented than others, since many data were collected and stored for specific purposes, for example, the production of thematic works at national or regional scale (Biondi et al. 2007; Pesaresi et al. 2007; Blasi et al. 2009, 2012a, 2012b; Rosati et al. 2010; Landucci et al. 2011; De Sillo et al. 2012; Lonati & Siniscalco 2012; Prisco et al. 2012a, 2012b). At the same time, also the

Table III. Main vegetation types stored in VegItaly (vp, vegetation plots).

	No. of vp	%
Forest vegetation	*10,786*	*34.68*
Climatophilous forest vegetation	10,157	32.66
Riparian and palustrine forest vegetation	579	1.86
Chestnut woods	50	0.16
Shrub vegetation	*1,768*	*5.68*
Supratimberline dwarf shrubs	24	0.08
Temperate bushy/shrubby vegetation	1,064	3.42
Riparian and palustrine bushy/shrubby vegetation	280	0.90
Heathlands	10	0.03
Mediterranean scrub and chamaephytic vegetation	414	1.33
Herbaceous vegetation	*17,412*	*55.99*
Edges and fringes (both climatophilous and azonal)	378	1.22
Supratimberline grasslands	127	0.41
Secondary grasslands	3,274	10.53
Annual non-niytrophilous dry grasslands	897	2.88
Pioneer annual wet vegetation	65	0.21
Temporary wetlands	238	0.77
Marshy and transitional pastures and meadows	1,277	4.11
Wet meadows (sedge dominated)	713	2.29
Helophytic vegetation	925	2.97
Spring vegetation (mainly bryophitic)	45	0.14
Bogs	217	0.70
Annual sub-nitrophilous wet vegetation	166	0.53
Ruderal/synanthropic annual vegetation	490	1.58
Ruderal/synanthropic biennial/perennial vegetation	296	0.95
Mediterranean salt marshes and salt meadows perennial vegetation	302	0.97
Mediterranean salt marshes annual vegetation	57	0.18
Wall vegetation	1,058	3.40
Scree vegetation	90	0.29
Rupicolous non-coastal vegetation	258	0.83
Rupicolous coastal vegetation	86	0.28
Badland pioneer vegetation	738	2.37
Dune vegetation	2,603	8.37
Aquatic and amphibian vegetation	3,112	10.01
Unclassified	*1,110*	*3.57*
Total	31,100	

geographical distribution of vegetation plots is not homogeneous across the national territory. However, through VegItaly, these gaps may be easily filled in the next future, encouraging the scientific community to actively take part into the project, not only providing relevés but also contributing to data storage and, hopefully, fundraising.

Moreover, new technical improvements of tools and utilities are going to come in a next future. Not only the improvement of GIS and the Web cartographic restitution of taxa and syntaxa distribution are already in progress, but also further implementation of functions for statistical analysis directly applicable online. Next functions to be developed in short time will be the possibility to store and manage synoptic table and the opportunity to export data in Veg-X format, the international vegetation-plot exchange data standard (Wiser et al. 2011). These two last functionalities will be particularly useful to facilitate large-scale revisions (Tichý et al. 2012) and to favour data exchange and integration with other national and European initiatives such as the Italian Network of Biodiversity (Martellos et al. 2011) and the EVA project.

References

Abeli T, Barni E, Siniscalco C, Amosso C, Rossi G. 2012. A cost-effective model for preliminary site evaluation for the reintroduction of a threatened quillwort. Aquat Conserv Mar Freshwater Ecosyst 22: 66–73.

Aleffi M, Tacchi R, Cortini Pedrotti C. 2008. Check-list of the hornworts, liverworts and mosses of Italy. Bocconea 22: 1–256.

Attorre F, Alfò M, Francesconi F, Valenti R, Vitale M, Bruno F. 2011. Evaluating the effects of climate change on tree species abundance and distribution in the Italian peninsula. Appl Veg Sci 14: 242–255.

Barkman JJ, Doing H, Segal S. 1964. Kritische Bemerkungen und Vorschläge zur quantitativen Vegetationsanalyse. Acta Bot Neerl 13: 394–419.

Barni E, Bacaro G, Falzoi S, Spanna F, Siniscalco C. 2012. Establishing climatic constraints shaping the distribution of alien plant species along elevation gradient in the Alps. Plant Ecol 213: 757–767.

Bazzichelli G, Abdelahad N. 2009. Alghe d'acqua dolce d'Italia. Flora analitica delle Caroficee. Roma: Università degli Studi di Roma La Sapienza.

Biondi E. 2011. Phytosociology today: Methodological and conceptual evolution. Plant Biosyst 145(Suppl. 1): 19–29.

Biondi E, Bracco F, Nola P. 1996. Bibliografia fitosociologica italiana (1909–1993). Fitosociologia 31: 5–10.

Biondi E, Bracco F, Nola P. 1997. Lista delle unità sintassonomiche della vegetazione italiana. Fitosociologia 33: 5–11.

Biondi E, Catorci A, Pandolfi M, Casavecchia S, Pesaresi S, Galassi S, et al. 2007. Il Progetto di Rete Ecologica della Regione Marche (REM): per il monitoraggio e la gestione dei siti Natura 2000 e l'organizzazione in rete delle aree di maggiore naturalità. Fitosociologia 44(2 Suppl. 1): 89–93.

Blasi C, Burrascano S, Del Vico E, Di Pietro R, Iocchi M, Rosati L. 2009. *Cynosurion cristati* grasslands in the central Apennines (Tyrrhenian sector): A phytosociological survey in the Lepini and Prenestini mountains. Plant Biosyst 143(Suppl. 1): 69–77.

Blasi C, Facioni L, Burrascano S, Del Vico E, Tilia A, Rosati L. 2012a. Submediterranean dry grasslands along the Tyrrhenian sector of central Italy: Synecology, syndynamics and syntaxonomy. Plant Biosyst 146(2): 66–290.

Blasi C, Tilia A, Rosati L, Del Vico E, Copiz R, Ciaschetti G, et al. 2012b. Geographical and ecological differentiation in Italian mesophilous pastures referred to the alliance *Cynosurion cristati* Tx. 1947. Phytocoenologia 41(4): 217–229.

Bracco F. 2001. Il primo aggiornamento della Lista sintassonomica italiana. Fitosociologia 38(2 Suppl. 1): 5–11.

Bracco F, Nola P. 1995. Project LISY: Data banks for the compilation of a national list of syntaxonomic units of Italy. Ann Bot (Roma) 53: 163–169.

Bracco F, Panfili E, Sburlino G, Venanzoni R. 2007. Il secondo aggiornamento della Lista sintassonomica italiana (2000–2004). Fitosociologia 44: 5–12.

Braun-Blanquet J. 1928. Pflanzensoziologie. Grundzüge der Vegetationskunde. Berlin: Springer.

Braun-Blanquet J. 1932. Plant sociology: The study of plant communities. New York and London: McGraw-Hill.

Braun-Blanquet J. 1964. Pflanzensoziologie. Grundzüge der Vegetationskunde. Wien/New York: Springer.

Brisse H, de Ruffray P, Grandjouan G, Hoff M. 1995. The Phytosociological Database "SOPHY" Part 1: Calibration of indicator plants, Part II: Socio-ecological classification of the relevés. Ann Bot (Roma) 53: 177–223.

Burba N, Feoli E, Malaroda M. 2008. MATEDIT: A software tool to integrate information in decision making processes. In: Neves R, Baretta JW, Mateus M, editors, Perspectives on integrated coastal zone management in South America. Lisboa: IST Press. pp. 123–127.

Castellano G, Marino P, Raimondo FM, Spadaro V. 2012. *Sorbus busambarensis* (*Rosaceae*), a new endemic species of Sicily. Plant Biosyst 146: S336–S342.

Celesti-Grapow L, Alessandrini A, Arrigoni PV, Assini S, Banfi E, Barni E, et al. 2010. Non-native flora of Italy: Species distribution and threats. Plant Biosyst 144(1): 12–28.

Chiarucci A, Bacaro G, Filibeck G, Landi S, Maccherini S, Scoppola A. 2012. Scale dependence of plant species richness in a network of protected areas. Biodivers Conserv 21: 503–516.

Chiarucci A, Bacaro G, Rocchini D. 2008. Quantifying plant species diversity in a Natura 2000 network: Old ideas and new proposals. Biol Conserv 141: 2608–2618.

Chytrý M. 2007–2011. Vegetace České republiky 1–3. Praha: Academia.

Chytrý M, Berg C, Dengler J, Ewald J, Hennekens S, Jansen F, et al. 2012. European Vegetation Archive (EVA): A new initiative to strengthen the European Vegetation Survey, 21st EVS Workshop, 24–27 May 2012. Vienna, Austria.

Chytrý M, Rafajová M. 2003. Czech National Phytosociological Database: Basic statistics of the available vegetation-plot data. Preslia 75: 1–15.

Conti F, Abbate G, Alessandrini A, Blasi C. 2005. An annotated check-list of the Italian vascular flora. Roma: Palombi.

De Sillo R, De Sanctis M, Bruno F, Attorre F. 2012. Vegetation and landscape of the Simbruini mountains (Central Apennines). Plant Sociol 49(1 Suppl. 1): 3–64.

Dengler J, Berendsohn WG, Bergmeier E, Chytrý M, Danihelka J, Jansen F, et al. 2012. The need for and requirements of EuroSL, an electronic taxonomic reference list of all plants of Europe. In: Dengler J, Chytrý M, Ewald J, Finckh M, Jansen F, Lopez-Gonzalez G, et al., editors. Vegetation databases for the 21st century. Biodivers Ecol 4: 15–24.

Dengler J, Chytrý M, Ewald J. 2008. Phytosociology. In: Jørgensen SE, Fath BD, editors. Encyclopedia of ecology. Vol. 4, General ecology. Oxford: Elsevier. pp. 2767–2779.

Dengler J, Jansen F, Glöckler F, Peet RK, De Cáceres M, Chytrý M, et al. 2011. The Global Index of Vegetation-Plot Databases (GIVD): A new resource for vegetation science. J Veg Sci 22: 582–597.

Ehrendorfer F, Hamann V. 1965. Vorschlägen zu einer floristichen Kartierung. Berichte der Deutschen Botanischen Gesellschaft 78: 35–50.

Ewald J. 1995. Eine vegetationskundliche Datenbank bayerischer Bergwälder. Hoppea 56: 453–465.

Ewald J. 2001. Der Beitrag pflanzensoziologischer Datenbanken zur vegetationsökologischen Forschung. Ber R-Tüxen-Ges 13: 53–69.

Feoli E, Ganis P, Venanzoni R, Zuccarello V. 2011. Toward a framework of integrated knowledge of terrestrial vegetation system: The role of databases of phytosociological relevés. Plant Biosyst 145(Suppl. 1): 74–84.

Font X, Ninot J-M. 1995. A regional project for drawing up inventories of flora and vegetation in Catalonia (Spain). Ann Bot (Roma) 53: 99–105.

Font X, Rodríguez-Rojo MP, Acedo C, Biurrun I, Fernández-González F, Lence C, et al. 2010. SIVIM: An online database of Iberian and Macaronesian vegetation. Waldökologie, Landschaftsforschung und Naturschutz 9: 15–22.

Guarino R, Becker T, Dembicz I, Dolnik C, Kacki Z, Kozub Ł, et al. 2012. Impressions from the 4th EDGG Research Expedition to Sicily: Community composition and diversity of Mediterranean grasslands. Bull Eur Dry Grassland Group 15: 13–22.

Guidi T, Foggi B. 2012. Use of phytosociological databases for species distribution models. Folia Geobot 47: 305–316.

Hennekens SM, Schaminée JHJ. 2001. TURBOVEG, a comprehensive data base management system for vegetation data. J Veg Sci 12: 589–591.

Jandt U, von Wehrden H, Bruelheide H. 2011. Exploring large vegetation databases to detect temporal trends in species occurrences. J Veg Sci 22: 957–972.

Jarolímek I, Zaliberová M, Mucina L, Mochnacký S. 1997. Rastlinné spoločenstvá Slovenska 2. Synantropná vegetácia. Bratislava: Veda. 420 pp.

Kącki Z, Śliwiński M 2012. The Polish Vegetation Database: Structure, resources and development. Acta Soc Bot Pol 81(2): 75–79.

Landucci F, Gigante D, Venanzoni R. 2011. An application of the Cocktail Method for the characterization of the hydrophytic vegetation at Lake Trasimeno (Central Italy). Fitosociologia 48(2): 3–22.

Lonati M, Siniscalco C. 2012. A redefinition of geographic boundaries between *Festuca paniculata* (L.) Schinz & Thell. Associations in the western Alps. Acta Bot Gallica 159: 109–119.

Martellos S, Attorre F, De Felici S, Cesaroni D, Sbordoni V, Blasi C, et al. 2011. Plant sciences and the Italian National Biodiversity Network. Plant Biosyst 145(4): 758–761.

Michener WK, Brunt JW. 2000. Ecological data: Design, management and processing. Oxford: Blackwell Science.

Mucina L, Bredenkamp GJ, Hoare DB, McDonald DJ. 2000. A national vegetation database for South Africa. S Afr J Sci 96: 497–498.

Mueller-Dombois D, Ellenberg H. 1974. Aims and methods of vegetation ecology. New York: John Wiley and Sons.

Niklfeld H. 1977. Bericht über die Kartierung der Flora Mitteleuropas. Taxon 20: 545–571.

Onofri S, Bernicchia A, Filipello Marchisio V, Padovan F, Perini C, Ripa C, et al. 2005. Checklist dei funghi italiani. Sassari: Delfino Editore. 380 pp.

Panfili E, Pesciaioli P, Venanzoni R. 2004. AnArchive: un software per la gestione di dati d'erbario, floristici e vegetazionali da internet (AnArchive: A software for herbarium, floristic and vegetational data management). Inf Bot Ital 36: 110–112.

Parolo G, Rossi G, Ferrarini A. 2008. Toward improved species niche modelling: *Arnica montana* in the Alps as a case study. J Appl Ecol 45: 1410–1418.

Pesaresi S, Biondi E, Casavecchia S, Catorci A., Foglia M. 2007. Il Geodatabase del Sistema Informativo Vegetazionale delle Marche. Fitosociologia 44(2 Suppl. 1): 95–101.

Pignatti S, Mengarda F. 1962. Un nuovo procedimento per l'elaborazione delle tabelle fitosociologiche. Acc. Naz. Lincei, Rend. cl. Sc. fis. mat. nat., s.8, 32: 215–222.

Podani J. 1995. SYN-TAX 5.0: Computer programs for multivariate analysis in ecology and systematics. In: Guariso G, Rizzoli A, editors. Software per l'Ambiente. Bologna: Patron. Pp. 37–43.

Prisco I, Acosta ATR, Ercole E. 2012a. An overview of Italian coastal dune EU habitats. Ann Bot (Roma) 2: 39–48.

Prisco I, Carboni M, Acosta ATR. 2012b. VegDunes – a coastal dune vegetation database for the analysis of Italian EU habitats. In: Dengler J, Chytrý M, Ewald J, Finckh M, Jansen F, Lopez-Gonzalez G, et al., editors. Vegetation databases for the 21st century. Biodivers Ecol. 4: 191–200.

R Core Team. 2012. R: A language and environment for statistical computing. Vienna, Austria: R Foundation for Statistical Computing. Available: www.R-project.org. Accessed Sep 2012 4.

Raimondo FM, Spadaro V. 2008. A new species of *Centaurea* (*Asteraceae*) from Sicily. Bot J Linn Soc 157(4): 785–788.

Rodwell JS. 1991–1995. British plant communities. Vols. 1–4. Cambridge: Cambridge University Press.

Rosati L, Filibeck G, De Lorenzis A, Lattanzi E, Surbera S, Fascetti S, et al. 2010. La vegetazione Forestale dei Monti Alburni, Parco Nazionale del Cilento e Vallo di Diano: analisi fitosociologia e significato fitogeografico. Fitosociologia 47(2): 17–55.

Scarnati L, Attorre F, De Sanctis M, Farcomeni A, Francesconi F, Mancini M, et al. 2009a. A multiple approach for the evaluation of the spatial distribution and dynamics of a forest habitat: The case of Apennine beech forests with *Taxus baccata* and *Ilex aquifolium*. Biodivers Conserv 18: 3099–3113.

Scarnati L, Attorre F, Farcomeni A, Francesconi F, De Sanctis M. 2009b. Modelling the spatial distribution of tree species with fragmented populations from abundance data. Community Ecol 10: 215–224.

Schaminée JHJ, Hennekens SM. 1995. Update of the installation of Turboveg in Europe. Ann Bot (Roma) 53: 159–161.

Schaminée JHJ, Hennekens SM, Chytrý M, Rodwell JS. 2009. Vegetation-plot data and databases in Europe: An overview. Preslia 81: 173–185.

Schaminée JHJ, Janssen AM, Hennekens SM, Ozinga WA. 2011. Large vegetation databases and information systems: New instruments for ecological research, nature conservation, and policy making. Plant Biosyst 145(Suppl. 1): 85–90.

Schaminée JHJ, Stortelder AHF. 1996. Recent developments in phytosociology. Acta Bot Neerl 45: 443–459.

Schaminée JHJ, Westhoff V. 1992. The national vegetation survey of the Netherlands. Ann Bot (Roma) 50: 125–130.

Tichý L. 2002. JUICE, software for vegetation classification. J Veg Sci 13: 451–453.

Tichý L, Chytrý M, Hennekens SM, Schamineé JHJ, Thébaud G, Roux C. 2012. Analysis of constancy columns in large-scale vegetation survey: Possible solutions. 21st EVS Workshop, 24–27 May 2012, Vienna, Austria.

Troia A, Raimondo FM, Castellano G, Spadaro V. 2012. Morphological, karyological and taxonomic remarks on *Ferulago nodosa* (L.) Boiss. (Apiaceae). Plant Biosyst 146: S328–S335.

Valachovič M. 1995–2001. Rastlinné spoločenstvá Slovenska. Vols. 1–3. Bratislava: Veda.

van der Maarel E. 1979. Transformation of cover-abundance values in phytosociology and its effects on community similarity. Vegetatio 39: 97–114.

Venanzoni R, Ballelli S, Bonini I, Lucarini D, Panfili E, Pesciaioli P. 2003. An archive for botanical data based on open source software. 46th Symposium of the International Association of Vegetation Science ''Water resources and vegetation'', 8–14 June 2003, Napoli. Abstracts: 234. Camerino: Università di Camerino.

Venanzoni R, Landucci F, Panfili E, Gigante D. 2012. Toward an Italian national vegetation database: VegItaly. In: Dengler J, Chytrý M, Ewald J, Finckh M, Jansen F, Lopez-Gonzalez G, et al., editors. Vegetation databases for the 21st century. Biodivers Ecol. 4: 185–190.

Venanzoni R, Panfili E. 2010. Proposta per una banca dati nazionale di rilievi fitosociologici (Proposal for a national phytosociological data bank). 46° Congresso SISV ''Countdown 2010 Save Biodiversity – Il contributo della scienza della vegetazione'', 17–19 febbraio 2010, Pavia. Abstract Book: 11.

Westhoff V, van der Maarel E. 1973. The Braun-Blanquet approach. In: Whittaker RH, editor. Ordination and classification of vegetation. The Hague: Dr. W. Junk. pp 617–726.

Wilson JB. 2012. Species presence/absence sometimes represents a plant community as well as species abundances do, or better. J Veg Sci. DOI: 10.1111/j.1654-1103.2012.01430.x.

Wiser SK, Spencer N, De Caceres M, Kleikamp M, Boyle B, Peet RK. 2011. Veg-X – an international exchange standard for plot-based vegetation data. J Veg Sci 22: 598–609.

Wohlgemuth T. 1992. Die vegetationskundliche Datenbank. Schweiz Z Forstwes 143: 22–36.