VEGETATION CLASSIFICATION AND SURVEY

International Association for Vegetation Science (IAVS)

Vegetation Classification and Survey 4: 285–290
doi: 10.3897/VCS.101648

FORUM PAPER

Syntaxonomic ranks, biogeography and typological inflation

Javier Loidi[1]

1 *Department of Plant Biology and Ecology, University of the Basque Country (UPV/EHU), Bilbao, Spain*

Corresponding author: Javier Loidi (javier.loidi@ehu.eus)

Academic editor: Arkadiusz Nowak ♦ **Linguistic editor:** Stephen Bell
Received 8 February 2023 ♦ **Accepted** 8 October 2023 ♦ **Published** 24 November 2023

Abstract

To reduce the typological inflation observed in some territories where intensive phytosociological studies have been carried out and numerous descriptive papers have been published, an outline of the biogeographical amplitude of the different syntaxonomic ranks is proposed. Phytosociological classes are divided into five main vegetation clusters: 1. Zonal vegetation, determined mainly by climatic conditions; 2. Azonal coastal and saline vegetation; 3. Azonal rocky vegetation; 4. Azonal wetland and aquatic vegetation; 5. Highly disturbed anthropogenic vegetation. In each of these, the various ranks (class, order, alliance, association and subassociation) have a particular range which is expressed by the biogeographical territory in which they most likely occur. This area can refer to different respective categories: kingdom, region, province, sector and district. Some additional comments about typological inflation are made in order to focus on two phenomena: desire for fame and geographic drift.

Keywords

alliance, association, biogeographical territories, class, desire for fame, order, subassociation, typological inflation

Introduction

After an entire century of the Braun-Blanquet approach being applied to classify vegetation in several regions of the world, most intensely in Europe, it is interesting to reflect on the patterns of territorial scope in the geographic distribution of the different syntaxonomic units in order to unify criteria for their description and acceptance. In relation to this, it is convenient to highlight some observable negative aspects in the practice of describing new syntaxa lacking unified criteria. Several improvements in the application of this approach have recently been introduced (Guarino et al. 2018) and extensive information on the history and epistemology of their development has been provided. In order to avoid repetition in any of the concepts and arguments presented, the aim of this work is to refer to some specific points in order to help researchers in their decision-making and promote more consistent description of new units. The comments only concern units regulated by the International Code of Phytosociological Nomenclature (ICPN; Theurillat et al. 2021).

It is important not to forget that the application of Braun-Blanquet's floristic-ecological approach requires a high level of knowledge of the surveyed region's flora, which has delayed its expansion in countries outside Europe and other areas where floristic knowledge is insufficient. However, the high diagnostic value of the described units, based on their intrinsic compositional content, make it an unrivalled approach as it is based on an essential attribute of the plant community. It is also invaluable in the assessment of biodiversity and in designing accurate and scientifically sound conservation policies. In addition, a hierarchical typology (syntaxonomy) allows the use of best-fit unit ranks for different levels of territorial division.

It is essential to retain rigorous criteria in defining and describing syntaxa, which must correspond to a clear systematic arrangement. Therefore, researchers should strictly follow the criteria and definitions of the system's founders and consider some suggested biogeographical indications. The basic conceptions on syantaxa have been extracted from the classic literature describing this topic, i.e. Braun-Blanquet (1928/1932), Braun-Blanquet and Pavillard (1928), Westhoff and van der Maarel (1978), Géhu and Rivas-Martínez (1981) and Dierschke (1994). Recently, some authors have contributed to the development of these concepts and updated others (Pignatti et al. 1995; Willner 2006, 2020; Loidi 2020).

The development of the Braun-Blanquet approach, mainly in Europe, but also in other parts of the world, has produced an enormous accumulation of information, which is now stored in large datasets, opening the way to highly efficient data management and analysis (Chytrý et al. 2016; Bruelheide et al. 2019). In addition, the production of a substantial amount of formally described syntaxa has taken place in recent decades. This is particularly observed in some regions that have been intensively surveyed by phytosociological studies, such as parts of Europe and the Mediterranean area, in which a certain "saturation" of described units can be observed (Mucina et al. 2016; Rivas-Martínez et al. 2001a). Theurillat (2000) summarized the typification of names recorded between 1987 and 1995 through a series of publications by Theurillat & Moravec. A total of 5066 new names were coined for the world, with the largest representation in the above mentioned areas. I believe that this increase in the number of described syntaxa, concentrated in certain areas over relatively short research periods, deserve some reflection.

The typological inflation

Some time ago, the phenomenon of intense publication of new units, often in local studies, was termed "typological inflation" by Pignatti (1968) and was discussed in the 1963 symposium of IVV (Internationale Vereinigung für Vegetationskunde, today's IAVS) in Stolzenau. The inflation affected various phytosociological ranks, but comments were provided mostly about the higher ones. Several recommendations were made to control this phenomenon, essentially calling for international collaboration and the development of a European Prodromus of the vegetation of the whole continent (almost fifty years later accomplished by Mucina et al. 2016). As part of this discussion, Tüxen (1967) addressed this issue by dividing vegetation studies into three categories: (1) local, (2) regional and (3) global or encompassing the highest rank units. He suggested that only well documented general surveys with a wide scope should propose formal new syntaxa. The studies on levels 1 and 2 should refrain from doing that, as they cannot have a general view of the high rank syntaxonomic units.

It has become clear that these recommendations were not optimally followed, and the description of new syntaxa has not been controlled by objective and universal criteria. This was the case both in many descriptive local surveys and in some of the checklists summarizing the plant communities of certain regions. Unfortunately, this tendency still continues in some regions, leading to the humorous note that *more associations than species* have been described.

Since phytosociology seeks to establish a universal typology of plant communities, it is necessary to respect homogeneity of the criteria when describing new syntaxa, as was recommended by Tüxen (1967). Any syntaxon, and specifically the association, must have a defined and clear characteristic in the following aspects: floristic, statistical, ecological, dynamic, biogeographical (chorological) and historical (Géhu and Rivas-Martínez 1981).

Two main reasons can be highlighted for this inflationary trend:

Desire for fame. Authors who describe a new syntaxon are "rewarded" with the authorship of the described unit at the end of its name, giving satisfaction to a certain vanity, which is not a rare feeling among scientists (Pignatti 1968; Mucina 1997). The ICPN (Theurillat et al. 2021) recommends (Rec. 46A) that the "name of each syntaxon should be accompanied by the author citation" at least once in every publication. However, avoiding repeated citing of the authorship of syntaxa could be a remedy of the appetite for describing new units. Citing it only once in each paper, as a way of presenting the original description (protologue) and the typus of each syntaxon, must be sufficient.

Geographic drift. This phenomenon could also explain a part of the inflation. Within the geographic range of an association, there may be subareas in which particular taxa occur that are absent in others. If these plants are forming distinct species combination of the syntaxon, there is the possibility to describe a local subassociation or even a new association separated from the original one. However, these geographically distinct taxa might have the optimum of occurrence in other vegetation types and appear only as companions in our surveyed sub- or association. It is the case of using stenochorous species of the seral stages, scrub or grassland communities, as differential species of a new forest association. One example of this could be the recently published forest association *Glandoro diffusae-Quercetum fagineae* (Cantoral et al. 2023) in which a typical scrub species, *Glandora diffusa*, is used to characterize a new local association. Moreover, there are even cases in which climatic variability has been used as an argument to create new associations. As Guarino et al. (2018) indicate, "*In some schools, such as the Latin one, secondary attributes of vegetation, such as climate, biogeography or successional position have been profusely used, sometimes to the extent of overcoming the primary attribute of the floristic composition*." Therefore, to avoid flaws such as these, distinguishing an association or alliance must be based on taxa which provide a good diagnosis of the vegetation type concerned. For instance, to accept a new forest association, it must be based on a unique combination of typical forest species. Defining a syntaxon based on some accompanying taxa, maybe of endemic or local distribution, but typical for other vegetation types (scrub or grassland) occurring in a certain part of the association's range, should be avoided. These accompanying taxa should be considered as having a lower diagnostic value to coin the new syntaxon and should not be used for their characterization.

For the coherence of the hierarchical system that describes the vegetation of a given territory, we should seek for a broad consensus on the conditions that the units of different rank must meet in order to be accepted by the scientific community. The criteria set out in the aforementioned literature should dominate this process, avoiding the unnecessary description of units outside the orthodoxy of the method. To reinforce these criteria, some indications are given about the biogeographical arguments that should be considered. This additional biogeographical perspective aims to achieve a homogeneity in the criteria for establishing and accepting new units.

Principal syntaxonomic ranks and their biogeographical range

In Table 1, the biogeographical range of the syntaxonomic ranks of the main European vegetation types is summarized.

The main biogeographical units considered here are as follows: Kingdom, Region, Province, Sector and District. Subordinate units such as Subkingdom, Subregion, Subprovince, Subsector and Subdistrict may be considered, too. They have been established based on their floristic (Mattick 1964; Meusel et al. 1965–1992; Good 1974; Takhtajan 1986; Rivas-Martínez et al. 2001b, 2017; Cox et al. 2016) and vegetation (Braun-Blanquet 1922, 1951; Loidi 2021) content.

Table 1. Scheme of the approximate biogeographic amplitude of the syntaxonomic ranks within each vegetation type in the western European vegetation (Rivas-Martínez et al. 2001a; Mucina et al. 2016).

		Biogeographic rank					
Syntaxonomic rank	**Vegetation types**	**District**	**Sector**	**Province**	**Region**	**Kingdom**	**Subcosmopolitan**
subassociation	1. zonal	xx	xx				
	2. Azonal coastal saline	xx	xx				
	3. Azonal rocky	xx	xx				
	4. Azonal wetland		xx				
	5. Disturbed		xx				
Association	1. Zonal		xx				
	2. Azonal coastal saline			xx			
	3. Azonal rocky	xx	xx				
	4. Azonal wetland			xx	xx		
	5. Disturbed			xx			
Alliance	1. Zonal			xx	xx		
	2. Azonal coastal saline				xx		
	3. Azonal rocky			xx			
	4. Azonal wetland				xx		
	5. Disturbed				xx		
Order	1. Zonal				xx		
	2. Azonal coastal saline				xx	xx	
	3. Azonal rocky			xx	xx		
	4. Azonal wetland					xx	
	5. Disturbed					xx	
Class	1. Zonal				xx	xx	
	2. Azonal coastal saline					xx	xx
	3. Azonal rocky				xx	xx	
	4. Azonal wetland					xx	xx
	5. Disturbed					xx	xx

The categories for the vegetation types are:

1. Zonal vegetation: Determined mainly by climatic conditions.

1a. Potential vegetation and associated units: natural climatic forests, woodlands and grasslands, woody and herbaceous forest mantles. *Carici rupestris-Kobresietea bellardii*, *Crataego-Prunetea*, *Cytisetea scopario-striati*, *Elyno-Seslerietea*, *Festucetea indigestae*, *Juncetea trifidi*, *Junipero-Pinetea*, *Nardetea strictae*, *Quercetea ilicis*, *Querco-Fagetea*, *Salicetea herbaceae*, *Trifolio-Geranietea sanguinei*, *Vaccinio-Piceetea*.

1b. Mainly seral vegetation: scrub and grasslands. *Calluno-Ulicetea*, *Cisto-Lavanduletea*, *Festuco-Brometea*, *Festuco hystricis-Ononidetea striati*, *Koelerio-Corynephoretea*, *Lygeo-Stipetea tenacissimae*, *Molinio-Arrhenatheretea*, *Mulgedio-Aconitetea*, *Ononido-Rosmarinetea*, *Sedo-Scleranthetea*, *Stipo giganteae-Agrostietea castellanae*.

2. Azonal coastal and saline vegetation. *Ammophiletea*, *Cakiletea*, *Crithmo-Staticetea*, *Helichryso-Crucianelletea*, *Juncetea maritimi*, *Ruppietea maritimae*, *Saginetea maritimi*, *Salicornietea fruticosae*, *Spartinetea maritimae*, *Therosalicornietea*, *Zosteretea*.

3. Azonal rocky vegetation. *Adiantetea*, *Asplenietea trichomanis*, *Cymbalario-Parietarietea*, *Phagnalo saxatilis-Rumicetea indurati*, *Polypodietea*, *Thlaspietea rotundifolii*.

4. Azonal wetland and aquatic vegetation. *Alnetea glutinosae*, *Nerio-Tamaricetea*, *Bidentetea*, *Isoëto-Nanojuncetea*, *Lemnetea*, *Littorelletea uniflorae*, *Montio-Cardaminetea*, *Oxycocco-Sphagnetea*, *Phragmito-Magnocaricetea*, *Potamogetonetea*, *Salicetea purpureae*, *Scheuchzerio palustris-Caricetea fuscae*.

5. Highly disturbed anthropogenic vegetation. *Artemisietea vulgaris*, *Epilobietea angustifolii*, *Helianthemetea guttati*, *Pegano-Salsoletea vermiculatae*, *Poetea bulbosae*, *Polygono-Poetea annuae*, *Stellarietea mediae*.

Association

The association is the fundamental unit of the system, similar to the species in botanical systematics. It is recognised by the characteristic species combination (*charakteristische Artenkombination*) and mainly by its characteristic species, as stated by Flahault and Schröter (1910), Braun-Blanquet (1928) and Braun-Blanquet and Pavillard (1928). The *definite* species combination is defined as the group of species more or less constant in the average association individuals (i.e., its typical relevés). These authors also noted the diagnostic value of the differential taxa for distinguishing species-poor associations. Accepting the "characteristic species combination" concept entails the possibility that none of the involved taxa are character species in a strict sense, but rather the typical combination of occurring taxa is the essential diagnostic 'character' of the unit (Westhoff and van der Maarel 1978; Willner 2006).

Each association must correspond to a habitat type occupying a well-defined biotope in a clearly defined territory (biogeography). Its characteristic species combination should be restricted to the plants that essentially constitute the community, overlooking, for diagnostic purposes, plants originating from other vegetation types occurring in the vicinity and entering the plot as companions. Elements not belonging to the considered vegetation type (e.g., deciduous wood in relation to fringe vegetation or grasslands) should not be considered good diagnostic taxa.

In the last decades, most of the described and accepted associations , mainly in Europe, are based on the characteristic species combination, rarely on characteristic taxa (Westhof and van der Maarel 1978; Willner 2006). Proposals from the mid-20th century to use geographical races, distinguishing between local, regional and general association (Oberdorfer 1968), have not been followed. This has resulted in the description of many associations of narrow geographical distribution in areas with intense phytosociological activity. The more associations are described in a particular territory, the fewer characteristic taxa will be available for future new syntaxa in the same region, and the diagnostic value of the new species combinations will be lower. Should the concept of geographical race be restored? What is then the real meaning and role of associations in the phytosociological approach?

Looking at the concepts posed by the above mentioned authors, the association has to have a combination of species which repeats across its range as well as a defined set of ecological requirements. Its area of occurrence is determined by the habitat type it describes, usually a moderate extent in the case of zonal vegetation. Climatically delimited forests, shrublands, scrub, crevices, and scree associations have often a narrow distribution, often a biogeographical sector or subprovince (e.g., associations within *Quercetea ilicis*: *Lauro nobilis-Quercetum ilicis* – eastern Cantabrian: Santanderian Biscayan district; *Querco-Fagetea*: *Pteridio aquilini-Quercetum pubescentis* – Eastern Pyrenees: eastern Pyrenean subsector; *Ononido-Rosmarinetea*: *Erico multiflorae-Lavanduletum dentatae* – South Valencia: Setabense sector). Some other vegetation types which harbour many endemics can have even narrower ranges such as the district or the sector (*Asplenietea trichomanis*: *Centrantho lecoquii-Saxifragetum canaliculatae* – Orocantabrian: Picoeuropean sector; *Thlaspietea rotundifolii*: *Rumici scutati-Aquilegietum cazorlensis* – Cazorla range: Subbetic sector; etc.). A much wider distribution, often a province, corresponds to disturbed vegetation, such as intensely grazed grasslands, nitrophilous vegetation or weed communities (associations of *Molinio-Arrhenatheretea*: *Malvo moschatae-Arrhenatheretum bulbosi*, *Galio-Urticetea*: *Aegopodio-Menthetum longifoliae*, etc.). Similarly, vegetation types associated with water, such as fens, have a large distribution, usually a province or region (associations of *Phragmito-Magnocaricetea*: *Typhetum angustifoliae*, *Potametea*: *Nupharetum pumilae*, etc.). This is proportional to the abundance of stenochorous taxa in each of the environments concerned. The Mediterranean scrubs, cliffs and screes are rich in endemics, while aquatic habitats and severely disturbed anthropic communities rarely host such species. This is likely related to the isolation phenomena, the ancestors of the former floristic groups experienced in their evolutionary history, combined with their poor dispersal abilities.

The **subassociation** is comparable to the subspecies and it is also defined by a species combination and distinguished only by differential species. There can be geographic and ecological (transitional) subassociations. Their range can correspond to a district or sector.

Alliance

The associations having evident floristic-ecological affinities and occupying similar habitats in neighbouring territories form an alliance. As a broader unit than association, alliances have an evolutionary and biogeographical meaning as they have characteristic species (at least one) (Willner 2020). For instance, the *Quercion roboris* comprises acidophilous oak forest associations in temperate Europe. Alliances have a broader distribution, often a province in the case of zonal vegetation, and a region in other types.

Order

The order gathers similar alliances and has a broader scope in terms of ecology and area. It has a higher number of characteristic taxa than the alliances. For instance, the order *Fagetalia* gathers several alliances of deciduous temperate forests in Europe. The distribution of an order is broader, often a province or group of provinces (region), or even a kingdom in coastal vegetation. It may be considered that the criteria for defining an order are similar to those for the class (Pignatti et al. 1995). For instance, the orders *Fagetalia* or *Arabidetalia caeruleae* expand across the Eurosiberian region.

Class

It is the supreme rank of the system that gathers one or several orders, characterised by a set of characteristic plant taxa. In the European tradition, there is an implicit consensus to maintain the traditional class typology as far as reasonably possible. Thus, general vegetation studies are quite conservative on this point (Theurillat et al. 1995; Rivas-Martínez et al. 2001a; Willner and Grabherr 2007; Costa et al. 2012; Mucina et al. 2016; Chytrý et al. 2017). Its geographic distribution is large, usually the region or group of regions (kingdom) in the case of zonal vegetation. Examples include the *Vaccinio-Piceetea*, *Quercetea ilicis*, *Querco-Fagetea*, *Cisto-Lavanduletea* and *Festuco-Brometea* for the Holarctic kingdom. For azonal wet and disturbed anthropic vegetation types, classes can expand to several kingdoms (subcosmopolitan) as in the case of *Phragmito-Magnocaricetea*, *Potametea*, *Polygono-Poetea annuae*, *Stellarietea mediae* or *Oryzetea sativae*.

The class is the most controversial unit of synsystematics, and several contributions have tried to clarify what a phytosociological class is (Pignatti et al. 1995; Guarino et al. 2018; Loidi 2020). As the highest floristic unit of the vegetation hierarchical system, units above the class could only be distinguished by non-floristic criteria, e.g. on the basis of a physiognomic approach or analysis of life forms, and they would not necessarily be characterised by any diagnostic species. Nevertheless, these non-floristic approaches have been progressively considered over the last decades (Guarino et al. 2018). Furthermore, the class has a certain biogeographical-evolutionary meaning (Guarino et al. 2018), as its core species set (characteristics of the class and its subordinate units) would result from a unitary speciation process (Pignatti et al. 1995). The set of species characterising a class have likely originated in a specific evolutionary episode that took place in a particular geographical area and under particular environmental conditions. It is hypothesised as a sort of "community of origin" and a "cohabitation along a certain period of the evolutionary history" in the characteristic flora of the class (Loidi 2020). This concept gives the class a profound evolutionary meaning.

Conclusion

The problem of inflation in syntaxonomy comes from an often narrow perspective that does not take biogeographical context into account when describing new vegetation types. This is particularly important in areas which have had intensive surveys over a long period of time. Sometimes, this excessive numerosity of defined syntaxa is a reflection of rash and ill-considered decisions or a lack of comparative phytosociological data. It is therefore important for future phytosociological studies, besides maintaining excellent research standards and high quality data sampling and management, to provide not only a reliable and accurate species composition and ecology when defining new vegetation units, but also to take into account the biogeographical aspects of the newly defined syntaxa.

References

Braun-Blanquet J (1922) L'origine et le développement des flores dans le Massif central de France avec aperçu sur les migrations des Flores dans l'Europe sud-occidentale. Publications de la Société Linnéenne de Lyon 68: 113–143. https://doi.org/10.3406/linly.1922.14600

Braun-Blanquet J (1928) Pflanzensoziologie. Grundzüge der Vegetationskunde. Berlin, DE, 330 pp. https://doi.org/10.1007/978-3-662-02056-2

Braun-Blanquet J (1932) Plant Sociology. The study of plant communities. McGraw-Hill Book Co., Inc., New York and London, US-UK, 439 pp.

Braun-Blanquet J, Pavillard J (1928) Vocabulaire de sociologie végétale. 3rd ed. Roumégous et Déban, Montpellier, FR, 23 pp.

Bruelheide H, Dengler J, Jiménez-Alfaro B, Purschke O, Hennekens SM, Chytrý M, Pillar VD, Jansen F, Kattge J, … Zverev A (2019) sPlot – A new tool for global vegetation analyses. Journal of Vegetation Science 30: 161–186. https://doi.org/10.1111/jvs.12710

Cantoral AL, Alonso Redondo R, García-González ME, Penas A, del Río S (2023) Phytosociological analysis of the endemic *Quercus faginea* forests of the Iberian Peninsula. Plant Biosystems 157: 419–436. https://doi.org/10.1080/11263504.2023.2165554

Dierschke H (1994) Pflanzensoziologie. Ulmer Verlag, Stuttgart, DE, 683 pp.

Chytrý M, Danihelka J, Kaplan Z, Pyšek P (eds) (2017) Flora and vegetation of the Czech Republic. Plant and Vegetation Vol. 14. Springer, Cham, CH, 466 pp. https://doi.org/10.1007/978-3-319-63181-3

Chytrý M, Hennekens SM, Jiménez-Alfaro B, Knollová I, Dengler J, Jansen F, Landucci F, Schaminée JHJ, Aćić S, … Yamalov S (2016) European Vegetation Archive (EVA): an integrated database of European vegetation plots. Applied Vegetation Science 19: 173–180. https://doi.org/10.1111/avsc.12191

Costa JC, Neto C, Aguiar C, Capelo J, Espirito-Santo MD, Honrado J (2012) Vascular plant communities in Portugal (Continental, the Azores and Madeira). Global Geobotany 2: 1–180.

Cox CB, Moore PD, Ladle RJ (2016) Biogeography. An ecological and evolutionary approach. 9th edition. Wiley Blackwell, Oxford, UK, 482 pp.

Flahault C, Schröter C (1910) Rapport sur la nomenclature phytogéographique. In: Wildeman E de (ed.) Actes du III me. Congrès International de Botanique, Bruxelles 1910. I. Compte-rendus des séances, excursions, etc. De Boeck, Bruxelles, BE, pp. 131–142.

Géhu J-M, Rivas-Martínez S (1981) Notions fondamentales de Phytosociologie. In: Dierschke H (ed.) Syntaxonomie [Berichte der Internationalen Symposien der Internationalen Vereinigung für Vegetationskunde 1980]. Cramer, Vaduz, LI, 5–33.

Good R (1974) The geography of the flowering plants. Longman, London, UK, 557 pp.

Guarino R, Willner W, Pignatti S, Attore F, Loidi J (2018) Spatio-temporal variations in the application of the Braun-Blanquet approach in Europe. Phytocoenologia 48: 239–250. https://doi.org/10.1127/phyto/2017/0181

Loidi J (2020) The concept of vegetation class in phytosociological syntaxonomy. Vegetation Classification and Survey 1: 163–167. https://doi.org/10.3897/VCS/2020/59977

Loidi J (2021) Mapping of biogeographical territories: flora, vegetation and landscape criteria. In: Pedrotti F, Box EO (eds) Tools for Landscape-Scale Geobotany and Conservation. Geobotany Studies. Springer, Cham, CH, 21–36. https://doi.org/10.1007/978-3-030-74950-7_3

Mattick F (1964) Übersicht über die Florenreiche und Florengebiete der Erde. In: A. Engler's Syllabus der Pflanzenfamilien. 12 ed. vol. 2. Angiospermen (Ed. by H. Melchior), Gebrüder Borntraeger, Berlin, DE, 626–629.

Meusel H, Jäger EJ, Weinert E, Rauschert S (1965–1992) Vergleichende Chorologie der zentraleuropäischen Flora I–III. Gustav Fischer, Jena, DE.

Mucina L (1997) Quo vadis Code of Phytosociological Nomenclature? Folia Geobotanica et Phytotaxonomica 32: 395–400. https://doi.org/10.1007/BF02821945

Mucina L, Bültmann H, Dierßen K, Theurillat JP, Raus T, Čarni A, Šumberová K, Willner W, Dengler J, … Tichý L (2016) Vegetation of Europe: hierarchical floristic classification system of vascular plant, bryophyte, lichen, and algal communities. Applied Vegetation Science 19(suppl. 1): 3–264. https://doi.org/10.1111/avsc.12257

Oberdorfer E (1968) Assoziation, Gebietsassoziation, Geographische Rasse. In: Tüxen R (ed.) Pflanzensoziologisch Systematik. [Berichte der Internationalen Symposien der Internationalen Vereinigung für Vegetationskunde 1964]. Junk, Den Haag, NL, 124–131.

Pignatti S (1968) Die Inflation der höheren pflanzensoziologischen Einheiten. In: Tüxen R (ed.) Pflanzensoziologische Systematik. [Berichte der Internationalen Symposien der Internationalen Vereinigung für Vegetationskunde 1964]. Junk, Den Haag, NL, 85–97.

Pignatti S, Oberdorfer E, Schaminée JHJ, Westhoff V (1995) On the concept of vegetation class in phytosociology. Journal of Vegetation Science 6: 143–152. https://doi.org/10.2307/3236265

Rivas-Martínez S, Fernández-González F, Loidi J, Penas A, Lousã M (2001a) Syntaxonomical checklist of the vascular plant communities of Spain and Portugal to association level. Itinera Geobotanica 14: 5–341.

Rivas-Martínez S, Penas A, Díaz TE (2001b) Biogeographic map of Europe. Cartographic Service. University of León, León, ES.

Rivas-Martínez S, Penas A, Díaz TE, Cantó P, del Río S, Costa JC, Herrero L, Molero M (2017) Biogeographic units of the Iberian Peninsula and Balearic Islands to district level. A concise Synopsis. In: Loidi J (ed.) The vegetation of the Iberian Peninsula. Vol. 1. Springer, Cham, CH, 131–188. https://doi.org/10.1007/978-3-319-54784-8_5

Takhtajan A (1986) Floristic regions of the world. University of California Press, Berkeley, US, 522 pp.

Theurillat J-P (2000) Eight years of indexing new names and typification of syntaxa. Colloques Phytosociologiques 27: 883–896.

Theurillat J-P, Aeschimann, D, Küpfer P, Spichiger R (1995) The higher vegetation units of the Alps. Colloques Phytosociologiques 23: 189–239.

Theurillat J-P, Willner W, Fernández-González F, Bültmann H, Čarni A, Gigante D, Mucina L, Weber H (2021) International Code of Phytosociological Nomenclature. 4th edition. Applied Vegetation Science 24: e12491. https://doi.org/10.1111/avsc.12491

Tüxen R (1967) Die Lage der pflanzensoziologischen Systematik. Mitteilungen der Floristisch-soziologischen Arbeitsgemeinschaft N. F. 11–12: 201–202.

Westhoff V, van der Maarel E (1978) The Braun-Blanquet approach. In: Whittaker RH (ed.) Classification of Plant Communities, 2nd ed. Junk, The Hage, NL, 287–399. https://doi.org/10.1007/978-94-009-9183-5_9

Willner W (2006) The association concept revisited. Phytocoenologia 36: 67–76. https://doi.org/10.1127/0340-269X/2006/0036-0067

Willner W (2020) What is an alliance? Vegetation Classification and Survey 1: 139–144. https://doi.org/10.3897/VCS/2020/56372

Willner W, Grabherr G (eds) (2007) Die Wälder und Gebüsche Österreichs. Ein Bestimmungswerk mit Tabellen. Spektrum Akademischer Verlag, Heidelberg, DE.

E-mail and ORCID

Javier Loidi (Corresponding author, javier.loidi@ehu.eus), ORCID: https://orcid.org/0000-0003-3163-2409