NEW IDEAS FOR MODERN PHYTOSOCIOLOGICAL MONOGRAPHS

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ABSTRACT - Within the framework of the project 'Plant communities of Mecklenburg-Vorpommern and their vulnerability' a team of 22 vegetation scientists, including the authors of the present paper, developed a current synopsis of all syntaxa known from this federal state in NE Germany. This synopsis is based on the classification of more than 50,000 relevés stored in a TURBOVEG database. It was recently published in a two-volume monograph. In the present paper, we present major aspects of the approaches used in the monograph and discuss the experiences gained with them. We also provide an overview of the 12 axiomatic rules that form the classification approach in the monograph; review the application of the central syntaxon concept and its advantages and drawbacks; and examine the importance of nomenclaturally reviewing all syntaxon names, including older synonyms. We furthermore provide an overview of our transparent methodology for assessing plant communities according to their vulnerability and conservation value. Finally, we take stock of what was learned from the project and provide an overview of future tasks.

KEYWORDS - Classification approach, Mecklenburg-Vorpommern, nature conservation, Red Data Book of plant communities, syntaxonomy, vegetation database.

INTRODUCTION

The project 'Plant communities of Mecklenburg-Vorpommern and their vulnerability' (Berg, Dengler & Abdank, 2001b; Berg, Dengler, Abdank & Isermann, 2004) had two major targets: (i) to provide a state-of-the-art overview of all vegetation types in its territory that are dominated by vascular plants; and (ii) to give a detailed assessment of these types for conservation purposes. The research area was the federal state of Mecklenburg-Vorpommern (also known as Mecklenburg-West Pomerania), situated in the northeastern German lowlands and covering 23,171 km^2.

Since the beginning of the 1990s, numerous comprehensive overviews of the vegetation types of countries and other large areas have been published in Europe (cf. Rodwell, Schaminée, Mucina, Pignatti, Dring & Moss, 2002). However, most of these are more or less compilations of names of syntaxa described from a certain territory, sometimes accompanied by short descriptions and rarely by synoptic tables. Despite the fact that powerful hardware and software are widely available, only two of these national overviews are based on the evaluation of relevés stored in an broad-based vegetation database (Britain: Rodwell, 1991-2000; Netherlands: Schaminée, Stortelder & Westhoff, 1995a; Schaminée, Weeda & Westhoff, 1995b; Schaminée, Stortelder & Weeda, 1996; Schaminée, Weeda & Westhoff, 1998; Stortelder, Schaminée & Hommel, 1999). As regards the nomenclature of syntaxa, only two comprehensive attempts have so far been made to establish the correct names (Mucina, Grabherr & Ellmauer, 1993a; Grabherr & Mucina, 1993; Mucina, Grabherr & Wallnöfer, 1993b for the syntaxa of Austria; Mucina, 1997 for the vegetation classes of Europe). Another development in addition to the creation of regional and national overviews is the increasing number of red lists that have been produced in recent years that deal not solely with species and habitats, as usual, but with plant communities (see overview by Köppel, 2002). These have often simply applied methodologies of conservation assessments developed for species. However, this is problematic since taxa and syntaxa are completely different categories. For example, a value of their own or even a 'right of existence' can only be assigned to species but not to syntaxa.

In our project, we tried to solve the above-mentioned problems and avoid the shortcomings of many of the previous phytosociological overviews. Specifically:

- the classification was based on a large vegetation database;
- it was carried out using a consistent and explicitly documented methodology;
- the Nomenclature Rules were carefully applied throughout;
- the plant communities were evaluated for conservation purposes with a comprehensive and transparent approach.

We thus pursued several new approaches both in our methodology and in the presentation of the data. The present paper aims to highlight major points of these approaches and make our experiences available to an international audience.

Outline of the Project

The project was started in 1992 with the collection of all available sources of relevés (publications, theses, expert reports, unpublished relevés; see Berg, 1993) and the input of these relevés into a database by technical staff. The major work was conducted in the years 1998-2004 by a team of 22 vegetation scientists and financially supported by the State Agency for Environment, Nature Conservation and Geology of Mecklenburg-Vorpommern.

The results were published in two volumes. The first volume (Berg *et al.*, 2001b) includes the synoptic tables of syntaxa above the rank of association. The second volume (Berg *et al.*, 2004) contains accompanying text including introductory chapters on the project, the research area and the methodology as well as detailed accounts of all syntaxa. It also has a comprehensive English summary with explanatory notes that make much of the information provided in the two volumes accessible to non-German-speaking readers. In addition, a CD-ROM with unabridged versions of all the tables and further information was published in 2004 (available at cost price from bibliothek@lung.mv-regierung.de).

The Vegetation Database

The classification was based on one of the world's largest phytosociological databases (cf. Ewald, 2001), containing more than 50,000 relevés. This includes nearly all the published relevés from the territory of Mecklenburg-Vorpommern as well as many from unpublished theses and reports. Vegetation types lacking character species are also well represented. A total of 42,207 relevés were used for the final table work, omitting only those from outside Mecklenburg-Vorpommern, those published more than once, those considered incomplete or erroneous, those without accurate determinations of the relevant species and those too small in size (≤ 1 m^2) to enable an adequate classification. The relevés were derived from 428 different sources and are relatively evenly distributed over the area of the state, with 80% of its 879 grid cells (ca. 5 km x 5 km) represented by at least one record (Berg & Dengler, 2004). The relevés were databased, stored and managed with the programme TURBOVEG (cf. Hennekens & Schaminée, 2001).

As is typical when using vast amounts of phytosociological data from different sources, we faced various nomenclatural problems concerning the taxa, such as synonyms, different taxonomic concepts and varying levels of taxonomic aggregation. From our experience it seems best if a widely accepted and complete list of taxa (valid names as well as synonyms) is available. For the process of data entry, this large list should be reduced to a subset of names necessary for the particular project. This ensures not only ease of use during the data entry process but also future compatibility with other databases. Such a reference list should preferably be constructed at the European scale.

Phytosociological Methods

Principal considerations

At the beginning of the project, two fundamental requirements were formulated which we aimed to meet with our classification:

- It should be carried out in a uniform manner for all vegetation types according to logical and transparent principles.
- The resulting vegetation units should be applicable for both conservationists and scientists, and they should be compatible, as much as possible, with overviews of plant communities from neighbouring regions.

Since the Braun-Blanquet approach (phytosociology) is the leading method for classifying vegetation in Germany and large parts of Europe, it was clear that this should be followed. However, even Braun-Blanquet (1964) himself did not provide a consistent methodology. His textbook offers alternative solutions for some methodological questions while other important steps of the classification process are not described in an operational, unambiguous manner (for examples see Dengler & Berg, 2002; Dengler, 2003). Since then, numerous more or less diverging methods have been included under the heading of the 'Braun-Blanquet approach', as can be seen for example in the textbook by Dierschke (1994).

We have thus had to develop a concept that puts the Braun-Blanquet approach in unambiguous concrete terms and definitions. Our concept is largely based on the suggestions of Bergmeier, Härdtle, Mierwald, Nowak & Peppler (1990), who made an important effort to 'distil' clear rules out of the Braun-Blanquet approach that should guide the classification process. A second important 'ingredient' is a broadened application of the central syntaxon concept (e.g. Dierschke, 1994: 324). Our approach to classification was published for the first time in Dengler & Berg (2002) and, in a more developed version and with more theoretical background, in Dengler (2003).

Our approach to classification

Twelve axiomatic definitions form the centre of our concept. Their English translations are given here in italics, accompanied by short explanations in normal letters if necessary. Detailed justifications can be found in Dengler & Berg (2002) and Dengler (2003):

Phytocoenosis: *The living plant individuals of all different species growing in a time-space unit of a certain dimension are termed a phytocoenosis if their occurrence is not due to intentional and immediate human action. Phytocoenoses are thus spatio-temporal parts of the vegetation.* - Neither discreteness nor integration is demanded *a priori*. This definition explicitly includes bryophytes, lichens and macro-algae, and also all synusiae thriving in that time-space unit as for example epiphytes. However, in most relevés available to us only terricolous plants were recorded.

Basic syntaxonomic axiom: *Every phytocoenosis belongs to exactly one syntaxon at each rank.* - This means that the syntaxonomic system derived by the classification should be complete, or, in other words, that it must be possible to assign every phytocoenosis of the current vegetation to a certain association, alliance, order and class. We do not believe that the practise of not recording supposedly atypical or fragmentary stands in the field or of eliminating such relevés in the table-work, both of which are still widespread, can be justified theoretically. Such an approach would lead to a syntaxonomic system of little practical relevance because such a classification would not reflect the real situation.

Differential species criterion: *(The term 'species' here and in the following also includes infraspecific taxa). A species meets the differential species criterion in one syntaxon compared with another of the same rank if it has at least twice the percent presence degree there and it can be assumed that this difference is not due to chance*. The classical definition of fidelity degrees by Szafer & Pawlowski

(1927), often referred to in phytosociology, is both contradictory and impractical. The formulation presented here goes back to Bergmeier *et al.* (1990) but uses percent presence degree values instead of presence degree classes, as otherwise there would be unreasonable changes in the minimum requirements for differential species below and above the borders of the presence degree classes.

Presence degree reference value: *Presence degree reference values ('presence degree') of superior syntaxa are calculated as a mean of the presence degree values in all associations belonging to it.* This method of calculation reflects the fact that associations are considered the basic units of the system and prevents the results from being influenced by different study intensities in different associations (the number of relevés available for a certain association rarely corresponds to its actual frequency).

Differential species: *A differential species below the class level must fulfil the differential species criterion against all other syntaxa of the same rank within the syntaxon of the next higher rank. Additionally, the presence degree in the differentiated syntaxon must be at least 10% higher than in the compared syntaxon/a where it must not exceed 20%.* - The latter two constraints aim to avoid two situations: (i) taxa from being named differential species which do not clearly contribute to the demarcation of the syntaxa; and (ii) effects due to chance. Note that in Dengler (2003) 'at least 10% higher' has been altered into 'at least 20 %' (absolutely).

Joint differential species of classes: *A species is called a joint differential species if it fulfils the differential species criterion for two or more classes of a structural type but cannot be regarded as character species for any unit in this structural type.* - For practical reasons we restricted this category to species that 'connect' a maximum of three classes.

Character species: *A species is called character species of a syntaxon if it meets the differential species criterion compared with all other syntaxa of the same rank within the same structural type. Vegetation dominated by phanerophytes, herbaceous vegetation (including dwarf shrubs), and one-layered cryptogam vegetation are discerned as structural types. The above criterion must be fulfilled only within the range of the next higher syntaxon.* - The function of character species is twofold: (i) In the classification process the principal demand for the existence of character taxa creates the benchmark for the approximate equivalence of syntaxa of one rank, which especially holds true for associations. (ii) When a classification is done on the basis of the complete species combination, character species (as those taxa which have a clear sociological optimum in a particular syntaxon) can be used best as a means for recognition and discrimination of the entities. If the next higher syntaxa are nowhere sympatric, an exception to the general rule can be made and one taxon could be named character species in two independent syntaxa. The major reason for restricting the character species to structural types is the dependency of constancy on plot size (Dengler, 2003). Since the customary plot sizes differ widely between different vegetation types (e.g. Dierschke, 1994), which seems to be sensible at least to some extent, it is not acceptable to classify all vegetation types within one 'system'. In our proj-

ect, we could only treat the first two named structural types due to a lack of data on one-layered cryptogam vegetation.

Transgressive character species: *A species is called a transgressive character species of a syntaxon when at the same time it is also a character species of a superior syntaxon.*

Central syntaxon: *Within each superior syntaxon, up to one central syntaxon of the next lower rank can be distinguished that clearly belongs to the first but has no or insufficient character species of its own rank.* - This definition includes both central and marginal syntaxa in the sense of Dierschke (1981; 1994) since these two cases could not be distinguished on the basis of their species composition. Such central syntaxa are named in the same manner as all other syntaxa. As compared to the 'deductive method' developed by Kopecký & Hejný (1974) and other approaches to deal with negatively characterised syntaxa the suggested method has several theoretical and practical advantages. Most important is probably the fact that the present approach avoids naming syntaxa in different ways, which unavoidably gives the impression that there would be an ecological difference, which in fact does not exist.

Syntaxon (general definition): *Each syntaxon of the principal and supplementary ranks from the association upwards either must be sufficiently characterised by character species of its own or be the central syntaxon of the next higher entity.* - 'Sufficiently' in this case means that the presence degree sum of all character species plus half of the constancy sum of the differential species must be at least 100%. In addition, at least one of the character species should reach a minimum of 20% constancy.

Association: *The association is the lowest syntaxon that could be characterised by character species of its own and not divided further in such entities or otherwise it can be regarded as the central syntaxon of a (sub-)alliance.*

Class: *The class is the highest syntaxon well characterised by character species within one structural type.* - To measure the 'quality' of a syntaxon the sum of the presence degree of its character species seems to be appropriate. An adequate classification then would be one in which the presence degree sums of all classes are as high as possible. To demand a common ecological space and chorological homogeneity as additional criteria for phytosociological classes as done by Pignatti, Oberdorfer, Schaminée & Westhoff (1995) would make the definition redundant and seems therefore not to be appropriate. Both features should implicitly result from a carefully performed classification based on purely floristic criteria.

Practical application

The classification was carried out manually, but with extensive computer assistance; a computer programme realising our specific classification approach is not yet available. For example, we used TWINSPAN and other cluster algorithms to generate possible classifications. These were tested as to whether and how well they complied with our principles, and if they did not, were further modified. In that way, the classification was an iterative process with alternating inductive and deductive elements.

The starting point of the classification was the class under which the relevé was originally published. The classification was carried out independently by the authors of the respective class chapters but was subject to the same clear criteria listed above. During the classificatory process, relevés were frequently shifted around between different classes, but a final check was made to ensure that each relevé was only used once. The authors also were only allowed to delete a relevé out of their contingent when another author agreed to use it or when it did not meet the formal quality criteria mentioned above. In large synoptic tables comprising all species and all the syntaxa of a certain rank, we repeatedly tested whether the presumed character species met their criterion, and if they did not, adopted another classification (the final versions of these tables are available on the above-mentioned CD-ROM).

Results of the classification in comparison with other overviews

In our results, we presented a *de novo* classification of the vegetation types dominated by vascular plants that occur in Mecklenburg-Vorpommern. This syntaxonomic system comprises 26 classes of herbaceous and eight classes of woody vegetation subdivided in 12 subclasses, 70 orders, six suborders, 125 alliances and 284 associations. Only a very few vegetation types, such as bramble shrubs and communities of marine macro-algae, could not be represented by tables due to the absence of sufficient data. While some critics argue that the 'Plant communities of Mecklenburg-Vorpommern' has contributed to an 'inflation of higher-ranked syntaxa' (e.g. Dierschke, 2005), our work actually reduced both the numbers of classes and lower ranked units considerably compared with other recent overviews (TABLE 1).

Our classification differs in many respects from other overviews, which is mainly a result of the consistent application of our integrated methodology throughout (e.g. the separate classification of woodland and non-woodland vegetation; the acceptance of up to one 'central' syntaxon within each higher-rankled syntaxon). On the one hand, we were able to support the merging of several existing classes into one. One example is the case with the perennial ruderal communities from anhydromorphic sites (*Artemisietea vulgaris* Lohmeyer *et al. ex* von Rochow 1951), in which we combine the former classes *Artemisietea vulgaris s. str.*, *Galio-Urticetea* Passarge *ex* Kopecký 1969 *p.p.*, *Agropyretea intermedio-repentis* Oberd. *et al. in* T. Müller & Görs 1969 and the herbaceous communities of the *Epilobietea angustifolii* Tx. & Preising *ex* von Rochow 1951. On the other hand, the restriction

TABLE 1 - Number of classes (incl. equivalent entities) and associations (incl. equivalent communities and assigned units/'zugeordnete Einheiten' [ZEH]) in different phytosociological monographs of the North central European lowlands.

Region	Area [km^2]	Source	Classes	Assoc. + Comm.
Mecklenburg-Vorpommern	23,171	Berg *et al.* (2001b; 2004)	34	284
Schleswig-Holstein	15,761	Dierflen *et al.* (1988)	35	338
Saxony-Anhalt	20,447	Schubert (2001)	47	460
Germany: lowlands	ca.150,000	Rennwald (2002)	38	577
Netherlands	33,882	Schaminèe *et al.* (1995b-1998; Stortelder *et al.*1999)	43	372

of the classification to structural types and the central syntaxon concept enabled a stronger subdivision of certain vegetation types, which better reflects the ecological conditions, such as is the case with the moor woodlands. Other major differences are highlighted and discussed in Berg & Dengler (2004). The careful consideration of (at least terricolous) bryophytes, lichens and macro-algae in the classification of all vegetation types resulted in numerous 'new' character and differential species from these groups, especially in classes in which they have until now not been thought to be important, e.g. *Bidentetea* Tx. *et al. ex* von Rochow 1951, *Stellarietea mediae* Tx. *et al. ex* von Rochow 1951 and *Trifolio-Geranietea sanguinei* T. Müller 1962 (see Berg & Dengler, 2005).

Phytosociological nomenclature

We paid particular attention to the careful application of the 'International Code of Phytosociological Nomenclature' (ICPN, Weber *et al.*, 2000). Our aim was to find the correct names according to the Code for all syntaxa used. We therefore checked each name in two stages:

- We collected the accepted names and syntaxonomic synonyms that completely or partly correspond to our syntaxonomic entities from the major phytosociological overviews in Central Europe and many specialised publications.
- Beginning with the oldest name, we checked their legitimacy and validity as well as their type location.

This time-consuming procedure enabled us to determine the oldest valid and legitimate name known to us, which is most probably the correct name. These names are used as accepted names in the headings of the syntaxon chapters in Berg *et al.* (2004). We viewed the protologues of the accepted names for all our 531 syntaxa, included the references to their author citations in the bibliography, and ensured that they are valid and legitimate. Furthermore, some 3,500 synonyms were listed, most of them with a nomenclatural assessment.

We found that many names used in other recent overviews are not correct, and often not even valid according to ICPN. Even in relation to the careful list of Mucina (1997) some alterations, partly of the names, partly only of the author citations, proved to be necessary (see synoptic overview in Berg & Dengler, 2004: TABLE 5). Our investigation also revealed that no names were available for 38 (7%) of all recognised syntaxa (see detailed statistics in Berg & Dengler, 2004), sometimes because of a novel classification by us but not seldom also because a name commonly used for a certain syntaxon proved to be invalid or a pseudonym. The necessary new descriptions and typifications of syntaxa have meanwhile been published in two collective papers (Dengler, Berg, Eisenberg, Isermann, Jansen, Koska, Löbel, Manthey, Päzolt, Spangenberg, Timmermann & Wollert, 2003; Dengler, Koska, Timmermann, Berg, Clausnitzer, Isermann, Linke, Päzolt, Polte & Spangenberg, 2004) as well as in some shorter articles (Dengler & Krebs, 2003; Kießlich, Dengler & Berg, 2003; Linke, 2003). Furthermore, proposals to the Nomenclature Commission for all *nomina proposita* used in Berg *et al.* (2004) are in preparation.

The 'nomenclature blocks' (FIGURE 1) in combination with the comprehensive reference list (ca. 2,000 titles) in Berg *et al.* (2004) can now be used for the deter-

Carici arenariae-Airetum praecocis Westhoff & al. 1962 nom. invers. propos. – Sandpionierrasen der Frühen Haferschmiele

Sonstige Namen: Airo praecocis-Caricetum arenariae Westhoff & al. 1962* – Syn.: Corynephoretum canescentis Schwickerath 1944* p. p. [Art. 31], Airo praecocis-Sedetum rupestris Tx. 1951* p. p. [Art. 3b], Airetum praecocis Krausch 1967* [Syntax. Syn.], Airetum praecocis (Schwickerath 1944*) Krausch 1967* sensu auct. [Art. 49], Cerastio-Scleranthetum polycarpi Hülbusch 1974 p. max.„p. [Syntax. Syn.], Filago minimae-Airetum praecocis Wattez & al. 1978* p. max. p., Ornithopodo-Corynephoretum Passarge 1960a* sensu Weeda & al. 1996a* p. p. [typo excl.], Ceratodonto purpurei-Airetum praecocis (Krausch 1967*) Passarge 2002* [Art. 29a]; incl.: RG *Aira praecox*-[Koelerio-Corynephoretea] sensu Weeda & al. 1996a*

FIGURE 1 - Example of a 'nomenclature block' from Berg *et al.* (2004). The synonyms are listed in chronological order, accompanied by a nomenclatural evaluation in square brackets whether they are later syntaxonomic synonyms or invalid/illegitimate names, the latter indicated by the respective Article(s) of the ICPN. Where necessary, the position of the nomenclatural type is also indicated. The asterisk (*) stands for syntaxon names whose protologue has been checked by us and included in the reference list.

mination of correct syntaxon names in other similar projects even if their classification deviates from ours.

CONSERVATION ASSESSMENT

General concept

Within the project, we assessed the vulnerability and conservation value of all the associations and some of their recognised subdivisions. Both vulnerability and conservation value are based on three criteria (some of them derived from subcriteria) that are separately assessed according to precise scales. The combination of the respective three criteria and also the combination of vulnerability and conservation value was carried out with the use of matrices and resulted in a list of plant communities requiring priority conservation measures (see TABLE 2). This procedure guarantees that only one derived value is assigned to each possible combination of criteria and makes the principles of these combinations transparent. As we not only documented the derived values but also the assessed categories of each individual criterion for all plant communities, it is possible for the users of our work to change the weightings of the different criteria or the underlying logic of their combination.

Vulnerability

The vulnerability category (see Abdank, Berg & Dengler, 2002) is based on three assessment criteria:

1. The **current distribution** is derived from the area covered by, and the spatial distribution of a plant community within Mecklenburg-Vorpommern in the last 10 years. The value zero for the current distribution means that it was absent during this period, whereas a value of 5 indicates that it is very widespread and frequent in Mecklenburg-Vorpommern. To estimate the values we used a coarse

grid net and both the known occurrences and the estimated degree of completeness of these recordings were taken into consideration.

2. The **quantitative development** since 1960, when an enormous change in land use took place in Mecklenburg-Vorpommern, especially in agriculture, is estimated on a scale from very large decrease (1), through more or less unchanged (4), to increasing (5).
3. The **foreseeable threat** from human activities within the next 10 years is assessed from very high (1), through none (4), to favoured by human activities (5).

The total category of **vulnerability** is derived by use of a matrix that combines these three criteria (see TABLE 2). Vulnerable plant communities are classified from 0 (vanished), through 1 (critical) and 2 (endangered), to 3 (threatened), but we also use R (very rare but not actually threatened). Non-threatened plant communities are

TABLE 2 - Matrix for the assessment of the category of vulnerability (modified from Berg *et al.*, 2004). Each combination of the three criteria indicated at the left and upper margin results in the vulnerability values given in the respective grid cells (for the meaning of these abbreviations, see text).

Current distribution	Quantitative development	Foreseeable threat				
		1	2	3	4	5
0	1	0	0	0	0	0
1	1	1	1	1	1	2
	2	1	1	1	2	2
	3	1	1	2	2	2
	4	1	2	2	R	R
	5	2	2	2	R	R
2	1	1	1	2	2	3
	2	1	2	2	3	3
	3	2	2	3	3	3
	4	2	3	3	*	*
	5	3	3	3	*<	*<
3	1	2	2	3	3	V
	2	2	3	3	V	V
	3	3	3	V	V	V
	4	3	V	V	*	*
	5	V	V	V	*<	*<
4	1	3	3	V	V	*
	2	3	V	V	*	*
	3	V	V	*	*	*
	4	V	*	*	*	*
	5	*	*	*	*<	*<
5	1	V	V	*	*	*
	2	V	*	*	*	*
	3	*	*	*	*	*
	4	*	*	*	*	*
	5	*	*	*	*<	*<

divided into V (near-threatened), * (not threatened) and *< (not threatened and increasing). Where our data are deficient, we use the categories G (vulnerability assumed, but degree uncertain), * and D (uncertain whether threatened or not).

Conservation value

Even more than is the case with Red Data Books for individual taxa (cf. Schnittler & Günther, 1999), vulnerability alone is not an adequate indicator for setting up conservation priorities for plant communities. We therefore developed the concept of the conservation value (see Berg, Timmermann & Dengler, 2001a) as an additional measure. It is based on three assessment criteria:

1. The **content of threat** represents the average number of threatened taxa occurring within a stand (relevé) of a given plant community. This assessment is based on the regional Red Data Books of Mecklenburg-Vorpommern for vascular plants, bryophytes, lichens and Charophyceae. The percent presence degree of each species is multiplied by a weighting factor for the different categories of vulnerability and these products are added together for all the species occurring in a given community. The resulting sums for all 284 associations are divided into 5 quintiles to derive the category of the content of threat.
2. The **degree of naturalness/human impact** extends from nearly natural (1) to artificial communities (5).
3. The **responsibility** of Mecklenburg-Vorpommern for the preservation of a plant community is given in a five point scale from highest (1) to lowest (5). This assessment is based on the proportion of the area covered by a community in Mecklenburg-Vorpommern to its overall area. Where knowledge was inadequate, the responsibility category has been estimated by referring to the number of species in the diagnostic species combination with restricted geographical ranges.

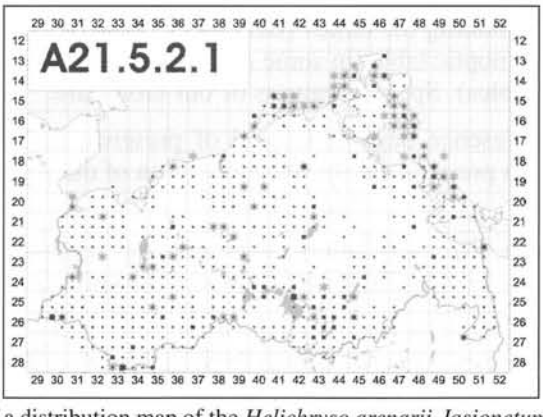

FIGURE 2 - Example of a distribution map of the *Helichryso arenarii-Jasionetum litoralis* Libbert 1940 from Berg *et al.* (2004: 322). The stars show the occurrences of the association documented by relevés, the three different sizes of squares indicate the number of diagnostic species co-occurring in the grid cells. Since the *Helichryso-Jasionetum* is a central association the species selection consists of character species of superior syntaxa.

The combination of these three criteria results in a summary category of **conservation value** by use of a matrix similar to FIGURE 2. It ranges from 'highest, worthy of priority conservation measures' (1), to 'lowest, only slightly worthy of conservation measures' (5).

Plant communities requiring priority conservation measures

Priorities for practical conservation measures (need for action) are derived from the combination of the categories of vulnerability and conservation value in a matrix. They are classified in four categories from '!!!' (very high need for action) through '!!' and '!' to '-' (no need for action).

Results - The Red Data Book of plant communities

All the above-mentioned assessments together form the Red Data Book of plant communities of Mecklenburg-Vorpommern. Only some principal results can be mentioned here; a detailed evaluation may be found in Berg *et al.* (2004: 493-516). A total of 55% of the associations are vulnerable and 1% has already been extirpated from the territory of Mecklenburg-Vorpommern. Fourteen associations (5%) are assigned to the highest category of nature conservation value. Of special interest is the responsibility of Mecklenburg-Vorpommern for the plant communities occurring on its territory; 17 associations have been included in the two highest categories, meaning that one fifth or more of their global ranges lies in this state. We found the highest need for action in the communities of the classes *Littorelletea* Br.-Bl. & Tx. *ex* Westhoff *et al.* 1946, *Parvo-Caricetea* den Held & Westhoff in Westhoff & den Held 1969 *nom. cons. propos.* and *Vaccinio uliginosi-Pinetea* Passarge & G. Hofmann 1968.

PRESENTATION OF THE RESULTS

Synoptic tables

In the volume containing the tables (Berg *et al.*, 2001b), each class is generally represented by one synoptic table (in some association-rich classes this may be split off in two or more tables). Special features of our tables are:

- Use of percent presence degrees instead of presence degrees classes. This is more precise and a prerequisite for the application of our differential species criterion.
- All syntaxa from the associations upwards are represented by their own columns, which makes the diagnostic values of the species and the classification verifiable.
- Only very rare species are excluded from the tables (< 1% presence degree on class level; however, they are included in the CD-ROM version).
- We took into consideration that in some syntaxa bryophytes, lichens and macroalgae ('cryptogams') were recorded in only some of the relevés. In these cases, the presence degree values of the cryptogams were calculated based only on the respective group of relevés in which they were sampled since otherwise the val-

ues would not correspond to the real situation and a comparison between different syntaxa would not be possible (cf. Berg & Dengler, 2005).

– In the headings of the columns for each syntaxon, the number of relevés, the number of relevés in which cryptogams fundamentally have been considered, the median size of the relevé and the mean species richness are indicated.

In addition to these class tables, we presented a so-called **all-class-table** (Berg *et al.*, 2001b: pp. 272-341; see TABLE 3). This comprises all taxa in alphabetical order that occur in any of the used relevés and lists their respective presence degree reference values for all 34 classes, accompanied by an indication of the diagnostic values in the non-wooded and in the wooded vegetation types. This table gives a 'sociological profile', so to speak, for nearly all plant taxa of Mecklenburg-Vorpommern.

Presentation of the text

The chapters dealing with the individual syntaxa consist of different sub-chapters, i.e. **Other names** ('nomenclature blocks', see FIGURE 1), **Syntaxonomy**, **Selected fungi and animals** (only for classes), **Diagnostic species combination** (only for associations = *), **Characteristics** (physiognomic, ecological and other general characteristics of the plant community), **Subdivision** (*), **Synchorology**

TABLE 3 - Part of the all-class-table (modified from Berg *et al.*, 2001b). The first 14 classes (K01 = Lemnetea … K14 = Juncetea maritimi) are shown. The numbers in the columns represent percent Presence degree values for the taxon in the respective class. The diagnostic values are indicated by both shading and underlining of these constancies and in the column at the left.
K = class; KD = joint character species of classes; n. b. = not evaluated; O = order; UK = subclass; V = alliance; x = sociologically indifferent.

Syntaxon	Diagnostic value herbaceous vegetation	Classes of the herbaceous vegetation														
		K01	K02	K03	K04	K05	K06	K07	K08	K09	K10	K11	K12	K13	K14	...
Associations		6	1	5	8	13	1	7	8	6	2	8	17	17	12	
Relevés		765	84	537	1344	2012	115	160	149	157	133	1287	2571	4042	2564	
Relevés with consideration of cryptogams		765	84	537	1344	2012	115	120	109	157	133	1287	2571	3921	2564	
Mean relevé size [m²]		*5,0*	*7,0*	*16*	*4,0*	*4,0*	*10*	*3,0*	*4,0*	*1,3*	*6,0*	*7,0*	*10*	*16*	*10*	
Mean species richness		*4,8*	*2,4*	*4,0*	*3,6*	*4,8*	*5,9*	*12*	*12*	*6,3*	*7,5*	*10*	*21*	*13*	*12*	
Juncus acutiflorus	KD12,23	.	.	.	.	.	.	.	.	0	.	.	0	0	.	
Juncus alpinus	O12.2, 12.2.4.1	.	.	.	.	.	.	2	.	.	.	.	9	0	.	
Juncus articulatus	–	1	.	.	1	0	.	35	4	19	9	1	29	6	6	
Juncus balticus	11.1.1.3	.	.	.	.	.	.	.	.	.	.	2	0	.	0	
Juncus bufonius	K07	.	.	.	.	0	4	60	19	.	.	0	0	2	4	
Juncus bulbosus (ges.)	KD07,09	1	.	.	.	.	.	24	.	31	.	1	6	.	.	
Juncus bulbosus	KD07,09	1	.	.	.	.	.	24	.	31	.	1	5	.	.	
– Juncus bulbosus kochii	n. b.	.	.	.	.	.	.	.	.	0	.	.	1	.	.	
Juncus capitatus	07.1.2.2	.	.	.	.	.	.	2	.	.	.	.	0	.	.	
Juncus compressus	KD07,08,23	.	.	.	.	.	.	2	6	.	.	.	1	1	1	
Juncus congl omerat us	KD20,23	.	.	.	.	.	.	.	.	.	.	1	1	0	0	
Juncus effusus	–	1	.	.	.	0	.	4	3	5	2	7	9	11	1	
Juncus filiformis	n. b.	.	.	.	.	.	.	.	.	.	.	0	0	0	.	
Juncus gerardii	K14, O14.1	.	.	.	.	.	18	.	.	.	.	.	.	0	56	
Juncus inflexus	–	.	.	.	.	.	.	.	.	0	5	.	1	2	0	
Juncus maritimus	K14, 14.1.2.4	.	.	.	.	.	2	.	.	.	.	.	.	0	13	
Juncus ranarius	KD06,08,14	.	.	.	.	.	7	1	4	.	.	.	1	0	3	
Juncus squarrosus	20.1.1.2	.	.	.	.	.	.	1	.	.	.	12	0	.	.	
Juncus subnodulosus	UK12b	.	.	.	.	0	.	.	.	.	.	.	18	3	0	
Juncus tenageia	V07.1.1, 07.1.1.4	.	.	.	.	.	.	19	.	2	.	.	.	0	.	
Juncus tenuis	n. b.	.	.	.	.	.	.	.	1	.	.	.	0	0	.	

and relationship to natural geographical units (*), **Legal status** (*), **Vulnerability** (*), **Conservation value** (*) and **Conservation strategies**. In addition to these sections, three other elements are used to illustrate the individual syntaxa: syntaxonomic overviews, distribution maps (see below) and photographs. **Syntaxonomic overviews** show the hierarchical arrangement of the syntaxa, with their character and differential species listed alphabetically. In addition to the information already included in the tables, transgressive character species are mentioned for all ranks and not only for the highest and lowest; some additional differential species are listed; and species that most probably comply with the character species criterion only within the territory of Mecklenburg-Vorpommern are indicated with 'terr.'.

Distribution maps of syntaxa

Four different types of grid maps were used to illustrate the distribution of syntaxa in Mecklenburg-Vorpommern: maps of single characteristic species, maps of sites where the community was found, and synoptic maps that combine this information with the representation of a potential distribution range derived by the superimposition of distribution data of the diagnostic species (synoptic maps, both for associations and for superior syntaxa; see FIGURE 2).

CONCLUSIONS

To sum up our experiences from the project, three major aspects could be stated:

- For modern phytosociological overviews, we regard the following points as indispensable: (i) uniform methodology for the classification of all syntaxa; (ii) comprehensive documentation of the methodology; (iii) presentation of the results in such a manner that enables the verification of their conformity with the methodology.
- The approach adopted here proved well suited for the creation of an internally consistent, comprehensive and complete classification of all vegetation types occurring in an area as large as a German federal state.
- In the resulting product, we were able to confirm customary classification schemes in many cases, whereas in others we proposed floristically better founded and mostly ecologically and chorologically more uniform syntaxa.

OUTLOOK

Now that the books have been published, the upkeep and maintenance of the database become important. The next steps will be to add information on the assigned syntaxonomic position as well as on location, data quality and possible mistakes that we found during the classification process to the individual relevés in the original database. Furthermore, this database is being continuously augmented with new relevés. At the moment, it is available for the working group on a server

at the University of Greifswald. As soon as the data update and the evaluation process are finished, we plan to transfer copies of the data sets both to the German national vegetation database (May, 2005) and to SYNBIOSYS Europe (cf. Schaminée & Hennekens, 2001).

In the future, the following tasks and questions wait for a solution:

- The applicability of our classification approach should be tested for larger geographic entities.
- The classification approach should be implemented into a computer algorithm. This would enable the following points to be addressed: (i) automatic search for the 'best' classification; (ii) consideration of thresholds of statistical significance (cf. Bruelheide, 2000; Chytrý, Tichý, Holt & Botta-Dukát, 2002); and (iii) consideration of geographical 'exterior' data (i.e. information on syntaxa that occur outside the research area and how species behave there sociologically) in a uniform manner by use of an 'expert system'.
- The problem that relevé sizes influence constancy values and hence classification results (cf. Dengler, 2003: pp. 74-81) needs to be solved.
- Finally, the large vegetation database of Mecklenburg-Vorpommern could also serve as a valuable basis for different evaluations other than syntaxonomic classification (biodiversity research, regional re-calibration of Ellenberg indicator values...).

Acknowledgments

We thank Toby Spribille, Göttingen, for the thorough linguistic correction of the manuscript.

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