Comparative application of two vegetation classification approaches to large-scale mapping of bog vegetation

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This article focuses on geobotanical mapping with special emphasis on mire vegetation. A brief review of the history of mire mapping in Russia is given. The purpose of the research reported here is to promote the application of cartographic methods to phytosociological studies as well as to contribute to further development of methods for large-scale mapping of mire vegetation. Kudrovsky mire massif (Leningrad region, NW Russia) was chosen as the study area. Two vegetation maps were prepared on the basis of different vegetation classification approaches, namely the dominant (ecologic-phytocoenotic) and floristic (Braun-Blanquet) methods. The same vegetation relevé data were classified using both approaches and the resulting classifications were used to construct legends for the maps. The traditions and problems of Russian vegetation cartography are briefly discussed.

Key words: dominant classification, geobotanical map, mire massif, Russian cartography

Introduction

The scientific and practical value of a geobotanical map depends upon the content of its legend, which can be based on the principles of vegetation classification. Thus, although most vegetation classifications have been developed without consideration of their compatibility with mapping procedures, many of them have later been used for mapping purposes (Pedrotti, 2004).

Russian scientists first attempted to map mires at the beginning of 20th century (Сукачев, 1906; Филатов, 1911, 1913; Какс, 1914). Traditionally, the mapping units were vegetation formations (for example, Hypnetum, Pinetum, Alnetum). The legends of these maps were rather primitive, and the mapped patterns were large and monotonous.

The published literature offers very few mapping schemes for single mire massifs (a synonym for Cajander's mire complexes which is widely used in Russian mire science) and mire systems that show the distribution of phytocoenoses and micro complexes. Иванов (1957) gives black-and-white schemes for several mire massifs, among them *Lamminsuo* mire on the Karelian Isthmus. In these, microlandscapes are used as the mapping units. Another example is a schematic map of the *Bor* mire massif from the well-known research on the *Shirinskaya* mire system in Leningrad region by Солоневич (1960). Publications by Галкина (1962) and Романова (1967) focus

directly on the mapping of mire vegetation, and these authors use vegetation associations as well as mire complex types as mapping units. Some further publications from the 1970s and 1980s include illustrations and schematic maps of mire systems (Козлова, 1971; Кирюшкин, 1980; Елина & Белоусова, 1971; Кузнецов & Елина, 1982; Елина et al., 1988).

Tatiana Yurkovskaya made an important contribution to developing the ideas of large- (Юрковская, 1970, 1983), medium- and small-scale mapping of mire vegetation (Юрковская, 1968, 1974, 1988, 1992; Исаченко & Юрковская, 1973; Yurkovskaya, 1995). She distinguished the regional distribution characteristics of mire massifs in European Russia and developed a general classification scheme for mapping purposes.

The objective of the study reported here was to compare two different approaches to vegetation classification in the context of mapping of mire vegetation. The methods compared were the traditional ecologic-phytocoenotic approach (known also as the dominant approach) and the floristic approach (Braun-Blanquet method). This is the first time that the floristic approach has been used in Russian vegetation mapping.

Methods

The floristic approach

The Braun-Blanquet floristic classification method has been applied to mapping in many European countries such as Italy (Pedrotti, 1981, 1982, 2003), former Czechoslovakia (Mikyška et al., 1968–1972; Neuhäuslová & Moravec, 1997), Poland (Matuszkiewicz, 1984; Matuszkiewicz et al., 1995; Herbich, 1992, 1994), Romania (Doniță & Roman, 1976) and Yugoslavia (Acceto et al., 1986), as well as in Japan (Miyawaki et al., 1969; Miyawaki 1979; Map of actual vegetation…, 1974). The recently published "Map of the Natural Vegetation of Europe" (Bohn et al., 2000/2003) was compiled mainly on the basis of the Braun-Blanquet method.

In the floristic approach the names of the plant communities are given in the legends of the large-scale (association level) maps. The legends of the medium-scale maps usually list the names of the vegetation orders and unions that have been distinguished (higher ranks of classification). This approach cannot, however, be applied directly in small-scale mapping. For example, the legend of the "Map of the Natural Vegetation of Europe" mentioned above employs aggregated mapping units for vegetation types which are more typical of the Russian cartographical school.

The ecological-phytocoenotic approach

Traditional Russian vegetation cartography employed the ecological-phytocoenotic approach, i.e. the dominant approach (Грибова & Самарина, 1963; Крауклис & Медведев, 1966). This approach, including large-scale mapping, is still in use today (Холод, 1994; Нешатаев & Ухачева, 2000).

In the dominant approach the names of the plant communities usually indicate the plants that provide most of the cover within the different vegetation layers (for example, *Andromeda polifolia-Eriophorum vaginatum-Sphagnum fuscum* community*)* without reference to any checklists or templates. Very often the results are subjective descriptions of the vegetation. In the floristic approach, on the other hand, the syntaxons are given valid names and they can be determined objectively.

Map legend

In geobotanical mapping the legend of the map should be based on a specific classification, but it is not necessary for the legend to repeat the classification (Сочава, 1979). Mapping is a complex procedure involving a great deal more than simply plotting an association's distribution on a map. The step from the practical classification work to the legend is an important element of the scientific generalization of the environment (Грибова & Исаченко, 1972).

There is some connection or relationship between the list of phytosociological syntaxons and the legend, but there are also fundamental differences between them. The dominant method unifies the associations and their groups into formations on the basis of indicator species
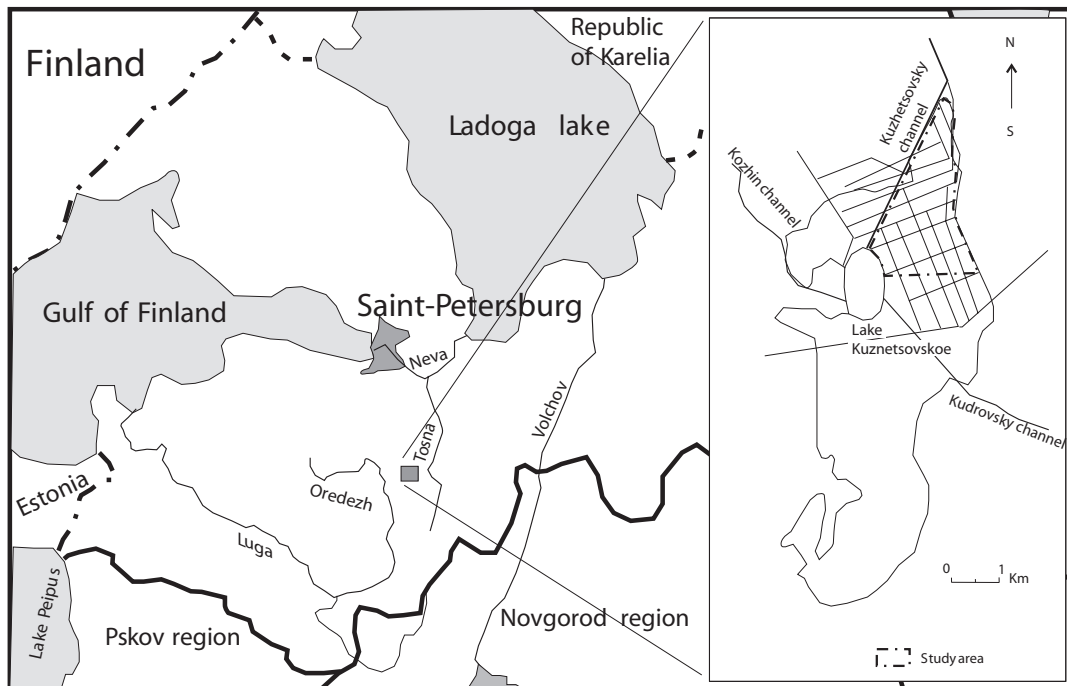
Fig. 1. General scheme of the Kudrovsky mire massif (Leningrad region, NW Russia).
Kuva 1. Kudrovskin suoalueen sijainti ja yleiskuvaus.

(for example the formations Pineta, Piceeta, Sphagneta). In the Braun-Blanquet approach, the syntaxons are organized in the synoptic tables of relevés according to the similarity in floristic composition of the communities, which reflects similarity in the ecological conditions of the sites or biotopes, whereas the mapping units in the legend are united according to other criteria such as geographical, typological or territorial factors (at medium and small scales).

When the dominant approach is applied in large-scale mapping, the mapping units are usually associations and groups of associations. Within the floristic approach, the mapping units can be not only the associations but also the alliances and orders, which are the classification units of a higher hierarchical level. It should also be pointed out that the association — the main unit of the system — is large and broad (Александрова 1969). There are also sub-associations and facies in this classification.

Kudrovsky mire massif

Kudrovsky mire massif is situated in the Leningrad region of Russia (Fig. 1), on the border between the Tosno and Gatchina administrative districts (59° 33' N 30° 54' E). It occupies the watershed of the Tosna and Oredezh rivers. Its northern part belongs to the "Lisinsky" regional complex nature reserve. The area investigated belongs to the southern subzone of the taiga zone (Геоботаническое..., 1989). The zonal vegetation is spruce forest represented by *Vaccinium myrtillus* and *Oxalis acetosella* types, sometimes with broadleaved forest elements such as *Tilia cordata, Corylus avellana*, *Pulmonaria obscura* and *Asarum europaeum* (scientific names according to S.K. Czerepanov,1995).

The total area of the Kudrovsky mire massif is 2,235 ha. It consists of three parts; the main part is an ombrotrophic bog and the other two are a minerotrophic mire and a small raised bog. It is probable that the parts initially developed separately, but later coalesced to form one massif due

to paludification processes. The average depth of the peat deposit is 3 metres and the deepest peat (7 metres) is in the southern part of the massif.

From 1879 to 1900 the Kudrovsky massif was used as an experimental area for the first Russian drainage project. It was drained again for forestry in 1929 (200 лет ..., 1997). The old ditch network is still visible in the north-eastern part of the massif (Fig. 1).

Most of the mire massif is covered by pine bog and dwarf-shrub bog with pine, and there is a hummock-hollow complex on its eastern slope. In hollows, *Scheuchzeria-Sphagnum* communities are common (mainly *Sphagnum balticum*, sometimes *S. majus* or *S. cuspidatum)*. On hummocks, bog dwarf shrub (*Empetrum nigrum*) cotton grass (*Eriophorum vaginatum*) and Sphagnum (*Sphagnum fuscum*) communities occur.

Lake Kuznetsovskoe is at the centre of the massif. It is surrounded by a narrow strip of pine bog vegetation. The dwarf shrubs *Vaccinium uliginosum*, *V. vitis-idaea* and *Ledum palustre* are typical and *Sphagnum angustifolium* dominates the moss layer. The eastern shore of the lake is being eroded by wind-driven wave action.

The vegetation map of the Kudrovsky mire massif was compiled from a preliminary interpretation of black-and-white aerial photographs at scale 1:5,000 (taken in 1992) and field observations.

The preliminary map derived from the aerial photographs was verified in the field in June 2000. Three transects crossing the mire massif were studied. The main transect started at the northern margin of the mire, and there were two cross-transects. Vegetation relevés were recorded for every distinct surface patch crossed by each transect. Recording followed the dominant approach; species abundance (Drude's scale) and percentage cover on 100 m^2 plots were estimated. Hummocks and hollows were described separately.

For data analysis the relevés were separated into four groups: 1) hummock vegetation, 2) hollow vegetation, 3) pine bog vegetation and 4) open bog vegetation. Within these groups, the typical communities were distinguished and named, and the names were subsequently used in the map legend.

The percentage cover data were readily trans-formed into Braun-Blanquet scores for analysis according to the floristic method. Classification units (associations and subassociations) were distinguished and later used as the mapping units listed in the legend of the map.

Thus, the same vegetation relevés were classified using both of the approaches under consideration, and a vegetation map of the Kudrovsky massif was prepared for each approach.

Results and discussion

The map based on the dominant approach shows homogeneous patterns characteristic of near-natural mire vegetation (Fig. 2). The drainage effect of the old ditch network seems no longer to have any influence on the bog vegetation, and there is only one plot where the experimental drainage still functions (Fig. 2, number 12 on the map).

Some diversity in vegetation cover was observed along the Kuznetsovsky channel, which has been used for transporting timber in the past (Fig. 1); and as a result of the fires that occasionally originate from carelessly extinguished campfires.

The legend to this map includes 15 classes. Bog vegetation is characteristic in Classes 1–12 and other mapping categories in Classes 13–15.

Russian geobotanical cartographers are criticized by Professor V. Vasilevich (St. Petersburg), who points out the lack of direct results of vegetation classification in their map legends. Unlike the map of the Kudrovsky mire massif published by Галанина et al. (2001), which has a traditional descriptive legend, the mapping given here (Fig. 2) attempts to directly apply the dominant vegetation classification by using the names of associations derived from field data together with a few association names previously distinguished by Богдановская-Гиенэф (1928) for the mires of the present Leningrad region.

The most common communities are represented by fairly large numbers of relevés so that it is easy to classify them. However, unique and rare communities tend to be missed in classification for mapping purposes. At the same time such communities must be shown on the map because it cannot have "white spots". In such cases the

Fig. 2. Vegetation map of the Kudrovsky mire massif based on dominant approach. The legend captions: 1) *Chamaedaphne calyculata-Sphagnum angustifolium+S. magellanicum;* 2) *Pinus sylvestris f. Litwinowii-Eriophorum vaginatum-Sphagnum angustifolium;* 3) *Eriophorum vaginatum-Sphagnum magellanicum;* 4) *Eriophorum vaginatum-Sphagnum angustifolium* (Bogdanowskaya-Guiheneuf 1928); 5) Hummock-hollow complex: *Eriophorum vaginatum-Sphagnum fuscum, Scheuchzeria palustris-Sphagnum balticum;* 6) *Pinus sylvestris f. Litwinowii-Ericaceae-Sphagnum ssp.* (Bogdanowskaya-Guiheneuf 1928); 7) *Calluna vulgaris-Sphagnum fuscum;* 8) *Pinus sylvestris f. uliginosa-Vaccinium ssp.-Sphagnum angustifolium* (Bogdanowskaya-Guiheneuf 1928); 9) *Calluna vulgaris-Sphagnum angustifolium* (Bogdanowskaya-Guiheneuf 1928); 10) *Pinus sylvestris-Calluna vulgaris-Polytrichum strictum;* 11) *Calluna vulgaris-Polytrichum strictum;* 12) *Pinus sylvestris f. uliginosa-Ledum palustre-Sphagnum magellanicum+S. angustifolium;* 13) non-studied area; 14) spruce and mixed southern taiga forests; 15) lake Kuznetsovskoe

Kuva 2. Kudrovskin suoalueen kasvillisuuskartta perustuen ekologis-fytokenoottiseen kasvillisuusluokitukseen.

cartographer is obliged to step out of the theory and use non-rank categories.
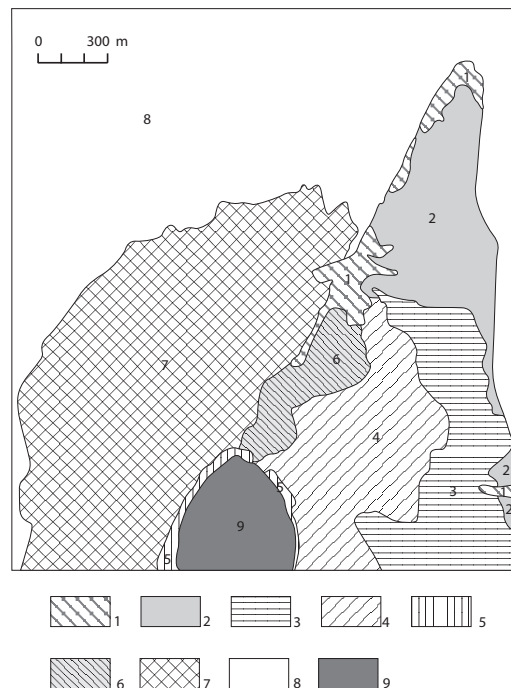
The process of mapping mire vegetation be-

Fig. 3. Vegetation map of the Kudrovsky mire massif (Leningrad region, NW Russia) based on floristic approach. The legend captions:1) *Ledo-Sphagnetum magellanici* (Sukopp 1959 em Neuhäusl 1969); 2) *Chamaedaphne-Sphagnetum magellanici* (Bogdanowskaya-Guiheneuf 1928 em. Boč 1990); 3) Hummock-hollow complex: *Ledo-Sphagnetum fusci* (Du-Rietz 1921) on bog hummocks and *Scheuchzerietum palustre* (Tx. 1937) in bog hollows; 4) *Ledo-Sphagnetum fusci* (Du-Rietz 1921); 5) *Vaccinio uliginosi-Pinetum* (Kleist 1929 em. Matuszkiewicz 1962); 6) *Sphagnion fusci* (Br.-Bl. (1915) 1926); 7) non-studied area; 8) spruce and mixed southern taiga forests; 9) lake Kuznetsovskoe

Kuva 3. Kudrovskin suoalueen kasvillisuuskartta perustuen floristiseen kasvillisuusluokitukseen.

comes complicated due to the mosaic character of mire communities and the small sizes of patches. A possible solution is to distinguish vegetation complexes and to map these instead.

The vegetation map of the Kudrovsky massif compiled on the basis of floristic classification (Fig. 3) also employs associations as the mapping units. The pattern of this map is different; the map based on the Braun-Blanquet approach looks unified. This can be explained by the different ranking of the classification units, the Braun-Blanquet association being a larger classification unit than an association determined using the dominant

classification approach.

The Braun-Blanquet system does not yet offer any suggestions for mapping anthropogenic mire vegetation, and the problem was overcome here by using classification units of higher rank (alliance) for patches with disturbed vegetation.

In view of the complex character of the vegetation cover, hummocks and hollows were characterized separately when applying the Braun-Blanquet approach. This is atypical for European cartography, although Herbich (1994) mapped overgrowing lakes at large scale using the Braun-Blanquet system and made an attempt to show the vegetation complexes. It is likely that this method has potential for mapping of vegetation structure, and this should be tested in the future. However, we cannot expect that a single method will perfectly fit all purposes.

Conclusions

Table 1 provides a comparative summary of the conclusions drawn from the present study regarding the utility of the two classification approaches in the context of mire vegetation mapping. The floristic approach yielded fewer mapping units and a simpler legend than the dominant approach. Mapping based on the Braun-Blanquet method captured the universal and formal characteristics of bog vegetation, but for information on local peculiarities and singular features of the floristic composition of communities it was usually necessary to refer to the synoptic tables of relevés rather than to the legend of the map. In general, the structure of the vegetation is not conveyed by maps based on the floristic method of vegetation classification.

Table 1. The strengths and weaknesses of the dominant approach (ecological-phytocoenotic -method) and the floristic approach (Braun-Blanquet -method) for vegetation mapping.

Taulukko 1. Ekologis-fytokenoottisen ja floristisen (Braun-Blanquet) menetelmän vahvuudet ja heikkoudet kasvillisuuskartoituksessa.

Evaluation	Dominant (ecological-phytocoenotic)	Floristic (Braun-Blanquet)
Positive	Suitable for mapping purposes	Well organized system
	Easy to name communities, as names are based on dominant plant species	Widely accepted
	Easy to interpret data	Easy to compare data from different geographical regions, peculiarities and common features obvious
	Objectively shows the natural vegetation in the legend without any explanatory text	
Negative	No general list of communities	Data for typical communities, collected in central and northern Europe, are not entirely appropriate to Russian circumstances, even for NW Russia
	Sometimes gives excessively detailed vegetation characteristics and produces units that are too small	
	Difficult to compare the results with data from European scientists	Procedures for transformed mire vegetation lacking

The differences between the results obtained using the two approaches can be explained in terms of the level of generalization of the vegetation data and the scale and detail of the patterns on the ground. On this basis, dominant associations are likely to be the most appropriate units for large-scale mapping of mire vegetation, and Braun-Blanquet associations more suitable for medium-scale maps.

Acknowledgements

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Tiivistelmä: Kahden kasvupaikkaluokitusmenetelmän vertailu suon kasvillisuuskartoituksessa

Tutkimuksessa vertailtiin ekologis-fytokenoottista (kasviyhdyskuntien luokitus vallitsevan kasvilajin perusteella) ja perinteistä floristista Braun-Blanquet -menetelmää (luokitus kasvilajiston ekologisen samankaltaisuuden perusteella) keidassuon kasvillisuuskartoituksessa Venäjällä. Tutkimus tehtiin Leningradin hallintoalueella sijaitsevalla Kudrovskin suoalueella, jonka kasvillisuus luokitettiin erikseen kummallakin menetelmällä. Menetelmien eri työvaiheet kirjattiin ylös ja luokitusten perusteella kasvupaikkatyypeistä laadittiin kartat. Kummankin menetelmän eduista ja heikkouksista on tehty tutkimuksessa lyhyt listaus. Floristinen menetelmä näytti tuottavan selkeitä kasvillisuusluokkia. Tämä johtui siitä, että ko. menetelmä tuottaa suurempia luokkayksiköitä maastossa kuin ekologis-fytokenoottinen menetelmä. Toisaalta floristisen menetelmän avulla ei ole mahdollista kuvata ihmisen aikaansaamia muutoksia kasvillisuudessa. Ekologis-fytokenoottinen menetelmä näyttäisi soveltuvan soilla parhaiten suuren mittakaavan kasvillisuuskartoitukseen, kun taas floristinen menetelmä soveltuu paremmin pienipiirteisempään kasvillisuuskartoitukseen.