RAISED BOGS ON THE NORTH-EAST OF EUROPE

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ABSTRACT - In the Northeastern Europe 2 types of raised bogs are distinguished: coastal (Southern White Sea raised bogs) and continental (Pechora-Onega raised bogs). They have been compared as to their flora, prevailing syntaxa, characteristics of their complexes, structure of mire massifs and composition of peat deposits.

KEY WORDS - Raised bog, flora, vegetation, pattern, peat, Russian Plain.

NOMENCLATURE: The author names associations following principles north-European (Russian) school of classification. To be understandable by west-European readers he relates them to associations, volume and names of which are adopted in the classification system by Braun-Blanquet using for this purposes some publications (Smagin, 1999, etc.).

INTRODUCTION

The taiga in the North-East of Europe is characterized by prevalence of spruce forests (*Picea obovata)* and raised bogs. This huge area within the limits of Russian Plain extends to the East from the Vyg R. and the eastern coast of Onega, Lake up to Ural Mts. and to the South from Polar Circle up to 60^0 N (FIGURE 1). Their area extends over 700 km from the North to South and over more than 1000 km from the West to East. It embraces the territory of northern, middle and southern taiga. Two types of raised bogs, belonging to different groups, are characteristic of this territory: the coastal and continental ones.

The coastal raised bogs are the northern most ones in the group of sub-oceanic mires. They predominate in landscape of the White Sea coast. Bogs are located on upper marine terraces; on the lower terraces they are replaced by coastal meadows, marches and sometimes by poor fens. Bogs occupy up to 70-80% of land, they cut by river valleys and somewhere by rocks (FIGURE 2). The most typical coastal bogs are situated in the West, in Karelia which lies outside the considered region. Here they are well studied (Yelina, Yurkovskaya, 1965; Elina, 1971, Jelina, 1985). Our studies in the east of their range permit us to gain a notion of the coastal bogs throughout the whole their range and to emphasize their differences from continental raised bogs.

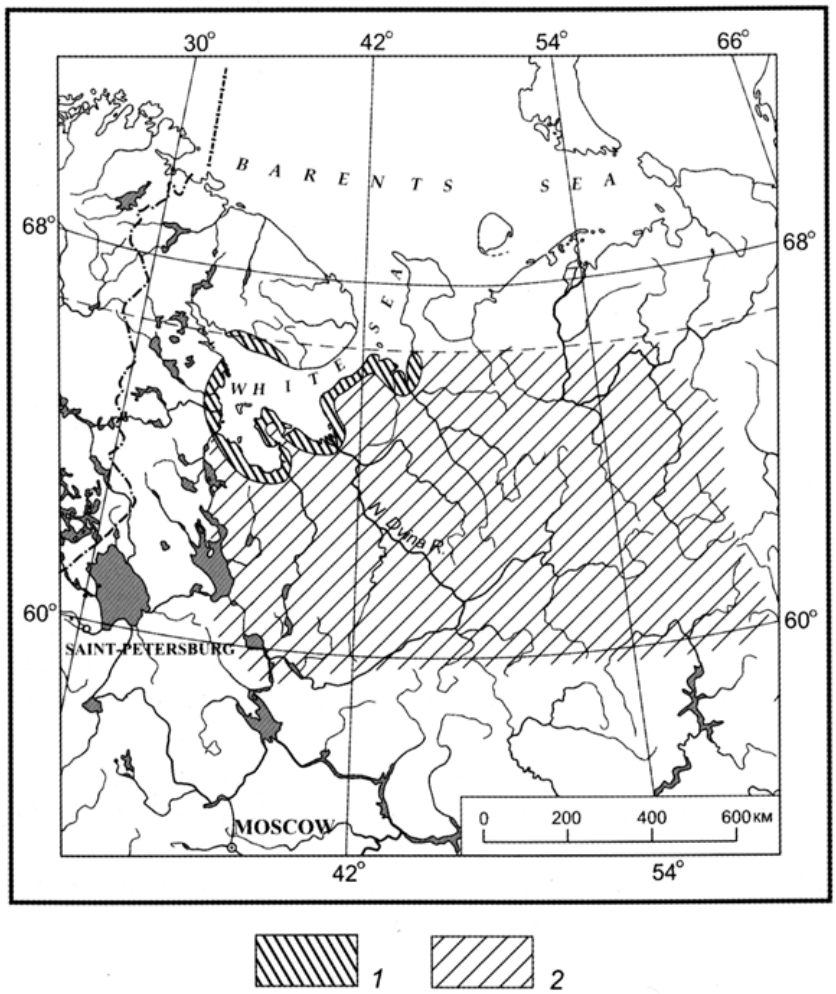

FIGURE 1 - Geographic location of studied area 1-coastal 2-continental.

Beyond the narrow coastal stripe the continental raised bogs spread. Besides them the other types here occur (aapa, rich and poor fens, spring fens, etc.), but raised bogs predominate. They are located at watersheds being surrounded by paludificated forests. Pechora-Onega raised bogs occupy ca. 25% of their range but are distributed unevenly being concentrated within the limits of the 50-100 m level above sea.

In this communication with brief analysis of flora and vegetation of raised bogs, located on the north-eastern Russian Plain, I emphasize the unity of the Southern White Sea coastal bogs throughout the whole area, note some their peculiarities in the East and compare them with the continental Pechora-Onega raised bogs.

FLORA

The bog flora is poor of species, some diversity is contributed by mesooligotrophic edges. North-boreal species predominate. Flora of the coastal bogs numbers 23 species of vascular plants, they are enumerated in the column "W" (TABLE 1). In

the column "P" the species of Pechora-Onega continental bogs are listed. Continental raised bogs include as much as 20 species of vascular plants-among them there are no *Calluna vulgaris, Carex rariflora, Arctous alpina.*

But *Arctous alpina* is hypoarctic species, very rare in the coastal raised bogs and was recorded only on ridge of bog Cherentichnoe (Winter Coast). *Calluna vulgaris* spreads throughout the whole range of Southern White Sea coastal raised bogs, however in the North-East it locally gives dominance to *Betula nana*-the one more hypoarctic species. Indeed, in this case *Calluna* is also presented in plant community. On the White Sea coastal bogs *Carex rariflora* replaces *Carex limosa* in hollows. In the continental bogs *Carex rariflora* hasn't been met by us, everywhere there has been *Carex limosa*. In the ecotone westward of North Dvina R. one can meet some western species on continental bogs (P), among them *Rhynchospora alba.*

Coenotic role of some species on the White Sea coastal raised bogs and on the continental ones is different. So, the role of pine immeasurable increases on the Pechora-Onega raised bogs. On the Southern White Sea bogs pine occurs on ridges, but only sporadically, and north-eastwards, at N. Zolotitsa, it is absent in central parts and appears only in the edges of bogs. *Chamaedaphne calyculata* grows sporadically on the coastal bogs, but never used to be constructor. In continental bogs it occurs almost with 100% constancy (V class) and very often dominates in plant cover. Considerably differ is the constancy of *Ledum palustre*: on the White Sea coastal bogs it is no more 50% and on the Pechora-Onega ones-100%.

Flora of leafy mosses is almost identical on White Sea coastal and continental bogs. On the letter we don't show *S. cuspidatum* and *S. tenellum*, but they nevertheless occur quite seldom in the ecotone westward of North Dvina R. In the continental bogs we didn't record *Dicranum elongatum,* rare species sometimes occurring on the ridges of coastal bogs.

Lichens occur on ridges and hollows both in the White Sea coastal raised bogs and in the continental ones. On the Pechora-Onega raised bogs 2 species, very characteristic of coastal raised bogs, are really absent. These are again hypoarctic species: *Cetraria nivalis* and *Icmadophilla ericetorum*. Both species are often as well on palsa mires in southern tundra and forest-tundra.

Thus, flora of raised bogs in White Sea region has definite peculiarities because of presence of *Calluna vulgaris*-subatlantic floristic element and often constitutive, together with hypoarctic species which role increase in North-East of the range of White Sea coastal bogs. In the flora of continental east-european raised bogs *Calluna vulgaris* is absent. *Chamaedaphne calyculata* dominates indivisibly on ridges, in hollows there is no northern species *Carex rariflora*, characteristic of coastal bogs, here it is replaced by *Carex limosa* common in boreal bogs.

Vegetation

The most characteristic communities of coastal raised bogs are the following associations: *Calluna vulgaris-Rubus chamaemorus-S. fuscum-Cladina, Calluna vulgaris-Empetrum nigrum-Cladina, Calluna vulgaris-Cladina.* Kuznetsov (1993), following the principles of classification by Braun-Blanquet, united all listed associations into a single unit: *Calluno-Cladinetum* Bogdanovskaya-Guienef 1928. In

the North-East the second association is the most often but, owing to decrease of the *Calluna vulgaris* role, 2 more associations are spread: *Empetrum nigrum-Rubus chamaemorus-S. fuscum-Cladina and Betula nana-Empetrum nigrum-Cladina.* The difference between phytocoenoses in typical and Eastern coastal bogs is not so big and has been already discussed in the chapter "Flora", are the followings: absence of pine on ridges, some strengthening the *Betula nana* positions and weakening those of *Calluna vulgaris.*

But the difference in species composition of communities on ridge of coastal and continental bogs is essential. The most common in continental bogs are plant communities with pine, *Chamaedaphne calyculata* and *Sphagnum fuscum* (ass. *Ledo-Sphagnetum fusci* Du Rietz 21).

In the TABLE 2 constancy is given for the coastal (W) and the continental (P) raised bogs. Quite remarkable as well is the difference between the values of species constancy in the communities of ridges: pine 3-5, *Betula nana* 5-2, *Calluna vulgaris* 5-0, *Chamaedaphne calyculata* 1-5, *Ledum palustre* 3-5, *Vaccinium vitis-idaea* 4-1, *Trichophorum caespitosum* 5-1, *Cetraria nivalis* 3-0.

In hollows plant communities with the dominance of *Sphagnum balticum, S. majus, S. lindbergii or Hepaticae* in moss cover predominate. The herb layer in these communities is dominated by *Carex rariflora, Trichophorum caespitosum, Eriophorum vaginatum, Scheuchzeria palustris.* The most widespread among them are communities with *Trichophorum caespitosum, Carex rariflora* and *Sphagnum lindbergii* as well as with *Cladopodiella fluitans.* Common are black hollows with surface of bare peat with rarely scattered cottongrass or *Trichophorum caespitosum* and obligatory participation of *Cetrariella delisei* in the shape of small spots.

PATTERN

The ridge-hollow-pool and ridge-pool complexes as well as the regressive complexes form peculiar pattern of the southern White Sea coastal raised bogs, easily recognisable on aerial photograph.

The narrow and long ridges, quite treeless in the East, occupy about 35% of area on the ridge-hollow complex and only up to 10-15% in the regressive complex. Ridge-pool complexes occupy from 10 to 40% of the mire massif area. In the east, on the bogs studied at N. Zolotitsa (Winter Coast), regressive and ridge-hollow complexes predominated.

In the regressive complex the hollows usually luck of cover but in the East the regressive complexes are very characteristic; their hollows have communities with continuous moss cover, in the center of hollows these communities surround an oval with bare peat. Thus, we have ternary complex, for instance, ridge (25%) with ass. *Calluna vulgaris-Empetrum hermaphroditum-Cladina*; hollows (45%) with ass. *Carex rariflora-Sphagnum lindbergii-Cladopodiella fluitans* and black hollows-30%.

In the continental bogs ridge-hollow complex prevails, it occupies the most part of slopes. The development of complexes is intimately connected with the size of mire massifs and their drainage areas (FIGURE 3). In not big bogs only the ridge-hollow complexes occur, in the larges ones the regressive complexes appear near the

top, whereas in extensive bogs considerable areas are occupied by the ridge-pool or regressive complexes.

Thus, the coastal and continental bogs differ essentially in the surface pattern on aerial photographs: chaotic drawing with black pools in center and white surrounding ridges (coastal bogs, FIGURE 2) and regular ridge-hollow complexes at slopes with light hollows and dark ridges (continental bog, FIGURE 3; the pattern of aapa mires is not discussed which are in the same system with continental raised bogs, see FIGURE 3, northern part).

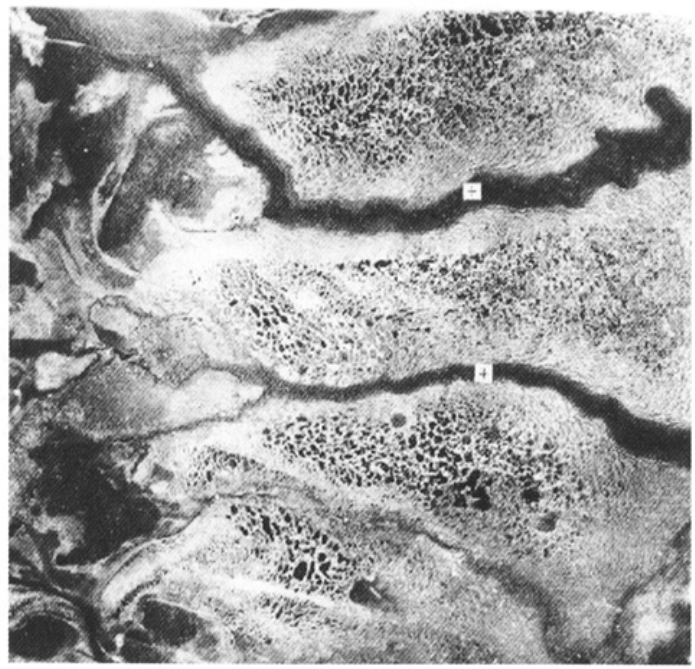

FIGURE 2 - Aerial photo of raised bogs of the South White Sea coastal type. Note: +-river valleys.

STRUCTURE OF MIRE MASSIFS

The typical coastal bogs have flat-convex surface and are easily divided into 2 morphological parts-central plateau and slopes. Lagg is usually absent. Edge slopes often have significant inclination and if one stands below it seems to him that hill towers above him. There is nothing of the kind in the East of coastal stripe: the mire massifs are almost flat and gradually slant to edge part which has the same species composition like ridges with the exception of abundant *Carex globularis* usually marking the edge of massif. The sparse stand of pine appears, sometime tree stand is absent. Thus, to the north-east the typical morphology of coastal bogs is gone.

Continental raised bogs have gentle convex surface. The top of bog shifts to one edge (excentric bog) and long fairly gentle slope turns into paludificated forest. There is usually mesooligotrophic herb-sphagnum stripe. Lagg is absent as well.

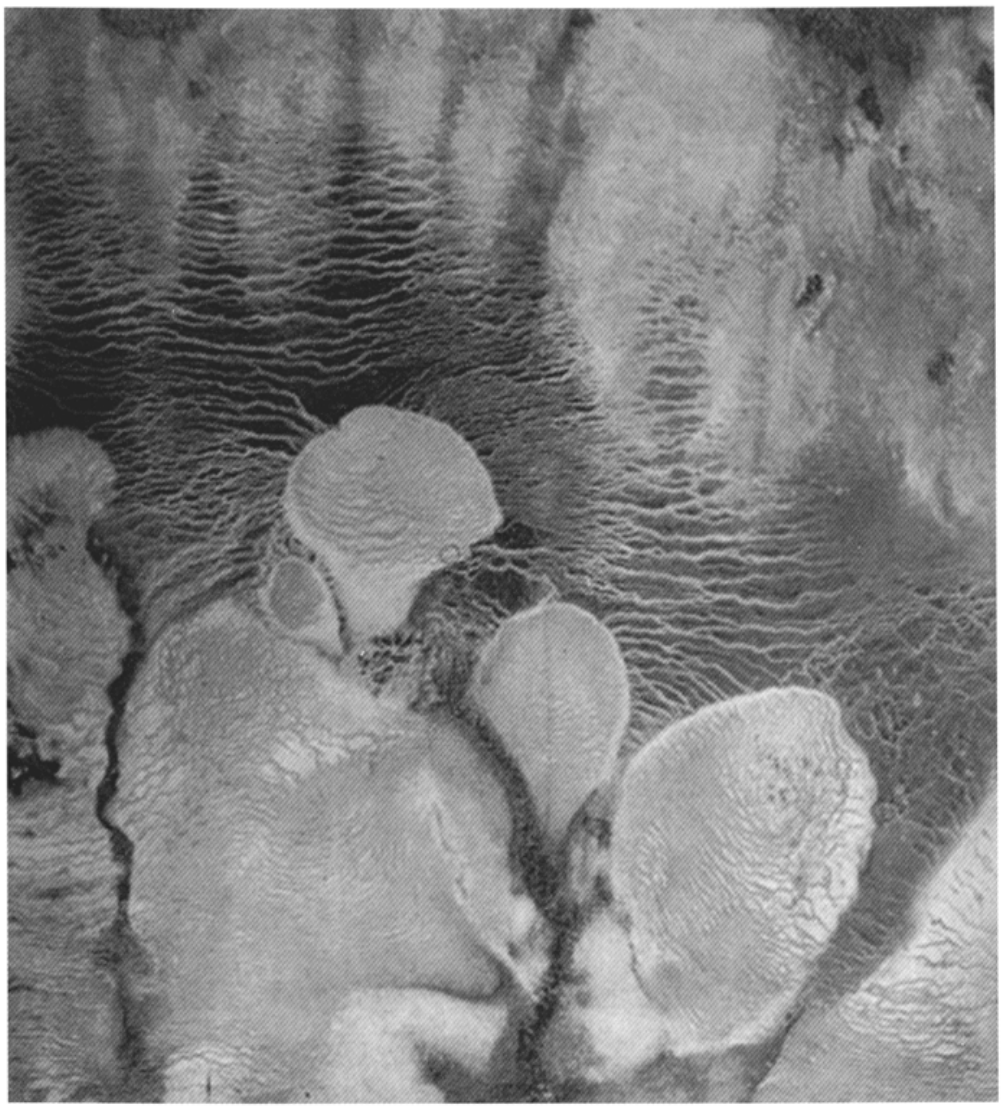

FIGURE 3 - Aerial photo of a typical continental mire system of raised bogs with aapa.

PEAT DEPOSIT

Peat deposit of coastal and continental bogs belongs to the oligotrophic type. In coastal raised bogs it consists of the complex or fuscum peat. Fuscum peats form the main part of deposit and not infrequently penetrate up to the bottom. More often the lowest layer consists of the mesotrophic or eutrophic peats. The upper part of deposit is formed by complex of ridge (fuscum) and hollow peats. It is true also of the coastal bogs in the East. The depth of peat deposit ranges to a large extent, mean depth is 3-4 m, whereas maximal one is 8 m. The north-east peat deposit of coastal bogs is much thin no more than 2.5 m.

In continental raised bogs the upper layer of deposit is formed by the complex of fuscum and hollow oligotrophic peats being underlain by the stratum of sphagnum-cottongrass oligotrophic peat which in its turn is underlain by the eutrophic peat.

The age of coastal bogs numbers 7500 years (beginning of Atlantic Time) whereas continental bogs begin to form in Boreal Time (8500 a.C.).

Conclusion

Thus, in conclusion it remains to emphasize once more again that the Southern White Sea coastal raised bogs preserve their main features throughout their whole area as to floristic and vegetation composition, pattern of vegetation cover, composition of peat deposit setting them apart from the Pechora-Onega continental raised bogs which border them.

Let us underline these differences. Flora of continental raised bogs lacks *Calluna vulgaris*-the essential component of ridges and heaths of the coastal bogs. *Chamaedaphne calyculata* becomes an essential dominant at ridges of continental bogs. *Carex rariflora*, really characteristic for hollows of coastal bogs, is replaced by *C. limosa* in continental bogs. The coenotic role of some species changes. So, the role of pine immeasurable increases on the continental bogs. Prevailing communities of ridges are fairly different. On the contrast, phytocoenoses of hollows are similar except for *Caricetum limosae* Osvald 23 (continental) and *Caricetum rariflorae* Fries 13 (coastal). Massifs of continental and coastal bogs differ in pattern of their complexes, surface morphology and composition of peat deposit. The role of bogs themselves in landscape is different. Coastal bogs dominate the landscape of White Sea coast whereas continental bogs give way largely to spruce forests and their derived communities, though play significant role in the structure of taiga vegetation cover.

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Riassunto

Nel nord-est della pianura Russa esistono 2 tipi caratteristici di paludi torbose: marine e continentali. Il confronto riguarda la flora, i prevalenti sintaxa, il carattere dei complessi, la struttura e le proprietà della torba tra questi due tipi di paludi. La flora è generalmente povera, con il predominio delle specie boreali. Le comunità dei dossi si differenziano nettamente. Nelle paludi marine predomina l'associazione *Calluno-Cladinetum* Bogdanovskaya-Guienef 1928, mentre il *Ledo-sphagnetum fusci* Du Rietz 1921 prevale nelle paludi continentali. La vegetazione delle paludi marittime e la vegetazione delle paludi continentali differiscono inoltre nell'aspetto dei complessi. I complessi di dossi e laghetti e i complessi regressivi occupano tutto il centro delle paludi marittime. Nelle paludi continentali prevalgono i complessi di dossi e depressioni situati sui pendii delle paludi. Le foto aeree mostrano superfici sostanzialmente diverse tra i due tipi di paludi: si trova una forma irregolare al centro con i laghetti neri e dossi bianchi attorno nelle paludi marine mentre i complessi dell'entroterra sono costituiti da dossi più scuri e da depressioni che risultano chiare. In tutti i due tipi di paludi la torba è di tipo oli-

gotrofico. Le paludi marine hanno origine dalla regressione del mare dall'inizio del periodo atlantico (7500 anni fa). Le paludi continentali invece hanno un'origine lacustre e cominciarono a formarsi nel periodo boreale (8500 anni fa).

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TABLE 1 - List of species of coastal (W) and continental (P) raised bogs.

VASCULAR PLANTS	W	P
Pinus sylvestris	+	+
Arctous alpina	+	–
Betula nana	+	+
Calluna vulgaris	+	–
Chamaedaphne calyculata	+	+
Empetrum nigrum	+	+
E. hermaphroditum	+	+
Ledum palustre	+	+
Oxycoccus microcarpus	+	+
O. palustris	+	+
Vaccinium myrtillus	+	+
V. uliginosum	+	+
V. vitis-idaea	+	+
Rubus chamaemorus	+	+
Carex limosa	+	+
C. pauciflora	+	+
C. rariflora	+	–
Drosera anglica	+	+
D. rotundifolia	+	+
Eriophorum russeolum	–	+
E. vaginatum	+	+
Rhynchospora alba	+	–
Scheuchzeria palustris	+	+
Trichophorum caespitosum	+	+
MOSSES AND LICHENES		
Sphagnum angustifolium	+	+
S. aongstroemii	+	+
S. balticum	+	+
S. capillifolium	+	+
S. compactum	+	+
S. cuspidatum	+	–
S. fallax	+	+
S. fuscum	+	+
S. lindbergii	+	+
S. magellanicum	+	+
S. majus	+	+
S. papillosum	+	+
S. russowii	+	+
S. tenellum	+	–
Dicranum bergeri	+	+
D. elongatum	+	–
Pleurozium schreberi	+	+
Pohlia nutans	+	+
Warnstorfia fluitans	+	+
Cladopodiella fluitans	+	+
Mylia anomala	+	+
Cetraria ericetorum	+	+
C. islandica	+	+
C. nivalis	+	–
Cetrariella delisei	+	+
Cladonia arbuscula	+	+
C.deformis	+	+
C. furcata	+	+
C. stellaris	+	+
C.rangiferina	+	+
Icmadophilla ericetorum	+	–

TABLE 2 - The values of species constancy in communities of ridges of coastal (W) and continental (P) bogs.

SPECIES	W	P
Pinus sylvestris	**III**	**V**
Andromeda polifolia	V	V
Arctous alpina	I	0
Betula nana	**V**	**II**
Calluna vulgaris	**V**	**0**
Chamaedaphne calyculata	**I**	**V**
Empetrum nigrum s.l.	V	IV
Ledum palustre	**III**	**V**
Oxycoccus microcarpus	V	V
Vaccinium myrtillus	**I**	**II**
V. uliginosum	IV	IV
V. vitis-idaea	**IV**	**I**
Rubus chamaemorus	V	V
Carex pauciflora	**I**	**II**
Drosera rotundifolia	IV	IV
Eriophorum vaginatum	**IV**	**V**
Trichophorum caespitosum	**V**	**II**
Dicranum bergeri	**III**	**V**
Pleurozium schreberi	III	III
Polytrichum strictum	II	III
Sphagnum capillifolium	III	II
S. fuscum	V	V
Mylia anomala	IV	III
Cetraria islandica	III	II
C. nivalis	**III**	**0**
Cladonia arbuscula	**V**	**III**
C.rangiferina	V	IV
C.stellaris	**V**	**III**
Icmadophilla ericetorum	**II**	**0**

Note: different values of species constancy shown in bold font.