ANNALI DI BOTANICA
*Ann. Bot. (Roma), 2010*

# DIVERSITY AND SIMILARITY OF LICHEN FLORAS OF COUNTRIES ALONG A SOUTH-NORTH GRADIENT FROM ITALY TO GREENLAND

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ABSTRACT - Species diversities and similarities of lichen floras from Italy via Austria, Germany, Denmark, Finland, Sweden and Norway to Greenland are compared for the complete floras and separately for bark, wood, rock and soil, the latter two also for acidic and calcareous. Lichen species diversity declines about 15% from Italy to Norway but 50% from Italy to Greenland, a much lower percentage than for vascular plants (92%!).
The Sørensen coefficient and an NMDS-ordination display geographic groups well: Italy, Austria and Germany, Finland, Sweden and Norway and finally Greenland. Denmark as the only country without mountains lacks saxicolous species and differs from the other countries.
About half of the lichen species grow on rock, followed by bark, except for Greenland, there soil. Diversity and composition of lichen floras on bark and wood are rather homogeneous from Italy to Scandinavia, on soil even from Italy to Greenland.
Diversity is higher on acidic than calcareous rock and soil, a contrast to observations from vascular plants. The diversity loss in "southern" calciphytic species in the northern countries is compensated by additional "nordic" species on acidic substrate. From Greenland even more acidophytic terricolous lichen species are known than from Italy. The reasons for the pH dependent diversity patterns are, same as for vascular plants, not known.

KEY WORDS - ACIDIC, CALCAREOUS, CLIMATE GRADIENT, SPECIES TURNOVER, SØRENSEN COEFFICIENT, SUBSTRATE.

## INTRODUCTION

The lichen floras of the European countries are rather well studied. The actual trend is to manage the knowledge in public on-line data bases as for example Nimis & Martellos (2008) for Italy and on a global scale Feuerer (2009) or the GLOBAL BIODIVERSITY INFORMATION FACILITY (http://www.gbif.net/welcome.htm).

The numbers of known lichen species even for the European countries still change due to advances in taxonomic research, which is very intensive for lichens, and to a lesser extent due to the migration of species following climate change. In spite of that variability, the numbers of species for countries are large enough to allow sufficiently reliable comparisons of diversity.

Calculations of species turnover rates based on the published checklists however are difficult because the checklists include species under different names. This would flaw similarity calculations seriously and might be the reason why those calculations are rare for larger sets of species (for large floristic zones

*Received September 02, 2009*
*Accepted November 05, 2009*

and continents see Feuerer & Hawksworth, 2007; Veste & Feuerer, 2008).

Lichens grow on a variety of substrates: rock, bark, soil etc. On each substrate the lichen species meet with different ecological challenges: terricolous lichens for example have to compete with vascular plants, species on rock and bark not. Rock and bark lichens on the other hand have to establish on hard surfaces and often have to survive rather harsh moisture regimes. The relation of lichen diversity and the lichen's substrate has never been studied in a macroecological approach.

A correlation between substrate pH and vascular plant diversity has been demonstrated by a large number of studies (see e.g. Ewald, 2003; Herben & Chytrý, 2003). Little is known about lichens in that respect.

Thus the aim of the present study is to explore the changes in lichen diversity, here from Italy to Greenland and then to show in detail the floristic changes along the climatic gradient with a special emphasis on detecting trends for different substrates.

## Study Areas

The study areas compared with Italy are Austria, Germany, Denmark, Finland, Sweden, Norway and Greenland. The study countries lie along a phytogeographical gradient from the meridional to the arctic phytogeographical zone (Table 1). All countries except Denmark have a comparable set of landscapes from lowland to the alpine zone and more or less extensive areas with calcareous and non-calcareous bedrocks. Denmark is the only country without mountains. Except Austria all countries have a sea shore line. Austria is comparatively small, but all landscapes except sea shores are present.

## Methods

Lichen diversity data of all study countries were collected from printed and on-line checklists (Feuerer 2009; Hafellner & Türk, 2001; Kristinsson *et al.*, 2006; Nimis, 1993; Nimis & Martellos 2008; Santesson *et al.,* 2004; Scholz, 2000; Søchting & Alstrup, 2006; Wirth *et al.*, 2007). The checklist data were supplemented with additions and corrections from more than 100 publications (not cited here; a list can be obtained on request from the author). Synonyms were traced with vast taxonomic literature, all mentioned checklists and online-resources like Index Fungorum (http://www.indexfungorum.org/Names/Names.asp). Doubtful species, which are traditionally included in checklists, are not counted here.

Each species was assigned with a substrate category according to Hafellner & Türk (2001), slightly simplified (see in Table 2). In case of more than one substrate given, the first one, which is the preferred substrate, was selected. For the species, which are not included in Hafellner & Türk (2001), one of the other mentioned checklist or the description of the species is the source of the substrate category.

The changes in species composition from country A to country B are composed of the "loss" of species from A to B and the number of species "new" in B. Both values together with the number of species, which both countries have in common, are used for the calculation of similarity coefficients.

The focus of the present paper is the comparison of the Italian lichen flora with the floras of the other countries. Therefore the percentage of species, which the other countries have in common with Italy and the percentages of species in the other countries, which do not occur in Italy, are evaluated separately. This allows more detailed interpretations than the similarity coefficients.

Similarity coefficients however facilitate the display of the inter-relationships for all study countries together. Here the Sørensen coefficient was chosen because it emphasises the numbers of species, which countries have in common, and thus reduces the influence of diversity differences. The visualiza-

| | I | A | D | DK | FIN | S | N | GR |
|---|---|---|---|---|---|---|---|---|
| land area (1000 km2) | 294 | 82 | 349 | 42 | 304 | 411 | 307 | 410* |
| elevation extremes (m) | 0<br>4748 | 115<br>3798 | -4<br>2963 | -7<br>173 | 0<br>1328 | -2<br>2111 | 0<br>2469 | 0<br>3700 |
| phytogeographical zone | mer<br>smer | (smer)<br>temp | temp | temp | (temp)<br>bor | (temp)<br>bor | (temp)<br>bor<br>(arc) | (bor)<br>arc |

I: Italy, A: Austria, D: Germany, DK: Denmark, FIN: Finland, S: Sweden, N: Norway, GR: Greenland.
Land area and elevation extremes: http://www.indexmundi.com/ access: September 2009; *ice-free land area;
phytogeographical zones after Bohn *et al.* (2000/2003): mer: meridional, smer: submeridional, temp: temperate, bor: boreal, arc: arctic.

TABLE 1 – Study areas: Land area, elevation extremes and phytogeographical zones.

tion of similarity or dissimilarity data is facilitated by a statistical ordination technique performed on distance measures here Nonmetric Multidimensional Scaling (NMDS). For the calculations the distance matrix of Sørensen dissimilarity coefficients was used: Sørensen dissimilarity coefficient = 1-Sørensen similarity coefficient; Sørensen similarity coefficient = 2C/(2C+A+B) with C: the number of species occurring in both countries, A and B: species only in country A or B. The ordinations were carried out with WinKyst 1.0. The procedure to choose the numbers of dimensions follows Hedenäs (2007), where a detailed description of the method can be found.

## RESULTS

The amplitude of the lichen species diversity of the study countries ranges from 2266 in Italy down to 906 species in Denmark and 1052 in Greenland (Table 2a). The decline from Italy to Greenland amounts to more than 50 % (decline = 100 minus the values in Table 2b). The slopes of the species diversity losses are not steady: The trend is a slow decline to Scandinavia and then a rather strong diversity drop to Greenland. But in spite of the decline a third of the Italian lichen species can still be found in Greenland, in Sweden and Norway even 60 % (Table 3b).

The two countries with the lowest diversity values, Denmark and Greenland, have almost only lost species in comparison with Italy without compensation by additional "nordic" species (Table 3c). The very low diversity values in Denmark mainly due to the lack of saxicolous "mountain" species do not allow comparisons with the other countries regarding the south-north gradient.

In most countries about half of the lichen species are saxicolous, only in Denmark much less (Table 2a). Outside the Arctic the number of saxicolous lichen species is followed by epiphytic, then terricolous and finally xylicolous lichens. Only in Greenland more terricolous than corticolous lichen species occur.

The decline of species diversity from Italy to Greenland is very pronouncedly different for the various substrates: 84 % for corticolous and 67 % for xylicolous species, 48 % for saxicolous and only 13 % for terricolous (decline = 100 minus the values in Table 2b).

The leading cause for the strong diversity decline of corticolous species is the absence of forest in almost the entire Greenland. The loss is moderate from Italy to Scandinavia due to the high percentage of corticolous lichen species Italy and respective Norway and Sweden have in common (62 %, Table 3b).

A similar pattern can be observed for the xylicolous

| | I | A | D | DK | FIN | S | N | GR | A | D | DK | FIN | S | N | GR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | a: number of species | | | | | | | | b: % of Italy | | | | | | |
| all lichens | 2266 | 2107 | 1959 | 906 | 1487 | 2027 | 1898 | 1052 | 93 | 86 | 40 | 66 | 89 | 84 | 46 |
| corticolous | 668 | 595 | 609 | 346 | 426 | 541 | 537 | 110 | 89 | 91 | 52 | 64 | 81 | 80 | 16 |
| xylicolous | 84 | 94 | 95 | 48 | 97 | 112 | 94 | 28 | 112 | 113 | 57 | 115 | 133 | 112 | 33 |
| saxicolous | 1154 | 1054 | 953 | 361 | 665 | 1010 | 897 | 600 | 91 | 83 | 31 | 58 | 88 | 78 | 52 |
| terricolous | 360 | 364 | 302 | 151 | 299 | 364 | 370 | 314 | 101 | 84 | 42 | 83 | 101 | 103 | 87 |
| saxicolous | | | | | | | | | | | | | | | |
| acidic | 631 | 590 | 541 | 243 | 469 | 669 | 632 | 415 | 94 | 86 | 39 | 74 | 106 | 100 | 66 |
| neutral | 84 | 46 | 48 | 17 | 44 | 51 | 49 | 48 | 55 | 57 | 20 | 52 | 61 | 58 | 57 |
| calcareous | 439 | 418 | 364 | 101 | 152 | 290 | 216 | 137 | 95 | 83 | 23 | 35 | 66 | 49 | 31 |
| terricolous | | | | | | | | | | | | | | | |
| acidic | 124 | 123 | 113 | 83 | 134 | 146 | 155 | 132 | 99 | 91 | 67 | 108 | 118 | 125 | 106 |
| calcareous | 115 | 91 | 78 | 25 | 56 | 75 | 70 | 65 | 79 | 68 | 22 | 49 | 65 | 61 | 57 |
| debris | 121 | 150 | 111 | 43 | 109 | 143 | 145 | 117 | 124 | 92 | 36 | 90 | 118 | 120 | 97 |

I: Italy, A: Austria, D: Germany, DK: Denmark, FIN: Finland, S: Sweden, N: Norway, GR: Greenland.

TABLE 2 - a. Lichen species diversity from Italy to Greenland and b. Percentage species diversity in comparison to Italy (Species Diversity of Italy=100%).

| | I | A | D | DK | FIN | S | N | GR | A | D | DK | FIN | S | N | GR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | a | b: % in common | | | | | | | c: % additional | | | | | | |
| all lichens | 2266 | 70 | 68 | 34 | 47 | 60 | 59 | 31 | 23 | 18 | 6 | 18 | 29 | 25 | 16 |
| corticolous | 668 | 71 | 75 | 47 | 51 | 62 | 62 | 14 | 18 | 16 | 5 | 13 | 19 | 18 | 2 |
| xylicolous | 84 | 87 | 83 | 52 | 76 | 88 | 81 | 30 | 25 | 30 | 5 | 39 | 45 | 31 | 4 |
| saxicolous | 1154 | 67 | 62 | 25 | 39 | 53 | 51 | 32 | 25 | 20 | 7 | 19 | 34 | 27 | 20 |
| terricolous | 360 | 78 | 70 | 37 | 62 | 73 | 73 | 57 | 23 | 14 | 5 | 21 | 29 | 29 | 30 |
| saxicolous | | | | | | | | | | | | | | | |
| acidic | 631 | 68 | 63 | 31 | 49 | 61 | 63 | 40 | 25 | 23 | 8 | 25 | 45 | 38 | 26 |
| neutral | 84 | 36 | 33 | 7 | 15 | 23 | 30 | 20 | 19 | 24 | 13 | 37 | 38 | 29 | 37 |
| calcareous | 439 | 70 | 67 | 19 | 28 | 47 | 39 | 22 | 25 | 15 | 4 | 6 | 19 | 10 | 9 |
| terricolous | | | | | | | | | | | | | | | |
| acidic | 124 | 81 | 74 | 58 | 77 | 82 | 82 | 62 | 18 | 17 | 9 | 31 | 35 | 43 | 44 |
| calcareous | 115 | 65 | 63 | 19 | 43 | 56 | 55 | 46 | 14 | 5 | 3 | 6 | 10 | 6 | 10 |
| debris | 121 | 86 | 73 | 32 | 66 | 79 | 82 | 63 | 38 | 19 | 3 | 24 | 40 | 38 | 34 |

For abbreviations of countries see Table 2.

TABLE 3 - a. Lichen species diversity of Italy, b. percentage part of species in common with Italy and c: % percentage additional species (in b, c: Lichen species diversity of Italy in Table 3 a=100%).

lichen species with the difference, that the diversity in Norway and Sweden is even higher than in Italy. The number of saxicolous lichens declines moderately, about 50 % from Italy to Greenland. Very surprising is the very low species diversity decline for the terricolous lichens with only 13 %. The patterns of saxicolous and terricolous lichen diversity differ for acidic and calcareous substrates with two similar trends for rock and soil dwellers as well. The first is that much more lichen species occur on acidic rock or soil than on calcareous (Table 2a) and the second is that the diversity decline from Italy to Greenland is stronger for calciphytic than for acidophytic species due to losses in species numbers (Table 2 a, b), which are not compensated by the additional species (Table 3c). Contrastingly the lichens on acidic substrate share a rather high percentage of species along the whole length of the gradient

(Table 3b), especially the terricolous lichens with the diversity on acidic soil even higher in Greenland than in Italy (Table 2a). Furthermore the losses in "southern" species are compensated by additional "nordic" species in Scandinavia, for the terricolous species even in Greenland (Table 3c).

The countries form three groups according to their floristic similarity (Sørensen dissimilarity coefficients), which display the geographical gradient (Figure 1, Table 4). In the ordination (Figure 1) Italy, Austria and Germany are assembled on one side of an ordination axis. Finland, Sweden and Norway are positioned in the middle with Sweden and Norway very close together and Finland slightly apart. Greenland finally is found on the opposite end. The position of Italy is very near to Austria and Germany and in most cases farthest away from Greenland, which corresponds with the high dissimilarity values (Table 4). The dissimilarity coefficients for Denmark with almost all other countries are high and consequently Denmark is separated on another ordination axis, usually the second. This principal grouping is found for all substrates though the exact positions of the countries vary.

The rather high similarity of the corticolous and xylicolous lichen floras from Italy to Scandinavia in contrast to Greenland, which could be seen from the percentage of species in common (Table 3b), can also be perceived by the rather low Sørensen dissimilarity coefficients (Table 4) and the ordination

| | **I &** | | | | | | | **A &** | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | D | DK | FIN | S | N | GR | D | DK | FIN | S | N | GR |
| all lichens | 27 | 27 | 51 | 43 | 36 | 36 | 58 | 20 | 49 | 38 | 30 | 30 | 53 |
| corticolous | 25 | 22 | 38 | 38 | 31 | 31 | 76 | 15 | 36 | 32 | 25 | 28 | 72 |
| xylicolous | 18 | 22 | 33 | 29 | 24 | 24 | 55 | 15 | 37 | 30 | 24 | 22 | 59 |
| saxicolous | 30 | 31 | 62 | 51 | 43 | 42 | 58 | 24 | 60 | 46 | 36 | 35 | 53 |
| terricolous | 23 | 24 | 48 | 32 | 28 | 28 | 39 | 20 | 47 | 27 | 21 | 23 | 34 |
| saxicolous | | | | | | | | | | | | | |
| acidic | 30 | 32 | 55 | 44 | 40 | 37 | 52 | 23 | 54 | 38 | 33 | 30 | 46 |
| calcareous | 28 | 26 | 69 | 58 | 43 | 48 | 66 | 20 | 67 | 55 | 39 | 44 | 64 |
| terricolous | | | | | | | | | | | | | |
| acidic | 18 | 22 | 30 | 26 | 24 | 27 | 40 | 18 | 30 | 21 | 18 | 22 | 34 |
| calcareous | 27 | 25 | 69 | 43 | 33 | 32 | 41 | 20 | 62 | 32 | 24 | 22 | 35 |

| | **D &** | | | | | **DK &** | | | | **FIN &** | | | **S &** | | **N&** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | DK | FIN | S | N | GR | FIN | S | N | GR | S | N | GR | N | GR | GR |
| all lichens | 41 | 35 | 28 | 29 | 57 | 41 | 44 | 44 | 61 | 23 | 26 | 45 | 15 | 46 | 42 |
| corticolous | 31 | 31 | 22 | 25 | 74 | 35 | 30 | 33 | 69 | 19 | 24 | 63 | 14 | 67 | 68 |
| xylicolous | 36 | 28 | 22 | 23 | 59 | 42 | 40 | 39 | 45 | 21 | 21 | 60 | 17 | 63 | 57 |
| saxicolous | 49 | 42 | 33 | 33 | 55 | 47 | 53 | 52 | 62 | 30 | 30 | 44 | 18 | 44 | 39 |
| terricolous | 37 | 29 | 26 | 28 | 42 | 40 | 44 | 47 | 56 | 15 | 18 | 28 | 11 | 25 | 23 |
| saxicolous | | | | | | | | | | | | | | | |
| acidic | 43 | 35 | 31 | 28 | 50 | 44 | 51 | 49 | 61 | 25 | 26 | 38 | 14 | 39 | 36 |
| calcareous | 59 | 48 | 35 | 38 | 63 | 45 | 57 | 56 | 61 | 38 | 39 | 54 | 27 | 55 | 46 |
| terricolous | | | | | | | | | | | | | | | |
| acidic | 20 | 27 | 24 | 28 | 45 | 33 | 31 | 35 | 49 | 11 | 16 | 26 | 10 | 27 | 25 |
| calcareous | 53 | 28 | 22 | 24 | 37 | 46 | 56 | 54 | 62 | 21 | 17 | 34 | 14 | 30 | 21 |

For abbreviations of countries see Table 2.

TABLE 4 - Sørensen dissimilarity coefficients in %.

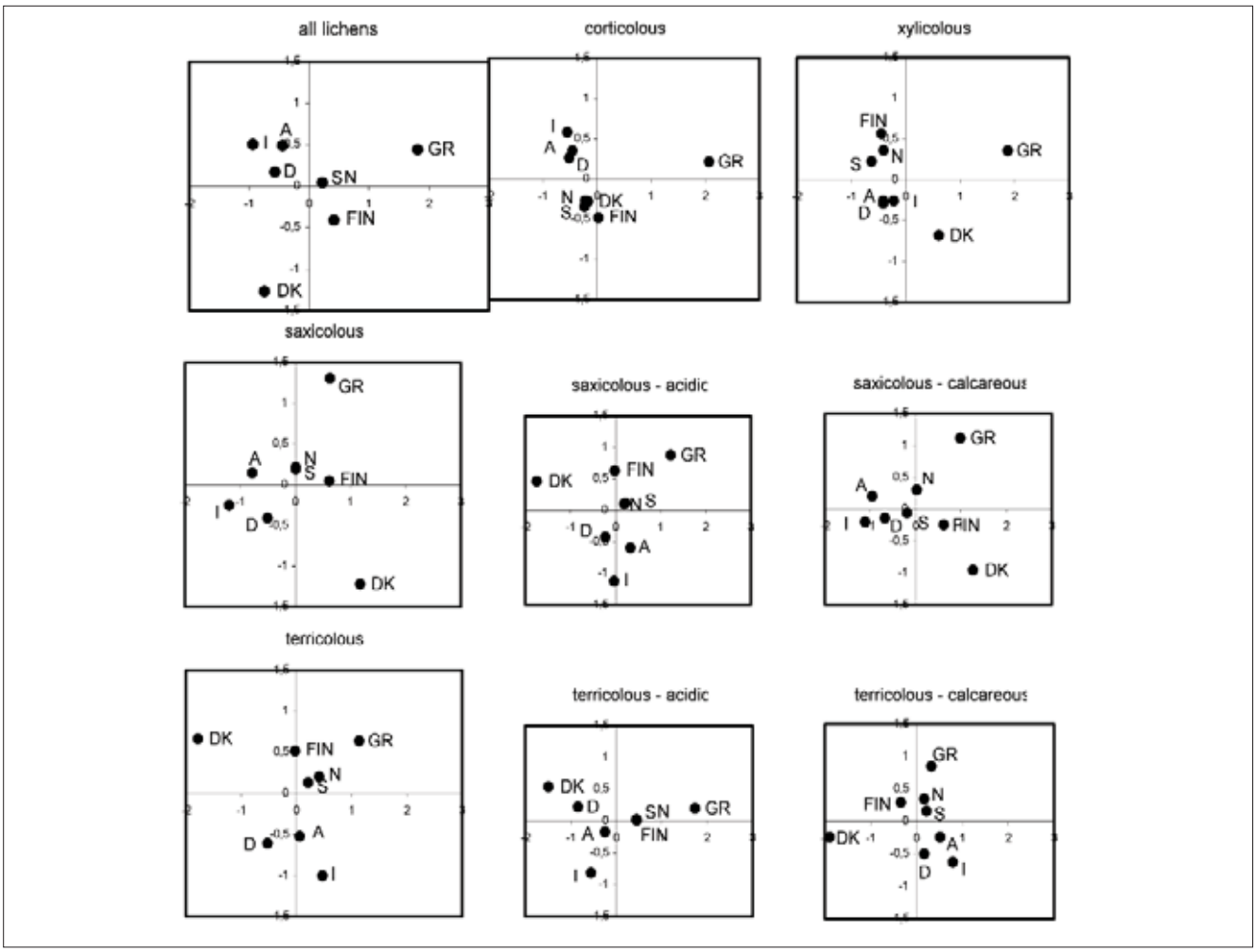


FIGURE 1 - NMDS-Ordination of Sørensen dissimilarity coefficients.

I: Italy, A: Austria, D: Germany, DK: Denmark, FIN: Finland, S: Sweden, N: Norway, GR: Greenland. Only the first two dimensions are shown in the graphs as they represent the gradients in the data sufficiently.

plots with almost all countries close together, only Greenland far apart (Figure 1).

The higher floristic similarity for the lichen species groups on acidic substrate compared with those on calcareous, which has already been shown by the lower losses and higher percentage of species in common with Italy (Table 3 b, c), results also in lower values of the Sørensen dissimilarity coefficients (Table 4).

For abbreviations of countries see Table 2.

## DISCUSSION

The highest species diversity of this study (2266 lichen species) is observed for Italy, the southernmost country, the lowest for Denmark and Greenland, the latter being the northernmost. Nimis & Martellos (2007) mention 2323 lichen taxa for Italy. This difference is caused by them including infraspecific taxa, which have been ignored in the present study, because they could not be separated in the checklists of all study countries.

The observed diversity decline of about 50 % from Italy to Greenland is moderate in contrast to vascular plants, of which 6711 are known from Italy (Abbate *et al.*, 2007) and only 515 from Greenland (Bay, 2003). It is a well known peculiarity of lichen floras, that their relative diversity is higher in polar regions ("Flechten-Koeffizient" by Mattick, 1953). The species diversity decline of bryophytes is with 1130 species in Italy (Aleffi, 2007) and 612 in Greenland (Lund, 2003) is analogue to that of lichens.

The fact, that the relative importance of lichens in the vegetation increases in the Arctic (see also e. g. Ahti & Oksanen, 1990), emphasizes their position as weak competitors (e.g. Grime, 2001). This is also stressed by the observation, that more lichen species have developed as colonisers on rock and bark, where they avoid competition by vascular plants.

High mountains are well known as diversity peaks (e. g. Nagy et al., 2003). The strong positive influence also on lichen species diversity especially of the saxicolous lichens is demonstrated here by the comparison of Austria and Denmark. Both countries are comparatively small. Austria has the second highest diversity in this study whereas Denmark, without any mountains, has the lowest. The high mountain areas in Finland are not very extensive and Finland has clearly less species than Sweden and Norway. The high floristic similarity of meridional Italy and temperate Austria and Germany might be caused by all three countries sharing the many species occurring in the Alps.

The results of this study show, that it is important to evaluate diversity data in the light of background information about species as done here for substrate. That the diversity patterns of lichens vary that pronouncedly for different substrate is demonstrated here for the first time.

The low diversity of corticolous lichens in arctic Greenland is not surprising. The continuous diversity and floristic similarity of corticolous lichens from Italy to Scandinavia may be due to the fact that all Scandinavian countries at least partly reach into the temperate zone with deciduous forest (delimitation of temperate and boreal zone according to Bohn *et al.*, 2000/2003). Astonishing is the low diversity loss and high similarity of the terricolous lichen floras along the whole length of the geographic gradient. The large distribution areas of the terricolous species suggest that they were widely distributed in the periglacial vegetation of the Pleistocene.

The detailed balance of gain and loss of species can only be derived from the original data, while in composed measures like similarity coefficients information is lost. A prominent example is the fact that the Scandinavian and Greenlandic lichen floras of calcareous rock and soil have only few additional "northern" species but almost exclusively loose "southern" calciphytic species, which occur in Italy, Austria and Germany. On the contrary the lichen floras on acidic substrate have not only a large percentage of species in common along the whole gradient but the losses are largely or completely compensated by a considerable number of additional "nordic" species.

Nimis & Martellos (2007) compared the diversity of Italian lichen species of different phytoclimatic elements and found a similar trend with the majority of arctic-alpine species being acidophytes (saxicolous species 42.9 % acidophytes and 13.2 % calciphytes; terricolous: respective 26.1 % and 15.9 %) and of southern species calciphytes (southern-temperate, submediterranean, semi-desert species; e. g. submediterranean saxicolous lichens with 52 % calciphytes and 18.6 % acidophytes).

The higher lichen diversity on acidic than on calcareous substrate is in contrast to observations for vascular plants: numerous studies have shown that the diversity of vascular plants is higher on calcareous than on acidic soil (see e. g. Ewald, 2003). The preference of lichens for acidic substrates is not an artefact due to the choice of data sets. It is confirmed by the Ellenberg indicator values with a majority of vascular plants being calciphytes and a

majority of lichens being acidophytes (Ellenberg, 2001; Wirth, 2001; Bültmann, 2006).

The reasons for this phenomenon are not known, neither for vascular plants (see Ewald, 2003) nor for lichens. The present explorative study cannot give explanations but it adds a contrasting point to the discussions about diversity and pH value.

It is shown here, how important it is to include characteristics of both study areas and of species in the interpretation of diversity data. However is less easy to gather the data for lichen species characteristics than for vascular plants. Vascular plant traits are already compiled in several databases (e. g. Grime *et al.*, 1988; Hodgson *et al.*, 1995; Klotz *et al.*, 2002; Kleyer *et al.*, 2008), for lichens this is a future task.


## Acknowledgements

The author wants to express sincere gratitude to all organisers of the workshop of the European Vegetation Science 2009 in Rome, by name Francesco Spada and Sandro Pignatti, Roma.

Thanks are also due to Fred Daniëls, Münster, for stimulating this work and his help in improving the manuscript.


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alle

| | | | | |
|---|---|---|---|---|
| I | -0,92797 | 0,50962 | I | |
| A | -0,43935 | 0,49268 | A | |
| D | -0,56828 | 0,17358 | D | |
| DK | -0,75563 | -1,26068 | DK | |
| F | 0,41635 | -0,41494 | F | |
| S | 0,22908 | 0,03942 | S | |
| N | 0,22941 | 0,03965 | N | |
| GR | 1,8164 | 0,42068 | GR | |
| 0 | 0 | 0 | | |

cor

| | | | | | |
|---|---|---|---|---|---|
| 1 | -0,54412 | 0,56572 | 0,04423 | 0,39456 | -0,1479 |
| 2 | -0,4456 | 0,35442 | 0,13521 | -0,40298 | 0,05909 |
| 3 | -0,53213 | 0,26096 | -0,01862 | -0,19747 | 0,00688 |
| 4 | -0,14499 | -0,24407 | -0,86816 | 0,01844 | -0,00892 |
| 5 | 0,01735 | -0,48848 | 0,2791 | -0,03513 | -0,39436 |
| 6 | -0,2267 | -0,34943 | 0,17064 | 0,0198 | 0,12604 |
| 7 | -0,21771 | -0,30423 | 0,24363 | 0,20649 | 0,3297 |
| 8 | 2,0939 | 0,2051 | 0,01396 | -0,00372 | 0,02947 |
| 0 | 0 | 0 | 0 | 0 | 0 |

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| | | | |
|---|---|---|---|
| 1 | -0,14694 | -0,26898 | 0,20169 |
| 2 | -0,41988 | -0,24557 | 0,3953 |
| 3 | -0,48249 | -0,29155 | 0,3085 |
| 4 | 0,64263 | -0,75418 | -0,57219 |
| 5 | -0,51228 | 0,58413 | -0,38735 |
| 6 | -0,64136 | 0,21972 | -0,15676 |
| 7 | -0,43774 | 0,36754 | 0,00514 |
| 8 | 1,99806 | 0,38888 | 0,20567 |
| 0 | 0 | 0 | 0 |

sax

| | | |
|---|---|---|
| 1 | -1,07965 | -0,31795 |
| 2 | -0,77226 | 0,13143 |
| 3 | -0,50753 | -0,36226 |
| 4 | 0,98587 | -1,39345 |
| 5 | 0,66788 | 0,14415 |
| 6 | 0,11237 | 0,18587 |
| 7 | 0,11015 | 0,19049 |
| 8 | 0,48316 | 1,42171 |
| 0 | 0 | 0 |

ter

| | | |
|---|---|---|
| 1 | 0,45626 | -1,00614 |
| 2 | 0,08455 | -0,52604 |
| 3 | -0,52172 | -0,63182 |
| 4 | -1,77979 | 0,66748 |
| 5 | 0,01445 | 0,51149 |
| 6 | 0,24396 | 0,07435 |
| 7 | 0,4048 | 0,2304 |
| 8 | 1,09749 | 0,68027 |
| 0 | 0 | 0 |

sax-sil

| | | |
|---|---|---|
| 1 | -0,12569 | -1,12656 |
| 2 | 0,27355 | -0,63268 |
| 3 | -0,2456 | -0,38713 |
| 4 | -1,70689 | 0,6042 |
| 5 | 0,03979 | 0,61128 |
| 6 | 0,24231 | 0,09404 |
| 7 | 0,23769 | 0,06418 |
| 8 | 1,28483 | 0,77268 |
| 0 | 0 | 0 |

sax cal

| | | |
|---|---|---|
| 1 | -1,10593 | -0,17242 |
| 2 | -0,94675 | 0,18053 |
| 3 | -0,73192 | -0,12951 |
| 4 | 1,26204 | -0,96726 |
| 5 | 0,5343 | -0,22919 |
| 6 | -0,09607 | -0,07727 |
| 7 | 0,10439 | 0,22857 |
| 8 | 0,97994 | 1,16654 |
| 0 | 0 | 0 |

ter-sil

| | | |
|---|---|---|
| 1 | -0,68242 | -0,62009 |
| 2 | -0,23783 | -0,15066 |
| 3 | -0,82714 | 0,11537 |
| 4 | -1,49545 | 0,44924 |
| 5 | 0,49246 | 0,00041 |
| 6 | 0,47314 | -0,0175 |
| 7 | 0,50095 | -0,0247 |
| 8 | 1,77628 | 0,24792 |
| 0 | 0 | 0 |

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|---|---|---|---|---|
| 1 | 0,81321 | -0,6587 | 0,38434 | 0,28974 |
| 2 | 0,54524 | -0,22654 | -0,15938 | -0,47569 |
| 3 | 0,19826 | -0,53283 | -0,10552 | -0,07103 |
| 4 | -1,91858 | -0,26484 | 0,23137 | -0,0641 |
| 5 | -0,34388 | 0,31697 | -0,40398 | 0,26075 |
| 6 | | 0,23189 | -0,38349 | 0,12882 |
| 7 | 0,11879 | 0,30402 | -0,08376 | 0,01831 |
| 8 | 0,33738 | 0,83004 | 0,52043 | -0,08681 |
| 0 | 0 | 0 | 0 | 0 |