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Biodiversity of terricolous lichen vegetation

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Zusammenfassung

Der Artenreichtum acidophytischer Erdflechtenvegetation wurde für temperate (NW-Deutschland, N-Dänemark), boreale (Finnland) und arktische Regionen (SO-Grönland) untersucht. Flechten sind eine der Ausnahmegruppen von Organismen, deren Artenreichtum zu nördlichen Breiten nicht abnimmt. Strauchflechten tragen i. d. R. den größten Anteil zum Artenreichtum von Erdflechten bei, in der Arktis zunehmend auch Krustenflechten.

Bestände mit intermediär intensiver und hoch frequenter Störung und intermediäre Sukzessionsstadien weisen hohe Artenzahlen auf. Die Artenreichtum-Biomasse-Kurven für die Sukzessionsreihe der acidophytischen Erdflechtenvegetation entsprechen weitgehend den Erwartungen nach dem „humped back model" von GRIME (1979). Allerdings sind in der Arktis biomassereiche Bestände verhältnismäßig artenreich durch die Omnipresenz von Störung und Stress.

1. Introduction

A lichen thallus is considered as a miniature ecosystem composed of one or several fungi and one or several algae respectively cyanobacteria. Hence considering autotrophy, lichens are a convergent development to green plants. Presumably, factors determining biodiversity of higher plants (see a. o. GRIME 1979, MAAREL 1997, PALMER 1994, SHMIDA & WILSON 1985) are valid for lichens as well.

2. Methods

Species richness of terricolous lichen vegetation from non-calcareous substrates was studied by means of uniform plots (50 cm x 50 cm). All observed vegetation types from temperate (northern Germany: 111 plots, northern Denmark: 85 plots), boreal (Finland: 140 plots) and low-arctic regions (south-eastern Greenland: 152 plots) were compared.

Species richness of lichens refers to lichenised mycobionts. The species concept and nomenclature of lichens principally follows VITIKAINEN et al. (1997). All lichens occurring in the plots were assigned to growth forms of BARKMAN (1988).

3. Results and discussion

Though the lichen flora of Germany encompasses more species than the lichen flora of Greenland (Tab. 1, 1. col.), species richness of lichens (number of species per unisized plot) considerably increases from Germany to Greenland (Tab. 1, 4. and 5. col.). Most organisms show a decline in diversity from equatorial to northern latitudes. Lichens are one of the exceptions (see a. o. MATTICK 1953).

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Tab. 1: Aspects of diversity of lichen flora and lichen vegetation

	DIV FLO	IN PLO	species richness lichens/plot all min.	species richness lichens/plot all mean	species richness lichens/plot all max.	species richness lichens/plot frutic. mean	species richness lichens/plot crust. mean	species richness lichens/plot folios. mean	species richness total/plot mean	species richness total/plot max.	NU PLO	NU MC
Germany	1674 [1]	66	1	8,5	19	6,9	1,5	0,1	16,3	26	111	37
Denmark	919 [2]	61	1	10,1	22	8,8	0,9	0,3	17,7	41	85	26
Finland	1458 [3]	100	1	10,6	29	9,5	0,9	0,2	16,7	39	140	35
Greenland	1013 [4]	160	2	18,6	47	12,0	5,7	1,0	31,3	71	152	36

DIV FLO: Species diversity of lichen flora
1: Wirth 1994; 2. Alstrup & Søchting 1989; 3. Vitikainen et al. 1997; 4. unpubl. Checkliste Kopenhagen
IN PLO: Species number of lichens occurring in all plots
NU PLO: Number of studied plots
NU MC: Number of studied microcommunities

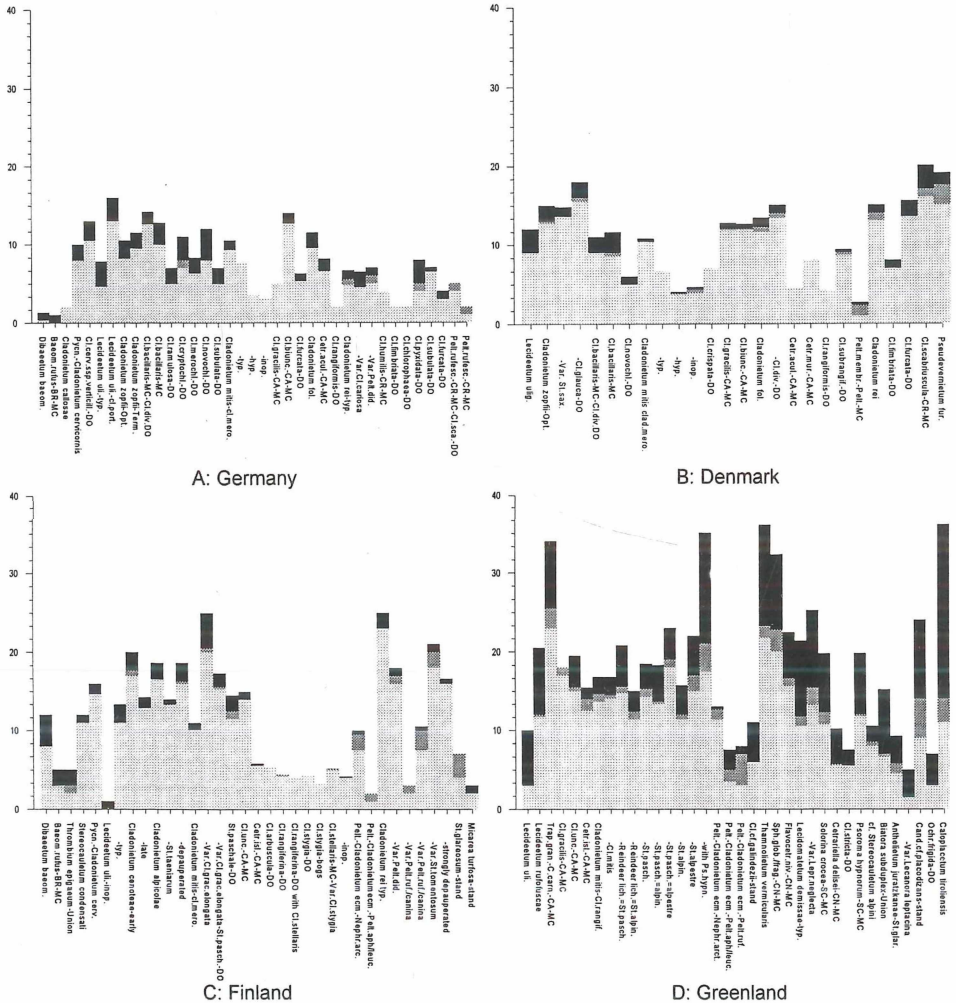
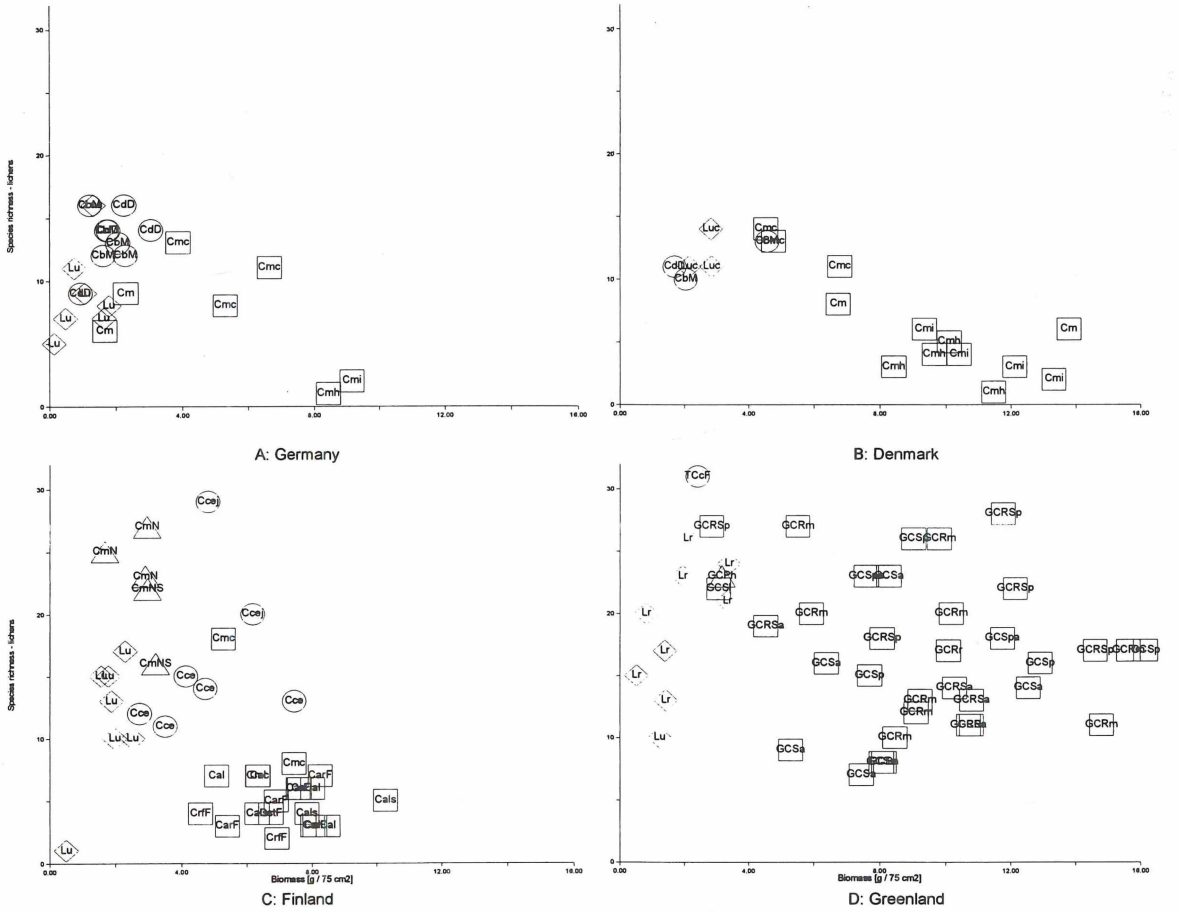


Fig. 1: Mean species richness of lichens for each microcommunity
light grey: fruticose dark grey: foliose black: crustose lichens
(Abbrev.: MC: microcommunity, DO: stand with one species dominant)



rhombi: pioneer stages

Lu: Lecideetum uliginosae typ.;
Luc: cladonietosum portentosae;
Lr: Lecideetum rufofuscae

circles: intermediate stages

CbM: *Cl. bacillaris*-microcommunity;
CdD: with *Cl. diversa* dominant;
Ccej: Cladonietum cenoteae early;
Cce: Cladonietum cenoteae later;
TCcF: *Trapeliopsis granulosa-Cl. carneol.* MC

quadrats: late stages

Cm: Cladonietum mitis typ.;
Cmc: cladonietosum merochloroph.;
Cmh: hypnetosum; Cmi: inops;
CarF: *Cl.arbuscula*-MC;
CrfF: *Cl. rangiferina*-MC,
CstF: *Cl. stygia*-MC;
Cals: *Cl. stellaris*-MC with *Cl. stygia*,
Cal: *Cl. stellaris*-MC inops;

GC: Cladonietum mitis Greeland, different species dominant:
Rr: *Cl. rangiferina*, Rm: *Cl. mitis*,
Rsp: reindeer lichens and *Stereocaulon paschale*,
Rsa: reindeer lich. and *St. alpinum*,
Sp: *St. paschale*,
Spa: *St. paschale* and *alpinum*,
Spl: *St. paschale* and *alpestre*,
Sa: *St. alpinum*, Sl: *St. alpestre*

trigones: later stages with highly frequent disturbance

In C: CmN, CmNS: Cladonietum mitis with grazing by reindeer: Var. of *Cl. gracilis elongata* and *St. paschale*,
CmNS: *St. paschale* dominant;
In D: GCPh: disturbed with *Psoroma hypnorum*-fragm. MC

Fig. 2: Species richness-biomass-relationship for succession of terricolous lichen vegetation on acidic substrate

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The fruticose growth form contribute most to species richness, followed by the crustose. The contribution of foliose lichens is small for all study areas. In Greenland, crustose lichens are clearly more prominent and foliose lichens occur more constantly but still in low numbers.

The species richness of lichens was found to be highly correlated with the number of growth forms according to BARKMAN (1988) (Pearson-coefficient: Germany: 0.87; Denmark 0.91; Finland 0.88; Greenland 0.77).

Species richness is high in stands with intermediately intensive but rather frequent disturbance and stress (later stages of *Cladonietum zopfii, Cladonietum mitis* variant of *Cl. gracilis elongata* (grazing by reindeer)). Especially lichen vegetation of windexposed sites in the low-arctic is rich in species (*Thamnolietum vermicularis, Sphaerophorus globosus/fragilis* microcommunity).

In the course of succession late pioneer and intermediate stages show an abundance of lichen species (e. g. *Lecideetum uliginosae cladonietosum merochlorophaeae, Cladonietum cenoteae, Trapeliopsis granulosa-Cl. carneola* microcommunity, *Cladonietum alpicolae*).

The extraordinarily high species richness in windexposed stands is presumably caused by the fine-grained micropattern of microhabitats, which enables species with such different habitat demands as chiono- and achionophytic species to grow together in one plot.

It is well-known that neutral to basic substrates usually achieve higher species richness than acidic. As this study focuses on non-calcareous substrates only one plot of the *Caloplacetum tiroliensis* is represented here (Fig. 1D: Greenland, last col.).

The species richness-biomass-relationship (GRIME's (1979) „humped back model") displays the dependence of species richness from disturbance and stress. The relationship is exemplarily demonstrated for the succession of terricolous lichen vegetation on acidic and nutrient poor substrate (Fig. 2A-D).The species richness-biomass-relationship for the succession sequence of terricolous acidophytic lichen vegetation mainly shows the presumed features. Species poor pioneer stands, dominated by crustose lichens, are poor in biomass; intermediate stages, often with numerous cup- or hornlike *Cladonia* species, are rich in species and intermediate in biomass; climax stages are usually species poor and the dominant reindeer lichens or large *Stereocaulon* species contribute a high amount of biomass. Frequently disturbed later stages (e. g. grazed by reindeer) are similar to intermediate stages (Fig. 2 C+D: CmN, CmNS, GCPh).

For Greenlandic plots the decline in species richness at high biomass values is barely observable. Stress and frequent disturbance (e. g. cryoturbation) reduce the vitality of the competitive species and cause a micropattern of microhabitats. The most important factor determining species richness at this level of observation appears to be the diversity of microhabitats.

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