THE LICHEN SYNTAXA IN THE CHECKLIST OF HIGHER SYNTAXA OF EUROPE – AN OVERVIEW AND WHAT WE CAN DO WITH THEM

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ABSTRACT – A Checklist of Higher Syntaxa of Europe includes lichen syntaxa from the eulittoral to the nival zone, in all 15 classes, 31 orders and 63 alliances of lichen syntaxa and five mixed lichen/bryophyte classes with 12 lichen alliances. Syntaxa diversity is highest for rock substrates, followed by bark, then soil, which corresponds with species diversity of lichens. The most important habitat factors to explain floristic differences on class level are type of substrate and source of moisture. The evaluation of the state of research shows a rather well established system of cryptogam syntaxa, however with gaps in the knowledge of the distribution of syntaxa. The epiphytic vegetation is dynamic due to changes in air pollution (less SO₂, more nutrients) and global change. Formal problems with the terms synusiae/microcommunities are discussed. Lichens are established as bioindicators. Species and syntaxa can help to screen air purity, forest quality, water quality, global change and also microhabitat factors. Cryptogam syntaxa are especially suited to explain complexity of the vegetation on the microhabitat level.

KEYWORDS: BIOINDICATION, COMPLEXITY, CRYPTOGRAMS, MICROCOMMUNITIES, SYNUSIAE, VEGETATION

INTRODUCTION

Distinct combinations of plant species with a typical habitat are described as plant communities or syntaxa. The method most commonly applied in Europe is the Braun-Blanquet-approach (e.g. Westhoff & Van der Maarel, 1973). Communities of this approach are sorted in a hierarchical system with the main levels of descending rank class, order, alliance and association. The names of syntaxa are governed by the “Code of Phytosociological Nomenclature” (Weber et al., 2000). Also distinct combinations of cryptogam species with a typical habitat have been recognized as syntaxa since the early days of vegetation description (e.g. Frey, 1923; Gams, 1927; Ochsner, 1928). Compilations of plant communities of countries included chapters listing cryptogam syntaxa (e.g. Klika & Hadac, 1944; Klika, 1948; Tomaselli, 1956; Westhoff & Den Held, 1969). Synopses of cryptogam syntaxa followed (lichens e.g. Klement, 1955; Barkman, 1958; Wirth, 1972; 1995, James et al., 1977; Drehwald, 1993; bryophytes e.g. Hübschmann, 1986; Dierssen, 2001; Marstaller, 2006, algae e.g. den Hartog, 1959; Pignatti, 1962; Giaccone, 1965) and also bibliographies (Delzenne-van Haluwyn, 1976; Liska, 1984). Cryptogam communities differ in their degree of independence from surrounding vascular plants. Communities on rock are indisputable independent. Epiphytic communities grow on trees, however in most cases they are not specific for one tree species or genus, but for several tree species with similar physical and chemical bark properties. In some cases commonly epiphytic communities can grow on consolidated soil or on rock. Bryophytes and lichens on soil frequently intermingle with vascular plants. Therefore the position of their communities as dependent part of the vegetation within plant communities (e.g. as synusiae) or as independent communities is discussed (Wilmanns, 1966; Barkman, 1968, 1973; Marstaller, 2006). However as most species combinations also occur independently or in gaps within the
vegetation, those syntaxa with a high degree of independence are included in the syntaxonomical system of cryptogam communities side by side with syntaxa on rock and bark (e.g. Drehwald, 1993; Paus, 1996; Dierssen, 2001; Marstaller, 2006).

Barkman (1973) proposes either synusia or microcommunities as name for the cryptogam syntaxa. Both are defined by characteristic floristic compositions and microhabitats, but in a synusia additionally all species belonging to one stratum and exploiting the environment in a similar way. A typical example of a vascular plant synusia is the group of spring geophytes in a forest community or of a lichen synusia the reindeer lichens in the ground cover of a pine forest. The latter two restrictions are not always fulfilled for the cryptogam syntaxa: e.g. they can include a layer of crust-like lichens together with shrubby lichens or parasitic lichens with purely autotrophic lichens. Thus the name “microcommunity” seems more appropriate. Nomenclature from the synusial system for cryptogam units has also led to erroneous declarations of invalidity of the concerned syntaxa (e.g. Müller & Otte, 2008), though cryptogam syntaxa defined by floristic-sociological criteria are all subject of the International Code of Syntaxonomical Nomenclature (Weber et al., 2000 Definition I) disregardful of being named communities (e.g. Marstaller, 2006), microcommunities (Bültmann, 2005) or synusiae (Dierssen, 2001, Paus, 1997; Wirth, 1972).

A conspectus of the highest syntaxonomical level, the classes, of Europe, classes, has been published more than ten years ago (Mucina, 1997). Since then an updated list extended to the higher syntaxa from alliances to classes has been elaborated (Mucina & the team of the Euro-checklist, 2009) and will be published soon (Mucina et al., in prep.). This new elaborated (Mucina & the team of the Euro-checklist, 2009) the higher syntaxa from alliances to classes has been published more than ten years ago (Mucina, 1997). Since then an updated list extended to the synusial system for cryptogam units has also led to erroneous declarations of invalidity of the concerned syntaxa (e.g. Müller & Otte, 2008), though cryptogam syntaxa defined by floristic-sociological criteria are all subject of the International Code of Syntaxonomical Nomenclature (Weber et al., 2000 Definition I) disregardful of being named communities (e.g. Marstaller, 2006), microcommunities (Bültmann, 2005) or synusiae (Dierssen, 2001, Paus, 1997; Wirth, 1972).

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**THE LICHEN SYNTAXA**

Abbreviations after the class name show the numbers of orders and alliances: L: lichen syntaxa, B: bryophyte syntaxa, O: orders, A: alliances

Ceratodonto purpurei-Polytrichetae piliferi Mohan 1978 – L: O-1, A-7 (B: O-1, A-2)

On soil: acidic to subneutral, at least acidic humus-patches.

Peligeretalia caninae-rufescensis Klement 1949:


On soil: neutral to calcareous.


Ephemeral lichen species (e.g. Gregorella humida, Thelocarpus spp.) are known from arable fields (probably in bryophyte communities of Phascion cuspidati Waldheim ex von Krusenstjerna 1945). They have never been included in relevés and thus their syntaxonomical position is unknown.


On soil & raw humus, sciophytic.


Platyhypnio-Fontinalietea antipyreticae Philippi 1956

On rock, mostly submerged in running water Few characteristic lichen species occur within the bryophyte communities.

Aspicilietea lacustris Wirth 1972 – L: O-1, A-4

On rock, more or less permanently submerged in clear water.


Verrucarietalia maurus Drehwald 1993 – L: O-1, A-1

On rock, halophytic, from the Eulittoral to mesic Supralittoral.

**Claudadeetalia immersae** Roux ex Roux 2009 – L: O-2, A-6
On rock, limestone, low nutrient level, typical growth form endolithic lichens.

**Verrucarietalia parmigerae** Roux ex von Brackel 1993

**Thelidietalia decipiens** Roux ex von Brackel 1993

**Verrucarietalia nigrescentis** Wirth 1980 – L: O-3, A-8
On rock, limestone, medium to high nutrient level.


**Rhizocarpetea geographici** Wirth 1972 – L: O-6, A-15
On rock, siliceous.

**Rhizocarpetalia obscurati** Wirth ex Wirth 1980 moister habitats than following, shaded or near the soil: *Lecideion tumidae* Wirth 1972.


**Umbilicarietalia cylindricae** Oberdorfer ex Klika et Hadač 1944 upper montane to nival or arctic: *Rhizocarpiion alpicola* Frey ex Klement 1955 (pioneer, growth form mainly crustose), *Umbilicarietalia cylindricae* Frey 1933 (growth form mainly foliose).

**Aspicielietea candidae** Asta et Roux ex Roux prov. – L: O-2, A-3
On rock, calcareous schists and decalcified calcareous rocks, subalpine-alpine, only short-time snow covered.


**Lecideetalia conflescentis** Roux prov. not thermophytic: *Lecideion conflescentis* Roux ex Roux prov.

**Porpidietea zeoroidis** Roux prov. – L: O-1, A-1
On rock: calcareous schists and decalcified calcareous rocks, subalpine-alpine, prolonged snow cover.

**Porpidietalia zeoroidis** Asta et Roux ex Roux prov.: *Porpidion zeoroidis* Asta et Roux ex Roux prov.

**Collematetalia cristati** Wirth 1980 – L: O-1, A-3
On rock, calccareous or base-rich rocks, seepage or drip water.


**Leprarietales chlorinae** Wirth 1972 – L: O-1, A-2
On rock: siliceous rocks in rain-shade.


**Roccelletalia phycopsis** Egea ex Egea prov. – L: O-2, A-3
On rock, siliceous or carbonatic rocks in rain-shade, halotolerant, mainly in coastal areas of Europe and northern Africa.

**Dirinietalia massiliensis** Egea ex Egea prov. on carbonatic rocks: *Roccellion phycopsis* Egea et Llimona 1984.

Neckeretia complanatae Marстaller 1986 – L: A-1? (B: O-1, A-2)

or Frullanio dilatatae-Leucodontetea sciroidis Mohan 1978 – L: A-1? (B: O-3, A-10)

On non-acidic partly soil covered rocks or on bark Lobaria pulmonariae Ochsner 1928 (attrition of this alliance to one of the classes above unclear).

Arthonio radiatae-Lecidelletea elaeocromae Drehwald 1993 – L: O-3, A-4

On bark: smooth bark, neutrophytic - moderately acidophytic, not very toxitolerant.

Bacidinetalia phacodis Bricaud et Roux prov. on porose bark: Agonimion octosporae Bricaud et Roux prov.

Graphidetalia scriptae Hadač in Klika et Hadač 1944 on very smooth bark: Graphidion scriptae Ochsner ex Felföldy 1941 (rather aerohygrophytic, preference for Fagus), Lecanorion subfuscae Ochsner 1928 (pioneer, more tox- and xerotolerant).

Schismatommetalia decolorantis Bricaud et Roux prov. thermomediterranean to thermoatlantic, subhumid, coastal: Bactrosporion patellarioidis Roux et Bricaud prov.

Alectorietea Hadač 1962 – L: O-2, A-7

On bark and twigs, acidic, rather nutrient poor, rather high air humidity.

Alectorietalia Dahl et Hadač in Klika et Hadač 1944 dominant growth forms fruticose and foliose lichens, sensitive to air pollution: Cetrarion pinastri Ochsner ex Kusan 1933 (high air humidity or prolonged snow cover), Parmelion physodis Beschel 1958 (rather exposed, dominated by medium sized foliose or fruticose lichens), Parmelion perlatae James, Hawksworth et Rose 1977 (slightly nitrophitic or neutrophytic, oceanic, large foliose species dominant), Parmelion laevigateae James, Hawksworth et Rose 1977 (similar to previous but more acidic & nutrient-poor due to leaching of bark by heavy rain), Usneion barbatae Ochsner 1928 (temporary high air humidity by fog or clouds, beard-like lichens typical).


Physcietia adscendentis Tomaselli et De Micheli 1952 – L: O-1, A-2

On bark, nitrophytic.

Physcietalia adscendentis Hadač in Klika et Hadač 1944: Buellion canescens Barkman 1958 (less nitrophytic than following), Xanthorion parietinae Ochsner 1928 (strongly nitrophytic).


On leaves, in Europe mainly meridional or macaronesian.


Leprarietea candelaris Wirth 1980 – L: O-1, A-2

On bark, in rain-shade.

Leprarietalia candelaris Barkman 1958: Calicion hyperelli Černohorský et Hadač in Klika et Hadač 1944 (less scio- and aerohygrophytic than the following), Leprariion incanae Alborn 1948 (very scio- and aerohygrophytic, leprose lichens dominant).

The present checklist of cryptogram syntaxa comprises 26 classes with 50 orders and 130 alliances. Six classes include only bryophyte syntaxa, 15 classes only lichen syntaxa and five classes are mixed. In two other bryophyte classes lichen species are characteristic, however with low diversity and without participating in names.

With ten classes and 46 alliances the diversity of lichen syntaxa is highest for rock habitats and syntaxa are known from the Eulittoral to the alpine zone. Five classes with 17 alliances are epiphytic. This includes one class from leaves and needles. The terricolous lichen syntaxa belong to three mixed lichen/bryophyte classes with 12 lichen dominated alliances.

The diversity of lichen syntaxa corresponds with the diversity of lichen species, which is highest on rocks, followed by bark and lastly soil (Bültmann, 2010).

The classes are distinguished by substrate type (rock, bark, leaves, soil), substrate chemistry (calcareous–non-c., nitrophitic–non-n., halophytic–non-h.), source of water (submerged–seepage–rain, fog or dew–air humidity) and once snow cover duration (short–prolonged). Orders are distinguished by special substrate chemistry (occurrence of heavy metals), climate factors (thermophytic–non-t., arid–non-a., altitudinal belts) and light conditions (shaded–exposed). Alliances represent succession stages and gradual differences of habitat factors.

Reason for substrate and source of moisture being such important for the floristic composition is that lichens are passively subjected to their environment and that the growth form of lichens is important for the exploitation of water (Rundel, 1982).
STATE OF RESEARCH

The cryptogamic vegetation of Europe is rather well explored for the countries with a tradition in vegetation description, e.g. France (Asta & Roux, 1977; Roux, 1981; Bricaud, 2005; Menard, 2009; Roux et al., 2009), Germany (Wirth, 1972; Paus, 1997), Italy (Nimis, 1984; Zedda, 2001), the Netherlands (Daniels & Harkema, 1992), Poland (e.g. Bieleczyk, 1986), Spain (Crespo, 1975; Crespo & Bueno, 1984; Egea & Llimona, 1987; Casas-Porcel & Gutiérrez-Carretero, 1993), former Yugoslavia (Kusan, 1933) etc. Less studied is northernmost Europe (Klement, 1959; Daniëls, 1975; Creveld, 1981; Bültmann, 2005).

Lichen vegetation on rock is rather well known (e.g. Wirth, 1972; Roux, 1981; Egea & Llimona, 1987; Menard, 2009), however the alpine rock vegetation seems underrepresented (e.g. Frey, 1922, 1937; Klement, 1965; Gloßner & Türk, 1999).

Also the corticolous lichen vegetation is well studied (e.g. Ochsner, 1928; Barkman, 1958). Strong changes affected the cryptogamic epiphytes in the 19th and 20th century. First high air pollution led to a dramatic decrease in the diversity in all areas subjected to SO2-emission. Efforts to improve air purity allowed bark lichens to come back since around 1980. However influence of global warming (van Herk et al., 2002; van Herk, 2009) and eutrophication caused by cattle farms and recently along roads also by catalytic converters of cars (van Herk, 2009) could be observed from long-term studies of epiphytic lichens in the Netherlands. Thus the epiphytic lichen vegetation is in many parts of Europe not identical to the original flora. Follicolous lichen syntaxa are well known in Europe (Bricaud et al., 2009), however should be studied in Macaronesia and in context with follicolous bryophyte syntaxa (Zippel, 1998).

Terricolous lichen syntaxa of lowland to montane areas are well known (e.g. Paus, 1997; Crespo & Barreno, 1978). Probably gaps of knowledge exist in S Europe including Macaronesia and also N Europe. Little is known about the syntaxonomical position of the inconspicuous ephemeral taxa.

Considering the comparatively small number of researchers, the existing system of cryptogam syntaxa is well established. Still, as most research was restricted to one country, there are gaps in the knowledge of the distribution areas. Also the merging of bryophyte and lichen syntaxa is probably not complete.

Lichen taxonomy is very intensively studied at the moment and frequent changes in lichen species concepts also affects characteristic species (e.g. Caloplaca saxicola-group) and new species are potentially good character species but have never been recorded or knowingly named in plots. The checklist will be the first synopsis of lichen syntaxa on a large scale and including all substrates after Klement (1955) and hopefully will simplify and stimulate the use of the existing but neglected cryptogam syntaxa.

WHAT CAN WE DO WITH LICHEN SYNTAXA?

Lichen species are known to be excellent bioindicators. Established are lichens as bioindicators of air purity. The approaches in present use avoid problematic species and thus can be applied by non-lichenologists (e.g. VDI, 1995). Lichens are also used to estimate forest quality (e.g. Rose, 1976; Zedda, 2002), water quality (Thüs, 2002) and recently, global change (e.g. van Herk, 2002). Ecological indicator values have been established for lichens same as for vascular plants and bryophytes (Bültmann, 2006; Wirth, 2010). In addition, lichen species and communities can indicate presence of heavy metals (Acarosporetalia sinopicae). Vegetation displays habitat, cryptogam vegetation microhabitat. Cryptogam syntaxa display number and distribution of microhabitats, in short, they are good indicators of complexity.

Schuwwerk (1986) studied complexity of forest phytocoenoses and added cryptogam syntaxa with a cover value to a phytosociological table instead of species. Studies of the author in arctic and alpine vegetation showed that high richness in plots, which could be as high as 47 lichen species on an area of 50 x 50 cm2 is due to co-occurrence of species of several higher syntaxa: of the class Ceratodonto-Polytrichetea with alliances Cladonion arbusculae on acidic soil, Cetrarion nivalis in the upper exposed layer, Solorion croceae in the gaps and Ochrolechion tartareae and Lecanorion verrucosae on plant debris and moss cushions. This microhabitat complexity is well shown by the cryptogam syntaxa, which can be used to explain the high diversity in certain types of terricolous vegetation, e.g. in the Arctic.

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