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Tuexenia 37: 143–161. Göttingen 2017.
doi: 10.14471/2016.37.022, available online at www.tuexenia.de

Retamoid scrubs of the *Cytisetea scopario-striati* in the Netherlands: a new approach to classify marginal associations

Rutenstrauchgebüsche der *Cytisetea scopario-striati* in den Niederlanden: ein neuer Ansatz zur Klassifikation von Marginalassoziationen

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Abstract

Marginal associations, *i.e.* floristically impoverished associations at the margin of the distribution area of a higher syntaxon, form a problem in vegetation classification, because true character species are lacking. We propose a new approach for the classification of such marginal associations, making use of the notion of 'chorological tension zones'. In the absence of true character species, the species from other syntaxa of the same formation can be used as such. Our proposal is to use the species group from every formation-true class only once within every marginal alliance, to limit the number of possible marginal associations. This approach is illustrated in a classification of the retamoid thickets in the Netherlands. On the basis of a numerical-subjective classification of the relevant species in the scrub layer and the evaluation of relevant literature, we conclude that the broom and gorse thickets in the Netherlands can be assigned to the *Cytisetea scopario-striati* Rivas-Mart. 1974, which is represented by four associations, each of which is characterised by the species of other scrub classes. The *Ulici europaei-Sarothamnion scoparii* Doing ex Weber 1997 is represented by the *Rubo plicati-Sarothamnetum scoparii* Weber 1987 and the *Crataego monogynae-Cytisetum scoparii* R. Haveman, I. de Ronde & J.H.J. Schaminée ass. nov., the *Ulici europaei-Cytision striati* Rivas-Mart., Báscones, Díaz, Fern. Gonz. & Loidi 1991 by the *Frangulo alni-Ulicetum europaei* De Foucault 1988 and the *Rubo ulmifolii-Ulicetum europaei* J.-M. Géhu ex R. Haveman, I. de Ronde & J.H.J. Schaminée ass. nov. This classification is based on a restricted dataset though, and a revision, based on a larger dataset from a wider region has to prove the tenability of the classification.

Keywords: character species, chorological tension zone, classification, *Cytisus scoparius*, differential species, distribution area, synchorology, syntaxonomy, *Ulex europaeus*

Erweiterte deutsche Zusammenfassung am Ende des Artikels

Manuscript received 08 July 2016, accepted 09 November 2016
Co-ordinating Editor: Erwin Bergmeier

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1. Introduction

Thickets of retamoid species (woody plants with strongly reduced leaves and photosynthesising branches) have their European centre of distribution in the Mediterranean-Atlantic vegetation zone, where the main constituent genera (*Genista*, *Cytisus*, *Adenocarpus*, and *Retama*) have evolved into many different species. The highest variation in retamoid scrub types in Europe, comprised in the class *Cytisetea scopario-striati* Rivas-Mart. 1974, is found in the Iberian Peninsula (COSTA et al. 2003, ANGIOLINI et al. 2007, GAVILÁN et al. 2011, PINTO-GOMES et al. 2012, DE FOUCAULT et al. 2013). To the north, these thickets become more and more restricted to a narrow zone along the Atlantic coast, step by step losing most of the typical species until only *Ulex europaeus* and in the end *Cytisus scoparius* are left, occasionally accompanied by the Mediterranean-Atlantic bramble species *Rubus ulmifolius*, which can be abundant in these thickets further south (WEBER 1998b). At the northern border of their distribution areas, limited by winter's cold (WEBER 2003), the mentioned species are often not able to form closed scrublands. Here, they are generally found as individual bushes (WEEDA 1981), or as part of scrubs dominated by *Rubus* and *Prunus spinosa*.

The classification of the retamoid thickets at their northern distribution edge has not yet been settled, and an assignment to the *Cytisetea scopario-striati* is often not even considered. The most detailed and broad overview was recently presented by DE FOUCAULT et al. (2013), who published a combined synoptic table of published syntaxa in France, and included also the impoverished retamoid thickets along the Atlantic in this class. For the temperate zone, they distinguished two alliances: the *Ulici europaei-Cytision striati* Rivas-Mart., Báscones, Díaz, Fern. Gonz. & Loidi 1991 for the southern atlantic retamoid scrublands, and the *Sarothamnion scoparii* Tüxen ex Oberd. 1958 for the impoverished atlantic to sub-continental retamoid scrublands at the northern and eastern borders of the distribution area of the class. The valid name for the latter is *Ulici europaei-Sarothamnion scoparii* Doing ex Weber 1997, an alliance that was assigned to the *Rubetalia plicati* Weber in Pott 1995 and attributed to the *Franguletea alni* Doing ex Westhoff & Den Held 1969 by WEBER (1997). In the Dutch national vegetation classification, broom thickets were classified as a basal community at the interface of the *Calluno-Ulicetea* Br.-Bl. & Tüxen ex Klika & Hadač 1944 and the *Nardetea strictae* Rivas Goday in Rivas Goday & Rivas-Mart. 1963 (STORTELDER et al. 1996, pp. 315–316). In the overview of British plant communities (RODWELL 1998), both *Ulex europaeus* and *Cytisus scoparius* have their highest frequency and abundance in type W23 - *Ulex europaeus-Rubus fruticosus* scrub, which was assigned to the *Ulici-Sarothamnion scoparii* as part of the *Rhamno-Prunetea* Rivas Goday & Borja Carbonell ex Tüxen 1962 (RODWELL et al. 2000).

The classification of broom and gorse thickets in the Central- and North-Atlantic zone of Europe is hampered by several problems. The first is the already mentioned floristic impoverishment towards the edge of the distribution area of the class, resulting in the lack of true character species. This phenomenon is not unique for the *Cytisetea scopario-striati,* as it has been described for a broad spectrum of vegetation classes (WERGER & VAN GILS 1976, DE FOUCAULT 1981). DIERSCHKE (1994) suggested the term 'marginal associations' for such floristically impoverished vegetation types. An example is the *Rubo plicati-Sarothamnetum* Weber 1987. According to the original publication of this broom community (WEBER 1987), *Cytisus scoparius* is said to be the only character species of this scrub type, but from an international viewpoint this cannot be maintained since this species grows frequently in most alliances of the *Cytisetea*. It therefore has to be considered a character species of the class (DE FOUCAULT et al. 2013). The other characteristic species, *Rubus plicatus*, has a rather

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broad sociological amplitude, with an optimum in the *Lonicero peryclymeni-Rubetea plicati* Haveman, Schaminée & Stortelder 1999 (WEBER 1998a, WEBER 1998b, HAVEMAN et al. 1999). As is clear from this example, the alleged character species of marginal associations are often 'borrowed' from other, structurally similar classes.

This brings us to the second problem: as in the *Prunetalia spinosae* Tüxen 1952, bramble species (*Rubus* subgen. *Rubus*) are supposed to be important for the classification of the *Cytisetea* (WEBER 1998a). However, in most attempts to classify broom and gorse thickets, bramble species are not taken into account, and most authors suffice with the notation of *Rubus fruticosus* or *Rubus* species (TOUFFET 1970, RODWELL 1998, OBERDORFER 1992a, SWERTZ et al. 1996, PROSSER & WALLACE 2003), or *Rubus* cf. *ulmifolius* (LECOINTE & PROVOST 1975). Positive exceptions are the already mentioned description of the *Rubo plicati-Sarothamnetum* for northern Germany (WEBER 1987), and the *Rubo bifrontis-Cytisetum scoparii* Robbe ex J.-M. Royer, Felzines, Misset & Thévenin 2006 for north-eastern France. Field observations of retamoid scrublands in France, Ireland, the Netherlands and Germany revealed that a rather large number of (partly regionally distributed) bramble species may occur in these thickets. An important question, *viz.* one that can influence the outcome of a syntaxonomical study of these scrublands profoundly, is how to value these *Rubus* species. A parallel can be found in the classification of the scrubs of the *Prunetalia spinosae*, in which WEBER (1998b, 1999) distinguished many regional associations for Germany purely on the basis of the occurring *Rubus* species, whereas OBERDORFER (1992b) at the other end of the spectrum recognised only one association for Central-Europe. Both approaches have their pros and cons, but remarkably enough, both have one disadvantage in common: the level of obtained ecological information is not maximised, due to the overrating of the value of regionally distributed species with similar ecological profiles by WEBER (1998b, 1999), and the disregard of the ecology of the occurring *Rubus* species by OBERDORFER (1992b). We advocate a middle course, in which the associations are clearly floristically defined, as well as indicative for different site conditions. This applies both to the *Prunetalia spinosae* and the retamoid thickets of the *Cytisetea scopario-striati*. This could be done for instance by clustering the *Rubus* species in formal or informal eco-sociologically meaningful groups, for instance on the basis of their optimum in alliances. In this approach, mutually regionally exclusive but ecologically equivalent species are placed together in one group.

The third problem is the pioneer character of both *Ulex europaeus* and *Cytisus scoparius*. Both species have a wide ecological amplitude, and are able to establish in a rather wide variety of vegetation types, ranging from dry and moist, acidophilous and basophilous grasslands, pioneer communities, fringes, heathlands, and ruderal communities. The species composition of the field layer in these thickets differs accordingly (OBERDORFER 1992b), even when the shrub layer consists of the same species. We suspect that part of the diversity in the French *Prodrome* (DE FOUCAULT et al. 2013) can be explained in this way.

In this paper we suggest a new approach when classifying marginal associations lacking true character species, based on the notion of ´chorological tension zones´ (VAN DER MAAREL 1976, WERGER & VAN GILS 1976). Such chorological tension zones are defined as areas of interference between vegetation units (e.g., classes) at the distribution margin of one of the units. In the absence of character species at this distribution margin, the variation in occupied sites is expressed by species from other units of the same formation ('sister units'), and these species can be used to characterise marginal associations. To restrict the possible number of associations, we propose to accept only maximally as much of them as sister units

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play a role in the marginal association. Such a procedure restricts the number of possible associations within each alliance, preventing the proliferation of innumerable ill-defined units. On the other hand, it segments the variation in the data in ecologically meaningful parts, giving the associations a sound basis.

We will illustrate this approach with a case study from the broom and gorse thickets in the Netherlands. In the presented classification, we included all bramble species, and we primarily classified these thickets on the basis of the occurring phanerophytes and hemi-phanerophytes. The classification is based on a relatively small set of Dutch relevés only, but we will discuss the validity for the surrounding countries by comparing some vegetation types we studied in Ireland and Germany. We asked the following two questions: (1) How many retamoid scrub associations can be distinguished in the Netherlands, following the explained approach, and (2) Can the broom and gorse thickets in the Netherlands be assigned to the *Cytisetea scopario-striati*, or should they be attributed to other scrub classes, like the *Rhamno-Prunetea* or *Lonicero-Rubetea plicati*?

2. Material and methods

2.1 Dataset

The basis for this survey are relevés from the Dutch National Vegetation Database (SCHAMINÉE et al. 2012) in which *Cytisus scoparius* or *Ulex europaeus* have an abundance of at least 25% and any combination of *C. scoparius*, *U. europaeus* and *Rubus ulmifolius* has an abundance of at least 50%. From this set, we deleted relevés in which the *Rubus* species were not identified at species level, relevés recorded with a semi-quantitative scale (mainly Tansley), as well as relevés with extraordinary small (< 10 m^2) or large (> 100 m^2) areas, relevés without at least an indication of the geographical area, without a date, or without an author. Because *Ulex europaeus* thickets were not represented in this set, dedicated field trips were made in 2013 and 2014 to sample such thickets along the southern edge of the Veluwe in the wider vicinity of Arnhem, one of the very few regions in the Netherlands where this rare species forms extensive scrublands. The final dataset consisted of 60 relevés, which are all stored in Turboveg (HENNEKENS & SCHAMINÉE 2001). Names of vascular plants (except the brambles) are according to VAN DER MEIJDEN (2005), *Rubus* names follow VAN DE BEEK et al. (2014) for the species occurring in the Netherlands and KURTTO et al. (2010) for all other species. Nomenclature of bryophytes follows SIEBEL & DURING (2006).

2.2 Classification and syntaxonomy

For the classification, all layers were merged in JUICE (TICHÝ 2002), after which the classification was done in several subsequent steps (all performed in JUICE). We classified the Dutch relevés in nine clusters on the basis of presence/absence (with Hellinger transformation) of woody species with the K-medoids method (Partioning Around Medoids, PAM: KAUFMAN & ROUSSEEUW 1987) with Bray-Curtis distances, using the R package (R DEVELOPMENT CORE TEAM 2011). The problem with PAM analyses is the determination of number of clusters. To overcome this, we made several classifications with different numbers of clusters (4–12), and accepted the one (9 clusters) which was most easy to interpret ecologically, i.e. in which the character species of the various scrub classes were separated clearly over the clusters. Differential species were calculated for each cluster using the phi coefficient (CHYTRÝ et al. 2002), and their significance was tested ($p < 0.01$) using Fisher's exact test. We considered species with *phi* > 30 as strong differential species, and species with a lower phi coefficient as weak differential species. Since the PAM algorithm, unlike TWINSPAN, results in a non-hierarchical classification, the clusters were grouped – in a third step – on the basis of the syntaxonomical position of the differential species, including the *Rubus* species. This resulted in five principal groups, three of which consist of a single initial PAM cluster, and two with three initial PAM clusters each. In a fourth

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and last step, six relevés were shifted on the basis of the distribution of differential species to optimise the 'crispness' (BOTTA-DUKÁT et al. 2005) of the classification. In this step, the number of groups was optimised as well and definitely reduced to five, after it showed in this way that the crispness was optimal. This procedure resulted in a hybrid classification, based on numerical methods, refined by subjective judgement. The found groups were assigned to described associations where possible, and the names were evaluated following the International Code of Phytosociological Nomenclature (from here: ICPN, WEBER et al. 2000).

3. Results

3.1 *Rubus* species

Table 1 comprises the *Rubus* species found in *Cytisus* and *Ulex* thickets, in order of decreasing frequency in the total dataset of Dutch relevés. For each species the supposed syntaxonomical position is given, based on literature references. In total, 15 species of *Rubus* subgen. *Rubus* are found in the Dutch data, from which *Rubus plicatus* (n = 27), *R. gratus* (n = 13), and *R. vestitus* (n = 11) are the most frequent.

3.2 Classification and characteristic species

The results of the classification are given in Supplement S1 (full table) and Table 2 (synoptic table). From the PAM analysis and the subsequent optimisation of the classification, we accepted five groups in the final table; both the first and the third group in Supplement S1 consist of three initial PAM clusters.

Regardless of the number of clusters in the PAM analysis, each group is characterised by the occurrence of either *Cytisus scoparius* or *Ulex europaeus*: only in Group 5, kept together by *Rubus ulmifolius*, and in one relevé in Group 4 both species are occurring. At lower latitudes, notably in France, these species do grow together (LECOINTE & PROVOST 1975, DE FOUCAULT et al. 2013), but in the Netherlands and likewise at the British Isles (pers. comm. J. Rodwell) mixed *Cytisus-Ulex* stands are rare. Both species seem to prefer slightly different growing conditions: *Ulex europaeus* is a rare species and missing in large parts of the Dutch distribution area of *Cytisus*, and in the dense *Ulex* thickets *Cytisus* seems to be a weak competitor.

Group 1 – Species-poor *Cytisus scoparius* scrub of the nutrient-poorest sands occupied by retamoid thickets; found throughout all Pleistocene sand areas. The only group without differential species. *Rubus* species in this group are *R. plicatus* (frequency 46%), *R. gratus* (31%), *R. nemoralis* (8%), *R. affinis*, *R. scissus*, *R. ferocior*, *R. integribasis*, and *R. passionis* (all 4%). The scrublands of Group 1 are closely related to the bramble scrubs of the *Lonicero-Rubetea plicati*. *Agrostis capillaris* and *Quercus robur* are constant species (> 50%). Average species number: 17.

Group 2 – Moderately species-rich *Cytisus scoparius* thickets of (slightly) buffered loamy and sandy soils in the coastal dunes, South-Limburg, and on glacial deposits in the northern, eastern and central parts of the Netherlands. Differential species are *Crataegus monogyna* and common grassland plants like *Plantago lanceolata*, *Veronica chamaedrys*, and *Festuca rubra*. Apart from *Rubus vestitus* (44%) and *R. affinis* (33%), *R. macrophyllus*, *R. rufescens*, *R. idaeus*, *R. armeniacus*, *R. nessensis*, and *R. plicatus* are noted (all 11%). These scrublands are syntaxonomically related to the scrubs of the *Rhamno-Prunetea*, which is not only clear from the already mentioned species, but also from the occasionally occur-

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Table 1. Frequency and syntaxonomical position (according to HAVEMAN et al. 1999, 2014) of *Rubus* species recorded in *Ulex europaeus* and *Cytisus scoparius* thickets. The species without a frequency account are only found in German and Irish thickets. Group affiliation: (between brackets) = species occurring in the mentioned groups, without optimum; normal font = species with a significant optimum in the mentioned group; bold = species in the mentioned group exclusively.

Tabelle 1. Frequenz und syntaxonomische Position (nach HAVEMAN et al. 1999, 2014) von *Rubus*-Arten in niederländischen *Ulex europaeus*-und *Cytisus scoparius*-Gebüschen. Die Arten ohne Frequenz wurden nur in Gebüschen in Deutschland oder Irland gefunden (Haveman, obs.). Gruppenzuordnung: (zwischen Klammern) = Arten, die in den genannten Gruppen ohne Optimum vorkommen; Normalschrift = Arten mit einem signifikanten Optimum in der genannten Gruppe; Fettdruck = Arten ausschließlich in der genannten Gruppe.

Number of relevés:	60	group affiliation	Syntaxon
Rubus plicatus	27	(1–4)	*Lonicero-Rubetea*
Rubus gratus	13	(1, 3)	*Lonicero-Rubetea*
Rubus vestitus	11	4	*Pruno-Rubetum vestiti* + *Athyrio-Rubion*
Rubus nemoralis	7	3	*Lonicero-Rubetea*
Rubus affinis	6	(1-3)	*Lonicero-Rubetea*
Rubus idaeus	4	(2, 3)	*Lonicero-Rubion silvatici* + *Athyrio-Rubion*
Rubus scissus	4	(1, 3, 4)	*Rubetum grati*
Rubus ulmifolius	4	**5**	*Rhamno-Prunetea* / *Pruno-Rubion ulmifolii*
Rubus integribasis	3	(1, 3, 4)	*Lonicero-Rubetea*
Rubus arrheniiformis	2	**4**	
Rubus caesius	2	**5**	*Rhamno-Prunetea*
Rubus sec. *corylifolii*	2	**5**	
Rubus elegantispinosus	1	**3**	*Pruno-Rubetum elegantispinosi*
Rubus armeniacus	1	**2**	
Rubus rufescens	1	**2**	*Pruno-Rubetum elegantispinosi*
Rubus macrophyllus	1	**2**	*Pruno-Rubion radulae* / *Pruno-Rubetum sprengelii*
Rubus nessensis	1	**2**	*Lonicero-Rubetea*
Rubus passionis	1	**1**	
Rubus ferocior	1	**1**	
Rubus amplificatus	-		
Rubus arduennensis	-		
Rubus bellardii	-		*Athyrio-Rubion*
Rubus cornubiense	-		
Rubus cuilinensis prov.	-		
Rubus cuspidatus	-		
Rubus dasyphyllus	-		
Rubus dumnoniense	-		
Rubus eifeliensis	-		
Rubus hesperius	-		
Rubus hostilis	-		
Rubus iricus	-		
Rubus prolongatus	-		
Rubus sprengelii	-		*Rubetum silvatici*
Rubus wirralense	-		

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Table 2. Shortened frequency table of the retamoid scrublands in the Netherlands. In superscript the phi coefficient is given for the significant (Fisher exact test ($p > 0.05$)) species occurrences.

Tabelle 2. Gekürtzte Frequenztabelle der Retamoidgebüsche in die Niederlanden. Die Hochgestellte Ziffer ist der Phi-coefficient für die signifikanten Vorkommen der Arten (Fisher exact test ($p > 0,05$)).

Cluster	1	2	3	4	5
Number of relevés	26	9	14	7	4
Average species number	17	24	16	33	11
Cytisetea scopario-striati					
Cytisus scoparius	100 $^{64.2}$	100 $^{---}$	. $^{---}$	14 $^{---}$	75 $^{---}$
Ulici europaei-Cytision striati					
Ulex europaeus	. $^{---}$	. $^{---}$	100 $^{72.5}$	100 $^{47.8}$	25 $^{---}$
Rubus ulmifolius	. $^{---}$	. $^{---}$	. $^{---}$	. $^{---}$	100 ^{100}
Differential species					
Crataegus monogyna	4 $^{---}$	67 $^{65.9}$	. $^{---}$	. $^{---}$	25 $^{---}$
Plantago lanceolata	8 $^{---}$	67 $^{60.8}$	7 $^{---}$	. $^{---}$	. $^{---}$
Taraxacum species	4 $^{---}$	56 $^{52.2}$	7 $^{---}$	14 $^{---}$	. $^{---}$
Cerastium fontanum subsp.*vulgare*	12 $^{---}$	56 $^{47.7}$	. $^{---}$	14 $^{---}$	. $^{---}$
Galium aparine	4 $^{---}$	33 $^{44.9}$	. $^{---}$	. $^{---}$	. $^{---}$
Veronica chamaedrys	4 $^{---}$	33 $^{44.9}$	. $^{---}$	. $^{---}$	. $^{---}$
Rumex acetosa	12 $^{---}$	56 $^{43.8}$	7 $^{---}$	. $^{---}$	25 $^{---}$
Festuca rubra	35 $^{---}$	78 $^{41.6}$	7 $^{---}$	. $^{---}$	50 $^{---}$
Campylopus pyriformis	4 $^{---}$	. $^{---}$	50 $^{41.4}$	57 $^{---}$	. $^{---}$
Rubus nemoralis	8 $^{---}$	. $^{---}$	36 $^{41.3}$	. $^{---}$	. $^{---}$
Holcus lanatus	38 $^{---}$	78 $^{---}$	86 $^{35.8}$	29 $^{---}$	25 $^{---}$
Atrichum undulatum	. $^{---}$	. $^{---}$	. $^{---}$	100 ^{100}	. $^{---}$
Erica tetralix	. $^{---}$	11 $^{---}$	. $^{---}$	100 $^{92.7}$	. $^{---}$
Vaccinium myrtillus	. $^{---}$	. $^{---}$	7 $^{---}$	86 $^{83.8}$	. $^{---}$
Polytrichum commune	8 $^{---}$	. $^{---}$	. $^{---}$	71 $^{67.7}$	. $^{---}$
Dryopteris carthusiana	. $^{---}$	. $^{---}$	7 $^{---}$	57 $^{64.2}$	. $^{---}$
Polytrichum formosum	. $^{---}$	. $^{---}$	7 $^{---}$	57 $^{64.2}$	. $^{---}$
Potentilla erecta	4 $^{---}$	11 $^{---}$	21 $^{---}$	86 $^{63.3}$	. $^{---}$
Rhamnus frangula	12 $^{---}$	11 $^{---}$	29 $^{---}$	100 $^{62.9}$	. $^{---}$
Carex pilulifera	23 $^{---}$	11 $^{---}$	14 $^{---}$	100 $^{60.3}$	. $^{---}$
Pleurozium schreberi	23 $^{---}$	. $^{---}$	. $^{---}$	86 $^{59.7}$	. $^{---}$
Galium saxatile	15 $^{---}$	11 $^{---}$	7 $^{---}$	86 $^{59.7}$	. $^{---}$
Molinia caerulea	23 $^{---}$	11 $^{---}$	21 $^{---}$	100 $^{57.8}$	. $^{---}$
Teucrium scorodonia	4 $^{---}$	33 $^{---}$	36 $^{---}$	100 $^{57.8}$	25 $^{---}$
Danthonia decumbens	12 $^{---}$	11 $^{---}$	. $^{---}$	71 $^{57.4}$	. $^{---}$
Betula pubescens	4 $^{---}$	. $^{---}$	7 $^{---}$	57 $^{57.1}$	. $^{---}$
Dryopteris dilatata	. $^{---}$	11 $^{---}$	7 $^{---}$	57 $^{57.1}$	. $^{---}$
Betula pendula	12 $^{---}$	11 $^{---}$	21 $^{---}$	86 $^{56.5}$	. $^{---}$
Rubus vestitus	. $^{---}$	44 $^{---}$	7 $^{---}$	71 $^{53.4}$	. $^{---}$
Pinus sylvestris	19 $^{---}$	. $^{---}$	. $^{---}$	71 $^{53.4}$	. $^{---}$
Athyrium filix-femina	. $^{---}$	. $^{---}$	7 $^{---}$	43 $^{52.7}$	. $^{---}$
Kindbergia praelonga	4 $^{---}$	22 $^{---}$	14 $^{---}$	57 $^{42.9}$	. $^{---}$
Hypnum jutlandicum	38 $^{---}$	. $^{---}$	64 $^{---}$	100 $^{41.6}$	. $^{---}$
Calluna vulgaris	46 $^{---}$	11 $^{---}$	50 $^{---}$	100 $^{40.2}$	. $^{---}$
Rubus sect. *Corylifolii*	. $^{---}$	. $^{---}$	. $^{---}$	. $^{---}$	50 $^{69.5}$
Rubus caesius	. $^{---}$	. $^{---}$	. $^{---}$	. $^{---}$	50 $^{69.5}$

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Cluster	1	2	3	4	5
Number of relevés	26	9	14	7	4
Average species number	17	24	16	33	11
Lonicero-Rubetea plicati					
Rubus plicatus	46 ---	11 ---	57 ---	86 ---	. ---
Rubus gratus	31 ---	. ---	36 ---	. ---	. ---
Rubus integribasis	4 ---	. ---	7 ---	14 ---	. ---
Rubus scissus	4 ---	. ---	7 ---	14 ---	. ---
Rubus nessensis subsp. *nessensis*	. ---	11 ---	. ---	. ---	. ---
Rhamno-Prunetea					
Sambucus nigra	4 ---	22 ---	. ---	14 ---	. ---
Sambucus racemosa	. ---	11 ---	. ---	. ---	. ---
Fraxinus excelsior	. ---	11 ---	. ---	. ---	. ---
Ligustrum vulgare	. ---	11 ---	. ---	. ---	. ---
Rosa canina s.l.	. ---	11 ---	. ---	. ---	. ---
Rubus macrophyllus	. ---	11 ---	. ---	. ---	. ---
Rubus rufescens	. ---	11 ---	. ---	. ---	. ---
Prunus spinosa	. ---	. ---	7 ---	. ---	. ---
Rubus elegantispinosus	. ---	. ---	7 ---	. ---	. ---
Bryonia dioica	. ---	. ---	. ---	. ---	25 ---
Ulmus minor	. ---	. ---	. ---	. ---	25 ---
Other species					
Scrub layer					
Quercus robur	58 ---	22 ---	79 ---	43 ---	75 ---
Prunus serotina	38 ---	33 ---	14 ---	14 ---	. ---
Sorbus aucuparia	8 ---	22 ---	21 ---	57 ---	. ---
Rubus affinis	4 ---	33 ---	7 ---	. ---	. ---
Rubus idaeus	. ---	11 ---	14 ---	. ---	. ---
Rubus arrheniiformis	. ---	. ---	. ---	29 ---	. ---
Rubus passionis	4 ---	. ---	. ---	. ---	. ---
Rubus ferocior	4 ---	. ---	. ---	. ---	. ---
Rubus armeniacus	. ---	11 ---	. ---	. ---	. ---
Herb layer					
Agrostis capillaris	62 ---	100 ---	93 ---	100 ---	25 ---
Deschampsia flexuosa	46 ---	11 ---	71 ---	86 ---	. ---
Rumex acetosella	42 ---	44 ---	21 ---	29 ---	. ---
Holcus mollis	35 ---	11 ---	7 ---	. ---	50 ---
Agrostis vinealis	23 ---	. ---	14 ---	43 ---	. ---
Carex arenaria	23 ---	11 ---	7 ---	. ---	75 ---
Arrhenatherum elatius	8 ---	11 ---	7 ---	. ---	50 ---
Moss layer					
Pseudoscleropodium purum	38 ---	56 ---	71 ---	14 ---	. ---
Brachythecium rutabulum	35 ---	44 ---	57 ---	29 ---	. ---
Dicranum scoparium	27 ---	. ---	21 ---	57 ---	. ---

ring *Sambucus nigra* (22%), *Rosa canina*, and *Ligustrum vulgare* (both 11%). *Agrostis capillaris* and *Holcus lanatus* are additional constant species, the average species number being 24.

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Group 3 – Species-poor *Ulex europaeus* scrubs of coarse sands and loamy sands in the southern Veluwe area. Differential species are *Rubus nemoralis* (frequency 36%), and the constant *Holcus lanatus* and *Campylopus pyriformis*. Other *Rubus* species in this group are *R. plicatus* (57%), *R. gratus* (36%), *R. idaeus* (14%) *R. affinis*, *R. vestitus*, *R. scissus*, *R. integribasis*, and *R. elegantispinosus* (all 7%). Like Group 1, these thickets show a remarkable affinity with the bramble scrubs of the *Lonicero-Rubetea plicati*. Constant species (apart from the already mentioned ones): *Agrostis capillaris*, *Quercus robur*, *Pseudoscleropodium purum*, *Hypnum jutlandicum*, and *Calluna vulgaris*; the average species number is 16.

Group 4 – Rare, species-rich *Ulex europaeus* thickets of the loess deposits in the Southern Veluwe. Differential species: *Betula pubescens*, *Rubus vestitus* (71%), *Betula pendula*, *Rhamnus frangula*, *Pinus sylvestris*, *Sorbus aucuparia*, as well as a remarkable number of dwarf-shrubs (e.g., *Erica tetralix*, *Vaccinium myrtillus*), ferns (*Dryopteris carthusiana*, *Dryopteris dilatata*, and *Athyrium filix-femina*), and mosses (e.g., *Atrichum undulatum*, *Pleurozium schreberi*, and *Polytrichum formosum*). Also *Teucrium scorodonia* is differential for this group. A remarkable feature of these scrublands is the richness in fern species, apart from the already mentioned species: *Dryopteris filix-mas*, *Blechnum spicant*, *Oreopteris limbosperma*, and *Dryopteris affinis* s.str. *Rubus* species in this group are *R. vestitus*, *R. plicatus* (86%), *R. arrheniiformis* (29%), *R. idaeus* (25%), *R. scissus*, and *R. integribasis* (both 14%). *Rhamno-Prunetea* species (*Crataegus monogyna*, *Sambucus nigra*, *Rosa canina* and *Prunus spinosa*) are not totally lacking, but they are rare and occur with low cover. This group shows some affinity with the *Franguletea alni*, but through *Rubus vestitus* and the already mentioned *Rhamno-Prunetea* species also with the latter class. *Agrostis capillaris*, *Rubus plicatus*, *Deschampsia flexuosa* and *Calluna vulgaris* are constant species; average species number: 33.

Group 5 – Rare, very species-poor *Ulex europaeus* and *Cytisus scoparius* thickets from the dunes in Southwest-Netherlands, differentiated and held together by *Rubus ulmifolius* (100%), *Rubus* sect. *Corylifolii* (50%), and *Rubus caesius* (50%). These scrublands show some affinity with the *Rhamno-Prunetea* through the occurrence of *Crataegus monogyna*, *Bryonia cretica* subsp. *dioica*, and *Ulmus minor* (all in 1 relevé = 25%), as well as *Rubus ulmifolius* and *R. caesius*. *Quercus robur, Holcus mollis*, *Carex arenaria*, and *Arrhenatherum elatius* are additional constant species. Average species number: 11.

4. Discussion

4.1 Syntaxonomical assignment

Considered from a Northwest-European point of view, it could be argued that the broom and gorse thickets in the north-atlantic domain (including our dataset) are too strongly entangled with the *Lonicero-Rubetea plicati*, *Rhamno-Prunetea*, and *Franguletea* to distinguish them separately, a solution that was chosen by several authors (OBERDORFER 1957, OBERDORFER 1992b, WEBER 1998a, RODWELL et al. 2000). However, viewed from the distribution centre of the *Cytisetea scopario-striati* in South-Europe, the studied vegetation belongs clearly to this class: the dominant species are considered character species (DE FOUCAULT et al. 2013), and the vegetation structure of these thickets does not differ from the

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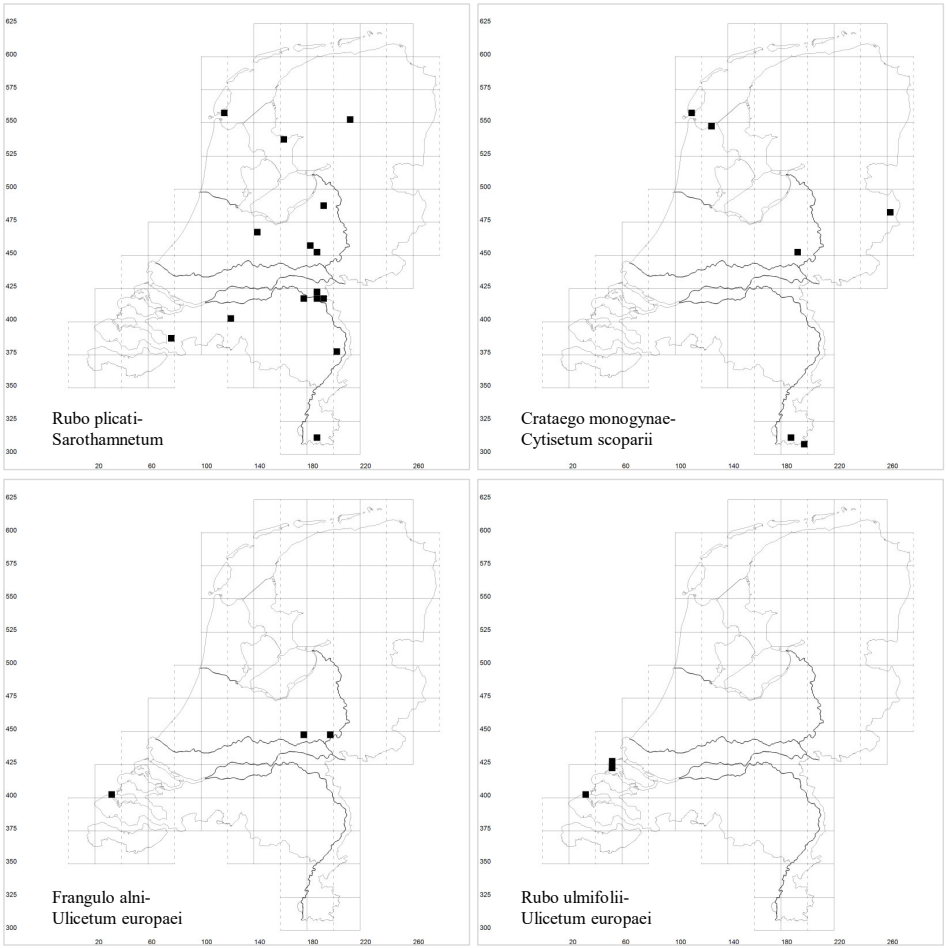

Fig. 1. Distribution of the associations of the *Cytisetea scopario-striati* in the Netherlands, based on the relevés used in this study (n = 60).

Abb. 1. Verbreitung der Assoziationen der *Cytisetea scopario-striati* in den Niederlanden, basierend auf den Vegetationsaufnahmen (n = 60).

structure of the *Cytisetea* in e.g., the Iberian Peninsula. The frequent occurrence of species from other scrub types can be understood from the pioneer character of the *Cytisetea* scrublands. As was stressed by DE FOUCAULT et al. (2013), the latter are generally replaced by *Rhamno-Prunetea* and other scrub types within a few years, not only in northern regions, but frequently also in the centre of their distribution.

In the northern part of their distribution area, only one order is recognised in the *Cytisetea scopario-striati*, i.e. the *Cytisetalia scopario-striati* Rivas-Mart. 1974 (GAVILÁN et al. 2011, DE FOUCAULT et al. 2013). For the temperate zone, DE FOUCAULT et al. (2013) recognised two alliances, as mentioned in the introduction. The *Ulici europaei-Cytision striati* comprises the southern atlantic retamoid thickets, with a known distribution area that stretches from the Atlantic coast in the Iberian Peninsula northwards at least to Picardie in

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Fig. 2. (a) The *Rubo plicati-Sarothametum scoparii* at the military air base Woensdrecht. *Cytisus scoparius* is invading the *Nardetea* grassland in the foreground (Photo: R. Haveman); **(b)** the *Crataego monogynae-Cytisetum scoparii* with *Rosa canina* and *Rubus macrophyllus* in the 'Curfsgroeve' near Geulhem (Photo: I. de Ronde); **(c)** the *Frangulo alni-Ulicetum europaei* with *Rubus plicatus* at the A12 highway near Bennekom (Photo: I. de Ronde); **(d)** the *Rubo ulmifoli-Ulicetum europaei* with *Rubus ulmifolius* and *Cytisus scoparius* in the dunes near Vrouwenpolder (Photo: R. Haveman).

Abb. 2. (a) Das *Rubo plicati-Sarothametum scoparii* am Fliegerhorst Woensdrecht. *Cytisus scoparius* wander ins *Nardetea*-Grasland im Vordergrund ein (Foto: R. Haveman); **(b)** das *Crataego monogynae-Cytisetum scoparii* mit *Rosa canina* und *Rubus macrophyllus* im 'Curfsgroeve' bei Geulhem (Foto: I. de Ronde); **(c)** das *Frangulo alni-Ulicetum europaei* mit *Rubus plicatus* an der Autobahn A12 bei Bennekom (Foto: I. de Ronde); **(d)** das *Rubo ulmifoli-Ulicetum europaei* mit *Rubus ulmifolius* und *Cytisus scoparius* in den Dünen bei Vrouwenpolder (Foto: R. Haveman).

Northern France. Differential species which are listed for this alliance by both WEBER (1998b, sub nomine *Ulici europaei-Rubion ulmifolii* Weber 1997 nom. superfl.) and DE FOUCAULT et al. (2013) are *Cistus salviifolius*, *Hedera helix*, *Rubus ulmifolius* and *Ulex europaeus*. Species listed by only one of these authors are e.g., *Arbutus unedo*, *Lonicera periclymenum*, *Quercus ilex*, *Q. petraea*, *Q. robur*, *Pteridium aquilinum*, *Rubia peregrina* and *Salix atrocinerea*. The second alliance is the *Ulici europaei-Sarothamnion scoparii*, which is the central alliance of the order, comprising the atlantic to suboceanic retamoid thickets at the north-eastern edge of the distribution area of the class. It has no differential species apart from the character species of the class, i.e. *Cytisus scoparius* and *Orobanche rapum-genistae*.

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On the basis of the mentioned differential species, all groups characterised by *Ulex europaeus* and/or *Rubus ulmifolius* (3–5) are assigned to the *Ulici europaei-Cytision striati*. The differential species of this alliance are lacking in the two other groups (1 and 2), and consequently these thickets are assigned to the central alliance *Ulici europaei-Sarothamnion scoparii*.

Group 1 – can be assigned to the *Rubo plicati-Sarothamnetum plicati* (Fig. 2a). As was concluded by WEBER (1987) already, these thickets have a conspicuous affinity with the *Rubetalia plicati* (*Lonicero-Rubetea plicati*). Although this association is widely distributed in the Netherlands (see Fig. 1 for the distribution), most stands are rather small, and there is some evidence that the total area has declined since the 1980s. Most stands are found in heathlands and especially on the verges of newly constructed roads and railways.

Group 2 – comprises *Cytisus scoparius* thickets with *Rhamno-Prunetea* species like *Crataegus monogyna* and *Rosa canina* (Fig. 2b). Although similar communities were described by various authors from different parts in Europe, until now their syntaxonomy is far from clear. ROBBE (1993) described a similar community from the Morvan, France, as 'Groupement a *Rubus ulmifolius*' within the *Sarothamnion scoparii*, characterised by the combination of *Cytisus* with *Prunus spinosa*, *Rubus ulmifolius*, *Rubus nessensis*, and *Rosa arvensis*. However, ROYER et al. (2006) corrected *Rubus ulmifolius* in *R. bifrons* and described this vegetation type as *Pruno bifrontis-Cytisetum scoparii* Royer et al. 2006, and mentioned it also from the Loire and Allier valley in France. This name was not validly published though (art. 5 ICPN, WEBER et al. 2000). Similar thickets with *Rubus bifrons* were described from the Black Forest, Germany, by SCHWABE-BRAUN (1983), and also occur in Hessen (pers. obs. R. Haveman). *Cytisus* stands in the Vulkaneifel near Daun, Germany, with *Prunus spinosa*, *Crataegus monogyna*, and *Corylus avellana* have a completely different *Rubus* flora (pers. obs. R. Haveman). In 5 relevés *Rubus hostilis*, *Rubus eifeliensis*, *Rubus vestitus*, *Rubus sprengelii*, *Rubus pedemontanus*, *Rubus arduennensis* and *Rubus cuspidatus* were noted. Like in the Netherlands (VAN DE BEEK et al. 2014), *Rubus bifrons* is (almost) completely lacking in the Eifel (MATZKE-HAJEK 1993). In our approach, all these different forms represent different forms of one broadly circumscribed association. However, we were not able to find a validly published name, and we therefore describe it as a new association: *Crataego monogynae-Cytisetum scoparii* Haveman, de Ronde et Schaminée ass. nov. (**holotypus**: Supplement S1, relevé 29 - R. Haveman (10–177) & I. de Ronde (10–130), 29–06-2016, Texel, zuid van Den Hoorn langs Mokweg, Bremstruweel in overhoek langs verharde weg [Texel, south of Den Hoorn along Mokweg, broomscrub in edge of paved road]). In the Netherlands, this association is found on loamy soils as well as in the calcareous coastal dunes. Notwithstanding its wide distribution, the *Crataego-Cytisetum* is a rare community in the Netherlands (Fig. 1).

Groups 3 and 4 – belong to the *Ulici europaei-Franguletum alni* De Foucault 1988, comprising relevés of *Ulex* thickets with *Franguletea alni* and *Lonicero-Rubetea plicati* species (Fig. 2c). This community was described by GLOAGUEN & TOUFFET (1975) for the Monts d'Arree in Brittany (France), although the authors explicitly renounced the association status. According to DE FOUCAULT (1988) and DE FOUCAULT et al. (2013), the *Ulici-Franguletum* does not belong to the *Cytisetea scopario-striati*, and DE FOUCAULT & ROYER (2014) consider it part of the *Franguletea*. Others have placed this association in the *Ulici-Cytision striati* (sub nomine *Ulici-Rubion ulmifolii*; CATTEAU et al. 2010, BOULANGER 2013), and on the basis of the tables published by GLOAGUEN & TOUFFET (1975) and BOULANGER (2013) we come to the same conclusion. The name of the association has to be

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corrected in *Frangulo alni-Ulicetum europaei* nom. invers. (Art. 10b ICPN, WEBER et al. 2000). As in most *Cytisetea* thickets, the field layer of the *Frangulo-Ulicetum* shows considerable variation, reflecting the former succession stages more than anything else. However, the fern-rich form of the association we recorded seems to be an older stage of the association, since the ferns do not grow in the surrounding heathlands. The two groups in our study might represent subassociations, but we refrain from a formal description, because more data are needed. The *Frangulo-Ulicetum* is a rare association in the Netherlands (Fig. 1).

Group 5 – can be assigned to the *Rubo ulmifolii-Ulicetum europaei* J.-M. Géhu ex R. Haveman, I. de Ronde & J.H.J. Schaminée ass. nov. hoc loco (Fig. 2d). Traditionally, *Ulex-Cytisus* stands with *Rubus ulmifolius* and other *Rhamno-Prunetea* taxa, like *Crataegus monogyna* and *Bryonia cretica* subsp. *dioica*, are assigned to the *Ulici europaei-Sarothamnetum scoparii* Oberdorfer 1992. However, the nomenclature of this association is confusing, and the name in use is not validly published: OBERDORFER (1992a) did not indicate a type (Art. 5 ICPN, WEBER et al. 2000), and the typification by DE FOUCAULT et al. (2013) is not valid because the association was not indicated as new *expressis verbis* (Art. 3i ICPN, WEBER et al. 2000). LECOINTE & PROVOST (1975) published this syntaxon as *Sarothamnetum* Lecointe et Provost, but WEBER (1998a) suggested to reject this name as *nomen ambiguum*. GÉHU (2008) published the *Rubo ulmifolii-Ulicetum europaei* J.-M. Géhu 2008, which we consider a synonym of both mentioned names. However, for the same reason as the *Ulici europaei-Sarothamnetum*, that name was not validly typified (Art. 3i ICPN, WEBER et al. 2000), for which reason we designate a type here, thus validating the *Rubo ulmifolii-Ulicetum europaei*: **holotypus**: relevé 4, tableau 21 in GÉHU (2008, p. 61). In the Netherlands, the *Rubo ulmifolii-Ulicetum europaei* is a rare association, which has hitherto been found only in the coastal dunes at the former isles of Goeree and Walcheren (Fig. 1).

4.2 Classification of marginal associations

The classification of marginal associations is one of the methodological problems in phytosociology (DIERSCHKE 1994). DIERSCHKE (1981) suggested to use the alliance character species as territorial character species of marginal associations, but we feel this approach has a serious drawback. Differently from the central association, the alliance character species do not have their optimum here, but, reaching their range boundaries, they are thought to have more restricted niches instead (BRAUN-BLANQUET 1964, BROWN 1984, OLIVER et al. 2009), show habitat shifts (WALTER 1954), or might be represented by adapted ecotypes (ROSENMEIER et al. 2013). Their stands are often characterised by species from other phytosociological units, as was shown in this paper using the idea of chorological tension zones. If we would have followed DIERSCHKE (1981), we would have distinguished two associations at maximum, *viz.* one dominated by *Ulex europaeus* in the *Ulici-Cytision striati*, and one dominated by *Cytisus scoparius* in the *Ulici-Sarothamnion scoparii*.

HEGG & BRUN-HOOL (1999) emphasised that, when it comes to the number of possible associations, more is not always better, because the phytosociological system can lose its tenability for the every-day user. However, we here defend the distinction of four broadly circumscribed and socio-ecologically defined associations. In this case, both *Ulex* and *Cytisus* occupy sites analogous to *Franguletea*/*Lonicero-Rubetea* as well as *Rhamno-Prunetea*, and we believe that (at least in the presented case) this is best reflected at the association level.

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The above results in the following syntaxonomical scheme:

Class: *Cytisetea scopario-striati* Rivas-Mart. 1974
Order: *Cytisetalia scopario-striati* Rivas-Mart. 1974
Alliance: *Ulici europaei-Cytision striati* Rivas-Mart., Báscones, Díaz, Fern. Gonz. & Loidi 1991
Association: *Frangulo alni-Ulicetum europaei* De Foucault 1988 nom. invers.
Association: *Rubo ulmifolii-Ulicetum europaei* J.-M. Géhu ex Haveman, de Ronde & Schaminée ass. nov.
Alliance: *Ulici europaei-Sarothamnion scoparii* Doing ex Weber 1997
Association: *Rubo plicati-Sarothamnetum scoparii* Weber 1987
Association: *Crataego monogynae-Cytisetum scoparii* Haveman, de Ronde & Schaminée ass. nov.

We are fully aware of the drawbacks of the relatively small dataset used in this study, and we therefore recommend a revision of the Cytisetea scopario-striati on the basis of a larger dataset from a larger geographical area to test the explained procedure, for instance on the basis of data from the EVA database (JIMÉNEZ-ALFARO et al. 2013).

4.3 The field layer and *Rubus* species

The presented classification is based on the phanerophytes and "pseudophanerophytes" (i.e. *Rubus* species) alone, and species in the field layer have played no part in the classification. A closer look at the full table (Supplement S1) makes clear however, that the herb and moss layer may vary considerably between the stands of one association. We suggest that these can be used to distinguish subassociations in a revision of the *Cytisetea* on the basis of a larger dataset, as suggested above.

In our classification, the *a priori* assignment of the *Rubus* species to a scrub class has proved to be helpful for a proper assignment of the clusters to one of the associations. As is clear from table 1, for a number of the found *Rubus* species, knowledge of their syntaxonomical position is lacking though. This is not much of a problem when a clear assignment is possible on the basis of the total species composition of the shrub layer. However, when the total species composition does not allow the assignment to one of the marginal associations, i.e. when apart from *Cytisus scoparius* or *Ulex europaeus* only brambles are present in the shrub layer, knowledge of the sociological position of the brambles becomes necessary. A survey of the species composition of *Ulex europaeus* thickets in County Gallway (Ireland) by the first author made clear that most of these scrublands can be assigned to the *Frangulo-Ulicetum europaei* on the basis of e.g., *Salix aurita*, *S. cinerea*, and *S. atrocinerea* (pers. archive, not published). The assignment of many stands, however, is severely obstructed by the simultaneous absence of phanerophytes of other scrub classes and lack of knowledge of the syntaxonomical position of the occurring *Rubus* species, like *Rubus iricus*, *Rubus dumnoniense*, and *R. hesperius*. More research on the sociological position of *Rubus* species in large areas in West-Europe is necessary to fill this gap in our knowledge.

5. Conclusion

Ulex europaeus and *Cytisus scoparius* thickets in the Netherlands and the neighbouring countries can best be assigned to the *Cytisetea scopario-striati* on the basis of the dominance of both mentioned retamoid species. The conspicuous presence of species of other scrub

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classes is a common phenomenon also in the diversity-centre of the class in the Iberian Peninsula, and therefore, in our opinion, no reason to include the broom and gorse thickets in one of these classes (*Rhamno-Prunetea*, *Franguletea alni*, *Lonicero-Rubetea plicati*). In the Netherlands, four associations can be distinguished using the procedure we suggest here for the classification of impoverished marginal associations, *viz.* two in both alliances (*Ulici-Cytision striati* and *Ulici-Sarothamnion scoparii*). We think the proposed procedure is promising for the classification of marginal associations: large-scale patterns can be made visible, whereas the number of possible associations is restricted at the same time, preventing a needless and inconvenient proliferation of new syntaxa.

Erweiterte deutsche Zusammenfassung

Einführung - Die größte Mannigfaltigkeit an retamoiden („Rutenstrauch"-)Gebüschen, zusammengefasst in der Klasse *Cytisetea scopario-striati* Rivas-Mart. 1974, findet sich auf der Iberischen Halbinsel (COSTA et al. 2003, GAVILÁN et al. 2011, PINTO-GOMES et al. 2012). Weiter nördlich ist die Klasse auf eine zunehmend schmalere Zone entlang der Atlantikküste beschränkt, und in Nordwesteuropa ist sie nur noch durch *Ulex europaeus* und *Cytisus scoparius* vertreten, begleitet zuweilen von dem mediterran-atlantischen *Rubus ulmifolius*. Die Klassifikation dieser retamoiden Gebüsche an ihrer nördlichen Verbreitungsgrenze ist noch ungeklärt, und ihre Zugehörigkeit zu den *Cytisetea scopario-striati* wird oft nicht einmal erwogen. DE FOUCAULT et al. (2013) unterschieden in Frankreich zwei Verbände dieser Klasse, das südlich verbreitete atlantische *Ulici europaei-Cytision striati* Rivas-Mart., Báscones, Díaz, Fern. Gonz. & Loidi 1991 und das *Ulici europaei-Sarothamnion scoparii* Doing ex Weber 1997 (bei DE FOUCAULT et al. 2013 unter dem Namen *Sarothamnion scoparii* Tüxen ex Oberd. 1958), das die artenärmeren (sub)atlantischen Rutenstrauch-Gebüsche an der nördlichen und östlichen Peripherie des Verbreitungsgebiets der Klasse umfasst. Die Klassifikation der Besenginster- und Stechginster-Gebüsche in den mittleren und nördlichen atlantischen Gebieten Europas bereitet Probleme, da (1) Charakterarten fehlen, (2) Brombeeren, deren Artzugehörigkeit oft ungeklärt bleibt, eine wichtige Rolle spielen, und (3) *Cytisetea*-Bestände als Pioniergesträuche bei gleichförmig-einartiger Strauchschicht in ihrer Feldschicht sehr unterschiedlich zusammengesetzt sein können.

Wir schlagen einen neuen Ansatz zur Klassifikation von Marginalassoziationen vor, basierend auf dem Konzept der „chorologischen Spannungszone" als eines Überlagerungsraums von Vegetationseinheiten (z. B. Klassen) am Verbreitungsrand einer dieser Einheiten (VAN DER MAAREL 1976, WERGER & VAN GILS 1976). Fehlen Charakterarten einer Einheit an ihrem Verbreitungsrand, kommt ihre Variationsbreite durch Arten anderer Einheiten der gleichen Formation („Geschwister-Einheiten", „*sister units*") zum Ausdruck, und diese Arten können zur Kennzeichnung von Marginalassoziationen herangezogen werden. In der vorliegenden Arbeit stellen wir diesen Ansatz am Beispiel der niederländischen Besenginster- und Stechginster-Gebüsche vor und fragen, wieviele retamoide Gebüschassoziationen sich in den Niederlanden unterscheiden lassen und ob diese Gebüsche den *Cytisetea scopario-striati* zugeordnet werden können.

Material und Methoden - Die Vegetationsaufnahmen von retamoiden Gebüschen für diese Studie (n = 60) wurden der Vegetationsdatenbank der Niederlande entnommen und vervollständigt durch Aufnahmen, die bei Exkursionen eigens für diese Untersuchung angefertigt wurden. Vor der Klassifizierung wurden Artnachweise aus verschiedenen Schichten vereint. Basierend auf der Präsenz/Absenz von Arten holziger Pflanzen unterschieden wir neun Cluster mit der K-medoids-Methode mit Bray-Curtis-Distanzen (*Partioning Around Medoids, PAM*; KAUFMAN & ROUSSEEUW 1987), durchgeführt in R. Differenzialarten für die einzelnen Cluster wurden berechnet mittels phi-Koeffizient und mit dem Exakten Fisher-Test auf Signifikanz geprüft. Im folgenden dritten Schritt wurden die Cluster gemäß ihrer syntaxonomischen Stellung neu gruppiert, woraus fünf hauptsächliche Gruppen resultierten. In einem vierten und letzten Schritt wurden sechs Aufnahmen aufgrund der Verteilung der Differentialarten umgestellt. Die Gruppen wurden wenn möglich beschriebenen Assoziationen zugeordnet.

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Ergebnisse - Beilage S1 und Tabelle 2 zeigen die Ergebnisse der Klassifikation. Zwei der unterschiedenen Gruppen (1 und 2) sind gekennzeichnet durch die Dominanz von *Cytisus scoparius* und das Fehlen von *Ulex europaeus*; in den drei anderen (3-5) sind *U. europaeus* und *Rubus ulmifolius* vorhanden und meist dominant. Gruppe 1 umfasst Gesträuch, das abgesehen von *C. scoparius* Phanerophyten der *Franguletea alni* und/oder *Lonicero-Rubetea* enthält, wie *Rubus gratus* und *Rubus plicatus*. In Gruppe 2 wird *C. scoparius* begleitet durch Arten der *Rhamno-Prunetea*, besonders *Crataegus monogyna*. *Rubus*-Arten dieser Gruppe sind *R. macrophyllus* und *R. vestitus*. Gruppe 3 umfasst artenarmes *Ulex*-Gestrüpp mit *Lonicero-Rubetea*-Brombeerarten wie *Rubus nemoralis*, *R. plicatus* und *R. gratus*. In Gruppe 4 wird *U. europaeus* begleitet von *Rhamnus frangula* und anderen Arten. Dieser Gebüschtyp, typisch für Lössablagerungen in zentralen Teilen der Niederlande, ist reich an Farnarten. In Gruppe 5 schließlich kommen *U. europaeus* und/oder *Rubus ulmifolius* zusammen mit *Rhamno-Prunetea*-Arten vor wie *Crataegus monogyna* und *Prunus serotina*.

Diskussion - Die fünf Gruppen können vier Assoziationen zugeordnet werden, die zwei Verbänden angehören. Innerhalb des *Ulici europaei-Sarothamnion scoparii* gehört Gruppe 1 zum *Rubo plicati-Sarothamnetum scoparii* Weber 1987 und Gruppe 2 zur hier neu beschriebenen Assoziation *Crataego monogynae-Cytisetum scoparii* Haveman, de Ronde & Schaminée. Innerhalb des *Ulici europaei-Cytision striati* können die Gruppen 3 und 4 dem *Frangulo alni-Ulicetum europaei* zugeordnet werden und Gruppe 5 dem *Rubo ulmifolii-Ulicetum europaei* J.-M. Géhu ex Haveman, de Ronde & Schaminée. Abbildung 1 zeigt die Verbreitung der Assoziationen in den Niederlanden, basierend auf den Aufnahmen dieser Untersuchung.

Abweichend von den Vorschlägen von DIERSCHKE (1981) im Rahmen der Klassifizierung von Zentralassoziationen haben wir die Verbandscharakterarten (*C. scoparius* für das *Ulici europaei-Sarothamnion scoparii* und *U. europaeus* für das *Ulici-Cytision striati*) nicht als Charakterarten der Assoziationen eingestuft, sondern verwenden Arten der zur gleichen Formation gehörigen „Geschwisterklassen". Wir meinen, dass dies gerechtfertigt ist, da Verbandscharakterarten in Marginalassoziationen oft nicht ihr Optimum haben, sondern eingeschränkte Nischen einnehmen, einen Habitatwechsel anzeigen oder durch angepasste Ökotypen vertreten sind. Ihre Bestände sind oft gekennzeichnet durch Arten anderer pflanzensoziologischer Einheiten, wie in dieser Arbeit anhand des Konzeptes der chorologischen Spannungszonen gezeigt wird. *Rubus*-Arten erwiesen sich als hilfreich bei der Zuordnung von Gruppen zu einer der Assoziationen, allerdings ist die soziologische Stellung von *Rubus*-Arten nur für einen Teil Europas bekannt. Um diese Wissenslücken zu schließen, bedarf es weiterer Forschungen. Die Feldschicht der retamoiden Gebüsche blieb in dieser Studie unberücksichtigt, kann aber wohl zur Unterscheidung von Subassoziationen herangezogen werden. Dies könnte unternommen werden im Rahmen einer breiter angelegten Forschungsarbeit über marginale retamoide Gebüsche gemäß der hier erläuterten Vorgehensweise, zum Beispiel mittels Daten der EVA-Datenbank.

Schlussfolgerung - Besenginster- und Stechginster-Dickichte mit *Cytisus scoparius* und *Ulex europaeus* lassen sich in den Niederlanden und angrenzenden Ländern wegen der Dominanz dieser retamoden Arten am besten der Klasse der Rutenstrauch-Gesellschaften *Cytisetea scopario-striati* zuordnen. In den Niederlanden können vier Assoziationen unterschieden werden gemäß der Vorgehensweise, die wir hier für die Klassifizierung artenarmer Marginalassoziationen vorschlagen.

Acknowledgements

We want to thank Erwin Bergmeier, Ulrich Deil, Hartmut Dierschke and Eddy Weeda who commented on an earlier version of this paper. Erwin Bergmeier also provided the Erweiterte deutsche Zusammenfassung.

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Supplements

Supplement S1. Full table of the *Cytisetea scopario-striati* in the Netherlands after the PAM analysis.

Beilage S1. PAM-Analyse der Aufnahmen der *Cytisetea scopario-striati* in den Niederlanden.

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Supplement S1. Full table of the Cytisetea scopario-striati in the Netherlands after the PAM analysis. The * in the table head is indicating the nomenclatural type of the *Crataego monogynae-Cytisetum scoparii* .

Beilage S1. PAM-Analyse der Aufnahmen der Cytisetea scopario-striati in den Niederlanden. Der * im Tabellenkopf kennzeichnet den nomenklatorischen Typus des *Crataego monogynae-Cytisetum scoparii* .

Relevé number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29*	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Year	2006	2013	2003	1968	1968	2000	2011	2013	2001	1999	1998	2013	2013	1968	2000	1999	2008	2001	2000	2013	2013	2000	2012	2013	1995	1995	2008	2013	2006	2010	2013	2014	2013	2014	2010	2014	2014	2014	2014	2014	2014	2014	2014	2014	2013	2013	2013	2013	2013	2014	2013	2014	2014	2014	2014	1961	2013	2006	2013
Size (m²)	25	100	25	25	25	30	25	30	30	40	50	30	30	100	12	24	15	15	30	30	30	40	25	16	30	30	24	100	63	32	11	32	100	30	25	30	30	30	30	30	30	30	30	32	30	30	30	30	30	30	30	20	30	20	32	32	20	30	40	30
Exposition	NW	SW	N	S							SW													NW	W		N	SW			W	W	SW		S	S	S	S	S	S	O	S	S	S	S	S	S	S	W	NW	SW	N	NO	N	SW	SO		S	O	SW
Inclination (degrees)	30	15	20	10							50													10			10	15			3	20	15		3	10	35	20	20	45	10	60	20	20	20	5	10	15	10	15	10	20	20	5	10	15		5	45	60
Cover shrublayer	70	70	55	80	30	70	50	75	70	70	70	60	80	100	60	60	85	90	70	70	70	70	70	70	75	100	70	60	90	96			70	80	80	96	95	96	90	96	90	90	95	90	95	99	95	95	70	90	80	80	96	90	85	90		99	95	85
Cover herblayer	20	70	70	60	70	30	80	25	40	40	95	30	20	3	60	50	96	20	7	40	20	50	30	70	50	90	20	70	10	15	80	25	40	60	40	5	15	10	30	10	20	5	40	15	15	15	10	7	70	40	60	60	10	40	40	20		10	20	10
Cover mosslayer	60		40	35	5	70	60	90	40	70	1	80	90	23	10	80	40	20	80	90	95	80	90	70		10	70	30		30		5	30	70	96	20	40	35	30		80	20	40	30	1	1	1	1		50	45	70	30	70	10	50				
Height shrublayer 1 (m)	1,2	2,0	2,0		4,5	2,5		2,5	1,5	2,0		1,8	2,0		4,0	2,5	3,0	2,5	2,5	2,5	1,8	2,5	1,5	3,0	2,5	2,5	2,5	1,8	2,5			2,0	2,2	3,0	1,5		1,6	1,6				1,6		2,0	2,5	2,0	5,0	3,0		2,5		4,0			4,0			4,0	2,0
Height shrublayer 2 (m)								1,4	1,8						2,0		2,0								1,0	1,5	0,6	0,8		2,5	1,5	0,8		1,5		2,0			2,5	1,5	1,5	2,0		2,5				2,0		3,5	1,2	2,0	2,5	2,5	3,0	2,5		1,6	2,5	
Average height herblayer (cm)	30	20	25	220	250	20	20	10	50	50	30	30	15	180		40	30		30	40	40	20	60	30	1	50	15	10	30	50		15	5	60	40	60	60	30	60	60	30	60	30	60	40	60	40	60	60	40	60	60	40	60	40	60		30	50	60
Max. height herblayer (cm)		60						60	100			70	60				60	50		80	70		60	150			70	40		100		40	15	150	60	120	120	90	120	120	150	120	90	120	150	120	150	150	120	120	150	100	100	100	100	150		80		120
No. species	22	21	12	11	8	17	27	18	18	20	17	22	17	13	8	14	15	18	27	32	15	28	21	15	7	18	21	24	13	13	26	19	24	16	13	17	16	9	19	10	11	16	23	15	19	17	13	16	29	31	32	24	31	32	34	33	7	11	15	13
JUICE cluster	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	5	5	5	5	6	6	6	6	6	7	7	7	7	7	8	8	8	8	8	8	8	9	9	9	9
Principal Group													1																			2												3									4								5		
CC Cytisetea scopario-striati																																																												
Cytisus scoparius	4	4	4	4	5	4	4	4	4	4	4	4	5	4	3	4	5	5	4	4	4	4	5	4	3	4	4	4	4	4	4	4	4	4	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2b	.	.	4	3	3	.
C/dA Ulici europaei-Cytision striati																																																												
Ulex europaeus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	4	4	5	5	5	5	5	4	5	4	5	5	4	4	4	4	4	4	4	4	.	.	.	5
Rubus ulmifolius	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2b	3	3	2b
Syntaxonomically important differential species																																																													
d1-3 / 5-8																																																													
L Rubus plicatus	.	.	.	1	.	.	.	.	.	2a	.	+	.	+	+	2a	.	.	1	+	.	2b	+	.	3	+	.	.	.	.	.	.	.	.	+	2b	3	2a	2b	.	.	.	.	.	2a	.	2a	2b	+	1	+	2a	2a	+	2a	.	.	.	.	.
L Rubus gratus	.	.	.	.	.	.	.	.	+	.	.	.	.	.	+	.	.	2b	1	.	+	+	.	.	+	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	2a	.	.	+	.	2a	+	.	.	.	.	.	.	.	.	.	.	.
L Rubus nemoralis	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	2a	+	2a	2b	.	.	.	.	.	.	.	.	.	.	.
L/F Rhamnus frangula	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	.	.	.	.	.	+	.	.	r	+	3	2a	3	2b	3	+	+	.	.	.	.
d4 / (8)																																																													
R Crataegus monogyna	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2a	2a	2a	2a	.	.	2b	2m	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.
R Rubus vestitus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2a	1	.	.	.	3	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2b	.	.	+	2a	+	+	+	.	.	.	.
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R Ligustrum vulgare	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
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R Bryonia dioica	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+
R Rubus caesius	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+
(R) Rubus sec. Corylifolii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	2a	.
Lonicero-Rubetea																																																													
Rubus scissus	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.	2a	.	.	.	.	.	.	.	.	.
Rubus integribasis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2a	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	2a	.	.	.	.	.	.	.
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Rhamno-Prunetea																																																													
Fraxinus excelsior	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Sambucus nigra	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.
Sambucus racemosa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Prunus spinosa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
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Rubus rufescens	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2a	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Rubus elegantispinosus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2a	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Salicetea arenariae																																																													
Hippophae rhamnoides	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+
Rubus species																																																													
Rubus idaeus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	2b	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.
Rubus ferocior	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Rubus arrheniiformis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	.	.	.	.
Rubus passionis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Rubus armeniacus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Phanerogams																																																													
Quercus robur	.	.	.	.	+	.	+	1	+	.	.	+	+	+	+	.	2b	.	.	2a	+	+	.	2a	2a	2m	.	.	.	.	+	.	.	+	.	+	2m	.	2m	2a	+	+	.	.	+	+	+	2b	+	.	+	+	.	.	.	+	+	+	2a	.
Prunus serotina	.	.	.	.	.	.	.	r	.	.	.	+	r	.	+	.	.	+	2a	2a	+	+	1	.	.	.	+	.	.	.	.	.	.	+	1	.	.	.	.	.	+	.	.	.	.	3	.	.	.	.	.	.	.	.	+	.	.	.	.
Betula pendula	.	.	.	.	.	.	.	.	.	.	.	.	+	+	2a	.	.	.	.	.	.	.	.	.	.	.	2a	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2a	.	2a	1	.	2a	.	2a	2a	+	2a	2a	.	.	.	.
Sorbus aucuparia	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	+	.	.	.	.	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	+	2a	.	.	+	+	+	.	.	.	.
Pinus sylvestris	.	.	.	.	.	.	.	.	.	.	.	+	r	+	2a	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.	.	+	r	+	2a	.	.	.	.
Betula pubescens	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	+	.	2a	.	+	.	.	.	.
Quercus rubra	.	.	.	.	.	.	.	.	.	.	.	r	.	.	+	.	r	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Acer pseudoplatanus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2m	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
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Ilex aquifolium	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.
Fagus sylvatica	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.
Pseudotsuga menziesii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.
Lianas																																																													
Lonicera periclymenum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	1	.	.
Solanum dulcamara	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Calluno-Ulicetea/Nardetea																																																													
Deschampsia flexuosa	2m	.	.	.	.	3	.	1	.	.	.	2m	2a	+	2b	+	.	.	2a	2m	2b	3	.	.	.	.	.	.	.	.	.	.	.	.	2m	2m	2a	1	2b	1	.	2m	1	2b	.	.	.	1	1	+	2a	+	+	+	1	.	.	.	.	.
Calluna vulgaris	2b	.	.	+	2b	+	.	.	.	.	.	+	+	5	2b	3	.	.	+	.	.	+	2a	.	.	.	.	.	.	.	.	.	.	.	2a	+	+	.	.	+	.	+	.	.	+	.	+	+	.	1	2a	+	1	+	2a	2a	.	.	.	.
Hypnum jutlandicum	2b	.	.	.	.	3	.	2a	.	.	.	4	2a	.	2a	5	.	.	.	.	3	2m	5	.	.	.	.	.	.	.	.	.	.	.	.	2a	2a	.	2b	2m	.	1	2a	.	2m	.	.	2m	2m	2a	3	2a	2a	2a	2m	2b	.	.	.	.
Molinia caerulea	.	.	.	2b	4	.	.	.	.	.	.	.	+	.	1	.	.	.	.	.	.	1	+	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	2a	.	2a	2a	.	2a	3	3	2m	2a	1	2a	.	.	.	.
Carex pilulifera	.	.	.	2b	.	+	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	1	+	.	.	.	.	.	.	.	.	.	.	.	2m	.	.	.	.	.	.	.	.	.	.	.	.	+	+	1	1	+	+	+	1	+	.	.	.	.
Potentilla erecta	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	+	.	+	+	+	+	1	2a	.	.	.	.
Galium saxatile	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	1	2b	2m	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	1	+	.	1	2m	1	.	.	.	.
Erica tetralix	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	1	1	+	2a	2a	.	.	.	.
Danthonia decumbens	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	+	.	.	+	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	+	+	+	.	.	.	.	.
Vaccinium myrtillus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	2b	1	2m	2a	+	.	+	.	.	.	.
Polytrichum commune v. perigoniale	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.

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Fortsetzung auf der Rückseite

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Relevé number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29*	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Principal Group	1											1															2																3										4								5			
Koelerio-Corynephoretea																																																													
Agrostis capillaris	.	2a	1	.	.	+	.	2a	.	+	2b	1	2a	.	.	2m	2a	.	1	2b	.	2m	.	3	2m	2m	2a	4	2m	2a	1	1	2b	2b	2a	2m	2m	1	2a	2m	1	2m	2a	2m	2m	2a	+	.	2b	2a	2m	+	2m	1	1	2a	.	.	2a	.
Pseudoscleropodium purum	.	.	1	.	.	2m	.	4	.	.	.	1	4	.	.	.	.	.	.	4	4	2m	+	+	.	.	.	2b	.	3	.	2a	2a	.	5	2a	2b	2b	2b	+	5	.	2a	2b	.	1	.	.	2a	.	.	.	.	.	.	1	.	.	.	.
Rumex acetosella	1	2m	.	+	.	+	r	1	.	.	.	+	.	.	.	.	.	.	1	.	1	.	+	r	.	.	1	.	.	.	.	.	2m	+	1	1	.	.	.	.	1	2m	.	.	.	.	.	.	.	.	.	.	+	.	.	r	.	.	.	.
Hypericum perforatum	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	+	+	r	+	.	+	.	.	.	.	+	.	.	.	.	.	2a	2m	.	.	.	1	.	.	.	.	1	.	.	.	.	+	.	.	.	.	.	.	.	+	.	.	.
Carex arenaria	1	.	2m	.	.	+	2m	.	.	.	2a	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	2a	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2a	.	.	.	.	.	.	.	.	.	.	2a	2a	2a
Agrostis vinealis	2m	.	.	2b	+	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	1	.	2a	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	3	.	2m	.	.	.	2a	1	.	.	.	.
Festuca filiformis	2m	.	.	.	.	.	r	+	.	.	.	2b	+	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	+	2m	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
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Lotus corniculatus s.s.	.	+	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	2a	2a	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
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Hieracium pilosella	.	.	.	.	.	.	.	+	.	.	.	.	+	.	.	.	.	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
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Campylopus fragilis	.	.	.	2b	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.
Polytrichum piliferum	.	.	.	+	.	2m	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
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Festuca brevipila	.	.	.	.	.	.	.	.	.	.	.	2a	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Molinio-Arrhenateretea																																																													
Holcus lanatus	.	2a	.	.	.	.	r	+	2b	.	3	.	.	.	.	.	5	2m	.	2m	.	+	.	1	.	.	.	1	+	+	.	2m	+	3	+	.	+	+	1	1	2b	2m	1	1	1	1	+	.	+	.	+	.	.	+	.	.	.	.	+	.
Anthoxanthum odoratum	.	2a	.	.	.	.	2a	.	.	+	.	.	.	.	.	.	.	.	.	+	.	.	+	2b	.	.	.	.	.	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	1	.	.
Rumex acetosa	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	r	.	+	.	.	.	.	.	2m	+	+	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2m	.	.	.	.	.	.	.	+	.	.	.
Cerastium fontanum s. vulgare	+	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	2m	.	.	.	.	.	.	.	.	.	.	1	.	.	+	.	1	1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.
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Achillea millefolium	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	1	.	.	.	.	.	.	+	.	.	.	+	.	.	.	.	.	2m	1	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Dactylis glomerata	.	+	.	.	.	.	r	.	2a	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	+	2a	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Arrhenatherum elatius	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	+	.
Stellaria graminea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	.	.	.	.	.	.	.	.	+	+	.	.	1	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Centaurea jacea	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	r	.	+	.	.	.	.	.	.	.	.	+	2a	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Juncus effusus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2a	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Melampyro-Holcetea																																																													
Teucrium scorodonia	.	2a	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	+	.	1	.	.	.	.	.	.	.	.	.	.	.	2a	+	2a	+	+	+	1	2a	1	2b	1	1	.	.	.	1
Holcus mollis	.	3	.	.	.	.	.	2a	.	3	.	.	+	.	.	.	.	.	1	.	.	1	+	.	2b	5	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	1	.	.
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Epilobietea angustifoliae																																																													
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Senecio sylvaticus	1	.	.	.	.	.	.	.	.	+	1	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	2a	.	.	+	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.
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Rumex obtusifolius	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.
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Cirsium arvense	.	.	.	.	.	.	.	.	2a	.	.	.	.	.	.	.	.	2a	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Pteridophytes																																																													
Dryopteris carthusiana	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	1	.	+	1	.	+	.	.	.	.	.	.
Dryopteris dilatata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	.	2a	+	.	.	r	.	.	.	.
Athyrium filix-femina	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	2a	.	+	.	.	.	.	.	.
Blechnum spicant	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2a	.	.	.	.	.	.	.	.	.	.	.
Pteridium aquilinum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.
Dryopteris filix-mas	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	+	.	r	.	.	.	.	.	.	+	.	.	.	.	.	.	+	.	.	.	r	.	.	.	.	.	.	.
Accompanying species																																																													
Field layer																																																													
Festuca rubra	.	+	.	.	.	.	.	2a	.	+	.	.	2a	.	.	.	.	.	.	2m	.	2m	.	1	2b	2m	.	2a	2m	1	3	2m	2b	2a	.	.	.	.	.	.	2b	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	+
Taraxacum species	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	+	.	r	.	+	1	2a	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.
Stellaria media	.	2m	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2m	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cardamine hirsuta	.	.	.	.	.	.	r	.	+	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Festuca species	.	.	2a	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Moss layer																																																													
Brachythecium rutabulum	2a	.	.	.	.	.	4	.	3	.	.	.	1	.	.	.	3	2b	.	.	.	.	+	4	.	3	1	.	.	2m	.	.	.	4	+	1	2a	2b	.	2m	.	2m	2b	2a	.	.	.	.	2b	+	.	.	.	1	.	.	.	.	.	.
Rhytidiadelphus squarrosus	.	.	.	.	.	2m	.	2a	.	.	.	.	2a	.	.	+	.	.	2m	3	.	2m	1	.	.	3	.	2b	.	.	.	1	.	+	.	.	2m	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	+	+	.	.	.	.	.	.
Dicranum scoparium	2b	.	2a	.	.	2b	.	.	.	.	.	2a	1	.	.	.	.	.	2m	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2a	2m	.	.	.	.	.	.	.	.	.	1	.	.	.	2m	.	1	1	+	.	.	.	.	.
Pleurozium schreberi	.	.	.	.	.	2m	.	2a	.	3	.	.	2a	.	.	.	.	.	5	.	.	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2b	.	4	2a	3	2m	2b	.	.	.
Campylopus pyriformis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2m	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	2a	1	.	.	+	+	+	.	.	.	2m	1	.	.	2m	.	+	2a	.	.	.	.
Kindbergia praelonga	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	.	r	.	.	.	.	.	.	.	2m	.	.	.	.	2m	.	.	.	.	.	.	.	2a	.	1	+	1	.	.	.	.	.	.
Plagiomnium affine	2m	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2m	.	.	.	.	.	+	.	.	.	.	2b	+	.	.	.	1	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Atrichum undulatum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2a	+	1	2m	1	2m	1	.	.	.	.
Polytrichum commune	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2m	.	+	2m	1	1	.	.	.	.	.
Pohlia nutans	.	.	.	2b	+	.	.	.	.	.	.	.	.	2b	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	+	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.
Polytrichum formosum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	2a	.	1	1	.	.	+	.	.	.	.
Dicranella heteromalla	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2m	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	.	.	.	.	.
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Campylopus introflexus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2b	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

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Zeitschrift/Journal: Tuexenia - Mitteilungen der Floristisch-soziologischen Arbeitsgemeinschaft

Jahr/Year: 2017

Band/Volume: NS_37

Autor(en)/Author(s): Haveman Rense, Ronde Iris de, Schaminee Jopp H. J.

Artikel/Article: Retamoid scrubs of the Cytisetea scopario-striati in the Netherlands: a new approach to classify marginal associations 143-161