

Forest-edge communities (*Trifolio-Geranietea sanguinei*) on the island of Saaremaa (Estonia): Phytosociology and biodiversity patterns

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Abstract

We studied the communities of the class *Trifolio-Geranietea sanguinei* on the Baltic island Saaremaa (Estonia, hemiboreal zone). These tall-forb communities of anhydromorphic, nutrient-poor sites usually grow as ecotones alongside forest edges. We documented the variety of community types occurring on the island by 41 relevés of 5 m² plots, in which we recorded all vascular plants, bryophytes, and lichens, and measured some soil parameters. According to the syntaxonomic analysis, the stands on Saaremaa belong to 12 communities, including 11 previously published associations and one unit with presumable association rank that has not yet been described formally. Of these communities, only one belongs to the acidophytic subclass *Melampyro pratensis-Holcenea mollis*, while the others are equally divided between the mesophytic order *Origanetalia vulgaris* s.str. and the xerophytic order *Antherico ramosi-Geranietalia sanguinei* within the basiphytic subclass *Trifolio-Geranietea sanguinei*. Within the first order, we accept the alliances *Knaution dipsacifoliae*, which is nomenclaturally validated here, and *Trifolion medii* s.str.; within the second order we accept the alliances *Galio veri-Geranium sanguinei* and *Geranium sanguinei* s.str. For all communities, we review the known distribution within the Nordic and Baltic region and provide a comprehensive overview of names that have previously been applied here. Due to the prevailing limestone bedrock, soil pH (H₂O) of the plots was consistently high (6.0–7.8). The communities analysed showed high species densities throughout, with association means from 24 to 45 species on 5 m². Compared to similar analyses of the same associations in NE Lower Saxony ($n = 7$) and NE Germany ($n = 6$), species densities of the Estonian stands were 1.2–2.2 times higher, with mean ratios of 1.82 relative to Lower Saxony and 1.60 relative to NE Germany. These differences were statistically significant in most cases and are in accordance with previous findings in various dry grassland types. As most of the causes suggested for dry grasslands do not hold for forest-edge communities, however, other explanations must be found. We consider the shorter vegetation period in the hemiboreal zone as a potential candidate, as this may reduce competition and thus enhance local coexistence of many species. Finally, we suggest further research that might help to explain the surprising biodiversity pattern we discovered.

Keywords: classification; ecotone; hemiboreal zone; *Knaution dipsacifoliae*; northern Europe; site condition; syntaxonomy; species density; tall-forb community

Kurzfassung: Saumgesellschaften (*Trifolio-Geranietea sanguinei*) auf der Insel Saaremaa (Estland): Pflanzensoziologie und Biodiversitätsmuster

Wir untersuchten die Gesellschaften der Klasse *Trifolio-Geranietea sanguinei* auf der Ostseeinsel Saaremaa (Estland, hemiboreale Zone). Diese Hochstaudengesellschaften grundwasserferner, nährstoffarmer Standorte wachsen gewöhnlich als Ökotope im Saum von Gehölzen. Um die vorkommenden Typen zu dokumentieren, fertigten wir 41 Aufnahmen von 5 m² großen Probestellen an, auf denen alle Gefäßpflanzen, Moose und Flechten erfasst sowie einige Bodenparameter bestimmt wurden. Die syntaxonomische Analyse ergab, dass sich die Bestände auf Saaremaa 12 verschiedenen Gesellschaften im Assoziationsrang zuordnen lassen, wovon eine bislang nicht gültig beschrieben ist. Von den Gesellschaften gehört nur eine zur azidophytischen Unterklasse *Melampyro pratensis-Holcenea mollis*, während die anderen sich zu glei-

chen Teilen auf die mesophytische Ordnung *Origanetalia vulgaris* s. str. und die xerophytische Ordnung *Antherico ramosi-Geranietalia sanguinei* innerhalb der basiphytischen Unterklasse *Trifolio-Geranienea sanguinei* verteilen. Erstere Ordnung lässt sich im Gebiet in das *Knaution dipsacifoliae*, das wir hier nomenklatorisch validieren, und das *Trifolium medii* s. str. gliedern, während zweite in das *Galio veri-Geranion sanguinei* und das *Geranion sanguinei* s. str. zerfällt. Für alle Gesellschaften referieren wir die bekannte Verbreitung im nordisch-baltischen Raum und geben einen umfassenden Überblick über hier früher für sie verwendete Namen. Als Folge des carbonatischen Ausgangsgesteins waren die Boden-pH-Werte (in H₂O gemessen) durchweg hoch (6,0–7,8). Die untersuchten Gesellschaften hatten durchweg hohe Artendichten mit Assoziationsmittelwerten zwischen 24 und 45 Arten auf 5 m². Im Vergleich zu ähnlichen Analysen derselben Assoziationen in Nordost-Niedersachsen ($n = 7$) bzw. in Nordostdeutschland ($n = 6$) waren die Artendichten in den estnischen Beständen 1,2–2,2 mal höher, mit mittleren Quotienten gegenüber den niedersächsischen Aufnahmen von 1,82 und gegenüber den nordostdeutschen Aufnahmen von 1,60. Diese Unterschiede waren in der Mehrzahl statistisch signifikant und stimmen mit ähnlichen Befunden in verschiedenen Trockenrasengesellschaften überein. Da jedoch die im Fall der Trockenrasen vorgeschlagenen Mechanismen für die Saumgesellschaften größtenteils nicht zutreffen dürften, müssen andere Erklärungen gesucht werden. Wir erachten die kürzere Vegetationsperiode in der hemiborealen Zone als einen aussichtsreichen Kandidaten, da diese zu reduziertem zwischenartlichem Wettbewerb führt und damit eine kleinräumige Koexistenz verschiedener Arten ermöglicht. Abschließend skizzieren wir Forschungsansätze, die helfen könnten, das von uns entdeckte, überraschende Biodiversitätsmuster zu erklären.

Schlüsselwörter: Artendichte; hemiboreale Zone; Hochstaudengesellschaft; Klassifikation; *Knaution dipsacifoliae*; Nordeuropa; Ökoton; Standortbedingung; Syntaxonomie

Nomenclature: Vascular plants: Wisskirchen & Haeupler (1998), Tutin et al. (1968, 1980) for taxa not present in Germany; bryophytes: Koperski et al. (2000); lichens: Scholz (2000)

Abbreviations: CEC = cation exchange capacity; ICPN = International Code of Phytosociological Nomenclature

We dedicate this article to Klaus Dierßen, who contributed to the knowledge of the Nordic vegetation more than anyone else, on occasion of his 60th birthday

1 Introduction

While studying phytosociology and biodiversity of the dry grasslands of the Estonian island Saaremaa (Boch 2005; cf. Boch & Dengler 2006) and therefore travelling to various dry grassland sites scattered throughout the island, we noticed well developed forest-edge communities (fringe or saum communities) of the class *Trifolio-Geranietea sanguinei* alongside the little-used roads that cross the extended forests (see Plate 1). With the colourful flowering aspect of character species such as *Geranium sanguineum*, *Melampyrum nemorosum*, *Trifolium alpestre*, *T. medium*, *Vicia cassubica* and *V. sylvatica*, these tall-forb stands added a very specific note to the landscape of Saaremaa. We cannot recall any other region in Europe where *Trifolio-Geranietea* communities occur so extensively. Thus, we took the opportunity and recorded the wealth of communities from this class to be found on Saaremaa and will describe them in this article.

The class *Trifolio-Geranietea* comprises tall-forb communities from nutrient-poor, anhydromorphic sites in lowland to montane regions of Europe (Dierschke 1974, de Foucault et al. 1983, Weber 2003, Dengler et al. 2006a) and thus complements similarly structured commu-

nities of wet sites (*Filipendulo-Convulvuletea* Géhu & Géhu-Franck 1987 nom. inval.), of anhydromorphic but nutrient-rich sites (*Artemisietea vulgaris* Lohmeyer et al. ex von Rochow 1951), and of montane to lower-alpine altitudes (*Mulgedio-Aconitetea* Hadač & Klika in Klika & Hadač 1944). While some authors separate acidophilic communities (*Melampyro-Holcetea mollis* Passarge 1979 nom. inval.) from basiphilous communities (*Trifolio-Geranietaea* s.str.; e.g., Schaminée et al. 1996, Weber 2003, Bardat et al. 2004) among the nutrient-poor dry sites, we accept a single, broadly delimited class *Trifolio-Geranietaea* s. l. comprising both subunits (e.g., Pott 1995, Mucina 1997, Dierßen & Dierßen 1996, Rodwell et al. 2002, Dengler 2004, Dengler et al. 2006a). As shown in previous studies (Dengler 2003, 2004, Dengler et al. 2006a), the forest-edge communities of acidic and of base-rich sites are connected by numerous common class character species, such as *Hypericum perforatum*, *Galium album* agg., *Veronica chamaedrys*, *Clinopodium vulgare* and *Solidago virgaurea* ssp. *virgaurea*; so this point of view seems well justified.

In northern Europe (Fennoscandia, Baltic countries) formalised documentation and classification of plant communities has received relatively little attention in the past. However, assignment of the community types that occur to meaningful, supra-regionally accepted classificatory units such as syntaxa is of great importance for the comparability and generalisation of ecological studies (Dengler 2003, Dengler et al. 2008) and particularly for the application of European nature-conservation legislation such as the Habitats Directive, which largely relies on phytosociological units (Rodwell et al. 2002, European Commission 2003). Among European countries, Estonia is one of the least-well documented countries in phytosociological terms. While there are a few rather old studies with relevé-based vegetation descriptions, mainly following the Uppsala school of vegetation science (e.g., Vilberg 1927, Tomson 1937), later descriptions were usually purely verbal (e.g. Laasimer 1965). Just recently numerical classifications for some specific vegetation types have been published (e.g. alvar grasslands: Pärtel et al. 1999; alluvial forests: Paal et al. 2007), but mostly without any attempt to integrate the units distinguished into the European phytosociological system. Most recently, we ourselves dealt with the classification of Estonian dry grasslands and proposed their formal classification as different associations within the general phytosociological system (Boch & Dengler 2006, Dengler et al. 2006b).

Regarding forest-edge communities, the phytosociological knowledge is particularly low in the Baltic countries and not much better in northern Europe in general (here, we use 'northern Europe' to refer to Fennoscandia + Denmark + the Baltic countries). Early records from Scandinavia mainly focus on conspicuous stands with *Geranium sanguineum* (e.g., Tüxen 1967, Hallberg 1971). Based on the phytosociological tables therein, as well as the description of some other *Trifolio-Geranietaea* communities in an unpublished report by Kielland-Lund (1965), Dierschke (1974), in his comprehensive overview of the state of knowledge on the class at that time suggested that the forest-edge communities of northern Europe form a third group ('Nördliche Gesellschaftsgruppe'), equivalent to the two known alliances *Trifolion medii* and *Geranion sanguinei*. As shown in the synoptic table of Dierschke (1974), this potential syntaxon combines diagnostic species of both central European alliances but is separated by additional diagnostic species. More than twenty years later, Dierßen & Dierßen (1996) could base their synoptic table of *Trifolio-Geranietaea* communities in northern Europe on only slightly more relevés than Dierschke (1974) did. They distinguished three associations each of the *Trifolion medii* and the *Geranion sanguinei*. For the other two Baltic countries besides Estonia, namely Lithuania and Latvia, recent phytosociological overviews of the *Trifolio-Geranietaea* communities occurring are available (Lithuania: Rašomavičius 1998,

Balevičienė et al. 2000; Latvia: Rūsiņa 2007) but again based on rather few relevés. For Estonia, we know of no reports of *Trifolio-Geranietea* communities apart from the frequent mentioning of a *Scorzonera humilis-Melampyrum nemorosum* association/union (Lippmaa 1932, Tomson 1937, Laasimer 1965, Paal 1998).

In the past, several authors have described the phenomenon that plant communities from northern Europe do not fit in classification schemes developed in central Europe (e.g. Dierschke 1974, Dierßen & Dierßen 1996, Diekmann 1997, Dengler et al. 2006b). This is particularly true for ‘southern’ vegetation classes that reach their northern limit in the hemiboreal zone, such as *Quercu-Fagetea*, *Trifolio-Geranietea sanguinei*, and *Festuco-Brometea*. According to these authors, the northern communities of these classes, on the one hand, lack a number of diagnostic species that are very common in central European stands, and on the other hand, often show a peculiar mixture of species that rarely occur together further south (e.g. mesophilous and xerophilous or acidophilous and basiphilous species). Moreover, for different dry grassland types, fine-scale species richness (e.g. for usual sizes of sample plots for phytosociological relevés) – contrary to intuition – is much higher in hemiboreal than in temperate stands of the same vegetation types (Dengler & Löbel 2006, Dengler et al. 2006b).

With our article we aim

- to characterise the full variety of *Trifolio-Geranietea* communities occurring on Saaremaa, floristically and ecologically,
- to compare them with those of other regions in order to place them into a supra-regionally valid classification scheme, and
- to explore whether the peculiarities in species composition and species density found for other syntaxa of the hemiboreal zone also hold for the forest-edge communities.

2 Study area

The Baltic island Saaremaa (2,673 km²; 57° 50′–58° 40′ N, 21° 45′–23° 20′ E) is located off the Estonian west coast. Its bedrock is formed by Silurian limestone (Raukas & Teedumäe 1997), which is located partly close to the surface but more often is covered by Weichselian moraines or Holocene marine sediments (Poska & Saarse 2002). The mean annual temperature is about 6.0 °C, with a rather continental temperature regime, that is, warm summers (mean July temperature: 16.5 °C) and cold winters (mean temperature of the coldest month February ranging from –3.5 °C in the west to –5.0 °C in the east; Anonymous 1970). The annual precipitation on Saaremaa varies between 540 mm and 675 mm (Raudsepp & Jaagus 2002).

The natural forest vegetation of Saaremaa mainly consists of hemiboreal mixed broadleaved-spruce forests (units D18 and D19) and of east European psammophytic pine forests (unit D49; Bohn et al. 2000, 2004). With 13.5 inhabitants per square kilometre, Saaremaa is only sparsely populated, generally resulting in low-intensity land use. More than half of the area is covered by pine, spruce and broad-leaved forests. Alvar grasslands (i.e. dry grasslands on superficial limestone bedrock) are also an important element of Saaremaa’s landscape, but their area has drastically declined from 260 km² in the 1930s to 78 km² in 2000, due to abandonment and subsequent encroachment of woody species (Helm et al. 2006).

3 Methods

3.1 Plot data

In July and August 2004, we made 41 relevés of tall-forb stands dominated by known character species of the class *Trifolio-Geranietea*. The plots, in visually homogeneous stands, were located in many different regions of the island and were selected with the aim to cover the full range of *Trifolio-Geranietea* communities occurring there. Most stands were recorded along roads crossing the forests. Coordinates and additional plot information are given in Appendix 1.

To allow comparisons with the study of Dengler et al. (2006a) on forest-edge communities in Lower Saxony, we applied the same methodology. Thus, the plots were sized 1 m × 5 m throughout, with the long side parallel to the forest edge. All plant taxa within the perpendicular projection of the plots were recorded, including bryophytes, lichens, non-terricolous taxa, and woody species whose branches reached over the plot. We used the modified Braun-Blanquet scale of Dengler (2003: 131), which is based solely on cover and not on abundance.

For determination of soil parameters we took mixed samples of the topsoil (uppermost 10 cm). After drying, we measured pH (in aqueous suspension; 10 g soil + 25 g water), content of organic matter (i.e. loss at ignition at 430 °C), as well as H and S values (Schlichting et al. 1995). The latter two were used to calculate base saturation and cation exchange capacity (CEC). Carbonate content and soil textural class were estimated according to Schlichting et al. (1995).

3.2 Phytosociological classification and table presentation

Data storage and phytosociological ‘tablework’ were done with SORT 4.0 (Ackermann & Durka 1998). Phytosociological classification follows the consistent approach outlined by Dengler (2003). Syntaxa are named according to the International Code of Phytosociological Nomenclature (ICPN; Weber et al. 2000). The references to the author citations of the communities and higher syntaxa included in the syntaxonomic overview (4.1) and in the ‘other names’ of section 4.2 are included in the reference list.

As we only had 41 relevés from Saaremaa available, classification was mainly done deductively by assigning the Estonian stands to associations and superior syntaxa that had been previously established based on more than 5,000 relevés from large parts of Europe (see Dengler et al. 2006a). However, a purely inductive approach based on the relevés from Saaremaa only would have yielded the same result at the association level and only minor deviations at higher hierarchical levels (for details, see sections 4.2 and 4.3.1). The diagnostic value of taxa as indicated in the tables (Supplements 1 and 2) has been assessed for the Estonian relevés but largely coincides with the supra-regional situation (compare Dengler et al. 2006a). No attempt was made to establish ‘new’ character species.

The presentation of the tables (Supplements 1 and 2), including the marking of diagnostic taxa, follows the same conventions as used, for example, by Berg et al. (2001) and Dengler et al. (2006a, 2006b). As suggested by Dengler (2003) and, for example, applied in Berg et al. (2001) and Dengler et al. (2006a, 2006b), constancy reference values (hereafter also called constancies) for superior taxa were calculated based on association values rather than on individual relevés. This approach avoids biases due to unequal sampling of different associations.

3.3 Biodiversity analyses

Potential relationships of species density with environmental and structural parameters (humus content, soil pH, CEC, cover of tree layer) were tested with linear regression analysis for single parameters in STATISTICA 7.1 (StatSoft, Inc. 2005).

We compared the species richness patterns of the Estonian forest-edge communities with the same associations in NE Lower Saxony (52° 45'–53° 30' N: Dengler et al. 2006a) and NE Germany (i.e. Brandenburg, Berlin, and Mecklenburg-Vorpommern; 51° 20'–54° 40' N: Dengler unpubl.). While Dengler et al. (2006a) applied exactly the same methodology as in the present study, the unpublished relevés were taken in a slightly different manner. The NE German plots were 10 m² instead of 5 m² in size, were usually square-shaped instead of 1:5-rectangles, and only terricolous taxa were recorded. As plot size significantly influences richness values, these had to be 'standardised' to 5 m² for the NE German data. We used the power-function species-area relationship for this standardisation. As we did not make our own species-area analyses in these stands, nor did we know of any such studies in *Trifolio-Geranietea* stands, we had to apply a z -value derived from other communities to do this transformation. We assumed $z = 0.210$, the average value calculated by Dengler (2005) for a wide range of European dry grassland types ($n = 14$), which are floristically and structurally quite similar to *Trifolio-Geranietea* communities. The mean value for nitrophilous tall-forb communities (including forest-edge communities) reported by Hobohm (1998) is nearly the same ($z = 0.201$; $n = 6$). The assumed z -value means that the richness values on 10 m² have to be multiplied by 0.865 to get the (probable) species density on 5 m². If we had used the extreme z -values from the two studies for the calculation, the resultant factors would have been 0.841 and 0.886, respectively. Thus, the precise value of z has little influence on our results. We did not apply any corrections for the other two methodological deviations of the NE German data, as their effects are most probably negligible. Although elongated plot shapes on average increase the recorded species richness compared to equally sized square plots (Dengler 2003), the differences are extremely small for length/width ratios in the order of 5 (e.g. Kunin 1997, Bossuyt & Hermy 2004). On the other hand, the contribution of non-terricolous taxa to the total species richness of the Estonian forest edges was far below 1% – and there is no reason why this should be different in other regions because inhabitable substrata other than earth are usually rare in forest-edge stands.

The actual comparisons of the density values on 5 m² were carried out as t -tests with STATISTICA 7.1 (StatSoft, Inc. 2005). Following the suggestions of Quinn & Keough (2002), we use a significance level of $\alpha = 0.05$ throughout but report p -values to allow interpretation of the results with other significance levels.

4 Results and discussion

According to the methodology applied, we were able to distinguish 12 associations or equivalent units. The relevés are presented in a relevé table (Supplement 1) and as a constancy table for the associations and superior syntaxa in order to visualise the accepted classification (see 4.1) and the diagnostic value of the taxa (Supplement 2).

4.1 Syntaxonomic overview

Here, we present the 12 communities with their full names and author citations, as well as their placement in the phytosociological hierarchy as accepted in this paper. Regarding the classification of syntaxa above the association level, we follow the suggestions of Dengler et al. (2006a) because these are based on the most extensive Europe-wide synthesis of the class so far:

Class: *Trifolio-Geranietea sanguinei* T. Müller 1962

Subclass: *Melampyro pratensis-Holcenea mollis* Passarge ex Dengler in Dengler et al. 2003

Order: *Melampyro pratensis-Holcetalia mollis* Passarge 1979b

Alliance: *Violo riviniana-Stellarion holostea* Passarge 1994b

Pteridietum aquilini Jouanne & Chouard 1929

Subclass: *Trifolio-Geranietea sanguinei* (T. Müller 1962) Dengler in Dengler et al. 2003

Order: *Origanetalia vulgaris* T. Müller 1962 [central order]

Alliance: *Knaution dipsacifoliae* Julve ex Dengler & Boch 2008 [for validation, see below]

Vicetum sylvaticae Oberd. & T. Müller ex T. Müller 1962 [central association]

Alliance: *Trifolion medii* T. Müller 1962

Agrimonio eupatoriae-Vicetum cassubicae Passarge 1967 nom. invers. propos.

Trifolio medii-Melampyretum nemorosi Dierschke 1973

Agrimonio eupatoriae-Trifolietum medii T. Müller 1962 nom. invers. propos. [central association]

Lathyrus sylvestris community

Galio albi-Astragaletum glycyphylli Schwarz 2001

Order: *Antherico ramosi-Geranietalia sanguinei* Julve ex Dengler in Dengler et al. 2003

Alliance: *Galio veri-Geranion sanguinei* Géhu & J. Géhu in de Foucault et al. 1983 nom. mut. propos. [central alliance; for name adaption, see below]

Sileno nutantis-Libanotidetum montanae Jeschke ex Passarge 1979a

Galio borealis-Geranietum sanguinei Tx. 1967 [central association]

Inuletum salicinae Marker 1969

Alliance: *Geranion sanguinei* Tx. in T. Müller 1962

Geranio sanguinei-Trifolietum alpestris T. Müller 1962

Trifolio medii-Laserpitietum latifolii van Gils & Gilissen 1976

4.2 Characterisation of the communities

In the following we give brief floristic and ecological characterisations of the 12 communities distinguished. For each of them we discuss syntaxonomic questions, if relevant, and review previous records from the Nordic and Baltic region (Fennoscandia, Denmark, Baltic countries, N Poland, and N Germany) in order to outline the presumable distribution of the associations. Preceding these treatments we list all other names (including informal ones) that have been applied to the respective communities in northern Europe, with an indication of their nomenclatural validity and legitimacy. For synonyms from other parts of Europe, we refer to the extensive lists in Dengler (2004) and Dengler et al. (2006a).

4.2.1 *Pteridietum aquilini* Jouanne & Chouard 1929 (Supplement 1: A1.1)

Syn.: *Rubo-Pteridietum aquilini* Hadač 1975

Incl.: Adlerfarn-Dickungen *sensu* Dierßen & Dierßen 1996

Pteridium aquilinum'i järk *sensu* Tomson 1937

Pteridium aquilinum ssp. *aquilinum*-typ [5.2.2.4] *sensu* Pålsson 1999

Pteridium aquilinum ssp. *latiusculum*-variant (av *Rubus fruticosus*-typ) [5.5.6.2.a] *sensu* Pålsson

1999

Vaccinium-Pteridium aquilinum ssp. *capense*-[*Holco-Pteridienion aquilini*]-Gesellschaft *sensu* Passarge 1994a

The *Pteridietum aquilini* consists of stands dominated by the name-giving species. Among and below the large, dense leaves of this fern, only relatively few other species with rather low cover values can grow. Thus the *Pteridietum aquilini* is by far the least species-rich of all forest-edge communities on Saaremaa. Also, mean CEC is lower than in any other community, but mean pH still lies above the neutral point.

It seems possible or even probable that the two European subspecies of *Pteridium aquilinum* characterise two separate, mostly vicariant associations, as indicated even in the coarse classification of Pålsson (1999). The unit with ssp. *aquilinum* then would occupy large parts of west, south, and central Europe, whereas the range of the unit with ssp. *latiusculum* (Desv.) Hultén would lie in the north-eastern part of the continent (Scotland, Fennoscandia, Russia; cf. Jonsell 2000). Unfortunately, we do not know the identity of the plants on Saaremaa, as neither we nor the checklist of the country (Kukk 2008) distinguished the two segregates. Thus, presently, all bracken-dominated communities are joined in one association.

Although *Pteridium aquilinum* is very widespread and frequent in northern Europe (Jalas & Suominen 1972, Jonsell 2000), and so also is probably the association, only very few phytosociological records have been published from this region (Saaremaa: Tomson 1937 – one relevé; SE Norway: Hadač 1975, SW Norway: Passarge 1994a). At least, in the overview of Nordic vegetation types, Pålsson (1999) lists two communities, each dominated by one of the two subspecies of *Pteridium aquilinum*; and Dierßen & Dierßen (1996: 672) mention *Pteridium aquilinum* stands from Jutland (placed in the *Epilobietea angustifolii* Tx. & Preisling ex von Rochow 1951). No such communities are mentioned in the comprehensive overviews of the *Trifolio-Geranietaea* communities of Poland (Brzeg 2005), Lithuania (Rašomavičius 1998), and Latvia (Rūsiņa 2007), but their authors potentially considered the *Pteridietum aquilini* as not belonging to the class. In northern Germany, the association is fairly common (Passarge 1994a, Dengler 2004, Dengler et al. 2006a).

4.2.2 *Vicietum sylvaticae* Oberd. & T. Müller ex T. Müller 1962 (Plate 2, Supplement 1: A2.1)

Incl.: *Vicia sylvatica*-Gesellschaft *sensu* Tüxen 1967

This community is characterised by *Vicia sylvatica*, whose climbing shoots cover the herb layer. Other herbs (including graminoids) rarely reach higher cover degrees, whereas the moss layer is usually well developed. Compared to the other communities of the *Origanetalia vulgaris* on Saaremaa, several acidophilous (e.g. *Deschampsia flexuosa* and *Melampyrum sylvaticum*) and forest species (e.g. *Anemone nemorosa*) differentiate, while some of the more light-demanding species of typical *Trifolio-Geranienea* communities (e.g. *Origanum vulgare* and *Galium verum*) are lacking.

In the literature, stands dominated by *Vicia sylvatica* and *V. dumetorum* have frequently been joined in one association, partly under the above-mentioned name and partly as *Vicietum sylvatico-dumetorum* auct. nom. illeg. (Art. 29 ICPN; e.g. Dierschke 1974). However, we prefer to treat them as separate communities because an analysis of all available relevés (Dengler unpubl.) showed that the two vetch species rarely grow together. Thus, we suggest restricting the name *Vicietum sylvaticae* to stands dominated by the name-giving species and

to place those with *Vicia dumetorum* in a new association (*Galio aparines-Vicietum dumetorum* Dengler in prep.).

In northern Europe, the *Vicietum sylvaticae* s.str. has previously been documented from SW Norway (Øvstedal 1985), SE Norway (Kielland-Lund 1965), as well as from S Sweden and S Finland (Dierßen & Dierßen 1996). We know of no previous records from the Baltic countries, but the association occurs occasionally in northern Poland (Brzeg 2005) and northern Germany (Passarge 1967, Dierßen et al. 1988).

4.2.3 *Agrimonio eupatoriae-Vicietum cassubicae* Passarge 1967 nom. invers. propos. (Supplement 1: A2.2)

As in the preceding community, the name-giving vetch, *Vicia cassubica*, covers the stands of this association. The *Agrimonio-Vicietum* often grows directly under the crowns of the outermost trees, on soils that are rather sandy compared to most of the other forest-edge communities on Saaremaa.

In the Nordic and Baltic region, the *Agrimonio-Vicietum* has previously been recorded from SE Sweden (Dierßen & Dierßen 1996), Estonia (Rūsiņa 2007), Latvia (Rašomavičius 1998), N Poland (Brzeg 2005), NE Germany (Passarge 1967, Dengler 1994, 2004), and NW Germany (Raabe 1956, Dierßen et al. 1988, Dengler et al. 2006a).

4.2.4 *Trifolio medii-Melampyretum nemorosi* Dierschke 1973 (Plate 3, Supplement 1: A2.3)

Syn.: *Scorzonero humilis-Melampyretum nemorosi* Lippmaa 1932 p. p. [Art. 7]

Melampyro nemorosi-Scorzoneretum humilis Laasimer 1965 p. p. [Art. 7]

Stachyo-Melampyretum nemorosi Passarge 1967 *sensu* Rašomavičius 1998, Balevičienė et al. 2000, [Art. 3c]

Melampyro-Scorzoneretum [*Scorzoneronetum*] Paal 1998 p. p. [Art. 7]

Incl.: *Scorzonera humilis-Melampyrum nemorosum*'i unioon *sensu* Tomson 1937 p. p.

The *Trifolio-Melampyretum* mostly grows directly under the crowns of the outermost trees. Apart from the character species of the association, *Melampyrum nemorosum*, other vascular plants also contribute significantly to structure and appearance of the community, namely *Rubus caesius* and some graminoids.

In the Estonian literature, a community type with *Melampyrum nemorosum* and *Scorzonera humilis* has frequently been mentioned (Lippmaa 1932, Tomson 1937, Laasimer 1965, Paal 1998; for the exact names, see above). While the *Trifolio-Melampyretum*, as documented here and in accordance with reports from other European regions (see below), was only found in forest-edge situations and has only infrequent and subordinate occurrences of *Scorzonera*, the *Scorzonero-Melampyretum* of Estonian authors seems to be more a grassland community that grows not only in narrow marginal bands but also on more extensive areas, which do not necessarily need to have direct contact with woodlands. For example, Paal (1998) describes the *Scorzonero-Melampyretum* as an 'approachingly rare' and fairly threatened type of 'dry boreo-nemoral grassland'. Moreover, the latter association is dominated by *Scorzonera*, with *Melampyrum* usually only a subordinate companion, according both to the only available relevés (Tomson 1937) and the photograph by Lippmaa (1932). We have not encountered stands matching these descriptions ourselves, although they should occur also on Saaremaa (Tomson 1937). Based on the discrepancies between the two descriptions, it seems reasonable to separate two associations, the *Trifolio-Melampyretum* s.str. of relatively dry forest edges and the *Scorzonero-Melampyretum* s.str. of periodically wet grasslands, mostly located within wooded meadows. With species such as *Solaria caerulea* and *Deschampsia cespitosa*, the

latter association probably belongs either to the *Molinio-Arrhenatheretea* Tx. 1937 or to the *Parvo-Caricetea* den Held & Westhoff in Westhoff & den Held 1969 nom. cons. propos.

Apart from the Estonian records of the '*Scorzonero-Melampyretum*', which partly belong to the *Trifolio-Melampyretum* (e.g. Tomson 1937: rel. 32/26 on p. 54), the latter association has been recorded from S Sweden and S Finland (Dierßen & Dierßen 1996), Lithuania (Rašomavičius 1998, Balevičienė et al. 2000), N Poland (Brzeg 2005), and N Germany (Dierßen et al. 1988, Dengler 2004, Dengler et al. 2006a).

4.2.5 *Agrimonia eupatoriae-Trifolietum medii* T. Müller 1962 nom. invers. propos. (Supplement 1: A2.4)

The *Agrimonia-Trifolietum*, the central association of the *Trifolion medii*, comprises stands dominated by *Trifolium medium* but lacking the character species of the other associations of this alliance. It typically grows in small bands in close contact with woodlands.

While some authors consider *Agrimonia eupatoria* as the character species of the association (e.g. Pott 1995, Brzeg 2005), this is not true for most regions, since this species is also very frequent in many other *Trifolio-Geranienea* communities (Dengler 2001, see also the tables of Brzeg 2005). In the four relevés of the *Agrimonia-Trifolietum* in Supplement 1, *Agrimonia eupatoria* is even missing, although this species is common on Saaremaa. As previously pointed out by Dengler (2004) and Dengler et al. (2006a), the two name-giving species of the association tend to separate more and more towards their northern distributional limits. Whether stands without *Trifolium medium* (named *Agrimonia eupatoria* facies by Dengler et al. 2006a) should be included at all in this association is questionable, as they closely resemble dry types of *Arrhenatheretum elatioris* Br.[-Bl.] 1915 (cf. Dierßen & Dierßen 1996).

The association is rather frequent in the Nordic and Baltic region, with records from Denmark, SE Norway, S Sweden, SW Finland, Latvia, Lithuania, N Poland, and N Germany (Mortensen 1953, Kielland-Lund 1965, Runge 1983, Dierßen et al. 1988, Dierßen & Dierßen 1996, Rašomavičius 1998, Dengler 2004, Lawesson 2004, Brzeg 2005, Dengler et al. 2006a, Rūsiņa 2007). Additionally, unpublished relevés by A. Hovi from the province of Etelä-Häme (S Finland) belong to this association.

4.2.6 *Lathyrus sylvestris* [*Trifolion medii*] community (Supplement 1: A2.5)

This community is characterised by dominating *Lathyrus sylvestris*, which overgrows the other vegetation. On Saaremaa it proved to be the most species-rich of all forest-edge communities, with particularly many cryptogams.

Lathyrus sylvestris stands have only recently been reported from NE Lower Saxony by Dengler et al. (2006a). These authors suggested that the community probably merits association rank, but they refrained from actually describing an association as they only had eight relevés available. The fact that we now have found quite similar stands to those in Germany hundreds of kilometres away supports the creation of a new association.

4.2.7 *Galio albi-Astragaletum glycyphylloides* Schwarz 2001 (Supplement 1: A2.6)

The *Galio-Astragaletum* comprises stands dominated by *Astragalus glycyphyllos*, which usually have a very dense herb layer. Other constant species in our relevés are *Dactylis glomerata*, *Festuca rubra*, *Galium album*, and *Veronica chamaedrys*.

Like the previous community, the *Galio-Astragaletum* has only recently been recognised as an association of its own. So far it has been recorded from different regions in Germany (Schwarz 2001, Dengler 2004, Dengler et al. 2006a), but it probably also occurs elsewhere, since *Astragalus glycyphyllos* has a distribution range that covers large proportions of Europe, from the submediterranean to the hemiboreal zone (Hultén & Fries 1986). The finding of very similar stands on Saaremaa supports the concept of such an association.

4.2.8 *Sileno nutantis-Libanotidetum montanae* Jeschke ex Passarge 1979 (Supplement 1: A3.1)

Incl.: *Poa compressa-Seseli libanotis* community *sensu* Mortensen 1953

Seseli libanotis communities *sensu* Mortensen 1953

Seseli libanotis-Geröllalvar *sensu* Böcher 1945

Seseli libanotis-[*Geranion sanguinei*]-Gesellschaft *sensu* Dierßen & Dierßen 1996

The *Sileno-Libanotidetum* usually grows on sandy soils without direct contact to woodlands, for example on field margins, mostly close to the sea. Apart from the dominating *Seseli libanotis* (= *Libanotis montana*), various grasses (*Dactylis glomerata*, *Elymus repens*, *Festuca rubra*) and some (dry) grassland herbs, such as *Filipendula vulgaris* and *Artemisia campestris*, occur with high constancy and abundance. In contrast to all other communities in this study, the moss layer is only poorly developed.

Previously, the *Sileno-Libanotidetum* has only been recorded from Denmark (Böcher 1945, Mortensen 1953) and from the German federal states Schleswig-Holstein (Drews & Dengler (2004) and Mecklenburg-Vorpommern (Dengler 2004), always from sites close to the sea. From the distribution maps of the character species (Hultén & Fries 1986), it seems likely, however, that the community also occurs on the Baltic coasts of Poland, Lithuania, Latvia, and perhaps SE Sweden.

4.2.9 *Galio borealis-Geranietum sanguinei* Tx. 1967 (Plates 1 and 4, Supplement 1: A3.2)

Syn.: *Filipendulo-Geranietum sanguinei* Sunding 1963, 1965 [Art. 1]

Galio littoralis-Geranietum sanguinei Tx. 1967 [syntax. syn.]

Geranietum sanguinei Marker 1969 [syntax. syn.]

Agrimonio-Geranietum Hallberg 1971 p. max. p. [syntax. syn.]

Incl.: Basic grass heath *sensu* Andersson 1950 p. min. p.

Brachypodium pinnatum-Inula salicina Type *sensu* Böcher et al. 1948 p. max. p.

Gentiano-Pimpinelletum saxifragae geranietosum sanguinei Tx. 1967 *sensu* Lundberg 1987 p. p.

Geranion sanguinei-Ges. *sensu* Runge 1983

Geranium sanguineum-Geröllalvar *sensu* Böcher 1945

Geranium sanguineum [*Geranion sanguinei*] sabiedrība *sensu* Rūsiņa 2007

Geranium sanguineum-Origanum vulgare-Soziation *sensu* Størmer 1938

The stands of the *Galio-Geranietum* are dominated by *Geranium sanguineum*, which on Saaremaa is a territorial character species of the association, and partly also by *Polygonatum odoratum*. The community is very conspicuous in summer due to the large, bright pink flowers and in fall through the blood-red leaves of the character taxon. The most frequent other herbs are *Asperula tinctoria*, *Campanula persicifolia*, *Filipendula vulgaris*, *Galium boreale*, *G. verum*, and *Pimpinella nigra*, whereas graminoids do not play a major role, either in terms of constancy or coverage. With a mean species density of 40.3 species on 5 m², the *Galio-Geranietum* is the second-richest forest-edge community on Saaremaa.

This association – due to its conspicuousness – was among the first *Trifolio-Geranietea* communities to be described from northern Europe, and various association names as well as

informal names have been applied to it in the past (see above). Nearly all authors agree that the Nordic *Geranium sanguineum* stands differ so much from communities dominated by the same species in the southern part of central Europe (*Geranio sanguinei-Peucedanum cervariae* T. Müller 1962) that they merit association rank on their own – or should even be placed in a separate alliance – as we suggest here. Less clear is differentiation from the *Thalictro mini-Geranium sanguinei* Korneck 1974, in which Dengler (2001, 2004) included stands with dominating *Geranium sanguineum* from the diluvial lowlands of Germany. Perhaps, the *Geranium sanguineum* stands from Denmark belong to the *Thalictro-Geranium* rather than to the *Galio-Geranium*. Finally, there have also been various descriptions of forest-edge communities dominated by *Polygonatum odoratum* from northern Europe (Böcher 1946: Møn, Denmark; Sunding 1963 and 1965: SE Norway, *Lino-Polygonatetum odorati* nom. inval.; Kielland-Lund 1965: S Norway, *Origano-Dracocephaletum* nom. inval.; Marker 1969: S Norway, included as a facies in the *Poo alpinae-Anthyllidetum vulnerariae* Marker 1969). Whether these communities should be placed better within the *Galio-Geranium* or joined with the *Polygonato-Lithospermetum* Weeda in Weeda et al. 1995, described from the Dutch North Sea coast (Weeda et al. 1995, cf. Dengler & Krebs 2003), remains to be solved. As we only recorded one stand with dominating *Polygonatum odoratum* on Saaremaa (relevé SaS12 in Supplement 1), which otherwise did not differ from the *Geranium*-dominated stands, we accept a widely delimited *Galio-Geranium* here, including *Polygonatum*-dominated stands.

Numerous previous records of the *Galio-Geranium* originate from S Norway, S Sweden (mainly provinces Bohuslän and Öland), Denmark (Jutland, Sealand, and Bornholm), and Latvia (Størmer 1938, Böcher 1945, Böcher et al. 1948, Andersson 1950, Sunding 1963, 1965, Kielland-Lund 1965, Tüxen 1967, Marker 1969, Hallberg 1971, Runge 1983, Westhoff et al. 1983, Lundberg 1987, Diekmann 1990, Bronger 1992, Dierßen & Dierßen 1996, Lawesson 2004, Rūsiņa 2007), while the inclusion of (some of) the Danish stands is questionable (see previous paragraph).

4.2.10 *Inuletum salicinae* Marker 1969 (Supplement 1: A3.3)

Syn.: *Inuletum salicinae* Sunding 1963, 1965 [Art. 1, 3b]

Incl.: *Agrimonio-Geranium inulosum* Hallberg 1971

Brachypodium pinnatum-Inula salicina Type *sensu* Böcher et al. 1948 p. max. p.

Inula-äng sensu Albertson 1941 p. max. p.

Inula salicina-consociation *sensu* Albertson 1946

The stands of the *Inuletum salicinae* are dominated by the name-giving species but are otherwise quite similar to the *Galio-Geranium* in terms of floristic composition, structure, and site conditions. However, the *Inuletum salicinae* shows distinctly lower species densities. Differential taxa such as *Geum rivale*, *Potentilla erecta*, and *Calliergonella cuspidata* indicate that the sites inhabited by the association are subject to alternating wetness.

In the past, this community has been recognised several times, either as a separate association (Sunding 1963, 1965, Marker 1969), as an informally named unit (Albertson 1941, 1946, Böcher et al. 1948), or as part of the *Galio-Geranium* s. l. (Hallberg 1971, Dierßen & Dierßen 1996). According to the methodology applied here, the association rank seems well justified for these numerous relevés recorded from various places throughout the Nordic and Baltic region. Note, however, that the relevés of the *Galio borealis-Geranium sanguinei inulosum salicinae* Diekmann 1990 published by Diekmann (1990) nevertheless belong to the *Galio-Geranium* s. str.

4.2.11 *Geranio sanguinei-Trifolietum alpestris* T. Müller 1962 (Supplement 1: A3.4)

The *Geranio-Trifolietum* grows on sandy-loamy soils and is characterised by *Trifolium alpestre*, which usually dominates the stands. Various other *Trifolio-Geranietea* species, such as *Convallaria majalis*, *Geranium sanguineum*, *Inula salicina*, and *Origanum vulgare*, or grasses, such as *Brachypodium pinnatum* or *Bromus erectus*, may occur as sub-dominants.

According to Dierßen & Dierßen (1996), the *Geranio-Trifolietum* within the Nordic countries is restricted to north-eastern Sealand (Denmark; also see Böcher 1945, Lawesson 2004). In the southern Baltic region, by contrast, the association occurs moderately frequently in Lithuania (Rašomavičius 1998), Poland (Brzeg 2005), NE Germany (Passarge 1979b, Dengler 2004), and NW Germany (Dierßen et al. 1988, Dengler et al. 2006a). There is also a single record from the Lahemaa National Park on the Estonian north coast (Dierschke 1988).

4.2.12 *Trifolio medii-Laserpitietum latifolii* van Gils & Gilissen 1976 (Supplement 1: A3.5)

Incl.: *Brachypodium pinnatum* [*Geranion sanguinei*] sabiedrīda sensu Rūsiņa 2007 p. p.
Galio borealis-Geranietum sanguinei Tx. 1967 sensu Diekmann 1990 p. p.

The *Trifolio-Laserpitietum* is characterised by the tall umbellifer *Laserpitium latifolium*, which dominates the herb layer with its large leaves. Among the forest-edge communities, the *Trifolio-Laserpitietum* is the second-least rich in species, with ‘only’ 30.0 species on 5 m² on average.

In the southern part of central Europe, where *Laserpitium latifolium* has its major area of distribution (Hultén & Fries 1986), at least two associations dominated by this species have been described (apart from the name accepted here, also *Bupleuro longifolii-Laserpitietum latifolii* T. Müller 1978); often such stands were placed in other associations or treated as informal communities. In northern Europe until now, *Laserpitium*-dominated stands, if recorded at all, have usually been placed within the *Galio-Geranietum* (Diekmann 1990, Rūsiņa 2007). Only Westhoff et al. (1983) suggested that they form a new regional association of their own, similar to the *Trifolio-Laserpitietum* of central Europe. According to the methodology applied here, however, it does not seem possible to distinguish two associations characterised by *Laserpitium latifolium*. Thus, we place our relevés in the association described from the Alps. Actually, the differential species of the association mentioned by van Gils & Gilissen (1976), namely *Trifolium medium*, *Galium boreale*, *Galium mollugo* agg., and *Vicia cracca*, are also frequent in the Estonian stand.

Within the Nordic and Baltic region, the *Trifolio-Laserpitietum* has previously been recorded from the Swedish islands Öland and Stora Karlsö near Gotland (Westhoff et al. 1983, Diekmann 1990) and Latvia (Rūsiņa 2007). According to Diekmann (1994), forest-edge stands with *Laserpitium latifolium* are the prevailing type in SE Sweden and S Finland, but unfortunately it is impossible to assign his synoptic columns to specific localities.

4.3 Syntaxonomy

4.3.1 Classification of higher syntaxa

Despite the fact that acidophilous forest-edge communities occur only rarely and in less typical fashion on Saaremaa, our local data fit very well the higher-rank classification of the *Trifolio-Geranietea* proposed by Dengler et al. (2006a; see also Dengler et al. 2003 and Dengler 2004) on the basis of more than 5,000 relevés from large parts of Europe. The two subclasses

and the three orders were clearly distinguishable by many character and differential taxa (see Supplement 2). Moreover, the lists of class character species proposed by Dengler et al. (2003, 2006a) and Dengler (2003, 2004) could largely be confirmed for Saaremaa, including taxa, such as *Galium album*, *Fragaria vesca*, *Veronica chamaedrys*, and *Solidago virgaurea* ssp. *virgaurea*, or mosses like *Scleropodium purum* and *Plagiomnium affine*, that are not usually acknowledged as *Trifolio-Geranietaea* species.

Regarding the subdivision of the mesophilous forest-edge communities (*Origanetalia vulgaris* s.str.), our few regional data follow the concept proposed by Dengler et al. (2003, 2006a) exactly. On the one hand, there is a group (A2.2–A2.6 in Supplement 2) with more light-demanding and more drought-tolerant associations, rich in typical grassland species. On the other hand, there is one association, namely the *Vicietum sylvaticae* (A2.1), that is clearly distinct floristically from the first group, with its species composition comprising more shade-tolerant and moisture-demanding species, or, in other words, typical grassland species being replaced by woodland species. Thus, we validate the second alliance, for which no valid name has been available so far, as *Knaution dipsacifoliae* (see below).

Finally, for the subdivision of the xerophytic order *Antherico-Geranietalia* into alliances, the regional data provided only little support. Since the broad-scale synthesis of Dengler et al. (2006a; see also Dengler 2001) showed a clear floristic separation between the central European *Geranion sanguinei* s.str. and the *Galio veri-Geranion sanguinei* of the hemiboreal zone and temperate seacoasts in Europe, however, we assigned our associations to these two alliances. For the *Galio-Geranion* we could add the *Inuletum salicinae* to the four associations mentioned by Dengler & Krebs (2003). It is not unusual that syntaxa that are clearly separated at broad scale lose their distinctness in certain parts of their distribution area. Although based on the Estonian data alone, a separation into two alliances would not be justified, even though some of the differential taxa elaborated by Dengler (2001) and Dengler et al. (2006a) proved to be valid even at the regional scale of Saaremaa, namely *Helictotrichon pratense* and *H. pubescens* for the ‘northern’ and *Brachypodium pinnatum* for the ‘southern’ alliance (see Supplement 2).

4.3.2 Validation of the *Knaution dipsacifoliae*

The idea of subdividing the mesophilous forest-edge communities (*Origanetalia vulgaris* s.str.) into two alliances was brought forward first by Julve (1993), but his description of a ‘*Knaution dipsacifoliae* ssp. *gracilis*’ was nomenclaturally invalid (see below). According to broad-scale analyses (Dengler unpubl.), Julve’s idea reflects the internal floristic and ecological structure of the order very well. Thus, Julve’s proposal was adopted in a number of our own papers (Dengler 2003, Dengler et al. 2003, 2006a) as well as in the new French syntaxonomic overview (Bardat et al. 2004). As there has been no valid name for the second alliance, apart from the *Trifolion medii* so far, the validation is provided here. Since *Knautia dipsacifolia* ssp. *dipsacifolia* is equally diagnostic for the alliance as ssp. *gracilis*, and the latter is regarded as a doubtful taxon by Aeschmann et al. (2004), however, we form the syntaxon name after the species.

***Knaution dipsacifoliae* Julve ex Dengler & Boch all. nov. hoc loco**

Type: *Knautium sylvaticae* Oberd. ex T. Müller 1978 (MÜLLER 1978: 290) [Holotypus hoc loco]

Syn.: *Trifolion medii* T. Müller 1961 p. p. [Art. 8]

Trifolion medii T. Müller 1962 p. p. [typo excl.]

Dactylido-Aegopodion Passarge 1967 p. min. p. [typo excl.]

'*Knautia dipsacifoliae* ssp. *gracilis*' Julve 1993 [Art. 5, 8, 10a Paragraph 2]

Knautia gracilis Julve 1993 *sensu* Bardat et al. 2004 [Art. 5, 8]

Incl.: Nördliche Gesellschaftsgruppe [*Trifolio-Geranietea*] *sensu* Dierschke 1974 p. min. p.

Character taxa of the alliance (and subordinate syntaxa):

Agrimonia repens, *Aquilegia vulgaris*, *Astrantia major*, *Calamintha nepeta* agg., *Carex pediformis*, *Geranium nodosum*, *Knautia dipsacifolia*, *Lathyrus heterophyllus*, *Vicia dumetorum*, *V. sepium*, *V. sylvatica*, *Viola collina*

Differential taxa of the alliance (against *Trifolion medii*):

Campanula trachelium, *Poa nemoralis*, *Securigera varia*, *Valeriana wallrothii*

Associations (as known so far):

- *Vicietum sylvaticae* Oberd. & T. Müller ex T. Müller 1962
- *Galio aparines-Vicietum dumetorum* Dengler in prep.
- *Caricetum paio-pediformis* Kielland-Lund ex Dierschke 1974
- *Agrimonio repentis-Brachypodietum sylvatici* Royer & Rameau 1983
- *Calamintho sylvaticae-Brachypodietum sylvatici* Royer & Rameau 1983
- *Violo riviniana-Lathyretum nigri* Schmitt & Rameau 1983 nom. inval.
- *Knautietum sylvaticae* Oberd. ex T. Müller 1978
- *Lathyro-Vicietum sylvaticae* Richard 1977
- *Geranio nodosi-Astragaletum glycyphylli* Gobat 1978 nom. inval.

A synoptic list of the alliance based on the above division in nine associations and joining 268 relevés from various sources and countries is contained in Dengler et al. (2006a: Table 1). As pointed out previously (Dengler et al. 2003, 2006a), we delimit the alliance somewhat more widely than Julve (1993) and Bardat et al. (2004). While the latter only include (sub-) montane communities from central Europe, we add floristically similar stands from central European lowlands (there usually restricted to inner forest edges) and from northern Europe. *Knautia dipsacifolia* itself is restricted to the mountainous regions of central Europe, but other character taxa (*Aquilegia vulgaris*, *Vicia sepium*, *V. sylvatica*) occur both in central European mountains and in the northern temperate and hemiboreal zones. Accordingly, the above-mentioned nine associations can potentially be arranged in two suballiances, one geographically widespread without *Knautia dipsacifolia* (the first six associations of the above list) and one geographically restricted with *Knautia dipsacifolia* (the last three associations of the above list).

4.3.3 Adaption of the name *Galio littoralis-Geranion sanguinei*

According to Art. 45 ICPN, we propose to alter the alliance name *Galio littoralis-Geranion sanguinei*, provisionally proposed by Géhu & Géhu (1983: 346) and validated by de Foucault et al. (1983: 454), to *Galio veri-Geranion sanguinei*. The original name refers to '*Galium verum* ssp. *euverum* var. *littorale*' used by Tüxen (1967). It is questionable, however, whether this is a valid taxon name at all. It refers to low-growing *Galium verum* plants from coastal dunes, also named ssp. *maritimum* (DC.) Adema but interpreted as a modification and not a valid biosystematic unit in all relevant floras of the last 20 years.

4.4 Site conditions and overall floristic composition

The forest edges occupied by *Trifolio-Geranietea* communities mostly occur on flat ground. They were exposed in all directions and did not show any prevalence of southern exposures or clear differences between the orders, as could have been expected. Various soil texture classes were present, from pure sand to sandy clay, but sandy silt was most frequently reported. Humus content varied from 3.2% to 29.4%, but without clear 'signals' for the syntaxa (Supplement 1). The total range of measured pH values (H₂O) of the topsoil was from 6.0 to 7.8, but

only three soils were below the neutral point (see Supplement 1). Differences among associations and also between higher syntaxa were negligible. All soils analysed contained carbonate, though to a different extent (Supplements 1 and 2). Correspondingly, base saturation was 100% with two exceptions (not shown). However, the communities differed regarding the mean CEC of the soil. Values were highest in the *Antherico-Geranietalia* (mean: 60.0 mval/100 g), intermediate in the *Origanetalia vulgaris* s.str. (46.8 mval/100 g), and lowest in the *Melampyro-Holcetalia* (38.9 mval/100 g).

Overall floristic composition of the Estonian *Trifolio-Geranietea* communities corresponds well to the picture outlined by Dengler et al. (2006a: Table 1). In this work, numerous data from Europe have been compiled, but relevés from northern Europe made up only a marginal part. Thus, the table from the cited paper mainly reflects the situation in central (temperate) Europe, allowing for comparisons with the data of Supplement 2 of this article. When comparing constancies, it must be taken into account that constancy values increase with increasing plot size (Dengler 2003). In this specific case, however, this should not be a major problem as the most frequently used plot size in *Trifolio-Geranietea* studies is 25 m² (Chytrý & Otýpková 2003), less than one order of magnitude larger than in our study. Some taxa with highly increased constancy values at the class level in the Estonian stands (> 3×) catch the eye. These are mainly ‘mesophilic’ grasses (*Calamagrostis epigejos*, *Festuca rubra*, *Helictotrichon pratense*, *H. pubescens*), forest graminoids (*Carex digitata*, *Melica nutans*), some non-grass herbs (*Anemone nemorosa*, *Asperula tinctoria*, *Campanula persicifolia*, *Filipendula vulgaris*, *Galium boreale*, *G. verum*, *Hepatica nobilis*, *Pimpinella saxifraga* agg.), and several pleurocarpous mosses (*Homalothecium lutescens*, *Hylocomium splendens*, *Rytiadelphus triquetrus*, *Thuidium abietinum*, *T. philibertii*). By contrast, only *Hypericum perforatum* was found to be less abundant in Estonia than in central Europe (19% vs. 33%). These findings show remarkable coincidences with the patterns reported by Dengler et al. (2006b) for northern European units of other xerophytic syntaxa, in which *Helictotrichon pratense*, *Festuca rubra* and *Homalothecium lutescens* also occurred quite frequently.

4.5 Species density

Species densities on 5 m² of individual plots ranged from 16 (*Pteridietum aquilini*) to 48 (*Lathyrus sylvestris* [*Trifolion medii*] community and *Inuletum salicinae*; see Supplement 1). Among the associations, again the *Pteridietum aquilini* was the poorest, with an average of 24.0 species on 5 m², and the *Lathyrus sylvestris* community with 45.0 species the richest (not shown). Regarding the superior syntaxa, there was a clear increase of average richness from the *Melampyro-Holcetalia* (24.0 species) via the *Antherico-Geranietalia* (34.3 species) to the *Origanetalia vulgaris* (37.2 species), while the alliances within the latter two orders did not differ much from each other (Supplement 2). Bryophytes and lichens contributed about 15% to the total species richness, with very little variation among the communities, and non-terricolous taxa were generally unimportant in these communities (see Supplements 1 and 2). The species densities (all plants) were not related to any of the environmental or structural parameters tested (humus content, soil pH, CEC, cover of tree layer), i.e. all regressions yielded *R*²-values close to zero and were insignificant.

Table 1: Comparison of species densities (mean \pm standard deviation) of all plants in *Trifolio-Geranietea* associations between Estonia (Saaremaa: this study), Lower Saxony (NE part: Dengler et al. 2006a), and NE Germany (i.e. Brandenburg, Berlin, and Mecklenburg-Vorpommern: Dengler unpubl.). The species-richness values in the data for NE Germany were recalculated to 5 m² using a species-area relationship (see Methods). For each comparison, the ratio and the probability are given.

Tab. 1: Vergleich der Artendichten (alle Pflanzen; arithmetisches Mittel \pm Standardabweichung) in *Trifolio-Geranietea*-Assoziationen zwischen Estland (Saaremaa: diese Publikation), Niedersachsen (Nordostteil: Dengler et al. 2006a) und Nordostdeutschland (d. h. Brandenburg, Berlin und Mecklenburg-Vorpommern: Dengler unpubl.). Die Artenzahlen der nordostdeutschen Untersuchung wurden mittels der Artenzahl-Areal-Beziehung auf 5 m² umgerechnet (zu Details siehe Methoden). Für die Vergleiche ist jeweils der Quotient und die Irrtumswahrscheinlichkeit angegeben.

No.	Association	Estonia		Lower Saxony		NE Germany		Estonia vs. Lower Saxony		Estonia vs. NE Germany		
		<i>n</i>	Species richness	<i>n</i>	Species richness	<i>n</i>	Species richness (10 m ²)	Ratio	<i>p</i>	Ratio	<i>p</i>	
A1.1	Pteridietum aquilini	3	24.0 (± 9.9)	14	10.9 (± 4.5)			2.2	< 0.001			
A2.1	Vicietum sylvaticae	3	38.7 (± 5.7)									
A2.2	Agrimonio-Vicietum cassubicae	3	32.7 (± 8.5)	12	20.8 (± 6.6)	7	23.3 (± 10.1)	20.1 (± 8.7)	1.6	0.017	1.6	0.061
A2.3	Trifolio-Melampyretum nemorosi	4	35.3 (± 9.9)	7	17.9 (± 7.6)	1	26.0	22.5	2.0	0.008	1.6	-
A2.4	Agrimonio-Trifolietum medii	4	36.5 (± 0.7)	25	21.6 (± 6.0)	10	23.9 (± 5.9)	20.7 (± 5.1)	1.7	< 0.001	1.8	< 0.001
A2.5	Lathyrus sylvestris comm.	2	45.0 (± 4.2)	8	20.1 (± 6.5)			2.2	0.001			
A2.6	Galio-Astragaletum glycyphylli	4	35.3 (± 16.3)	10	24.8 (± 7.3)	7	21.6 (± 4.9)	18.6 (± 4.3)	1.4	0.065	1.9	0.007
A3.1	Sileno-Libanotidetum	3	31.7 (± 2.1)			7	30.7 (± 11.2)	26.5 (± 9.7)			1.2	0.270
A3.4	Geranio-Trifolietum alpestris	3	37.0 (± 12.0)	8	22.0 (± 3.5)	3	27.7 (± 7.4)	24.0 (± 6.4)	1.7	0.002	1.5	0.462

Species densities (all plants) on 5 m² were higher in Estonian stands of *Trifolio-Geranietea* associations than in stands of the same associations in Lower Saxony or NE Germany throughout (Table 1). However, five of the 13 comparisons were non-significant due to small sample sizes. The richness ratios between Estonia and Germany range from 1.22 to 2.20, with mean values of 1.82 for Lower Saxony and 1.60 for NE Germany. The ratios did not differ significantly between the two German regions (paired *t*-test; *n* = 5; *p* = 0.41). The richness of both vascular and non-vascular plants showed equally increased values in Estonia. Thus, the relative contribution of non-vascular plants to the species richness, on average, did not change between the two countries, i.e. the proportion increased in some communities and decreased in others.

5 Conclusions and outlook

5.1 Community diversity

With our study we provide a first overview of the phytosociological class *Trifolio-Geranietea sanguinei* in Estonia, where such forest-edge communities had been almost completely neglected previously. We assume that our classification system with 11 associations and one equivalent unit is close to complete for Saaremaa, although we may have missed some very rare associations there. As xerothermophilic species within Estonia are concentrated on Saaremaa, our overview should also cover the major syntaxa to be found in the whole country and thus could be a good basis for further investigations.

Additional associations are mainly to be expected from the acidophilic subclass *Melampyro-Holcenea* because this is poorly represented on Saaremaa for geological reasons (limestone bedrock). For an overview of potential units, see Dengler et al. (2006a). Based on records from neighbouring regions and on distributional data of character species (e.g. Hultén & Fries 1986), the following four additional associations of the basiphilic subclass *Trifolio-Geranienea* can be expected to occur on Saaremaa or in Estonia as a whole: *Fragario vescae-Campanuletum cervicariae* Glazeg & Brzeg in Brzeg 2005 (we have seen *Campanula cervicaria* in forest edges a few times but these appeared not to be a distinct community); *Rubocaesii-Origanetum vulgaris* van Gils & Huits 1978 (although the name-giving species are frequent, we did not find the association); *Artemisio campestris-Vincetoxicetum hirundinariae* Dengler & Krebs 2003 (*Vincetoxicum hirundinaria* occurs very rarely in dry grasslands on Saaremaa, but we did not find it in forest-edge/tall-forb communities); and *Geranio sanguinei-Anemonetum sylvestris* T. Müller 1962 (frequent in Estonia according to Dierßen & Dierßen 1996, but we could not find such stands on Saaremaa).

Our study is a further contribution to the identification of vegetation types of Estonia in a systematic and internationally comparable manner. Such syntaxonomic overviews presently exist for only few major vegetation types, namely alluvial forests (Paal et al. 2007) and dry grasslands (Pärtel et al. 1999, Boch & Dengler 2006, Dengler et al. 2006a). Our analyses and review of the situation in the complete Nordic and Baltic region could also provide inspiration for the next vegetation overviews of other regions, such as Denmark (cf. Lawesson 2004), Norway (cf. Fremstad 1998), or the Nordic countries as a whole (cf. Pålsson 1999), because in the present editions, the large variety of forest-edge communities occurring is pooled into one or two units, probably due to a lack of more detailed knowledge.

Reproducible and supra-nationally compatible vegetation classifications are a basic requirement for meaningful comparisons between ecological studies in different regions (Dengler 2003, Dengler et al. 2008). Moreover, such classifications are particularly important for nature conservation. For example, the Habitats Directive of the European Union is largely based on phytosociological units (European Commission 2003). Specifically, red lists of plant communities, which could be a powerful instrument in nature conservation, require *inter alia* a clear classification methodology and comprehensively documented vegetation units, including the non-threatened types (Dierßen 1986, Dengler et al. 2005, Timmermann et al. 2006). Thus, the red list of Estonian plant communities by Paal (1998) could only be a first step, as the communities listed lack references to comprehensive descriptions with phytosociological tables that could provide unambiguous definitions. Moreover, this list is far from representing the Estonian vegetation types comprehensively (forest edges for example are completely missing apart from the partial inclusion of one association in the ‘*Melampyro-Scorzoneronetum*’).

There are good arguments why *Trifolio-Geranietea* communities should be more in the focus of nature conservation. First, a comprehensive analysis in Mecklenburg-Vorpommern (NE Germany) showed that their communities are above average in both vulnerability and nature conservation value (Berg et al. 2004). For the whole of Germany, Korneck et al. (1998) showed that these vegetation types contain particularly high proportions of endangered vascular plants. The red list of Estonian vascular plants also contains several typical *Trifolio-Geranietea* taxa, although forest edges are not recognised as a specific habitat there (e.g. *Holcus mollis*, *Hypericum montanum*, *Laserpitium latifolium*, *Lathyrus linifolius*, *L. niger*, *Peucedanum oreoselinum*, *Trifolium alpestre*, *Vicia cassubica*, *Vincetoxicum hirsutinaria*). Finally, communities of woodland margins usually contain a disproportionately high fraction of the overall plant diversity of a region (Dengler et al. 2006a).

Although the present study largely confirmed the classificatory view of Dengler et al. (2006a), some items still remain unsolved. For example, the delimitation of the alliances *Geranion sanguinei* and *Galio veri-Geranion sanguinei* needs clarification, and the justification of a *Trifolion medii* association characterised by *Lathyrus sylvestris* should be verified with further relevés from other regions. Here the *Working Group on Dry Grasslands in the Nordic and Baltic Region* (http://www.biologie.uni-hamburg.de/bzf/syst/wg_dry_grasslands_nordic/wg_dgnb1_eng.htm, cf. Dengler et al. 2006c) offers a great opportunity, as it aims at establishing a comprehensive databank not only of dry grassland but also of *Trifolio-Geranietea* relevés and at using them for consistent supra-regional classifications. Any regional studies contributing to this databank are highly welcome.

5.2 Species diversity

Our general result of increased plot-scale species densities in Nordic vs. central European stands corresponds well with the findings of Dengler & Löbel (2006) and Dengler et al. (2006a) for dry grassland communities. For example, Dengler & Löbel (2006) reported an average 2.4-fold species-richness increase between central Europe and the hemiboreal zone for communities of the order *Alysso alyssoidis-Sedetalia* Moravec 1967. According to Dengler et al. (2006a), communities of the *Koelerio-Corynephoronea* (Klika in Klika & V. Novák 1941) Dengler in Dengler et al. 2003 and *Festuco-Brometea* Br.-Bl. & Tx. ex Klika & Hadač 1944 also show increased plot-scale species densities in the Nordic region, albeit less pronounced. Although bryophytes and lichens of the *Alysso-Sedetalia* contribute

disproportionally to the higher richness of Nordic stands, this is actually not the case for the *Trifolio-Geranietea*, for which Dengler et al. (2006a) had assumed a similar situation.

Thanks to identical sampling schemes and even partially the same researchers in the studies of Saaremaa and NE Lower Saxony, it could largely be ruled out this time that ‘sampling artifacts’ (e.g. less thorough sampling by some persons) contributed to the large differences. On the other hand, some of the potential explanations brought forward in the case of Nordic *Alysso-Sedetalia* communities (and particularly those of the Ölandic Great Alvar) by Dengler & Löbel (2006) and Dengler et al. (2006b) can be ruled out or seem at least unlikely in the case of *Trifolio-Geranietea* communities: (i) While high fine-scale spatio-temporal variability in environmental conditions is evident for alvar grasslands (water logging in winter vs. severe drought in summer + often a pronounced microrelief), we see no reason why Estonian forest edges should show more variable environmental conditions than their German counterparts. (ii) Also, the argument of our previous publications that the generally smaller plant individuals in Nordic communities by chance permit more different species to occur on the same area seems rather implausible in the case of the *Trifolio-Geranietea*, whose members show no distinct size differences between the regions compared. (iii) Finally, the size of the regional species pool could play a role in the comparison of Saaremaa vs. NE Lower Saxony, but this should not be the case for NE Germany, since in the Uckermark, for example, certainly more *Trifolio-Geranietea* species are present in the regional species pool than on Saaremaa. Thus, which plausible explanations for the detected pattern remain?

(1) Despite classification within the same associations, there may be systematic differences in the site conditions between the *Trifolio-Geranietea* communities in both countries that affect species densities. (i) Firstly, one could think of the consistently high pH values of the Estonian stands (see above). For most community types in temperate and boreal Europe, a positive relationship between pH values and plot-scale species densities is well documented (e.g. Pärtel 2002, Schuster & Diekmann 2003, Tyler 2003, Dengler et al. 2007). It is improbable, however, that this factor alone accounts for the huge differences in species densities. With mean pH values of 4.6–5.9 per association (Dengler et al. 2006a), the soils in NE Lower Saxony are indeed approximately two pH-units more acidic than those of the Estonian stands, but the differences between the NE German data-set (the majority of relevés there originates from the Uckermark) and the Estonian data-set are much smaller. Moreover, in the Estonian data, pH within the range 6.0–7.8 had no effect on species density at all (see Results). (ii) Additionally, nutrient pollution comes to mind. Actually, the air-borne N input is approximately twice as high in the German regions studied as it is in Estonia (UBA 2001: 181) – and this certainly could contribute to the pattern observed.

(2) Having ruled out or qualified all other proposed reasons, we suggest that the different length of the vegetative period in the two countries could be the major reason for the richness patterns observed. Competition between plants happens overwhelmingly during the vegetative period. As most species in the forest-edge communities are hemicryptophytes and thus have to regenerate their above-ground parts each year, the time for competition becomes even shorter than the whole vegetative period because the shoots first have to gain a certain size before they interact competitively with neighbour shoots. We argue that shorter vegetative period means less competition and in turn less competitive exclusion, leading to higher species densities. Presently, this is just an idea how to explain the strong and consistent richness increase for *Trifolio-Geranietea* communities and many other vegetation types in the hemiboreal compared to the temperate zone, when other reasons seem to be improbable. We are aware that, for tropical rainforests, the argument has been put forward the other way

round, i.e. the longer the vegetative period, the higher the species richness because of faster evolution and lower risk of extinction (e.g. Richter 2001). Thus, our idea needs serious testing in the future.

Our surprising results call for further research. Standardised sampling schemes (e.g. Dengler et al. 2004) should be used to test whether species densities also increase in hemiboreal, as compared to temperate, stands for other syntaxa and at other spatial scales. Additionally, it would be interesting to analyse what happens north of the hemiboreal and south of the temperate zone. Studies of the vegetative-period hypothesis along altitudinal instead of latitudinal gradients would be particularly promising because there factors other than length of the vegetative period (e.g. regional species pool, geology, land-use intensity) could be controlled much better.

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Supplements

This article contains two separate supplements.

Zu diesem Artikel gehören zwei Loseblattbeilagen.

Appendix

Appendix 1: Date and geographic coordinates of the plots analysed. The coordinates are given according to UTM WGS-84, and all belong to zone 34V. The relevés starting with ‘JD’ were made by J. Dengler (partly together with S. Boch), those with ‘SaS’ by S. Boch.

Anhang 1: Aufnahmedatum und geografische Koordinaten der untersuchten Aufnahme­flächen. Die Koordinaten sind gemäß UTM WGS-84 angegeben und gehören alle zur Zone 34V. Die Aufnahme­nummern, welche mit „JD“ beginnen, wurden von J. Dengler (teilweise gemeinsam mit S. Boch), jene, welche mit „SaS“ beginnen, von S. Boch angefertigt.

Relevé number	Date	X coordinate	Y coordinate
JD01	2 July 2004	564,891	6,467,352
JD02	2 July 2004	567,349	6,467,218
JD03	2 July 2004	572,715	6,465,742
JD04	3 July 2004	568,304	6,460,706
JD05	3 July 2004	564,657	6,460,892
JD06	3 July 2004	556,164	6,456,381
JD07	3 July 2004	560,218	6,462,545
JD08	3 July 2004	562,597	6,468,727
JD09	4 July 2004	572,167	6,471,074
JD10	4 July 2004	572,190	6,471,231
JD11	4 July 2004	572,201	6,471,129
JD12	4 July 2004	569,350	6,473,286
JD13	4 July 2004	568,654	6,474,736
JD14	4 July 2004	567,191	6,476,709
JD15	4 July 2004	568,157	6,475,919
JD16	4 July 2004	568,606	6,474,416
JD17	4 July 2004	569,401	6,473,261
JD18	4 July 2004	575,959	6,465,587
SaS01	8 July 2004	576,669	6,461,522
SaS02	8 July 2004	577,627	6,461,712
SaS03	8 July 2004	583,638	6,461,012
SaS04	8 July 2004	583,783	6,460,927
SaS05	8 July 2004	582,738	6,461,540
SaS06	9 July 2004	575,809	6,465,685
SaS07	9 July 2004	576,434	6,465,280
SaS08	9 July 2004	576,580	6,465,174
SaS09	9 July 2004	576,651	6,465,126
SaS10	9 July 2004	569,622	6,467,097
SaS11	9 July 2004	567,909	6,467,189
SaS12	10 July 2004	568,637	6,473,440
SaS13	10 July 2004	569,269	6,473,287
SaS14	11 July 2004	572,138	6,470,755
SaS15	15 July 2004	568,213	6,470,711
SaS16	27 July 2004	565,480	6,467,338
SaS17	29 July 2004	555,444	6,456,478
SaS18	30 July 2004	560,105	6,466,216
SaS19	4 August 2004	577,809	6,487,500
SaS20	8 August 2004	607,839	6,480,577
SaS21	8 August 2004	609,188	6,478,721
SaS22	10 August 2004	606,314	6,473,834
SaS23	10 August 2004	606,872	6,472,438



Plate 1: On Saaremaa, *Trifolio-Geranietea sanguinei* communities are often developed for hundreds of metres along the lonely roads, such as, for example, this *Galio litoralis-Geranium sanguinei* (photo: J. Dengler 07/2004).

Tafel 1: Auf Saaremaa sind Gesellschaften der *Trifolio-Geranietea sanguinei* oft über Hunderte von Metern entlang der einsamen Straßen entwickelt, wie im Bild etwa das *Galio litoralis-Geranium sanguinei* (Foto: J. Dengler 07/2004).



Plate 2: A stand of the *Vicium sylvaticae* on Saaremaa (photo: J. Dengler 07/2004).

Tafel 2: Bestand des *Vicium sylvaticae* auf Saaremaa (Foto: J. Dengler 07/2004).



Plate 3: A stand of the *Trifolium medii-Melampyretum nemorosi* on Saaremaa (photo: J. Dengler 07/2004).

Tafel 3: Bestand des *Trifolium medii-Melampyretum nemorosi* auf Saaremaa (Foto: J. Dengler 07/2004).



Plate 4: A stand of the *Galio borealis-Geranium sanguinei* on Saaremaa (photo: J. Dengler 07/2004).

Tafel 4: Bestand des *Galio borealis-Geranium sanguinei* auf Saaremaa (Foto: J. Dengler 07/2004).

Supplement 1: Relevé table of the *Trifolio-Geranietea sanguinei* communities on Saaremaa.

Beilage 1: Tabelle der Einzelaufnahme der Gesellschaften der *Trifolio-Geranietea sanguinei* auf Saaremaa.

Serial number	Subcl. A			Subcl. B																																					
	Order 1			Order 2													Order 3																								
	Alliance 1			Alliance 2a			Alliance 2b			Alliance 2c							Alliance 3a			Alliance 3b																					
	A1.1	A2.1	A2.2	A2.3	A2.4	A2.5	A2.6	A3.1	A3.2	A3.3	A3.4	A3.5																													
Relevé number	JD15	JD17	Sa14	JD09	Sa11	Sa13	JD02	JD16	Sa08	JD04	Sa04	Sa05	Sa23	JD03	JD11	Sa01	Sa20	JD12	Sa16	JD10	Sa15	Sa21	Sa22	JD06	Sa17	Sa19	Sa18	JD01	JD05	JD13	Sa06	Sa12	JD07	Sa09	Sa03	Sa10	JD18	Sa07	Sa09	JD14	JD08
Slope aspect	-	-	-	N	-	-	S	-	-	-	-	-	-	-	-	-	-	N	-	-	-	-	-	-	-	-	-	-	SW	W	-	-	-	S	-	-	-	-	-		
Slope angle [%]	0	0	0	60	0	0	15	0	0	0	0	0	0	0	0	0	0	0	45	0	0	0	0	0	0	0	0	0	0	7	40	0	0	0	45	0	0	0	0	0	
Aspect of forest-edge	NE	N	W	NE	S	N	S	SE	NE	S	NE	NE	S	NE	W	N	E	S	S	SW	E	S	S	-	-	-	S	SE	S	E	W	W	NW	NE	S	SW	SW	NE	SW	N	
pH [Aqua dest.]	7.7	6.5	7.4	6.1	7.4	7.4	? 7.5	7.3	7.3	7.2	7.8	6.0	6.0	7.7	7.7	7.5	7.2	7.7	7.5	7.5	7.5	6.9	7.1	7.3	7.4	7.8	7.6	? 7.4	7.8	7.4	7.8	7.4	7.3	7.3	7.7	7.6	7.5	7.7	7.5	7.3	
Organic matter [mass %]	6.3	8.7	9.1	7.6	4.3	7.1	? 3.2	4.9	13.3	10.5	3.3	8.2	3.2	3.2	6.8	8.4	6.4	4.0	5.9	7.7	4.0	9.5	11.7	6.9	29.4	1.5	16.3	? 10.8	4.5	13.3	3.1	13.9	7.5	10.7	5.6	11.1	6.1	2.7	8.4	11.3	
Carbonate [ordinat]	c3	c1	c3	c1	c3	c1	? c2	c4	c3	c2	>c4	c1	>c4	c4	c3	c4	c4	c3	c3	c3	c1	c1	c4	c4	>c4	c4	? c3	c4	c2	c4	c3	c3	c2	c4	c4	c3	>c4	c4	c3		
Cation exchange capacity [mval/100 g]	52.2	14.9	49.6	11.7	60.2	23.2	? 37.4	47.4	61.6	33.6	70.5	11.4	79.0	61.6	49.6	49.6	49.6	74.2	37.4	59.0	60.0	22.7	45.2	69.0	86.5	73.0	81.0	? 45.2	70.5	46.0	69.2	50.5	33.4	41.1	58.0	69.2	56.4	41.0	75.0	45.8	
Soil texture	Us	St	Su	Ls4	Sl	Su	Ss	Sl	Ls4	Us	Us	Ls4	Ls4	Us	Us	Ls3	Ls4	Ss	Us	Ls4	Ls4	Lts	Ts	Ss	Us	Su	Us	Ls	Us	St	Ut	Us	Uu	Su	Us	Us	Lts	Su	Sl	Uu	Ts
Cover tree layer [%]	40	75	0	0	0	50	0	80	35	7	10	40	70	10	7	35	50	0	2	40	0	3	0	0	0	0	0	2	40	30	0	0	5	70	85	20	0	20	0	0	0
Cover shrub layer [%]	0	3	0	5	0	0	0	0	0.5	2	5	5	3	0	2	1	0	0	0	2	0	2	0	0	0	0	0	0	1	0	2	0	5	0	0	0	1	4	0	0	2
Cover herb layer [%]	70	70	100	60	95	95	65	50	95	80	90	90	85	85	80	95	99	70	92	90	95	99	99	90	99	85	99	75	80	70	70	75	80	98	90	90	75	98	95	70	80
Cover cryptogam layer [%]	80	25	4	60	60	95	15	15	95	70	50	70	2	30	70	90	60	30	85	55	15	45	35	1	0.5	15	90	25	10	70	40	65	5	95	75	2	80	13	85	25	95
Cover stones and bedrock [%]	0	0	0	5	10	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	1	0	0	0	0	0	0	0	0	0	3	3	0	0	0	0.5	0	1	15	0	0
Cover dead wood [%]	0	3	0	7	0.5	0	0	0	0	0	0	1	3	0	0	1	0	0	0	0	0.5	0	0	0	0	0	0	0	1	0	1	0	0	1	0	4	0	1	0	0	2
Cover litter [%]	50	80	90	5	15	60	70	80	60	25	40	25	80	30	30	50	65	20	40	10	60	65	45	60	35	5	55	20	50	35	10	30	30	60	60	? 50	5	80	10	10	
Species richness (total)	30	26	16	32	44	40	29	28	41	36	43	40	22	36	35	40	35	48	42	19	46	34	42	36	26	33	38	46	41	46	40	31	13	48	36	32	29	36	46	29	31
Species richness (vascular plants)	26	20	15	22	40	37	26	24	35	31	41	34	21	28	31	29	32	38	31	17	37	31	40	34	25	27	34	31	34	40	34	23	11	41	31	30	24	31	38	25	27
Species richness (non-vascular plants)	4	6	1	10	4	3	3	4	6	5	2	6	1	8	4	11	3	10	11	2	9	3	2	2	1	6	4	15	7	6	6	8	2	7	5	2	5	5	8	4	4
Class: Trifolio-Geranietea sanguinei																																									
C Galium album ssp. album	r	r	r	r	r	r	r	+	+	r	1	+	+	+	+	+	+	r	r	r	r	r	1	r	r	r	+	+	+	+	+	r	r	r	r	r	r	r	r	1	
Campanula persicifolia	r	r	r	r	r	r	r	+	+	r	1	+	+	+	+	+	+	r	r	r	r	r	1	r	r	r	+	+	+	+	+	r	r	r	r	r	r	r	r	1	
Fragaria vesca	2a	2a	2a	2a	2a	2a	2a	2a	2a	2a	2a	2a	2a	2a	2a	2a	2a	2a	2a	2a	2a	2a	2a	2a	2a	2a	2a	2a	2a	2a	2a	2a	2a	2a	2a	2a	2a	2a	2a	2a	2a
Veronica chamaedrys ssp. chamaedrys	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r
Scleropodium purum	3	2b	4	4	2a	2b	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Melica nutans	1	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r
Solidago virgaurea ssp. virgaurea	2b	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r
Plagiomnium affine	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r
Viola riviniana	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Hypericum perforatum	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r
Rubus saxatilis	4	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r
Poa humilis	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r
Carex muricata	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r
Ranunculus polyanthemos	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r
Hieracium cf. lachenalii	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r
Hypericum cf. maculatum	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r
Melampyrum arvense ssp. arvense	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r
Melampyrum cf. sylvaticum	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r
Hieracium cf. murorum	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r
Hieracium vulgatum	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r
Melampyrum pratense	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r
Hypericum montanum	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r
Lathyrus linifolius	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r
Subclass A: Melampyro pratensis-Holcenea mollis																																									
C Melampyrum sylvaticum	1	r	r	+	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r
D Festuca ovina	+	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r</																		

Supplement 2: Abridged constancy table of the higher *Trifolio-Geranietea sanguinei* syntaxa on Saaremaa. Central syntaxa are marked with an asterisk (*). In the columns, the constancy reference values were calculated as mean values of the associations included. Columns based on fewer than five relevés and thus only weakly guaranteed are printed in italics. Taxa that occurred in only one relevé are not shown except for known character species. Similarly, trees, shrubs, and non-terricolous taxa are excluded. The abbreviations 'C' and 'D' in the far-left column denote character and differential taxa, respectively. Taxa that are only, or in addition to their diagnostic value for a higher syntaxon assumed to be character species of an association, are marked as 'only AC' or 'AC' plus association number after their names.

Beilage 2: Gekürzte Stetigkeitstabelle der höheren Syntaxa der *Trifolio-Geranietea sanguinei* auf Saaremaa. Zentralsyntaxa sind mit einem Stern (*) markiert. In den Spalten sind jeweils "Stetigkeitsreferenzwerte" angegeben (d. h. mittlere Stetigkeit in den zugehörigen Assoziationen). Spalten, die auf weniger als fünf Aufnahmen beruhen und deren Werte deswegen mit großer Unsicherheit behaftet sind, wurden kursiv gesetzt. Arten, die nur in einer einzigen Aufnahme vorkamen, sind mit Ausnahme bekannter Charakterarten nicht wiedergegeben. Ebenfalls nicht aufgenommen wurden Bäume, Sträucher sowie alle nicht epigäisch wachsenden Arten. Die Abkürzungen "C" und "D" in der ganz linken Spalte bezeichnen Charakter- bzw. Differenzialtaxa. Arten, die ausschließlich oder zusätzlich zu ihrem Kennwert in einem höheren Syntaxon als Kennarten einer bestimmten Assoziation gelten können, sind hinter ihrem Namen mit "only AC" oder "AC" und der jeweiligen Assoziationsnummer gekennzeichnet.

	Class	Subcl. A	Subcl. B	Ord. 1	Ord. 2*	Ord. 3	All. 1	All. 2a	All. 2b*	All. 3a*	All. 3b	
Number of associations per superior syntaxon	12	1	11	1	6	5	1	1	5	3	2	
Number of relevés included	41	3	38	3	20	18	3	3	17	13	5	
pH [Aqua dest.]	7.4	7.2	7.4	7.2	7.3	7.5	7.2	7.0	7.4	7.5	7.5	
Organic matter [mass %]	7.9	8.0	7.9	8.0	6.4	9.6	8.0	6.3	6.5	10.5	8.2	
Carbonate [ordinal]	3.1	2.3	3.2	2.3	2.8	3.6	2.3	1.7	3.1	3.6	3.8	
Cation exchange capacity [mval/100 g]	51.7	38.9	52.8	38.9	46.8	60.0	38.9	31.7	49.8	61.4	58.0	
Cover tree layer [%]	19	38	17	38	21	13	38	17	21	19	3	
Cover shrub layer [%]	1	1	1	1	1	1	1	2	1	1	1	
Cover herb layer [%]	84	80	84	80	84	85	80	83	85	86	82	
Cover cryptogam layer [%]	48	36	49	36	53	44	36	72	49	33	60	
Cover stones and bedrock [%]	1	0	1	0	1	1	0	5	0	0	3	
Cover dead wood [%]	1	1	1	1	1	1	1	3	0	1	1	
Cover litter [%]	43	73	40	73	43	38	73	27	46	38	36	
Species richness (total)	34.9	24.0	35.9	24.0	37.2	34.3	24.0	38.7	36.9	34.8	33.5	
Species richness (vascular plants)	29.6	20.3	30.5	20.3	31.5	29.3	20.3	33.0	31.2	29.9	28.5	
Species richness (non-vascular plants)	5.2	3.7	5.4	3.7	5.8	4.9	3.7	5.7	5.8	4.9	5.0	
Class: Trifolio-Geranietea sanguinei												
C	Galium album ssp. album	62	100	58	100	72	42	100	67	73	42	42
	Campanula persicifolia	55	67	54	67	54	53	67	33	58	39	75
	Fragaria vesca	51	33	53	33	64	40	33	100	57	11	84
	Veronica chamaedrys ssp. chamaedrys	49	67	48	67	65	27	67	67	65	28	25
	Scleropodium purum	48	67	46	67	56	35	67	67	53	25	50
	Melica nutans	47	67	46	67	45	47	67	67	40	22	84
	Solidago virgaurea ssp. virgaurea	47	33	48	33	39	60	33	33	40	50	75
	Plagiominium affine	44	33	45	33	58	30	33	67	57	28	34
	Viola riviniana	21	33	20	33	22	17	33	33	20	11	25
	Hypericum perforatum	19	21			28	13		33	27	11	17
	Rubus saxatilis	7	33	5	33		10	33				25
	Poa humilis	6		7		8	5			10	8	
	Carex muricata	6		6		8	3			10	6	
	Ranunculus polyanthemus	6		6		8	3			10	6	
	Hieracium cf. lachenalii	6		6		6	7			7	11	
	Hypericum cf. maculatum	6		6		6	7		33		11	
	Melampyrum arvense ssp. arvense	4		5		8				10		
	Melampyrum cf. sylvaticum	4		5		10						25
	Hieracium cf. murorum	3		3		6			33			
	Hieracium vulgatum	3		3		6			33			
	Melampyrum pratense	3		3		6			33			
	Hypericum montanum	1		2		3					6	
	Lathyrus linifolius	1		2		3					6	
Subclass A: Melampyro pratensis-Holcenea mollis												
C	Pteridium aquilinum (AC 1.1)	19	100	12	100	14	10	100	33	10		25
	Melampyrum sylvaticum	10	33	8	33	15		33	67	5		
D	Festuca ovina	19	67	14	67	15	13	67		18	22	
	Vaccinium vitis-idaea	10	67	5	67	6	3	67		7	6	
	Vaccinium myrtillus	8	67	3	67	6		67	33			
Subclass B: Trifolio-Geranietea sanguinei												
C	Origanum vulgare ssp. vulgare	24		26		21	32			25	25	42
	Agrimonia eupatoria ssp. eupatoria	22		24		29	18			35	30	
D	Galium verum	63		69		58	82			70	86	75
	Filipendula vulgaris	59		64		58	72			67	57	64
	Galium boreale	48		52		32	77			33	32	72
	Plantago lanceolata	46		50		43	58			52	42	84
	Poa compressa	37		40		40	40			48	56	17
	Medicago lupulina	34		37		35	40			33	35	39
	Campanula rotundifolia	33		36		26	48			32	47	50
	Poa angustifolia	33		36		35	38			42	53	17
	Potentilla reptans	33		36		42	28			50	47	
	Briza media	30		33		32	33			38	33	34
	Taraxacum sect. Ruderalia	23		25		21	30			25	28	34
	Carex flacca	22		24		24	25			33	22	25
	Plantago media	22		23		17	32			20	42	17
	Artemisia campestris ssp. campestris	18		20		14	27			17	33	17
Order 2: Origanetalia vulgaris												
C	Ranunculus polyanthemoides	12		13		24				67	15	
	Vicia sepium	8		9		17				20		
D	Carex digitata	28	33	28	33	46	7	33	67	42	11	
	Prunella vulgaris	17		18		29	5		67	22	8	
	Luzula pilosa	17	33	15	33	28		33	33	27		
	Aegopodium podagraria	16	33	14	33	26		33	33	25		
	Geum rivale	15		17		22	10		33	20	17	
Alliance 2a: Knautia dipsacifoliae												
C	Vicia sylvatica (AC 2.1)	8		9		17			100			
D	Anemone nemorosa	19	33	17	33	17	18	33	67	7	14	25
	Deschampsia flexuosa	8	33	6	33	11		33	67			
	Hieracium umbellatum	13	33	11	33	15	7	33	67	5	17	
	Succisa pratensis	17		18		20	17		67	10	28	
	Viola cf. reichenbachiana	6		6		11			67			
Alliance 2b: Trifolion medii												
C	Trifolium medium	34	33	34	33	46	20	33		55	17	25
	Vicia cassubica (AC 2.2)	13		14		25				30		
	Melampyrum nemorosum ssp. nemorosum (only AC 2.3)	8		9		17				20		
	Lathyrus sylvestris ssp. sylvestris (only AC 2.5)	8		9		17				20		
	Astragalus glycyphyllos (only AC 2.6)	8		9		17				20		
D	Knautia arvensis	31	33	31	33	53	5	33		63	8	
	Achillea millefolium ssp. millefolium	43	33	44	33	43	45	33		52	53	34
	Ranunculus acris ssp. acris	39	67	36	67	35	38	67		42	31	50
	Vicia cracca	46	67	44	67	35	55	67		42	64	42
	Elymus repens ssp. repens	29	33	29	33	33	23	33		40	28	17
	Daucus carota ssp. carota	17		19		31	5			37	8	
	Hieracium pilosella	13		14		24	3			28	6	
	Listera ovata	25	67	21	67	22	20	67		27	17	25
	Rhytidadelphus squarrosus	16	33	14	33	22	5	33		27	8	
	Phleum bertolonii	13		14		21	5			25	8	
	Stellaria graminea	17		18		17	20			20	33	

Continued overleaf.
Fortsetzung auf der Rückseite.

Supplement 2 (cont.)

Beilage 2 (Forts.)

	Class	Subcl. A	Subcl. B	Ord. 1	Ord. 2*	Ord. 3	All. 1	All. 2a	All. 2b*	All. 3a*	All. 3b
Number of associations per superior syntaxon	12	1	11	1	6	5	1	1	5	3	2
Number of relevés included	41	3	38	3	20	18	3	3	17	13	5
Order 3: Antherico ramosi-Geranietalia sanguinei											
C	Geranium sanguineum (AC 3.2)	22	33	21	33	8	37	33	10	33	42
	Inula salicina (AC 3.3)	20	22	22	10	37	33	5	33	42	
	Silene nutans	17	18	18	8	30	33	10	39	17	
	Convallaria majalis	13	14	14	4	25	33	5	14	42	
	Polygonatum odoratum	10	11	11	25	25	33	5	25	25	
	Trifolium alpestre (AC 3.4)	10	11	11	23	23	33	5	6	50	
D	Asperula tinctoria	24	26	26	10	47	33	12	39	59	
	Centaurea jacea	24	26	26	14	40	33	17	39	42	
	Sesleria caerulea	18	20	20	10	32	33	12	25	42	
	Ranunculus bulbosus ssp. bulbosus	14	15	15	4	28	33	5	25	34	
	Fragaria viridis	13	14	14	8	20	33	10	33	17	
	Pseudolysimachion spicatum ssp. spicatum	10	11	11	4	20	33	5	33	17	
	Ditrichum flexicaule	10	11	11	4	20	33	5	22	17	
	Hypnum cupressiforme var. lacunosum	8	9	9	20	20	33	5	11	34	
Alliance 3a: Galio veri-Geranium sanguinei											
C	Seseli libanotis ssp. libanotis (AC 3.1)	10	11	11	23	23	33	5	39	17	
D	Helictotrichon pratense	33	33	33	33	33	33	40	44	17	
	Helictotrichon pubescens ssp. pubescens	10	11	11	4	18	33	5	31	17	
	Thuidium abietinum	17	15	15	13	18	33	15	31	17	
	Rumex acetosa	9	10	10	4	17	33	5	28	17	
Alliance 3b: Geranium sanguinei											
C	Laserpitium latifolium (only AC 3.5)	8	9	9	20	20	33	5	50	17	
D	Brachypodium pinnatum	15	16	16	10	23	33	12	11	42	
Compagnions: vascular plants											
	Dactylis glomerata ssp. glomerata	74	67	67	67	81	67	100	77	72	59
	Festuca rubra	64	33	67	33	54	82	33	33	58	81
	Hepatica nobilis	55	33	57	33	64	48	33	100	57	25
	Pimpinella nigra	48	33	49	33	40	60	33	33	42	61
	Rubus caesius	42	33	42	33	53	30	33	67	50	28
	Primula veris ssp. veris	41	33	42	33	47	35	33	33	50	42
	Arrhenatherum elatius	40	67	38	67	39	37	67	33	40	45
	Lathyrus pratensis	39	67	36	67	38	35	67	67	32	42
	Calamagrostis epigejos	37	67	35	67	32	38	67	33	32	36
	Pimpinella saxifraga	18	33	17	33	18	15	33	22	14	17
	Trifolium montanum	17	18	18	14	23	23	33	17	17	34
	Heracleum sphondylium ssp. sibiricum	15	17	17	14	20	20	33	10	11	34
	Bromus erectus	15	16	16	14	18	18	33	17	19	17
	Hieracium subg. Hieracium	13	14	14	6	25	25	33	19	34	
	Cornus sanguinea ssp. sanguinea	10	11	11	14	8	8	33	10	14	
	Linum catharticum	10	11	11	8	15	15	33	10	14	
	Pinus sylvestris ssp. sylvestris	10	11	11	10	13	13	33	5	34	
	Anthyllis vulneraria ssp. vulneraria	10	11	11	10	13	13	33	5	11	
	Epipactis atrorubens	10	33	8	33	15	15	33	33	12	
	Polygala amarella	10	33	8	33	6	12	33	7	8	
	Alchemilla sp.	10	11	11	17	3	3	33	20	6	
	Sedum acre	10	11	11	14	7	7	33	17	11	
	Veronica officinalis	10	11	11	14	7	7	33	10	11	
	Carex pilulifera	9	10	10	15	3	3	33	18	6	
	Carex ornithopoda var. ornithopoda	9	10	10	8	12	12	33	10	8	
	Equisetum arvense	9	10	10	14	5	5	33	10	8	
	Potentilla erecta	9	10	10	6	15	15	33	25	17	
	Quercus robur	9	10	10	14	5	5	33	10	8	
	Leucanthemum vulgare	8	9	9	10	8	8	33	12	14	
	Alchemilla glaucescens	8	8	8	13	3	3	33	15	6	
	Campanula glomerata ssp. glomerata	8	8	8	4	13	13	33	5	11	
	Lonicera xylosteum	8	8	8	10	7	7	33	5	17	
	Trifolium repens	8	8	8	4	13	13	33	5	11	
	Anthemis tinctoria	7	8	8	14	7	7	33	17	11	
	Carex hirta	7	8	8	4	12	12	33	5	19	
	Festuca arundinacea	7	8	8	8	7	7	33	10	11	
	Fraxinus excelsior	7	8	8	10	5	5	33	5	8	
	Phleum pratense	7	8	8	10	5	5	33	12	8	
	Platanthera sp.	7	8	8	10	5	5	33	12	8	
	Senecio jacobaea ssp. jacobaea	7	8	8	6	10	10	33	7	6	
	Tussilago farfara	7	8	8	10	5	5	33	5	8	
	Viola hirta	7	8	8	6	10	10	33	7	6	
	Carex ericetorum	6	7	7	15	3	3	33	14	17	
	Molinia caerulea	6	7	7	4	10	10	33	5	17	
	Trifolium pratense ssp. pratense	6	7	7	4	10	10	33	5	17	
	Viola rupestris	6	33	4	33	4	3	33	5	6	
	Betula pubescens	6	6	6	11	3	3	33	67	11	
	Leontodon hispidus ssp. hispidus	6	6	6	8	3	3	33	10	6	
	Picea abies	6	6	6	11	3	3	33	67	11	
	Potentilla argentea agg.	6	6	6	13	3	3	33	22	14	
	Potentilla tabernaemontani	6	6	6	4	8	8	33	5	14	
	Angelica archangelica	5	5	5	6	5	5	33	8	8	
	Cerastium holosteoides	5	5	5	6	5	5	33	8	8	
	Corylus avellana	5	5	5	10	3	3	33	12	11	
	Filipendula ulmaria	5	33	2	33	4	4	33	5	11	
	Linaria vulgaris	5	5	5	4	7	7	33	5	11	
	Poa nemoralis	5	5	5	10	3	3	33	5	11	
	Populus tremula	5	5	5	4	7	7	33	5	17	
	Sanicula europaea	5	5	5	10	3	3	33	5	11	
	Scorzonera humilis	5	5	5	10	3	3	33	5	11	
	Antennaria dioica	4	5	5	6	3	3	33	7	6	
	Arabis hirsuta	4	5	5	10	3	3	33	7	6	
	Cirsium acule	4	5	5	10	3	3	33	7	6	
	Cirsium arvense	4	5	5	4	5	5	33	7	6	
	Erigeron acris ssp. acris	4	5	5	6	3	3	33	7	6	
	Helianthemum nummularium ssp. nummular.	4	5	5	10	3	3	33	7	6	
	Hypochaeris maculata	4	5	5	6	3	3	33	7	6	
	Juniperus communis ssp. communis	4	5	5	10	3	3	33	7	6	
	Potentilla x subcinerea	4	5	5	6	3	3	33	7	6	
	Ranunculus auricomus agg.	4	5	5	8	3	3	33	10	6	
	Thymus serpyllum ssp. serpyllum	4	33	2	33	3	3	33	6	6	
	Viburnum opulus	4	5	5	8	3	3	33	10	6	
	Pulsatilla pratensis	3	3	3	7	3	3	33	11	6	
Compagnions: non-vascular plants											
	Homalothecium lutescens	58	33	61	33	45	80	33	53	67	100
	Rhytidiadelphus triquetrus	35	33	36	33	47	22	33	67	43	19
	Brachythecium rutabulum	35	33	36	33	43	27	33	33	45	33
	Hylocomium splendens	24	33	23	33	28	17	33	33	27	11
	Thuidium cf. philibertii	19	33	17	33	18	17	33	33	15	11
	Thuidium philibertii	15	16	16	14	18	18	33	17	19	
	Amblystegium serpens var. serpens	13	14	14	14	13	13	33	10	34	
	Ceratodon purpureus ssp. purpureus	12	13	13	18	7	7	33	15	11	
	Cirriphyllum piliferum	12	33	10	33	14	5	33	33	10	
	Bryum sp.	10	11	11	8	13	13	33	10	22	
	Campyllum chrysophyllum	10	11	11	6	17	17	33	10	6	
	Brachythecium albicans	8	9	9	14	3	3	33	17	6	
	Hypnum cupressiforme var. cupressif.	8	9	9	14	3	3	33	17	6	
	Climacium dendroides	8	8	8	13	3	3	33	15	6	
	Ctenidium molluscum	7	8	8	17	3	3	33	6	34	
	Cf. Brachythecium rutabulum	7	8	8	17	3	3	33	11	25	
	Rhodobryum roseum	7	8	8	8	7	7	33	10	11	
	Calliergonella cuspidata	6	7	7	4	10	10	33	5	17	
	Pleurozium schreberi	6	7	7	13	3	3	33	15	6	
	Barbula convoluta	5	5	5	4	7	7	33	5	11	
	Fissidens dubius	4	5	5	6	3	3	33	6	6	
	Tortula ruralis agg.	4	5	5	6	3	3	33	7	6	