Local distribution patterns of lichen epiphytes in a western Norwegian deciduous forest

– relationship to available substrate

Trude Myhre

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Natural History Museum
Faculty of Mathematics and Natural Sciences
University of Oslo

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2 ABSTRACT

Environmental variables and epiphytic lichen flora of 279 deciduous rich bark trees of a boreonemoral rainforest in the oceanic region of Western Norway were studied. The lichen flora from base to breast height of the tree trunks was investigated for epiphytic macrolichens with cyanobacterial photobiont, 41 species were studied. Descriptive spatial patterns were summarised for each species based upon presence/absence data in two ways: by (1) point pattern analysis and (2) semivariance analysis, e.g. using the geoR package of the R software. Patterns of distribution of trees and their properties were summarised in the same ways (point pattern analysis applicable to geo-referenced tree occurrences only; not to their characteristics). Modelling of species presence (binary response variable) as function of the entire set of predictors was performed primarily using R software. The study revealed a main gradient from trees with great dimensions at low elevation in the north to trees with small dimensions at higher elevation in the south. Fourteen of the investigated lichen species were strongly affiliated with the north end of the gradient, nine species with the south end and only one was spread out evenly. Tree dimension and elevation were found to be the two most important environmental factors. Of the lichen species investigated 16 were oceanic, 24 indicators of long old forest continuity with high and stable humidity, 26 indicators of old deciduous forest continuity and 8 red-listed species. A total of 2/3 of trees investigated was pollarded and these trees had greater dimensions of the stem and higher species richness than the unpollarded 1/3. The old pollarding practice has almost ceased and the remaining pollards in the woodland are relicts ('living deads') with a limited lifespan, making the hot spot habitat in need of conservation and recruitment of new host trees.

Key words: *Fraxinus excelsior*, pollarding, epiphytic lichens, cyanolichens, boreonemoral rainforest, conservation, Tungesvikstranda, oceanic, cyanolichen, cultural landscape, rare species, Lobarion, management

3 INTRODUCTION

Background

Humans have influenced Scandinavian forests for at least 400 years (Esseen et al. 1997), and most of the forested areas show some impact of logging or other types of utilisation. The forest environment contains an important part of natural diversity in Norway and probably more than half of all species in the country are occurring mainly in forests (Framstad et al. 2002). This also pertains to threatened, rare and other species of conservation interest (red-listed species) and a large part of these is assumed to be threatened by forestry and other human activities in forests (Framstad et al. 2002). Of the 4599 species on the Norwegian red list, 1838 (40%) of the red-listed species are dependent on the forest environment. 20% of the red-listed species occur mainly in old forest (Kålås et al. 2010). Of the 1985 registered lichen species in Norway, 267 (21%) of the 1253 evaluated species are on the red-list (Timdal et al. 2010).

Western Norway (W Norway) is exceptional for its temperate oceanic climate and, accordingly, a species rich lichen epiphyte flora with many red-listed species (Bendiksen et al. 2008, Kålås et al. 2010). When describing the oceanic element in the Scandinavian lichen flora, Jørgensen (1996) states that the most exciting finds are those from pollarded common ash (*Fraxinus excelsior*). He lists *Gomphillus calycioides, Leptogium cochleatum, Leptogium hibernicum, Megalospora pachycarpa, Ramonia subsphaeroides* and *Rinodina isidiodes* as obviously very rare lichen species with specific requirements, being found only in very favourable localities. Five of these six species are found in the Tungesvikstranda study area. W Norway has for hundreds of years been relatively densely populated, and hence intensively utilised. A noticeable feature is the extensive use of deciduous trees as food for over-wintering livestock, made possible by pollarding (Austad 1988, Nedkvitne & Gjerdåker 1993).

Farming became the mainstay of life in Etne about 2000 BC (Indrelid & Kutschera 2001), and pollarding of trees has been common in Norway the same time period (Austad et al. 2007). This means that the cultural landscape at Tungesvikstranda might have continuity of old pollarded trees of up to 4000 years. Because the transition to life as farmers did not happen overnight, the area probably had a pretty smooth transition from natural forest to pollarding and selective cutting. The deforestation of W Norway started 4000-4500 years ago, accelerated around year 0 and was maximized around 1000 years ago (Kaland 1986). Only 1% of the productive forest of Norway is older than 160 years (Tomter 1996) because the rotational period of the forestry is between 60 and 120 years, which capture the old forest lichens in small and highly fragmented remnants of old forests (Gauslaa & Ohlson 1997).

Old unpollarded *Fraxinus excelsior* trees occur very sporadically in W Norway (Moe & Botnen 1997), mainly *Fraxinus excelsior* trees found in W Norway are pollarded. The cultural landscapes with old pollarded trees have worked as refugia for old growth lichen species in heavily managed forest areas (Nilsson et al. 1994, Tønsberg et al. 1996, Gauslaa & Ohlson 1997, Moe & Botnen 1997, Bendiksen et al. 2008, Timdal et al. 2010). In a study in Småland, Sweden, Nilsson et al. (1994) demonstrated that many epiphytic lichens of the primeval forests may have survived on large pollards in the traditional agricultural landscape. These populations are often small, mostly comprising a few trees in each locality. Similar observations were done under the investigations for the red list of Norwegian macrolichens by Tønsberg et al. (1996). The pollards have worked as a replacement for old growth elements in heavily managed forest areas (Gauslaa & Ohlson 1997). For oceanic epiphytic lichens, *Ulmus* *glabra*- and *Fraxinus excelsior*-pollards have been the most important replacement-element in bottleneck periods with heavy management by humans and little old growth forest left (Bendiksen et al. 2008). Consequently, source populations have become rare and the old forest lichens have thus lost their migratory potential (Gauslaa & Ohlson 1997).

Old pollarded trees, especially *Fraxinus excelsior*, are still common in W Norway (Tønsberg et al. 1996) and currently make up core habitats for many red-listed epiphytes (Timdal et al. 2010). The huge boles provide habitats for many slowly colonizing epiphytes (Rose 1992). Pollarding of deciduous trees was common over much of Norway up to World War II (Austad 1988, Nedkvitne & Gjerdåker 1993). Trees managed this way are disappearing rapidly from the landscape, mainly because of aging trees, lack of pollarding, felling of trees for timber and subsequent replacement by spruce (*Picea sp.*) plantations (Austad 1988). The aging tree trunks are weakened by the heavy branches, and they are not being replaced by young, pollarded trees. Their habitat, namely open fields with favourable light conditions, is being taken over by young deciduous-tree growth which establishes a shadier habitat (Austad & Skogen 1988, 1990). The main threat to wooded meadows and their biodiversity are considered to be ceased management leading to succession into closed forest conditions (Johanson 2006). These changes of use are likely to reduce the suitable substrate for most red-listed epiphytes with time, as well as making the deciduous forest a generally less well suited habitat due to reduction of light at low vertical levels. Several red-listed lichen species are associated with pollarded trees which may soon become an extinct microhabitat (Timdal et al. 2010). Species restricted to ancient pollards will become extinct without resumed management of the agricultural landscape, including pollarding of the old *Fraxinus* pollards and recruitment of new trees (Tønsberg 1994).

Through various international conventions and other agreements, Norway is obliged to preserve nature and its biodiversity. Norway's neighbor countries Sweden and Finland have so far protected 4-5% of their productive forest area, and have stated ambitions for protection up to 10% (Framstad et al. 2002). For comparison, Norway had by 2002 protected 1% (Framstad et al. 2002) and currently Norway has protected 2% of the productive forest. Of threatened forest types, additional protection is particularly needed for broad-leaved deciduous forest in general and especially oceanic *Ulmus glabra* and *Fraxinus excelsior* forests for which Norway has a particular international responsibility (Framstad et al. 2002). In 2003 only 18 km^2 in the nemoral and boreonemoral zone of the W Norway was protected, when 127 km^2 was the recommended extent by Framstad et al. (2002). Holtan (2006) states that Norway is lacking nature reserves of boreonemoral rainforest and Framstad et al. (2003) concludes in their list of prioritized shortcomings of the Norwegian forest conservation that especially oceanic old *Ulmus glabra*/*Fraxinus excelsior* forest; pollarded areas with coarse *Ulmus glabra* and *Fraxinus excelsior* should be protected.

In nature, living beings are distributed neither uniformly nor random. Rather, they are aggregated in patches, or they form gradients or other kinds of spatial structure (Legendre & Fortin 1989). Few studies of the spatial distribution of red-listed epiphytes and their substrate have been carried out in Norwegian deciduous forests, and the ability of most species to disperse and colonise new substrate is poorly known.

Moe & Botnen (1997) investigated the epiphytic vegetation on 19 pollarded trees of *Fraxinus excelsior* at Havrå, W Norway and found floristic differences between the epiphythic vegetation on trunks in the open fields and in the woodland. This suggests a change in the epiphytic vegetation because creation of a more shady habitat in parts of the area during a few decades. Furthermore the epiphytic vegetation on 24 pollarded trees of *Fraxinus excelsior* at the farm Grinde, W Norway was investigated by Moe & Botnen (2000). They found floristic differences between four different habitats; open meadow, wooded hay meadow, deciduous wood and *Picea* sp. plantation, which suggests that changes in the vegetation have developed during the last two or three decades. The *Picea* sp. plantation was the shadiest habitat having very sparse epiphytic vegetation, mainly remnants from vegetation established during more open area conditions. Bjelland (1997, 2001) studied the distribution pattern of four oceanic lichen species in the genus *Leptogium* from 18 localities in Norway. Bjelland found that there is a relationship between niche width and geographical distribution, and between anatomy and morphology and water relations in the species. The distribution pattern suggest that *L. burgessii, L. cochleatum and L. hibernicum* are likely to have spread from the British Isles by long-distance dispersal, while *L. cyanescens* could also have been spread gradually to southwest Norway from the Oslo area. Schei et al. (in press) investigated spatial distribution and abundance of 15 *Lobarion* lichen species in 10 forest sites and found that both environmental filtering and local dispersal dynamics are important processes explaining the distribution and abundance pattern of *Lobarion* lichens at finer spatial scales.

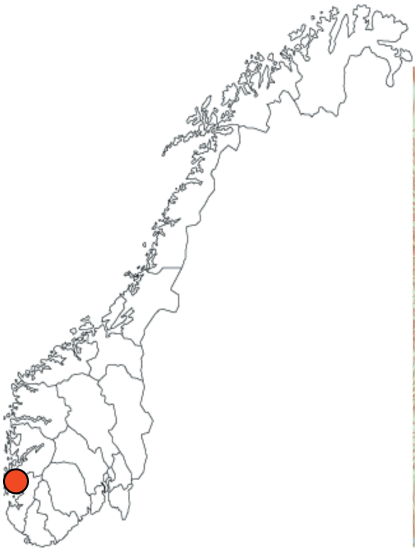
Moe (1995) analysed temperate deciduous forest reserves in Hordaland county, W Norway and stated that where pollarded trees occur in large accumulations one should continue the pollarding practice, but that protected hilly temperate deciduous forest in general should be allowed to develop freely (until one can say anything about clear negative trends). He also concluded that it is better to manage too little than too much in the reserves, while alien species such as *Picea sp.* should definitely be removed. Røynstrand (2010) reinvestigated Moe's permanent plots and found a rather high stability of the forest vegetation (note: ground vegetation studied, epiphytic flora was not considered) at least for the last 15 years and practically unchanged species inventories the last 25-30 years. The natural dynamics of the forests thereby seem to be sufficient to maintain the present species diversity. Vatne (2010) investigated epiphytic lichens before and after pollarding of *Ulmus glabra* and *Tilia cordata* managed for the first time in 80-120 years and found several negative effects. Compared to the pollards still standing in dense forest, the recently pollarded trees had lower epiphyte coverage, especially low density of fruit bodies of two of the investigated lichen species and the 'stumps' in the tree tops had dried out. The old pollards had probably been weakened by the heavy treatment of the top shots and the rapid changes in light conditions and humidity may have affected the lichens negatively.

Aims of the study

Knowledge of spatial distribution of red-listed epiphytes and their substrate is fundamental for optimal management of W Norwegian deciduous forests. This study has two main aims: (1) To describe the spatial distribution pattern of (a) epiphytic macrolichens with cyanobacterial photobiont either as primary photobiont or as cephalodia and three chlorolichens (henceforth referred to as target species) and (b) available substrates, in a W Norwegian deciduous forest. (2) To model factors of importance for the distribution of the target species, as a basis for discussing future population development and evaluation of management strategies.

4 MATERIALS AND METHODS

The investigation area
The study was conducted in W Norway at the site Tungesvikstranda ('Beach of Tungesvik'), which is a deciduous woodland area situated within the southern boreal region and located near Skånevik in Etne municipality, southernmost Hordaland County. It covers the northeast foothills of Mount Prestafjellet, south of Åkrafjorden at 59˚44'N, 05˚58'E.



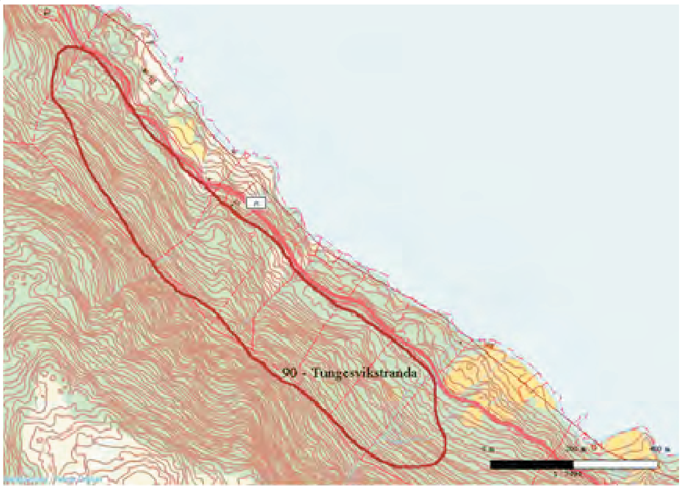


Figure 1. Location. Figure 2. Map of study area (from Gaarder & Fjeldstad 2009)

The topography is steep from the fjord to the mountain top. The bedrock is gabbro (Bjelland 1997, Brekke et al. 2001). The climate in the area is wet with mild winters and lies within the markedly oceanic vegetation section (O2), according to Moen et al. (1999). Mean annual precipitation measured in the period 1961–1990 was 1949 mm per year, measured mean for January was 176 mm and for July 123 mm (Førland 1993). The mean annual temperature 1961–1990 was 7.2˚C, with extremes 1.1˚C in January and 14.2˚C in July (Førland 1993). The studied woodland has been characterized as boreonemoral rainforest (cf. Holien & Tønsberg 1996, Bendiksen et al. 2008), typical due to the high and frequent precipitation and its rich epiphytic lichen flora. The woodland, a pasture-woodland, was dominated by old pollards of *Fraxinus excelsior* mixed with various other deciduous trees, mainly black alder (*Alnus glutinosa)*, grey alder (*A. Incana*), birch (*Betula pubescens*)*,* common hazel (*Corylus avellana*)*,* goat willow (*Salix caprea*) and rowan (*Sorbus aucuparia*). A few elm (*Ulmus glabra*) pollards were also present (Tønsberg 1994).

This unique locality has proven to be rich in oceanic lichens and no other site in Norway is known to have such a concentration of rare south-western lichen species which in Scandinavia are restricted to Norway, the site is clearly of national and Scandinavian importance (Tønsberg 1994). Being the northernmost known locality in the world for *Leptogium cochleatum* and *Rinodina isidiodes*, it is also of general international importance (Tønsberg 1994).

Sampling design
A part of the locality was selected for this study. The locality is transversed by state road 48 at about 40 m altitude from north to south and only the part of the locality that was situated

above the road was selected as study area. The heavily pollarded neighbour woodland was used as a south-eastern border of the study area. From the south-easternmost point along the road (tree # 1, see map figure 4) the study area was stretched upwards and westwards for a sufficient distance to encompass approximately 300 target trees. All field work was carried out in the summer of 2006 except exact georeferencing of trees and recording of bark variables which was made in April 2010.

Sampling of trees

Single trees were chosen as sampling units and for each tree several environmental variables were recorded. Recording of information (sampling) was performed on all rich-bark, temperate deciduous trees in the study area that had the potential for carrying any of the target species. This included all trees with diameter at breast height larger of at least 20 cm. Standing dead trees were also included. Trees without any of the target species were not included (also see below). Rich-bark (DuRietz 1945) is bark with high pH, which gives a richer lichen flora than bark with low pH. Of the Norwegian rich bark trees, *Populus tremula, Salix caprea, UImus glabra* and *Fraxinus excelsior* (Krog et al. 1994) were found in the study area. *Salix caprea* and *Populus tremula* were not included in the study. Young *Salix* trees held none of the target species and the (few) older ones held very few if any. *Populus tremula* is not included in the term temperate (nemoral) deciduous forest tree ('edelløvtre' in Norwegian) and was therefore out defined in the study. This gave mainly *Fraxinus excelsior* trees as target trees and only a few (six) *Ulmus glabra* trees. Each tree was marked and numbered from 1 to 300. Nine trees were not found during georeferencing in 2010 (123, 140, 163, 179, 186, 211, 258, 264 and 290), ten trees were abandoned due to time constraints during georeferencing (238, 239, 240, 241, 242, 295, 296, 297, 298, 299) and two trees (81 and 247) were discovered not to have any target species during lichen determination *ex situ*. This left 279 trees for investigation.

Epiphytic lichen sampling

All macrolichen species with cyanobacterial photobiont (cyanolichens) and three species with green algal photobiont (chlorolichens) *Rinodina isidiodes, Cetrelia olivetorum* and *Normandina pulchella* were selected as target species and recorded on each host tree as present (1) or absent (0). The three chlorolichens were added because the two red-listed *Rinodina isidiodes* and *Cetralia olivetorum* and the uncommon *Normandina pulchella* are apparently sharing the same ecological demands as the cyanolichens. Some of the identification work was done *in situ*, but samples were made whenever necessary for determination *ex situ*. The nomenclature follows Santesson 2004. After the fieldwork was finished, *Degelia plumbea* was divided into two species; *D. plumbea* and *D. cyanoloma* (Blom & Lindblom 2009). *Leptogium cyanescens* has been divided into two species in North America (Stone & Ruchty 2006) and *Leptogium* samples from Tungesvikstranda were sent to Daphne Stone (Oregon, USA) for DNA identification to see if this might be the case in Norway as well. These two species divisions were not taken into account in this study. Collections not possible to identify to species level were left unrecorded. In total 41 species were recorded, for list of target species with Latin and common Norwegian name, frequency, relative frequency and their red-list category see appendix 1 and for full data set of recorded target lichens see appendix 2 .

Recording of explanatory variables

Epiphyte cover properties
Bryophyte cover, epiphloeic lichen cover (cover of crustose lichens that may block colonisation of other lichens) and macrolichen cover from basis to lowermost cleft on each tree were measured in percent (%). For an overview of all explanatory variables, see table 1 in the chapter 5 Results.

Geographic position variables
The study site is situated in a 'difficult area' when it comes to accurate recording of coordinates by the GPS system. After testing several different methods, the Total Station Theodolite Sokkia SET5F was chosen by which geographic coordinates were recorded in April 2010. Positions (in UTM zone 32) were broken down to three components: (1) x co-ordinate, (2) y co-ordinate and (3) z co-ordinate. Other geographic variables were derived from co-ordinates and tree characteristics, such as distance to nearest neighbouring tree, distance to nearest conspecific neighbouring tree, etc. by ArcGIS 9.3 (www.esri.com).

Environmental characteristics of the site
Downhill terrain shape (i.e. terrain shape in direction of steepest descent through the tree in question) was recorded on a scale from 1 (top; convex) to 5 (valley bottom; concave shape). Horizontal terrain shape (i.e. terrain shape in both directions from the tree at the same altitude) was recorded similarly. Aspect and hill slope were measured in degrees (360° scale) by a clinometer compass. Drainage was recorded on a scale from 1 (dry, stony) to 5 (brooklet, spring). Canopy cover was measured by a convex spherical densiometer (Lemmon 1956); one measurement in each cardinal direction from the stem of the sampled tree. These variables were used separately, and the average was calculated as well.

Tree properties
Host tree species, *Fraxinus excelsior* and *Ulmus glabra* were recorded as factor-type variable with two levels. Pollarded or not, was recorded as binary variable; 0 = not pollarded; 1 = pollarded. Diameter at breast height (i.e. 1.4 m above normal cutting height) and diameter of the tree at basis were measured in m. Stem inclination at breast height was measured in degrees (360° scale) by a clinometer compass. Occurrence of crevice(s) in stem (i.e. a cavity with an overhang of 5 cm or more; cf. Halvorsen et al. 2009) was recorded as a factor-type variable with two levels (0 = crevice absent; 1 = crevice present). Occurrence of callus(es) was recorded similarly (0 = callus absent, 1 = callus present). Occurrence of more than one stem with diameter > 5 cm that diverted below breast height was recorded as a factor variable (0 = single-stemmed, 1 = multi-stemmed). Height to lowermost living branch (with leaves) was measured in decimetres from normal cutting height to cleft above branch. Bark structure was divided into three groups (1) smooth bark; smooth texture without any rough structure, (2) rough bark; rough texture, but without fissures or (3) fissured bark; fissured texture occurring mainly in elderly and /or sun-exposed trees. And measured on a scale from 1 to 5 where 5 = < 50%, 4 = 25-50%, 3 = 12.5-25%, 2 = 6.25-12.5%, 1 = appears, but less than 6.25% and 0 = none. Bark structure was recorded during exact georeferencing in April 2010.

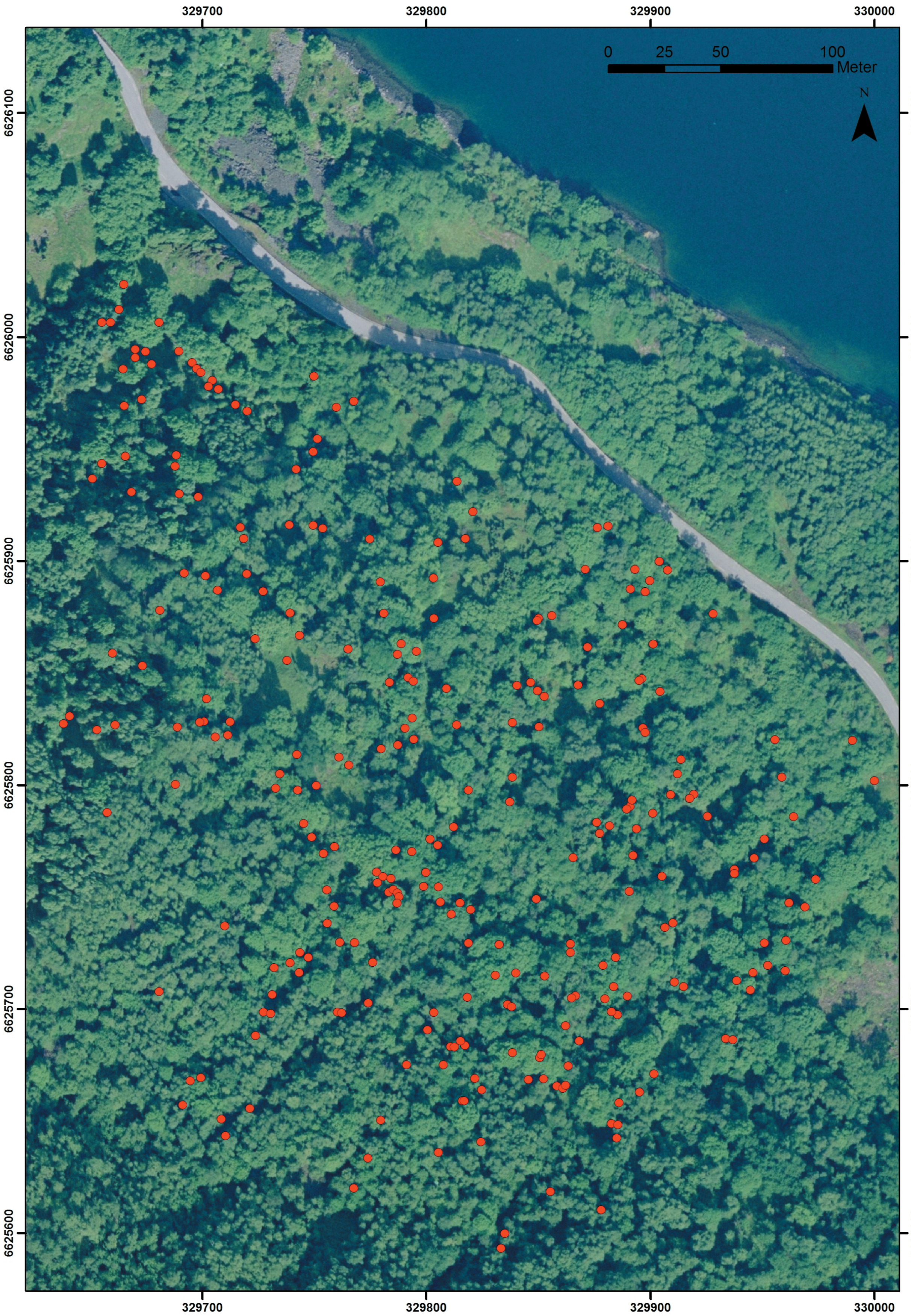


Figure 3. Aerial map showing target trees as red points in the Tungesvikstranda study area.

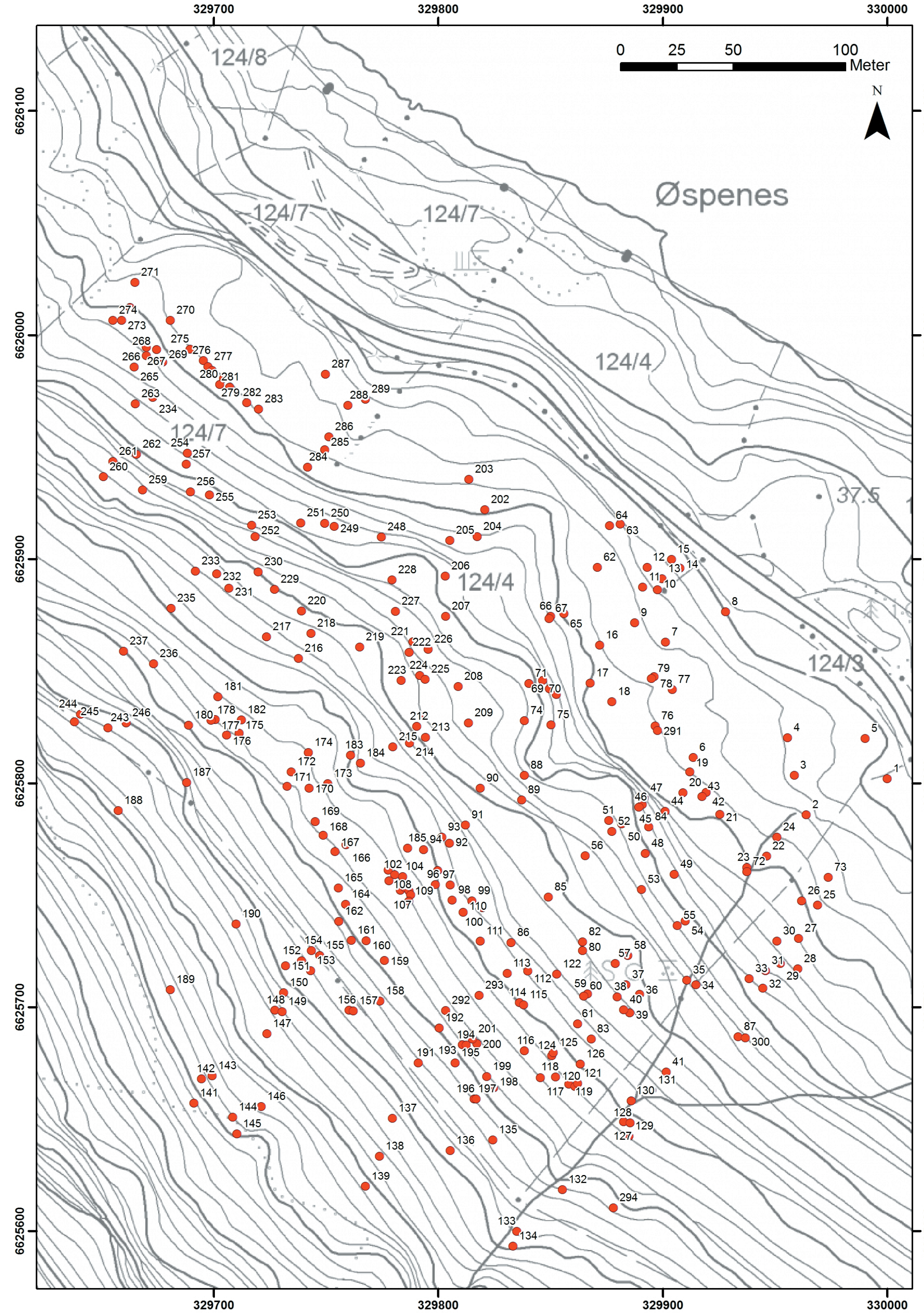


Figure 4. Topographic map with target trees as red points and tree number.

Data analysis

Editing and manipulation of data
Editing and transforming of data was performed in Microsoft Office Excel (Anonymous 2003) and all statistical analyses were done using R software version 2.11.1 (R Development Core Team 2010). Vegan library (Community Ecology Package) version 1.17-2 was used for all multivariate analyses. Spatstat library (Spatial Point Pattern analysis) version 1.19-3 was used for the spatial point pattern analysis and geoR library (Analysis of geostatistical data) version 1.6-27 was used for the geostatistics.

Transformation and standardisation
All continuous variables were transformed to zero skewness by the 'zero skewness transformation' (R. Økland et al. 2001) prior to analyses to reduce skewness in distributions and, hence, to improve homoscedasticity. Approximate homogeneity of variances is achieved by finding the value of c that gives the transformed variables zero skewness. Depending on whether a variable (x) was skewed to the left or right, it was transformed using the following formulae:

x left skewed:	$y = e^{cx}$	skewness is negative (< 0)
x right skewed:	$y = \ln (c + x)$	skewness is positive (> 0)

By manual iteration the value for c that corresponded to the skewness minimum was found for each variable. After transformation all variables were ranged to a standard 0–1 scale by the formulae:

$$Z = \frac{y - y_{\min}}{y_{\max} - y_{\min}}$$

Stem inclination was expressed as deviation from the vertical axis, (100–x), where x is the tree's angle with the horizontal plane. Factor variables were not transformed. A total account of untransformed and transformed values of variables is given in appendices 3 and 4.

Relationship between explanatory variables

PCA
Multivariate patterns, e.g. in the distribution of environmental and tree characteristics (explanatory variables), were summarised by Principal Component Analysis (PCA) ordination (Pearson 1901; ter Braak & Prentice 1988). PCA was used for ordination of the 20 continuous variables of the explanatory data matrix. PCA is an extension of the parametric linear regression and assumes a linear relationship between variables and axis; hence the transformed variables were used in the analysis.

Correlation analysis
Kendall's non-parametric correlation coefficient (Kendall 1938) was calculated for all pairs of explanatory variables as a measure of strength of pair-wise relationships.

Ordination of species composition

DCA and GNMDS ordination of trees

Ordination methods representing the two main families of ordination techniques; purely geometric and multivariate statistical methods were applied to extract gradient structure of the species-plot data matrix. Detrended Correspondence Analysis (DCA) ordination (Hill 1979, Hill & Gauch 1980) and Global Non-metric Multidimensional Scaling (GNMDS) ordination (Kruskal 1964a, 1964b, Minchin 1987) are considered complementary because of their innate differences, thus similar results by the two should indicate that a reliable gradient structure has been found (R. Økland 1990a, 1996). DCA ordination has two sets of eigenvalues; 'DCA eigenvalues' and 'DECORANA values', both were included for comparison (Oksanen et al. 2007). GNMDS was performed with the following options (see recommendations for LNMDS by T. Økland, 1996): distance measure = Bray–Curtis distance, dimensions = 2, initial configuration = 100, maximum iterations = 200 and convergence ratio for stress = 0.9999999. Both ordinations were inspected for known artefacts like arch effect (in GNMDS), edge effect, tongue effect and other patterns (R. Økland 1990b, R. Økland & Eilertsen 1993).

Comparison of ordination methods (DCA and GNMDS)

The non-parametric Kendall's correlation coefficient tau (τ) was calculated for pair-wise DCA and GNMDS axes 1 and 2. Congruent configurations indicate strongly that a realistic ordination has been achieved (R. Økland 1990 b). Liu et al. (2008) launched that ordination axes are similar at $\tau = 0.4$.

Ecological interpretation of ordination axes

Relationship between ordination axes and explanatory variables

DCA and GNMDS axes were interpreted ecologically by calculating Kendall's τ between the ordination axes and the 20 continuous explanatory variables. The paired Wilcoxon test was used for the seven factor variables (calluses, crevices, pollarding, stems and the three bark types).

DCA biplot

The DCA biplot diagram has two kinds of information; (1) DCA-ordination of trees/sample plots comprising all species as background and (2) explanatory continuous variables as vectors and explanatory factor variables as coloured points. The centroid of the ordination diagram is at the origin and the explanatory variables are indicated as arrows (vectors) from the origin. Vectors of explanatory variables are pointing in the direction of strongest (maximum) change in the variable. Circles show median position for all trees with the actual factor variable. The closer to the middle the circles are, the more observations the actual explanatory factor variable have. A biplot with the DCA ordination (plot scores of trees), was made by use of the procedure "envfit" in Vegan. Only variables that explained significantly more variation than expected of a randomised variable in a Monte Carlo test were shown.

DCA isoline diagram

DCA isoline (or contour line) diagrams were made separately for untransformed continuous explanatory variables that were significant in the "envfit" test, with respect to DCA axes 1 and 2. Only isoline diagrams of the continuous explanatory variables that are significant due to the biplot analysis were interpreted. The significant variables were; downhill terrain shape, slope, average canopy, canopy south, canopy north, canopy east, diameter at breast height, diameter at base, lowermost branch, macrolichen cover, easting, northing and elevation. Isoline diagrams would not be meaningful for factor variables and non-significant variables would not be reliable.

DCA species plot
A DCA plot with present and absent data on trees plotted at the trees positions in the DCA diagram for axes 1 and 2, was made for each single target species. Ten species with less than 5 findings in the study area were not taken into account in this context (number of findings in parentheses): *Cetrelia olivetorum* (1), *Collema furfuraceum* (3), *Collema subnigrescens* (1) *Fuscopannaria mediterranea* (3), *Massalongia carnosa* (1), *Rinodina isidiodes* (1), *Sticta limbata* (2), *Peltigera hymenina* (4), *Peltigera polydactylon* (3) and *Protopannaria pezizoides* (1).

Species richness

A Kendall's rank correlation test on number of species per tree against the ordination axes was done and a map of species richness on trees was made. GLM correlation tests were done on species richness versus all explanatory variables. A species richness plot with trees as circles of different colour for species frequencies and a species richness barplot with the frequency of different number of sampled target lichens species per tree was made. A GLM t-test of diameter and number of species versus pollarding was performed.

Geostatistics - Spatial structure

Geostatistical methods were used to explore the spatial structure of explanatory variables and ordination axes. The Euclidian ('ordinary') distance between the trees was used as a measure of geographical distance. Only continuous variables in addition to DCA ordination axes of species sample-plot were used in the analyses.

Standardised semi-variograms
A semi-variogram (Rossi et al. 1992) was made for the first two DCA axes and for each of the continuous explanatory variables. Semi-variograms measures how quickly spatial autocorrelation falls off with increasing distance (Crawley 2006). Eight lag classes on a 2-logarithmic scale were used for the inter-tree distances to ease interpretation of patterns. (1) 0-4m, (2) 4-8m, (3) 8-16m, (4) 16-32, (5) 32-64, (6) 64-128, (7) 128- 256, (8) 256-512. The longest distance between two points (tree # 271 and 294) was 465 metres, which gave 512 m as the upper boundary of the lag class of highest order. Each class contained a minimum of 25-30 tree pairs. Envelopes were added to the variograms and thereby showing great distance where there is few pair of trees in the lag class and narrow distance where there are many tree pairs in the lag class. When spatial dependence is present at the scale sampled, semi-variance will be low at short distances, it will increase for intermediate distances, and typically reach an asymptote ('sill') when data separated by large distances become spatially independent (Ettema & Wardle 2002).

Spatial point pattern analysis

Point pattern is an important example of spatial pattern where the dataset consists of a series of mapped point locations in a study region (Wiegand & Moloney 2004). Point pattern analysis was applied to study spatial pattern (e.g. point pattern) in the study area to infer the existence of underlying processes. Instead of being a rectangle, the spatial sampling area, in which the points (trees) were recorded, had an arbitrary irregular shape (cf. Baddeley & Turner 2005). To create a point pattern object from a realistic data set and to avoid 'edge effects' a 'window' (the spatial region) was made. A window is a region in two-dimensional space that represents the study area (Baddeley & Turner 2005). The window was made by drawing a line between the positions of one metre outside the outermost trees of a minimum polygon.

Point pattern tree plots
A plot showing number and positions of the trees and a plot of trees pollarded or not was made to ease the interpretation.

Point pattern lichen species plots
Plots showing trees with species as red points and trees without species as grey dots were made for each lichen species; marked point pattern with lichen species absent or not as a categorical variate (Baddeley & Turner 2005). Ten species with less than 5 findings were excluded, cf. DCA species plots.

Point pattern lichen density plots
Density plots ('heat maps') showing the distribution of target species on the trees in the study area were made for each species. Same ten species as for the lichen species plos were not taken into account. Note that the default colour map for image plots in R has only 12 colours and can convey a misleading impression of the gradation of pixel values in the image. Each figure shows two plots; 0 = were species is absent, 1 = were species is present/shows aggregation.

Random labelling test, lichens
The random labelling test, a randomisation test of the random labelling null hypothesis (Baddeley 2008), was used for each target species to test for aggregation (clumping) of species on certain trees or in certain areas of the study area. Species that were found on fewer than 10 trees were not analysed.

L-function, trees
A plot for the L-function of the trees was made to investigate the pattern of tree distribution in the study area, e.g. to see whether the trees are aggregated (clumped), randomly spread out (completely independent) or spaced out in a regular pattern (Crawley 2006). L was used instead of Ripley's K, to avoid scale dependence. The plot has a red dotted line showing the expected number of trees within a radius r (in meters) of a tree under the assumption of complete spatial randomness (CSP). The black observed curve lies above this line when indicating spatial aggregation, on top of it indicating CSP or under it when indicating a regular pattern (more spaced out than in a random pattern).

Species plot comparison

Results from the analyses of DCA ordination plots, point pattern species plots and point pattern density plots was organized in a table to investigate and discuss pattern of similarity between the three different analysis of target lichen dispersal in the study area.

Phytogeography and dispersal strategy

Phytogeography

Current Norwegian distribution of the target species (artskart.artsdatabanken.no) was analyzed based on phytogeography of vascular plants (cf. R. Økland 1989). Species were classified into five elements; W, S, SE, E and N, according to their distribution in Fennoscandia and Denmark and each element is divided into a series of distributional groups according to regional distribution (R. Økland 1989). For full definition of phytogeographic elements and distributional groups see Økland (1989), the following distributional groups were used for species at Tungesvikstranda: W1 – strongly western species, W2 – western species, W3 – slightly western species and W4 – widespread species with a western tendency. S3 – slightly southern species, S4 – widespread species with a southern tendency, SE4 – widespread species with a southern tendency, Ub – ubiquitous (everywhere). Phytogeography of vascular plants was not easily transferred to lichens and target species found outside of the western (W) distribution defined by R. Økland (1989) was marked with a star (*).

Dispersal strategy

Different dispersal strategies of the target lichens were listed for interpretation, for definition and explanation of different reproduction and dispersal structures of lichens see Krogh et al. (1994) or Holien & Tønsberg (2006).

5 RESULTS

Explanatory binary factor variables

The study area had 191 trees were pollarded, 88 unpollarded (cf. figure 19), 33 trees had more than one stem (2 or 3), 262 trees had fissured bark, 109 trees had callus(es) and 142 had crevice(s).

Explanatory continuous variables

Epiphytic cover properties
Bryophyte coverage on the trees varied between 10 and 95% with a mean of 51.33, epiphloeic lichen cover had a range from 0-60% coverage with mean of 7.20 and macrolichen coverage lied between 1 and 50% with a mean of 11.32.

Geographic position variables
The elevation (z-value) ranged from 55 meter to 262 meter above sea level with a mean of 135 meter.

Environmental characteristics of the site
Downhill terrain shape had a range from 2-5, horizontal terrain shape ranged from 1-5 and drainage from 2-5 on their 1-5 scales. Aspect and slope of the terrain varied from 7-140 and 0-80 degrees, respectively.

Tree properties
Canopy cover facing south, west, east and north varied from a 8-24, 7-24, 4-24 and 9-24 of 24 possible, respectively. Average canopy cover range was 8.5-24 with a mean of 21.13. Diameter at breast height ranged from 7 – 178 centimetres with a mean of 73 and diameter at basis differed between 25-191 centimetres with a mean of 89. Stem inclination varied from 10 to 100 degrees and had a mean of 77.67. Height to the lowermost branch varied from 8 to 80 decimetres and had a mean of 25.3 dm. Factor variables were not meaningful in this context.

See table 1 below for all explanatory variables; variable type, abbreviations, unit of measurement, summary statistics of the untransformed variable, transformation type and c-value.

Table 1. Explanatory variables measured in the study area. X-and Y coordinates in UTM zone 32

Abbreviations	***Variable***	***Unit of measurement***	***Summary statistics of untransformed variable***		***Transformation***		***Variable type C = continuous F = factor***
			Range	Mean	Type	c-value	
Epiphyte cover properties							
bryophyte	Bryophyte cover	%	10-95	51.33	e^cx	0.01	C
lichens	Epiphloeic lichen cover	%	0-60	7.20	ln(c+x)	0.049834	C
macrolichen	Macrolichen cover	%	1-50	11.32	ln(c+x)	3.7253	C
Geographic position variables							
easting	X co-ordinate	-	(-6568)-(-6113)	(-6304)	e^cx	0.003	C
northing	Y co-ordinate	-	6656543-6656878	6656721	e^cx	0.001	C
elevation	Z co-ordinate	m	55-262	135	ln(c+x)	159.97	C
Environmental characteristics of the site							
down_terra	Downhill terrain shape	1-5 scale	2-5	3.21	ln(c+x)	-0.14303	C
hori_terra	Horizontal terrain shape	1-5 scale	1-5	2.90	e^cx	0.07	C
aspect	Aspect	^{O}(360 – g scale)	7-140	59.33	ln(c+x)	666.4	C
slope	Slope	^{O}(360 – g scale)	0-80	48.07	e^cx	0.02	C
drainage	Drainage	1-5 scale	2-5	3.14	ln(c+x)	-0.42875	C
Tree properties							
canopy_s	Canopy cover facing south	-	8-24	21.11	e^cx	0.215881	C
canopy_w	Canopy cover facing west	-	7-24	20.95	e^cx	0.213	C
canopy_n	Canopy cover facing east	-	4-24	21.36	e^cx	0.243	C
canopy_e	Canopy cover facing north	-	9-24	21.08	e^cx	0.226	C
aver_canopy	Average canopy cover	-	8.5-24	21.13	e^cx	0.245	C
diam_breast	Diameter at breast height	m	0.07-1.78	0.73	ln(c+x)	0.833549	C
diam_base	Diameter at basis	m	0.25-1.91	0.89	ln(c+x)	0.995839	C
stem_incli	Stem inclination	^{O}(360 – g scale)	10-100	77.67	ln(c+x)	18.459	C
lowe_branch	Height to lowermost living branch	dm	8-80	25.3	ln(c+x)	-5.32472	C
pollarding	Pollarded or not	-	0-1	-	e^cx	-	F
crevices	Occurrence of crevise(s)	-	0-1	-	e^cx	-	F
callus	Occurrence of callus(es)	-	0-1	-	ln(c+x)	-	F
stems	Number of stems	-	0-1	-	ln(c+x)	-	F
smBark	Smooth bark structure	-	0-1	-	ln(c+x)	-	F
roBark	Rough bark structure	-	0-1	-	ln(c+x)	-	F
fiBark	Fissured bark structure	-	0-1	-	e^cx	-	F

Relationship between explanatory variables

PCA

The first four PCA axes explained 47.3 % of the total variation in the matrix of 20 continuous explanatory variables. The eigenvalues for PCA axes 1-4 were 4.795, 3.255, 1.996 and 1.767, respectively, corresponding to 19.20, 13.00, 7.99 and 7.07 % of the variance in the data set, respectively.

The 20 continuous variables fell into three loosely defined groups along axes 1 and 2 (figure 5). The first group (1), with northing and elevation, had long arrows (vectors) pointing in direction along PCA axis 1 (in the negative and positive directions, respectively), indicating strong relationships with the axis. The same applied to a second group (2) which included diameter breast, diameter base in the positive direction and height to lowermost branch (negative), with arrows (vectors) along PCA axis 2. A third group (3), consisting of the five canopy variables, also had long vectors, which pointed in the positive direction between PCA axes 1 and 2. Canopy average had the longest vector, elevation the next to longest, then northing and diameter breast and base. Drainage, stem inclination, topography variables (aspect, slope, horizontal terrain shape and downhill terrain shape) and epiphyte cover variables (macrolichen cover, epiphloeic cover and bryophyte cover) all had overall relatively short vectors which indicate weak relationships with the first two PCA axes. Along axis 3 there were two groups of variables with long vectors (figure 5). One group of slope, horizontal terrain shape and stem inclination negatively correlated along axis 3 with a group of epiphloeic lichen cover, drainage, downhill terrain shape and aspect. Axis 4 was not considered because of little additional variation explained.

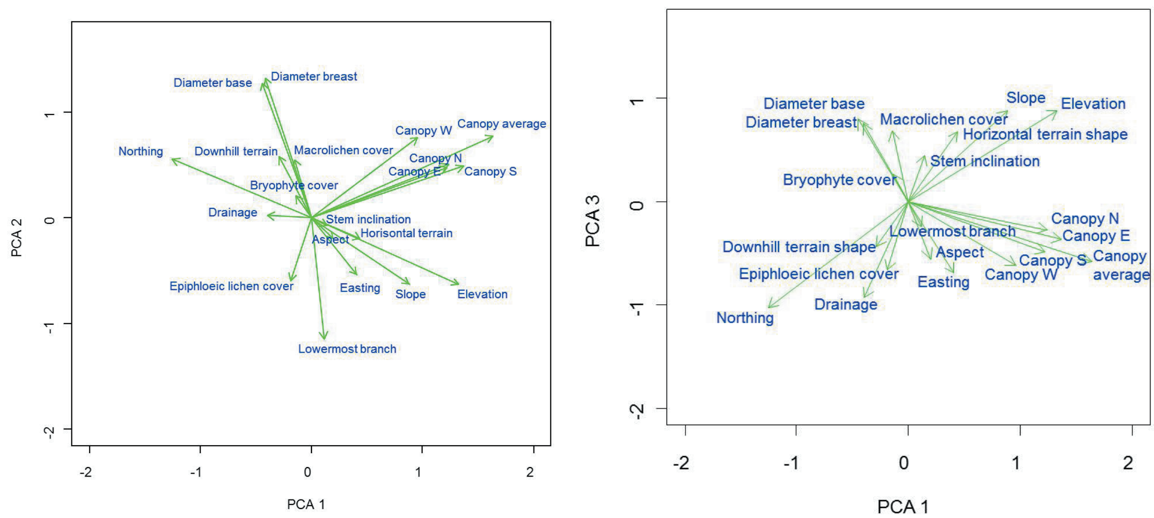


Figure 5. PCA ordination axes 1 and 2 of continuous explanatory variables and PCA ordination axes 1 and 3 of continuous explanatory variables.

Correlation analysis

Kendall's correlation coefficients tau (τ) between continuous explanatory variables confirmed the loose grouping of variables identified by PCA ordination (see appendix 5 for the full table). This corresponded to (1) a geographical group with northing and elevation, (2) a group of both diameter variables and height to lowermost branch and (3) the canopy group. In addition macrolichen cover was most strongly correlated with the two tree diameter variables and second most strongly correlated with bryophyte cover. Additionally epiphloeic lichen cover was most strongly correlated with bryophyte cover and second most strongly correlated with stem inclination.

Ordination of species composition

DCA ordination of the macrolichen composition of trees

DCA axes 1 to 4, based upon 279 trees, had eigenvalues of 0.2524, 0.1568, 0.1331 and 0.1410 respectively.

Table 2. Summary of DCA results.

	DCA 1	DCA 2	DCA 3	DCA 4
Eigenvalues	0.2524	0.1568	0.1331	0.1410
Decorana values	0.2583	0.1888	0.1630	0.1418
Axis lengths (S.D. units)	2.9462	2.5643	3.3085	2.5605

Gradient lengths of DCA axes 1 and 2 were 2.95 and 2.56 S.D. units, respectively. Scores for trees were relatively evenly distributed along the two first axes, although with somewhat lower density towards the fringes (see figure 6). No tongue or trumpet shapes, no outliers nor other visual pattern were seen.

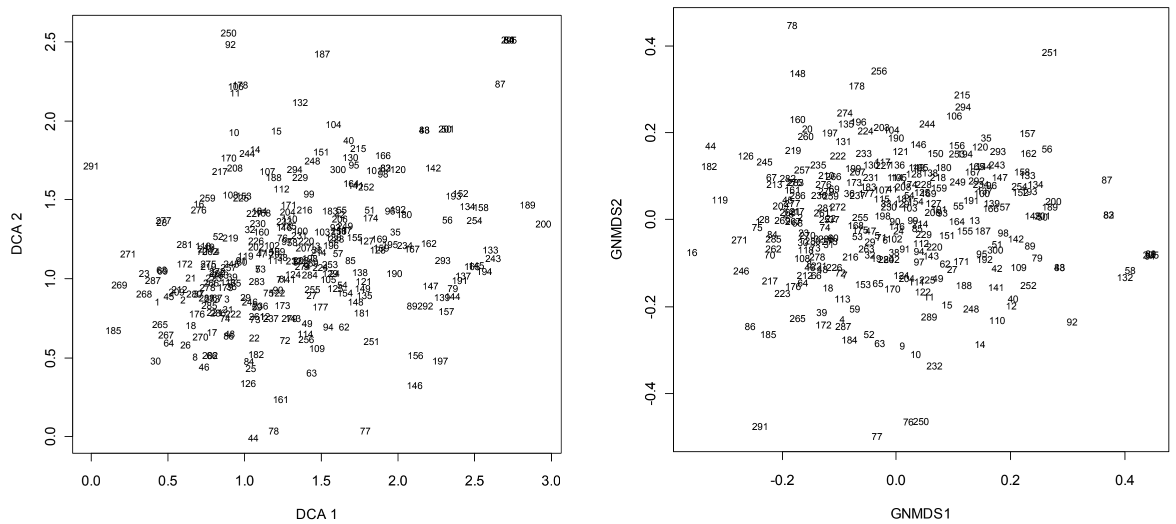


Figure 6. DCA and GNMDS ordination of the macrolichen composition on trees.

GNMDS ordination of the macrolichen composition of trees

The gradient lengths of the first and second GNMDS axes were 0.804 and 0.946 respectively. Scores for trees were relatively evenly distributed along the two GNMDS axes, although with somewhat lower density towards the fringes (see figure 6). There were no tongue, no trumpet, no outliers no visual patterns or arch effect.

Comparison of ordination methods

The absence of artefacts congruence of the two ordinations is a strong indication that the true structure of the data matrix was recovered. Kendall's correlation coefficients τ calculated between DCA axes 1–3 against GNMDS axes 1–2 revealed just one strong correlation; between the first axes of the two ordinations ($\tau = 0.617$, $P < 0.001$, $n = 2$). The correlations between GNMDS axis 2 and DCA axes 2 and 3 were weak (τ = –0.0247, P = 0.539; and τ = 0.151, P<0.001, respectively). Although this showed that neither of the second axes could be fully trusted, both of axes 1 and 2 were subjected to interpretation.

Table 3. Correlation values of DCA and GNMDS ordination axes 1–3.

	DCA 1	**DCA 2**	**DCA 3**
GNMDS 1	$\tau = 0.617$ $p < 0.001$	$\tau = 0.356$ $p < 0.001$	$\tau = -0.193$ $p < 0.001$
GNMDS 2	$\tau = 0.210$ $p < 0.001$	$\tau = -0.025$ $p = 0.539$	$\tau = 0.151$ $p < 0.001$

Ecological interpretation of ordination axes

Relationship between ordination axes and explanatory variables

Sample plot scores (trees) along DCA 1 and GNMDS 1 were most strongly correlated to the diameter of the trees (diameter breast and diameter base). Then to altitude (elevation), north-south orientation (northing) and east-west orientation (easting), see table 4 for relations. The diameter variables and northing were negatively correlated with axis 1, which gave smaller dimensions and further away from north towards the right of the ordination diagram (high scores). Elevation and easting were positively correlated with the axis and provided greater altitude and towards east at high scores (towards the right of the ordination diagram). The trees were distributed along the main ordination axis along a gradient from trees with large diameter to the north at low altitudes (low axis 1 scores) to trees with small diameter to the south at higher altitudes (high axis 1 scores). The factor variables callus, crevices, pollarding and fissured bark were significantly and negatively correlated with axis 1, which gave a pattern of less of these features on the trees to the right of the ordination diagram and more of them to the left end of the diagram. Opposite, the factor variables smooth bark and rough bark had positive relationships with axis 1, although not with a significant p-value. Macrolichen cover had a slight negative relationship to axis 1, which gave less macrolichen cover to the right of the diagram and more macrolichen cover to the left of the diagram. Slope had a slightly positive relationship with axis 1 as well, which gave steeper slope to the right end of the ordination diagram and a flatter slope to the left end of the diagram. Both pollarding and fissured bark structure was significantly negative correlated with the DCA 1 with a p-value <0.0001, which gave more pollarded trees and fissured bark to the north.

Table 4. DCA and GNMDS ordination axes 1 relationship with explanatory variables. Strongest relationships in bold. Kendall's τ correlation test for continuous variables (1-20) and Wilcoxon test for factor variables (21-27).

Variable	**DCA 1**		**GNMDS 1**	
	τ	***P***	***τ***	***P***
01 down_terra	-0.127	0.0063	-0.156	0.0008
02 hori_terra	0.087	0.0585	0.063	0.1688
03 aspect	-0.004	0.9313	0.028	0.5000
04 slope	**0.218**	**0**	0.160	0.0002
05 drainage	0.051	0.2634	0.112	0.0148
06 canopy_s	0.121	0.0050	0.081	0.0603
07 canopy_w	0.0160	0.711	0.026	0.5398
08 canopy_n	0.120	0.0054	0.100	0.0208
09 canopy_e	0.122	0.0046	0.110	0.0111
10 aver_canopy	0.118	0.0041	0.092	0.0245
11 diam_breast	**-0.345**	**0**	**-0.333**	**0**
12 diam_base	**-0.350**	**0**	**-0.360**	**0**
13 stem_incli	-0.056	0.1879	-0.054	0.2053
14 lowebranch	**0.186**	**<0,0001**	**0.221**	**0**
15 bryophyte	-0.028	0.5182	-0.076	0.0786
16 lichens	0.028	0.5392	0.0289	0.5392
17 macrolichen	-0.102	0.0202	-0.160	0.0003
18 easting	**0.201**	**0**	**0.159**	**<0.0001**
19 northing	**-0.314**	**0**	**-0.209**	**0**
20 elevation	**0.349**	**0**	**0.238**	**0**
21 stems	N	0.7625	N	0.6254
22 callus	**N**	**<0.0001**	**N**	**<0.0001**
23 crevices	**N**	**<0.0001**	**N**	**<0.0001**
24 pollarding	**N**	**<0.0001**	**N**	**<0.0001**
25 smBark	P	0.0447	P	0.0176
26 roBark	P	0.0005	P	0.0097
27 fiBark	**N**	**<0.0001**	**N**	**<0.0001**

There was only one semi strong correlation; macrolichen cover, between DCA 2 and GNMDS 2 and explanatory variables, see table 5. This indicated a possible second gradient from high degree of macrolichen cover at low ordinations scores and low degree of macrolichen cover at high ordination scores, along axis 2. A count of relations showed that DCA had the most relationships between the axis and the variables compared to GNMDS, hence DCA was chosen for the further analyses.

Table 5. DCA and GNMDS ordination axes 2 relationships with explanatory variables. Strongest relationships in bold. Kendall's τ correlation test for continuous variables (1-20) and Wilcoxon test for factor variables (21-27).

Variable	DCA 2		GNMDS 2	
	τ	***P***	***τ***	***P***
01 down_terra	-0.118	0.0114	-0.032	0.4905
02 hori_terra	0.034	0.4564	0.052	0.2592
03 aspect	0.034	0.3989	-0.143	0.0004
04 slope	0.079	0.0677	0.197	0
05 drainage	0.109	0.0169	-0.121	0.0084
06 canopy_s	-0.015	0.7344	0.062	0.1496
07 canopy_w	-0.040	0.3513	0.016	0.7052
08 canopy_n	0.020	0.6416	0.032	0.4566
09 canopy_e	0.019	0.6677	0.055	0.2012
10 aver_canopy	-0.018	0.6554	0.064	0.1175
11 diam_breast	-0.120	0.0033	-0.009	0.8166
12 diam_base	-0.107	0.0087	-0.044	0.2765
13 stem_incli	0.073	0.0872	0.014	0.7505
14 lowe_branch	0.101	0.0143	-0.064	0.1192
15 bryophyte	-0.005	0.909	0.045	0.3007
16 lichens	0.034	0.4536	0.0004	0.9936
17 macrolichen	**-0.173**	**0.0001**	**0.155**	**0.0004**
18 easting	0.021	0.6048	0.010	0
19 northing	-0.130	0.0012	-0.258	0
20 elevation	0.141	0.0005	0.230	0
21 stems	P	0.472	P	0.5948
22 callus	N	<0.0001	N	0.9412
23 crevices	N	0.0329	N	0.0023
24 pollarding	N	0.1998	N	0.0357
25 smBark	P	0.0068	N	0.2289
26 roBark	P	0.0814	P	0.9772
27 fiBark	N	0.0022	P	0.0826

DCA biplot

Environmental variables were fitted to the DCA ordination diagram in a biplot which confirmed the gradient found when relating the ordinations to the explanatory variables. The vector fitting procedure revealed that the following continuous variables were significantly related ($p < 0.05$) to tree positions in the two-dimensional ordination diagram: downhill terrain shape, slope, average canopy, canopy south, canopy north, canopy east, diameter at breast height, diameter at base, lowermost branch, macrolichen, easting, northing and elevation. All seven factor variables were significantly related to tree positions. The vectors (arrows of continuous explanatory variables) showed a pattern along the DCA axis 1, with the gradient from north with low altitude and large diameters of the trees to the left of the diagram and south with high altitude and small diameters of the trees to the right, (see biplot figure 7 below). There were few trees with smooth bark (filled pink circle), but very many with fissured bark (green filled) and opposite; very many trees without smooth bark (open pink circle close to origin) and very few without fissured bark (open green circle). The orange circles of rough bark might look contra intuitive, but was because the trees usually had either smooth or fissured bark; very few had rough bark at all.

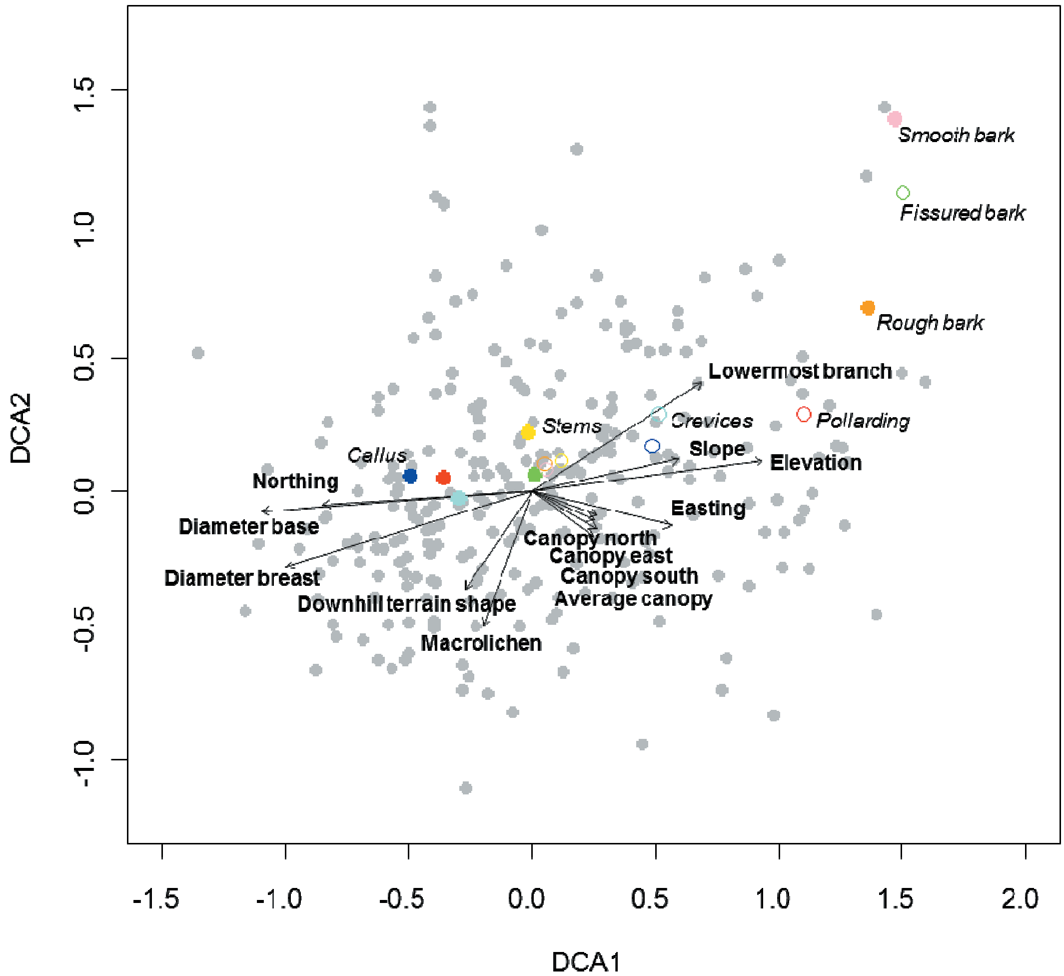


Figure 7. DCA biplot of significant explanatory variables; continuous variables as vectors and the seven factor variables as circles. Open circle = 0 (absent), filled circle = 1 (present). Circle colour: callus = blue, crevices = turquoise, pollarding = red, fissured bark = green, rough bark = orange, smooth bark = pink, stems = yellow. Coordinates for factor variables were multiplied by 2 to avoid clumping close to the origin or else they would have been difficult to distinguish.

DCA isoline diagrams

The isoline diagram for the explanatory variable downhill terrain shape, confirmed the main gradient along DCA axis 1 by showing that there is a gradient of values of downhill terrain shape from north that lied on the low part of the hillside towards the fjord to south that lied at high elevation on the hill side of Mt. Prestafjell. The diagram for slope (measured in degrees) shows the similar pattern: the hillside gets steeper from north to south, (see figure 8). For all isoline diagrams, see appendix 8.

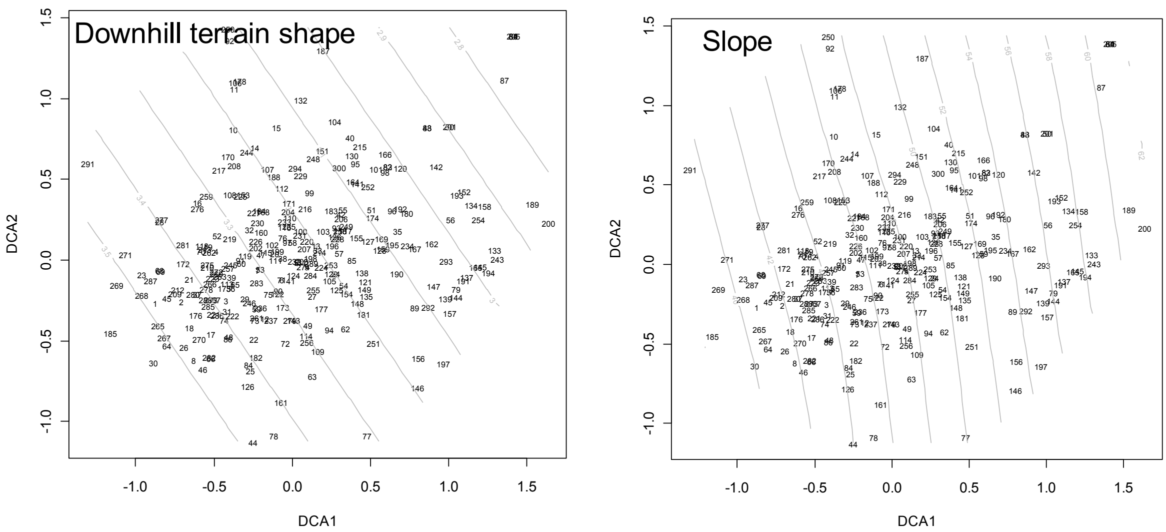


Figure 8. Isoline diagrams of the explanatory variable downhill terrain shape and slope.

All the canopy cover variables showed that canopy cover increased from the low areas in the north to the higher areas in the south of the area (see figure 9 for average canopy). The canopy cover seemed to be strongly correlated with DCA axis 1 and therefore could explain some of the variation along the axis, together with the main gradient. While canopy cover increased from south to north, the diameter of the trees increased in the opposite direction. The largest dimensions were found at the low areas to the north and the smaller dimensions at higher areas to the south (see figure 9 for diameter at base). Canopy cover and tree dimensions combined showed that there was a combination of trees with smaller dimensions and more canopy cover to the south and trees with larger dimensions and less canopy cover to the north.

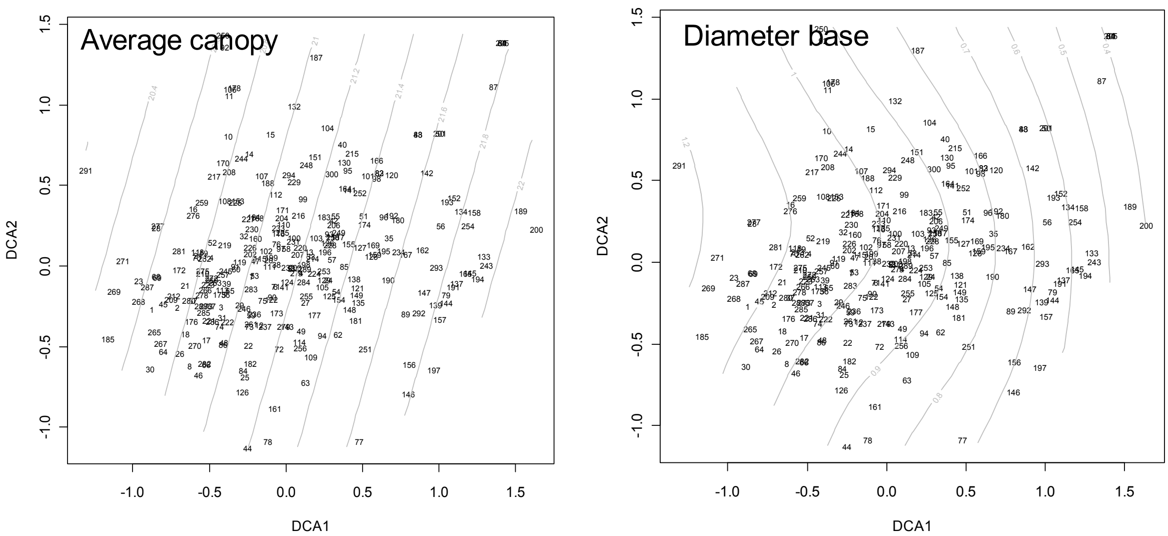


Figure 9. Isoline diagrams of average canopy cover and diameter at base.

The explanatory variable height to the lowermost branch increased from north to south, which corresponded with the tree dimensions. These two variables were correlated (cf. appendix 4), diameter breast and height to the lowermost branch had the strongest negative correlation with tau value of -0.2616, diameter base and height to the lowermost branch had a tau value of -0.1454.

Macrolichen cover, decreased along DCA axis 2. This corresponded with the possible second gradient from high degree of macrolichen cover at low ordinations scores and low degree of macrolichen cover at high ordination scores, along axis 2. Bryophyte cover was not significant due to the biplot calculation, but the isoline diagram showed an opposite pattern of macrolichen cover, see figure 10 under. Macrolichen cover had highest correlation with diameter at breast height (τ = 0.1607) and base (τ = 0.1766), but second most with bryophyte cover (negative correlation). Although this was a low correlation of τ value = -0.1139.

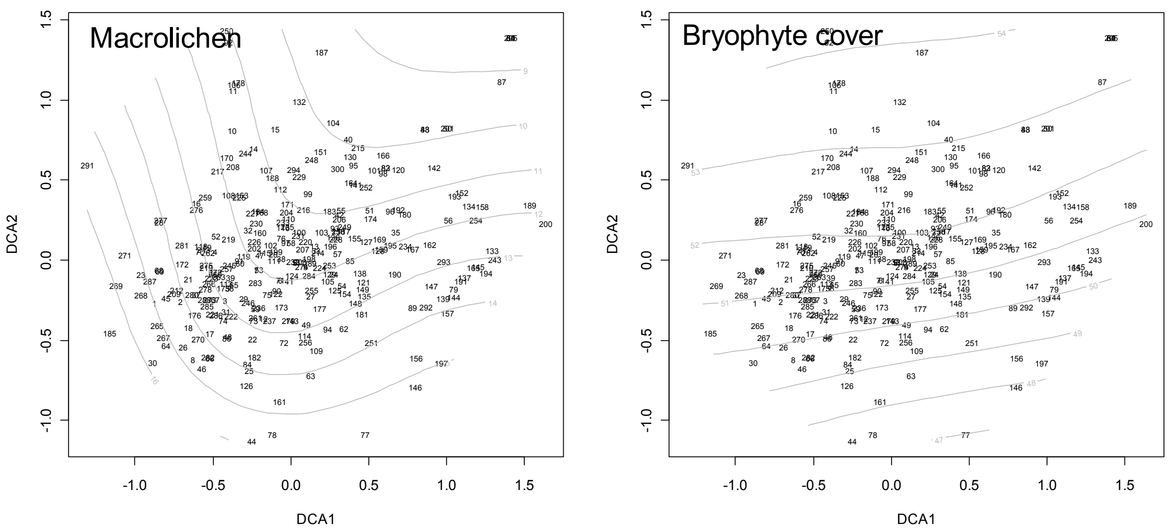


Figure 10. Isoline diagrams of macrolichen cover and bryophyte cover (latter not significant).

Isoline diagrams for easting, northing and elevation confirmed the main gradient found on DCA axis 1, see appendix 8 for isoline diagrams of all significant explanatory variables.

DCA species plots
DCA axis 1
Six species of the genus *Leptogium* and seven other species were more or less strongly affiliated with the left part of DCA axis one (low tree scores), see appendix 6 of all DCA species plots (in alphabetical order). The left was the end of the gradient to the north of the study area, with low elevation above sea level and great dimensions of the trees. The species were listed below, in ranked order from strongest relationship with the left side of DCA axis 1 to weakest (not measured, but observed by looking at the plots)**;** *Leptogium hibernicum, Leptogium cochleatum, Fuscopannaria sampaiana, Leptogium saturninum, Leptogium burgessii, Leptogium cyanescens, Nephroma resupinatum, Peltigera membranacea, Collema subflaccidum, Collema flaccidum, Peltigera horizontalis, Lobaria virens, Leptogium lichenoides* and *Sticta sylvatica.*

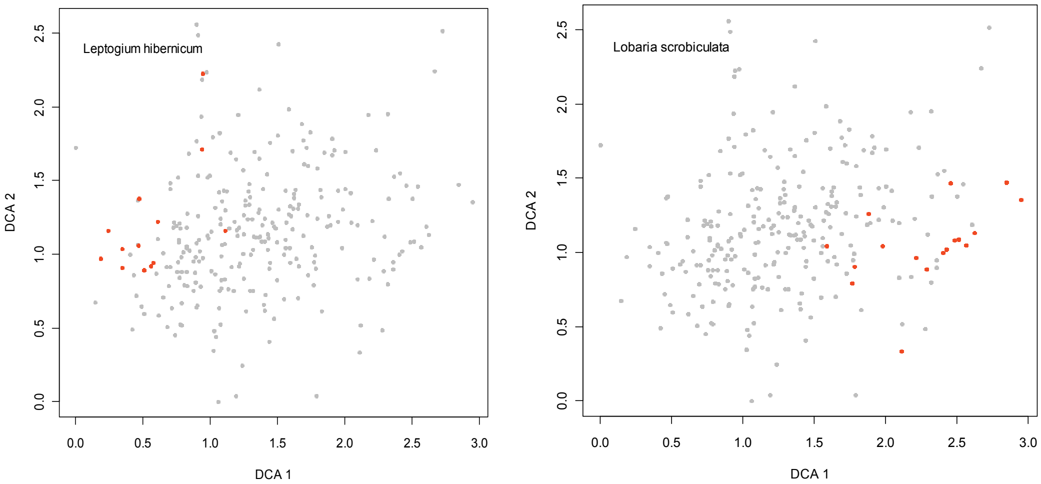


Figure 11. Example of species (*Leptogium hibernicum*) showing affiliation to the left side of DCA plot and species (*Lobaria scrobiculata*) showing affiliation to the right side of DCA plot. Red dot = species present on tree, grey dot = species absent on tree.

Nine species were more or less strongly affiliated with the right part of DCA axis 1 (high tree scores). The right was the other end of the gradient; to the south of the study area, with higher elevation above sea level and trees of small diameters. The species were listed below, from strongest relationship with the right side to weakest; *Lobaria scrobiculata, Pannaria rubiginosa, Collema fasciculare, Peltigera collina, Normandina pulchella, Nephroma parile, Degelia plumbea, Pannaria conoplea* and *Lobaria pulmonaria.*

Five target species were found on trees in the middle of the ordination plot along axis 1. These species were affiliated with the middle of the study area, not along the ends of the gradient. The species were listed below from narrowest range till broadest range along axis; *Peltigera malacea, Nephroma laevigatum, Fuscopannaria ignobilis, Nephroma bellum, Lobaria amplissima.* The rest of the species were more or less evenly spread out without any pattern in the DCA ordination diagram: *Parmeliella triptophylla, Peltigera praetextata,* and *Sticta fuliginosa. Collema fasciculare* and *Collema flaccidum* seemed to be mutually exclusive in the study area.

DCA axis 2

Few species showed clear affiliations along DCA axis 2. E.g. *Peltigera malacea* with low macrolichen cover, *Leptogium cochleatum* with high macrolichen cover and *Pannaria rubiginosa* liking the middle area (see figure 12 below).

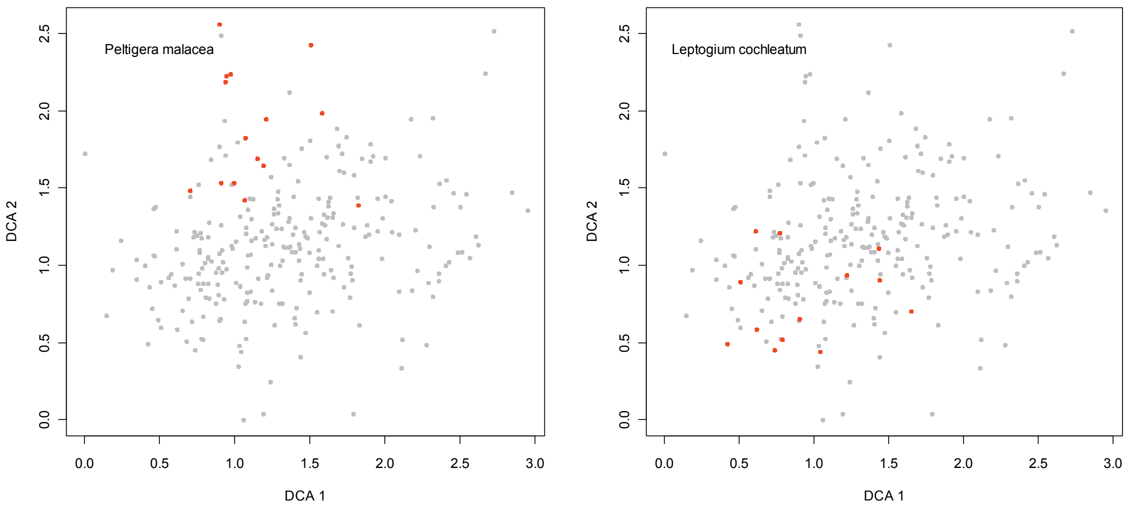


Figure 12. Example of species (*Peltigera malacea* and *Leptogium cochleatum*) showing affiliation to axis 2 of the DCA plot.

Species richness

Correlation test

The Kendall's rank correlation test on number of species per tree against the ordination axes gave the following results: DCA axis 1 against number of species per tree had a $\tau = -0.114$ and p-value = 0.0068, DCA axis 2 and number of species per tree had a p-value <0.0001 and $\tau = -0.216$. GNMDS axis 1 and number of species per tree had a p-value = <0.0001 and $\tau = -0.195$ and GNMDS 2 and number of species per tree had a p-value = 0.0003 and $\tau = 0.152$. The correlation test showed that number of species per tree was negatively, although not strongly, correlated with the tree's positions along the first DCA ordination axis, which run from trees with high stem diameter at low elevations in the north-western part of the study area to *vice versa*.

GLM analysis

GLM analysis results, see table 6 under, showed that fissured bark structure, diameter of the stem at base and breast height were significantly ($p < 0.0001$) positive correlated to species richness of target species, explaining 18.2%, 16.4% and 15.5% of the variation, respectively. With a lower significance level ($p = 0.0004$) and a positive correlation the factor variable pollarding explained 3.5% of the variation in species richness. The continuous variables drainage ($p = 0.0007$) and epiphloeic lichen cover ($p = 0.0009$) were negatively correlated with the richness of target species and explained 3.2% and 3.1% of the variation. The factor variables smooth bark and rough bark were significant ($p = 0.0001$), with estimated factor level B higher than A, hence estimated species richness were lower when the variables were present (opposite of fissured bark). Presence of smooth bark explained 15.2% of the species richness, while presence of rough bark explained 4,9%. Macrolichen cover were positively correlated with the species richness of the target macrolichen species ($p < 0.0001$ and 23.7% of the variation explained). The target lichens at Tungesvikstranda tended to aggregate more on some trees than other. GLM analysis supported the correlation to the main gradient with higher number of species to the north-western end, showing that great dimensions and fissured bark of the stem are the variables explaining most of the variation in species richness.

Table 6. GLM analysis results of species richness versus explanatory variable. Strongest correlations in bold. For variable explanation, see table 1. For continuous variables, A = an estimate for the lowest value for the predictor and B = an estimate for the highest value (ex. Diameter: A=lowest diameter B=greatest diameter). For factor variables, A = an estimate for present, B = an estimate for absent (ex. Pollarding: A=pollarded, B=not pollarded). A lower B value for factor variables means that estimated species richness is lower for factor level 1 than 0 (negatively correlated).

Variable	**Variable type**	**Variance explained**	**p-value**	**Estimated predictor values**		**Negative or positive correlation**
				A	B	
bryophyte	C	0.0000	0.9272	7.64	7.55	N
lichens	C	0.0309	0.0009	11.53	6.06	N
macrolichen	**C**	**0.2373**	**<0.0001**	**4.79**	**13.38**	**P**
easting	C	0.0002	0.7870	7.71	7.55	N
northing	C	0.0060	0.1600	8.20	8.20	N
elevation	C	0.0028	0.3195	7.43	7.44	P
down_terra	C	0.0140	0.0259	6.89	8.39	P
hori_terra	C	0.0002	0.7800	7.50	7.73	P
aspect	C	0.0060	0.1477	8.24	6.77	N
Slope	C	0.0102	0.0568	8.44	6.61	N
drainage	C	0.0325	0.0007	8.46	6.66	N
canopy_s	C	0.0003	0.7390	7.47	7.70	P
canopy_w	C	0.0034	0.2739	7.17	7.94	P
canopy_n	C	0.0004	0.7173	7.75	7.50	N
canopy_e	C	0.0023	0.3621	7.24	7.89	P
aver_canopy	C	0.0025	0.3469	7.18	8.01	P
diam_ breast	**C**	**0.1550**	**<0.0001**	**4.67**	**11.99**	**P**
diam_base	**C**	**0.1646**	**<0.0001**	**5.03**	**11.74**	**P**
stem_incli	C	0.0141	0.0253	8.24	6.71	N
lowe_branch	C	0.0223	0.0049	9.52	6.37	N
pollarding	F	0.0350	0.0004	6.75	7.99	P
crevices	F	0.0006	0.6485	7.53	7.68	P
callus	F	0.0078	0.0972	7.38	7.94	P
stems	F	0.0216	0.0056	7.43	8.88	P
smBark	**F**	**0.1524**	**<0.0001**	**7.79**	**2.00**	**N**
roBark	**F**	**0.0492**	**<0.0001**	**7.73**	**4.49**	**N**
fiBark	**F**	**0.1825**	**<0.0001**	**3.00**	**7.90**	**P**

Species richness plot

The species richness plot with trees as circles of different colour for frequency of species showed no significant pattern correlated to the main gradient, see figure 13 below.

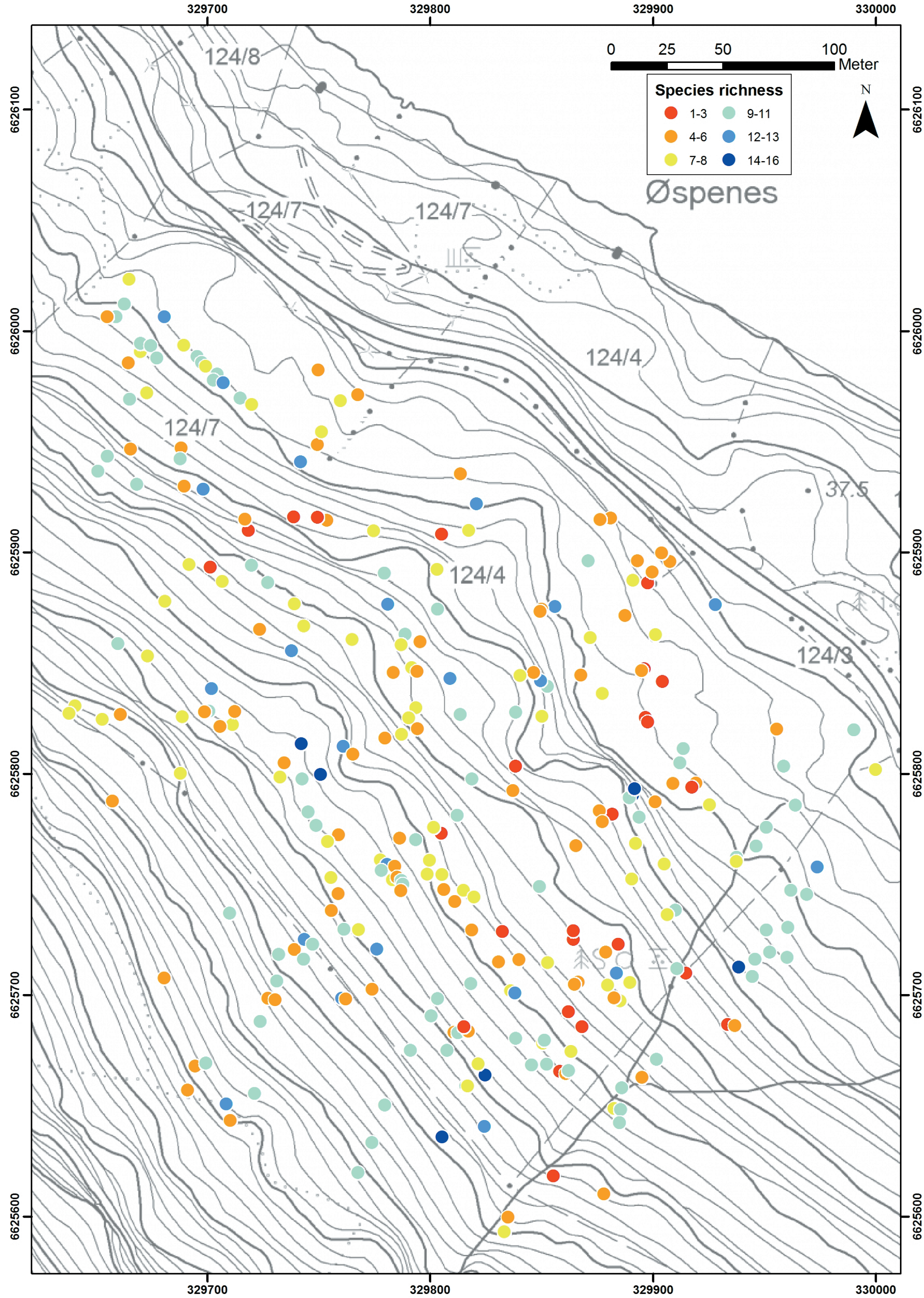


Figure 13. Species richness map with trees as cirkels of different color after what number of species on the tree.

Species richness barplot

Highest number of target species was on tree number 174 with 16 species and tree number 198 with 15 species. Mean number of species per tree were 7.6. The barplot of target lichens frequency per tree in figure 14 and table 6 under. (Frequency of each lichen specie was listed in appendix 1.)

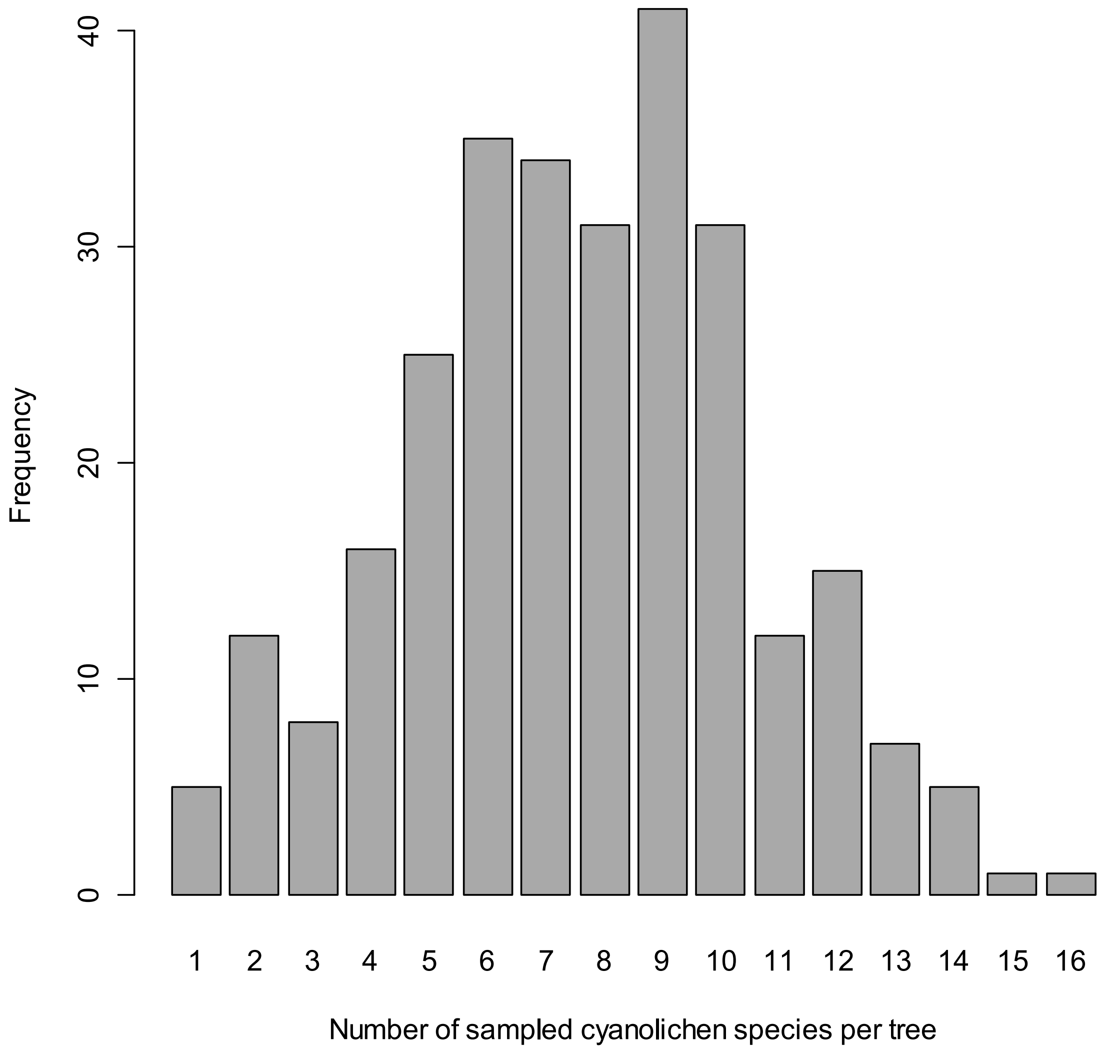


Figure 14. Species richness barplot with the frequency of different number of sampled target lichens species per tree.

Table 7. Species number and frequencies. # = number of species, F = frequency

#	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
F	*5*	*12*	*8*	*16*	*25*	*35*	*34*	*31*	*41*	*31*	*12*	*15*	*7*	*5*	*1*	*1*

Species number and DBH vs. pollarding

GLM t-test of diameter and number of species versus pollarding showed that pollarded trees have higher number of species and greater dimensions than unpollarded trees, see table 8 under.

Table 8. GLM t-test results; species number and DBH vs. pollarding, estimated mean values.

	Unpollarded	**Pollarded**
Diameter base	0.6648	0.9938
Diameter breast	0.5098	0.8382
Number of species	1.9095	2.0787

Geostatistics - Spatial structure

Standardised semi-variograms

The standardised semi-variograms for DCA axes 1 (figure 15 a) demonstrated that there was a spatial structure in species composition along DCA axes 1 (for all variograms of continuous explanatory variables, see appendix 7). DCA axes 1 showed a drop in semivariance as a function of distance (lag class) between 0 and 6 meters, and an increase from 6-512 meters. DCA 2 (figure 15, b) showed very little semivariance, which accord well with the result that DCA 2 was most strongly correlated with macrolichen cover. This indicated that the macrolichen variable does not vary among trees in a spatially explicit manner. Figure 15, c with the semivariogram for aspect was representative for all the topographical explanatory variables (downhill terrain shape, horizontal terrain shape, aspect, slope and drainage) which showed the same pattern. This pattern was similar to the DCA 1 and therefore is the ones to explain DCA axis 1.

Most of the explanatory variables had strong spatial structure on fine scale and a pretty obvious range. Both lichen cover variables (epiphloeic lichen cover and macrolichen cover) had lower standardised semivariance on low distances (see figure 15 e and f), which indicated that lichen coverage was more similar on neighbour trees than trees further away. The variogram for bryophyte cover showed no semivariance pattern (see figure 15 d). This could only be explained with the fact that all the trees had high coverage of bryophytes and therefore the variance within the area was too small to show semivariance.

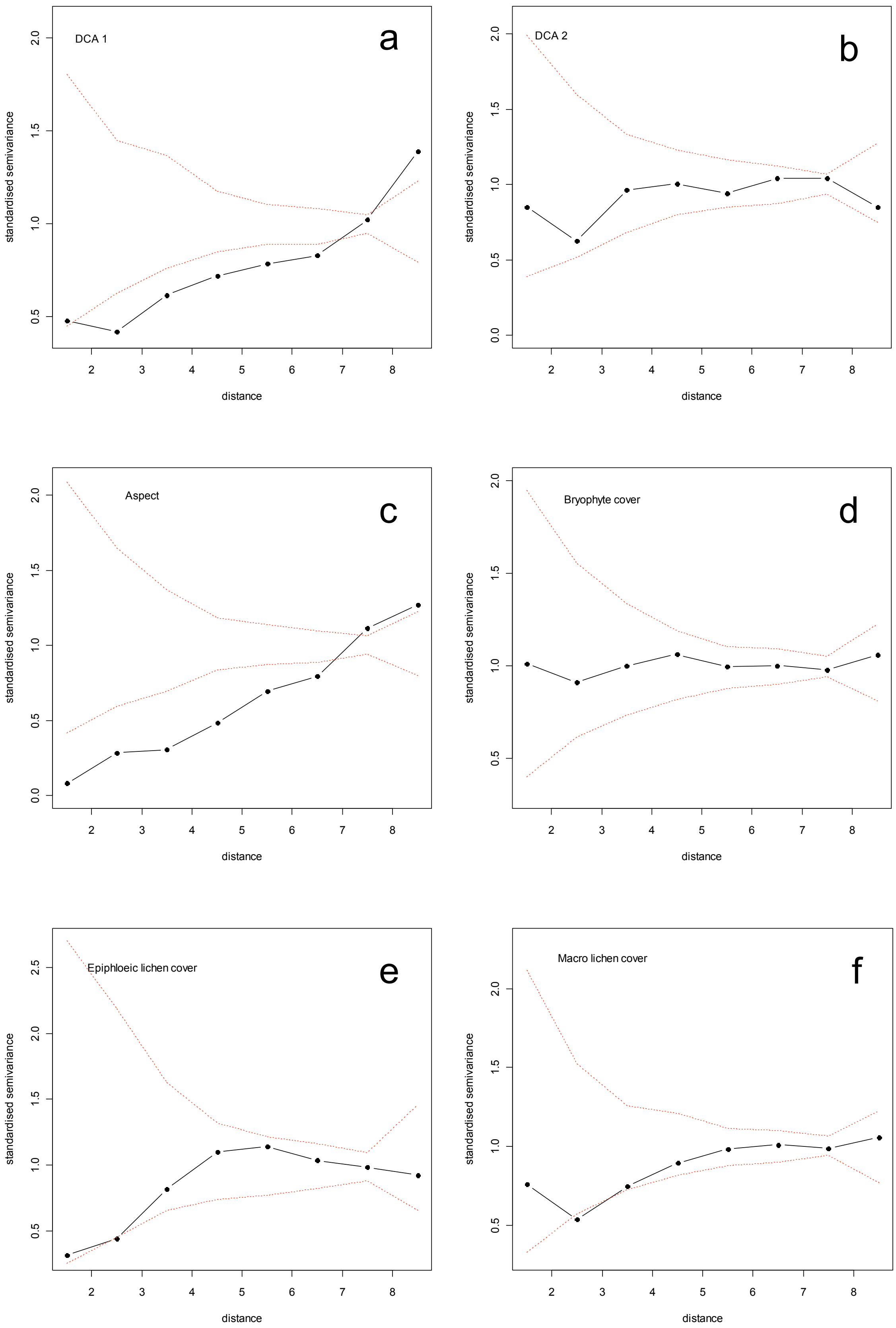


Figure 15 a-f. Variograms with standardised semivariance plotted against distance (2 to 8 represented geometric mean of lag classes to power of 2: '2' = 2^2 = 4, '3' = 2^3 = 8 etc. to 2^8 = 256 m). Punctuated lines represented envelopes of 95% confidence intervals.

The canopy variables and stem inclination showed no semivariance pattern (i.e. standardised semivariance close to 1 for all lag classes) and therefore varied independently from tree to tree. Canopy average had a hint of semivariance at small distances, but on small distances there was also very few pairs (39) so it was hard to trust the first lag class. Height to lowermost branch also had some, but not enough to show a significance level.

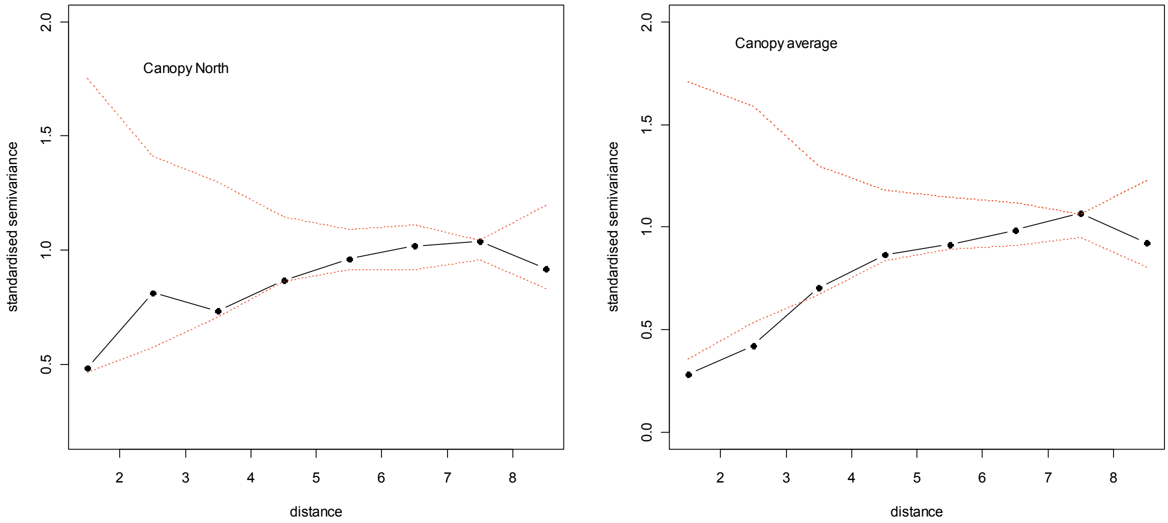


Figure 16. Semivariograms for canopy north and canopy average.

The explanatory variables easting, northing and elevation stand out with similar graphs that demonstrated a clear spatial structure with increasing distance (see figure 17 under). They seemed to have the first 32 meters with no variability, i.e. they are homogeneous in the first 32 meters of separation, and then after 32 meters there was some variance which increased and did not seem to stabilize. This demonstrated that the area studied was not large enough for data to become spatially independent.

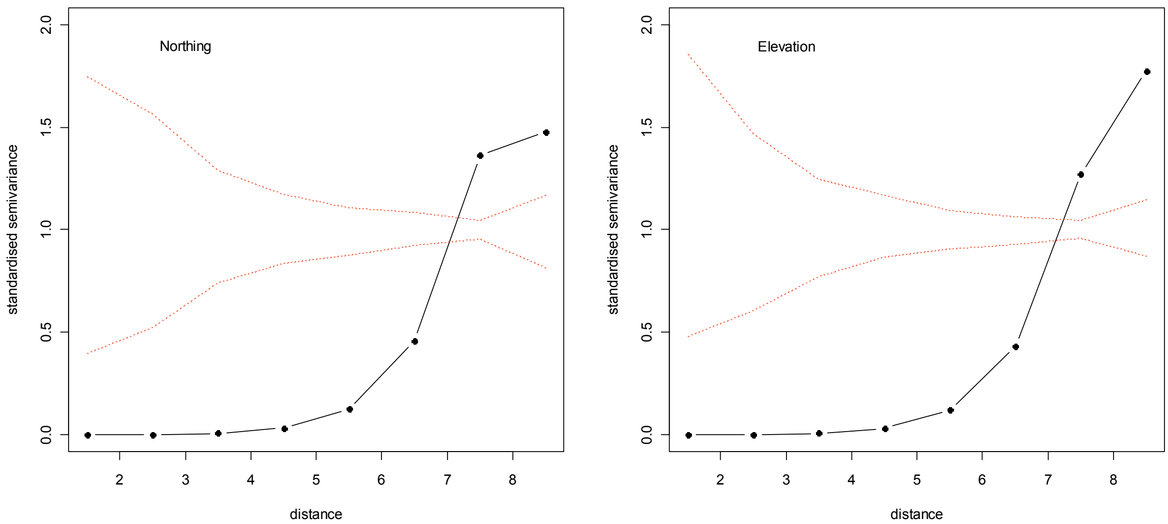


Figure 17. Semivariograms for northing and elevation.

Spatial point pattern analysis

Point pattern tree plots

Point pattern plot with the target trees as mapped point locations in the Tungesvikstranda study area (see figure 18 under). The plot showed number and positions of the trees in north-south orientation (northing) and east-west orientation (easting), with a punctuated line as envelope of the arbitrary irregular shaped area.

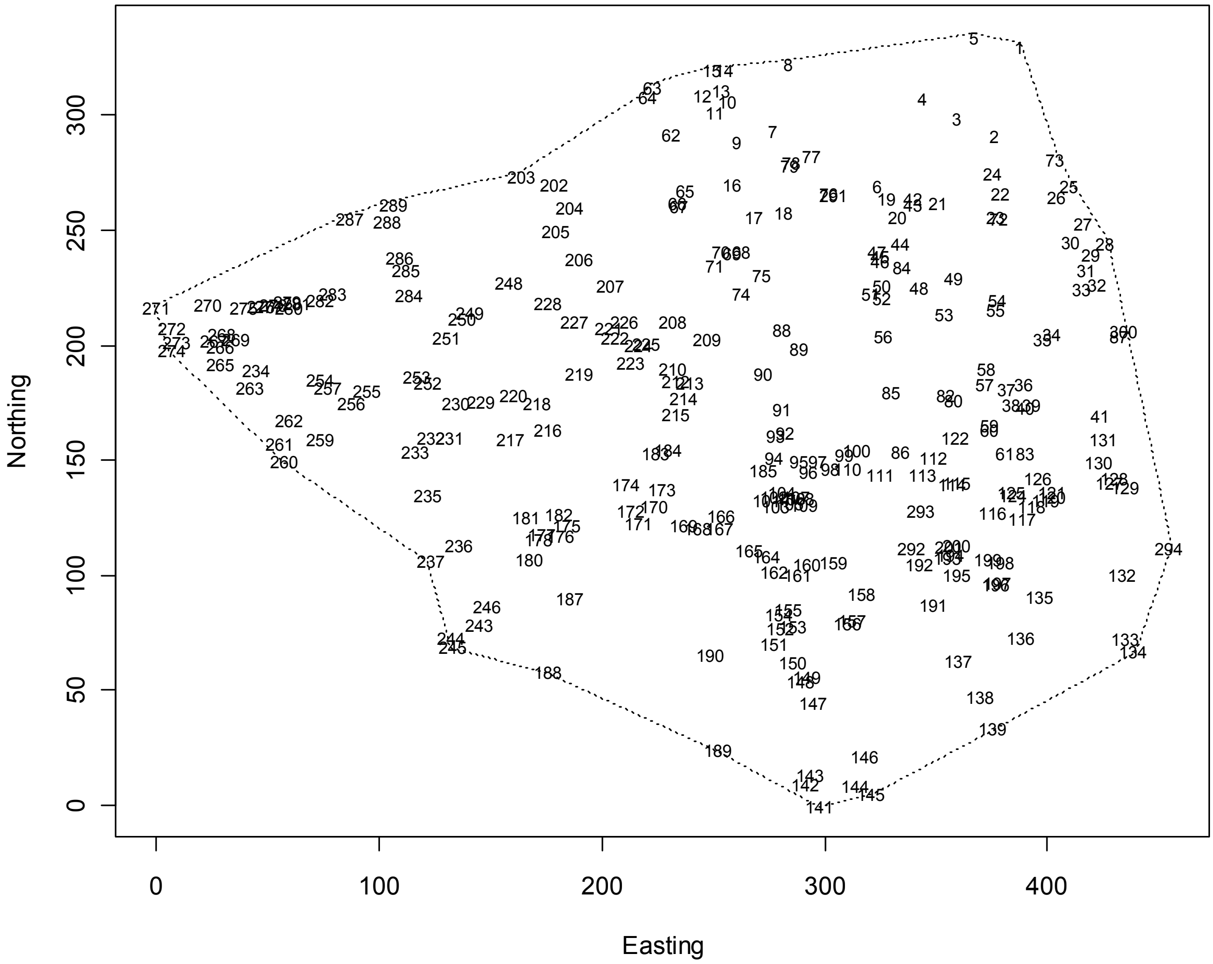


Figure 18. Plot of tree number and tree positions, punctuated line as envelope of the study area.

The plot of pollarded trees showed that unpollarded trees occur sporadically in most parts of the study area, but continuously at higher elevations to the south (see figure 19 below). The study area had many big, old *Fraxinus excelsior* (and a few *Ulmus glabra*) trees: 191 of 279 were pollards. This gives almost 1/3 unpollarded (31.54%) of the total investigated trees, a number higher than expected on beforehand.

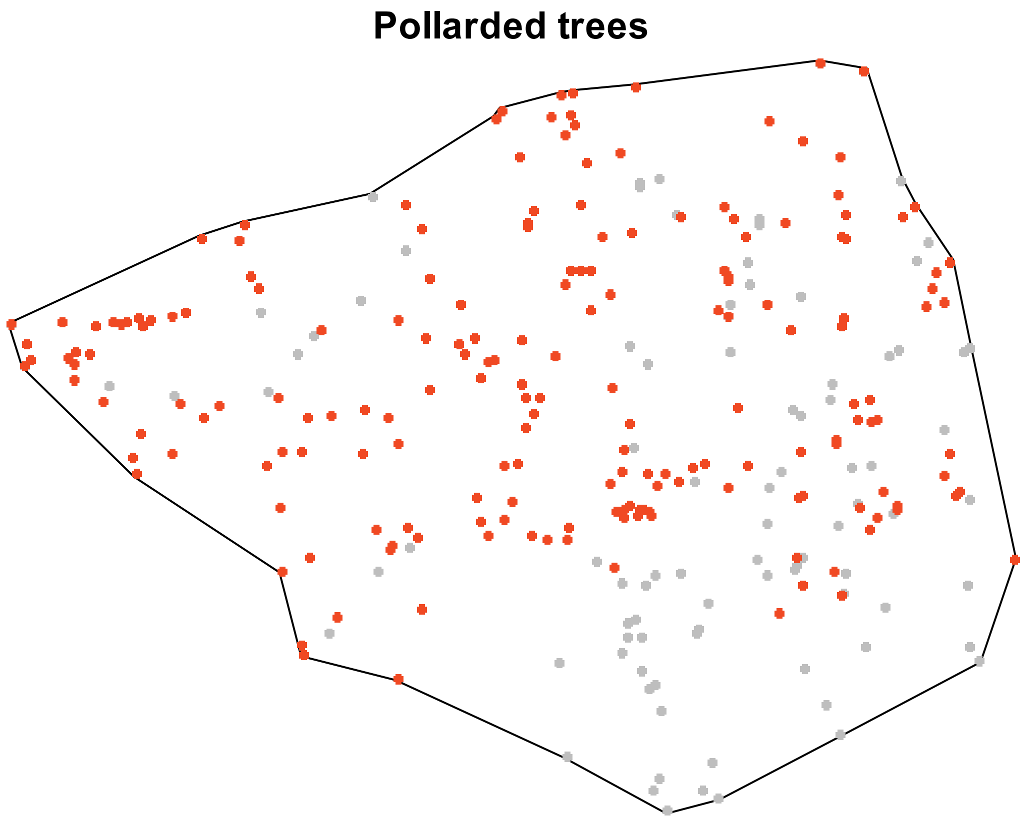


Figure 19. Plot of pollarded trees (red) and unpollarded trees (grey).

Point pattern lichen species plot

Nine species was more or less absent in the lower part of the study area; *Lobaria scrobiculata* (except for one outlier), *Nephroma parile, L. amplissima, Degelia plumbea*, *Pannaria rubiginosa*, *P. conoplea, Collema fasciculare, Peltigera collina* and *L.pulmonaria* (in ranked order from most to least 'obvious'). Examples in figure 20 under, for all lichen species plots see appendix 9. The eight first of these species are also found in the list of DCA species plots with affiliation to the south-eastern part of the main gradient (at high elevation with small trees), which confirms the results from DCA species plots.

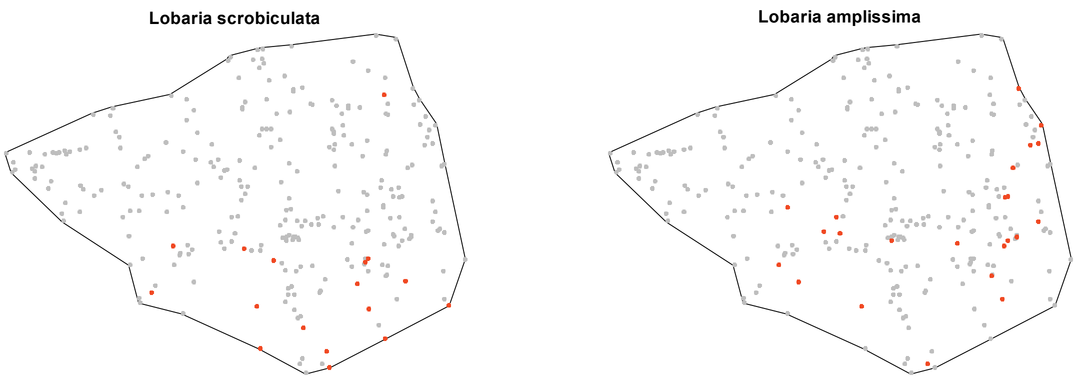


Figure 20. Point pattern species plots of *Lobaria scrobiculata* and *L. amplissima* with categorical marks; lichen species present on tree = red dot, absent on tree = grey dot.

Twelve of the lichen species were more or less absent from higher elevations in the study area*: Leptogium cochleatum, Fuscopannaria sampaiana, Leptogium hibernicum, Leptogium cyanescens, Nephroma resupinatum, Peltigera horizontalis, Leptogium burgessii, Lobaria virens, Leptogium saturninum, Collema flaccidu, Sticta sylvatica* and *Peltigera membranacea* (examples shown in figure 21 below.) This list of twelve species covers nine of the ten species showing affiliation to the left end (low scores) along DCA axis 1, which corresponds with the north end of the gradient with low elevation and great dimensions. The exception was *Leptogium lichenoides* (in the group of ten species) which showed a pattern different from the other twelve species. *Leptogium burgessii* and *L. hibernicum* were to some degree affiliated with both groups (absent both at high and at low elevations). *L. hibernicum* had a gap between two aggregations of occurrences in the middle part of the study area. *L. cyanescens* and *Peltigera membranacea* were not totally absent from high elevations, but was more frequent on trees at lower elevations.

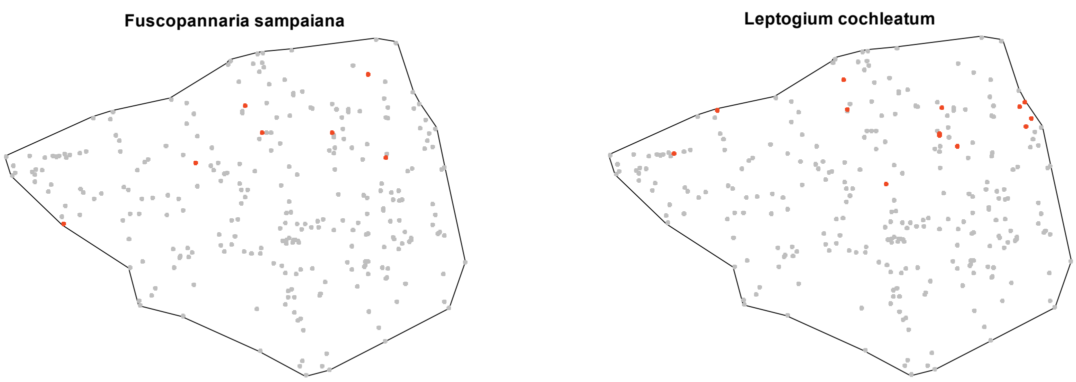


Figure 21. Point pattern species plot of *Fuscopannaria sampaiana* and *Leptogium cochleatum* with cathegorical marks; lichen species present on tree = red dot, absent on tree = grey dot.

Peltigera malacea and *Nephroma bellum* were only found in the middle part of the study area. The rest of the lichen species showed no specific distributional pattern and seemed to be spread throughout the study area; *Collema subflaccidum, Fuscopannaria ignobilis, Leptogium lichenoides, Nephroma laevigtum, Normandina pulchella, Parmeliella triptophylla, Peltigera praetextata* and *Sticta fuliginosa* (see figure 22 under for examples). These findings correspond with their positions in the DCA species plots.

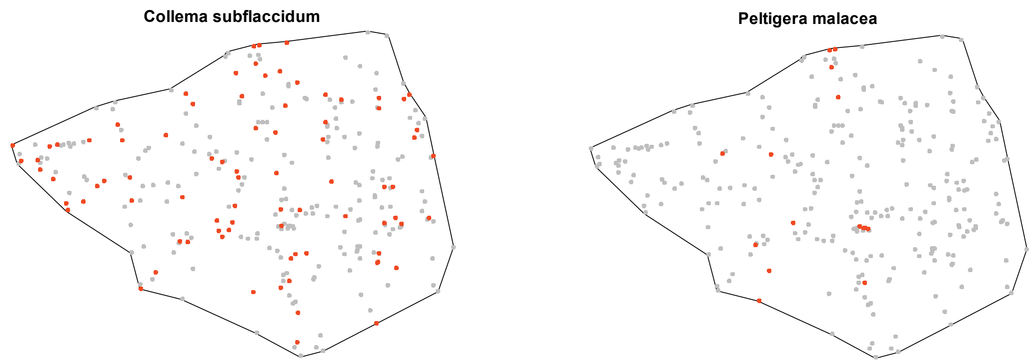


Figure 22. Point pattern species plot with cathegorical marks; lichen species present on tree = red dot, absent on tree = grey dot. *Collema subflaccidum* as example of no pattern, *Peltigera malacea* as example of affiliation for the middle area.

Point pattern lichen density plots

Twelve species showed clumped distributions at higher elevations: *Pannaria rubiginosa, Lobaria scrobiculata*, *Fuscopannaria ignobilis, Degelia plumbea, L.amplissima, L.pulmonaria Nephroma parile, Collema fasciculare, Peltigera collina, Pannaria conoplea, Nephroma bellum* and *Normandina pulchella. Normandina pulchella* was widespread, but with aggregation to the south. These results supported the findings both for the point pattern species plots and DCA species plots. *Pannaria rubiginosa* and *L. scrobiculata* showed the strongest aggregation to higher areas (see figure 23 under and appendix 9 for density plots for all lichens). *L. pulmonaria* had a broader range than *L. scrobiculata*, and *L. amplissima* which showed a concentration to the southern parts of the study area.

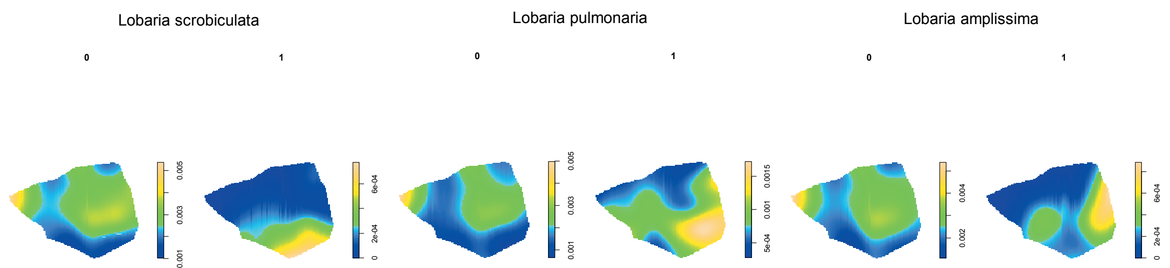


Figure 23. Density plots of *Lobaira scrobiculata, L. pulmonaria and L. amplissima*, 0 = were species is absent, 1 = were species is present/aggregated.

Seventeen species tended to aggregate on trees in the low, open area with trees of great dimensions in the north-western part of the study area; *Peltigera horizontalis, Leptogium lichenoides, Leptogium cyanescens, Collema flaccidum, Collema subflaccidum, Parmeliella tripthophylla, Peltigera membranacea, Sticta fuliginosa, Lobaria virens, Sticta sylvatica, Leptogium hibernicum, Leptogium saturninum, Leptogium burgessii, Nephroma laevigatum, Nephroma resupinatum, Leptogium cochleatum* and *Fuscopannaria sampaiana. Nephroma resupinatum* showed aggregation both towards the northern and the southern end of the study area. The first twelve of these all aggregate at the north of the study area. *Peltigera malacea* was found in the middle of the study area, with an aggregation at the lowlying northern side along the road. *Leptogium cochleatum* only showed aggregation towards the south end. *Fuscopannaria sampaiana* showed clumping on trees mainly in the low-lying eastern part of the area, but also some clumping towards the northern 'corner' of the study area. *Peltigera praetextata* was mainly clumped on trees in the lowlying eastern end and towards the south also at higher elevations, in addition to a smaller area along the road to the east (where also *P. malacea* showed clumping).

Random labelling test, lichens

All except ten lichen species with < 10 findings were tested (see appendix 11 for all random labelling plots). Twelve species showed significant deviations from expected at random, see table 10. The test results revealed clumping of *Fuscopannaria ignobilis* on trees at a spatial scale between 10 and 27 meters. *Leptogium cyanescens* showed clumping on finer scales; 2-6 meters. *Lobaria pulmonaria* showed a weak clumping in the range between 25 and 42 meters, while *L. scrobiculata* showed a stronger clumping, in almost the same range as *L. pulmonaria*, was observed. *Nephroma laevigatum* and *Nephroma parile* showed clumping at 10-20 meters and 6-11 meters, respectively. *Pannaria rubiginosa* had a slight aggregation at 68-73 meters. Five species showed an opposite pattern of aggregation (clumping) – a tendency to be more regular spread out than expected at random (see table 9 under and figure 24). The rest of the lichen species showed no visual pattern on the random labelling test.

Table 9. Test results of random labelling of lichen species. Species with no deviation of observations from the expectations (envelopes) are not listed in table. Clumped = more clumped than expected at random and Regular = more regular than expected at random.

Lichen species	**Frequency**	**Deviation (in meter)**
Clumped		
Fuscopannaria ignobilis	29	Clumped 10-27
Leptogium cyanescens	75	Clumped 2-6
Lobaria pulmonaria	85	Clumped 25-42
Lobaria scrobiculata	17	Clumped 23-47
Nephroma laevigatum	33	Clumped 10-20
Nephroma parile	30	Clumped 6-11
Pannaria rubiginosa	21	Clumped 67-71
Regular		
Collema fasciculare	11	Regular 1-3
Leptogium hibernicum	13	Regular 5-8
Leptogium saturninum	49	Regular 20-24 & 42-47
Lobaria virens	172	Regular 10-17
Sticta sylvatica	140	Regular 41-47 & 74-80
Peltigera malacea	15	Regular 6-21

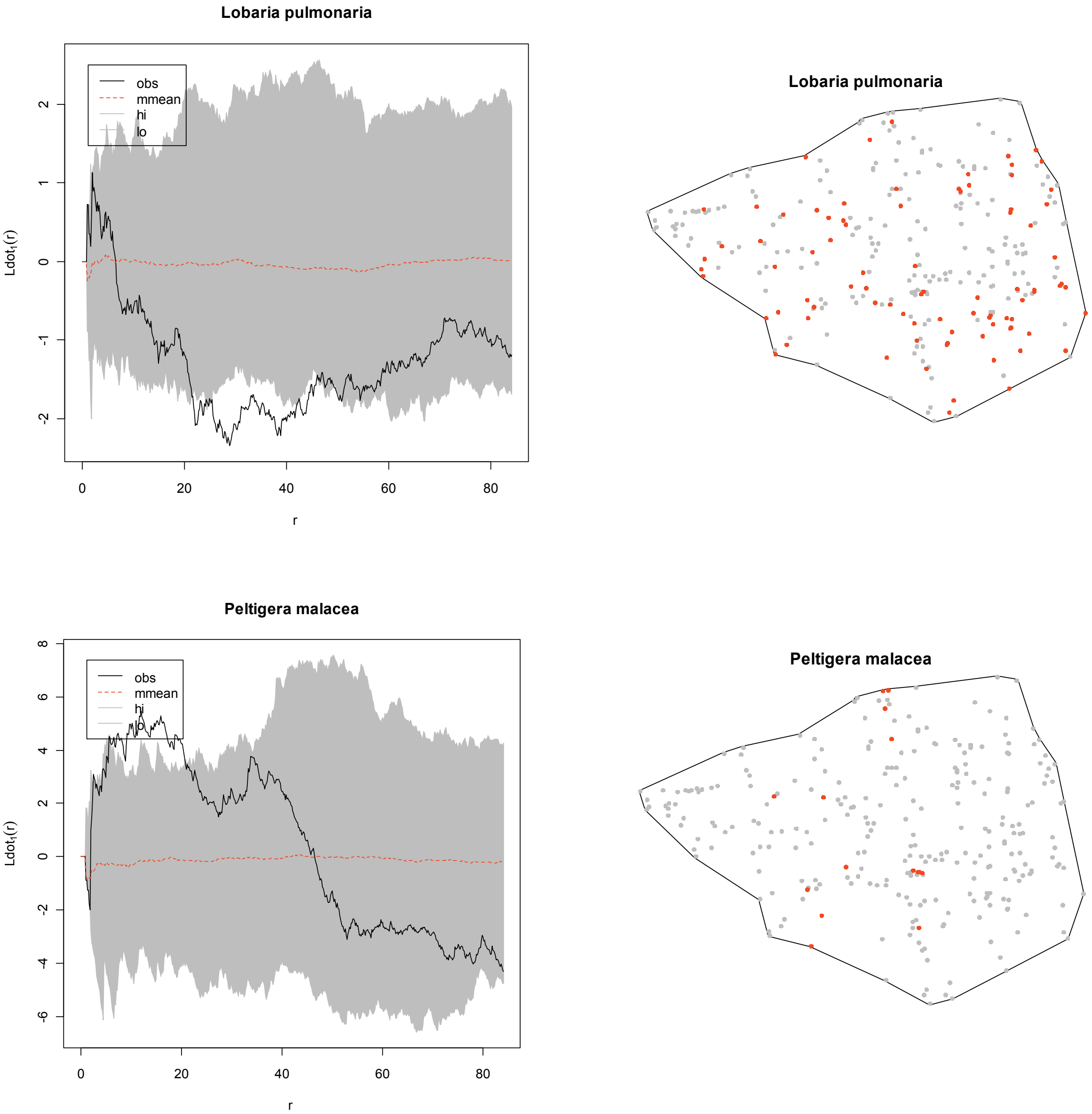


Figure 24. Random labelling test and point pattern species plots of *Lobaria pulmonaria* showed significant clumping and of *Peltigera malacea* showed a pattern more regular than expected.

L-function, trees

The L-function plot showed that the observed black curve (target trees) was situated more or less on top of the red dotted line (complete spatial randomness) up to around 55 meters and from there lies a little above the red line (see figure 26 under). This indicated that the distribution of target trees was more or less completely independent of each other, on scales up to 55 meters. Figure 26 also indicated that trees are somewhat more regularly distributed (more spaced out than random) at distances greater than 55 meters. This was confirmed in the semivariance analysis which demonstrated that there were very few tree pairs (39) on small distances (which made it hard to trust the first lag class). The overall intensity (numbers of trees per m^2) was 0.00286.

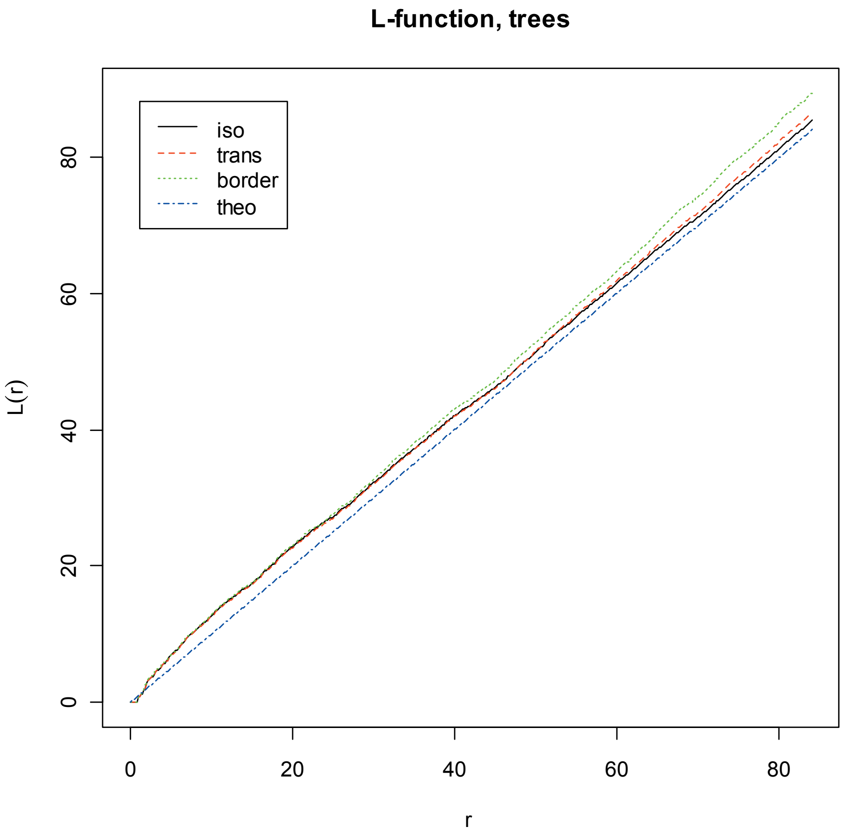


Figure 25. L-function, target trees.

Species plot comparison

An organization of target species in table 9 under, with results from the DCA ordination plots, point pattern species plots and point pattern density plots; showed a relatively clear gradient in species composition on tree trunks from low elevation near the fjord to higher elevations. The lichen species was divided into two groups with opposite patterns in respect to this gradient. Group I consists of fourteen species, strongly affiliated with the northern, low-elevation part of the study area (and low scores with respect to DCA axis 1); (1) *Leptogium hibernicum,* (2) *Leptogium cochleatum,* (3) *Fuscopannaria sampaiana,* (4) *Leptogium saturninum,* (5) *Leptogium burgessii,* (6) *Leptogium cyanescens,* (7) *Nephroma resupinatum,* (8) *Peltigera membranacea,* (9) *Collema subflaccidum,* (10) *Collema flaccidum,* (11) *Peltigera horizontalis,* (12) *Lobaria virens,* (13) *Leptogium lichenoides* and (14) *Sticta sylvatica.* Four additional species, *Parmeliella triptophylla*, *Sticta fuliginosa*, *Nephroma laevigatum* and *Peltigera malacea*, which are evenly spread out in the middle part of the study area but aggregates to the north, affiliate weakly with this group.

Group II consists of nine species strongly affiliated with the south-eastern, high-elevation part of the study area (and high scores with respect to DCA axis 1); (1) *Lobaria scrobiculata,* (2) *Pannaria rubiginosa,* (3) *Collema fasciculare,* (4) *Peltigera collina,* (5) *Normandina pulchella,* (6) *Nephroma parile,* (7) *Degelia plumbea,* (8) *Lobaria pulmonaria* and (9) *Pannaria conoplea.* Three additional species, *Lobaria amplissima, Fuscopannaria ignobilis* and *Nephroma bellum*, which are affiliated to the middle (transversed) of the study area, but aggregate to the south, affiliated weakly with this group. *Peltigera praetextata* was the only example of a species truly spread out evenly, showing no significant pattern.

Table 10. Organization of target species into groups based on the three different plot analyses.

#	Species	DCA ordination species plots	Point pattern species plots	Point pattern density plots
Group I, Species to the north; low elevation and great dimensions				
1	*Leptogium hibernicum*	x	x	x
2	*Leptogium cochleatum*	x	x	x
3	*Fuscopannaria sampaiana*	x	x	x
4	*Leptogium saturninum*	x	x	x
5	*Leptogium burgessii*	x	x	x
6	*Leptogium cyanescens*	x	x	x
7	*Nephroma resupinatum*	x	x	x
8	*Peltigera membranacea*	x	x	x
9	*Collema subflaccidum*	x	-	x
10	*Collema flaccidum*	x	x	x
11	*Peltigera horizontalis*	x	x	x
12	*Lobaria virens*	x	x	x
13	*Leptogium lichenoides*	x	-	x
14	*Sticta sylvatica*	x	x	x
(15)	*Parmeliella tripthophylla*	-	-	x
(16)	*Sticta fuliginosa*	-	-	x
(17)	*Nephroma laevigatum*	-	-	x
(18)	*Peltigera malacea*	-	-	x
Group II, Species to the south; high elevation and small dimensions				
1	*Lobaria scrobiculata*	x	x	x
2	*Pannaria rubiginosa*	x	x	x
3	*Collema fasciculare*	x	x	x
4	*Peltigera collina*	x	x	x
5	*Normandina pulchella*	x	-	x
6	*Nephroma parile*	x	x	x
7	*Degelia plumbea*	x	x	x
8	*Lobaria pulmonaria*	x	x	x
9	*Pannaria conoplea*	x	x	x
(10)	*Lobaria amplissima*	-	x	x
(11)	*Fuscopannaria ignobilis*	-	-	x
(12)	*Nephroma bellum*	-	-	x
Species in the middle of the study area				
-	*Peltigera malacea*	x	x	-
-	*Nephroma laevigatum*	x	-	-
-	*Fuscopannaria ignobilis*	x	-	-
-	*Nephroma bellum*	x	x	-
-	*Lobaria amplissima*	x	-	-
Species with no obvious pattern / evenly spread out				
1	*Peltigera praetextata*	x	x	x
-	*Collema subflaccidum*	-	x	-
-	*Leptogium lichenoides*	-	x	-
-	*Nephroma laevigatum*	-	x	-
-	*Normandina pulchella*	-	x	-
-	*Fuscopannaria ignobilis*	-	x	-
-	*Parmeliella triptophylla*	x	x	-
-	*Sticta fuliginosa*	x	x	-

Phytogeography and dispersal strategy

Phytogeopgraphy

Interpretation of the current Norwegian distribution of the target species demonstrated a strong western tendency; a western element among the sampled lichens. Both of groups I and II were dominated by species with a western tendency (see table 11). In group I to the north end of the main gradient 57% (8 of the 14 strongly affiliated) had a western tendency. In group II to the south end of the main gradient 33% (6 of the 9 strongly affiliated) had the same tendency. By only looking at the species with strong affiliation to the groups there seem to be more western coastal species or species with a western aggregation in group I than in group II. The tree strongly western species (W1); *Leptogium hibernicum*, *Leptogium cochleatum* and *Leptogium burgessii* were all in group I and also among the top five strongest affiliations to the group. Including the weakly affiliated species, group I had 11 (56%) of 18 western species and group II had 8 (67%) out of 12. In the group of ten species with less than five findings seven had a western tendency. One of them; *Rinodina isidiodes* was also a strongly western species (W1) found on tree number 11 which is situated at low elevation to the north of the study area. The target lichens have a different pattern than the vascular plants. Many of the species had a main western coastal distribution, but also appeared in the humid valleys of Eastern Norway, away from the ocean. The different species phytogeographical distribution in table 11, the species also found outside of the traditional western distribution (like in the Eastern valleys) are marked with a star. The evenly spread out species *Peltigera praetextata* was widespread with a southern tendency.

Dispersal strategy

Of all lichens in group I, nine species had vegetative dispersal by isidia, soredia or conidia, while 14 had sexual dispersal structures (apotecia). Of the 14 species with apotecia, half of the species (7) rarely had apotecia. All species in group I not known to have apotecia and species that rarely have apotecia have vegetative reproduction. Except for *Peltigera malacea* that rarely had apotecia and was not known to have vegetative reproduction. Of the lichens in group II, seven species had vegetative dispersal by conidia, soredia, isidia or gymnidia, while 11 had apotecia. Of these 11 species, five rarely had apotecia and of the six species that commonly had apotecia, two of them also have vegetative reproduction by conidia. The only species evenly spread, *Peltigera praetextata*, commonly had apotecia. In group I seven of the nine species with vegetative reproduction had isidia, while only one of the seven in group II had isidia.

Table 11. Phytogeographic distribution and dispersal strategy of target lichens. (ceph. = cephalodia, apot. = apotecia)

#	Species	Phytogeographic distribution (cf. Økland 1989)	Dispersal strategy (Ahti et al. 2007)	
			Vegetative	Apotecia
Group I, Species to the north; low elevation and great dimensions				
1	*Leptogium hibernicum*	W1*	Isidia	-
2	*Leptogium cochleatum*	W1*	-	Usually
3	*Fuscopannaria sampaiana*	W2*	Soredia	-
4	*Leptogium saturninum*	Ub.	Isidia	Rare
5	*Leptogium burgessii*	W1*	-	Common
6	*Leptogium cyanescens*	W3*	Isidia	Rare
7	*Nephroma resupinatum*	Ub.	-	Frequent
8	*Peltigera membranacea*	Ub. /S4	-	Common
9	*Collema subflaccidum*	W4*	Conidia	-
10	*Collema flaccidum*	Ub.	Isidia, conidia	Rare
11	*Peltigera horizontalis*	S3	-	Common
12	*Lobaria virens*	W2	-	Common
13	*Leptogium lichenoides*	Ub.	-	Rare
14	*Sticta sylvatica*	W2*	Isidia	-
(15)	*Parmeliella tripthophylla*	Ub.	Isidia	Rare
(16)	*Sticta fuliginosa*	W3*	Isidia	Rare
(17)	*Nephroma laevigatum*	W3*	-	Common
(18)	*Peltigera malacea*	SE4	-	Rare
Group II, Species to the south; high elevation and small dimensions				
1	*Lobaria scrobiculata*	Ub.	-	Rare
2	*Pannaria rubiginosa*	W2*	-	Frequent
3	*Collema fasciculare*	W3	Conidia	Common
4	*Peltigera collina*	W4*	Soredia	Rare
5	*Normandina pulchella*	W2	Soredia	-
6	*Nephroma parile*	Ub.	Conidia, soredia	Rare
7	*Degelia plumbea*	W3	Conidia	Numerous
8	*Lobaria pulmonaria*	S4	Isidia, soredia	Rare
9	*Pannaria conoplea*	W4*	Gymnidia	Rare
(10)	*Lobaria amplissima*	W4	-.	Ceph. or apot.
(11)	*Fuscopannaria ignobilis*	W2	-	Numerous
(12)	*Nephroma bellum*	Ub.	-	Frequent
Species with no obvious pattern / evenly spread out				
1	*Peltigera praetextata*	S4	-	Common
Species with less than five findings				
(1)	*Cetrelia olivetorum*	W2*	Soredia	-
(2)	*Collema furfuraceum*	W4	Isidia	Rare
(3)	*Collema subnigrescens*	W3	-	Numerous
(4)	*Fuscopannaria mediterranea*	W4*	Soredia	Rare
(5)	*Massalongia carnosa*	Ub.	Isidia	Rare
(6)	*Peltigera hymenina*	W4	-	Common
(7)	*Peltigera polydactylon*	Ub.	-	Common
(8)	*Protopannaria pezizoides*	Ub.	-	Abundant
(9)	*Rinodina isidiodes*	W1	Isidia	Scattered
(10)	*Sticta limbata*	W2	Soredia	-

6 DISCUSSION

Local gradients in lichen species composition and distribution: the main gradient

Ordination analyses of species composition on trees revealed a main gradient in species composition from trees with large dimensions at low elevation in the north-western part of the study area to trees with small dimensions at higher elevation in the south-eastern part of the area. The explanatory variables that correlated with the main compositional gradient were made up by groups of intercorrelated variables that segregated into separate groups in the PCA. This interpretation was also confirmed by correlation analysis, ordination biplot and isoline diagrams. The ordination analyses also revealed a possible second gradient from trees with high macrolichen cover to trees with less macrolichen cover. I will start my discussion of the main gradient by considering the contributions of different ecological factors to the main compositional gradient. This will be used as a background for discussing the distributions of target macrolichens in the study area.

Ecological factors making up the underlying complex gradient

Diameter at base/breast height (DBH) was the most important variable explaining the variation along the main compositional gradient, see table 4. Isoline diagrams from Tungesvikstranda showed a combination of smaller tree dimensions to the south of the study area and greater dimensions to the north. Easy access and more easily pollarding of target trees, thinning and logging of other trees (like alder) in the less steep areas close to the road and the sea may explain this pattern. In addition trees may reach greater dimensions at lower elevations to the north due to better site index with deeper and less stony soils and because this part of the area is less exposed to rockslides and avalanches. Trees at higher elevations in steep, rocky slopes with a more rugged topography have been less accessible for the farmers to cut and pollard and are also more prune to rockslides and avalanches. Thor et al. (2010) found, in their unique large data set of 1294 trees of 17 trees species and 246 lichen taxa; that lichen species composition and the average number of red-listed lichens were primarily correlated to tree diameter on *Fraxinus excelsior* (and *Quercus robur*, but no such pattern was evident on *Ulmus glabra*). More about tree diameter under discussion of species richness further down.

Height above sea level, Elevation, was at Tungesvikstranda found to be among the two most important variable groups in explaining variation along the main compositional gradient. In a similar study at Havrå in 1997, Moe & Botnen found elevation to be the most important environmental variable. Even though the altitudinal range in their study area was not more than 210 m they found apparent altitudinal limits for some species. Near the sea, conditions are more humid, less windy, and not so affected by low temperatures in winter compared to higher altitudes (Moe & Botnen 1997). The Tungesvikstranda study area comprises about the same altitudinal range (207 m), from 55 to 262 meters above sea level, while Havrå comprises a range from 10 to 220 meters.

Height to the lowermost branch increases and tree dimensions get smaller from north to south and the two variables are strongly negatively correlated. This is explained by higher frequency of pollarded trees at low elevations. Tree heights were not measured, but observations in field indicate that unpollarded trees with smaller dimensions are taller than pollarded trees, because unpollarded tops have been left uncut. Accordingly, in the study area tree height is expected to be positively correlated with height to lowermost branch and negatively correlated with stem dimension: pollarded trees have larger stem diameter, but are mainly shorter than unpollarded. Another explanation of the trees being taller in the steep areas at higher altitude could be that the forest is denser and less open, thus the trees grow taller because they are all competing for sunlight. In a close proximity situation trees do tend to grow upward to reach the light. The taller the tree, the more light its leaves will receive.

There was more fissured bark to the north end of the gradient than to the south. And opposite; there were less smooth and rough bark to the north than to the south. Also the presence of calluses and crevices in the bark and pollarding of the trees was significantly more prominent to the north end of the gradient and less prominent to the south. These factor bark structure variables were not considered in the Kendalls correlation analysis of explanatory variables, though it is obvious that these are related to the dimensions and to pollarding of the trees. Pollarding gives more breadth growth when the tree top is cut and thus not growing upwards and the pollarding management gives more risk of cuts and scars which gives calluses and crevices. The low altitude north end of the gradient has large, pollarded trees with fissured bark, calluses and crevices. While the high altitude south end of the gradient have higher frequencies of unpollarded trees with smaller dimensions and more smooth and rough bark, thus less pollarded trees with calluses and crevices.

The investigated trees are mostly old, pollarded trees, many of them probably close to the maximum age for Fraxinus excelsior trees of 300-400 years (Nedkvitne & Gjerdåker 1993). However, some of the investigated trees are younger, but few young trees were included, in lack of target lichens. Trees usually had either smooth or fissured bark; very few trees had rough bark. Of the 279 trees, 262 had fissured bark, which leaves us only 17 trees with smooth and / or rough bark; this might explain the lack of significance between smooth and rough bark and the main gradient in the relationship analysis. During the field work it became obvious that the surface bark structure of the trees was an important factor for the lichen community. By looking at the trees there seemed to be a time gradient or a succession from the (few) young, smooth trees with only totally resupinate mosses and micro-lichens like *Graphis* and *Lecanora* sp, to really old trees with rough fissured surface and a diverse community of mosses and macrolichens growing out from the tree. So a species turnover from young trees with smooth bark to old trees with fissured bark was observed. Thor et al. (2010) found larger *Fraxinus excelsior* to share more lichen species with *Ulmus glabra* than with younger *Fraxinus* trees. Bark structure is well known to depend on tree age, so the observed patterns of bark structure (mainly fissured bark) at Tungesvikstranda can be explained by the lack of a continuum of host trees from young to old trees. Most of the trees studied have passed the period of extensive growth; most trees are old and recruitment of new Fraxinus excelsior trees is low. Pollarding gives no seed production (Nedkvitne & Gjerdåker 1993) which limits natural regeneration and grazing limits establishment of new trees (Rose 1992).

It is interesting that both lichen- and bryophyte cover arrows in the PCA-ordination point in the same direction as DBH. It indicates that there is a certain correlation. However, the correlation matrix in App. 4 indicates that there is no such correlation, while there is a slight negative correlation between bryophyte and macrolichen cover. Bryophyte cover was not significant due to the PCA ordination or the biplot calculation, but the isoline diagram interestingly showed an opposite pattern of macrolichen cover. This accord with observations at single trees; macrolichen and bryophyte dominance often occurs at separate parts of the trunks. Almost all the trees in the study area were dominated by bryophytes (10–95% cover, mean 51%), while macrolichens were less dominant with cover ranging from 1 to 50% and with mean of 11%. Macrolichen cover has a slight negative relationship to axis 1, which gives less macrolichen cover to the south with small dimensions at high elevation and more macrolichen cover to the north with large dimensions and low elevation. Moe & Botnen in their study of 2000 found that the investigated trunks where mainly dominated by mosses even though they found the number of recorded taxa to be higher for the lichens than for the bryophytes.

That it is neither correlation between lichen- or bryophyte cover with DBH could indicate that these distinct spots remain (separate parts of trunk) for much of the tree's life, and the species that have colonized a tree can stay there very long. The fact that the ordination axis correlates with DBH and other factors are relatively weak (and that we find relatively weak geographic distribution patterns), could also indicate that it is important to come first and that species composition does not change much through the wood aging or that the whole woodland has reached a climax and are saturated with species. On the other hand, it was observed during fieldwork that the thick bryophyte mat on several trees was partly or totally loosened from the trunks and when still attached the mat was very easily disturbed, with appearing bare bark underneath. The same was seen at Havrå by Moe and Botnen (1997) and they suggest that a cyclical succession occur on the trees and that cryptogamic epiphytes colonize the trunk again and again after peeling off, a process also known to happen on rocks. This gives unstable epiphytic vegetation on the trunks, even though the trees have reached the climax stage of rough bark (cf. Moe & Botnen 1997).

Light was not measured directly at Tungesvikstranda, but would have been negatively correlated to canopy cover; hence canopy cover works as an indirect measure of light availability. The canopy cover seemed to be strongly correlated with DCA axis 1 and therefore could explain some of the variation along the axis, together with the main gradient. In a similar study at Grinde in 2000, Moe & Botnen found light availability to be the most important explanatory variable. Moe & Botnen (1997) and Tønsberg (1994) states that the pollards richest in species are those which are not too heavily shaded. Isoline diagrams from Tungesvikstranda showed a combination of smaller tree dimensions with greater canopy cover to the south of the study area and greater dimensions with less canopy cover to the north; canopy cover increases with increasing elevation. Unpollarded trees that have not been cut and surrounding trees not thinned or cut have denser canopy cover than pollarded trees that used to be cut and thinned around every 5–7 years (cf. Austad 1988, Nedkvitne & Gjerdåker 1993, Norderhaug et al. 1999, Austad et al. 2007). However, at the time the investigation was carried out the pollards had neither been trimmed nor the surrounding trees thinned for many years – pollarding might thus not explain the pattern of variation in canopy alone.

Moe & Botnen (1997) also found a decrease in tree girth with increasing altitude, but in contrast to my findings at Tungesvikstranda, they found that canopy cover decreases towards higher levels. The latter may appear contra-intuitive, because Moe & Botnen (1997) also found that the time since the last pollarding increased uphill with increasing elevation. Intuitively one would think that the longer the time since pollarding, the bigger the crown, but according to Moe & Botnen this is more than compensated for by an altitudinal effect (reduced humidity, more windy conditions, colder winters) that reduces tree growth and keeps the crowns of higher altitude trees small. However, Moe & Botnen (1997) only investigated 19 trees, all of them pollarded while at Tungesvikstranda 279 trees were investigated of which 2/3 were pollarded. Moe & Botnen also investigated all epiphytes of bryophytes and lichens on the pollarded stems, while at Tungesvikstranda only cyanolichens were investigated. This may explain the difference in the relationship between elevation and canopy cover between the two studies. Trees at high altitude at Tungesvikstranda have not been pollarded which gives them bigger crowns and the surrounding trees have not been cut, so the total canopy cover are greater. On the other hand, *Fraxinus excelsior* is a tree species with strong apical dominance (the end bud develops stronger than the side buds) and it is so powerful that it forms a distinct main axis (stem) with smaller side branches on unpollarded trees, while pollarded trees develop several side buds, giving the treetop a more rounded or candelabra shape (cf. Austad 1988). Pollarded *Fraxinus excelsior* trees might therefore have a wider crown than unpollarded trees, when management has ceased.

When trees shed their leaves, they stop growing and this helps them conserve energy during winter, when there is not enough sunlight to make food. Shedding leaves also helps trees save water, since it stops water from evaporating. *Fraxinus excelsior* trees develop their leaves late in spring and shed them early in the fall (Nedkvitne & Gjerdåker 1993), this gives the lichens some time to grow each year, even if the canopies are becoming denser in lack of management. This fact might explain how the photophilus lichen species still survive, while they occur as relicts due to extinction debt (cf. Hanski 2000, Hanski & Ovaskainen 2002) in the denser and shadier habitat. This might also explain why canopy cover is explaining so little of the variation in the gradient, while almost all lichen literature expresses how important light is for the lichens. Larvae of *Galerucella lineola* beetle have been attacking the surrounding *Alnus* trees at Tungesvikstranda the last few years; these outbreaks make the leaves brown and fall off early in the season, which might also counteract for the woodland growing denser and shadier in lack of management. To the contrary sheep do not eat alder seedlings, which make *Alnus* contribute to the canopy cover as long as the trees are not cut.

Species distribution patterns that make up the gradient in species composition

A typical example of a species in group I is *Leptogium hibernicum*. *L. hibernicum* is bryophilus or corticolous on old, mossy, trunks of pollarded *Fraxinus excelsior* in moist lowland, agricultural landscapes (Jørgensen 2007), and has in Scandinavia only been found in such habitats in Rogaland and Hordaland counties of SW Norway (Tønsberg et al. 1996, Jørgensen 1996). These are the northernmost localities in a more or less continuous distribution along the Atlantic coast, from Macaronesia to Norway. *L.hibernicum* clearly belongs to the group of extremely oceanic species (Jørgensen 1996) and it appears to be among the rare amphiatlantic cyanolichens that include such species as *Erioderma pedicellatum* and *E. mollissimum* (Neily & Anderson 2010). Outside Europe it is known from the mountains of South and East Africa, Chile (Jørgensen 1996), Bolivia, China (Wang et al 2010) and North America (Neily & Anderson 2010). In Norway the species is only found from about sea level to 150 m altitude and it always occur on sites rich in oceanic lichens (Tønsberg et al 1996). In the British Isles *L. hibernicum* belongs to the Scottish-Hiberian distribution group of western species, and is described as dependent on a very humid climate with more than 200 rain days per year (Coppins 1976). True oceanic (euoceanic) species like these in Europe only occur along the western coasts (Jørgensen 1996). Four of the species in group I at Tungesvikstranda which, according to Jørgensen (1996) are considered as having the most strongly oceanic distribution, *Leptogium hibernicum, L. cochleatum, Fuscopannaria sampaiana* and *L.burgessii*, were restricted to the low-score end of the main compositional gradient, i.e. low elevations, the northern part of the study area and to pollarded trees with large stem diameter. The three *Leptogium* species are extremely frost sensitive and have strict preferences for high moisture (Bjelland 2001).

L.scrobiculata, a typical example of a species in group II, is mostly found in humid temperate areas with high rainfall, especially coastal districts of northwest Europe, north-eastern North America and north-western North America. A few occurrences are also known from warmer countries such as Kenya. In Norway *L.scrobiculata* is found on trees, especially rich bark trees and on rocks, in places with relatively high humidity, up to 1400 meters altitude. The species is widespread in Norway, not common but locally frequent (Jørgensen & Tønsberg 2007). *L. scrobiculata* is concentrated to the south-western parts of the study area, i.e., to higher altitudes, and to trees with smaller stem dimensions and higher canopy cover.

Both of groups I and II contain many moisture-demanding species, while all the western and extremely oceanic species affiliate with group I. Because the entire Tungesvikstranda study area is characterised by high humidity, the altitudinal gradient is likely to be the key to explaining the opposite pattern of the two species groups. Near the sea, conditions are less windy and not so affected by winter cold compared to higher altitudes (Moe & Botnen 1997). Analyzing the phytogeographical distribution of the target lichens in Norway shows that the phytogeography of vascular plants (R. Økland 1989) is not easily transferred to lichens. The target lichens have a different pattern than the vascular plants; being more restricted by humidity in addition to temperature. This is showed by a lot of the species having a main western coastal distribution, but also appears in the humid valleys of eastern Norway, away from the ocean.

The only species sampled for analysis to be evenly spread out in the Tungesvikstranda study area is *Peltigera praetetextata*. This species is known to grow on moss-covered rock walls, sloping rock surfaces and on the basis of moss-covered trees, usually somewhat shady, although it is lacking in higher altitudes the species is known from the whole country (www.nhm.uio.no/botanisk/lav/LAVFLORA/). The generalist nature of this species thus accords will with its even distribution over the study area.

Table 12. The investigated lichen species: environmental preferences and distribution. Information from other sources about the lichens and the target species' phtyogeographig distribution and dispersal strategy (ceph. = cephalodia, apot. = apotecia).

#	Species	Oceanic species (Jørgensen 1996, Ahti et al. 2007)	Continuity & humidity indicator (Nitare 2000)	Old deciduous forest indicator (Rose 1992)	Redlist status (Kålås et al. 2010)	'Lobarion community' species (Rose 1992)	Phytogeographic distribution (cf. Økland 1989)	Dispersal strategy (Ahti et al. 2007)	
Group I, Species to the north; low elevation and great dimensions								**Vegetative**	**Apothecia**
1	*Leptogium hibernicum*	Extremely oceanic	-	-	EN	-	W1*	Isidia	-
2	*Leptogium cochleatum*	Extremely oceanic	-	x	EN	-	W1*	-	Usually
3	*Fuscopannaria sampaiana*	Extremely oceanic	-	x	VU	x	W2*	Soredia	-
4	*Leptogium saturninum*	-	-	-	-	-	Ub.	Isidia	Rare
5	*Leptogium burgessii*	Extremely oceanic	x	x	VU	x	W1*	-	Common
6	*Leptogium cyanescens*	-	x	x	-	-	W3*	Isidia	Rare
7	*Nephroma resupinatum*	-	x	-	-	x	Ub.	-	Frequent
8	*Peltigera membranacea*	-	-	-	-	-	Ub. /S4	-	Common
9	*Collema subflaccidum*	-	x	x	-	-	W4*	Conidia	-
10	*Collema flaccidum*	-	x	-	-	-	Ub.	Isidia, conidia	Rare
11	*Peltigera horizontalis*	-	-	x	-	-	S3	-	Common
12	*Lobaria virens*	-	x	x	-	x	W2	-	Common
13	*Leptogium lichenoides*	-	x	x	-	-	Ub.	-	Rare
14	*Sticta sylvatica*	Oceanic	-	x	-	x	W2*	Isidia	-
(15)	*Parmeliella tripthophylla*	Suboceanic	x	x	-	x	Ub.	Isidia	Rare
(16)	*Sticta fuliginosa*	Oceanic	-	x	-	x	W3*	Isidia	Rare
(17)	*Nephroma laevigatum*	(Sub)oceanic	x	x	-	x	W3*	-	Common
(18)	*Peltigera malacea*	-	-	-	-	-	SE4	-	Rare
Group II, Species to the south; high elevation and small dimensions									
1	*Lobaria scrobiculata*	Oceanic	x	x	-	x	Ub.	-	Rare
2	*Pannaria rubiginosa*	Oceanic	x	x	-	x	W2*	-	Frequent
3	*Collema fasciculare*	-	x	-	-	-	W3	Conidia	Common
4	*Peltigera collina*	-	x	x	-	x	W4*	Soredia	Rare
5	*Normandina pulchella*	-	x	-	-	x	W2	Soredia	-
6	*Nephroma parile*	-	x	x	-	x	Ub.	Conidia, soredia	Rare
7	*Degelia plumbea*	Suboceanic	x	x	-	x	W3	Conidia	Numerous
8	*Lobaria pulmonaria*	-	x	x	-	x	S4	Isidia, soredia	Rare
9	*Pannaria conoplea*	Suboceanic	x	x	-	x	W4*	Gymnidia	Rare
(10)	*Lobaria amplissima*	Suboceanic	x	x	-	x	W4	-.	Ceph. or apot.
(11)	*Fuscopannaria ignobilis*	Suboceanic	-	-	NT	-	W2	-	Numerous
(12)	*Nephroma bellum*	-	x	-	-	x	Ub.	-	Frequent

#	Species	Oceanic species (Jørgensen 1996, Ahti et al. 2007)	Continuity & humidity indicator (Nitare 2000)	Old deciduous forest indicator (Rose 1992)	Redlist status (Kålås et al. 2010)	'Lobarion community' species (Rose 1992)	Phytogeographic distribution (cf. Økland 1989)	Dispersal strategy (Ahti et al. 2007)	
Species with no obvious pattern / evenly spread out									
1	*Peltigera praetextata*	-	-	-	-	-	S4	-	Common
Species with less than five findings									
(1)	*Cetrelia olivetorum*	-	-	x	VU	-	W2*	Soredia	-
(2)	*Collema furfuraceum*	-	x	x	-	-	W4	Isidia	Rare
(3)	*Collema subnigrescens*	-	x	x	-	-	W3	-	Numerous
(4)	*Fuscopannaria mediterranea*	-	x	x	NT	-	W4*	Soredia	Rare
(5)	*Massalongia carnosa*	-	-	-	-	-	Ub.	Isidia	Rare
(6)	*Peltigera hymenina*	-	-	-	-	-	W4	-	Common
(7)	*Peltigera polydactylon*	-	-	-	-	-	Ub.	-	Common
(8)	*Protopannaria pezizoides*	-	x	-	-	-	Ub.	-	Abundant
(9)	*Rinodina isidiodes*	Extremely oceanic	-	x	CR	-	W1	Isidia	Scattered
(10)	*Sticta limbata*	Oceanic	-	x	-	-	W2	Soredia	-
Total 41		**16**	**24**	**26**	**8**	**18**			
Other rare lichens known from Tungesvikstranda *(Gaarder & Fjelstad 2009)*									
1	*Gomphillus calycioides*	Extremely oceanic	-	-	CR	-	-	-	-
2	*Gyalecta flotowii*	-	-		VU	-	-	-	-
3	*Megalosphora pachycarpa*	Extremely oceanic	-	x	EN	-	-	-	-
4	*Opegrapha vermicellifera*	-	x	-	VU	-	-	-	-
5	*Pyrenula occidentalis*	Extremely oceanic	-	-	NT	-	-	-	-
6	*Thelopsis rubella*	-	-	x	VU	-	-	-	-
Total 47		**19**	**25**	**28**	**14**	**18**	**-**	**-**	**-**

Species richness

There was found a weak negative correlation between species richness and the main gradient at Tungesvikstranda; there are highest numbers of species at low elevation with greater diameter to the north. This accord well with the strong positive correlation between species number and DBH and fissured bark. I interpret this as DBH and age of trees are important for the colonization of the target species. Also pollarding had a weak positively correlation to species richness. Macrolichen cover in general was positively correlated with species number. Moreover; the pollarded trees have higher species richness and greater dimensions than unpollarded trees. There might be several explanations on different scales to these findings.

Trees of great dimensions are well known from the literature to be important for species richness of lichens (Rose 1976, 1992, Lesica et al. 1991, Tønsberg et al. 1996, Uliczka & Angelstam 1999, Nitare 2000, Gjerde & Baumann 2002, Löbel et al. 2006, Johansson et al. 2007, Leppik & Jüriado 2008, Jüriado et al. 2009, Thor et al. 2010, Jönsson et al. 2011, Leppik et al. 2011). Also epiphyte biomass is known to increase with tree stem diameter (Esseen et al 1996, Diaz et al. 2010) and with age of the forest stand (McCune 1993). McCune (1993) found cyanolichen biomass to peak when stand age were > 400 yr. A very high number of the target species are good indicators of old forest continuity (cf. Nitare 2000 and Rose 1992) which accord with these indicators being slow colonizers. Longlived trees of great diameter are stable substrates to depend on. Both the greater areal of the stem and the presence of fissured bark, or the two factors combinded might explain the richness. Great stem areal for the lichen diaspora to hit should increase the chance of establishment, cf. island biogeography (MacArthur & Wilson 1963, 1967, Whittaker & Fernández-Palacios 2007) and greater areal give more room for different species to coexist on the stem. Thor et al. (2010) found that average number of red-listed lichen species and occupancy frequencies generally increased with increasing tree diameter on *Fraxinus excelsior*. Moreover, bark pH has been shown to increase with increasing tree diameter of *Fraxinus* (Bates 1992), suggesting the trees to be even more favorable to epiphytic lichen in terms of acidity (Thor et al. 2010).

Pollarding is well known to be important for epiphytic lichen species richness (Rose 1976, 1992, Tønsberg 1994, Tønsberg et al 1996, Jørgensen 1996, Moe & Botnen 1997, 2000, Leppik & Jüriado 2008, Thor et al. 2010, Jönsson et al. 2011). The huge pollarded trunks have a variety of ecological niches, the rough bark surface and the various stem inclinations account for a number of habitats that give increased opportunities for many different epiphytic species to occur on the same trunk (Moe & Botnen 1997). On a landscape level the pollarded trees have been untouched by regular forestry and left to grow to high age and great dimensions, developing fissured bark in an open landscape and making up small refuges for the species to survive in, while the rest of the forest have been deforested, fragmented or densely planted for timber production (cf. Rose 1992, Gauslaa & Ohlson 1997, Leppik et al. 2011). Pollarding prolongs the life expectancy of the trees (Rackham 1988) which gives the lichen species longer time for colonization. Thor et al. (2010) found that Estonian *Fraxinus* trees hosted fewer species than the Swedish trees, which most probably is the result of pollarding not being a tradition in Estionia (Leppik et al. 2011), giving fewer pollarded, large and old *Fraxinus* trees. Also the low height of the pollarded trunks with a more candelabra shaped crown might contribute to the species richness, both because the low canopy gather more humidity (cf. more humidity at base) and that the water stream running down the stem are less powerful than on a higher stem, hence the diaspora are not washed away (pers.comm Astrid Botnen).

Both pollarding and great diameter give fissured bark, which was positively related to species richness at Tungesvikstranda, while smooth and rough was negatively related. Smooth and rough (but not fissured) bark clearly limits colonization of macrolichens, and thus richness of such species, cf. species turnover and bark structure above. Epiphloeic lichen cover is slightly negatively related with the species richness at Tungesvikstranda and it is likely that a cover of microlichens hamper colonization by macrolichens.

Drainage is at Tungesvikstranda negatively, although not strongly, related to the species richness. It has been known for centuries that *Fraxinus excelsior* thrives in places where flowing water is abundant and Moe & Botnen (1997) states that the pollarded *Fraxinus excelsior* trees require (favorable light -) and moisture conditions to achieve an epiphytic flora rich in species. Therefore the GLM result for drainage seems contra intuitive and not so easy to explain. It might be because the Tungesvikstranda study area is very humid all over; there is very little variation within the area. None of the trees were situated at a dry spot (with drainage = 1 stony, dry end of scale), all trees were in within the range of 2-5 on the scale and the mean was 3.14. While moisture is considered to be the most important factor for lichen growth (Ahmadjian 1993), they are also dependent on the drying out, and in fact they are dependent on the switch between drought and humidity (Harris & Kershaw 1971). Laboratory experiments have shown that lichens quickly die if they are kept constantly moist (Farrar 1976) and some lichens has shown that they can handle stress better during dry periods than in wet periods (Honegger 1995). Of the lichen species considered at Tungesvikstranda 12 are oceanic (Jørgensen 1996) and 25 are indicators of old forest continuity, high and stable humidity (cf. Nitare 2000). They are moisture-intensive and should not be damaged by too much humidity; however water saturation might be able to reduce growth and hence; species richness. To the contrary; open woodlands with more light and increased evaporation give more rapid cycles of wetting and drying (cf. Leppik et al 2011).

Clumping and regularity of lichen species distribution at among-tree spatial scales

In the random labeling test of lichen species at Tungesvikstranda, seven species were found to be more clumped and six species more regular than expected at random in some distance intervals. I consider this to be a weak pattern, for two reasons: that the number of species which deviate from the random expectation is low and that there is a balance between the directions of the deviations. These results indicate that the distributions of the investigated lichen species is not *in general* governed by distance-dependent distribution of diasporas, but rather by the distribution of environmental conditions and, perhaps even more importantly, by apparent randomness (chance events). On a local scale it may seem like the lichen species are able to find their way if the habitat structure is right and the ambient environment is favorable. Schei et al. (in press) found both environmental filtering and local dispersal dynamics to be important processes explaining the distribution and abundance pattern of *Lobarion* lichens at fine spatial scales. Bjelland (2001) states that dispersal strategy, ecology and history are important factors controlling the distribution of *Leptogium burgessii, L. cochleatum, L. cyanescens* and *L.hibernicum* in Norway. Bjelland also found that *Leptogium burgessii, L. cochleatu,* and *L.hibernicum* are likely to have spread from the British Isles by long-distance dispersal, while *L. cyanescens* might have spread gradually to the southwest from the Oslo area. Several of the most demanding oceanic species at Tungesvikstranda show clear affinities to sub-tropical and tropical regions. Some of the species, such as *Gomphillus calycioides, Leptogium burgessii, L. cochleatum* and *L. hibernicum* grow in the humid, misty forests of tropical Africa and America, but at high altitudes up to 3000-4000 m (Jørgensen 1996). It can be tempting to explain the rainforest lichen distribution with that these species has the ability to long-distance dispersal. But this does not fit into the current image where the majority of the species, as well as the *Lobarion* community represent a cultural surplus element of relict character with poor ability to colonize potential habitats (Gauslaa & Ohlson 1997). It is recognized that species linked to long-lived habitats have low dispersal potential, while species associated with transient habitats need to have a purpose well enough dispersal potential (Southwood 1977). The four *Leptogium* species Bjelland (1997, 2001) investigated are not well developed for long distance dispersal. It is possible that they migrated from Africa via the Canary Islands northward to the Mediterranean in periods when the climate was more humid than today (Bjelland 2001).

The lichens may have survived in pollarded cultural landscape, because these old woodlands are mimicking the open natural European temperate woodlands of Pleistocen. Those woodlands were grazed by giant herbivores (extinct megafauna) and now the lichens are trapped in small fragmented refuges of old trees of long continuity, with no escape route. There is evidence of significant changes in the structure, composition and pattern of plant communities following megafaunal extinctions in Pleistocene, and reason to think that the ecological aftershocks of those extinctions are still with us (Johnson 2009). To understand living plant communities, we need to re-imagine them with their full complement of Pleistocene megafauna (Johnson 2009). In a longterm Pleistocene time perspective, Norwegian forest lichens reached their present distribution ranges from ice-free refugia outside Scandinavia which nowadays have extinct or threatened populations of several species. For the *Leptogium*-species; most probably from the Iberian Peninsula, which had an oceanic deciduous forest 10000 BP and the species probably followed the temperate deciduous forest northwards along the Atlantic coast when the climate got warmer (cf. Bjelland 1997).

There has been a massive depletion of the lichen flora of forests in these possible ice age refugia and for many species there are no longer viable populations (in Europe outside Scandinavia) that can buffer the impact of the new ice age (Gauslaa & Ohlson 1997). The highly fragmented forests of Europe today represent a break in continuity of former migration routes. Fragmentation causes a reduction in the area of available habitat (particularly core habitat due to edge impacts) and an increase in the distance between woodlands. A number of scientific theories (MacArthur and Wilson, 1967; Hanski, 1998) suggest that the reduction in area may lead to increased local extinctions, while increased isolation may cause a reduction in the exchange of individuals between isolated patches, threatening their long-term viability Although some species are still found in southern Europe, the fragmentation of the previously continuous European forests (Godwin 1975) probably hamper a new journey north (Gauslaa & Ohlson 1997). It is be hard to decide whether it is the strict environmental demands of the species and hence the few available habitats, or the dispersal strategy that limits the distribution (Bjelland 1997).

The L-function plot indicates that the distribution of target trees is more or less completely independent of each other, on scales up to 55 meters and also indicates that trees are somewhat more regularly distributed (more spaced out than random) at distances greater than 55 meters. These results can be explained by the study area being managed by humans for centuries and the trees spread out in a useful pattern; hence neither a natural random nor aggregated distribution pattern was seen. This pattern indicate that the forest structure does not provide a basis for finding clumping of the lichen species on very fine scales, simply because the trees are spread out and not close to each other. Also that the pollarded trees are spread more regularly than random might give less competition between the trees and let the trees grow better and bigger than in a natural forest.

The lichen flora and the study area in a regional context

The main gradient found, with its main explanatory factors cannot explain the extreme aggregation of rare lichen species at Tungesvikstranda study area alone. To the contrary, the analyses indicate that the range of variation in species composition within the area is small. Nevertheless, the area is a real hotspot for epiphytic macrolichens. Of the lichen species found at Tungesvikstranda 19 are oceanic (Jørgensen 1996, Ahti et al. 2007), 25 are indicators of old forest continuity, high and stable humidity (Nitare 2000) and 28 of the species are indicators of old deciduous forest (Rose 1992), see table 12. These findings indicate that continuity of big old trees as substrates and high and stable humidity are important factors for the lichens. Also the coastal- and outer fjord-region from Bergen southwards to the border of Rogaland is particularly rich in oceanic lichens, see figure 26 under, many of them being extremely oceanic (Jørgensen 1996). Jørgensen (1996) explains this not by more extensive collecting in this region, but with a combination of larger variety of habitats, including presence of rich vegetation on brown soil, calciferous mica-schist as well as other calcareous rocks, and fairly high summer temperatures and mild winters. The region is also known for its rich flora of other plant groups, containing documented relicts from warmer periods (Jørgensen 1996).

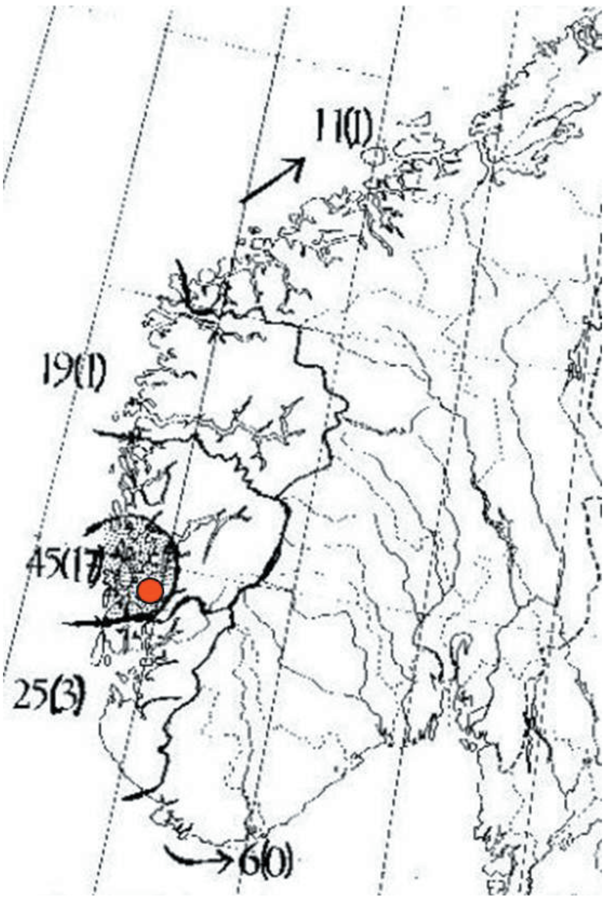


Figure 26. Hatched area indicate the central region for true oceanic (euoceanic) species in Scandinavia, where about 90 % of them occur. Numbers indicate euoceanic species according to different counties. Number in parentheses indicates amount of species known only from that county (Jørgensen 1996). Red dot indicating Tungesvikstranda study area.

Old trees in the cultural landscape have been refuges for the lichen species through periods of deforestation (Gauslaa & Ohlsen 1997, Nilsson et al 1994, Bendiksen et al 2008). A pollard may be regarded as an important refuge, a key stone element and source where epiphytic species dependent on long continuity may survive and can be spread successively to younger trunks as new trees develop (cf. Gauslaa 1985 and Moe & Botnen 1997). Old forest lichens are captured in small and highly fragmented remnants of old forests and source populations have become rare and the old forest lichens have thus lost their migratory potential (Gauslaa & Ohlson 1997). Tree diameter (i.e. substrate patch area) and old age (i.e. longer time available for colonization) are important variables for rare species with low population densities and dispersal-units (i.e. spores, diaspores) depositions (Hedenås & Ericson 2000). Many remaining older forests are over-saturated with species; especially species that have long relaxation time, like lichens (Naturvårdsverket 2005). This phenomenon is referred to as extinction debt (cf. Hanski & Ovaskainen 2002) or relict forests. Deforestation of western Norway started 4000-4500 ya and peaked about 1000 ya, which has made the region in lack of old trees the last 1000-1200 yr (Kaland 1986).

Gauslaa (1995) investigated the '*Lobarion*-community' of lichens (see table 12 for lichens at Tungesvikstranda associated with this community), and found that '*Lobarion'* species are restricted to sites with a soil rich in Ca, which partially counteract bark acidification. Tungesvikstranda consists of gabbro (Bjelland 1997, Brekke et al 2001) which is an igneous rock derived from calcite, giving rise to soil with high (basic) pH (Gauslaa 1995). The chemical properties of the bark were not measured in this study, but it is well known that *Fraxinus excelsior* bark is rich in important cations, with high buffer capacity (Moe & Botnen 1997). As for the species typical of 'boreal rainforests' in middle Norway; the Trøndelag phytogeographical element (northern rainforest species) (Tønsberg & Holien 1996), the oceanic species in SW Norway require stable and high humidity. Tønsberg & Holien (1996) point out that the '*Lobarion* community' of lichen species have high demands on light and postulate higher survival probabilities for these species in the boreal rainforest than in other types of forest after felling of single trees. This may also pertain to Tungesvikstranda where pollarding of *Fraxinus*, felling of *Alnus* and the regularly distributed trees (cf. L-function of trees) brought about increased light supply to the tree trunks. Adding to the explanation could be that the lichens survived in pollarded cultural landscape, because these old cultural woodlands are mimicking the open natural European temperate woodlands of Pleistocen grazed by giant herbivores (extinct megafauna) and now the lichens are trapped in small fragmented refuges of old trees of long continuity.

The combination of the large extent of the Tungesvikstranda area, which makes it contain many individuals of the rich-bark trees *Fraxinus excelsior* and *Ulmus glabra*, a favourable climate and a long history of pollarding which has prevented the forest from becoming too dense or clear cut, are likely to be the main reason for the high species richness of the area.

Future research

To ensure the survival of the lichens it is important to test the pollarding practice on some trees and analyze how it affects the species. Some of the important species, like *Gomphillus calycioides* are only found on 1-3 trees and can easily go extinct if they suddenly get more sun than they can stand (pers.comm. Tor Tønsberg). The heavily pollarded neighboring woodland south of the study area can be useful for measuring the effect of the pollarding practice. It could be inventoried for species abundance and the two areas compared. It will be important to consider the risk extinction debt and sink / source issues in such a study. Presence of extinction debts has significant implications for conservation and restoration of old pollarded woodlands. Recording species that are currently present without considering predictable extinctions will entail a too optimistic view of long-term species richness (Hanskii & Ovaskainen 2002). A master student at the University of Oslo (UiO) started her thesis work on bryophytes at Tungesvikstranda, with same trees as a basis in 2011 and another master student at the University of Bergen (UiB) has started her work on resampling of Moe and Botnen's study from 1997 at Havrå, W Norway. The present study at Tungesvikstranda could, together with the two other studies, make the base for areas of important supervision of epiphytic vegetation over time. The sampling could as such be repeated with intervals of 10 years or less, using the same methods. Changing environmental parameters that could contribute to explain the composition and abundance of the vegetation could be measured at the same times or more frequently.

Conservation implications

Tønsberg, in his article of 1994, suggested conservation actions to protect the species and their habitat at Tungesvikstranda. Today, seventeen years later, nothing has happened; the area is still unprotected and open for the owners to do as they please. Right now the locality is under acute threat by a new power line, road building, possible logging for firewood, *Picea abies* spreading, over-grazing, the fungal disease *Hymenoscyphus pseudoalbidus* (ash-dieback) and too extensive pollarding and logging. All these threaten the locality and one cannot be sure if the species are safe. The only way is to protect it as a nature reserve and make a restoration plan to secure viable hosts for the endangered lichens. Predictions of future climate change urge the conservation of present hot-spots for lichen diversity that may act as future sources for dispersal, persistence and adaptation to a changing landscape (Johanson 2006).

The Tungesvikstranda woodland requires immediate careful management. Creation of new host trees is needed to bridge the 'generation gap' before it is too late (cf. Rose 1992) either by new planting of trees or aided natural regeneration and maybe with fencing against sheep and elk grazing. The pollards are vulnerable to crown collapse in lack of the traditional management (cf. Lonsdale 1999, Moe & Botnen 1997 and Tønsberg et al. 1996) and introduction of gradually pollarding of the old pollard relicts is highly desirable. Due to the unique lichenology in the area and because the old pollards have not been managed in a long time, it is extremely important to act carefully when and if the pollarding practice are to be reintroduced, to secure the survival of both the trees and their epiphytes. High light intensity causes rapid chlorophyll degradation in air-dry thalli of *Lobarion* species; a few days are enough to kill a thallus (Gauslaa & Solhaug 1996). Until thorough research has shown how much pollarding the lichens can resist or are in need of, only slow 'first aid' restoration through an 'individual pollarded tree management plan' over several years (cf. Fay 2008) should be introduced. Implementation of such a plan might take decades, so this work should start immediately.

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9 APPENDICES

Appendix 1 Lichen species list

#	Lichen species	Norwegian common name	Frequency	Relative frequency	Redlist category (Kålås et al. 2010)
1	*Cetrelia olivetorum*	praktlav	1	0.004	VU
2	*Collema fasciculare*	puteglye	11	0.039	
3	*Collema flaccidum*	skjellglye	107	0.384	
4	*Collema furfuraceum*	fløyelsglye	3	0.011	
5	*Collema subflaccidum*	stiftglye	83	0.297	
6	*Collema subnigrescens*	ospeblæreglye	1	0.004	
7	*Degelia plumbea*	vanlig blåfiltlav	51	0.183	
8	*Fuscopannaria ignobilis*	skorpefiltlav	29	0.104	NT
9	*Fuscopannaria mediterranea*	olivenfiltlav	3	0.011	NT
10	*Fuscopannaria sampaiana*	kastanjefiltlav	7	0.025	VU
11	*Leptogium burgessii*	kranshinnelav	30	0.108	VU
12	*Leptogium cochleatum*	prakthinnelav	13	0.047	EN
13	*Leptogium cyanescens*	blyhinnelav	75	0.269	
14	*Leptogium hibernicum*	irsk hinnelav	13	0.047	EN
15	*Leptogium lichenoides*	flishinnelav	99	0.355	
16	*Leptogium saturninum*	filthinnelav	49	0.176	
17	*Lobaria amplissima*	sølvnever	23	0.082	
18	*Lobaria pulmonaria*	lungenever	85	0.305	
19	*Lobaria scrobiculata*	skrubbenever	17	0.061	
20	*Lobaria virens*	kystnever	172	0.616	
21	*Massalongia carnosa*	moseskjell	1	0.004	
22	*Nephroma bellum*	glattvrenge	12	0.043	
23	*Nephroma laevigatum*	kystvrenge	33	0.118	
24	*Nephroma parile*	grynvrenge	30	0.108	
25	*Nephroma resupinatum*	lodnevrenge	57	0.204	
26	*Normandina pulchella*	muslinglav	146	0.523	
27	*Pannaria conoplea*	grynfiltlav	135	0.484	
28	*Pannaria rubiginosa*	kystfiltlav	21	0.075	
29	*Parmeliella triptophylla*	stiftfiltlav	228	0.817	
30	*Peltigera collina*	kystårenever	35	0.125	
31	*Peltigera horizontalis*	blanknever	58	0.208	
32	*Peltigera hymenina*	papirnever	4	0.014	
33	*Peltigera malacea*	mattnever	15	0.054	
34	*Peltigera membranacea*	hinnenever	55	0.197	
35	*Peltigera polydactylon*	fingernever	3	0.011	
36	*Peltigera praetextata*	skjellnever	134	0.480	
37	*Protopannaria pezizoides*	skålfiltlav	1	0.004	
38	*Rinodina isidiodes*	'en ringlav'	1	0.004	CR
39	*Sticta fuliginosa*	rund porelav	128	0.459	
40	*Sticta limbata*	grynporelav	2	0.007	
41	*Sticta sylvatica*	buktporelav	140	0.502	

Appendix 2 Data set - Target species

Tree number	cetr_olivet	coll_fasci	coll_flacc	coll_furfu	coll_subfl	coll_subni	dege_plumb	fusc_ignob	fusc_medit	fusc_sampa	lept_burge	lept_cochl	lept_cyane	lept_hiber	lept_liche	lept_satur	loba_ampli	loba_pulmo	loba_scrob	loba_viren	mass_carno	neph_bellu	neph_laevi	neph_paril	neph_resup	norm_pulch	pann_conop	pann_rubig	parm_tript	pelt_colli	pelt_horiz	pelt_hymen	pelt_malac	pelt_membr	prot_peziz	pelt_polyd	pelt_praet	rino_isidi	stic_fulig	stic_limba	stic_sylva
1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1	0	1	0	1
2	0	0	1	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0	1	0	1	0	0	1	0	0	0	0	1	0	1
3	0	0	1	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0	1	0	0	0	0	1	0	1	0	0	0	0	0	1	0	1	0	1
4	0	0	1	0	0	0	0	1	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	1	0	0	1	0	0	1	0	0	1	1	0	0	0	0	0	0	1	0	1	0	1
6	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1	1	0	0	1	0	0	0	0	0	0	0	1	0	1	0	1
7	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	1	0	1	0	1
8	0	0	1	0	1	0	0	0	0	0	0	0	1	0	1	1	0	0	0	1	0	0	1	0	1	0	0	0	1	0	0	0	0	0	0	0	1	0	1	0	0
9	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0
11	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	1	0	0	0	1	1	0	0	0	1	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	1	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0
15	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	1	0	0	0	1	0	0	0	0
16	0	0	0	0	0	0	0	1	0	0	0	0	1	0	1	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	1
18	0	0	1	0	1	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	1	0	1	0	0
19	0	0	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	1	0	1	0	0	0	0	0	1	0	0	0	1
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0
21	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	1	0	1	0	0	0	0	0	0	0	1	0	1
22	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	1	0	1	0	1
23	0	0	1	0	0	0	1	0	0	0	0	0	0	1	0	1	0	0	0	1	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	1	0	1	0	1
24	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	1	1	0	0	1	0	0	0	0	0	0	0	1	0	0	0	1
25	0	0	0	0	1	0	0	0	0	0	0	1	0	0	1	0	0	1	0	1	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	1	0	1
26	0	0	0	0	1	0	0	0	0	0	0	1	0	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0	1	0	1	0	0	0	0	0	0	0	1	0	1
27	0	0	1	0	0	0	1	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0	1	0	0	0	0
28	0	0	1	0	0	0	0	0	0	0	1	0	1	0	0	1	1	0	0	1	0	0	0	0	1	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	1
29	0	0	1	0	0	0	0	0	0	0	0	0	1	0	1	0	0	1	0	1	0	0	0	0	1	1	0	0	1	0	0	0	0	0	0	0	1	0	1	0	0
30	0	0	1	1	0	0	0	0	0	0	0	1	0	0	1	1	0	0	0	1	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	1	0	1	0	1

Tree number	cetr_olivet	coll_fasci	coll_flacc	coll_furfu	coll_subfl	coll_subni	dege_plumb	fusc_ignob	fusc_medit	fusc_sampa	lept_burge	lept_cochl	lept_cyane	lept_hiber	lept_liche	lept_satur	loba_ampli	loba_pulmo	loba_scrob	loba_viren	mass_carno
31	0	0	1	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0
32	0	0	1	0	0	0	1	0	0	0	0	0	1	0	0	1	1	0	0	1	0
33	0	0	1	0	1	0	1	1	0	0	0	0	1	0	1	0	1	1	0	1	0
34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	1	0	0	0
36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0
37	0	0	1	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	1	0
38	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0
39	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	0
40	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
41	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	0
42	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
43	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
44	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	0
45	0	0	1	0	0	0	1	0	0	0	1	1	0	1	1	1	0	1	0	1	0
46	0	0	1	0	0	0	0	0	0	0	0	1	0	0	1	1	0	0	0	1	0
47	0	0	0	0	1	0	0	1	0	1	0	0	1	1	1	0	0	1	0	1	0
48	0	0	1	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	1	0
49	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0
50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
51	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
52	0	0	1	0	0	0	1	0	0	0	1	0	0	0	0	1	0	0	0	0	0
53	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0
54	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	1	0
55	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	1	0
56	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
57	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
58	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
59	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
60	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
61	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
62	0	0	0	0	1	0	1	0	0	0	0	1	0	0	0	0	0	1	0	1	0

Tree number	neph_bellu	neph_laevi	neph_paril	neph_resup	norm_pulch	pann_conop	pann_rubig	parm_tript	pelt_colli	pelt_horiz	pelt_hymen	pelt_malac	pelt_membr	prot_peziz	pelt_polyd	pelt_praet	rino_isidi	stic_fulig	stic_limba	stic_sylva
31	0	1	0	1	0	0	0	1	0	0	0	0	0	0	0	1	0	1	0	1
32	0	0	0	0	1	0	0	1	0	1	0	0	0	0	0	0	0	0	0	1
33	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0	1	0	1
34	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35	0	1	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	1	1
36	0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	1	0	0	0	1
37	0	0	0	1	0	1	0	1	0	1	0	0	1	0	0	1	0	1	0	1
38	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	1	0	0	0	1
39	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0
40	0	1	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
41	0	0	1	0	1	1	0	1	0	1	0	0	0	0	0	0	0	1	0	1
42	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
43	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
44	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
45	0	0	0	1	0	0	0	1	0	1	0	0	0	0	0	0	0	1	0	1
46	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	1	0	1	0	0
47	0	0	0	0	1	0	1	1	0	0	0	0	0	0	0	1	0	1	0	1
48	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	1	0	1	0	0
49	0	0	0	1	1	0	0	1	0	0	0	0	0	0	0	1	0	1	0	0
50	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
51	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
52	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0
53	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	1	0	1	0	0
54	0	0	0	1	1	1	0	1	0	0	0	0	0	0	0	1	0	1	0	1
55	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	1	0	0	0	0
56	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
57	0	0	0	1	1	1	0	1	0	0	0	0	0	0	0	0	0	1	0	0
58	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
59	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	1
60	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	1	0	1
61	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
62	0	0	1	0	1	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0

Tree number	cetr_olivet	coll_fasci	coll_flacc	coll_furfu	coll_subfl	coll_subni	dege_plumb	fusc_ignob	fusc_medit	fusc_sampa	lept_burge	lept_cochl	lept_cyane	lept_hiber	lept_liche	lept_satur	loba_ampli	loba_pulmo	loba_scrob	loba_viren	mass_carno	neph_bellu	neph_laevi	neph_paril	neph_resup	norm_pulch	pann_conop	pann_rubig	parm_tript	pelt_colli	pelt_horiz	pelt_hymen	pelt_malac	pelt_membr	prot_peziz	pelt_polyd	pelt_praet	rino_isidi	stic_fulig	stic_limba	stic_sylva
63	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0
64	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0
65	0	0	0	0	1	0	1	0	0	1	0	0	1	0	1	1	0	0	0	1	0	0	1	0	0	1	0	0	1	0	1	0	0	0	0	0	1	0	0	0	0
66	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	1	0	0
67	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
68	0	0	1	0	0	0	0	0	0	0	1	0	1	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0	1	0	1	0	0	0	0	0	0	0	1	0	1
69	0	0	1	0	0	0	0	0	0	0	0	0	1	1	1	0	0	1	0	1	1	0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	1	0	1
70	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0
71	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	1	0	1	0	1
72	0	0	0	0	1	0	1	0	0	0	0	0	0	0	1	0	0	1	0	1	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0
73	0	0	1	0	0	0	1	0	0	0	0	0	1	0	1	1	1	1	0	0	0	0	1	0	1	0	0	0	1	0	0	0	0	0	0	0	1	0	1	0	1
74	0	0	1	0	0	0	0	0	0	0	0	0	1	0	1	0	0	1	0	1	0	1	0	0	0	0	0	0	1	0	1	0	0	0	0	0	1	0	1	0	1
75	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	1	0	1
76	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
77	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
78	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
79	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0
80	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
82	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
83	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
84	0	0	1	0	0	0	1	0	0	0	0	0	0	0	1	1	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1
85	1	0	0	0	1	0	1	1	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	1	0	0	0	1
86	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
87	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
88	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
89	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
90	0	0	0	0	1	0	0	0	0	0	0	1	0	0	1	0	0	0	0	1	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	1	0	1	0	1
91	0	0	1	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	1	0	0	0	1
92	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
93	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	1	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	1	0	0	0	0
94	0	0	1	0	1	0	1	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	1	0	1	1	0	1	0	0	1	0	0	0	0	1	0	0	0	0
95	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	1	1	0	0	0	0	0	0	1	0	0	0	0

Tree number	cetr_olivet	coll_fasci	coll_flacc	coll_furfu	coll_subfl	coll_subni	dege_plumb	fusc_ignob	fusc_medit	fusc_sampa	lept_burge	lept_cochl	lept_cyane	lept_hiber	lept_liche	lept_satur	loba_ampli	loba_pulmo	loba_scrob	loba_viren	mass_carno	neph_bellu	neph_laevi	neph_paril	neph_resup	norm_pulch	pann_conop	pann_rubig	parm_tript	pelt_colli	pelt_horiz	pelt_hymen	pelt_malac	pelt_membr	prot_peziz	pelt_polyd	pelt_praet	rino_isidi	stic_fulig	stic_limba	stic_sylva
96	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	1
97	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0	0	0	0	0	1	0	1	0	1
98	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	1	0	0	1	0	0	0	0
99	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1	0	1	0	0	0	0	1	0	0	1	0	0	0	1
100	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	1	0	1	1	1	0	0	0	0	0	0	0	0	0	1
101	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1	0	1	1	0	0	0	0	0	0	1	0	0	0	1
102	0	0	1	0	1	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	1	1	0	1	1	1	0	0	0	0	0	1	0	1	0	1
103	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	1	0	1	1	1	0	1	0	0	0	0	0	0	0	1	0	1	0	1
104	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	1	1	0	0	1	0	0	0	0	0	0	0	1
105	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	1	0	1	0	1
106	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	1
107	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	1	0	0	0	0	0	1	0	0	1	0	0	0	1	0	0	0	0	0	1	0	1
108	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	1	1	1	0	1	0	0	0	1	0	1	0	0
109	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
110	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	1	0	1	0	0
111	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	1	0	1	0	0
112	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
113	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	1	0	0	0	1
114	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	1	1	0	0	0	0	1	0	0	0	0	1	0	1	0	1
115	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	1	0	0	0	1	0	0	0	0	0	1	1	0	1	0	0	0	0	1	0	0	0	0	1	0	1
116	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0	0	1	1	0	1	1	0	0	0	0	0	0	1	0	0	0	1
117	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	1	0	1	0	1	0	0	0	0	0	1	0	0	0	1
118	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	1	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	1	0	0	0	1
119	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
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121	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	1	1	0	0	1	1	0	0	0	1	0	0	0	0	1	0	0
122	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	1	0	0	1	0	1	0	0	0	0	0	0	0	1	0	0
124	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	1	0	1	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0
125	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	0	1	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	1
126	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	1
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128	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	1	1	0	1	1	0	0	0	1	0	0	0	0	1	0	1

Tree number	cetr_olivet	coll_fasci	coll_flacc	coll_furfu	coll_subfl	coll_subni	dege_plumb	fusc_ignob	fusc_medit	fusc_sampa	lept_burge	lept_cochl	lept_cyane	lept_hiber	lept_liche	lept_satur	loba_ampli	loba_pulmo	loba_scrob	loba_viren	mass_carno	neph_bellu	neph_laevi	neph_paril	neph_resup	norm_pulch	pann_conop	pann_rubig	parm_tript	pelt_colli	pelt_horiz	pelt_hymen	pelt_malac	pelt_membr	prot_peziz	pelt_polyd	pelt_praet	rino_isidi	stic_fulig	stic_limba	stic_sylva
129	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	1	0	1	0	1
130	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	1	0	1	1	0	0	0	0	0	1	1	0	1	0	1
131	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	1	0	1	0	1
132	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
133	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
134	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1	0	1	1	1	0	0	0	0	0	0	0	0	0	0
135	0	1	0	0	1	0	0	1	0	0	0	0	1	0	0	1	0	1	1	1	0	0	1	0	0	0	1	0	0	1	0	0	0	0	0	0	1	0	1	0	0
136	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	1	1	1	0	1	0	0	1	0	0	1	1	0	1	1	0	0	0	1	0	0	0	0	1	0	1
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156	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1	1	1	0	1	1	0	0	0	0	0	0	0	0	1	0	1
157	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0
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Tree number	cetr_olivet	coll_fasci	coll_flacc	coll_furfu	coll_subfl	coll_subni	dege_plumb	fusc_ignob	fusc_medit	fusc_sampa	lept_burge	lept_cochl	lept_cyane	lept_hiber	lept_liche	lept_satur	loba_ampli	loba_pulmo	loba_scrob	loba_viren	mass_carno	neph_bellu	neph_laevi	neph_paril	neph_resup	norm_pulch	pann_conop	pann_rubig	parm_tript	pelt_colli	pelt_horiz	pelt_hymen	pelt_malac	pelt_membr	prot_peziz	pelt_polyd	pelt_praet	rino_isidi	stic_fulig	stic_limba	stic_sylva
162	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1	0	0	1	0	0	0	0
164	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1	0	1	0	0	0	0	1	0	0	1	0	0	0	0
165	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
166	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
167	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	1	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
168	0	0	1	0	0	0	1	0	0	0	1	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	1	0	0	0	0	1	0	0	1	0	0	0	0
169	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	1	1	0	1	0	1	0	0	0	0	0	1	0	0	0	1
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Tree number	cetr_olivet	coll_fasci	coll_flacc	coll_furfu	coll_subfl	coll_subni	dege_plumb	fusc_ignob	fusc_medit	fusc_sampa	lept_burge	lept_cochl	lept_cyane	lept_hiber	lept_liche	lept_satur	loba_ampli	loba_pulmo	loba_scrob	loba_viren	mass_carno	neph_bellu	neph_laevi	neph_paril	neph_resup	norm_pulch	pann_conop	pann_rubig	parm_tript	pelt_colli	pelt_horiz	pelt_hymen	pelt_malac	pelt_membr	prot_peziz	pelt_polyd	pelt_praet	rino_isidi	stic_fulig	stic_limba	stic_sylva
197	0	1	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
198	0	0	1	0	1	0	0	1	0	0	0	0	1	0	1	0	0	1	0	1	0	0	0	0	0	1	1	1	1	0	0	0	0	1	0	0	1	0	1	0	1
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204	0	0	0	0	1	0	0	1	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	1	0	0	0	0	1	0	0	1	0	0	0	0
205	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
206	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1	0	1	0	0	0	0	1	0	0	1	0	1	0	0
207	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	1	0	0	0	0	0	0	1	0	1	1	0	0	0	1	0	0	0	0	1	0	1
208	0	0	1	0	0	0	1	1	0	0	1	0	1	1	0	0	0	0	0	1	0	0	0	0	0	1	1	0	1	0	1	0	0	0	0	0	0	0	0	0	1
209	0	0	1	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	1	0	0	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0	0	1	0	1
210	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	1	0	0	0	1	0	0	0	0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	1
212	0	0	0	0	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	1	0	0
213	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	1	0	0	1	0	0	0	0	0	0	1
214	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	1	0	1	0	0
215	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	0	0	1	0	0	0	0	0	1	0
216	0	0	1	0	1	0	0	1	0	0	0	0	0	0	0	1	1	0	0	1	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	1	0	1	0	0
217	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0
218	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	1	1	0	1	0	1	0	0	0	0	0	0	0	1	0	0
219	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	1	0	1	0	0	0	0	0	0	0	0	1	0	1	0	0	1	0	0	0	0	0	0	0
220	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	1	0	1	0	0
221	0	0	1	0	0	0	0	0	0	0	0	0	1	0	1	1	0	1	0	1	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0
222	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	1	0	1	0	1	0	0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
223	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	1	0	0
224	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	1	1	1	0	0	0	0	1	0	0	0	0	0	0	0
225	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
226	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	1
227	0	0	0	0	0	0	0	0	0	1	1	0	1	0	1	0	0	1	0	1	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	0	1	0	1	0	1
228	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	1	0	0	1	1	0	1	0	0	0	0	1	0	0	0	0	1	0	0
229	0	0	1	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	1	0	0	1	0	0	1	1	0	1	0	0	0	0	0	0	0	1	0	1	0	0

Tree number	cetr_olivet	coll_fasci	coll_flacc	coll_furfu	coll_subfl	coll_subni	dege_plumb	fusc_ignob	fusc_medit	fusc_sampa	lept_burge	lept_cochl	lept_cyane	lept_hiber	lept_liche	lept_satur	loba_ampli	loba_pulmo	loba_scrob	loba_viren	mass_carno	neph_bellu	neph_laevi	neph_paril	neph_resup	norm_pulch	pann_conop	pann_rubig	parm_tript	pelt_colli	pelt_horiz	pelt_hymen	pelt_malac	pelt_membr	prot_peziz	pelt_polyd	pelt_praet	rino_isidi	stic_fulig	stic_limba	stic_sylva
230	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	1	1	0	1	0	1	0	0	0	0	0	0	0	1	0	1
231	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	1	0	1	0	1
232	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
233	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	1	0	1
234	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	1	0	1
235	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	1	0	0	1	0	0	0	1	0	0	1	0	0	0	1
236	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	1	0	1
237	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	1	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	1	0	1	0	1
243	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	1
244	0	0	1	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0
245	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	1	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
246	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0
248	0	0	0	0	1	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0
249	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	1	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0
251	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
252	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
253	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	1	0	0	0	0
254	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	1	0	0	0	0	0	0	0	0	1	0	0
255	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0	1	1	1	0	0	0	0	0	0	0	1	0	1	0	1
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257	0	0	1	0	0	0	1	0	0	0	1	0	0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	1	0	0
259	0	0	1	0	1	0	0	0	0	0	1	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	1
260	0	0	0	0	1	0	0	0	0	1	1	0	0	0	1	0	0	1	0	1	0	0	0	0	1	0	1	0	0	0	1	0	0	0	0	0	0	0	1	0	0
261	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0	0	0	0	1	0	0	0	1	0	0	0	0	1	0	0	1	0	0	0	1
262	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0
263	0	0	0	0	1	0	0	0	0	0	0	0	1	0	1	0	0	0	0	1	0	0	0	0	1	1	0	0	1	0	1	0	0	0	0	0	1	0	0	0	1
265	0	0	0	0	1	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0
266	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	1	0	0	0	0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	1	0	1
267	0	0	0	0	1	0	0	0	0	0	0	0	1	0	1	1	0	0	0	1	0	0	0	0	1	0	0	0	1	0	1	0	0	0	0	0	0	0	1	0	1
268	0	0	1	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	1	0	0	0	0	1	0	0	0	1	0	0	0	0	1	0	0	0	0	1	0	1
269	0	0	1	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	1	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	1

Tree number	cetr_olivet	coll_fasci	coll_flacc	coll_furfu	coll_subfl	coll_subni	dege_plumb	fusc_ignob	fusc_medit	fusc_sampa	lept_burge	lept_cochl	lept_cyane	lept_hiber	lept_liche	lept_satur	loba_ampli	loba_pulmo	loba_scrob	loba_viren	mass_carno	neph_bellu	neph_laevi	neph_paril	neph_resup	norm_pulch	pann_conop	pann_rubig	parm_tript	pelt_colli	pelt_horiz	pelt_hymen	pelt_malac	pelt_membr	prot_peziz	pelt_polyd	pelt_praet	rino_isidi	stic_fulig	stic_limba	stic_sylva
270	0	0	1	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	1	0	1	1	0	1	0	0	0	1	0	0	0	0	1	0	0	1	0	1	0	1
271	0	0	0	0	1	0	0	0	0	0	0	0	1	1	0	1	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0
272	0	0	1	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	1	0	0	0	0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	1	0	1
273	0	0	1	0	1	0	0	0	0	0	0	0	1	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	1	0	1
274	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	1	0	1
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277	0	0	1	0	0	0	0	0	0	0	1	0	0	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	1	0	1
278	0	0	1	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	1	0	0	1	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
279	0	0	1	0	0	0	1	0	0	0	0	0	0	0	1	0	0	1	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	1	0	1
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282	0	0	1	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	1	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	1
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284	0	0	1	0	1	0	0	1	0	0	0	0	1	0	1	0	0	1	0	0	0	0	1	0	0	1	0	1	1	0	0	0	0	0	0	0	1	0	1	0	1
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288	0	0	1	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	1	0	1
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291	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
292	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	1	1	0	1	0	0	0	0	0	0	0	1	0	0	0	1
293	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	1	0	1	1	0	1	0	0	0	0	0	0	0	0	0	1	0	0
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300	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0

Appendix 3 Data set - Raw data; explanatory variables

Tree number	down_terra	hori_terra	aspect	slope	drainage	canopy_s	canopy_w	canopy_n	canopy_e	aver_canopy	diam_breast	diam_base	stem_incli	lowe_branch	bryophyte	lichens	macrolichen	easting	northing	elevation	callus	crevices	pollarding	smBark	roBark	fiBark	stems
1	4	3	140	20	3	13	14	12	12	12.75	0.853503185	1.369426752	82	32	85	3	10	386.74	330.26	-25.949393	2	2	2	0	0	1	1
2	3	4	60	40	2	13	22	17	17	17.25	1.108280255	1.101910828	92	25	50	33	4	375.62	292.11	-13.650843	2	2	2	0	0	1	1
3	4	4	30	10	5	18	19	22	19	19.5	0.76433121	1.299363057	81	21.5	70	5	10	358.74	299.48	-16.955542	2	2	2	0	0	1	2
4	3	2	87	20	5	20	21	15	18	18.5	0.605095541	0.732484076	70	18	60	3	10	343.95	308.03	-20.64456	1	2	2	0	0	1	1
5	2	3	60	22	3	21	21	4	14	15	0.630573248	0.662420382	70	14.5	45	5	8	366.65	334.37	-22.961363	2	2	2	0	0	1	1
6	3	3	40	27	3	22	24	18	20	21	1.044585987	1.035031847	100	21	50	2	7	323.47	270.28	-8.424609	1	1	2	0	0	1	1
7	3	2	77	32	5	19	22	23	22	21.5	0.923566879	0.875796178	90	22	60	2	7	276.10	294.11	-13.731481	2	2	2	0	0	1	1
8	5	4	61	42	5	22	21	20	22	21.25	1.210191083	1.52866242	83	25	50	2	20	283.12	323.40	-30.306703	2	2	2	0	0	1	1
9	5	3	75	4	3	17	22	20	17	19	0.684713376	0.859872611	100	19	70	1	10	260.53	289.28	-11.787482	1	2	2	0	0	1	1
10	2	3	70	30	5	22	22	23	23	22.5	0.605095541	0.732484076	30	24	65	5	10	255.80	306.57	-15.609954	2	2	2	0	0	1	1
11	4	3	60	40	5	23	24	22	23	23	0.796178344	0.700636943	33	20	35	5	5	250.64	302.24	-14.210711	2	2	2	0	0	1	1
12	3	2	78	55	5	23	23	23	23	23	0.477707006	0.541401274	77	15	50	3	2	245.26	309.63	-17.48769	1	1	2	0	0	1	1
13	4	2	60	45	4	24	23	23	23	23.25	0.621019108	0.557324841	13	20	70	2	4	253.44	311.34	-19.476904	1	2	2	0	0	1	1
14	2	2	72	50	5	22	24	23	23	23	0.700636943	0.812101911	95	25	20	2	5	254.99	320.38	-25.570076	1	2	2	0	0	1	1
15	3	3	57	45	4	24	24	23	24	23.75	0.668789809	0.636942675	90	15	50	1	10	249.46	320.13	-24.961108	1	1	2	0	0	1	1
16	3	3	90	35	2	21	22	21	22	21.5	0.923566879	0.866242038	80	18	45	10	10	258.16	270.84	-4.929448	1	1	2	0	0	1	1
17	3	3	90	40	2	12	20	18	12	15.5	0.605095541	0.732484076	57	32	50	5	15	268.37	256.63	2.520083	1	2	2	0	0	1	1
18	3	2	94	45	2	15	19	20	17	17.75	1.082802548	1.01910828	70	32	40	10	15	281.01	258.65	-0.960077	1	2	2	0	0	1	1
19	3	3	68	40	4	21	20	21	21	20.75	0.955414013	0.987261146	100	24	40	5	15	327.47	264.93	-5.70761	2	2	2	0	0	1	1
20	3	3	64	40	4	23	20	21	22	21.5	0.50955414	0.796178344	40	35	30	30	5	332.52	256.54	-0.817971	2	2	2	0	0	1	1
21	3	3	84	40	4	22	21	18	19	20	0.573248408	1.01910828	60	30	70	5	15	350.64	262.83	-4.090164	1	2	2	0	0	1	1
22	2	2	40	0	3	18	14	19	17	17	1.337579618	1.242038217	90	26	30	5	50	378.31	266.66	-5.372805	2	2	2	0	0	1	1
23	3	3	66	40	4	22	20	23	22	21.75	1.082802548	1.01910828	100	14	40	5	50	376.57	256.73	-0.655329	1	2	2	0	0	1	1
24	4	4	64	20	4	22	21	21	20	21	0.668789809	0.828025478	90	26	20	5	40	374.85	275.71	-8.927774	1	2	2	0	1	1	1
25	3	2	70	40	5	21	24	12	20	19.25	0.732484076	1.178343949	80	20	30	5	10	409.78	269.82	-1.538156	2	1	2	0	0	1	2
26	3	3	54	40	2	20	23	22	21	21.5	0.891719745	0.923566879	95	23	20	30	5	403.78	265.61	-0.802869	1	1	2	0	0	1	1
27	3	3	92	40	5	21	19	20	22	20.5	0.636942675	0.732484076	100	36	60	5	15	415.68	253.72	4.666512	1	1	1	0	0	1	1
28	3	3	60	40	2	21	22	21	24	22	1.178343949	1.337579618	100	25	15	5	10	425.83	244.78	8.642001	2	2	2	0	0	1	1
29	3	2	60	40	4	20	24	21	20	21.25	0.859872611	0.828025478	90	18	50	5	15	419.10	240.33	10.831321	1	2	2	0	0	1	1
30	3	4	54	45	4	21	21	21	22	21.25	0.684713376	0.796178344	90	27	50	5	15	410.35	245.69	9.284696	1	1	1	0	0	1	1

Tree number	down_terra	hori_terra	aspect	slope	drainage	canopy_s	canopy_w	canopy_n	canopy_e	aver_canopy	diam_breast	diam_base	stem_incli	lowe_branch	bryophyte	lichens	macrolichen	easting	northing	elevation	callus	crevices	pollarding	smBark	roBark	fiBark	stems
31	4	2	70	40	4	21	23	22	21	21.75	1.01910828	0.875796178	100	23	80	5	10	417.24	233.22	14.329105	1	1	2	0	0	1	1
32	4	2	58	40	4	20	23	22	21	21.5	1.050955414	0.76433121	100	24	40	7	7	422.37	227.26	17.433097	2	1	2	0	0	1	1
33	3	4	78	40	5	20	21	23	20	21	0.541401274	1.210191083	80	29	30	5	15	415.15	225.35	19.962579	1	2	2	0	0	1	2
34	4	1	84	80	5	23	22	21	22	22	0.350318471	0.445859873	100	38	40	40	2	401.89	205.49	34.151248	1	1	1	1	0	0	1
35	5	1	78	60	5	22	21	21	23	21.75	0.414012739	0.461783439	70	10	70	5	7	397.71	203.61	42.873209	1	1	1	0	0	1	1
36	3	2	98	20	3	21	20	23	22	21.5	1.27388535	1.114649682	85	8	60	5	10	388.87	183.53	50.729028	1	2	2	0	0	1	1
37	2	4	88	20	2	22	21	24	22	22.25	1.146496815	1.050955414	100	24	70	5	20	381.69	181.46	54.059401	1	1	2	0	0	1	1
38	3	2	100	40	3	15	18	23	21	19.25	0.76433121	0.796178344	70	22	80	2	5	383.28	175.06	55.987225	1	2	2	0	0	1	1
39	3	4	78	45	3	14	20	22	20	19	1.337579618	1.146496815	100	29	30	2	10	392.41	174.72	56.091304	2	2	2	0	0	1	1
40	3	4	78	45	3	20	20	23	21	21	0.477707006	0.573248408	40	22	80	4	2	389.69	173.50	55.603431	1	2	2	0	0	1	1
41	4	2	38	40	5	22	18	21	22	20.75	1.178343949	1.337579618	70	20	50	5	20	423.16	170.01	56.230215	2	2	1	0	0	1	1
42	3	3	60	50	4	22	22	19	22	21.25	0.445859873	0.589171975	100	37	30	30	5	339.12	264.56	-4.694819	1	1	1	0	1	0	1
43	3	3	60	50	4	24	21	21	20	21.5	0.318471338	0.414012739	100	55	10	50	2	339.30	261.85	-3.229801	1	1	1	0	1	0	1
44	3	3	60	40	4	23	22	22	20	21.75	0.50955414	0.541401274	83	13	30	5	20	333.72	245.03	7.383671	2	2	1	0	0	1	1
45	3	3	50	50	2	22	24	22	24	23	1.114649682	1.01910828	60	14	60	5	10	324.80	239.19	12.655281	2	2	2	0	0	1	1
46	3	3	50	50	2	22	24	21	22	22.25	0.923566879	1.003184713	70	13	50	5	10	324.84	237.33	14.240814	1	2	2	0	0	1	1
47	3	3	50	50	2	23	22	20	19	21	0.636942675	0.732484076	60	17	70	5	10	323.19	241.78	10.865652	1	1	2	0	0	1	1
48	3	2	62	50	5	24	21	20	17	20.5	0.987261146	1.082802548	80	20	40	5	10	342.51	226.14	20.666218	1	2	2	0	0	1	1
49	2	3	60	60	2	24	21	23	21	22.25	0.350318471	0.541401274	90	24	30	5	10	357.92	229.96	21.893119	1	1	1	0	0	1	1
50	3	3	64	50	4	24	23	14	22	20.75	0.350318471	0.445859873	100	23	50	20	2	325.56	226.63	25.574678	2	1	1	0	1	0	1
51	3	3	62	50	4	22	19	23	21	21.25	0.445859873	1.01910828	65	27	40	5	10	320.63	223.27	29.151529	1	2	2	0	0	1	3
52	3	3	64	50	4	21	22	21	20	21	0.636942675	0.828025478	60	23	70	5	10	325.26	221.12	30.717816	1	2	2	0	0	1	1
53	3	2	50	60	5	21	19	22	19	20.25	1.082802548	1.050955414	95	27	50	5	15	353.70	214.37	36.682921	1	1	2	0	0	1	1
54	3	3	82	60	3	21	22	22	21	21.5	0.780254777	0.859872611	90	20	60	5	10	376.98	220.21	32.829551	1	1	2	0	0	1	1
55	3	3	82	60	3	18	20	22	18	19.5	0.621019108	0.732484076	90	20	40	5	30	376.30	216.21	37.03432	1	1	2	0	0	1	1
56	2	3	25	40	4	20	21	20	21	20.5	0.382165605	0.541401274	80	35	70	5	15	325.85	204.90	42.806377	1	1	1	0	0	1	1
57	3	3	50	40	3	19	23	24	24	22.5	0.286624204	0.398089172	95	24	30	40	1	371.37	183.97	51.76046	1	1	1	1	0	0	1
58	4	3	50	10	3	24	22	23	23	23	0.350318471	0.461783439	80	22	40	40	1	372.28	190.55	49.836079	1	1	1	0	0	1	1
59	3	3	80	40	3	22	20	17	17	19	1.27388535	1.433121019	60	32	70	5	10	373.78	165.80	61.219539	2	2	2	0	0	1	1
60	3	3	80	40	3	17	20	21	13	17.75	0.732484076	1.01910828	80	32	70	5	10	373.43	163.85	61.532694	2	2	2	0	0	1	1
61	3	3	80	40	4	23	18	20	22	20.75	0.25477707	0.414012739	80	42	20	50	1	381.03	153.81	66.794304	1	1	1	1	0	0	1
62	4	2	40	40	3	19	22	22	19	20.5	0.668789809	0.859872611	85	25	30	5	10	230.89	292.57	-10.984786	1	1	2	0	0	1	1

Tree number	down_terra	hori_terra	aspect	slope	drainage	canopy_s	canopy_w	canopy_n	canopy_e	aver_canopy	diam_breast	diam_base	stem_incli	lowe_branch	bryophyte	lichens	macrolichen	easting	northing	elevation	callus	crevices	pollarding	smBark	roBark	fiBark	stems
63	3	3	65	50	3	23	23	22	22	22.5	0.541401274	0.684713376	100	8	70	3	5	222.70	312.75	-21.804348	1	2	2	0	0	1	1
64	3	3	65	50	5	23	24	22	24	23.25	0.50955414	0.605095541	40	18	40	5	10	220.09	308.84	-19.913284	1	2	2	0	0	1	1
65	3	2	98	50	3	21	22	20	22	21.25	0.828025478	0.859872611	75	20	30	3	10	236.99	267.79	-1.546361	1	1	2	0	0	1	1
66	4	2	106	50	2	21	22	23	22	22	0.605095541	0.573248408	80	19	40	5	10	234.04	262.48	1.796364	1	1	2	0	0	1	1
67	4	2	106	50	2	22	22	22	21	21.75	0.5	0.433121019	70	20	50	5	10	234.46	261.29	1.879146	2	2	2	0	0	1	1
68	3	2	84	50	3	21	24	24	12	20.25	0.668789809	0.76433121	90	24	70	5	15	262.43	241.79	12.569342	2	1	2	0	0	1	1
69	3	2	84	50	2	22	23	24	24	23.25	0.780254777	0.700636943	70	14	70	5	20	258.54	241.08	13.976643	1	1	2	0	0	1	1
70	3	2	84	50	2	19	23	24	20	21.5	0.732484076	0.828025478	40	30	50	2	5	253.63	241.21	16.058756	1	2	2	0	0	1	1
71	4	3	78	60	2	24	23	20	24	22.75	0.445859873	0.605095541	70	24	40	2	10	250.84	235.68	19.44516	2	2	2	0	0	1	1
72	3	3	66	40	4	22	22	23	23	22.5	0.50955414	0.541401274	100	40	10	5	30	377.90	255.47	0.109114	1	2	2	0	0	1	1
73	4	2	50	20	5	20	21	19	20	20	0.445859873	0.50955414	100	35	60	10	10	403.40	281.58	-9.107366	1	1	1	0	0	1	1
74	3	2	90	50	2	22	24	24	22	23	0.828025478	0.987261146	85	20	20	5	10	262.24	223.32	27.294117	1	2	2	0	0	1	1
75	3	3	102	50	2	24	21	24	24	23.25	0.573248408	0.668789809	70	21	60	5	10	271.27	231.24	18.386778	1	1	2	0	0	1	1
76	4	3	86	30	4	21	22	20	22	21.25	0.398089172	0.305732484	100	28	60	25	1	301.76	266.44	-6.406467	1	1	1	1	0	0	1
77	4	2	43	25	4	22	22	24	20	22	0.404458599	0.557324841	100	29	60	10	1	294.21	282.67	-8.937723	1	2	1	0	1	0	1
78	3	2	72	40	4	20	19	20	21	20	0.321656051	0.414012739	100	45	65	30	1	284.61	280.31	-9.365308	1	1	1	1	0	0	1
79	3	2	72	40	4	19	18	21	20	19.5	0.382165605	0.50955414	100	36.5	80	10	1	284.45	278.82	-8.717707	1	1	1	0	0	1	1
80	3	4	72	30	3	20	20	22	19	20.25	0.25477707	0.414012739	95	60	10	60	1	357.56	176.65	54.8965	1	1	1	1	0	0	1
82	3	3	70	30	3	21	14	19	23	19.25	0.25477707	0.350318471	90	25	40	50	1	354.48	179.12	53.255029	1	1	1	1	0	0	1
83	3	4	64	40	4	23	21	22	23	22.25	0.222929936	0.382165605	90	50	20	50	1	390.15	154.02	66.927533	1	1	1	1	0	0	1
84	3	3	60	40	5	22	23	22	19	21.5	0.398089172	0.477707006	60	10	80	5	10	334.34	235.00	14.840826	1	2	1	0	0	1	1
85	4	3	74	20	3	8	8	9	9	8.5	0.573248408	1.464968153	60	33	50	5	10	329.34	180.39	52.223477	2	2	2	0	0	1	1
86	3	3	70	40	4	23	21	22	21	21.75	0.414012739	1.242038217	50	22	70	5	5	334.11	154.62	64.364773	2	2	2	0	0	1	1
87	2	4	49	60	4	22	23	23	22	22.5	0.382165605	0.318471338	80	70	60	5	5	431.79	204.67	37.789274	1	1	1	0	1	1	1
88	3	2	64	50	4	20	19	24	12	18.75	0.382165605	0.700636943	70	35	60	2	1	280.79	207.48	35.162579	1	1	1	0	0	1	1
89	2	2	76	50	4	18	20	24	22	21	0.382165605	1.01910828	80	45	70	5	5	288.50	199.45	41.862636	1	1	1	0	0	1	3
90	4	4	64	20	2	21	12	18	21	18	1.050955414	1.146496815	70	27	30	5	5	272.50	188.68	48.221823	2	2	2	0	0	1	1
91	3	3	48	40	2	22	22	24	22	22.5	1.114649682	1.464968153	60	24	30	2	10	280.76	173.06	56.88743	2	1	2	0	0	1	1
92	2	3	68	60	3	19	21	20	19	19.75	0.302547771	0.445859873	70	80	20	5	5	282.38	162.39	65.148027	1	2	1	0	0	0	1
93	4	3	60	60	3	24	24	24	23	23.75	0.668789809	1.178343949	70	21	60	5	10	278.15	161.48	64.799751	1	2	2	0	0	1	2
94	4	3	80	50	3	24	22	21	22	22.25	0.668789809	1.878980892	80	22	50	5	15	277.13	151.64	72.205066	1	2	2	0	0	1	2
95	4	3	78	40	3	23	23	24	23	23.25	0.987261146	1.114649682	100	20	60	2	10	288.28	150.42	72.042571	2	2	2	0	0	1	1

Tree number	down_terra	hori_terra	aspect	slope	drainage	canopy_s	canopy_w	canopy_n	canopy_e	aver_canopy	diam_breast	diam_base	stem_incli	lowe_branch	bryophyte	lichens	macrolichen	easting	northing	elevation	callus	crevices	pollarding	smBark	roBark	fiBark	stems
96	4	3	78	40	3	22	22	22	21	21.75	1.687898089	0.923566879	80	25.4	60	10	10	292.44	145.50	72.306484	2	1	2	0	0	1	1
97	3	2	100	40	3	20	22	23	24	22.25	0.668789809	0.828025478	80	32	70	2	5	296.80	150.52	68.865904	1	2	2	0	0	1	1
98	3	2	72	40	3	15	20	24	21	20	0.859872611	0.828025478	70	20	50	2	5	302.57	146.75	70.491277	1	2	2	0	0	1	1
99	3	3	60	40	3	22	22	23	23	22.5	0.71656051	0.732484076	70	21	30	5	10	308.62	153.33	67.670165	1	2	2	0	0	1	1
100	3	3	58	40	3	23	22	23	22	22.5	0.828025478	1.050955414	70	21	70	2	5	313.96	154.89	66.287238	2	1	2	0	0	1	1
101	5	2	78	50	3	23	21	18	24	21.5	0.522292994	0.738853503	80	21	70	10	5	273.96	133.67	80.917794	2	1	2	0	0	1	1
102	5	2	88	40	3	21	19	23	20	20.75	0.76433121	1.050955414	90	27	70	2	10	277.35	134.63	79.432899	1	1	2	0	0	1	1
103	4	2	66	50	3	20	19	24	21	21	0.875796178	0.891719745	85	14	50	5	10	277.78	130.93	81.531708	1	2	2	0	0	1	1
104	4	2	88	30	3	23	22	23	19	21.75	0.828025478	1.003184713	80	22	50	5	10	280.38	136.73	78.657408	2	2	2	0	0	1	1
105	4	2	94	50	3	18	23	24	16	20.25	0.891719745	1.01910828	100	16	60	5	10	284.32	132.10	80.656095	1	2	2	0	0	1	1
106	4	2	96	40	3	20	24	19	20	20.75	0.557324841	0.636942675	90	21	60	5	10	284.72	134.36	79.333589	2	1	2	0	0	1	1
107	4	2	84	40	3	18	24	20	17	19.75	0.605095541	0.76433121	80	21	50	5	30	287.06	134.83	79.201374	1	1	2	0	0	1	1
108	4	2	84	40	3	16	23	19	17	18.75	0.573248408	0.987261146	65	24	85	2	5	288.89	134.20	79.187921	1	2	2	0	0	1	1
109	4	2	70	50	3	17	22	21	11	17.75	0.636942675	0.636942675	90	20	20	5	20	290.52	131.62	80.202937	2	2	2	0	0	0	1
110	3	3	67	40	3	22	21	24	22	22.25	0.732484076	0.732484076	60	24	50	5	5	309.95	146.95	71.009081	2	2	1	0	0	1	1
111	3	3	68	40	4	21	21	23	22	21.75	1.242038217	1.178343949	90	25	60	5	5	324.72	144.52	71.22603	1	2	2	0	0	1	1
112	3	2	90	50	3	22	17	19	21	19.75	0.76433121	1.178343949	90	30	50	5	5	348.64	152.03	66.271611	1	2	1	0	0	1	1
113	3	3	70	50	3	21	14	21	22	19.5	0.700636943	0.891719745	60	24	40	2	5	343.55	144.29	70.701381	1	2	1	0	0	1	1
114	3	4	80	50	3	21	22	23	22	22	1.035031847	1.035031847	95	18	50	5	10	357.13	140.10	76.419162	1	1	2	0	0	1	1
115	3	4	80	50	3	21	21	23	23	22	0.891719745	0.891719745	95	20	30	5	30	359.00	140.81	75.881019	1	2	2	0	0	1	1
116	3	3	74	50	3	22	21	22	22	21.75	0.875796178	0.923566879	100	25	70	2	5	374.91	127.78	82.307745	1	2	1	0	0	1	1
117	3	3	60	50	3	21	22	23	19	21.25	1.178343949	1.242038217	75	19	60	1	30	388.78	125.42	83.95547	2	2	2	0	0	1	1
118	3	3	60	50	3	18	21	20	20	19.75	0.828025478	1.401273885	60	29	60	1	10	392.90	130.77	80.432759	1	2	2	0	0	1	2
119	3	3	40	50	3	17	22	23	21	20.75	0.398089172	0.50955414	10	17	80	1	1	399.25	133.36	79.401765	1	2	1	0	0	1	1
120	3	3	40	50	3	20	19	24	23	21.5	0.668789809	0.700636943	100	20	50	1	10	401.80	134.71	79.489126	1	1	2	0	0	1	1
121	3	3	40	50	3	22	22	24	23	22.75	0.891719745	1.210191083	80	17	50	2	5	401.44	136.63	77.852195	1	2	2	0	0	1	1
122	3	4	44	50	3	22	22	19	22	21.25	1.050955414	1.27388535	100	21	60	2	10	358.11	160.92	62.727641	2	2	2	0	0	1	1
124	3	4	60	50	3	21	22	22	24	22.25	0.732484076	0.923566879	80	21	60	2	20	384.51	135.73	77.773162	2	2	2	0	0	1	1
125	3	4	60	50	3	22	22	23	23	22.5	0.828025478	0.923566879	70	60	70	1	5	383.89	137.21	76.838415	2	2	1	0	0	1	1
126	3	2	71	50	3	23	23	22	18	21.5	0.955414013	1.178343949	90	26	50	2	10	395.60	143.15	71.915722	2	2	2	0	0	1	1
127	3	4	52	50	5	23	22	22	23	22.5	0.76433121	0.828025478	70	18	50	5	10	427.84	141.03	78.656098	1	1	2	0	0	1	1
128	3	4	52	50	5	23	22	23	23	22.75	1.01910828	1.210191083	70	23	50	2	20	430.02	143.02	77.606728	1	2	2	0	0	1	1

Tree number	down_terra	hori_terra	aspect	slope	drainage	canopy_s	canopy_w	canopy_n	canopy_e	aver_canopy	diam_breast	diam_base	stem_incli	lowe_branch	bryophyte	lichens	macrolichen	easting	northing	elevation	callus	crevices	pollarding	smBark	roBark	fiBark	stems
129	3	1	56	40	5	22	21	22	23	22	0.573248408	0.573248408	70	50	50	5	5	434.35	138.80	77.853564	1	1	1	0	0	1	1
130	3	3	56	55	5	23	21	23	22	22.25	0.859872611	1.050955414	80	19	60	7	10	422.92	149.71	71.108132	1	2	2	0	0	1	1
131	3	4	52	40	5	22	23	24	22	22.75	0.955414013	1.130573248	60	20	95	0	5	425.17	159.84	62.767233	1	2	2	0	0	1	2
132	3	1	74	50	5	23	22	22	23	22.5	0.318471338	0.525477707	70	50	40	30	5	433.46	100.57	103.361579	1	1	1	0	0	1	2
133	3	1	50	60	5	21	21	22	23	21.75	0.668789809	0.50955414	80	50	60	3	20	434.58	72.94	119.125897	1	1	1	0	0	1	1
134	3	1	44	60	5	23	20	21	22	21.5	0.541401274	0.700636943	80	60	60	2	5	438.45	67.27	121.618449	1	1	1	0	0	1	1
135	3	3	42	50	3	22	22	23	22	22.25	0.605095541	0.859872611	90	33	20	5	15	396.20	91.28	108.477833	1	1	1	0	0	1	1
136	3	3	52	50	3	23	23	23	22	22.75	0.891719745	1.624203822	60	21	50	5	15	387.60	73.77	119.815968	2	2	1	0	0	1	2
137	3	3	60	55	3	23	22	22	23	22.5	0.414012739	0.987261146	40	33	50	2	15	359.94	63.34	129.137819	1	1	1	0	0	1	3
138	3	3	60	50	3	23	22	21	22	22	0.732484076	0.859872611	60	15	50	5	15	369.21	47.95	142.296932	1	1	1	0	0	1	1
139	3	3	60	50	3	21	22	23	22	22	0.414012739	0.477707006	100	28	30	2	15	375.44	34.36	151.776468	1	1	1	0	0	1	1
141	4	4	60	70	2	19	20	24	21	21	0.477707006	0.732484076	60	50	50	5	5	297.51	0.00	176.981251	1	2	1	0	0	1	1
142	2	4	88	70	2	23	22	24	24	23.25	0.318471338	0.955414013	60	25	30	2	10	291.26	9.65	171.492182	1	1	1	0	0	1	3
143	4	2	72	60	2	23	22	23	22	22.5	0.621019108	0.493630573	100	20	20	5	5	293.34	14.19	165.245007	1	1	1	0	0	1	1
144	3	3	60	60	2	23	24	24	24	23.75	0.700636943	0.955414013	100	25	20	5	30	313.43	9.21	168.292747	1	1	1	0	0	1	1
145	3	3	60	60	2	24	22	24	23	23.25	0.525477707	0.668789809	20	20	50	5	15	320.34	5.72	172.499069	1	2	1	0	0	1	1
146	3	3	52	55	2	24	22	24	24	23.5	0.414012739	0.541401274	80	26	50	5	15	318.04	22.11	159.704576	1	1	1	0	0	1	1
147	3	2	78	60	3	22	21	21	22	21.5	0.573248408	0.859872611	80	50	30	5	15	294.87	45.01	144.031865	1	1	1	0	0	1	1
148	4	4	74	75	2	23	22	23	24	23	0.541401274	0.589171975	40	20	60	2	5	289.09	54.56	135.77658	1	2	1	0	1	1	1
149	4	4	58	70	2	22	22	23	24	22.75	0.302547771	0.382165605	100	20	50	10	5	291.61	56.53	133.080077	1	1	1	0	0	1	1
150	4	4	80	50	3	22	22	24	22	22.5	0.541401274	0.828025478	70	26	50	5	15	285.59	62.56	129.177027	1	1	1	0	0	1	1
151	3	4	79	50	3	22	21	23	21	21.75	0.636942675	0.796178344	100	21	40	5	10	276.95	70.92	125.841776	1	1	1	0	0	1	1
152	3	4	50	60	3	21	23	23	23	22.5	0.350318471	0.541401274	90	60	40	5	30	279.95	77.87	120.562685	1	1	1	0	0	1	1
153	4	2	90	45	3	24	23	23	22	23	1.337579618	1.305732484	100	21	10	10	15	285.88	78.16	117.464466	2	2	1	0	0	1	1
154	3	4	64	45	3	24	24	23	24	23.75	0.477707006	0.796178344	80	50	70	5	15	279.28	84.15	116.88748	1	1	1	0	0	1	2
155	3	4	86	45	3	24	23	23	21	22.75	0.636942675	0.828025478	80	26	60	5	10	283.30	85.69	114.286235	1	1	1	0	0	1	1
156	3	3	60	55	3	24	20	21	24	22.25	0.50955414	0.668789809	100	23	30	5	20	310.38	79.81	115.53582	1	1	1	0	0	1	1
157	3	3	70	55	3	24	22	24	23	23.25	0.461783439	0.366242038	80	25	60	2	20	311.94	80.91	114.998556	1	1	1	0	0	1	1
158	3	3	56	55	3	24	20	24	23	22.75	0.50955414	0.636942675	80	35	55	30	10	316.26	92.85	106.328544	1	1	1	0	0	1	1
159	3	2	60	55	3	24	22	22	23	22.75	0.891719745	1.369426752	90	20	60	5	10	303.79	106.23	96.824434	2	2	1	0	0	1	2
160	3	2	88	50	3	24	21	22	22	22.25	0.732484076	1.146496815	60	22	40	5	10	291.74	105.73	99.023678	2	2	1	0	0	1	1
161	3	4	56	50	3	20	17	19	22	19.5	0.987261146	1.01910828	70	25.4	60	5	10	287.29	100.70	103.165919	2	2	1	0	0	1	1

Tree number	down_terra	hori_terra	aspect	slope	drainage	canopy_s	canopy_w	canopy_n	canopy_e	aver_canopy	diam_breast	diam_base	stem_incli	lowe_branch	bryophyte	lichens	macrolichen	easting	northing	elevation	callus	crevices	pollarding	smBark	roBark	fiBark	stems
162	3	3	68	50	3	23	23	21	23	22.5	0.668789809	0.796178344	85	21	40	30	5	277.24	101.99	103.635076	1	1	1	0	0	1	1
164	3	3	64	60	3	24	24	23	22	23.25	0.828025478	0.891719745	70	18	50	20	5	273.28	109.29	98.816945	1	2	2	0	0	1	1
165	3	3	60	60	3	24	24	23	22	23.25	0.668789809	0.796178344	80	17	60	2	5	265.63	111.56	98.577718	1	1	1	0	0	1	1
166	2	4	57	45	3	20	22	23	23	22	0.796178344	0.859872611	85	15	80	3	15	253.04	126.69	86.175092	2	2	2	0	0	1	1
167	2	4	43	45	3	17	24	20	18	19.75	0.796178344	0.76433121	80	15	60	3	10	252.29	120.95	90.851651	2	2	2	0	0	1	1
168	2	4	52	45	3	23	23	20	22	22	0.923566879	1.082802548	80	25	40	10	15	243.17	121.57	88.819339	1	2	2	0	0	1	1
169	3	2	68	45	3	21	22	23	21	21.75	0.76433121	0.859872611	80	21	60	5	10	236.30	122.79	88.826914	1	1	2	0	0	1	1
170	3	4	57	45	3	18	20	20	21	19.75	0.955414013	1.210191083	85	20	60	2	7	223.08	130.43	85.414994	2	2	2	0	0	1	1
171	3	4	42	45	3	22	22	24	24	23	0.859872611	0.955414013	70	20	30	15	10	216.18	123.41	89.248451	1	2	2	0	0	1	1
172	3	4	50	45	3	24	24	24	24	24	1.178343949	1.78343949	95	22	50	5	5	212.47	129.04	86.521652	2	2	2	0	0	1	2
173	3	2	45	50	3	24	24	24	24	24	1.78343949	1.815286624	95	16	30	10	15	226.92	138.01	82.058157	2	2	2	0	0	1	2
174	3	2	44	45	3	20	20	18	21	19.75	1.01910828	1.050955414	70	18	50	5	10	210.72	140.43	81.091901	1	1	2	0	0	1	1
175	3	3	55	50	2	24	24	18	19	21.25	0.828025478	0.891719745	70	19	30	5	5	184.20	122.46	89.261903	1	1	2	0	0	1	1
176	3	4	60	60	2	24	24	24	24	24	0.414012739	0.573248408	40	14	60	1	1	181.18	117.64	92.365983	1	1	1	0	0	1	1
177	2	4	58	70	2	20	18	18	19	18.75	0.955414013	0.859872611	80	17	70	2	10	172.58	118.27	90.750911	1	1	2	0	0	1	1
178	2	4	58	70	2	19	18	19	20	19	0.636942675	0.796178344	80	19	60	2	15	171.58	116.55	91.735751	1	1	2	0	0	1	1
180	4	2	54	70	2	19	20	18	19	19	0.318471338	0.541401274	70	60	70	2	7	166.89	107.56	101.154101	1	1	1	0	0	0	2
181	3	3	32	70	2	20	19	20	21	20	0.636942675	0.796178344	80	21	60	5	10	165.51	125.72	83.059742	1	2	2	0	0	1	1
182	3	3	42	70	2	20	21	19	19	19.75	0.636942675	0.732484076	80	20	30	5	15	180.23	127.13	85.040879	1	2	2	0	0	1	1
183	2	2	74	60	3	24	19	19	19	20.25	0.477707006	0.955414013	90	23	60	2	15	223.73	154.14	73.843994	1	1	2	0	0	1	2
184	2	2	100	60	3	18	19	20	21	19.5	0.732484076	0.891719745	40	21	50	5	5	229.43	155.09	72.512893	1	2	2	0	0	1	1
185	5	2	60	30	3	24	19	24	23	22.5	1.146496815	1.305732484	90	23	70	1	5	271.95	146.68	75.450103	2	2	2	0	0	1	1
187	2	5	110	50	3	22	16	15	19	18	0.50955414	0.700636943	65	21	50	5	30	185.73	90.33	122.354946	2	1	2	0	0	1	1
188	3	5	84	65	3	20	20	22	22	21	0.955414013	1.01910828	70	19	60	5	5	175.68	58.88	145.353624	2	1	2	0	0	1	1
189	2	4	80	60	3	18	20	22	20	20	0.318471338	0.445859873	60	50	70	5	10	251.89	24.72	171.545952	1	1	1	0	0	1	1
190	3	4	82	60	3	21	24	23	24	23	0.987261146	0.955414013	100	18	60	5	10	248.54	66.23	135.527446	2	2	1	0	0	1	1
191	3	3	40	60	2	23	23	21	22	22.25	0.382165605	0.573248408	80	21	60	5	20	348.40	88.19	110.532019	1	1	2	0	0	1	1
192	3	2	54	60	3	22	23	23	23	22.75	0.445859873	0.605095541	90	50	40	5	20	342.58	105.32	97.304264	1	1	1	0	0	1	1
193	3	3	60	60	3	16	17	22	23	19.5	0.382165605	0.541401274	70	18	40	5	20	354.96	108.47	97.49744	1	1	1	0	0	1	1
194	3	3	60	60	3	21	22	23	22	22	0.350318471	0.414012739	60	23	70	5	10	356.24	109.62	96.046276	1	1	1	0	0	1	1
195	3	4	76	60	2	22	21	23	23	22.25	0.573248408	0.668789809	40	23	40	5	10	359.10	100.68	102.744161	1	1	2	0	0	1	1
196	3	3	56	60	2	23	22	22	23	22.5	0.50955414	0.987261146	90	60	30	5	15	376.84	96.79	103.396223	1	1	2	0	0	1	2

Tree number	down_terra	hori_terra	aspect	slope	drainage	canopy_s	canopy_w	canopy_n	canopy_e	aver_canopy	diam_breast	diam_base	stem_incli	lowe_branch	bryophyte	lichens	macrolichen	easting	northing	elevation	callus	crevices	pollarding	smBark	roBark	fiBark	stems
197	3	3	56	60	2	23	22	23	23	22.75	0.222929936	0.25477707	80	26	20	5	30	377.40	97.40	103.47073	1	2	1	0	0	1	1
198	3	3	66	60	2	24	22	22	22	22.5	0.573248408	0.859872611	80	31	70	5	15	378.70	106.55	97.745938	1	2	1	0	0	1	2
199	3	3	56	60	2	22	22	23	22	22.25	1.050955414	1.082802548	80	21	60	5	15	372.91	107.52	95.739011	2	1	2	0	0	1	1
200	3	3	70	60	2	21	20	22	23	21.5	0.222929936	0.318471338	85	39	50	5	10	358.73	113.68	92.922136	1	1	1	0	0	1	1
201	3	3	70	60	2	21	19	22	21	20.75	0.366242038	0.382165605	100	70	40	10	20	355.85	113.42	93.189386	1	1	2	0	0	1	1
202	2	2	7	45	3	19	19	20	20	19.5	0.859872611	1.01910828	75	28	30	10	15	178.61	270.85	-6.972882	2	2	2	0	0	1	1
203	2	2	34	30	3	21	21	22	22	21.5	0.477707006	0.859872611	50	15	40	5	40	163.66	274.14	-12.771013	2	2	1	0	0	1	2
204	2	2	10	45	3	17	21	21	21	20	0.732484076	0.891719745	90	20	45	5	10	185.70	260.40	-0.398077	2	1	2	0	0	1	1
205	2	2	35	50	3	16	10	22	11	14.75	0.159235669	0.318471338	20	16	50	5	3	179.05	250.10	4.801898	1	1	1	0	1	0	1
206	4	2	55	50	3	20	23	22	21	21.5	0.700636943	0.859872611	70	16	70	10	3	189.93	238.18	13.047086	1	1	2	0	0	1	1
207	5	2	30	10	3	22	20	20	22	21	0.828025478	0.891719745	90	20	60	5	10	203.83	226.72	23.505187	1	1	2	0	0	1	1
208	3	2	21	50	3	15	21	21	18	18.75	1.01910828	1.687898089	80	16	40	5	30	231.41	210.69	31.910043	2	1	2	0	0	1	1
209	4	4	68	40	2	21	18	21	22	20.5	0.732484076	1.369426752	70	14	60	5	15	246.81	203.67	38.719245	2	2	2	0	0	1	2
210	3	2	62	50	2	21	22	20	21	21	0.987261146	0.955414013	60	22	60	2	10	231.62	190.48	43.441192	2	2	2	0	0	1	1
212	3	2	78	50	3	20	20	23	19	20.5	0.796178344	0.796178344	70	16	30	10	10	233.05	184.88	45.825724	1	2	2	0	0	1	1
213	3	2	60	50	3	23	24	21	22	22.5	1.114649682	1.337579618	20	18	60	5	10	239.24	184.77	45.816392	2	2	2	0	0	1	2
214	3	2	86	60	3	23	20	19	20	20.5	1.433121019	1.082802548	10	12	60	5	5	236.67	177.76	50.177286	1	2	2	0	0	1	1
215	3	2	58	60	3	23	23	24	23	23.25	0.76433121	0.76433121	90	21	50	5	5	233.22	170.90	57.10014	2	1	2	0	0	1	1
216	5	4	22	20	3	22	19	20	23	21	1.496815287	1.910828025	100	31	60	5	10	175.76	164.26	63.15344	2	2	2	0	0	1	1
217	3	2	60	60	3	20	21	21	20	20.5	1.210191083	1.656050955	90	20	40	15	10	159.07	159.77	58.481868	2	2	2	0	0	1	2
218	3	4	40	60	3	23	19	20	23	21.25	0.828025478	0.891719745	80	22	70	5	10	170.74	175.89	51.190102	2	1	2	0	0	1	1
219	3	4	46	60	4	21	23	23	20	21.75	0.891719745	0.923566879	50	27	60	5	10	189.39	188.49	44.604806	2	1	2	0	0	1	1
220	3	4	40	60	4	21	23	22	22	22	0.636942675	0.668789809	80	20	70	2	10	160.47	179.05	46.803666	1	1	2	0	0	1	1
221	4	2	32	60	2	24	20	23	23	22.5	0.955414013	1.210191083	60	19	60	5	15	203.08	208.16	32.338093	2	2	2	0	0	1	1
222	4	2	50	60	2	24	23	23	22	23	0.573248408	0.828025478	70	15	40	1	5	205.62	203.82	36.095505	1	1	2	0	0	1	3
223	3	3	73	60	3	22	23	23	22	22.5	1.464968153	1.656050955	60	18	50	10	5	212.93	193.01	46.282973	2	2	2	0	0	1	1
224	3	3	56	60	2	23	22	21	22	22	0.636942675	0.923566879	80	16	50	5	5	216.49	200.71	39.228876	1	1	2	0	0	1	1
225	3	3	56	60	2	22	22	21	20	21.25	0.796178344	0.955414013	70	24	50	5	10	219.39	201.41	39.460781	2	1	2	0	0	1	1
226	4	4	60	50	3	22	23	23	20	22	0.796178344	0.828025478	100	18	30	10	20	210.08	211.20	31.582689	2	1	2	0	0	1	1
227	3	4	53	50	2	19	14	20	20	18.25	1.050955414	1.01910828	80	17	60	5	10	187.58	211.02	29.338101	1	2	2	0	0	1	1
228	3	4	25	55	3	20	22	21	21	21	0.923566879	0.828025478	80	19	60	5	20	175.85	218.93	23.109148	1	2	2	0	0	1	1
229	2	4	30	60	4	21	23	23	23	22.5	0.50955414	0.76433121	80	23	70	5	10	145.28	176.12	43.10201	1	1	2	0	0	1	2

Tree number	down_terra	hori_terra	aspect	slope	drainage	canopy_s	canopy_w	canopy_n	canopy_e	aver_canopy	diam_breast	diam_base	stem_incli	lowe_branch	bryophyte	lichens	macrolichen	easting	northing	elevation	callus	crevices	pollarding	smBark	roBark	fiBark	stems
230	3	4	40	60	2	19	21	17	20	19.25	1.050955414	1.369426752	90	23	70	5	10	134.50	175.66	43.568313	2	2	2	0	1	1	2
231	2	3	48	60	2	19	23	22	23	21.75	0.732484076	0.76433121	80	17	60	5	10	131.56	160.89	51.409542	1	1	2	0	0	1	1
232	2	3	45	60	2	23	24	21	23	22.75	0.796178344	0.796178344	80	24	50	5	5	123.29	160.91	50.901381	1	2	2	0	0	1	1
233	2	3	70	60	2	22	22	23	21	22	1.050955414	1.01910828	90	19	40	5	5	116.14	154.46	55.694406	2	2	2	0	0	1	1
234	4	3	42	60	2	23	19	19	20	20.25	0.573248408	0.414012739	100	60	60	5	15	44.47	190.20	7.689777	1	1	1	0	0	1	1
235	3	2	43	65	3	22	16	19	21	19.5	0.828025478	0.923566879	60	20	70	5	10	121.77	135.40	73.072428	1	1	2	0	0	1	1
236	2	4	42	60	2	21	22	24	22	22.25	0.955414013	0.955414013	70	16	50	5	20	135.73	113.50	91.474831	2	2	2	0	0	1	1
237	2	4	54	60	2	22	21	24	22	22.25	0.732484076	1.050955414	70	10	60	5	15	122.80	106.82	93.87667	2	2	2	0	0	1	1
243	3	4	20	75	3	20	21	22	19	20.5	0.350318471	0.50955414	80	32	50	10	10	144.53	79.29	120.473501	1	1	1	0	1	1	1
244	3	4	30	65	3	23	21	22	22	22	0.700636943	0.828025478	60	25.4	70	5	5	131.93	73.87	120.475913	2	2	2	0	0	1	1
245	4	4	30	70	3	23	20	21	24	22	1.178343949	1.146496815	80	18	60	5	5	132.73	69.66	123.549358	2	2	2	0	0	1	1
246	4	4	40	70	3	20	19	18	20	19.25	0.700636943	0.891719745	80	21	60	5	5	148.08	86.95	112.47756	1	2	2	0	0	1	1
248	3	3	8	60	2	20	20	19	21	20	0.636942675	0.987261146	80	36	20	2	5	158.16	227.72	8.633873	1	1	1	0	0	1	1
249	3	3	8	60	2	18	20	22	18	19.5	0.382165605	0.50955414	90	20	30	5	5	140.88	214.73	9.224106	1	1	2	0	1	0	1
250	3	3	22	60	4	20	19	22	19	20	0.382165605	0.859872611	40	30	60	5	10	137.14	212.44	11.008271	1	1	1	0	0	1	2
251	3	4	20	60	4	20	22	20	20	20.5	0.50955414	0.700636943	90	28	50	10	10	130.10	204.19	15.348031	2	1	1	0	0	1	1
252	3	4	20	60	3	24	19	19	18	20	0.828025478	0.859872611	80	24	50	5	5	121.53	184.78	25.755382	2	2	2	0	0	1	1
253	3	4	20	60	3	19	23	22	20	21	0.541401274	0.668789809	80	50	50	5	5	116.69	186.85	20.574831	1	1	1	0	0	1	1
254	3	4	20	60	3	22	22	20	21	21.25	0.477707006	0.382165605	90	40	50	10	5	73.59	185.81	14.809795	1	1	1	0	0	1	1
255	3	4	45	60	3	22	23	23	20	22	0.987261146	1.242038217	80	15	60	5	10	94.09	181.28	21.259495	2	2	2	0	0	1	2
256	3	4	28	60	3	21	13	20	20	18.5	0.987261146	1.082802548	70	21	50	5	5	87.69	175.64	24.038642	1	2	2	0	0	1	1
257	3	3	46	60	3	19	17	20	23	19.75	0.955414013	0.796178344	60	20	50	5	10	77.00	182.30	18.368197	2	1	2	0	0	1	1
259	3	3	46	60	3	23	20	19	21	20.75	0.700636943	1.146496815	80	25	70	5	10	73.15	159.93	34.665855	2	2	2	0	0	1	2
260	3	3	20	60	3	21	22	23	21	21.75	1.242038217	1.560509554	100	16	60	5	10	57.35	150.38	38.963863	2	2	2	0	0	1	1
261	3	3	20	60	3	22	20	20	22	21	0.859872611	1.01910828	80	17	60	5	20	54.88	158.03	31.99693	1	1	2	0	0	1	1
262	3	3	34	60	3	20	19	21	21	20.25	0.955414013	1.114649682	70	20	70	5	15	59.15	168.20	25.67196	2	2	2	0	0	1	1
263	3	3	30	60	3	12	7	19	22	15	0.923566879	1.178343949	60	23	30	5	15	41.73	182.36	11.817003	2	2	2	0	0	1	1
265	3	3	28	55	3	20	21	20	22	20.75	1.242038217	1.27388535	80	17	60	5	15	28.72	192.71	3.318532	2	2	2	0	0	1	1
266	3	2	44	60	3	21	20	20	20	20.25	0.891719745	1.01910828	90	24	10	5	20	28.34	200.03	-0.885052	2	2	2	0	0	1	1
267	3	3	30	55	2	20	18	18	20	19	0.796178344	1.210191083	90	25	40	5	15	25.51	202.59	-2.447256	2	2	2	0	0	1	1
268	3	3	42	55	2	21	21	21	20	20.75	0.923566879	1.210191083	95	21	60	5	25	29.24	205.33	-3.257575	2	1	2	0	0	1	1
269	3	3	35	55	2	21	22	21	21	21.25	1.27388535	1.050955414	90	16	20	15	30	35.41	203.79	-2.926724	2	2	2	0	0	1	1

Tree number	down_terra	hori_terra	aspect	slope	drainage	canopy_s	canopy_w	canopy_n	canopy_e	aver_canopy	diam_breast	diam_base	stem_incli	lowe_branch	bryophyte	lichens	macrolichen	easting	northing	elevation	callus	crevices	pollarding	smBark	roBark	fiBark	stems
270	5	4	64	20	2	21	19	22	20	20.5	0.955414013	1.050955414	85	18	40	15	20	23.20	218.48	-6.906219	1	1	2	0	0	1	1
271	3	1	20	55	5	22	8	21	22	18.25	0.828025478	1.242038217	80	28	60	5	20	0.00	217.34	-13.383119	2	1	2	0	0	1	1
272	3	1	42	55	5	21	20	21	20	20.5	0.796178344	1.146496815	80	17	40	10	20	7.18	208.49	-8.187279	2	2	2	0	0	1	1
273	3	1	25	55	5	21	19	20	21	20.25	0.955414013	0.955414013	80	16	40	10	15	9.13	201.82	-4.684378	2	2	2	0	0	1	1
274	3	1	38	55	5	21	21	21	21	21	1.305732484	1.146496815	80	12	35	10	15	6.68	198.92	-4.386792	2	1	2	0	0	1	1
275	5	2	38	20	3	21	20	22	20	20.75	0.796178344	1.082802548	80	19	60	5	15	38.79	216.86	-8.925019	2	1	2	0	0	1	1
276	5	2	25	20	3	20	21	22	22	21.25	1.114649682	1.401273885	90	17	50	5	20	46.48	218.04	-9.459562	2	2	2	0	0	1	1
277	5	3	50	20	3	21	20	22	21	21	0.700636943	1.146496815	80	27	70	5	5	49.98	217.84	-8.766659	2	1	2	0	0	1	1
278	5	3	50	20	3	20	23	22	22	21.75	0.891719745	1.146496815	80	21	40	5	10	52.45	218.14	-8.58017	2	2	2	0	0	1	1
279	5	3	60	20	3	22	22	21	22	21.75	0.796178344	0.987261146	80	20	70	10	10	58.39	219.84	-6.457453	2	1	2	0	0	1	1
280	5	3	60	30	3	22	20	22	22	21.5	0.76433121	0.923566879	70	27	70	5	20	59.33	216.74	-7.08778	2	1	2	0	0	1	1
281	5	3	36	30	3	21	22	23	22	22	0.573248408	1.496815287	80	26	40	5	20	63.19	219.34	-6.85276	2	1	2	0	0	1	2
282	5	3	41	30	3	16	20	18	21	18.75	1.242038217	1.178343949	100	22	60	5	15	73.39	220.77	-7.93404	2	1	2	0	0	1	1
283	5	3	58	30	3	22	21	23	22	22	0.477707006	0.414012739	75	11	70	5	15	79.04	222.89	-9.123794	1	1	2	0	0	1	1
284	5	3	38	30	2	22	19	22	21	21	0.605095541	0.828025478	80	40	60	5	15	112.97	222.76	-5.448425	2	1	1	0	0	1	1
285	5	2	50	30	3	22	17	20	21	20	0.605095541	0.732484076	80	23	70	5	5	111.98	233.67	-10.344189	1	1	2	0	0	1	1
286	5	3	30	30	3	21	22	22	22	21.75	0.732484076	1.178343949	80	21	70	5	5	108.80	238.72	-10.65663	1	1	2	0	0	1	1
287	5	3	50	30	3	22	24	23	22	22.75	0.923566879	1.369426752	80	20	60	5	10	86.42	255.67	-18.253308	2	2	2	0	0	1	2
288	3	2	60	40	3	23	22	21	21	21.75	0.923566879	1.114649682	90	20	70	5	20	103.53	254.45	-16.262748	2	1	2	0	0	1	1
289	3	2	50	40	4	23	24	22	24	23.25	0.445859873	1.01910828	90	25	50	5	10	106.43	262.11	-23.677643	2	1	2	0	0	1	1
291	4	3	100	30	4	20	20	20	21	20.25	0.070063694	1.178343949	50	9	50	10	5	303.97	265.75	-6.733471	2	2	2	1	0	1	1
292	3	3	52	60	3	20	20	17	20	19.25	0.573248408	0.382165605	90	45	60	40	10	338.50	112.72	91.244871	1	2	1	0	0	1	1
293	3	3	50	60	3	22	23	23	21	22.25	0.414012739	0.50955414	70	28	70	5	10	342.92	128.41	81.387768	1	2	1	0	0	1	1
294	3	3	40	60	5	23	20	19	20	20.5	0.796178344	0.76433121	70	22	60	2	10	454.42	112.68	99.636765	2	2	2	0	0	1	1
300	2	4	40	60	4	23	22	22	22	22.25	0.541401274	0.700636943	60	60	70	5	5	434.31	206.94	34.417604	1	2	1	0	0	1	1

Appendix 4 Data set - Transformed explanatory variables

Tree number	down_terra	hori_terra	aspect	slope	drainage	aver_canopy	canopy_s	canopy_w	canopy_n	canopy_e	diam_breast	diam_base	stem_incli	lowe_branch	bryophyte	lichens	macrolichen	elevation	easting	northing	stems	callus	crevices	pollarding	smBark	roBark	fiBark
1	0.760	0.465	1.000	0.125	0.461	0.042	0.063	0.094	0.047	0.034	0.587	0.756	0.384	0.691	0.832	0.580	0.439	0.035	0.756	0.987	0	1	1	1	0	0	1
2	0.448	0.723	0.420	0.310	0.000	0.172	0.063	0.643	0.176	0.177	0.719	0.613	0.203	0.599	0.363	0.916	0.202	0.127	0.720	0.864	0	1	1	1	0	0	1
3	0.760	0.723	0.186	0.056	1.000	0.316	0.250	0.326	0.612	0.299	0.536	0.720	0.400	0.541	0.610	0.651	0.439	0.103	0.669	0.888	1	1	1	1	0	0	1
4	0.448	0.224	0.623	0.125	1.000	0.242	0.403	0.515	0.105	0.231	0.437	0.384	0.545	0.467	0.480	0.580	0.439	0.075	0.625	0.915	0	0	1	1	0	0	1
5	0.000	0.465	0.420	0.140	0.461	0.090	0.508	0.515	0.000	0.073	0.454	0.335	0.545	0.370	0.309	0.651	0.374	0.058	0.693	1.000	0	1	1	1	0	0	1
6	0.448	0.465	0.265	0.181	0.461	0.467	0.638	1.000	0.226	0.384	0.688	0.575	0.000	0.531	0.363	0.524	0.337	0.163	0.568	0.795	0	0	0	1	0	0	1
7	0.448	0.224	0.549	0.227	1.000	0.531	0.318	0.643	0.782	0.623	0.625	0.478	0.244	0.550	0.480	0.524	0.337	0.126	0.448	0.870	0	1	1	1	0	0	1
8	1.000	0.723	0.428	0.333	1.000	0.498	0.638	0.515	0.373	0.623	0.767	0.833	0.369	0.599	0.363	0.524	0.664	0.000	0.465	0.964	0	1	1	1	0	0	1
9	1.000	0.465	0.534	0.021	0.461	0.277	0.195	0.643	0.373	0.177	0.488	0.468	0.000	0.490	0.610	0.430	0.439	0.140	0.412	0.855	0	0	1	1	0	0	1
10	0.000	0.465	0.496	0.208	1.000	0.685	0.638	0.643	0.782	0.790	0.437	0.384	0.885	0.584	0.544	0.651	0.439	0.112	0.401	0.910	0	1	1	1	0	0	1
11	0.760	0.465	0.420	0.310	1.000	0.777	0.799	1.000	0.612	0.790	0.555	0.362	0.865	0.511	0.209	0.651	0.252	0.123	0.390	0.896	0	1	1	1	0	0	1
12	0.448	0.224	0.556	0.507	1.000	0.777	0.799	0.803	0.782	0.790	0.350	0.245	0.457	0.386	0.363	0.580	0.079	0.099	0.378	0.920	0	0	0	1	0	0	1
13	0.760	0.224	0.420	0.370	0.769	0.828	1.000	0.803	0.782	0.790	0.448	0.257	0.984	0.511	0.610	0.524	0.202	0.084	0.396	0.926	0	0	1	1	0	0	1
14	0.000	0.224	0.511	0.435	1.000	0.777	0.638	1.000	0.782	0.790	0.498	0.437	0.135	0.599	0.077	0.524	0.252	0.038	0.400	0.955	0	0	1	1	0	0	1
15	0.448	0.465	0.397	0.370	0.769	0.939	1.000	1.000	0.782	1.000	0.478	0.316	0.244	0.386	0.363	0.430	0.439	0.042	0.387	0.954	0	0	0	1	0	0	1
16	0.448	0.465	0.645	0.257	0.000	0.531	0.508	0.643	0.478	0.623	0.625	0.472	0.415	0.467	0.309	0.748	0.439	0.187	0.407	0.797	0	0	0	1	0	0	1
17	0.448	0.465	0.645	0.310	0.000	0.104	0.045	0.411	0.226	0.034	0.437	0.384	0.679	0.691	0.363	0.651	0.566	0.236	0.430	0.752	0	0	1	1	0	0	1
18	0.448	0.224	0.674	0.370	0.000	0.198	0.115	0.326	0.373	0.177	0.707	0.566	0.545	0.691	0.258	0.748	0.566	0.214	0.460	0.758	0	0	1	1	0	0	1
19	0.448	0.465	0.481	0.310	0.769	0.438	0.508	0.411	0.478	0.490	0.642	0.547	0.000	0.584	0.258	0.651	0.566	0.182	0.579	0.778	0	1	1	1	0	0	1
20	0.448	0.465	0.451	0.310	0.769	0.531	0.799	0.411	0.478	0.623	0.373	0.427	0.817	0.723	0.163	0.902	0.252	0.215	0.593	0.752	0	1	1	1	0	0	1
21	0.448	0.465	0.601	0.310	0.769	0.360	0.638	0.515	0.226	0.299	0.416	0.566	0.651	0.667	0.610	0.651	0.566	0.193	0.644	0.772	0	0	1	1	0	0	1
22	0.000	0.224	0.265	0.000	0.461	0.161	0.250	0.094	0.291	0.177	0.824	0.690	0.244	0.614	0.163	0.651	1.000	0.184	0.729	0.784	0	1	1	1	0	0	1
23	0.448	0.465	0.466	0.310	0.769	0.566	0.638	0.411	0.782	0.623	0.707	0.566	0.000	0.353	0.258	0.651	1.000	0.216	0.723	0.752	0	0	1	1	0	0	1
24	0.760	0.723	0.451	0.125	0.769	0.467	0.638	0.515	0.478	0.384	0.478	0.447	0.244	0.614	0.077	0.651	0.915	0.160	0.718	0.812	0	0	1	1	0	1	1
25	0.448	0.224	0.496	0.310	1.000	0.296	0.508	1.000	0.047	0.384	0.517	0.656	0.415	0.511	0.163	0.651	0.439	0.210	0.834	0.794	1	1	0	1	0	0	1
26	0.448	0.465	0.374	0.310	0.000	0.531	0.403	0.803	0.612	0.490	0.608	0.508	0.135	0.567	0.077	0.902	0.252	0.215	0.813	0.780	0	0	0	1	0	0	1
27	0.448	0.465	0.660	0.310	1.000	0.411	0.508	0.326	0.373	0.623	0.458	0.384	0.000	0.733	0.480	0.651	0.566	0.250	0.855	0.743	0	0	0	0	0	0	1
28	0.448	0.465	0.420	0.310	0.000	0.603	0.508	0.643	0.478	1.000	0.753	0.740	0.000	0.599	0.038	0.651	0.439	0.275	0.891	0.715	0	1	1	1	0	0	1
29	0.448	0.224	0.420	0.310	0.769	0.498	0.403	1.000	0.478	0.384	0.591	0.447	0.244	0.467	0.363	0.651	0.566	0.289	0.867	0.701	0	0	1	1	0	0	1
30	0.448	0.723	0.374	0.370	0.769	0.498	0.508	0.515	0.478	0.623	0.488	0.427	0.244	0.628	0.363	0.651	0.566	0.279	0.836	0.718	0	0	0	0	0	0	1

Tree number	down_terra	hori_terra	aspect	slope	drainage	aver_canopy	canopy_s	canopy_w	canopy_n	canopy_e	diam_breast	diam_base	stem_incli	lowe_branch	bryophyte	lichens	macrolichen	elevation	easting	northing	stems	callus	crevices	pollarding	smBark	roBark	fiBark
31	0.760	0.224	0.496	0.310	0.769	0.566	0.508	0.803	0.612	0.490	0.675	0.478	0.000	0.567	0.754	0.651	0.439	0.310	0.860	0.679	0	0	0	1	0	0	1
32	0.760	0.224	0.405	0.310	0.769	0.531	0.403	0.803	0.612	0.490	0.691	0.405	0.000	0.584	0.258	0.698	0.337	0.328	0.879	0.661	0	1	0	1	0	0	1
33	0.448	0.723	0.556	0.310	1.000	0.467	0.403	0.515	0.782	0.384	0.395	0.673	0.415	0.655	0.163	0.651	0.566	0.343	0.853	0.655	1	0	1	1	0	0	1
34	0.760	0.000	0.601	1.000	1.000	0.603	0.799	0.643	0.478	0.623	0.254	0.169	0.000	0.752	0.258	0.943	0.079	0.423	0.807	0.594	0	0	0	0	1	0	0
35	1.000	0.000	0.556	0.587	1.000	0.566	0.638	0.515	0.478	0.790	0.303	0.182	0.545	0.168	0.610	0.651	0.337	0.469	0.792	0.589	0	0	0	0	0	0	1
36	0.448	0.224	0.703	0.125	0.461	0.531	0.508	0.411	0.782	0.623	0.796	0.620	0.336	0.000	0.480	0.651	0.439	0.508	0.763	0.528	0	0	1	1	0	0	1
37	0.000	0.723	0.630	0.125	0.000	0.643	0.638	0.515	1.000	0.623	0.738	0.584	0.000	0.584	0.610	0.651	0.664	0.525	0.740	0.522	0	0	0	1	0	0	1
38	0.448	0.224	0.718	0.310	0.461	0.296	0.115	0.259	0.782	0.490	0.536	0.427	0.545	0.550	0.754	0.524	0.252	0.534	0.745	0.502	0	0	1	1	0	0	1
39	0.448	0.723	0.556	0.370	0.461	0.277	0.087	0.411	0.612	0.384	0.824	0.638	0.000	0.655	0.163	0.524	0.439	0.535	0.775	0.501	0	1	1	1	0	0	1
40	0.448	0.723	0.556	0.370	0.461	0.467	0.403	0.411	0.782	0.490	0.350	0.269	0.817	0.550	0.754	0.620	0.079	0.532	0.766	0.498	0	0	1	1	0	0	1
41	0.760	0.224	0.250	0.310	1.000	0.438	0.638	0.259	0.478	0.623	0.753	0.740	0.545	0.511	0.363	0.651	0.664	0.535	0.881	0.487	0	1	1	0	0	0	1
42	0.448	0.465	0.420	0.435	0.769	0.498	0.638	0.643	0.291	0.623	0.327	0.281	0.000	0.742	0.163	0.902	0.252	0.189	0.611	0.777	0	0	0	0	0	1	0
43	0.448	0.465	0.420	0.435	0.769	0.531	1.000	0.515	0.478	0.384	0.228	0.142	0.000	0.878	0.000	0.974	0.079	0.199	0.612	0.768	0	0	0	0	0	1	0
44	0.448	0.465	0.420	0.310	0.769	0.566	0.799	0.643	0.612	0.384	0.373	0.245	0.369	0.317	0.163	0.651	0.664	0.267	0.596	0.716	0	1	1	0	0	0	1
45	0.448	0.465	0.343	0.435	0.000	0.777	0.638	1.000	0.612	1.000	0.722	0.566	0.651	0.353	0.480	0.651	0.439	0.300	0.571	0.698	0	1	1	1	0	0	1
46	0.448	0.465	0.343	0.435	0.000	0.643	0.638	1.000	0.478	0.623	0.625	0.556	0.545	0.317	0.363	0.651	0.439	0.309	0.572	0.692	0	0	1	1	0	0	1
47	0.448	0.465	0.343	0.435	0.000	0.467	0.799	0.643	0.373	0.299	0.458	0.384	0.651	0.443	0.610	0.651	0.439	0.289	0.567	0.706	0	0	0	1	0	0	1
48	0.448	0.224	0.436	0.435	1.000	0.411	1.000	0.515	0.373	0.177	0.659	0.602	0.415	0.511	0.258	0.651	0.439	0.347	0.621	0.658	0	0	1	1	0	0	1
49	0.000	0.465	0.420	0.587	0.000	0.643	1.000	0.515	0.782	0.490	0.254	0.245	0.244	0.584	0.163	0.651	0.439	0.354	0.666	0.669	0	0	0	0	0	0	1
50	0.448	0.465	0.451	0.435	0.769	0.438	1.000	0.803	0.081	0.623	0.254	0.169	0.000	0.567	0.363	0.845	0.079	0.375	0.574	0.659	0	1	0	0	0	1	0
51	0.448	0.465	0.436	0.435	0.769	0.498	0.638	0.326	0.782	0.490	0.327	0.566	0.600	0.628	0.258	0.651	0.439	0.395	0.560	0.649	1	0	1	1	0	0	1
52	0.448	0.465	0.451	0.435	0.769	0.467	0.508	0.643	0.478	0.384	0.458	0.447	0.651	0.567	0.610	0.651	0.439	0.404	0.573	0.642	0	0	1	1	0	0	1
53	0.448	0.224	0.343	0.587	1.000	0.385	0.508	0.326	0.612	0.299	0.707	0.584	0.135	0.628	0.363	0.651	0.566	0.436	0.653	0.621	0	0	0	1	0	0	1
54	0.448	0.465	0.586	0.587	0.461	0.531	0.508	0.643	0.612	0.490	0.545	0.468	0.244	0.511	0.480	0.651	0.439	0.415	0.725	0.639	0	0	0	1	0	0	1
55	0.448	0.465	0.586	0.587	0.461	0.316	0.250	0.411	0.612	0.231	0.448	0.384	0.244	0.511	0.258	0.651	0.808	0.438	0.723	0.627	0	0	0	1	0	0	1
56	0.000	0.465	0.146	0.310	0.769	0.411	0.403	0.515	0.373	0.490	0.279	0.245	0.415	0.723	0.610	0.651	0.566	0.468	0.574	0.593	0	0	0	0	0	0	1
57	0.448	0.465	0.343	0.310	0.461	0.685	0.318	0.803	1.000	1.000	0.202	0.129	0.135	0.584	0.163	0.943	0.000	0.513	0.707	0.529	0	0	0	0	1	0	0
58	0.760	0.465	0.343	0.056	0.461	0.777	1.000	0.643	0.782	0.790	0.254	0.182	0.415	0.550	0.258	0.943	0.000	0.504	0.710	0.549	0	0	0	0	0	0	1
59	0.448	0.465	0.571	0.310	0.461	0.277	0.638	0.411	0.176	0.177	0.796	0.787	0.651	0.691	0.610	0.651	0.439	0.559	0.715	0.475	0	1	1	1	0	0	1
60	0.448	0.465	0.571	0.310	0.461	0.198	0.195	0.411	0.478	0.051	0.517	0.566	0.415	0.691	0.610	0.651	0.439	0.561	0.714	0.469	0	1	1	1	0	0	1
61	0.448	0.465	0.571	0.310	0.769	0.438	0.799	0.259	0.373	0.623	0.175	0.142	0.415	0.786	0.077	0.974	0.000	0.585	0.738	0.439	0	0	0	0	1	0	0
62	0.760	0.224	0.265	0.310	0.461	0.411	0.318	0.643	0.612	0.299	0.478	0.468	0.336	0.599	0.163	0.651	0.439	0.145	0.348	0.866	0	0	0	1	0	0	1

Tree number	down_terra	hori_terra	aspect	slope	drainage	aver_canopy	canopy_s	canopy_w	canopy_n	canopy_e	diam_breast	diam_base	stem_incli	lowe_branch	bryophyte	lichens	macrolichen	elevation	easting	northing	stems	callus	crevices	pollarding	smBark	roBark	fiBark
63	0.448	0.465	0.458	0.435	0.461	0.685	0.799	0.803	0.612	0.623	0.395	0.350	0.000	0.000	0.610	0.580	0.252	0.067	0.331	0.930	0	0	1	1	0	0	1
64	0.448	0.465	0.458	0.435	1.000	0.828	0.799	1.000	0.612	1.000	0.373	0.293	0.817	0.467	0.258	0.651	0.439	0.081	0.326	0.918	0	0	1	1	0	0	1
65	0.448	0.224	0.703	0.435	0.461	0.498	0.508	0.643	0.373	0.623	0.573	0.468	0.484	0.511	0.163	0.580	0.439	0.210	0.361	0.787	0	0	0	1	0	0	1
66	0.760	0.224	0.761	0.435	0.000	0.603	0.508	0.643	0.782	0.623	0.437	0.269	0.415	0.490	0.258	0.651	0.439	0.232	0.354	0.770	0	0	0	1	0	0	1
67	0.760	0.224	0.761	0.435	0.000	0.566	0.638	0.643	0.612	0.490	0.366	0.158	0.545	0.511	0.363	0.651	0.439	0.232	0.355	0.767	0	1	1	1	0	0	1
68	0.448	0.224	0.601	0.435	0.461	0.385	0.508	1.000	1.000	0.034	0.478	0.405	0.244	0.584	0.610	0.651	0.566	0.299	0.416	0.706	0	1	0	1	0	0	1
69	0.448	0.224	0.601	0.435	0.000	0.828	0.638	0.803	1.000	1.000	0.545	0.362	0.545	0.353	0.610	0.651	0.664	0.308	0.407	0.704	0	0	0	1	0	0	1
70	0.448	0.224	0.601	0.435	0.000	0.531	0.318	0.803	1.000	0.384	0.517	0.447	0.817	0.667	0.363	0.524	0.252	0.320	0.397	0.704	0	0	1	1	0	0	1
71	0.760	0.465	0.556	0.587	0.000	0.730	1.000	0.803	0.373	1.000	0.327	0.293	0.545	0.584	0.258	0.524	0.439	0.340	0.390	0.687	0	1	1	1	0	0	1
72	0.448	0.465	0.466	0.310	0.769	0.685	0.638	0.643	0.782	0.790	0.373	0.245	0.000	0.770	0.000	0.651	0.808	0.221	0.728	0.749	0	0	1	1	0	0	1
73	0.760	0.224	0.343	0.125	1.000	0.360	0.403	0.515	0.291	0.384	0.327	0.220	0.000	0.723	0.480	0.748	0.439	0.159	0.812	0.831	0	0	0	0	0	0	1
74	0.448	0.224	0.645	0.435	0.000	0.777	0.638	1.000	1.000	0.623	0.573	0.547	0.336	0.511	0.077	0.651	0.439	0.385	0.416	0.649	0	0	1	1	0	0	1
75	0.448	0.465	0.732	0.435	0.000	0.828	1.000	0.515	1.000	1.000	0.416	0.339	0.545	0.531	0.480	0.651	0.439	0.334	0.437	0.673	0	0	0	1	0	0	1
76	0.760	0.465	0.615	0.208	0.769	0.498	0.508	0.643	0.373	0.623	0.291	0.047	0.000	0.642	0.480	0.877	0.000	0.177	0.511	0.783	0	0	0	0	1	0	0
77	0.760	0.224	0.289	0.164	0.769	0.603	0.638	0.643	1.000	0.384	0.296	0.257	0.000	0.655	0.480	0.748	0.000	0.160	0.492	0.834	0	0	1	0	0	1	0
78	0.448	0.224	0.511	0.310	0.769	0.360	0.403	0.326	0.373	0.490	0.231	0.142	0.000	0.810	0.544	0.902	0.000	0.157	0.468	0.827	0	0	0	0	1	0	0
79	0.448	0.224	0.511	0.310	0.769	0.316	0.318	0.259	0.478	0.384	0.279	0.220	0.000	0.738	0.754	0.748	0.000	0.161	0.468	0.822	0	0	0	0	0	0	1
80	0.448	0.723	0.511	0.208	0.461	0.385	0.403	0.411	0.612	0.299	0.175	0.142	0.135	0.906	0.000	1.000	0.000	0.529	0.665	0.507	0	0	0	0	1	0	0
82	0.448	0.465	0.496	0.208	0.461	0.296	0.508	0.094	0.291	0.790	0.175	0.087	0.244	0.599	0.258	0.974	0.000	0.521	0.656	0.515	0	0	0	0	1	0	0
83	0.448	0.723	0.451	0.310	0.769	0.643	0.799	0.515	0.612	0.790	0.147	0.115	0.244	0.846	0.077	0.974	0.000	0.586	0.767	0.440	0	0	0	0	1	0	0
84	0.448	0.465	0.420	0.310	1.000	0.531	0.638	0.803	0.612	0.299	0.291	0.194	0.651	0.168	0.754	0.651	0.439	0.313	0.598	0.685	0	0	1	0	0	0	1
85	0.760	0.465	0.526	0.125	0.461	0.000	0.000	0.007	0.018	0.000	0.416	0.803	0.651	0.702	0.363	0.651	0.439	0.516	0.584	0.518	0	1	1	1	0	0	1
86	0.448	0.465	0.496	0.310	0.769	0.566	0.799	0.515	0.612	0.490	0.303	0.690	0.740	0.550	0.610	0.651	0.252	0.574	0.597	0.441	0	1	1	1	0	0	1
87	0.000	0.723	0.336	0.587	0.769	0.685	0.638	0.803	0.782	0.623	0.279	0.059	0.415	0.957	0.480	0.651	0.252	0.442	0.913	0.592	0	0	0	0	0	1	1
88	0.448	0.224	0.451	0.435	0.769	0.259	0.403	0.326	1.000	0.034	0.279	0.362	0.545	0.723	0.480	0.524	0.000	0.428	0.459	0.600	0	0	0	0	0	0	1
89	0.000	0.224	0.541	0.435	0.769	0.467	0.250	0.411	1.000	0.623	0.279	0.566	0.415	0.810	0.610	0.651	0.252	0.463	0.478	0.576	1	0	0	0	0	0	1
90	0.760	0.723	0.451	0.125	0.000	0.212	0.508	0.052	0.226	0.490	0.691	0.638	0.545	0.628	0.163	0.651	0.252	0.496	0.439	0.543	0	1	1	1	0	0	1
91	0.448	0.465	0.328	0.310	0.000	0.685	0.638	0.643	1.000	0.623	0.722	0.803	0.651	0.584	0.163	0.524	0.439	0.539	0.459	0.496	0	1	0	1	0	0	1
92	0.000	0.465	0.481	0.587	0.461	0.338	0.318	0.515	0.373	0.299	0.215	0.169	0.545	1.000	0.077	0.651	0.252	0.578	0.463	0.465	0	0	1	0	0	0	0
93	0.760	0.465	0.420	0.587	0.461	0.939	1.000	1.000	1.000	0.790	0.478	0.656	0.545	0.531	0.480	0.651	0.439	0.576	0.453	0.462	1	0	1	1	0	0	1
94	0.760	0.465	0.571	0.435	0.461	0.643	1.000	0.643	0.478	0.623	0.478	0.987	0.415	0.550	0.363	0.651	0.566	0.610	0.450	0.433	1	0	1	1	0	0	1
95	0.760	0.465	0.556	0.310	0.461	0.828	0.799	0.803	1.000	0.790	0.659	0.620	0.000	0.511	0.480	0.524	0.439	0.609	0.477	0.429	0	1	1	1	0	0	1

Tree number	down_terra	hori_terra	aspect	slope	drainage	aver_canopy	canopy_s	canopy_w	canopy_n	canopy_e	diam_breast	diam_base	stem_incli	lowe_branch	bryophyte	lichens	macrolichen	elevation	easting	northing	stems	callus	crevices	pollarding	smBark	roBark	fiBark
96	0.760	0.465	0.556	0.310	0.461	0.566	0.638	0.643	0.612	0.490	0.965	0.508	0.415	0.605	0.480	0.748	0.439	0.610	0.487	0.414	0	1	0	1	0	0	1
97	0.448	0.224	0.718	0.310	0.461	0.643	0.403	0.643	0.782	1.000	0.478	0.447	0.415	0.691	0.610	0.524	0.252	0.595	0.498	0.429	0	0	1	1	0	0	1
98	0.448	0.224	0.511	0.310	0.461	0.360	0.115	0.411	1.000	0.490	0.591	0.447	0.545	0.511	0.363	0.524	0.252	0.602	0.513	0.418	0	0	1	1	0	0	1
99	0.448	0.465	0.420	0.310	0.461	0.685	0.638	0.643	0.782	0.790	0.508	0.384	0.545	0.531	0.163	0.651	0.439	0.589	0.528	0.438	0	0	1	1	0	0	1
100	0.448	0.465	0.405	0.310	0.461	0.685	0.799	0.643	0.782	0.623	0.573	0.584	0.545	0.531	0.610	0.524	0.252	0.583	0.542	0.442	0	1	0	1	0	0	1
101	1.000	0.224	0.556	0.435	0.461	0.531	0.799	0.515	0.226	1.000	0.382	0.388	0.415	0.531	0.610	0.748	0.252	0.649	0.443	0.380	0	1	0	1	0	0	1
102	1.000	0.224	0.630	0.310	0.461	0.438	0.508	0.326	0.782	0.384	0.536	0.584	0.244	0.628	0.610	0.524	0.439	0.642	0.451	0.382	0	0	0	1	0	0	1
103	0.760	0.224	0.466	0.435	0.461	0.467	0.403	0.326	1.000	0.490	0.599	0.488	0.336	0.353	0.363	0.651	0.439	0.651	0.452	0.371	0	0	1	1	0	0	1
104	0.760	0.224	0.630	0.208	0.461	0.566	0.799	0.643	0.782	0.299	0.573	0.556	0.415	0.550	0.363	0.651	0.439	0.639	0.458	0.389	0	1	1	1	0	0	1
105	0.760	0.224	0.674	0.435	0.461	0.385	0.250	0.803	1.000	0.134	0.608	0.566	0.000	0.416	0.480	0.651	0.439	0.647	0.468	0.375	0	0	1	1	0	0	1
106	0.760	0.224	0.689	0.310	0.461	0.438	0.403	1.000	0.291	0.384	0.406	0.316	0.244	0.531	0.480	0.651	0.439	0.642	0.469	0.382	0	1	0	1	0	0	1
107	0.760	0.224	0.601	0.310	0.461	0.338	0.250	1.000	0.373	0.177	0.437	0.405	0.415	0.531	0.363	0.651	0.808	0.641	0.474	0.383	0	0	0	1	0	0	1
108	0.760	0.224	0.601	0.310	0.461	0.259	0.151	0.803	0.291	0.177	0.416	0.547	0.600	0.584	0.832	0.524	0.252	0.641	0.479	0.381	0	0	1	1	0	0	1
109	0.760	0.224	0.496	0.435	0.461	0.198	0.195	0.643	0.478	0.020	0.458	0.316	0.244	0.511	0.077	0.651	0.664	0.645	0.483	0.374	0	1	1	1	0	0	0
110	0.448	0.465	0.474	0.310	0.461	0.643	0.638	0.515	1.000	0.623	0.517	0.384	0.651	0.584	0.363	0.651	0.252	0.605	0.532	0.419	0	1	1	0	0	0	1
111	0.448	0.465	0.481	0.310	0.769	0.566	0.508	0.515	0.782	0.623	0.782	0.656	0.244	0.599	0.480	0.651	0.252	0.606	0.571	0.412	0	0	1	1	0	0	1
112	0.448	0.224	0.645	0.435	0.461	0.338	0.638	0.204	0.291	0.490	0.536	0.656	0.244	0.667	0.363	0.651	0.252	0.583	0.639	0.434	0	0	1	0	0	0	1
113	0.448	0.465	0.496	0.435	0.461	0.316	0.508	0.094	0.478	0.623	0.498	0.488	0.651	0.584	0.258	0.524	0.252	0.603	0.624	0.411	0	0	1	0	0	0	1
114	0.448	0.723	0.571	0.435	0.461	0.603	0.508	0.643	0.782	0.623	0.683	0.575	0.135	0.467	0.363	0.651	0.439	0.629	0.664	0.398	0	0	0	1	0	0	1
115	0.448	0.723	0.571	0.435	0.461	0.603	0.508	0.515	0.782	0.790	0.608	0.488	0.135	0.511	0.163	0.651	0.808	0.626	0.669	0.401	0	0	1	1	0	0	1
116	0.448	0.465	0.526	0.435	0.461	0.566	0.638	0.515	0.612	0.623	0.599	0.508	0.000	0.599	0.610	0.524	0.252	0.655	0.718	0.362	0	0	1	0	0	0	1
117	0.448	0.465	0.420	0.435	0.461	0.498	0.508	0.643	0.782	0.299	0.753	0.690	0.484	0.490	0.480	0.430	0.808	0.662	0.763	0.355	0	1	1	1	0	0	1
118	0.448	0.465	0.420	0.435	0.461	0.338	0.250	0.515	0.373	0.384	0.573	0.771	0.651	0.655	0.480	0.430	0.439	0.646	0.776	0.371	1	0	1	1	0	0	1
119	0.448	0.465	0.265	0.435	0.461	0.438	0.195	0.643	0.782	0.490	0.291	0.220	1.000	0.443	0.754	0.430	0.000	0.642	0.798	0.379	0	0	1	0	0	0	1
120	0.448	0.465	0.265	0.435	0.461	0.531	0.403	0.326	1.000	0.790	0.478	0.362	0.000	0.511	0.363	0.430	0.439	0.642	0.806	0.383	0	0	0	1	0	0	1
121	0.448	0.465	0.265	0.435	0.461	0.730	0.638	0.643	1.000	0.790	0.608	0.673	0.415	0.443	0.363	0.524	0.252	0.635	0.805	0.388	0	0	1	1	0	0	1
122	0.448	0.723	0.297	0.435	0.461	0.498	0.638	0.643	0.291	0.623	0.691	0.707	0.000	0.531	0.480	0.524	0.439	0.566	0.667	0.460	0	1	1	1	0	0	1
124	0.448	0.723	0.420	0.435	0.461	0.643	0.508	0.643	0.612	1.000	0.517	0.508	0.415	0.531	0.480	0.524	0.664	0.635	0.749	0.386	0	1	1	1	0	0	1
125	0.448	0.723	0.420	0.435	0.461	0.685	0.638	0.643	0.782	0.790	0.573	0.508	0.545	0.906	0.610	0.430	0.252	0.631	0.747	0.390	0	1	1	0	0	0	1
126	0.448	0.224	0.504	0.435	0.461	0.531	0.799	0.803	0.612	0.231	0.642	0.656	0.244	0.614	0.363	0.524	0.439	0.609	0.785	0.407	0	1	1	1	0	0	1
127	0.448	0.723	0.359	0.435	1.000	0.685	0.799	0.643	0.612	0.790	0.536	0.447	0.545	0.467	0.363	0.651	0.439	0.639	0.898	0.401	0	0	0	1	0	0	1
128	0.448	0.723	0.359	0.435	1.000	0.730	0.799	0.643	0.782	0.790	0.675	0.673	0.545	0.567	0.363	0.524	0.664	0.634	0.906	0.407	0	0	1	1	0	0	1

Tree number	down_terra	hori_terra	aspect	slope	drainage	aver_canopy	canopy_s	canopy_w	canopy_n	canopy_e	diam_breast	diam_base	stem_incli	lowe_branch	bryophyte	lichens	macrolichen	elevation	easting	northing	stems	callus	crevices	pollarding	smBark	roBark	fiBark
129	0.448	0.000	0.390	0.310	1.000	0.603	0.638	0.515	0.612	0.790	0.416	0.269	0.545	0.846	0.363	0.651	0.252	0.635	0.923	0.395	0	0	0	0	0	0	1
130	0.448	0.465	0.390	0.507	1.000	0.643	0.799	0.515	0.782	0.623	0.591	0.584	0.415	0.490	0.480	0.698	0.439	0.605	0.881	0.427	0	0	1	1	0	0	1
131	0.448	0.723	0.359	0.310	1.000	0.730	0.638	0.803	1.000	0.623	0.642	0.629	0.651	0.511	1.000	0.000	0.252	0.567	0.889	0.457	1	0	1	1	0	0	1
132	0.448	0.000	0.526	0.435	1.000	0.685	0.799	0.643	0.612	0.790	0.228	0.232	0.545	0.846	0.258	0.902	0.252	0.742	0.919	0.283	1	0	0	0	0	0	1
133	0.448	0.000	0.343	0.587	1.000	0.566	0.508	0.515	0.612	0.790	0.478	0.220	0.415	0.846	0.480	0.580	0.664	0.803	0.923	0.204	0	0	0	0	0	0	1
134	0.448	0.000	0.297	0.587	1.000	0.531	0.799	0.411	0.478	0.623	0.395	0.362	0.415	0.906	0.480	0.524	0.252	0.812	0.938	0.188	0	0	0	0	0	0	1
135	0.448	0.465	0.281	0.435	0.461	0.643	0.638	0.643	0.782	0.623	0.437	0.468	0.244	0.702	0.077	0.651	0.566	0.762	0.787	0.256	0	0	0	0	0	0	1
136	0.448	0.465	0.359	0.435	0.461	0.730	0.799	0.803	0.782	0.623	0.608	0.877	0.651	0.531	0.363	0.651	0.566	0.805	0.759	0.206	1	1	1	0	0	0	1
137	0.448	0.465	0.420	0.507	0.461	0.685	0.799	0.643	0.612	0.790	0.303	0.547	0.817	0.702	0.363	0.524	0.566	0.840	0.672	0.177	1	0	0	0	0	0	1
138	0.448	0.465	0.420	0.435	0.461	0.603	0.799	0.643	0.478	0.623	0.517	0.468	0.651	0.386	0.363	0.651	0.566	0.886	0.700	0.133	0	0	0	0	0	0	1
139	0.448	0.465	0.420	0.435	0.461	0.603	0.508	0.643	0.782	0.623	0.303	0.194	0.000	0.642	0.163	0.524	0.566	0.919	0.720	0.095	0	0	0	0	0	0	1
141	0.760	0.723	0.420	0.773	0.000	0.467	0.318	0.411	1.000	0.490	0.350	0.384	0.651	0.846	0.363	0.651	0.252	1.000	0.500	0.000	0	0	1	0	0	0	1
142	0.000	0.723	0.630	0.773	0.000	0.828	0.799	0.643	1.000	1.000	0.228	0.527	0.651	0.599	0.163	0.524	0.439	0.983	0.484	0.027	1	0	0	0	0	0	1
143	0.760	0.224	0.511	0.587	0.000	0.685	0.799	0.643	0.782	0.623	0.448	0.207	0.000	0.511	0.077	0.651	0.252	0.963	0.490	0.039	0	0	0	0	0	0	1
144	0.448	0.465	0.420	0.587	0.000	0.939	0.799	1.000	1.000	1.000	0.498	0.527	0.000	0.599	0.077	0.651	0.808	0.973	0.541	0.025	0	0	0	0	0	0	1
145	0.448	0.465	0.420	0.587	0.000	0.828	1.000	0.643	1.000	0.790	0.384	0.339	0.945	0.511	0.363	0.651	0.566	0.986	0.559	0.016	0	0	1	0	0	0	1
146	0.448	0.465	0.359	0.507	0.000	0.882	1.000	0.643	1.000	1.000	0.303	0.245	0.415	0.614	0.363	0.651	0.566	0.945	0.553	0.061	0	0	0	0	0	0	1
147	0.448	0.224	0.556	0.587	0.461	0.531	0.638	0.515	0.478	0.623	0.416	0.468	0.415	0.846	0.163	0.651	0.566	0.892	0.493	0.125	0	0	0	0	0	0	1
148	0.760	0.723	0.526	0.881	0.000	0.777	0.799	0.643	0.782	1.000	0.395	0.281	0.817	0.511	0.480	0.524	0.252	0.863	0.479	0.152	0	0	1	0	0	1	1
149	0.760	0.723	0.405	0.773	0.000	0.730	0.638	0.643	0.782	1.000	0.215	0.115	0.000	0.511	0.363	0.748	0.252	0.854	0.485	0.157	0	0	0	0	0	0	1
150	0.760	0.723	0.571	0.435	0.461	0.685	0.638	0.643	1.000	0.623	0.395	0.447	0.545	0.614	0.363	0.651	0.566	0.840	0.471	0.174	0	0	0	0	0	0	1
151	0.448	0.723	0.564	0.435	0.461	0.566	0.638	0.515	0.782	0.490	0.458	0.427	0.000	0.531	0.258	0.651	0.439	0.828	0.450	0.198	0	0	0	0	0	0	1
152	0.448	0.723	0.343	0.587	0.461	0.685	0.508	0.803	0.782	0.790	0.254	0.245	0.244	0.906	0.258	0.651	0.808	0.808	0.457	0.218	0	0	0	0	0	0	1
153	0.760	0.224	0.645	0.370	0.461	0.777	1.000	0.803	0.782	0.623	0.824	0.723	0.000	0.531	0.000	0.748	0.566	0.796	0.471	0.219	0	1	1	0	0	0	1
154	0.448	0.723	0.451	0.370	0.461	0.939	1.000	1.000	0.782	1.000	0.350	0.427	0.415	0.846	0.610	0.651	0.566	0.794	0.455	0.236	1	0	0	0	0	0	1
155	0.448	0.723	0.615	0.370	0.461	0.730	1.000	0.803	0.782	0.490	0.458	0.447	0.415	0.614	0.480	0.651	0.439	0.784	0.465	0.240	0	0	0	0	0	0	1
156	0.448	0.465	0.420	0.507	0.461	0.643	1.000	0.411	0.478	1.000	0.373	0.339	0.000	0.567	0.163	0.651	0.664	0.789	0.533	0.224	0	0	0	0	0	0	1
157	0.448	0.465	0.496	0.507	0.461	0.828	1.000	0.643	1.000	0.790	0.339	0.101	0.415	0.599	0.480	0.524	0.664	0.787	0.537	0.227	0	0	0	0	0	0	1
158	0.448	0.465	0.390	0.507	0.461	0.730	1.000	0.411	1.000	0.790	0.373	0.316	0.415	0.723	0.420	0.902	0.439	0.754	0.548	0.261	0	0	0	0	0	0	1
159	0.448	0.224	0.420	0.507	0.461	0.730	1.000	0.643	0.612	0.790	0.608	0.756	0.244	0.511	0.480	0.651	0.439	0.716	0.516	0.300	1	1	1	0	0	0	1
160	0.448	0.224	0.630	0.435	0.461	0.643	1.000	0.515	0.612	0.623	0.517	0.638	0.651	0.550	0.258	0.651	0.439	0.724	0.486	0.298	0	1	1	0	0	0	1
161	0.448	0.723	0.390	0.435	0.461	0.316	0.403	0.204	0.291	0.623	0.659	0.566	0.545	0.605	0.480	0.651	0.439	0.741	0.475	0.284	0	1	1	0	0	0	1

Tree number	down_terra	hori_terra	aspect	slope	drainage	aver_canopy	canopy_s	canopy_w	canopy_n	canopy_e	diam_breast	diam_base	stem_incli	lowe_branch	bryophyte	lichens	macrolichen	elevation	easting	northing	stems	callus	crevices	pollarding	smBark	roBark	fiBark
162	0.448	0.465	0.481	0.435	0.461	0.685	0.799	0.803	0.478	0.790	0.478	0.427	0.336	0.531	0.258	0.902	0.252	0.743	0.451	0.287	0	0	0	0	0	0	1
164	0.448	0.465	0.451	0.587	0.461	0.828	1.000	1.000	0.782	0.623	0.573	0.488	0.545	0.467	0.363	0.845	0.252	0.724	0.441	0.308	0	0	1	1	0	0	1
165	0.448	0.465	0.420	0.587	0.461	0.828	1.000	1.000	0.782	0.623	0.478	0.427	0.415	0.443	0.480	0.524	0.252	0.723	0.424	0.315	0	0	0	0	0	0	1
166	0.000	0.723	0.397	0.370	0.461	0.603	0.403	0.643	0.782	0.790	0.555	0.468	0.336	0.386	0.754	0.580	0.566	0.671	0.395	0.359	0	1	1	1	0	0	1
167	0.000	0.723	0.289	0.370	0.461	0.338	0.195	1.000	0.373	0.231	0.555	0.405	0.415	0.386	0.480	0.580	0.439	0.691	0.394	0.342	0	1	1	1	0	0	1
168	0.000	0.723	0.359	0.370	0.461	0.603	0.799	0.803	0.373	0.623	0.625	0.602	0.415	0.599	0.258	0.748	0.566	0.682	0.374	0.344	0	0	1	1	0	0	1
169	0.448	0.224	0.481	0.370	0.461	0.566	0.508	0.643	0.782	0.490	0.536	0.468	0.415	0.531	0.480	0.651	0.439	0.682	0.359	0.348	0	0	0	1	0	0	1
170	0.448	0.723	0.397	0.370	0.461	0.338	0.250	0.411	0.373	0.490	0.642	0.673	0.336	0.511	0.480	0.524	0.337	0.668	0.332	0.370	0	1	1	1	0	0	1
171	0.448	0.723	0.281	0.370	0.461	0.777	0.638	0.643	1.000	1.000	0.591	0.527	0.545	0.511	0.163	0.805	0.439	0.684	0.318	0.350	0	0	1	1	0	0	1
172	0.448	0.723	0.343	0.370	0.461	1.000	1.000	1.000	1.000	1.000	0.753	0.947	0.135	0.550	0.363	0.651	0.252	0.673	0.311	0.366	1	1	1	1	0	0	1
173	0.448	0.224	0.305	0.435	0.461	1.000	1.000	1.000	1.000	1.000	1.000	0.960	0.135	0.416	0.163	0.748	0.566	0.654	0.340	0.392	1	1	1	1	0	0	1
174	0.448	0.224	0.297	0.370	0.461	0.338	0.403	0.411	0.226	0.490	0.675	0.584	0.545	0.467	0.363	0.651	0.439	0.649	0.307	0.399	0	0	0	1	0	0	1
175	0.448	0.465	0.382	0.435	0.000	0.498	1.000	1.000	0.226	0.299	0.573	0.488	0.545	0.490	0.163	0.651	0.252	0.684	0.258	0.347	0	0	0	1	0	0	1
176	0.448	0.723	0.420	0.587	0.000	1.000	1.000	1.000	1.000	1.000	0.303	0.269	0.817	0.353	0.480	0.430	0.000	0.697	0.252	0.333	0	0	0	0	0	0	1
177	0.000	0.723	0.405	0.773	0.000	0.259	0.403	0.259	0.226	0.299	0.642	0.468	0.415	0.443	0.610	0.524	0.439	0.690	0.237	0.334	0	0	0	1	0	0	1
178	0.000	0.723	0.405	0.773	0.000	0.277	0.318	0.259	0.291	0.384	0.458	0.427	0.415	0.490	0.480	0.524	0.566	0.695	0.235	0.330	0	0	0	1	0	0	1
180	0.760	0.224	0.374	0.773	0.000	0.277	0.318	0.411	0.226	0.299	0.228	0.245	0.545	0.906	0.610	0.524	0.337	0.733	0.227	0.303	1	0	0	0	0	0	0
181	0.448	0.465	0.202	0.773	0.000	0.360	0.403	0.326	0.373	0.490	0.458	0.427	0.415	0.531	0.480	0.651	0.439	0.658	0.225	0.356	0	0	1	1	0	0	1
182	0.448	0.465	0.281	0.773	0.000	0.338	0.403	0.515	0.291	0.299	0.458	0.384	0.415	0.511	0.163	0.651	0.566	0.666	0.250	0.360	0	0	1	1	0	0	1
183	0.000	0.224	0.526	0.587	0.461	0.385	1.000	0.326	0.291	0.299	0.350	0.527	0.244	0.567	0.480	0.524	0.566	0.617	0.333	0.440	1	0	0	1	0	0	1
184	0.000	0.224	0.718	0.587	0.461	0.316	0.250	0.326	0.373	0.490	0.517	0.488	0.817	0.531	0.363	0.651	0.252	0.611	0.345	0.443	0	0	1	1	0	0	1
185	1.000	0.224	0.420	0.208	0.461	0.685	1.000	0.326	1.000	0.790	0.738	0.723	0.244	0.567	0.610	0.430	0.252	0.625	0.438	0.418	0	1	1	1	0	0	1
187	0.000	1.000	0.790	0.435	0.461	0.212	0.638	0.159	0.105	0.299	0.373	0.362	0.600	0.531	0.363	0.651	0.808	0.815	0.260	0.254	0	1	0	1	0	0	1
188	0.448	1.000	0.601	0.676	0.461	0.467	0.403	0.411	0.612	0.623	0.642	0.566	0.545	0.490	0.480	0.651	0.252	0.897	0.242	0.164	0	1	0	1	0	0	1
189	0.000	0.723	0.571	0.587	0.461	0.360	0.250	0.411	0.612	0.384	0.228	0.169	0.651	0.846	0.610	0.651	0.439	0.983	0.393	0.068	0	0	0	0	0	0	1
190	0.448	0.723	0.586	0.587	0.461	0.777	0.508	1.000	0.782	1.000	0.659	0.527	0.000	0.467	0.480	0.651	0.439	0.863	0.385	0.185	0	1	1	0	0	0	1
191	0.448	0.465	0.265	0.587	0.000	0.643	0.799	0.803	0.478	0.623	0.279	0.269	0.415	0.531	0.480	0.651	0.664	0.770	0.638	0.248	0	0	0	1	0	0	1
192	0.448	0.224	0.374	0.587	0.461	0.730	0.638	0.803	0.782	0.790	0.327	0.293	0.244	0.846	0.258	0.651	0.664	0.717	0.621	0.297	0	0	0	0	0	0	1
193	0.448	0.465	0.420	0.587	0.461	0.316	0.151	0.204	0.612	0.790	0.279	0.245	0.545	0.467	0.258	0.651	0.664	0.718	0.657	0.306	0	0	0	0	0	0	1
194	0.448	0.465	0.420	0.587	0.461	0.603	0.508	0.643	0.782	0.623	0.254	0.142	0.651	0.567	0.610	0.651	0.439	0.712	0.661	0.309	0	0	0	0	0	0	1
195	0.448	0.723	0.541	0.587	0.000	0.643	0.638	0.515	0.782	0.790	0.416	0.339	0.817	0.567	0.258	0.651	0.439	0.739	0.670	0.283	0	0	0	1	0	0	1
196	0.448	0.465	0.390	0.587	0.000	0.685	0.799	0.643	0.612	0.790	0.373	0.547	0.244	0.906	0.163	0.651	0.566	0.742	0.724	0.272	1	0	0	1	0	0	1

Tree number	down_terra	hori_terra	aspect	slope	drainage	aver_canopy	canopy_s	canopy_w	canopy_n	canopy_e	diam_breast	diam_base	stem_incli	lowe_branch	bryophyte	lichens	macrolichen	elevation	easting	northing	stems	callus	crevices	pollarding	smBark	roBark	fiBark
197	0.448	0.465	0.390	0.587	0.000	0.730	0.799	0.643	0.782	0.790	0.147	0.000	0.415	0.614	0.077	0.651	0.808	0.742	0.726	0.274	0	0	1	0	0	0	1
198	0.448	0.465	0.466	0.587	0.000	0.685	1.000	0.643	0.612	0.623	0.416	0.468	0.415	0.679	0.610	0.651	0.566	0.719	0.730	0.300	1	0	1	0	0	0	1
199	0.448	0.465	0.390	0.587	0.000	0.643	0.638	0.643	0.782	0.623	0.691	0.602	0.415	0.531	0.480	0.651	0.566	0.711	0.712	0.303	0	1	0	1	0	0	1
200	0.448	0.465	0.496	0.587	0.000	0.531	0.508	0.411	0.612	0.790	0.147	0.059	0.336	0.761	0.363	0.651	0.439	0.700	0.668	0.321	0	0	0	0	0	0	1
201	0.448	0.465	0.496	0.587	0.000	0.438	0.508	0.326	0.612	0.490	0.267	0.115	0.000	0.957	0.258	0.748	0.664	0.701	0.660	0.320	0	0	0	1	0	0	1
202	0.000	0.224	0.000	0.370	0.461	0.316	0.318	0.326	0.373	0.384	0.591	0.566	0.484	0.642	0.163	0.748	0.566	0.173	0.248	0.797	0	1	1	1	0	0	1
203	0.000	0.224	0.218	0.208	0.461	0.531	0.508	0.515	0.612	0.623	0.350	0.468	0.740	0.386	0.258	0.651	0.915	0.133	0.221	0.807	1	1	1	0	0	0	1
204	0.000	0.224	0.025	0.370	0.461	0.360	0.195	0.515	0.478	0.490	0.517	0.488	0.244	0.511	0.309	0.651	0.439	0.217	0.260	0.764	0	1	0	1	0	0	1
205	0.000	0.224	0.226	0.435	0.461	0.083	0.151	0.025	0.612	0.020	0.089	0.059	0.945	0.416	0.363	0.651	0.145	0.251	0.248	0.732	0	0	0	0	0	1	0
206	0.760	0.224	0.382	0.435	0.461	0.531	0.403	0.803	0.612	0.490	0.498	0.468	0.545	0.416	0.610	0.748	0.145	0.302	0.268	0.695	0	0	0	1	0	0	1
207	1.000	0.224	0.186	0.056	0.461	0.467	0.638	0.411	0.373	0.623	0.573	0.488	0.244	0.511	0.480	0.651	0.439	0.363	0.294	0.659	0	0	0	1	0	0	1
208	0.448	0.224	0.114	0.435	0.461	0.259	0.115	0.515	0.478	0.231	0.675	0.905	0.415	0.416	0.258	0.651	0.808	0.410	0.349	0.610	0	1	0	1	0	0	1
209	0.760	0.723	0.481	0.310	0.000	0.411	0.508	0.259	0.478	0.623	0.517	0.756	0.545	0.353	0.480	0.651	0.566	0.447	0.382	0.589	1	1	1	1	0	0	1
210	0.448	0.224	0.436	0.435	0.000	0.467	0.508	0.643	0.373	0.490	0.659	0.527	0.651	0.550	0.480	0.524	0.439	0.472	0.349	0.549	0	1	1	1	0	0	1
212	0.448	0.224	0.556	0.435	0.461	0.411	0.403	0.411	0.782	0.299	0.555	0.427	0.545	0.416	0.163	0.748	0.439	0.484	0.352	0.532	0	0	1	1	0	0	1
213	0.448	0.224	0.420	0.435	0.461	0.685	0.799	1.000	0.478	0.623	0.722	0.740	0.945	0.467	0.480	0.651	0.439	0.484	0.365	0.532	1	1	1	1	0	0	1
214	0.448	0.224	0.615	0.587	0.461	0.411	0.799	0.411	0.291	0.384	0.865	0.602	1.000	0.275	0.480	0.651	0.252	0.506	0.360	0.510	0	0	1	1	0	0	1
215	0.448	0.224	0.405	0.587	0.461	0.828	0.799	0.803	1.000	0.790	0.536	0.405	0.244	0.531	0.363	0.651	0.252	0.540	0.353	0.490	0	1	0	1	0	0	1
216	1.000	0.723	0.122	0.125	0.461	0.467	0.638	0.326	0.373	0.790	0.891	1.000	0.000	0.679	0.480	0.651	0.439	0.568	0.242	0.470	0	1	1	1	0	0	1
217	0.448	0.224	0.420	0.587	0.461	0.411	0.403	0.515	0.478	0.384	0.767	0.891	0.244	0.511	0.258	0.805	0.439	0.546	0.214	0.457	1	1	1	1	0	0	1
218	0.448	0.723	0.265	0.587	0.461	0.498	0.799	0.326	0.373	0.790	0.573	0.488	0.415	0.550	0.610	0.651	0.439	0.511	0.234	0.505	0	1	0	1	0	0	1
219	0.448	0.723	0.312	0.587	0.769	0.566	0.508	0.803	0.782	0.384	0.608	0.508	0.740	0.628	0.480	0.651	0.439	0.477	0.267	0.543	0	1	0	1	0	0	1
220	0.448	0.723	0.265	0.587	0.769	0.603	0.508	0.803	0.612	0.623	0.458	0.339	0.415	0.511	0.610	0.524	0.439	0.489	0.216	0.514	0	0	0	1	0	0	1
221	0.760	0.224	0.202	0.587	0.000	0.685	1.000	0.411	0.782	0.790	0.642	0.673	0.651	0.490	0.480	0.651	0.566	0.413	0.293	0.602	0	1	1	1	0	0	1
222	0.760	0.224	0.343	0.587	0.000	0.777	1.000	0.803	0.782	0.623	0.416	0.447	0.545	0.386	0.258	0.430	0.252	0.433	0.297	0.589	1	0	0	1	0	0	1
223	0.448	0.465	0.519	0.587	0.461	0.685	0.638	0.803	0.782	0.623	0.878	0.891	0.651	0.467	0.363	0.748	0.252	0.486	0.312	0.556	0	1	1	1	0	0	1
224	0.448	0.465	0.390	0.587	0.000	0.603	0.799	0.643	0.478	0.623	0.458	0.508	0.415	0.416	0.363	0.651	0.252	0.450	0.319	0.580	0	0	0	1	0	0	1
225	0.448	0.465	0.390	0.587	0.000	0.498	0.638	0.643	0.478	0.384	0.555	0.527	0.545	0.584	0.363	0.651	0.439	0.451	0.324	0.582	0	1	0	1	0	0	1
226	0.760	0.723	0.420	0.435	0.461	0.603	0.638	0.803	0.782	0.384	0.555	0.447	0.000	0.467	0.163	0.748	0.664	0.409	0.306	0.612	0	1	0	1	0	0	1
227	0.448	0.723	0.367	0.435	0.000	0.227	0.318	0.094	0.373	0.384	0.691	0.566	0.415	0.443	0.480	0.651	0.439	0.396	0.264	0.611	0	0	1	1	0	0	1
228	0.448	0.723	0.146	0.507	0.461	0.467	0.403	0.643	0.478	0.490	0.625	0.447	0.415	0.490	0.480	0.651	0.664	0.361	0.243	0.635	0	0	1	1	0	0	1
229	0.000	0.723	0.186	0.587	0.769	0.685	0.508	0.803	0.782	0.790	0.373	0.405	0.415	0.567	0.610	0.651	0.439	0.470	0.191	0.506	1	0	0	1	0	0	1

Tree number	down_terra	hori_terra	aspect	slope	drainage	aver_canopy	canopy_s	canopy_w	canopy_n	canopy_e	diam_breast	diam_base	stem_incli	lowe_branch	bryophyte	lichens	macrolichen	elevation	easting	northing	stems	callus	crevices	pollarding	smBark	roBark	fiBark
230	0.448	0.723	0.265	0.587	0.000	0.296	0.318	0.515	0.176	0.384	0.691	0.756	0.244	0.567	0.610	0.651	0.439	0.472	0.174	0.504	1	1	1	1	0	1	1
231	0.000	0.465	0.328	0.587	0.000	0.566	0.318	0.803	0.612	0.790	0.517	0.405	0.415	0.443	0.480	0.651	0.439	0.512	0.169	0.460	0	0	0	1	0	0	1
232	0.000	0.465	0.305	0.587	0.000	0.730	0.799	1.000	0.478	0.790	0.555	0.427	0.415	0.584	0.363	0.651	0.252	0.509	0.157	0.460	0	0	1	1	0	0	1
233	0.000	0.465	0.496	0.587	0.000	0.603	0.638	0.643	0.782	0.490	0.691	0.566	0.244	0.490	0.258	0.651	0.252	0.533	0.146	0.441	0	1	1	1	0	0	1
234	0.760	0.465	0.281	0.587	0.000	0.385	0.799	0.326	0.291	0.384	0.416	0.142	0.000	0.906	0.480	0.651	0.566	0.269	0.050	0.548	0	0	0	0	0	0	1
235	0.448	0.224	0.289	0.676	0.461	0.316	0.638	0.159	0.291	0.490	0.573	0.508	0.651	0.511	0.610	0.651	0.439	0.614	0.154	0.385	0	0	0	1	0	0	1
236	0.000	0.723	0.281	0.587	0.000	0.643	0.508	0.643	1.000	0.623	0.642	0.527	0.545	0.416	0.363	0.651	0.664	0.693	0.176	0.321	0	1	1	1	0	0	1
237	0.000	0.723	0.374	0.587	0.000	0.643	0.638	0.515	1.000	0.623	0.517	0.584	0.545	0.168	0.480	0.651	0.566	0.703	0.156	0.301	0	1	1	1	0	0	1
243	0.448	0.723	0.106	0.881	0.461	0.411	0.403	0.515	0.612	0.299	0.254	0.220	0.415	0.691	0.363	0.748	0.439	0.808	0.190	0.222	0	0	0	0	0	1	1
244	0.448	0.723	0.186	0.676	0.461	0.603	0.799	0.515	0.612	0.623	0.498	0.447	0.651	0.605	0.610	0.651	0.252	0.808	0.170	0.207	0	1	1	1	0	0	1
245	0.760	0.723	0.186	0.773	0.461	0.603	0.799	0.411	0.478	1.000	0.753	0.638	0.415	0.467	0.480	0.651	0.252	0.819	0.171	0.195	0	1	1	1	0	0	1
246	0.760	0.723	0.265	0.773	0.461	0.296	0.403	0.326	0.226	0.384	0.498	0.488	0.415	0.531	0.480	0.651	0.252	0.777	0.196	0.244	0	0	1	1	0	0	1
248	0.448	0.465	0.008	0.587	0.000	0.360	0.403	0.411	0.291	0.490	0.458	0.547	0.415	0.733	0.077	0.524	0.252	0.275	0.212	0.662	0	0	0	0	0	0	1
249	0.448	0.465	0.008	0.587	0.000	0.316	0.250	0.411	0.612	0.231	0.279	0.220	0.244	0.511	0.163	0.651	0.252	0.279	0.184	0.623	0	0	0	1	0	1	0
250	0.448	0.465	0.122	0.587	0.769	0.360	0.403	0.326	0.612	0.299	0.279	0.468	0.817	0.667	0.480	0.651	0.439	0.290	0.178	0.616	1	0	0	0	0	0	1
251	0.448	0.723	0.106	0.587	0.769	0.411	0.403	0.643	0.373	0.384	0.373	0.362	0.244	0.642	0.363	0.748	0.439	0.316	0.167	0.590	0	1	0	0	0	0	1
252	0.448	0.723	0.106	0.587	0.461	0.360	1.000	0.326	0.291	0.231	0.573	0.468	0.415	0.584	0.363	0.651	0.252	0.376	0.154	0.532	0	1	1	1	0	0	1
253	0.448	0.723	0.106	0.587	0.461	0.467	0.318	0.803	0.612	0.384	0.395	0.339	0.415	0.846	0.363	0.651	0.252	0.347	0.147	0.538	0	0	0	0	0	0	1
254	0.448	0.723	0.106	0.587	0.461	0.498	0.638	0.643	0.373	0.490	0.350	0.115	0.244	0.770	0.363	0.748	0.252	0.313	0.087	0.535	0	0	0	0	0	0	1
255	0.448	0.723	0.305	0.587	0.461	0.603	0.638	0.803	0.782	0.384	0.659	0.690	0.415	0.386	0.480	0.651	0.439	0.351	0.114	0.521	1	1	1	1	0	0	1
256	0.448	0.723	0.170	0.587	0.461	0.242	0.508	0.071	0.373	0.384	0.659	0.602	0.545	0.531	0.363	0.651	0.252	0.367	0.106	0.504	0	0	1	1	0	0	1
257	0.448	0.465	0.312	0.587	0.461	0.338	0.318	0.204	0.373	0.790	0.642	0.427	0.651	0.511	0.363	0.651	0.439	0.334	0.091	0.524	0	1	0	1	0	0	1
259	0.448	0.465	0.312	0.587	0.461	0.438	0.799	0.411	0.291	0.490	0.498	0.638	0.415	0.599	0.610	0.651	0.439	0.425	0.086	0.457	1	1	1	1	0	0	1
260	0.448	0.465	0.106	0.587	0.461	0.566	0.508	0.643	0.782	0.490	0.782	0.848	0.000	0.416	0.480	0.651	0.439	0.448	0.066	0.429	0	1	1	1	0	0	1
261	0.448	0.465	0.106	0.587	0.461	0.467	0.638	0.411	0.373	0.623	0.591	0.566	0.415	0.443	0.480	0.651	0.664	0.411	0.063	0.452	0	0	0	1	0	0	1
262	0.448	0.465	0.218	0.587	0.461	0.385	0.403	0.326	0.478	0.490	0.642	0.620	0.545	0.511	0.610	0.651	0.566	0.376	0.068	0.482	0	1	1	1	0	0	1
263	0.448	0.465	0.186	0.587	0.461	0.090	0.045	0.000	0.291	0.623	0.625	0.656	0.651	0.567	0.163	0.651	0.566	0.295	0.047	0.524	0	1	1	1	0	0	1
265	0.448	0.465	0.170	0.507	0.461	0.438	0.403	0.515	0.373	0.623	0.782	0.707	0.415	0.443	0.480	0.651	0.566	0.241	0.032	0.556	0	1	1	1	0	0	1
266	0.448	0.224	0.297	0.587	0.461	0.385	0.508	0.411	0.373	0.384	0.608	0.566	0.244	0.584	0.000	0.651	0.664	0.214	0.031	0.578	0	1	1	1	0	0	1
267	0.448	0.465	0.186	0.507	0.000	0.277	0.403	0.259	0.226	0.384	0.555	0.673	0.244	0.599	0.258	0.651	0.566	0.204	0.028	0.586	0	1	1	1	0	0	1
268	0.448	0.465	0.281	0.507	0.000	0.438	0.508	0.515	0.478	0.384	0.625	0.673	0.135	0.531	0.480	0.651	0.742	0.198	0.032	0.594	0	1	0	1	0	0	1
269	0.448	0.465	0.226	0.507	0.000	0.498	0.508	0.643	0.478	0.490	0.796	0.584	0.244	0.416	0.077	0.805	0.808	0.201	0.039	0.589	0	1	1	1	0	0	1

Tree number	down_terra	hori_terra	aspect	slope	drainage	aver_canopy	canopy_s	canopy_w	canopy_n	canopy_e	diam_breast	diam_base	stem_incli	lowe_branch	bryophyte	lichens	macrolichen	elevation	easting	northing	stems	callus	crevices	pollarding	smBark	roBark	fiBark
270	1.000	0.723	0.451	0.125	0.000	0.411	0.508	0.326	0.612	0.384	0.642	0.584	0.336	0.467	0.258	0.805	0.664	0.174	0.025	0.634	0	0	0	1	0	0	1
271	0.448	0.000	0.106	0.507	1.000	0.227	0.638	0.007	0.478	0.623	0.573	0.690	0.415	0.642	0.480	0.651	0.664	0.128	0.000	0.631	0	1	0	1	0	0	1
272	0.448	0.000	0.281	0.507	1.000	0.411	0.508	0.411	0.478	0.384	0.555	0.638	0.415	0.443	0.258	0.748	0.664	0.165	0.008	0.604	0	1	1	1	0	0	1
273	0.448	0.000	0.146	0.507	1.000	0.385	0.508	0.326	0.373	0.490	0.642	0.527	0.415	0.416	0.258	0.748	0.566	0.189	0.010	0.583	0	1	1	1	0	0	1
274	0.448	0.000	0.250	0.507	1.000	0.467	0.508	0.515	0.478	0.490	0.810	0.638	0.415	0.275	0.209	0.748	0.566	0.191	0.007	0.574	0	1	0	1	0	0	1
275	1.000	0.224	0.250	0.125	0.461	0.438	0.508	0.411	0.612	0.384	0.555	0.602	0.415	0.490	0.480	0.651	0.566	0.160	0.043	0.629	0	1	0	1	0	0	1
276	1.000	0.224	0.146	0.125	0.461	0.498	0.403	0.515	0.612	0.623	0.722	0.771	0.244	0.443	0.363	0.651	0.664	0.156	0.053	0.633	0	1	1	1	0	0	1
277	1.000	0.465	0.343	0.125	0.461	0.467	0.508	0.411	0.612	0.490	0.498	0.638	0.415	0.628	0.610	0.651	0.252	0.161	0.057	0.632	0	1	0	1	0	0	1
278	1.000	0.465	0.343	0.125	0.461	0.566	0.403	0.803	0.612	0.623	0.608	0.638	0.415	0.531	0.258	0.651	0.439	0.162	0.060	0.633	0	1	1	1	0	0	1
279	1.000	0.465	0.420	0.125	0.461	0.566	0.638	0.643	0.478	0.623	0.555	0.547	0.415	0.511	0.610	0.748	0.439	0.177	0.067	0.638	0	1	0	1	0	0	1
280	1.000	0.465	0.420	0.208	0.461	0.531	0.638	0.411	0.612	0.623	0.536	0.508	0.545	0.628	0.610	0.651	0.664	0.172	0.068	0.629	0	1	0	1	0	0	1
281	1.000	0.465	0.234	0.208	0.461	0.603	0.508	0.643	0.782	0.623	0.416	0.818	0.415	0.614	0.258	0.651	0.664	0.174	0.073	0.637	1	1	0	1	0	0	1
282	1.000	0.465	0.273	0.208	0.461	0.259	0.151	0.411	0.226	0.490	0.782	0.656	0.000	0.550	0.480	0.651	0.566	0.167	0.086	0.641	0	1	0	1	0	0	1
283	1.000	0.465	0.405	0.208	0.461	0.603	0.638	0.515	0.782	0.623	0.350	0.142	0.484	0.226	0.610	0.651	0.566	0.158	0.094	0.648	0	0	0	1	0	0	1
284	1.000	0.465	0.250	0.208	0.000	0.467	0.638	0.326	0.612	0.490	0.437	0.447	0.415	0.770	0.480	0.651	0.566	0.184	0.141	0.647	0	1	0	0	0	0	1
285	1.000	0.224	0.343	0.208	0.461	0.360	0.638	0.204	0.373	0.490	0.437	0.384	0.415	0.567	0.610	0.651	0.252	0.150	0.140	0.681	0	0	0	1	0	0	1
286	1.000	0.465	0.186	0.208	0.461	0.566	0.508	0.643	0.612	0.623	0.517	0.656	0.415	0.531	0.610	0.651	0.252	0.148	0.135	0.696	0	0	0	1	0	0	1
287	1.000	0.465	0.343	0.208	0.461	0.730	0.638	1.000	0.782	0.623	0.625	0.756	0.415	0.511	0.480	0.651	0.439	0.093	0.104	0.749	1	1	1	1	0	0	1
288	0.448	0.224	0.420	0.310	0.461	0.566	0.799	0.643	0.478	0.490	0.625	0.620	0.244	0.511	0.610	0.651	0.664	0.108	0.128	0.745	0	1	0	1	0	0	1
289	0.448	0.224	0.343	0.310	0.769	0.828	0.799	1.000	0.612	1.000	0.327	0.566	0.244	0.599	0.363	0.651	0.439	0.052	0.132	0.769	0	1	0	1	0	0	1
291	0.760	0.465	0.718	0.208	0.769	0.385	0.403	0.411	0.373	0.490	0.000	0.656	0.740	0.095	0.363	0.748	0.252	0.175	0.516	0.781	0	1	1	1	1	0	1
292	0.448	0.465	0.359	0.587	0.461	0.296	0.403	0.411	0.176	0.384	0.416	0.115	0.244	0.810	0.480	0.943	0.439	0.693	0.609	0.318	0	0	1	0	0	0	1
293	0.448	0.465	0.343	0.587	0.461	0.643	0.638	0.803	0.782	0.490	0.303	0.220	0.545	0.642	0.610	0.651	0.439	0.651	0.622	0.364	0	0	1	0	0	0	1
294	0.448	0.465	0.265	0.587	1.000	0.411	0.799	0.411	0.291	0.384	0.555	0.405	0.545	0.550	0.480	0.524	0.439	0.727	1.000	0.318	0	1	1	1	0	0	1
300	0.000	0.723	0.265	0.587	0.769	0.643	0.799	0.643	0.612	0.623	0.395	0.362	0.651	0.906	0.610	0.651	0.252	0.424	0.922	0.599	0	0	1	0	0	0	1

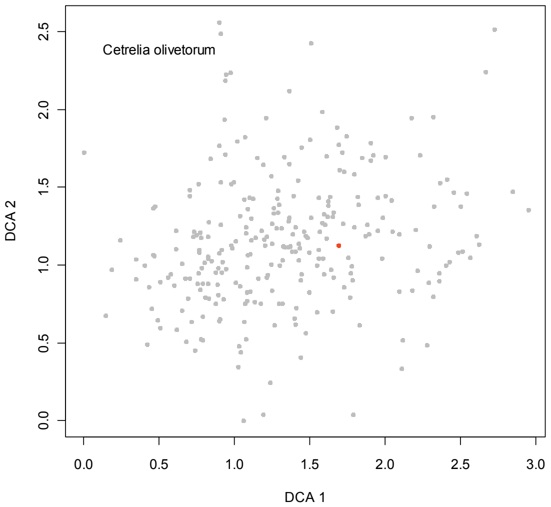
Appendix 5 Pairwise Kendall's tau correlations - Continuous explanatory variables

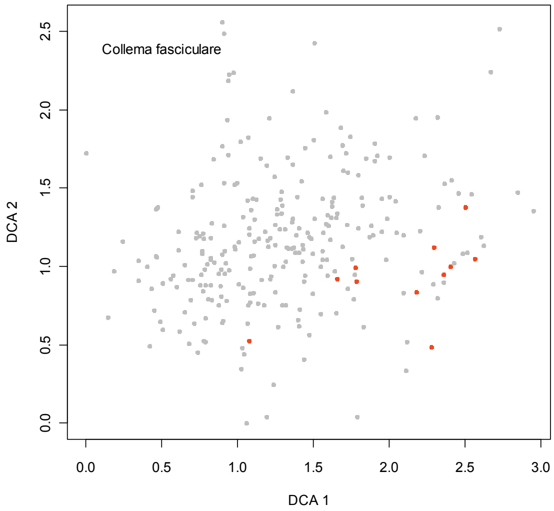
τ -values on the left lower side and p-values on the right upper side. Strong relations in bold.

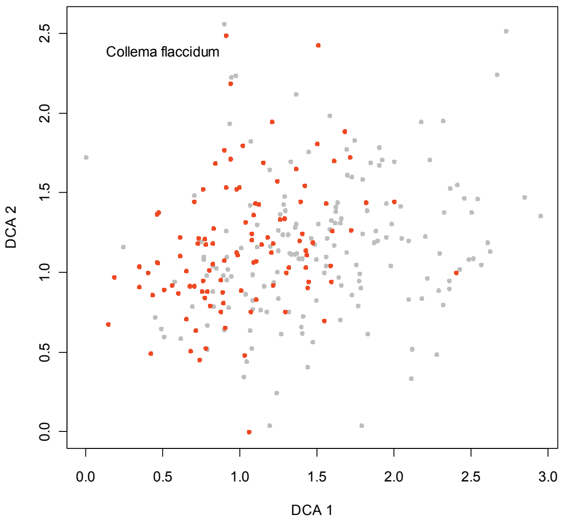
	down_terra	hori_terra	aspect	slope	drainage	canopy_s	canopy_w	canopy_n	canopy_e	aver_canopy	diam_breast	diam_base	stem_incli	lowe_branch	bryophyte	lichens	macrolichen	easting	northing	elevation
down_terra		0.0077	0.2606	**<0.0001**	0.8443	0.3993	0.9694	0.8584	0.9639	0.8330	0.3132	0.0637	0.0447	0.5847	0.0993	0.2750	0.4754	0.0893	0.0484	0.0064
hori_terra	-0.1416		0.0122	0.0148	0.0023	0.7182	0.7798	0.4525	0.0531	0.1097	0.8840	0.9547	0.6170	0.2709	0.3485	0.5965	0.7528	0.9356	**<0.0001**	**<0.0001**
aspect	0.0532	-0.1168		0.0004	0.9263	0.4065	0.3041	0.0360	0.9958	0.3153	0.0350	0.0446	0.7906	0.3056	0.9083	0.4680	0.0566	**<0.0001**	0.7955	0.0413
slope	**-0.2682**	0.1200	-0.1546		**<0.0001**	0.0127	0.7437	0.5117	0.0597	0.4311	0.0181	0.0017	0.0215	0.6898	0.6356	0.2969	0.8023	0.0009	**<0.0001**	**<0.0001**
drainage	0.0104	-0.1600	0.0043	**-0.2231**		0.6689	0.7926	0.3918	0.7103	0.4384	0.1209	0.4109	0.3720	0.0320	0.1360	0.2313	0.0851	**<0.0001**	**<0.0001**	**<0.0001**
canopy_s	0.0419	0.0177	0.0362	0.1149	0.0209		**<0.0001**	**<0.0001**	**<0.0001**	**<0.0001**	0.9065	0.1679	0.4344	0.6040	0.3561	0.6760	0.4673	0.2087	0.0019	0.0009
canopy_w	-0.0019	0.0137	0.0449	0.0151	-0.0130	**0.2687**		**<0.0001**	**<0.0001**	**<0.0001**	0.1441	0.4424	0.4345	0.6040	0.3561	0.6760	0.4673	0.2087	0.0019	0.0009
canopy_n	-0.0089	0.0370	0.0917	0.0303	-0.0420	**0.1963**	**0.3000**		**<0.0001**	**<0.0001**	0.9065	0.1679	0.2831	0.0014	0.4131	0.3778	0.3079	0.2382	0.9200	0.3892
canopy_e	0.0023	0.0965	-0.0002	0.0872	-0.0183	**0.4143**	**0.2413**	**0.3511**		**<0.0001**	0.2050	0.1148	0.8124	0.3580	0.3297	0.4470	0.5101	0.1147	**<0.0001**	**<0.0001**
aver_canopy	0.0100	0.0751	0.0419	0.0892	-0.0363	**0.5722**	**0.5411**	**0.5558**	**0.6309**		-0.0536	-0.0677	0.0094	-0.0773	-0.0475	-0.0410	-0.0245	0.0815	-0.1554	**0.1777**
diam_breast	0.0475	-0.0068	-0.0871	-0.1031	-0.0719	-0.0634	-0.0051	-0.0507	-0.0553	0.1975		**<0.0001**	0.0590	**<0.0001**	0.6042	0.0879	0.0003	0.0010	0.2774	0.0694
diam_base	0.0873	0.0026	-0.0829	-0.1366	-0.3811	-0.0334	-0.0600	-0.0605	-0.0688	0.1037	**0.6101**		0.9646	0.0005	0.4210	0.0321	**<0.0001**	0.0005	0.4477	0.0632
stem_incli	-0.0995	0.0244	0.0115	0.1060	-0.0436	0.0357	-0.0489	0.0136	0.0109	0.8295	-0.0818	0.0019		0.0195	0.0010	0.0011	0.0464	0.2478	0.0873	0.0624
lowe_branch	-0.0260	0.0516	0.0428	-0.0176	0.1004	-0.0228	-0.1401	-0.0691	-0.0405	0.0659	**-0.2616**	-0.1455	-0.1022		0.3251	0.1360	0.0962	**<0.0001**	0.1611	0.0990
bryophyte	0.0824	0.0463	-0.0050	-0.0220	0.0734	-0.0426	-0.0378	-0.0133	-0.0452	0.2826	0.0227	0.0352	0.1513	-0.0435		**<0.0001**	0.0157	0.2364	0.6912	0.9573
lichens	0.0574	-0.0275	-0.0335	-0.0509	0.0620	0.0203	-0.0429	-0.1144	-0.0371	0.3774	-0.0784	-0.0985	-0.1578	0.0692	**-0.2514**		0.6630	0.1360	0.0462	0.0311
macrolichen	-0.0363	0.0158	-0.0850	0.0118	-0.0861	-0.0341	-0.0479	-0.0138	-0.0310	0.5854	0.1608	**0.1766**	-0.0931	-0.0746	-0.1139	-0.2116		0.2021	0.2054	0.7180
easting	-0.7903	0.0037	**0.2374**	-0.1426	**0.2150**	0.0540	0.0507	0.0965	0.0680	0.0472	-0.1335	-0.1411	-0.0495	**0.1985**	-0.0511	-0.0677	-0.0559		0.0756	**<0.0001**
northing	0.0918	**-0.1842**	-0.0106	**-0.3610**	**0.2143**	-0.1331	-0.0043	-0.1583	**-0.1870**	0.0002	0.0441	0.0309	-0.0731	-0.0575	-0.0172	0.0905	-0.0555	-0.0713		**<0.0001**
elevation	-0.1268	**0.1815**	0.0833	**0.3529**	**-0.2084**	0.1425	0.0370	0.1752	**0.1834**	**<0.0001**	-0.0738	-0.0755	0.0797	0.0677	0.0023	-0.0979	0.0158	**0.1672**	**-0.8760**	

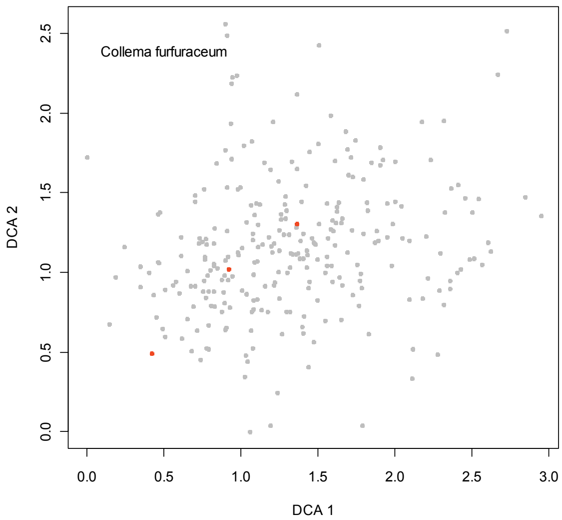
Appendix 6 DCA lichen species plots

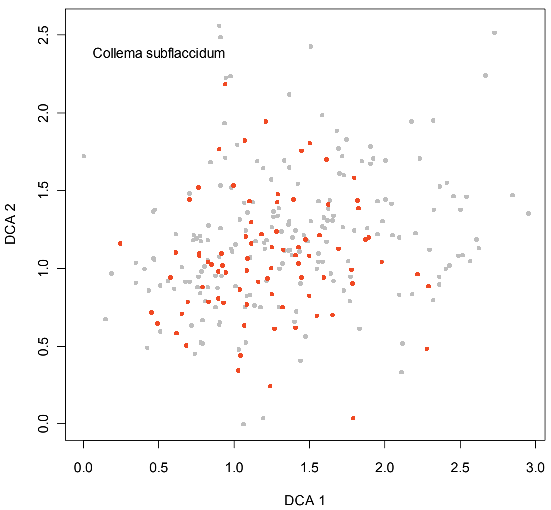
Red dot = present on tree. Grey = absent on tree.

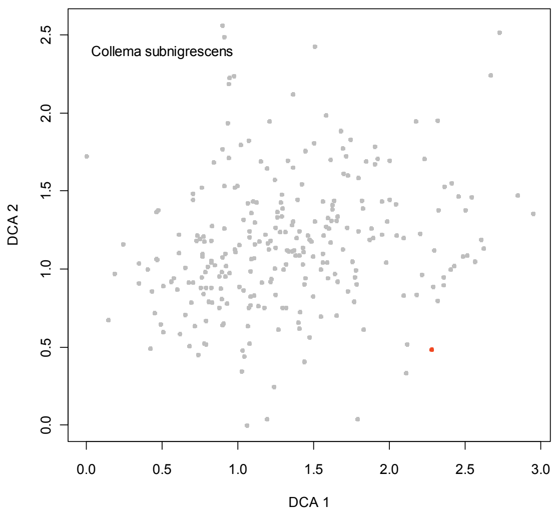


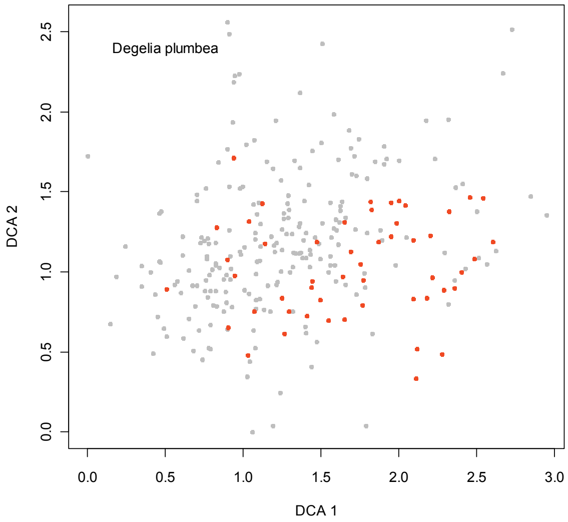


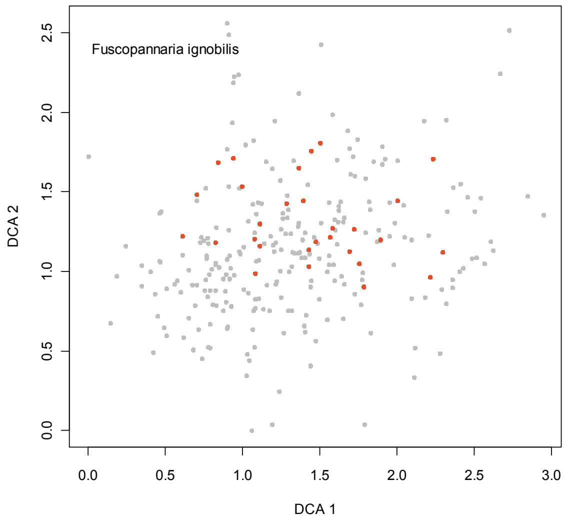


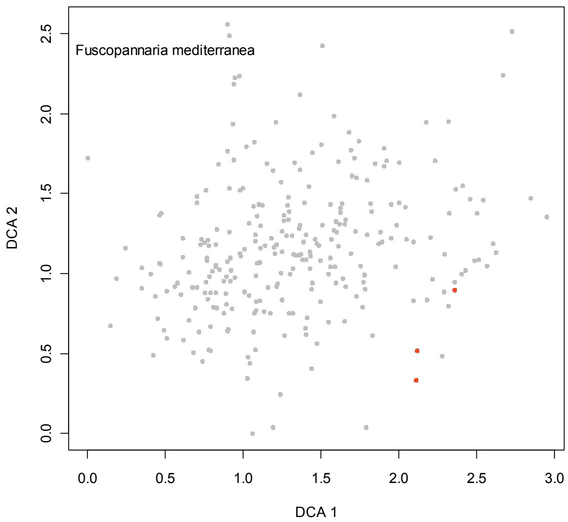


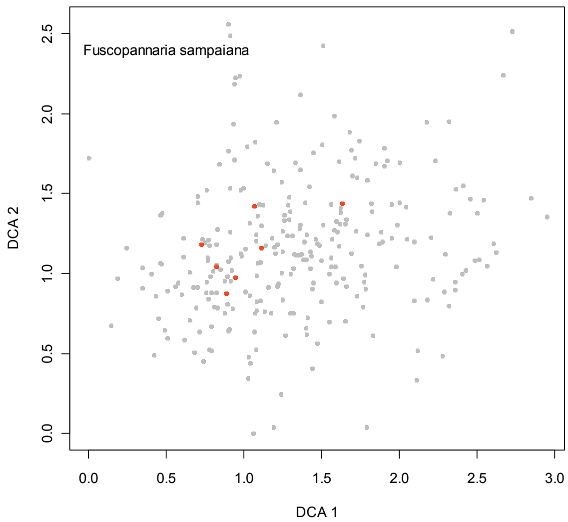


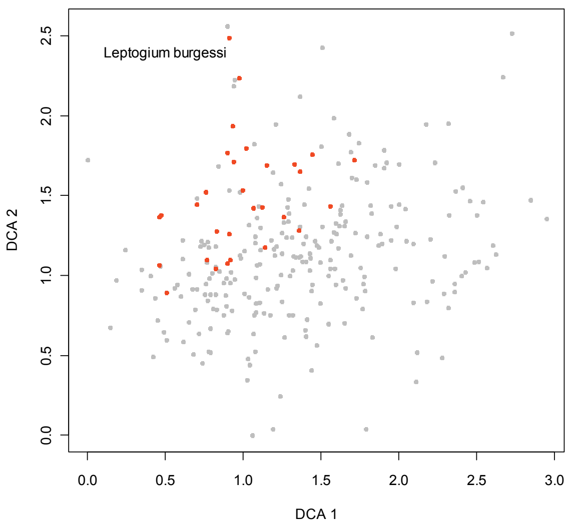


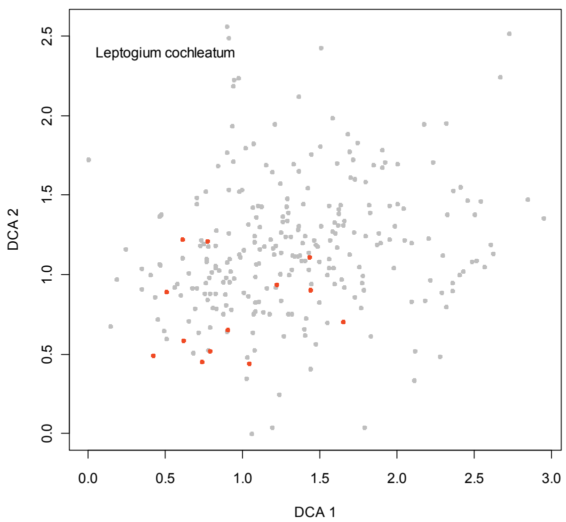

Degelia plumbea
DCA 1
DCA 2

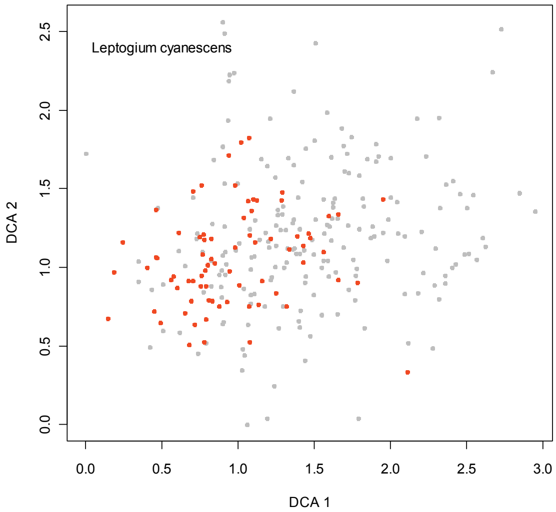

Fuscopannaria ignobilis
DCA 1
DCA 2


Fuscopannaria mediterranea
DCA 1
DCA 2


Fuscopannaria sampaiana
DCA 1
DCA 2


Leptogium burgessi
DCA 1
DCA 2


Leptogium cochleatum
DCA 1
DCA 2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DCA 1
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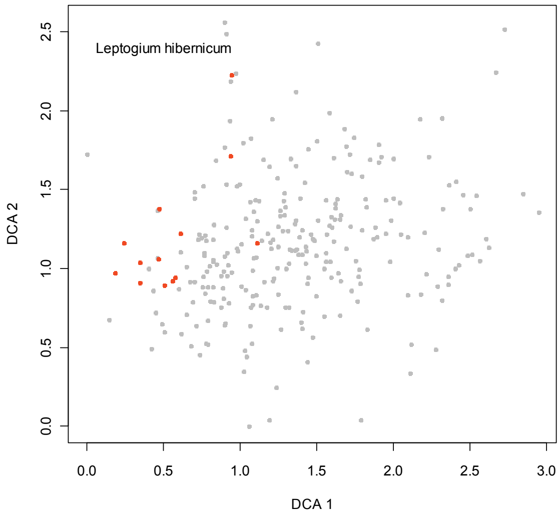
2.0
2.5
3.0


Leptogium hibernicum
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1.0
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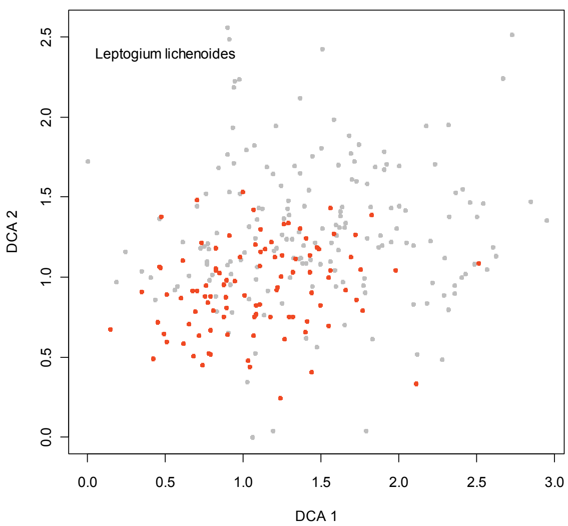
2.0
2.5
3.0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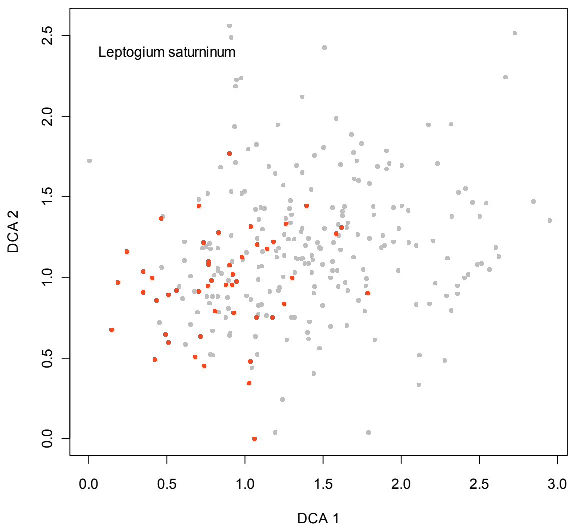
2.5
3.0


Leptogium saturninum
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DCA 1
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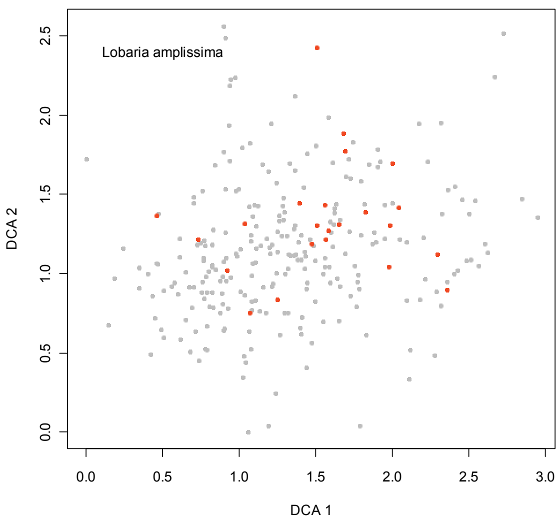
2.0
2.5
3.0


Lobaria amplissima
DCA 2
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DCA 1
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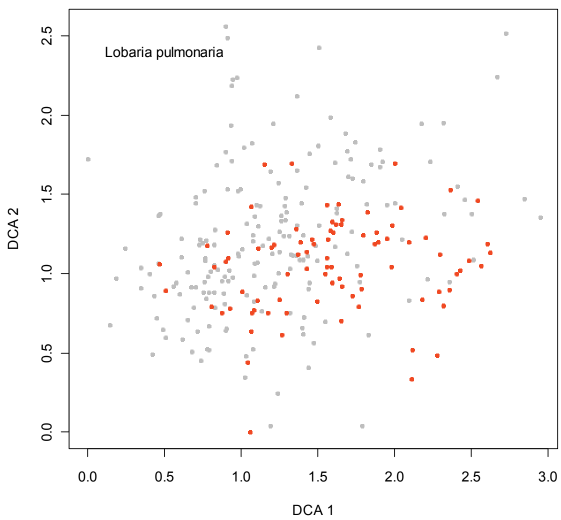
1.0
1.5
2.0
2.5
3.0


Lobaria pulmonaria
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2.0
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DCA 1
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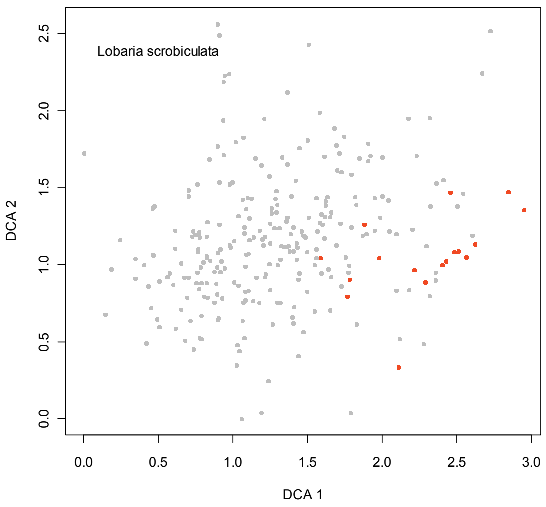
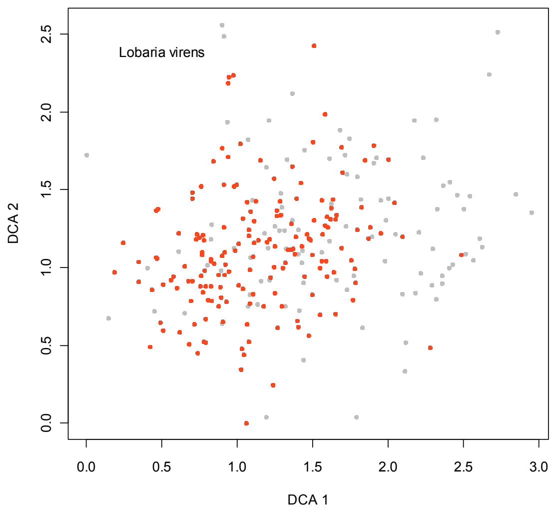
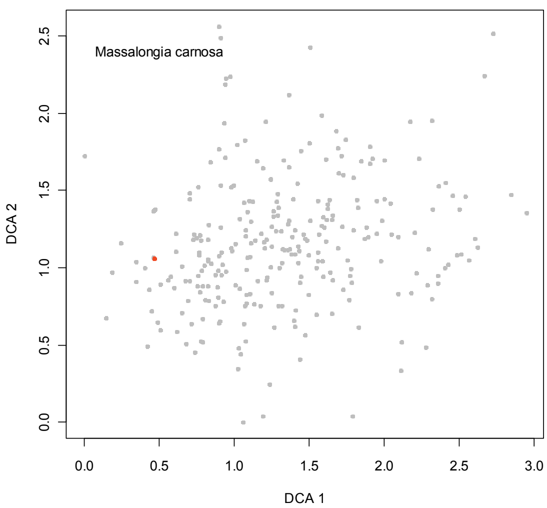
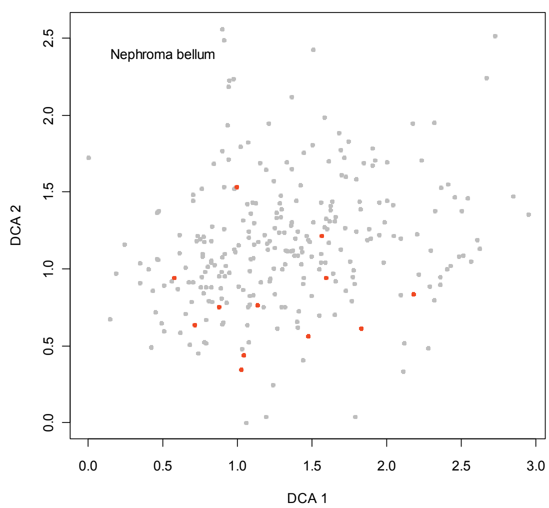
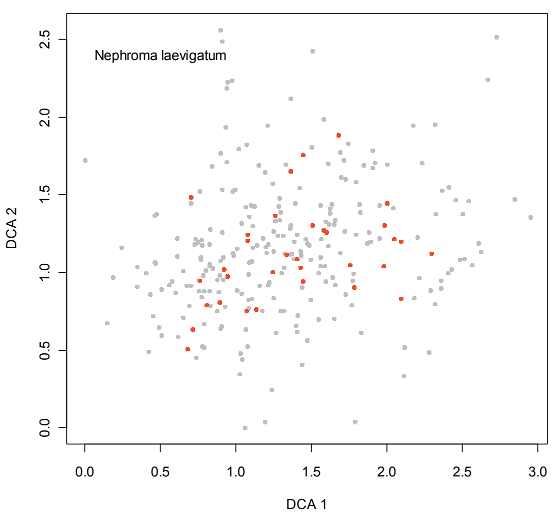
1.0
1.5
2.0
2.5
3.0

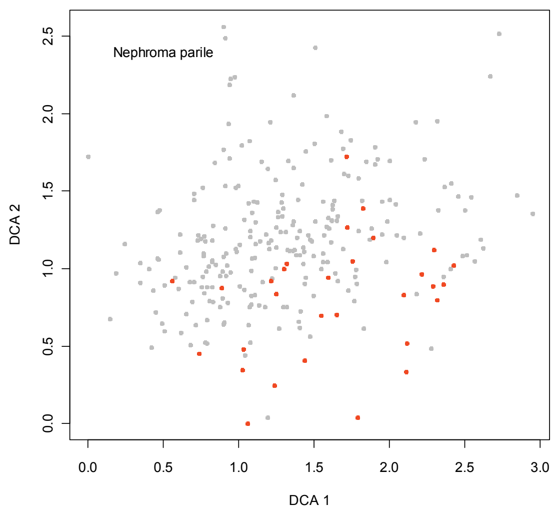

Lobaria scrobiculata
DCA 1
DCA 2

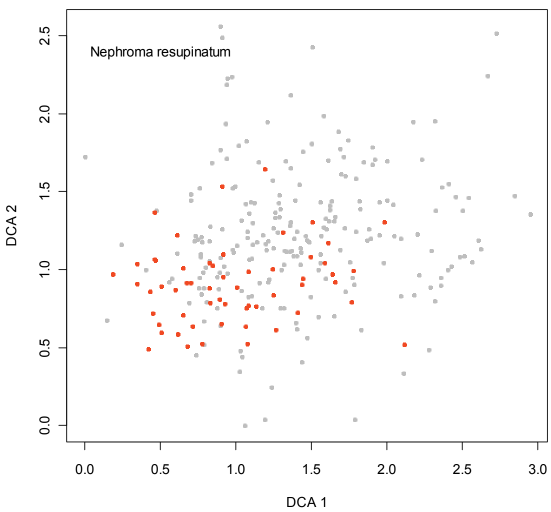

Lobaria virens
DCA 1
DCA 2

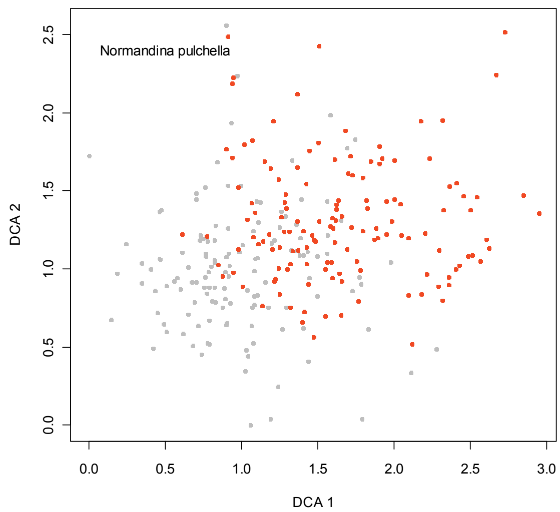

Massalongia carnosa
DCA 1
DCA 2

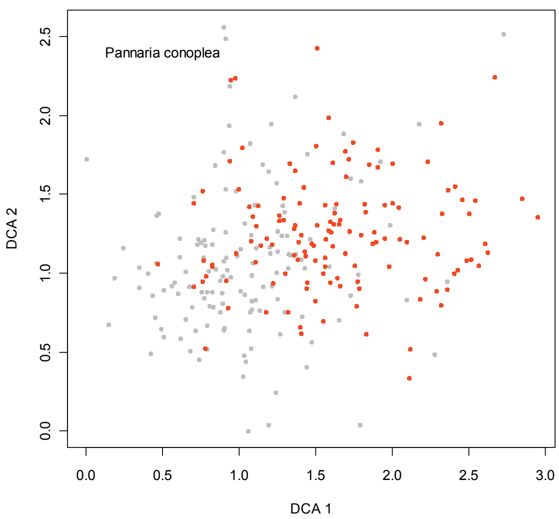

Nephroma bellum
DCA 1
DCA 2

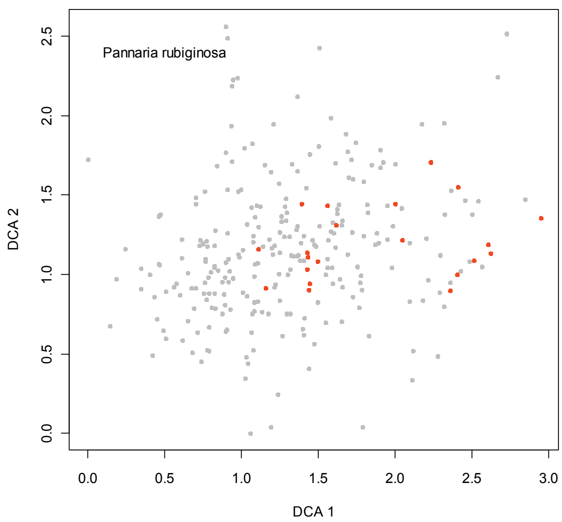

Nephroma laevigatum
DCA 1
DCA 2

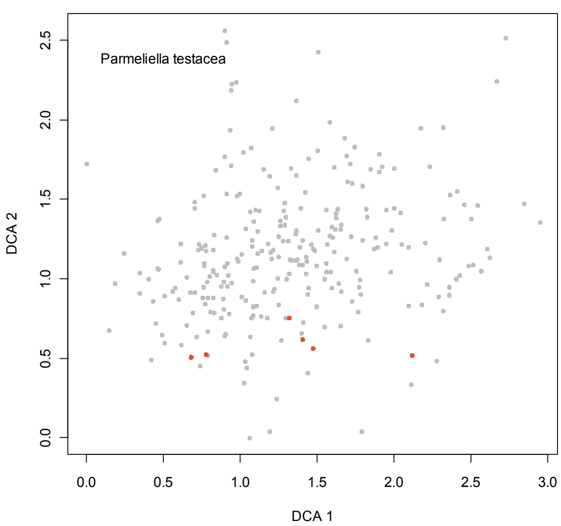

Nephroma parile
DCA 1
DCA 2

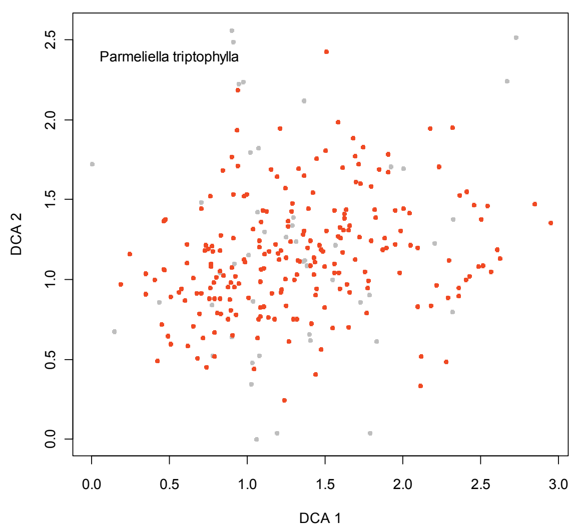

Nephroma resupinatum
DCA 1
DCA 2
0.0 0.5 1.0 1.5 2.0 2.5 3.0
0.0 0.5 1.0 1.5 2.0 2.5

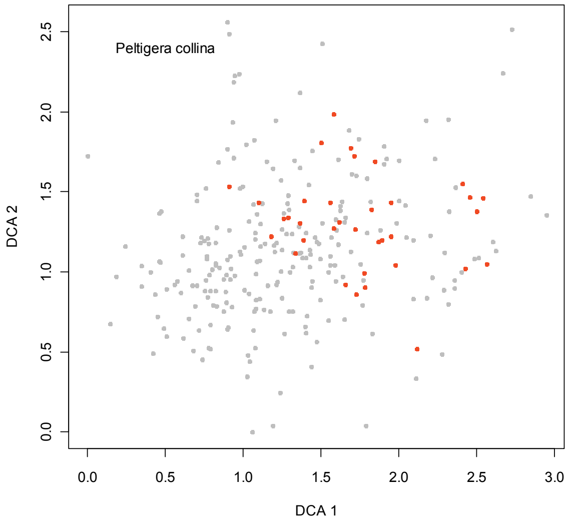

Normandina pulchella
DCA 1
DCA 2
0.0 0.5 1.0 1.5 2.0 2.5 3.0
0.0 0.5 1.0 1.5 2.0 2.5

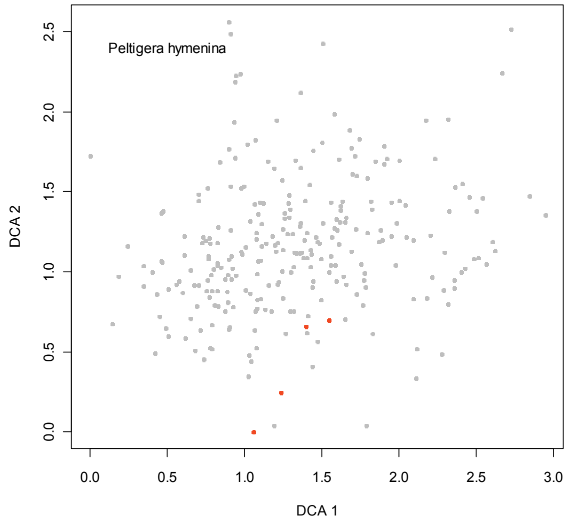

Pannaria conoplea
DCA 1
DCA 2
0.0 0.5 1.0 1.5 2.0 2.5 3.0
0.0 0.5 1.0 1.5 2.0 2.5

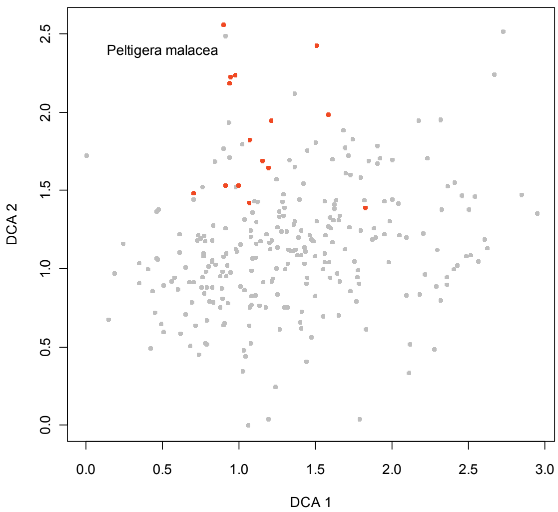

Pannaria rubiginosa
DCA 1
DCA 2
0.0 0.5 1.0 1.5 2.0 2.5 3.0
0.0 0.5 1.0 1.5 2.0 2.5

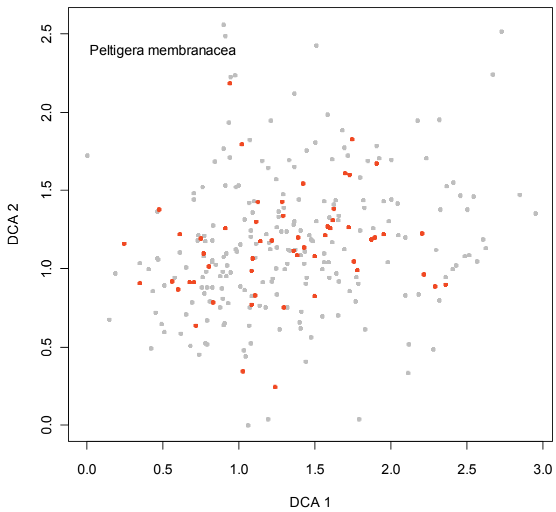

Parmeliella testacea
DCA 1
DCA 2
0.0 0.5 1.0 1.5 2.0 2.5 3.0
0.0 0.5 1.0 1.5 2.0 2.5

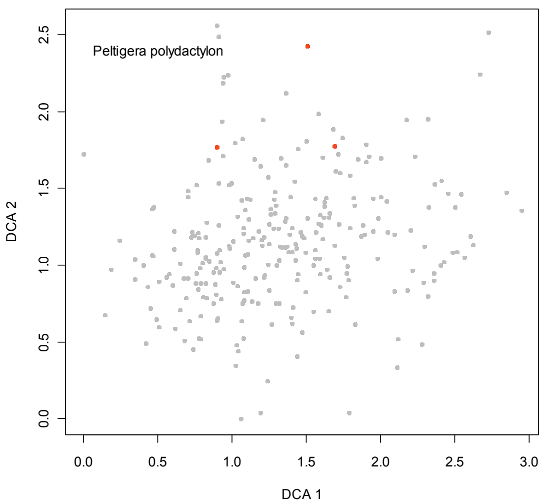

Parmeliella triptophylla
DCA 1
DCA 2
0.0 0.5 1.0 1.5 2.0 2.5 3.0
0.0 0.5 1.0 1.5 2.0 2.5

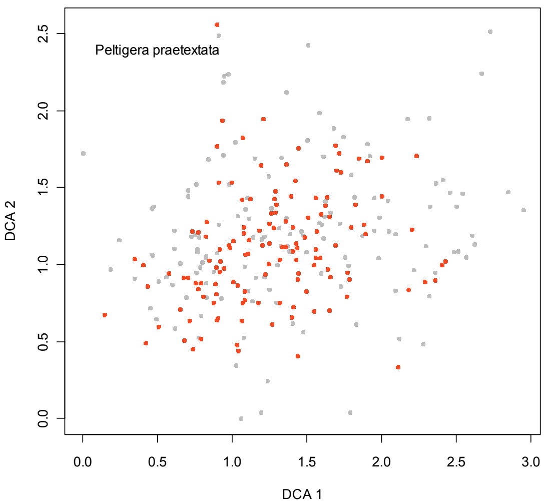

Peltigera collina
DCA 2
0.0 0.5 1.0 1.5 2.0 2.5
DCA 1
0.0 0.5 1.0 1.5 2.0 2.5 3.0

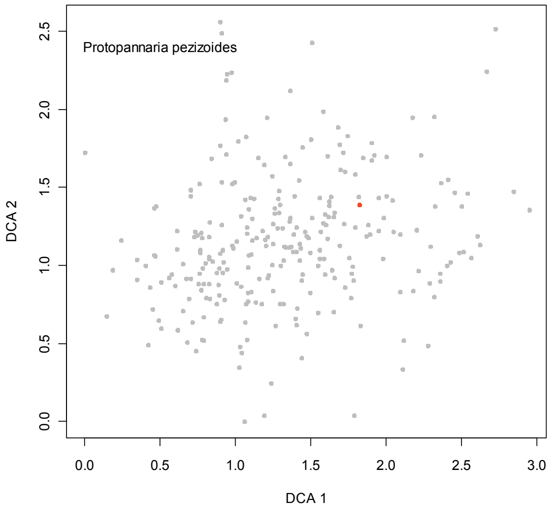

Peltigera hymenina
DCA 2
0.0 0.5 1.0 1.5 2.0 2.5
DCA 1
0.0 0.5 1.0 1.5 2.0 2.5 3.0

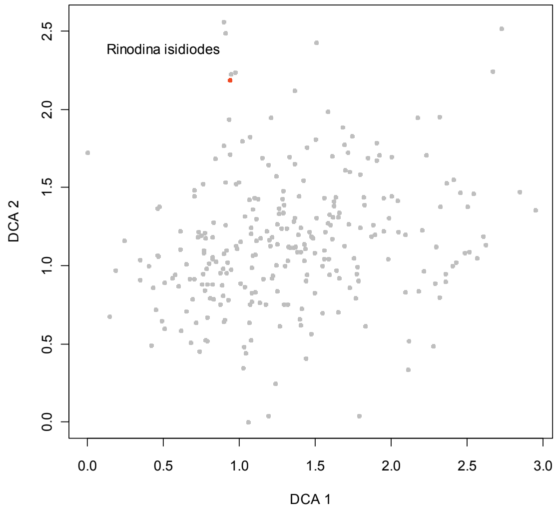

Peltigera malacea
DCA 2
0.0 0.5 1.0 1.5 2.0 2.5
DCA 1
0.0 0.5 1.0 1.5 2.0 2.5 3.0

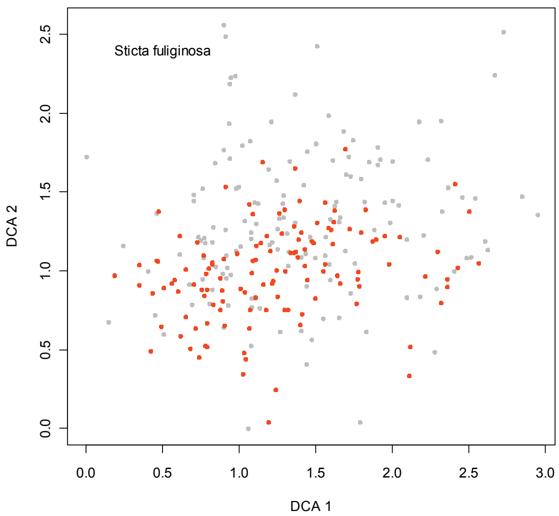

Peltigera membranacea
DCA 2
0.0 0.5 1.0 1.5 2.0 2.5
DCA 1
0.0 0.5 1.0 1.5 2.0 2.5 3.0

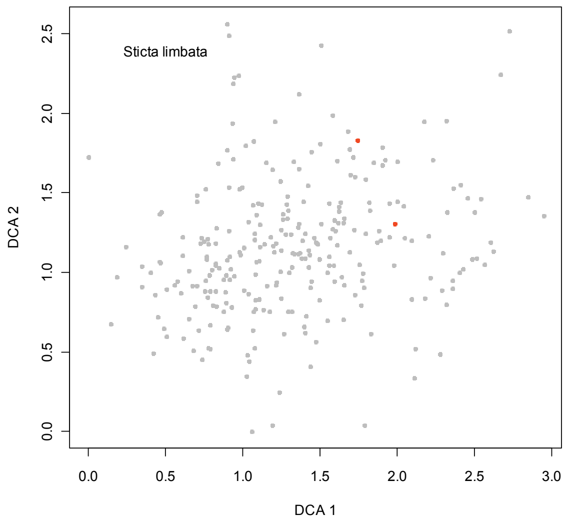

Peltigera polydactylon
DCA 2
0.0 0.5 1.0 1.5 2.0 2.5
DCA 1
0.0 0.5 1.0 1.5 2.0 2.5 3.0

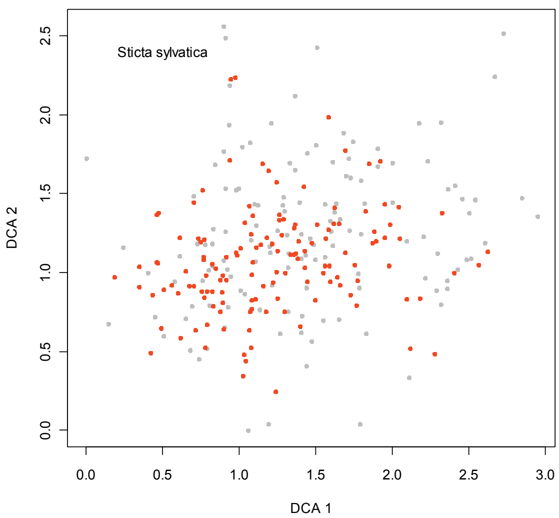

Peltigera praetextata
DCA 2
0.0 0.5 1.0 1.5 2.0 2.5
DCA 1
0.0 0.5 1.0 1.5 2.0 2.5 3.0


Protopannaria pezizoides
DCA 1
DCA 2

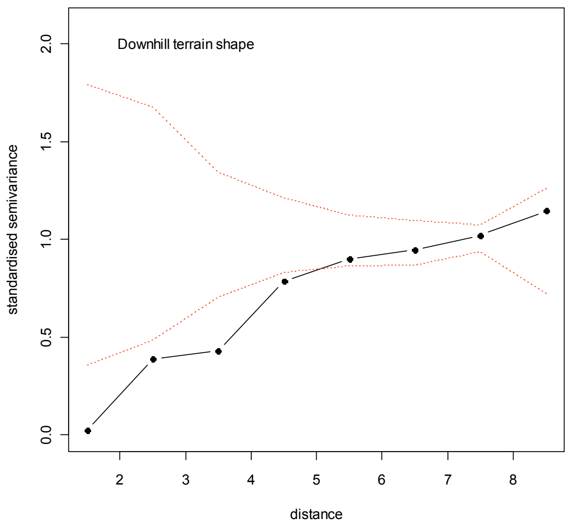

Rinodina isidiodes
DCA 1
DCA 2

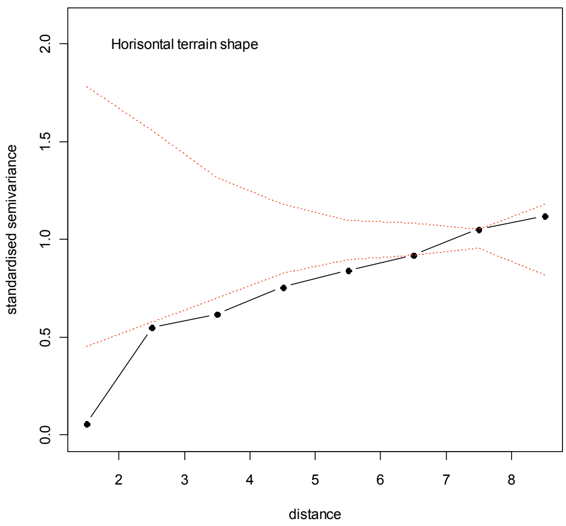

Sticta fuliginosa
DCA 1
DCA 2

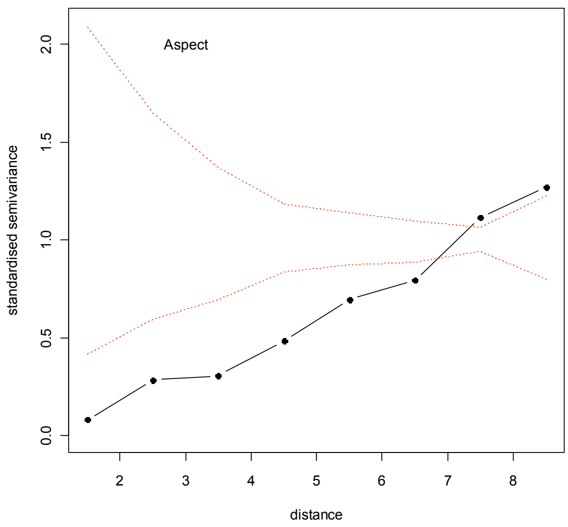

Sticta limbata
DCA 1
DCA 2

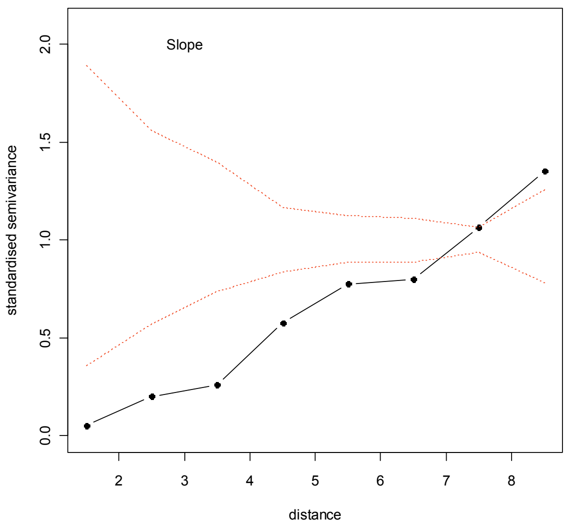

Sticta sylvatica
DCA 1
DCA 2

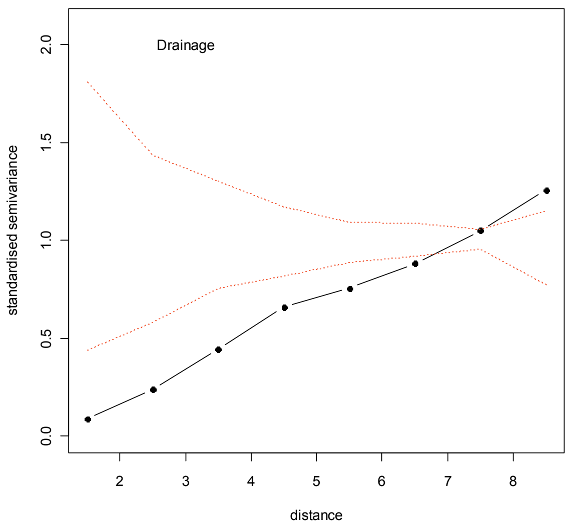
Appendix 7 Semivariograms - Continuous explanatory variables

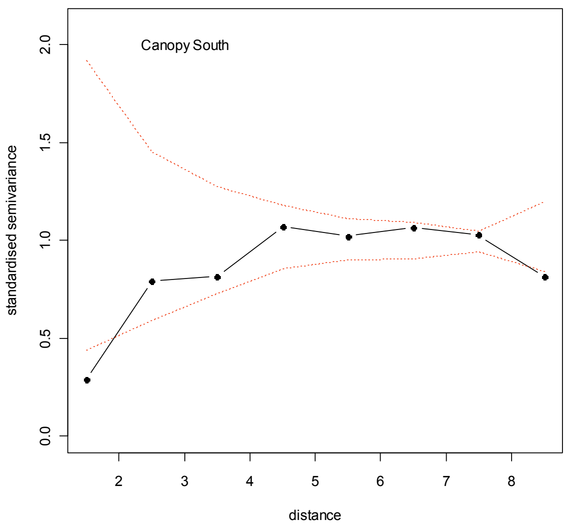


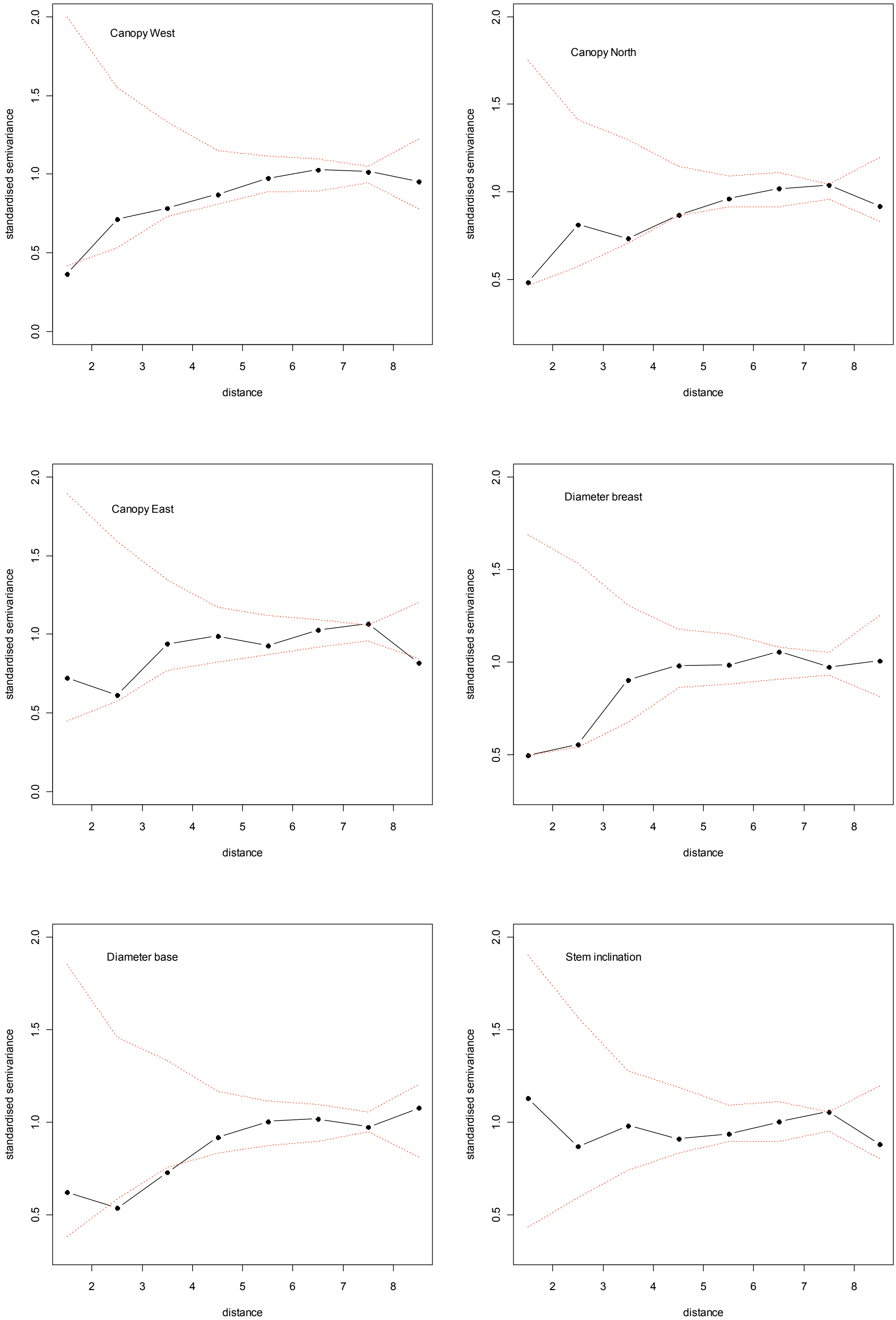


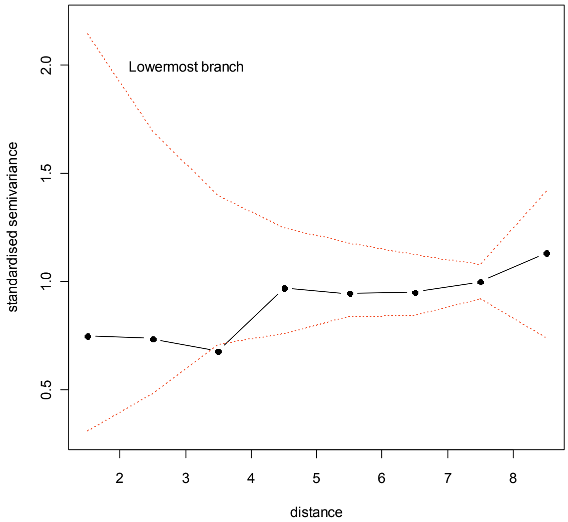


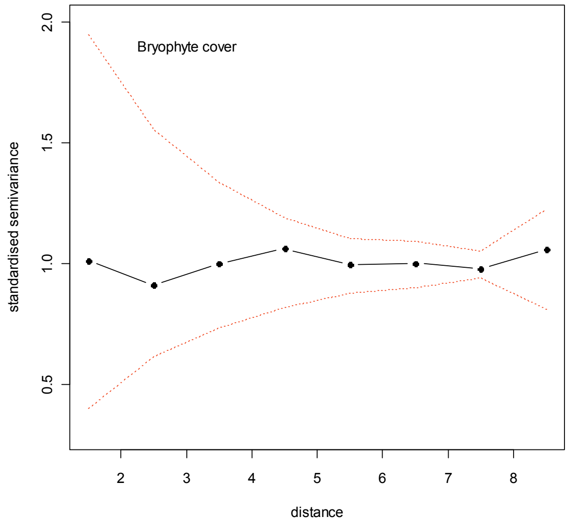


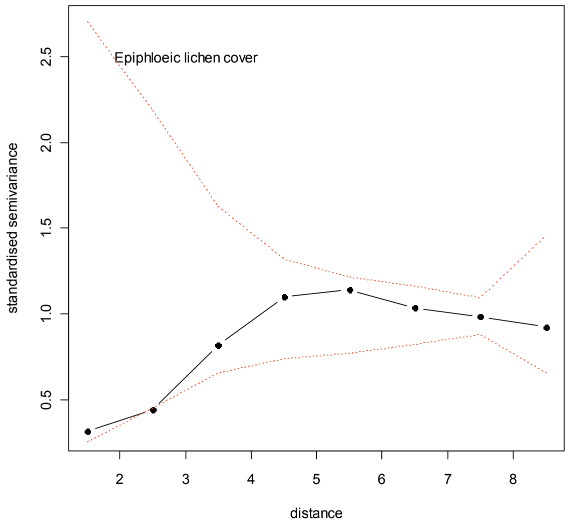


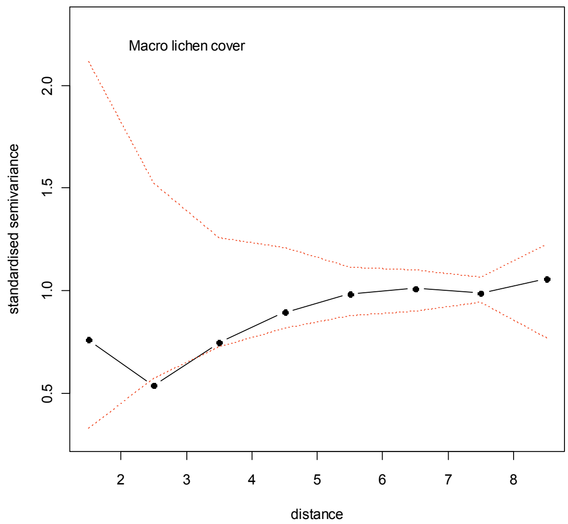


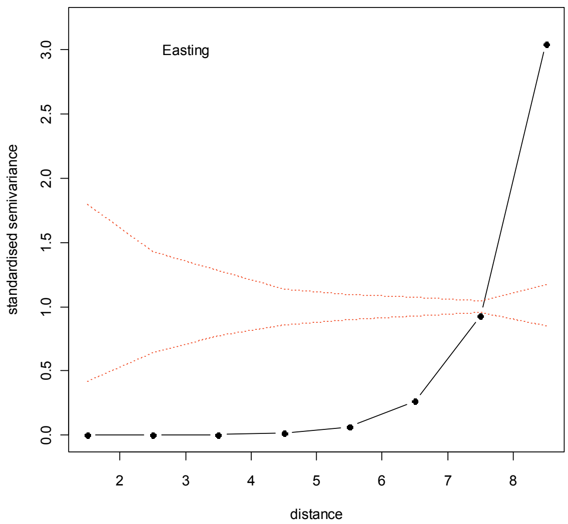

Canopy West
Canopy North
Canopy East
Diameter breast
Diameter base
Stem inclination
standardised semivariance
distance
0.0
0.5
1.0
1.5
2.0
2
3
4
5
6
7
8

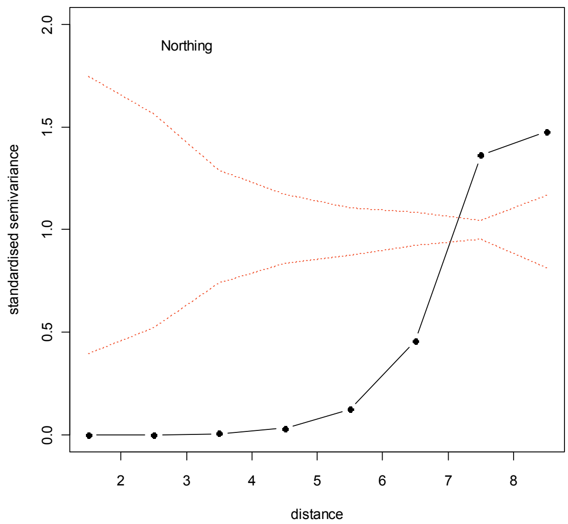

Lowermost branch
standardised semivariance
0.5 1.0 1.5 2.0
2 3 4 5 6 7 8
distance

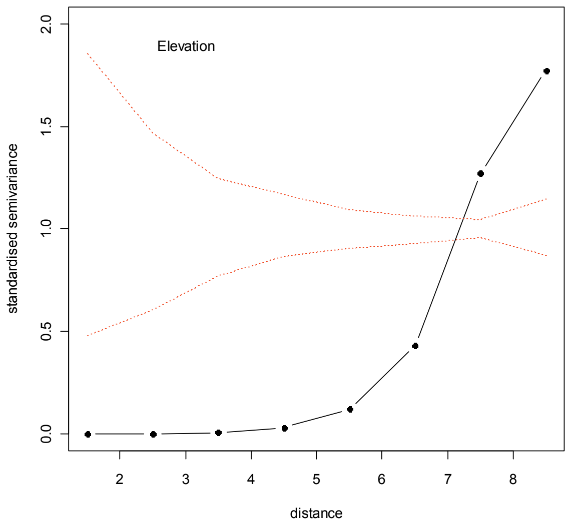

Bryophyte cover
standardised semivariance
0.5 1.0 1.5 2.0
2 3 4 5 6 7 8
distance

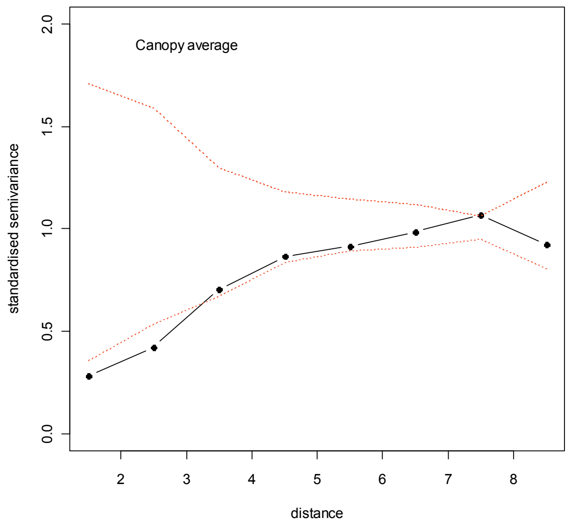

Epiphloeic lichen cover
standardised semivariance
0.5 1.0 1.5 2.0 2.5
2 3 4 5 6 7 8
distance


Macro lichen cover
standardised semivariance
0.5 1.0 1.5 2.0
2 3 4 5 6 7 8
distance

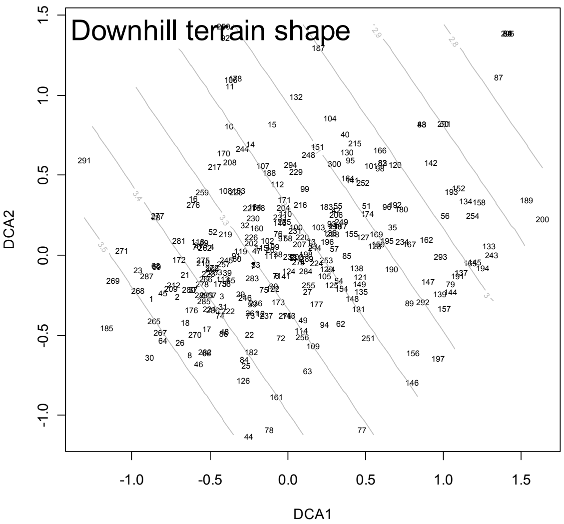

Easting
standardised semivariance
0.0 0.5 1.0 1.5 2.0 2.5 3.0
2 3 4 5 6 7 8
distance

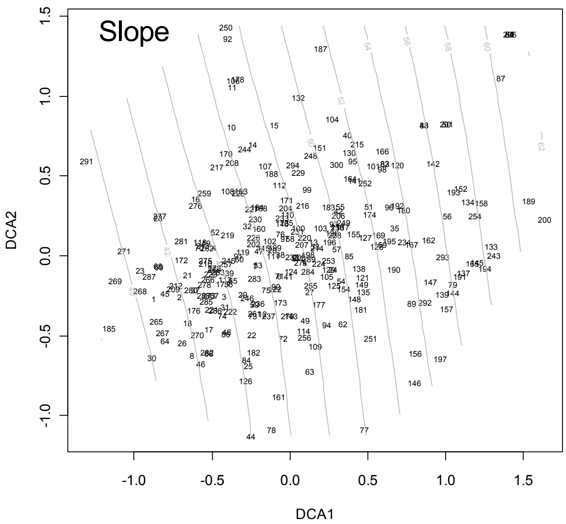

Northing
standardised semivariance
0.0 0.5 1.0 1.5 2.0
2 3 4 5 6 7 8
distance

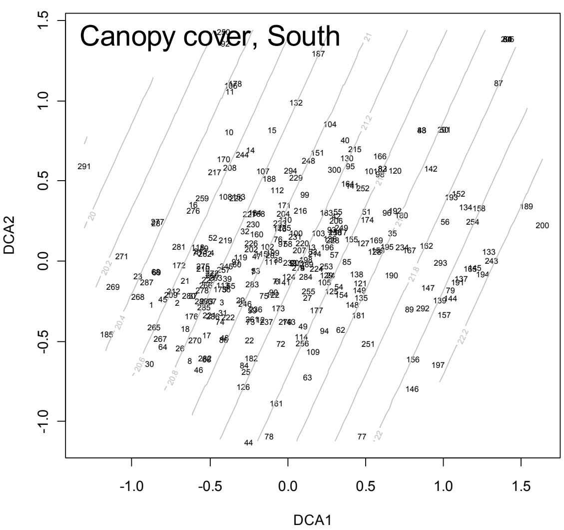

Elevation
standardised semivariance
distance
0.0
0.5
1.0
1.5
2.0
2
3
4
5
6
7
8

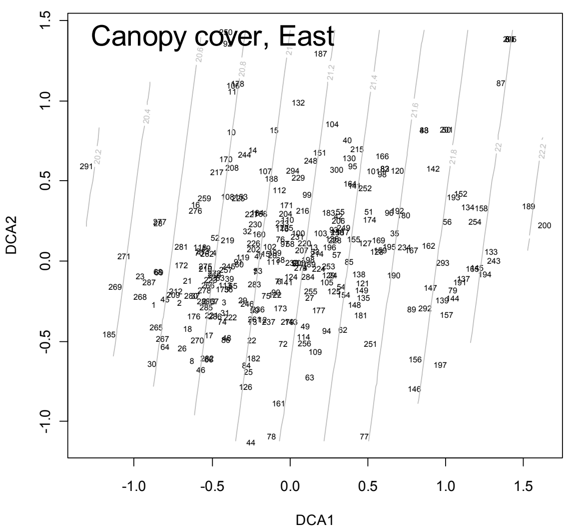

Canopy average
standardised semivariance
distance
0.0
0.5
1.0
1.5
2.0
2
3
4
5
6
7
8

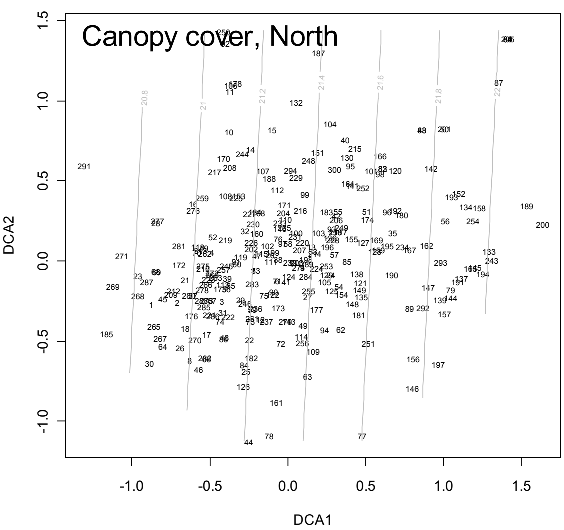
Appendix 8 DCA isoline diagrams - Significant explanatory variables

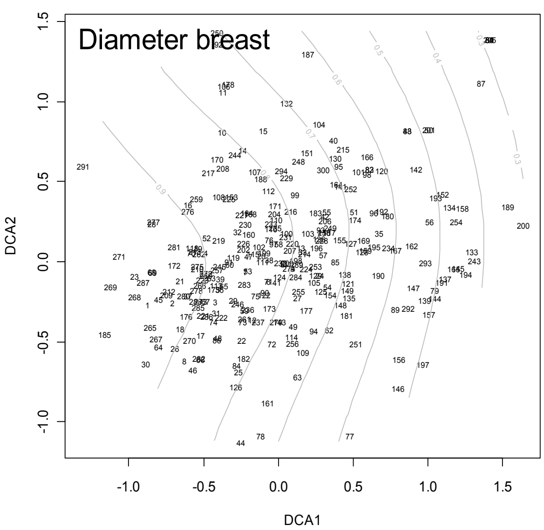


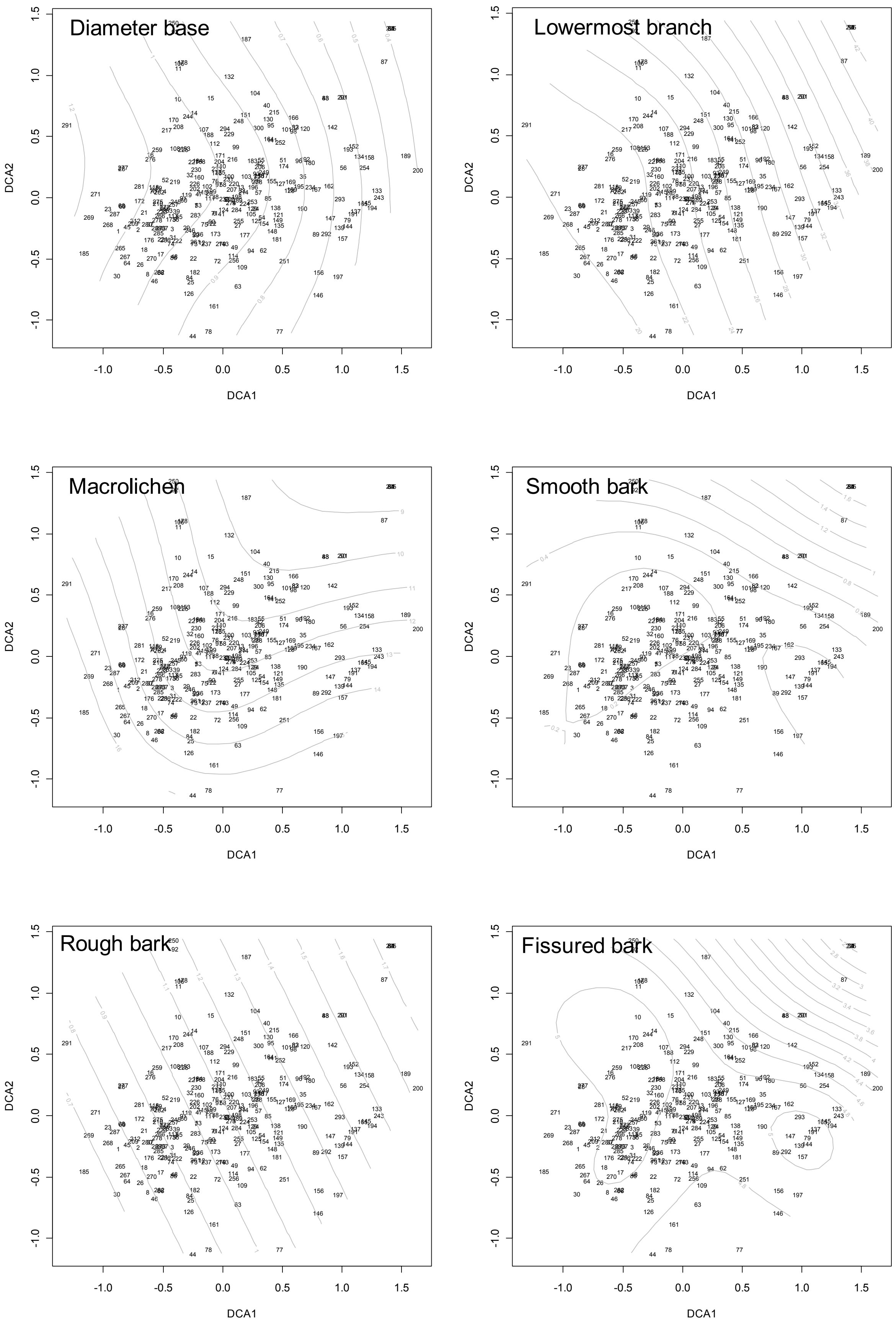


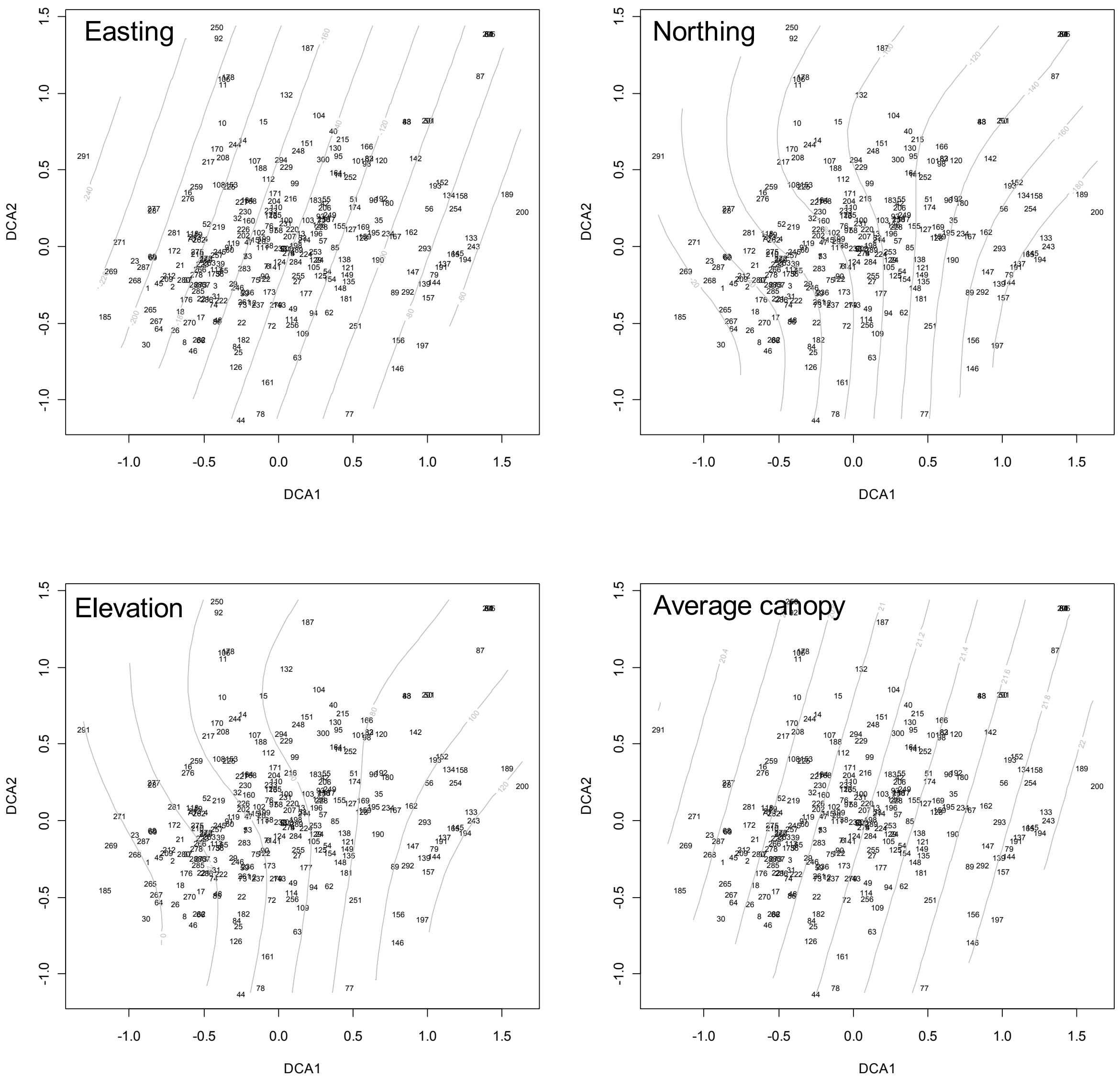




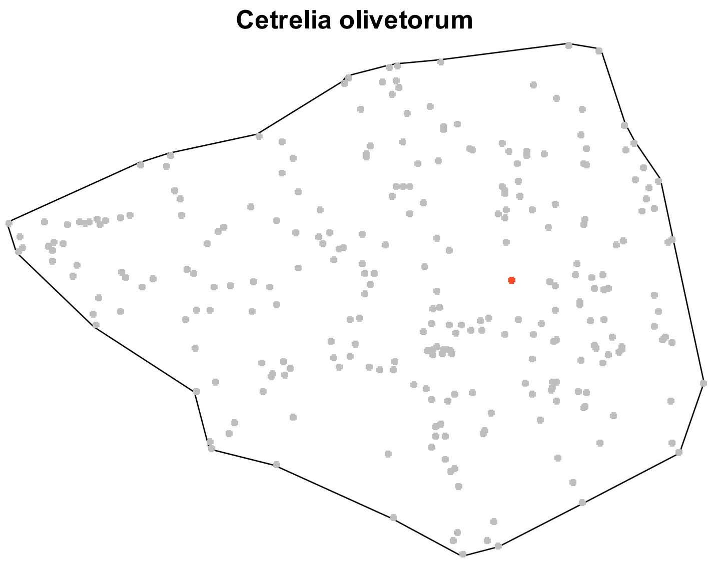


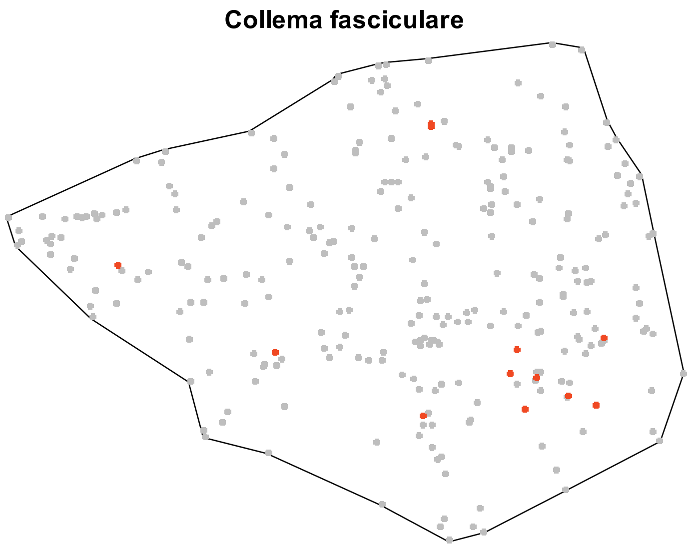



Diameter base
Lowermost branch
Macrolichen
Smooth bark
Rough bark
Fissured bark
DCA1
DCA2

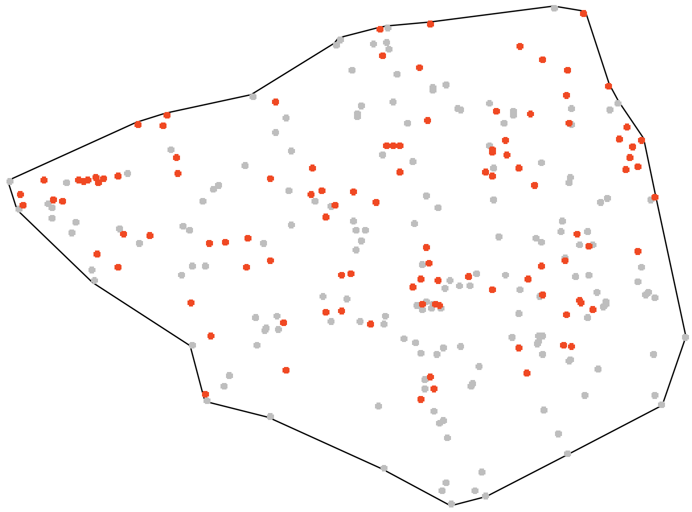

Easting
Northing
Elevation
Average canopy
DCA1
DCA2

Appendix 9 Point pattern lichen species plots

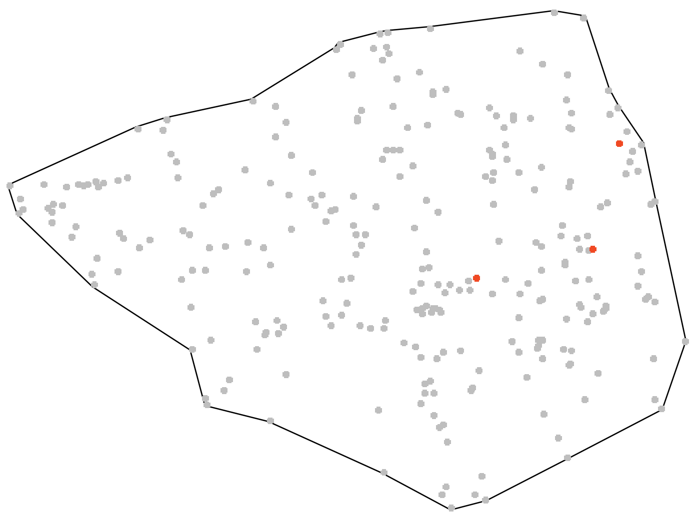




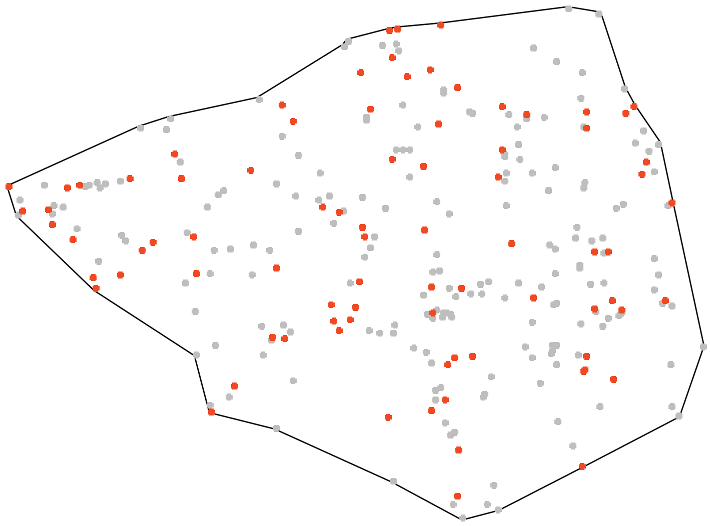
Collema flaccidum



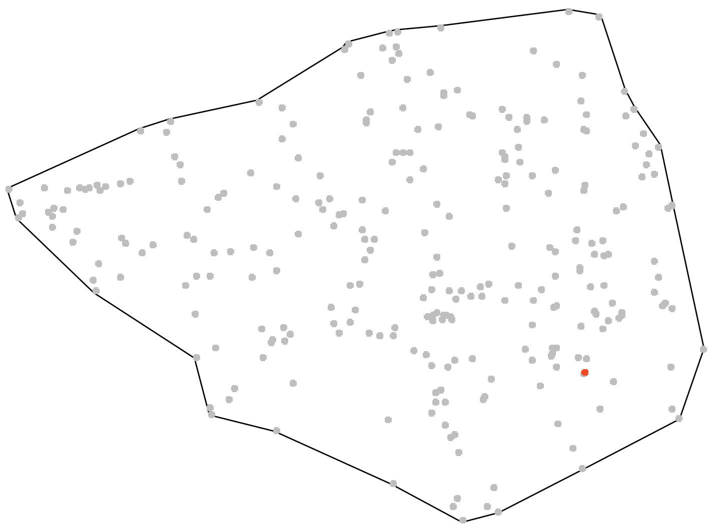
Collema furfuraceum



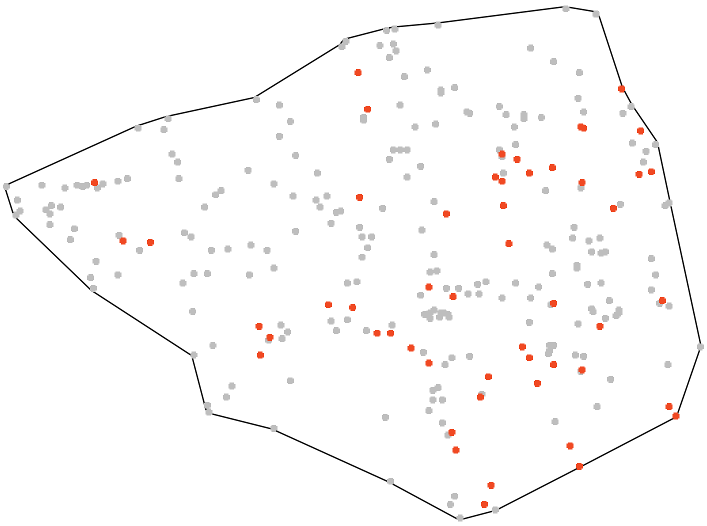
Collema subflaccidum



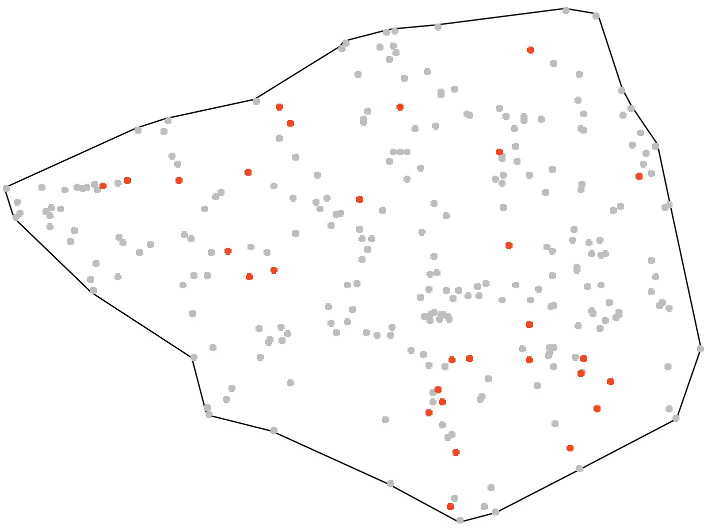
Collema subnigrescens



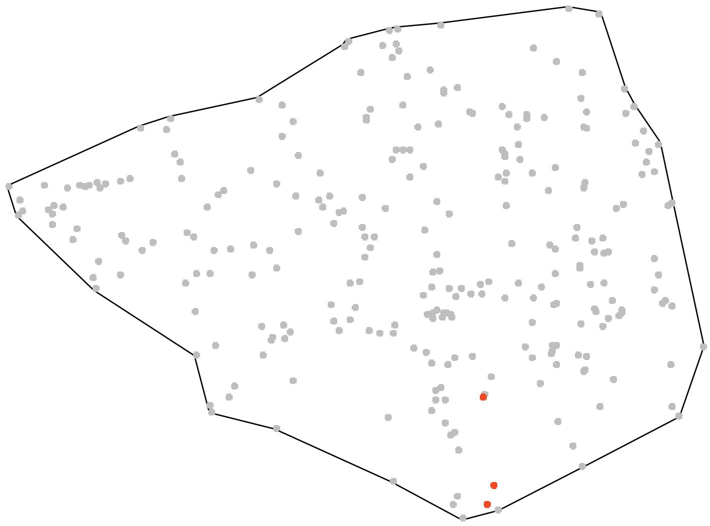
Degelia plumbea



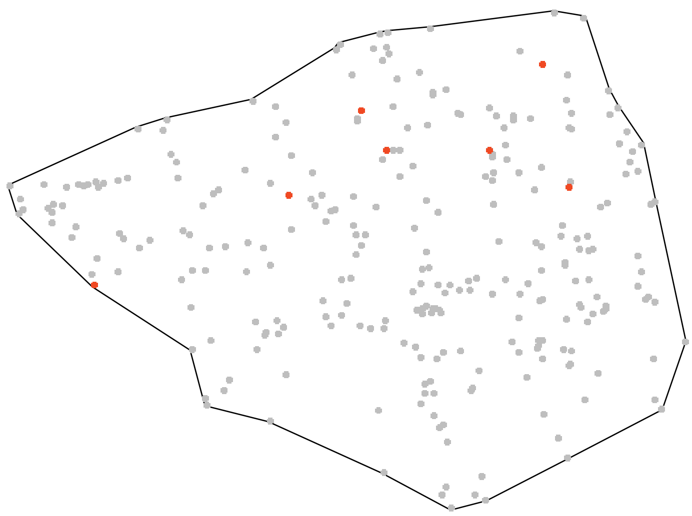
Fuscopannaria ignobilis



Fuscopannaria mediterranea

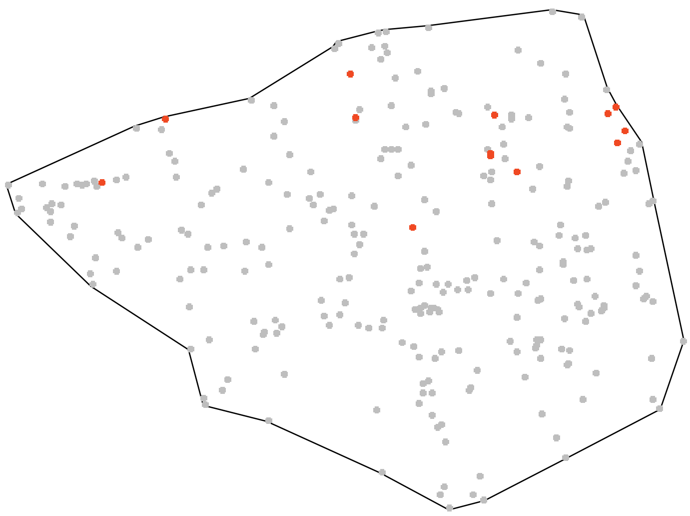


Fuscopannaria sampaiana



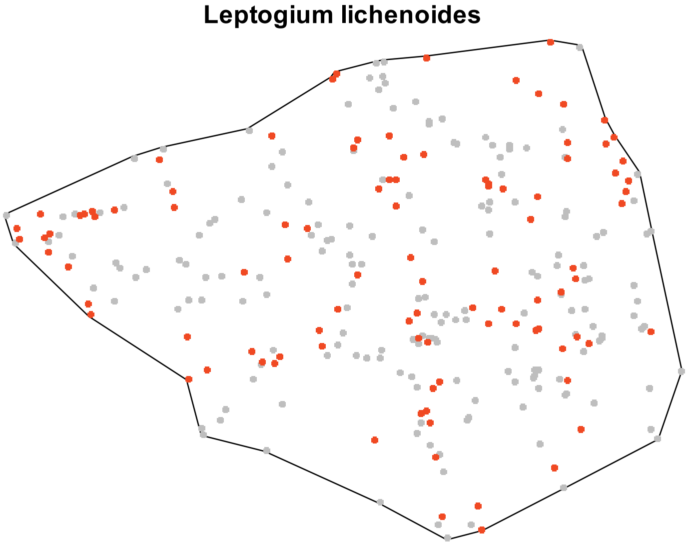
Leptogium burgessii

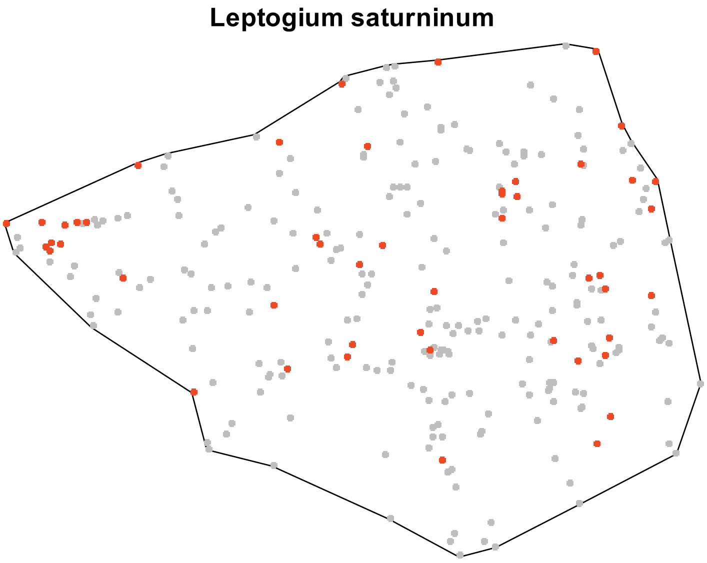
Leptogium cochleatum



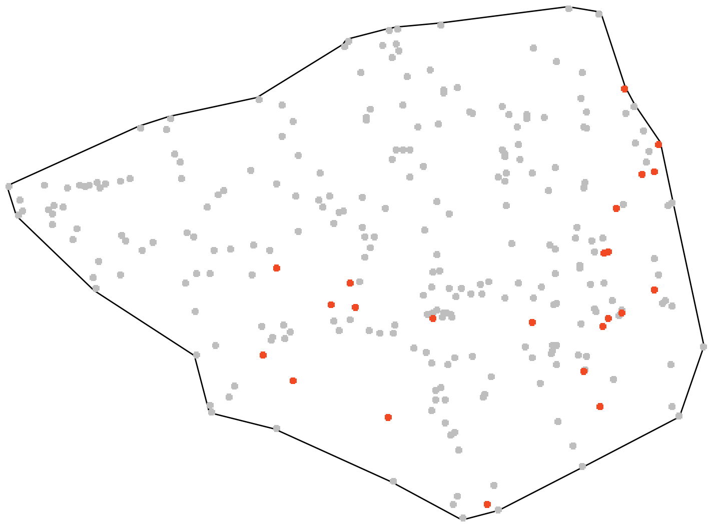
Leptogium cyanescens

Leptogium hibernicum

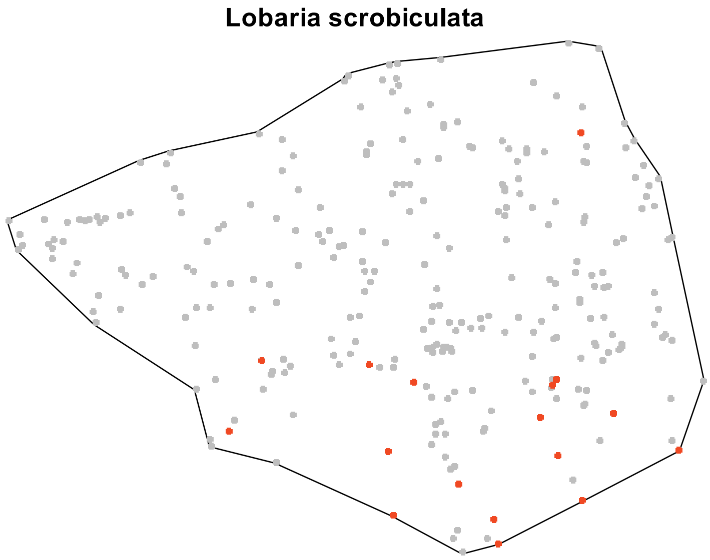

Leptogium lichenoides

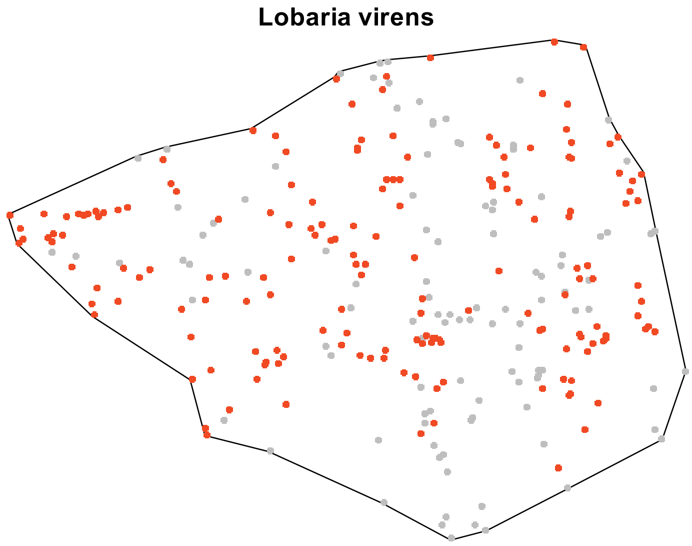

Leptogium saturninum

Lobaria amplissima

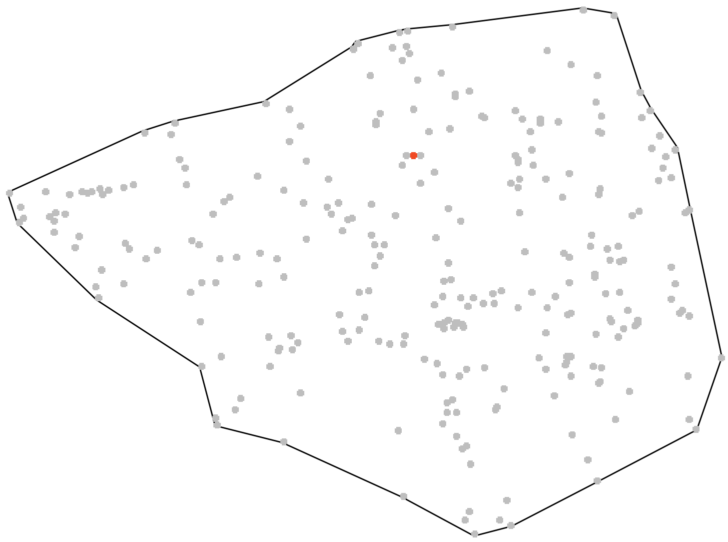


Lobaria pulmonaria

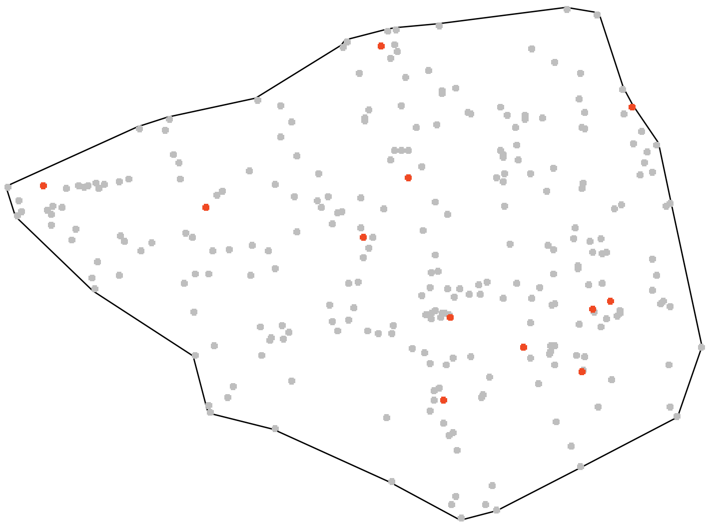

Lobaria scrobiculata


Lobaria virens

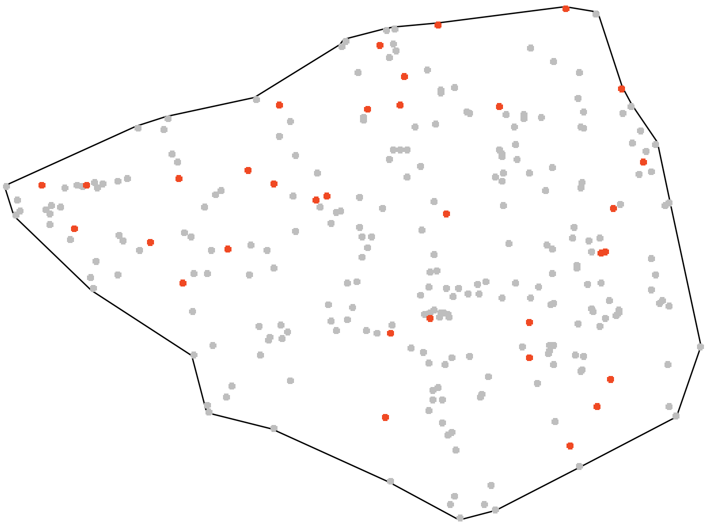
Massalongia carnosa



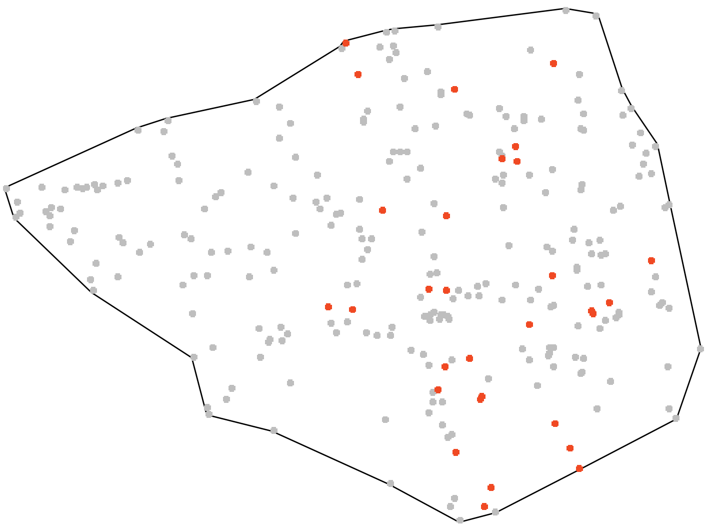
Nephroma bellum



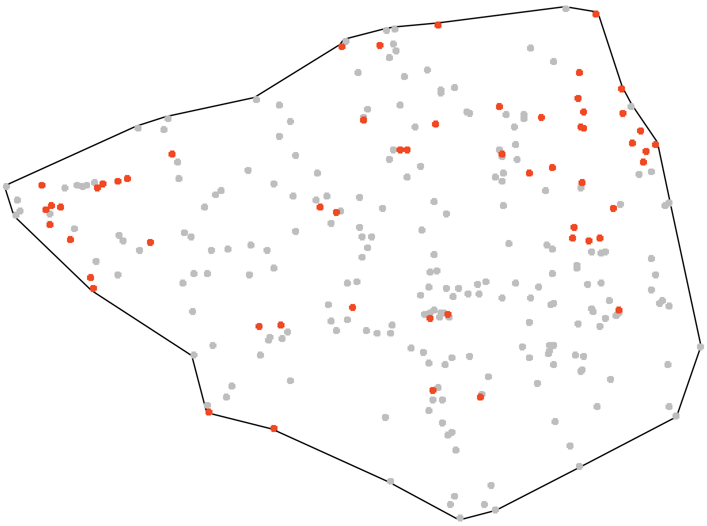
Nephroma laevigatum



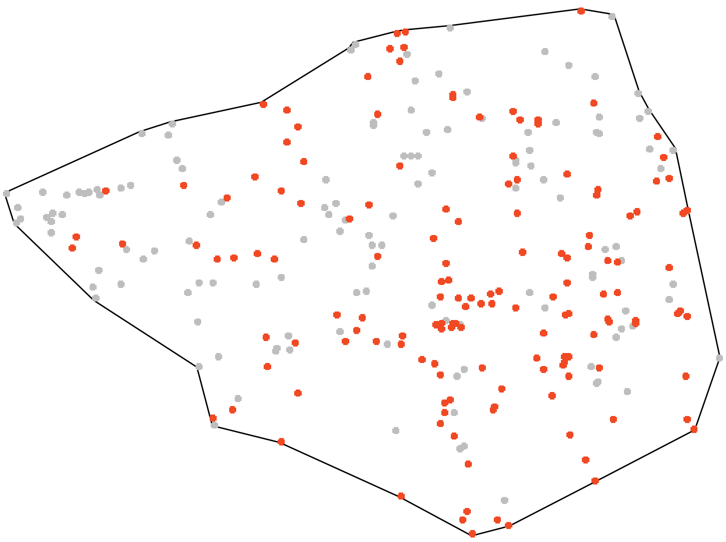
Nephroma parile



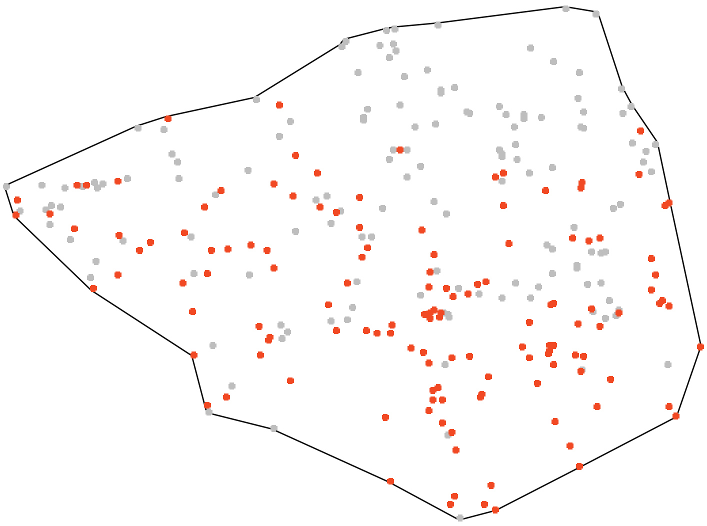
Nephroma resupinatum



Normandina pulchella

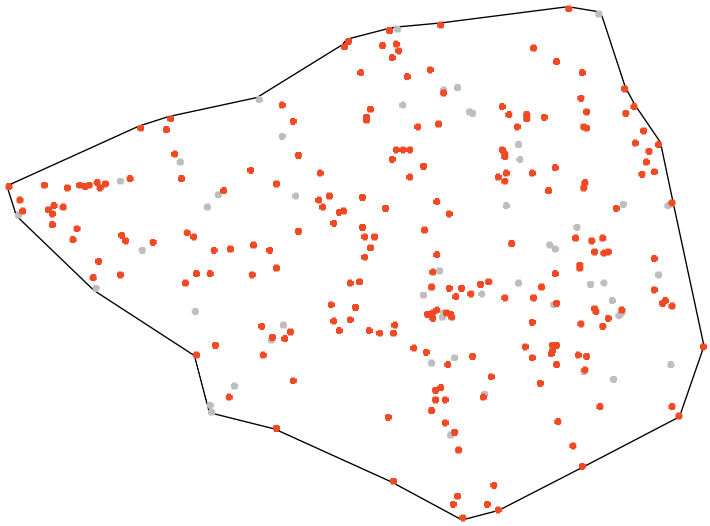


Pannaria conoplea

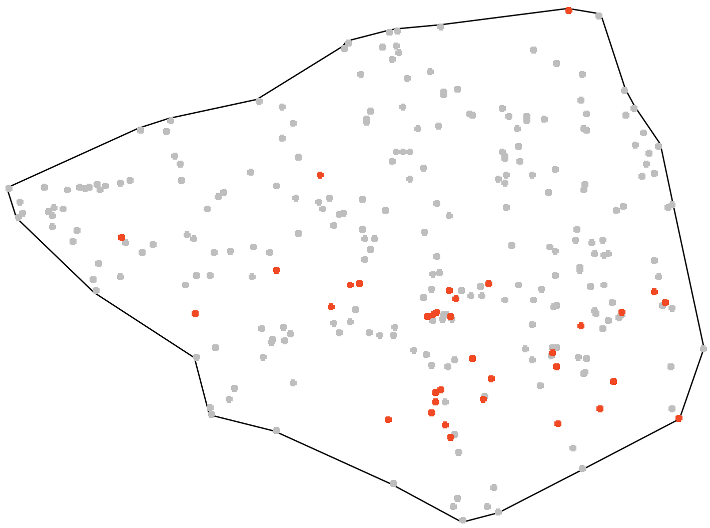


Pannaria rubiginosa

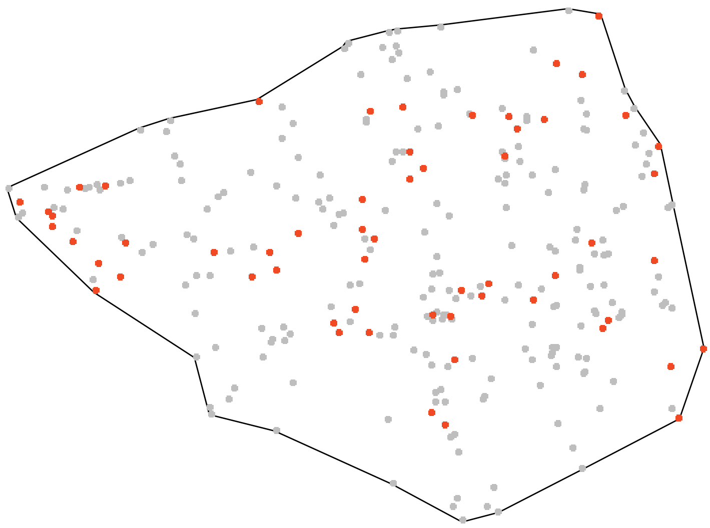
Parmeliella triptophylla



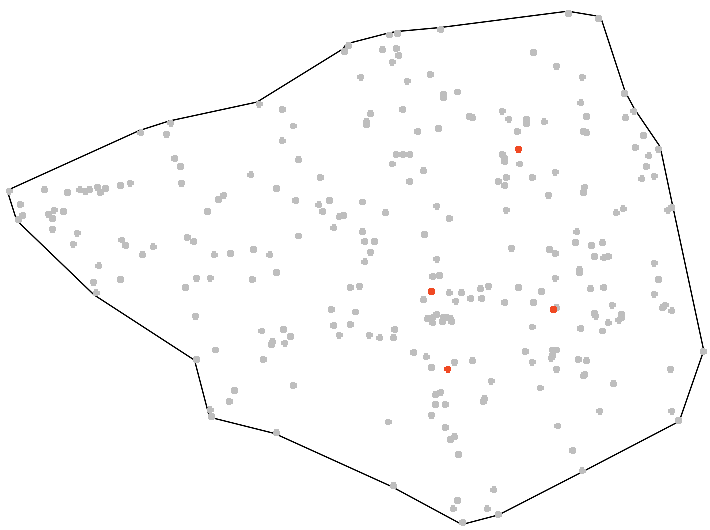
Peltigera collina



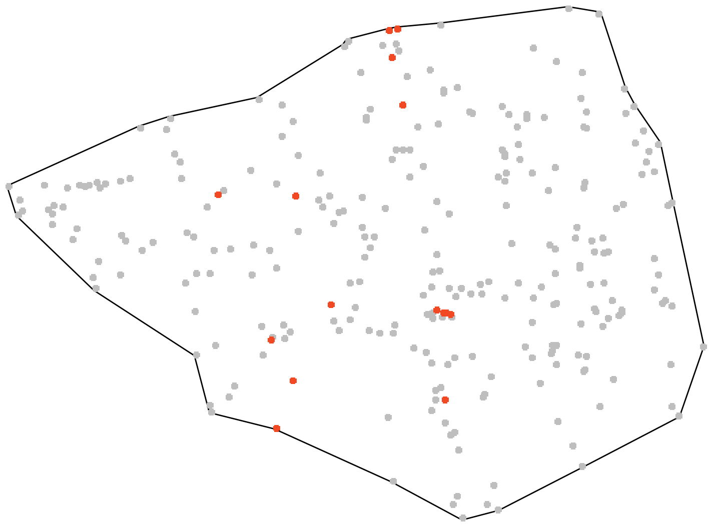
Peltigera horizontalis



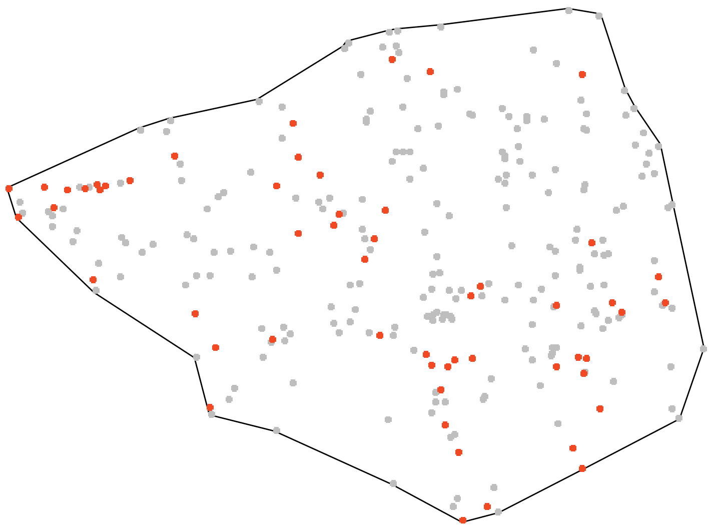
Peltigera hymenina



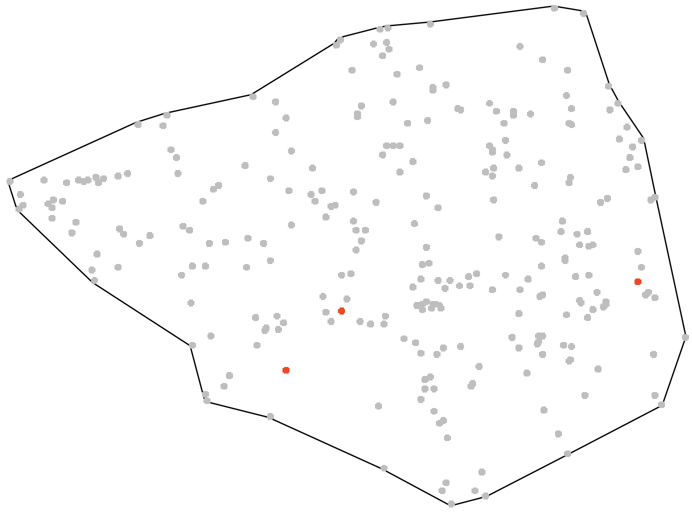
Peltigera malacea



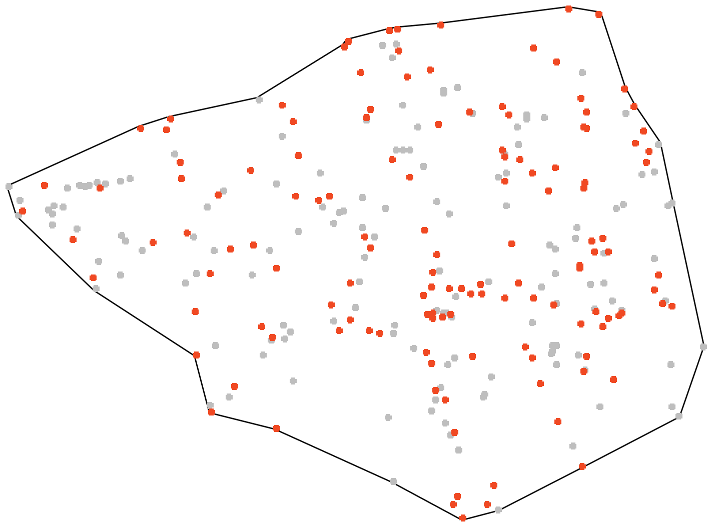
Peltigera membranacea

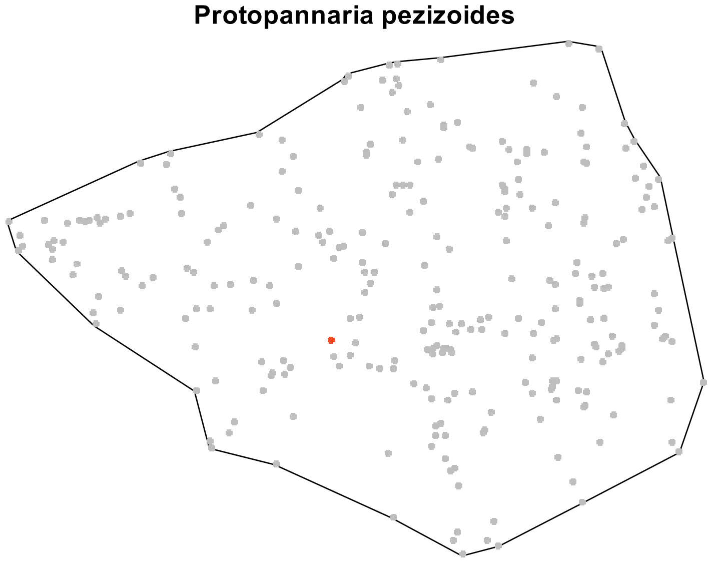


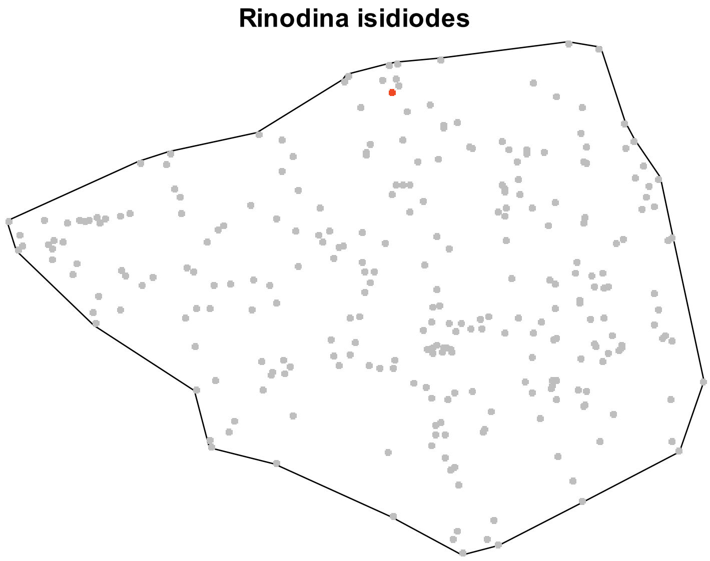
Peltigera polydactylon



Peltigera praetextata

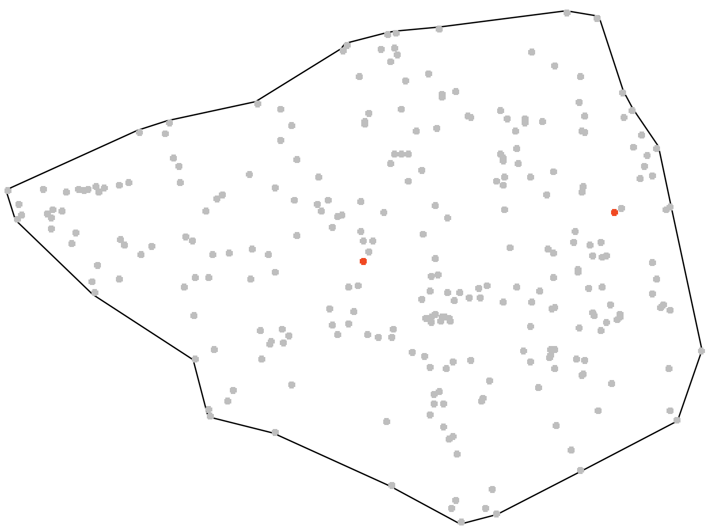



Protopannaria pezizoides


Rinodina isidiodes

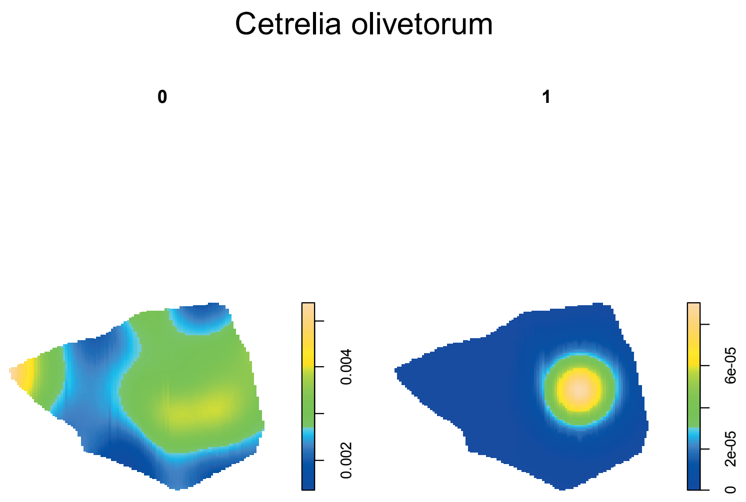
Sticta fuliginosa

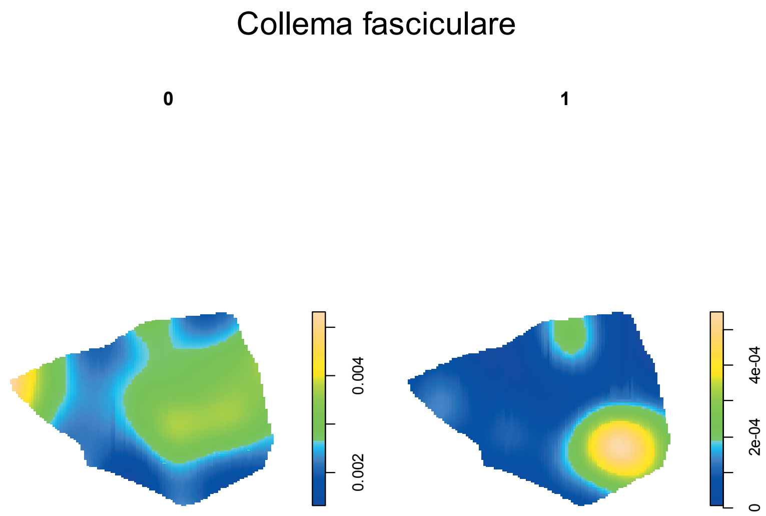
Sticta limbata



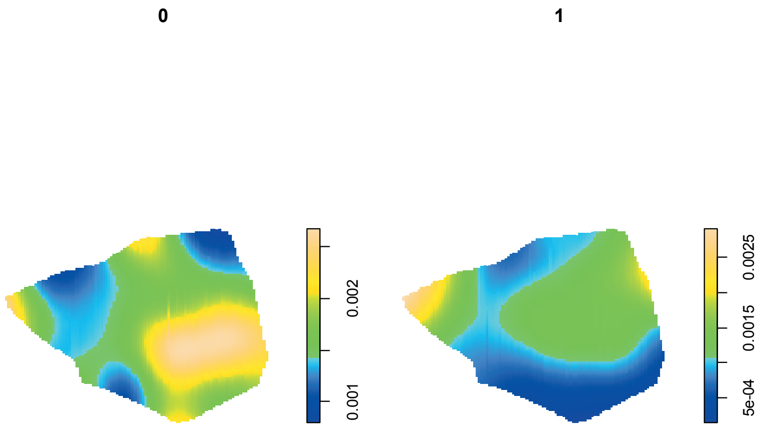
Sticta sylvatica

Appendix 10 Point pattern density plots of lichen species

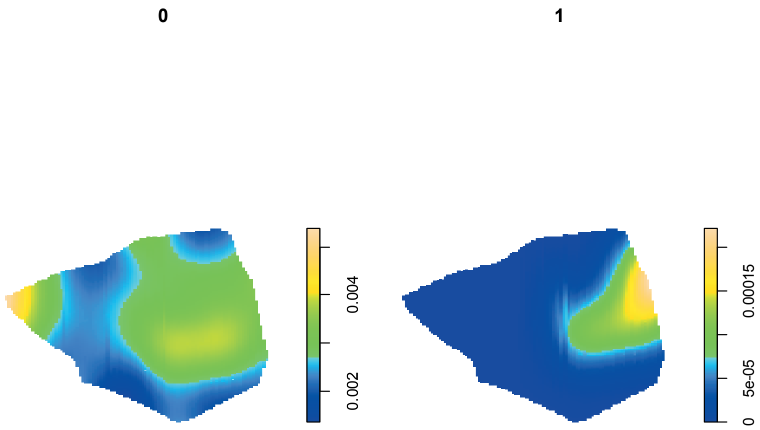


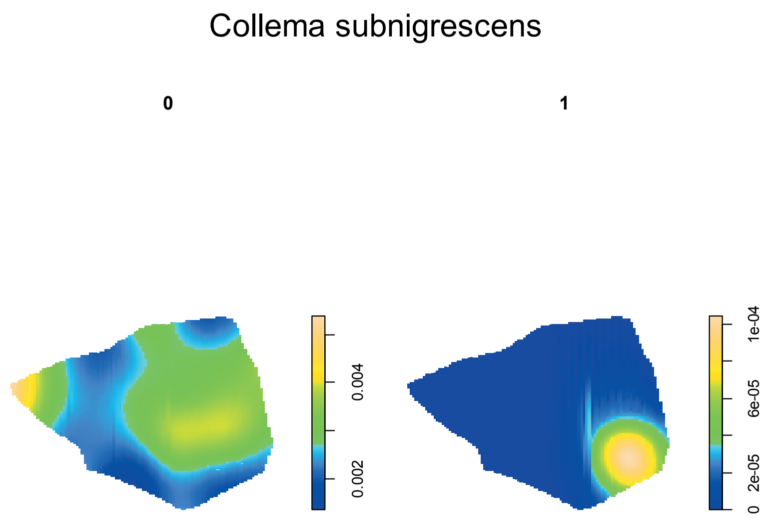


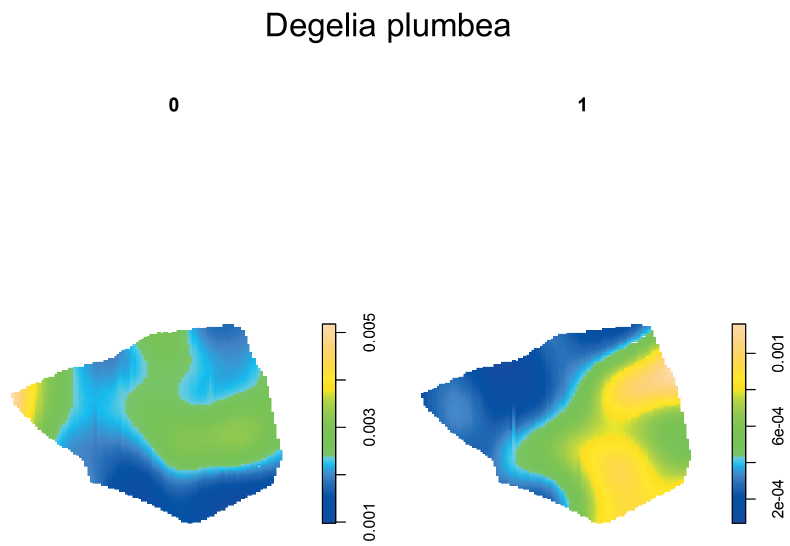
Collema flaccidum



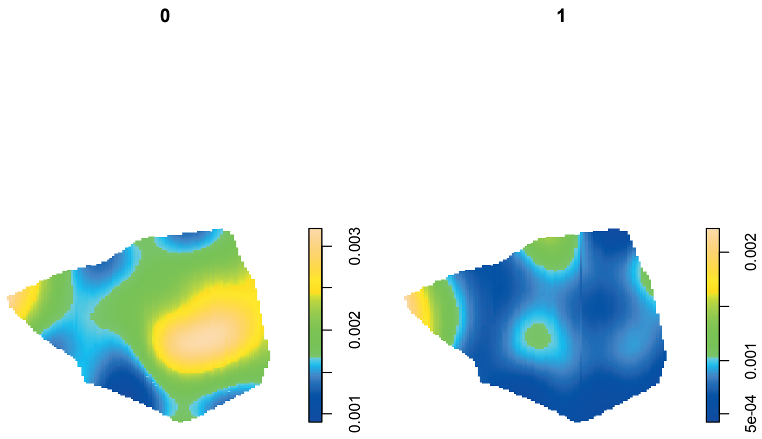
Collema furfuraceum



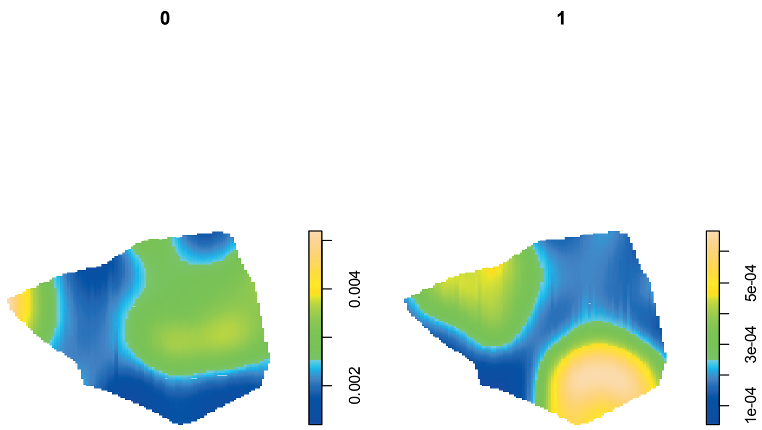

Collema subnigrescens
0
1
0.002
0.004
0
2e-05
6e-05
1e-04


Degelia plumbea
0
1
0.001
0.003
0.005
2e-04
6e-04
0.001

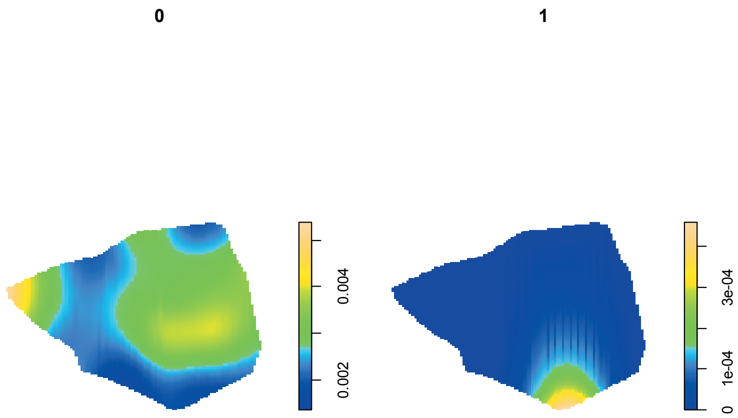
Collema subflaccidum



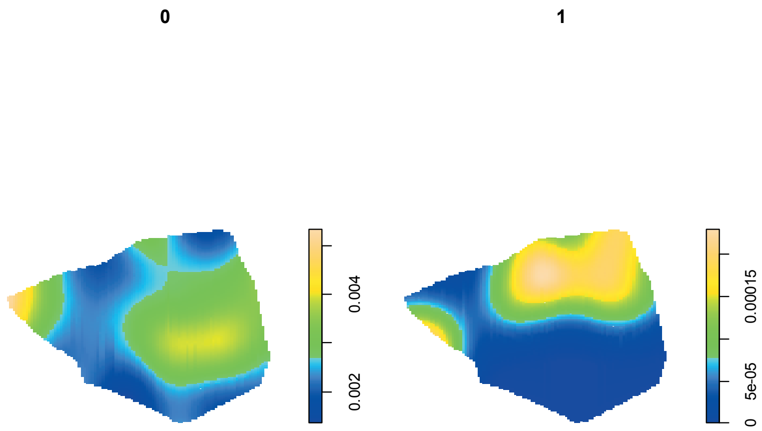
Fuscopannaria ignobilis

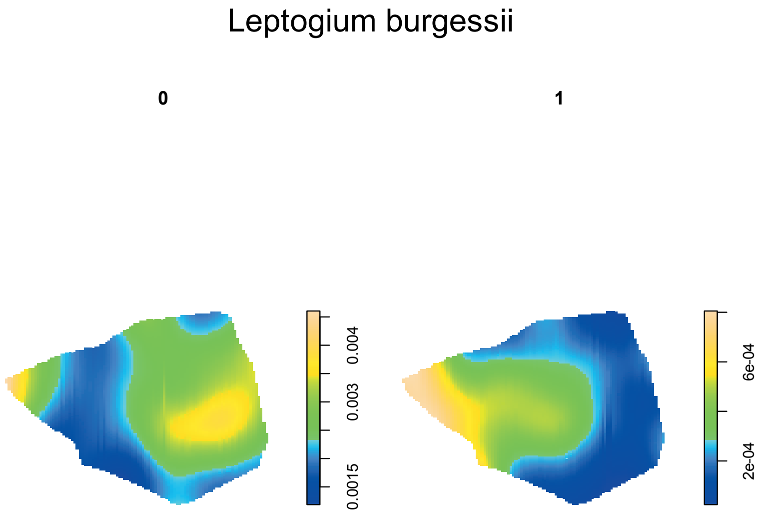


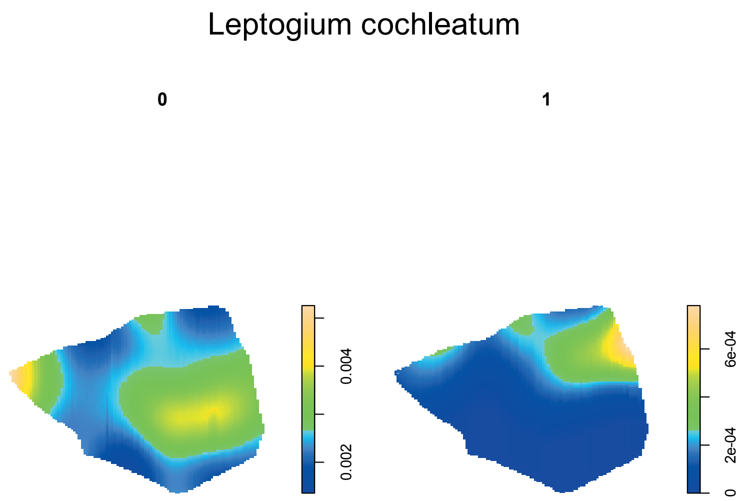
Fuscopannaria mediterranea



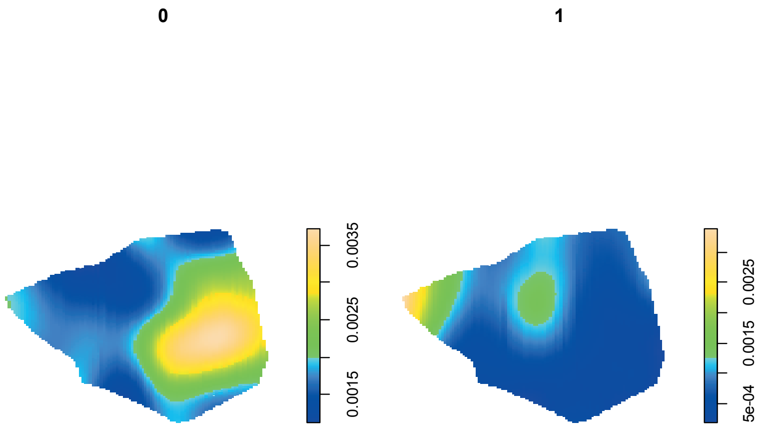
Fuscopannaria sampaiana



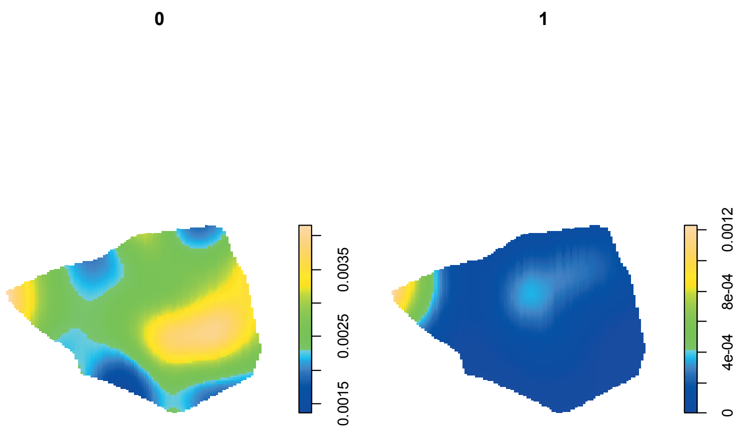

Leptogium burgessii
0
1
0.0015
0.003
0.004
2e-04
6e-04


Leptogium cochleatum
0
1
0.002
0.004
0
2e-04
6e-04

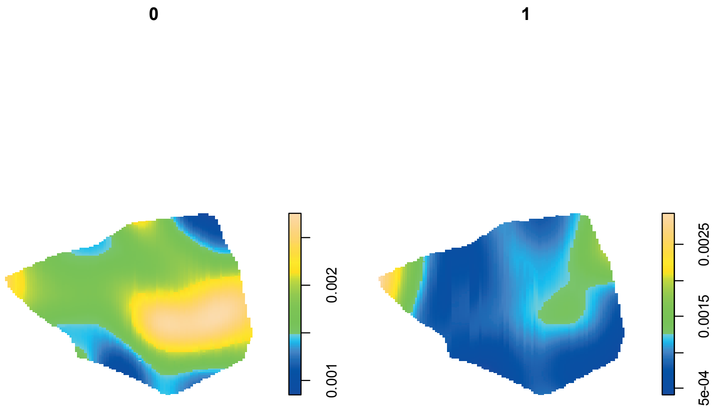
Leptogium cyanescens



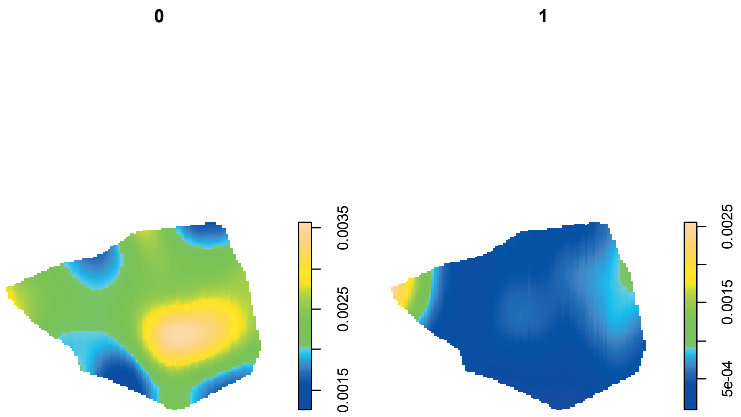
Leptogium hibernicum



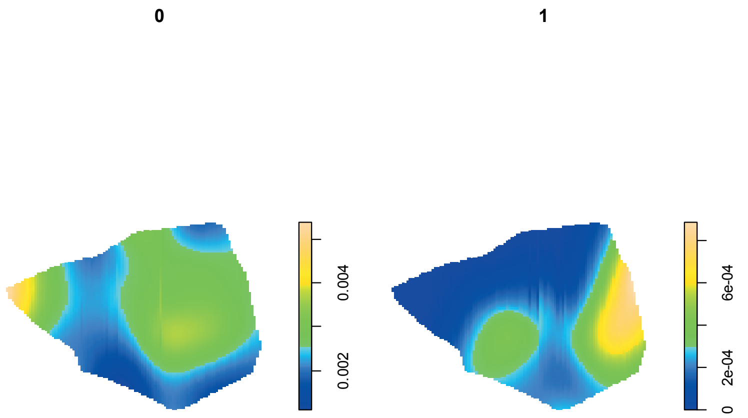
Leptogium lichenoides



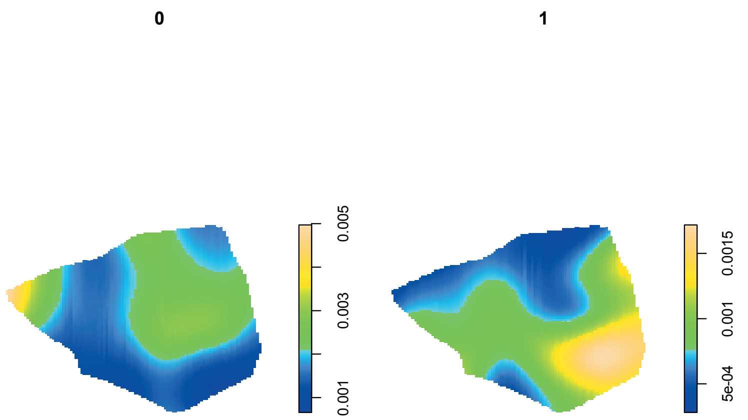
Leptogium saturninum



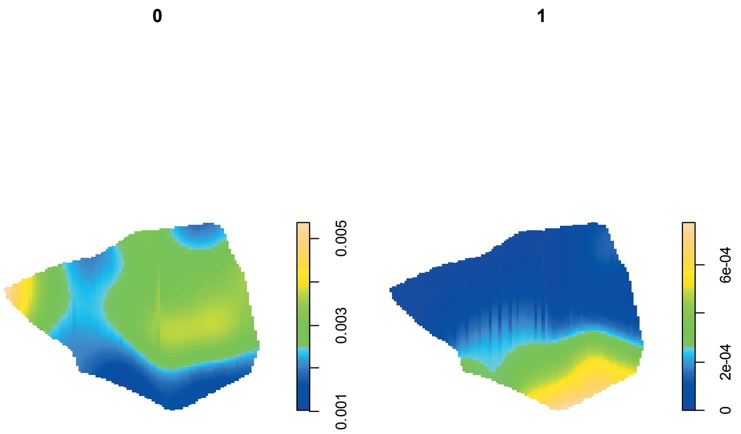
Lobaria amplissima



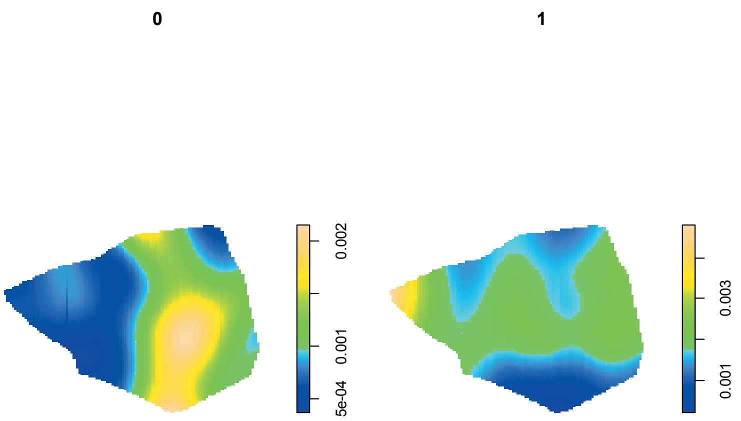
Lobaria pulmonaria

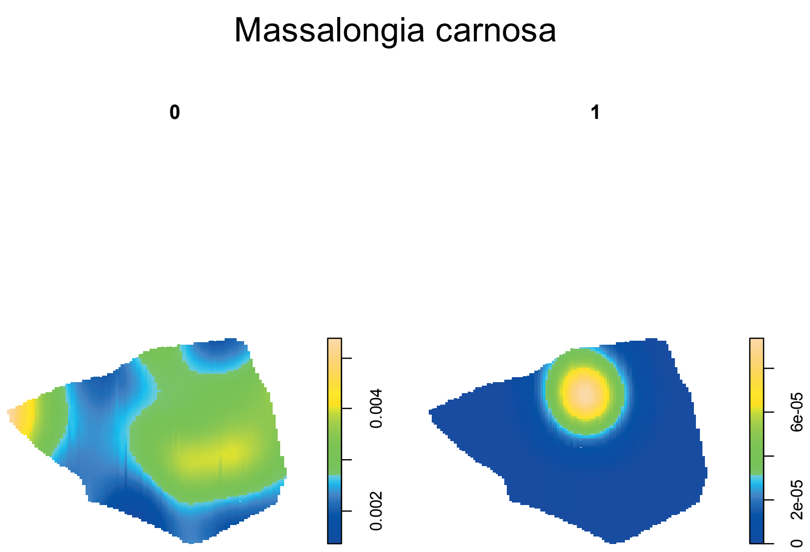


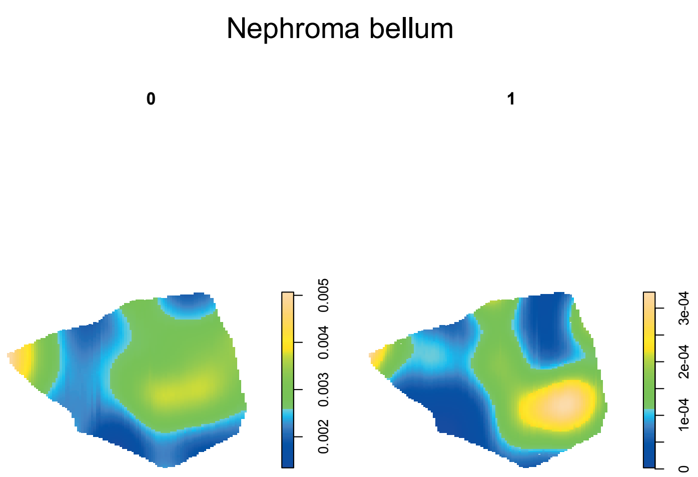
Lobaria scrobiculata

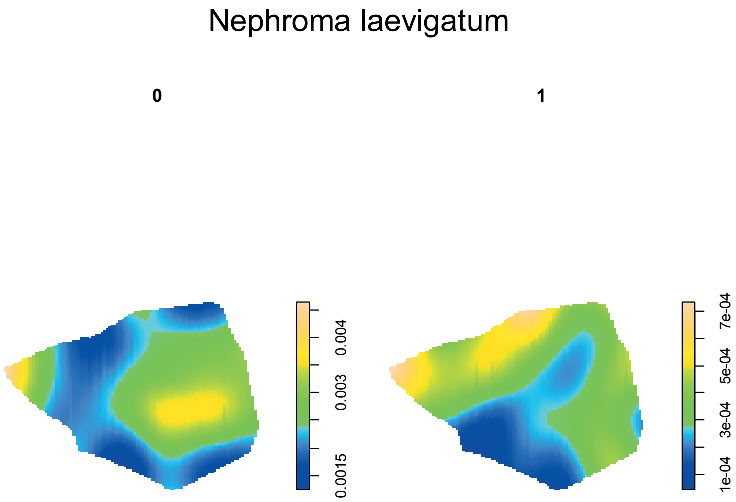


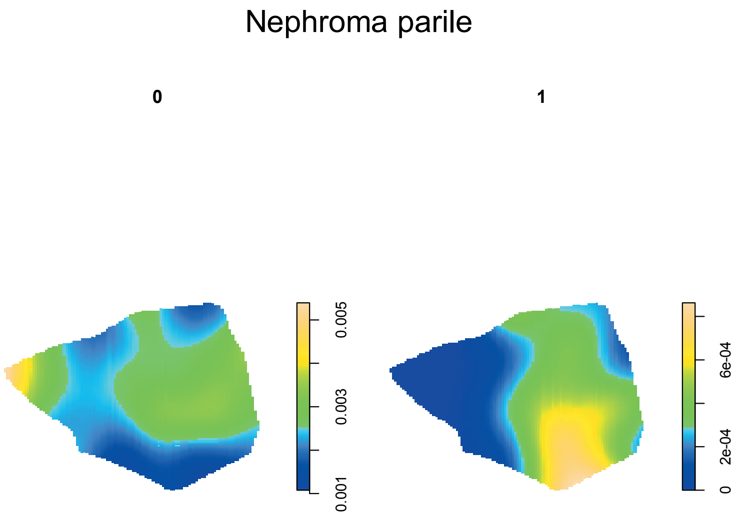
Lobaria virens



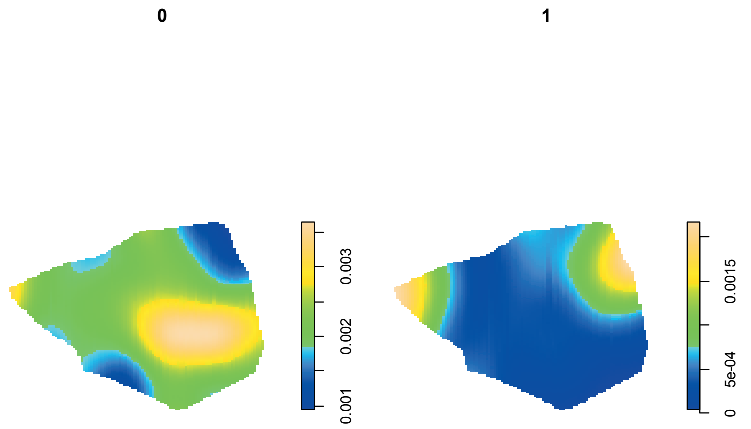

Massalongia carnosa
0
1
0.002
0.004
0
2e-05
6e-05


Nephroma bellum
0
1
0.002
0.003
0.004
0.005
0
1e-04
2e-04
3e-04

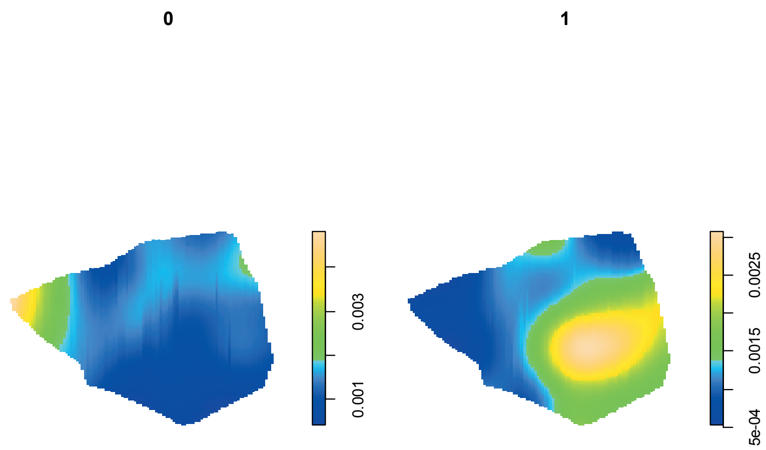

Nephroma laevigatum
0
1
0.0015
0.003
0.004
1e-04
3e-04
5e-04
7e-04

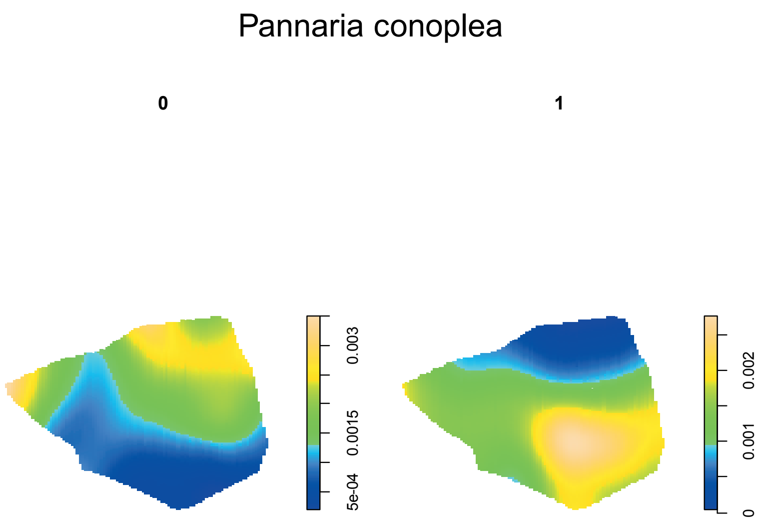

Nephroma parile
0
1
0.001
0.003
0.005
0
2e-04
6e-04

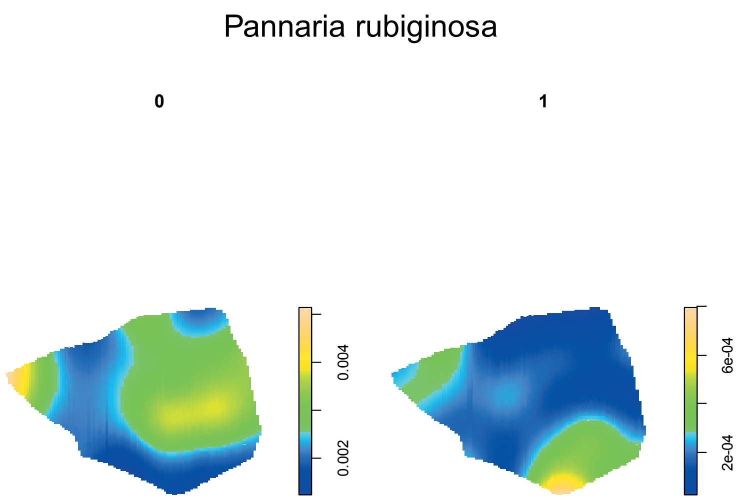
Nephroma resupinatum



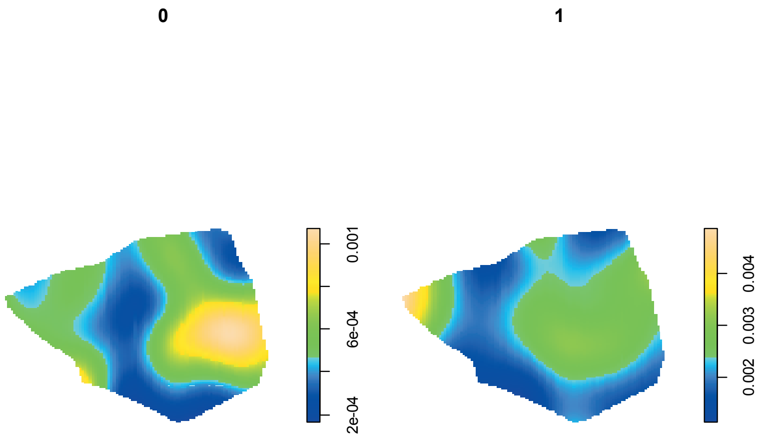
Normandina pulchella



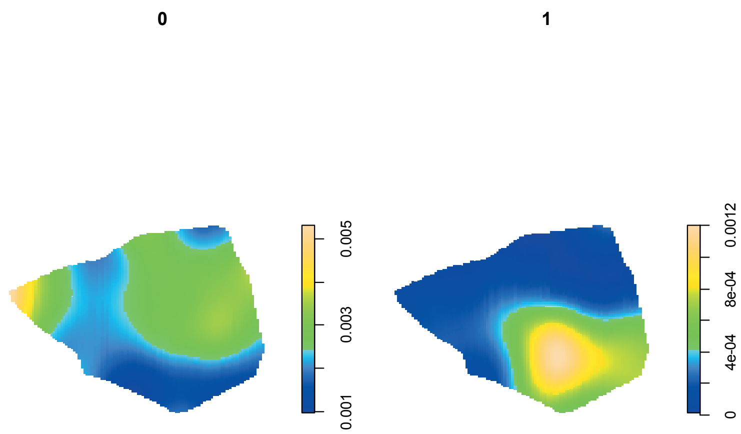

Pannaria conoplea
0
1
5e-04
0.0015
0.003
0
0.001
0.002

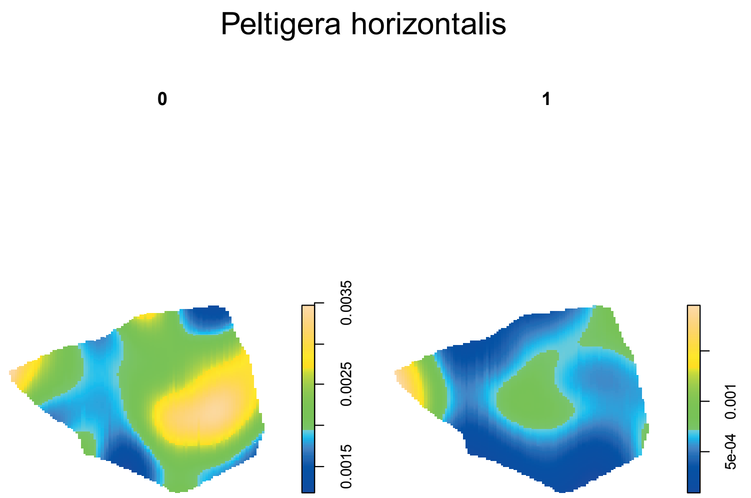

Pannaria rubiginosa
0
1
0.002
0.004
2e-04
6e-04

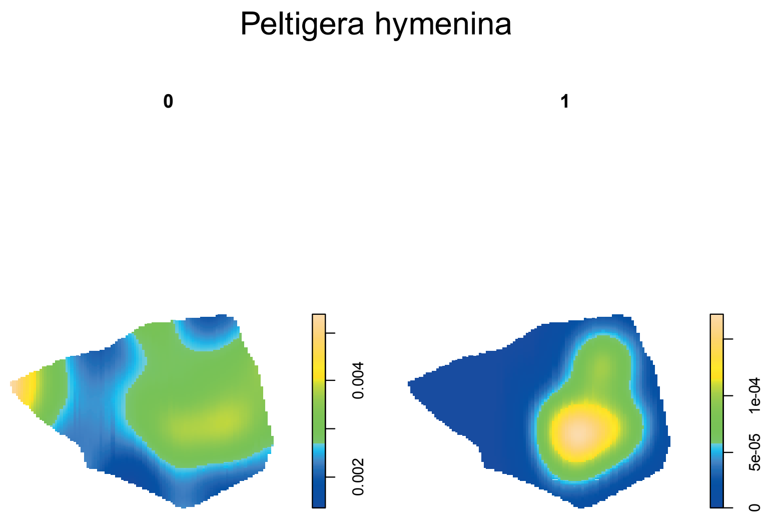
Parmeliella triptophylla



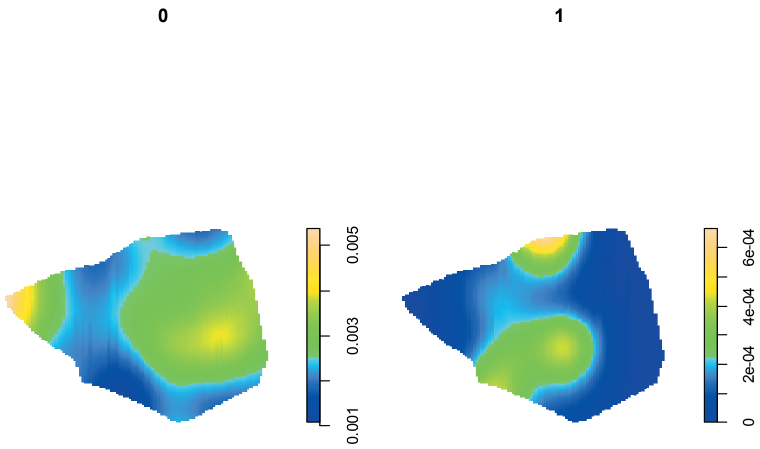
Peltigera collina



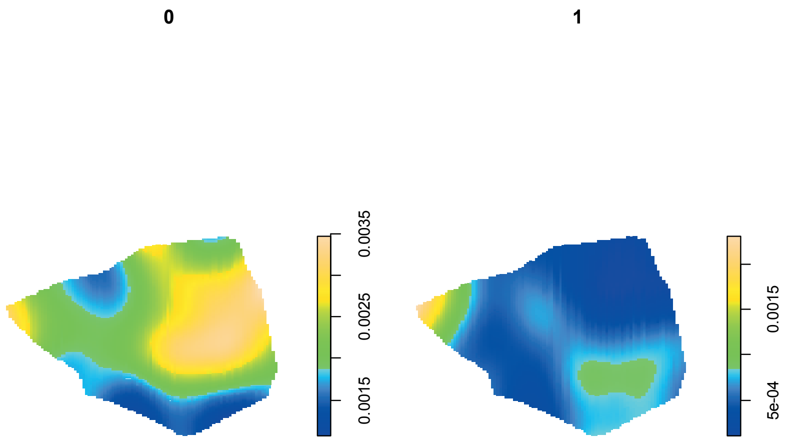

Peltigera horizontalis
0
1
0.0035
0.0025
0.0015
0.001
5e-04


Peltigera hymenina
0
1
0.004
0.002
1e-04
5e-05
0

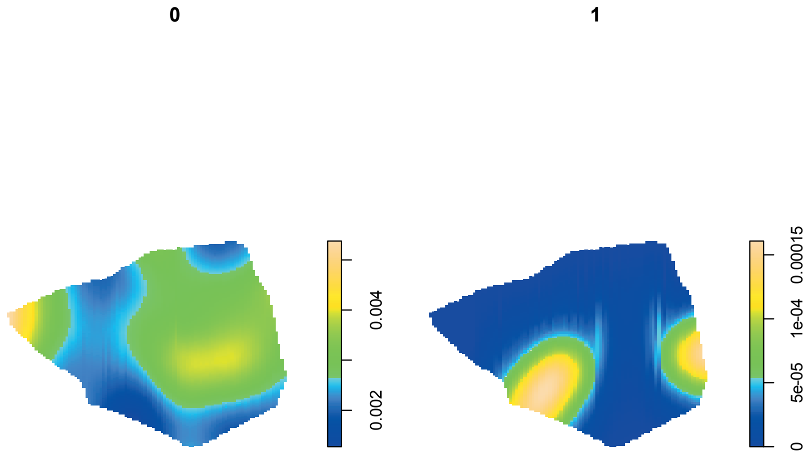
Peltigera malacea



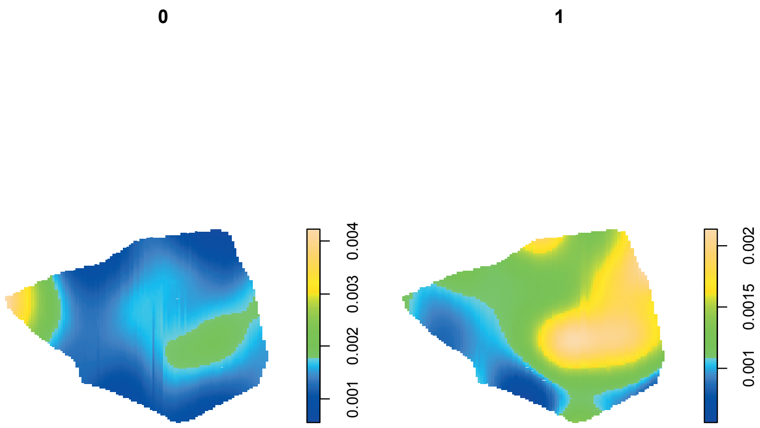
Peltigera membranacea



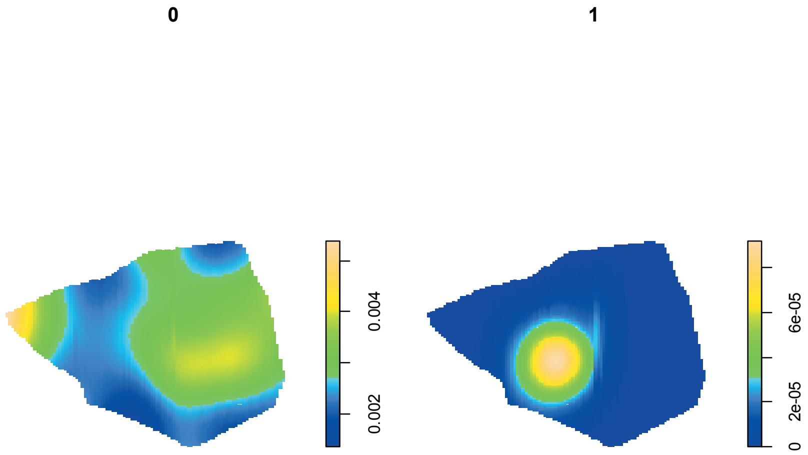
Peltigera polydactylon



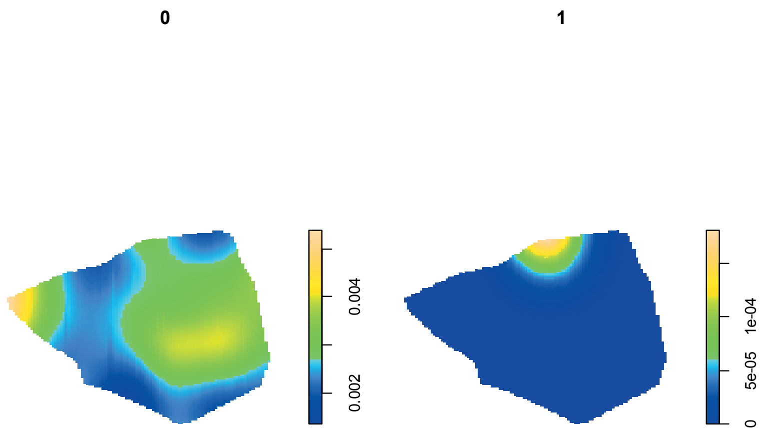
Peltigera praetextata

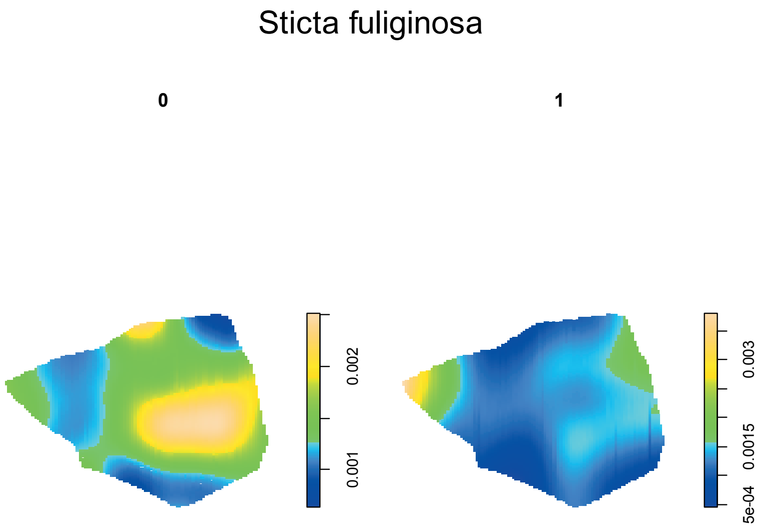


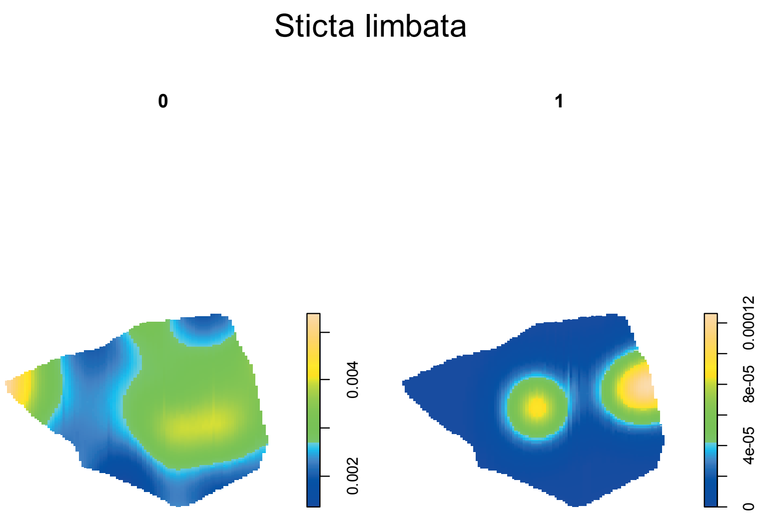
Protopannaria pezizoides

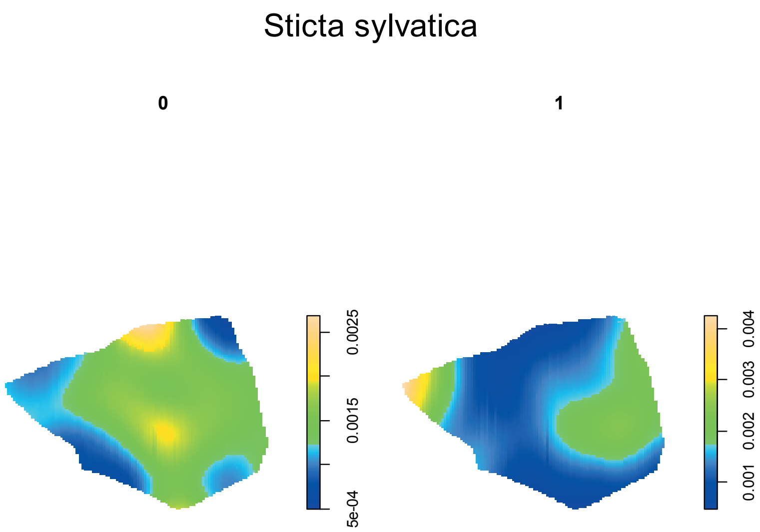


Rinodina isidiodes

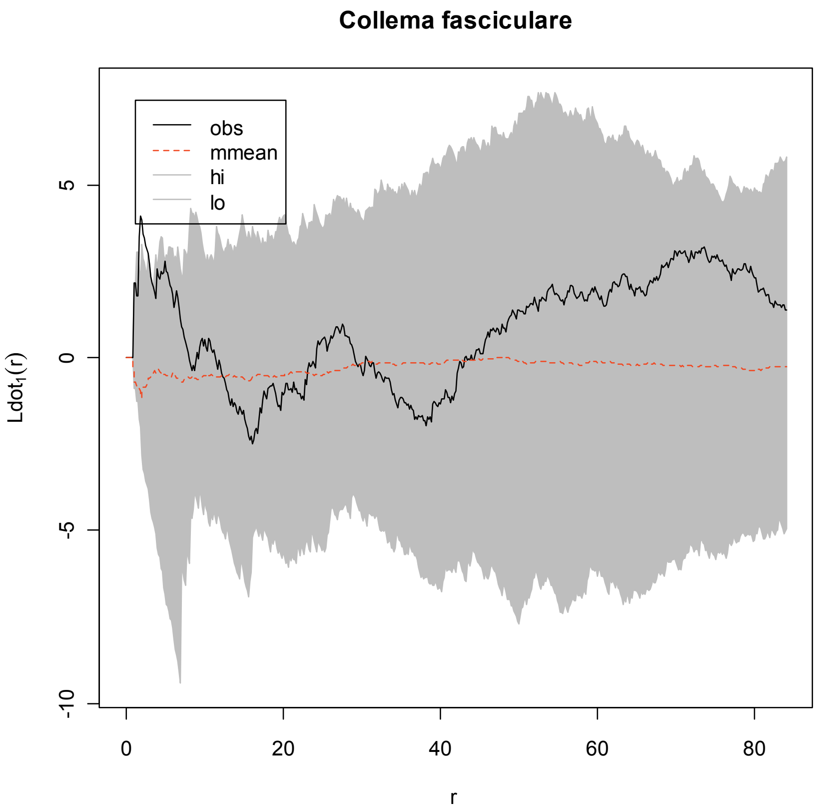


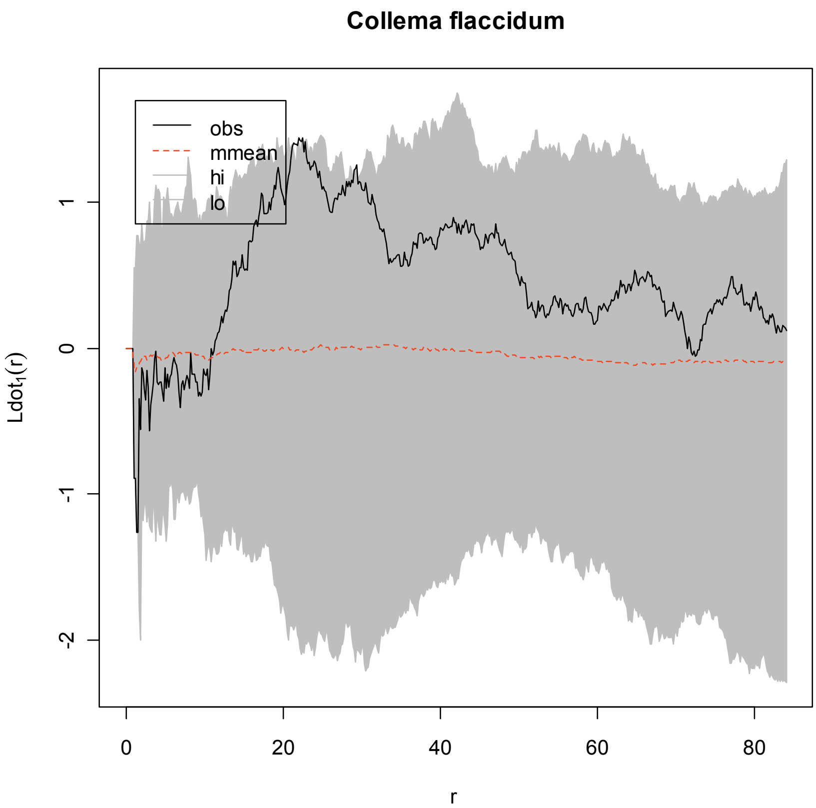

Sticta fuliginosa
0
1
0.002
0.001
0.003
0.0015
5e-04

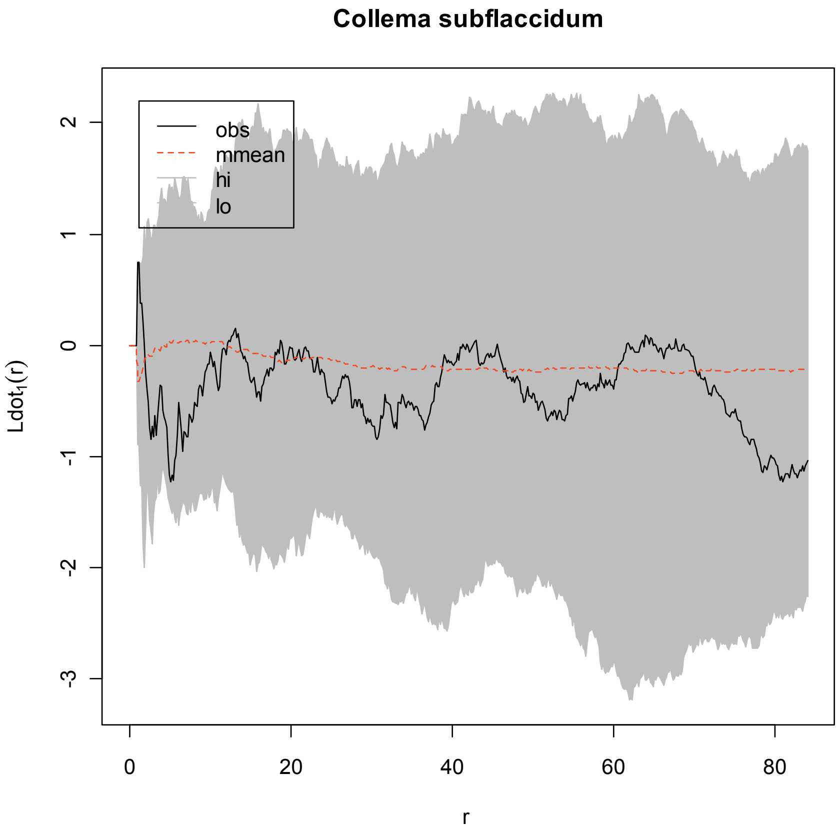

Sticta limbata
0
1
0.004
0.002
0.00012
8e-05
4e-05
0

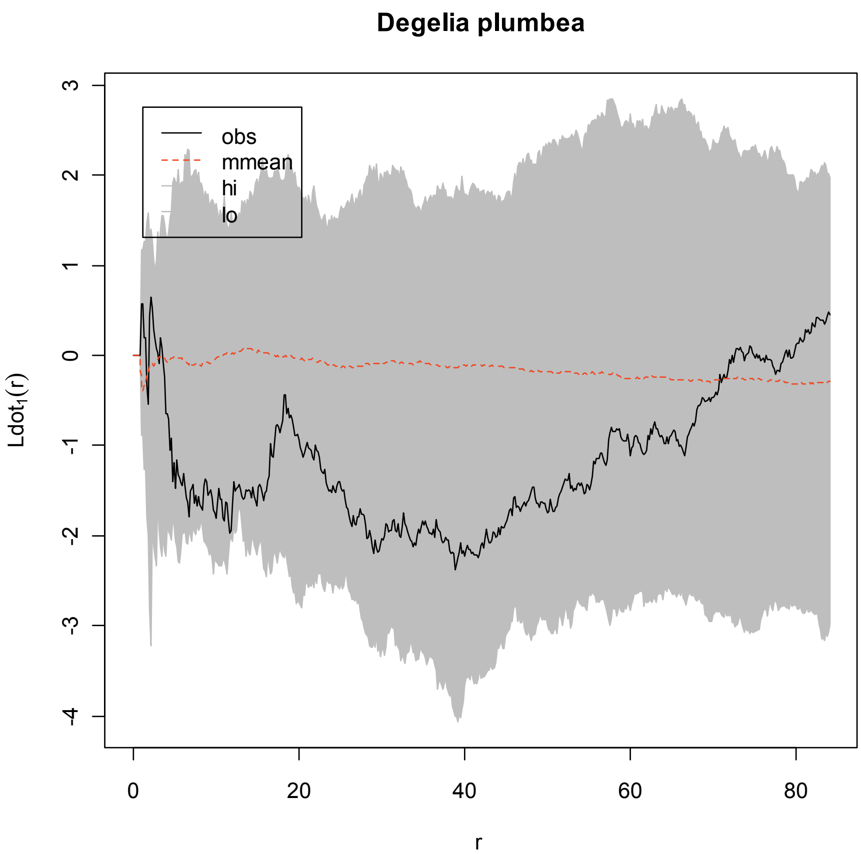

Sticta sylvatica
0
1
0.0025
0.0015
5e-04
0.004
0.003
0.002
0.001

Appendix 11 Random labelling test - Lichen species (frequency > 10)

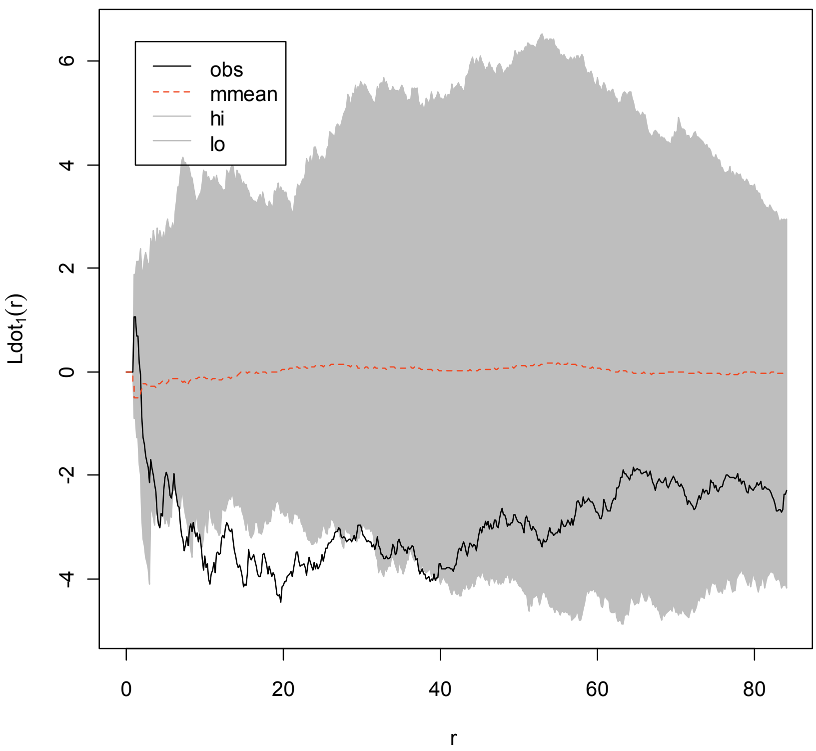




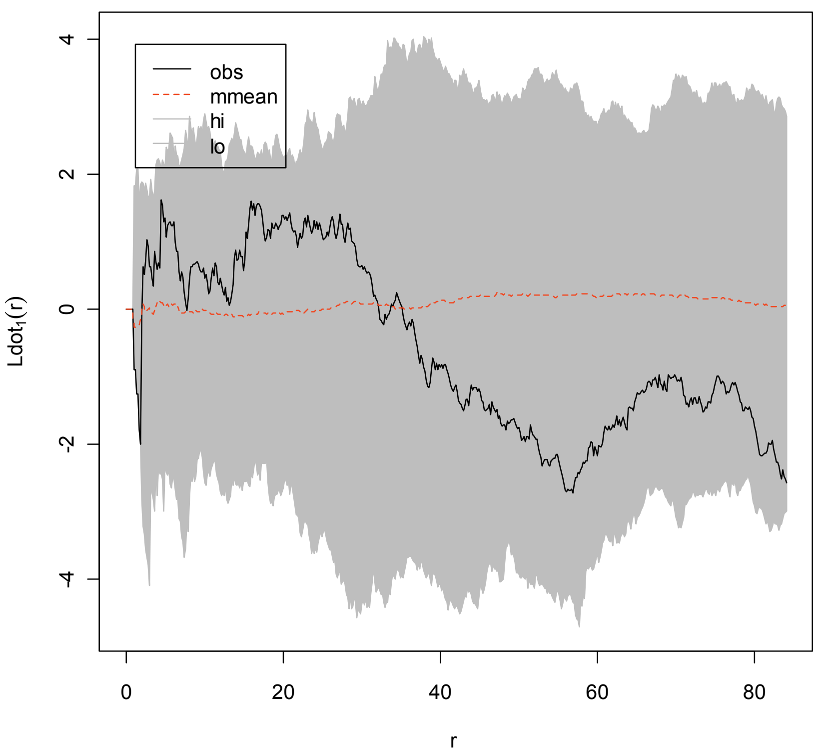

Collema subflaccidum
obs
mmean
hi
lo
Ldot1(r)
2
1
0
-1
-2
-3
0
20
40
60
80
r

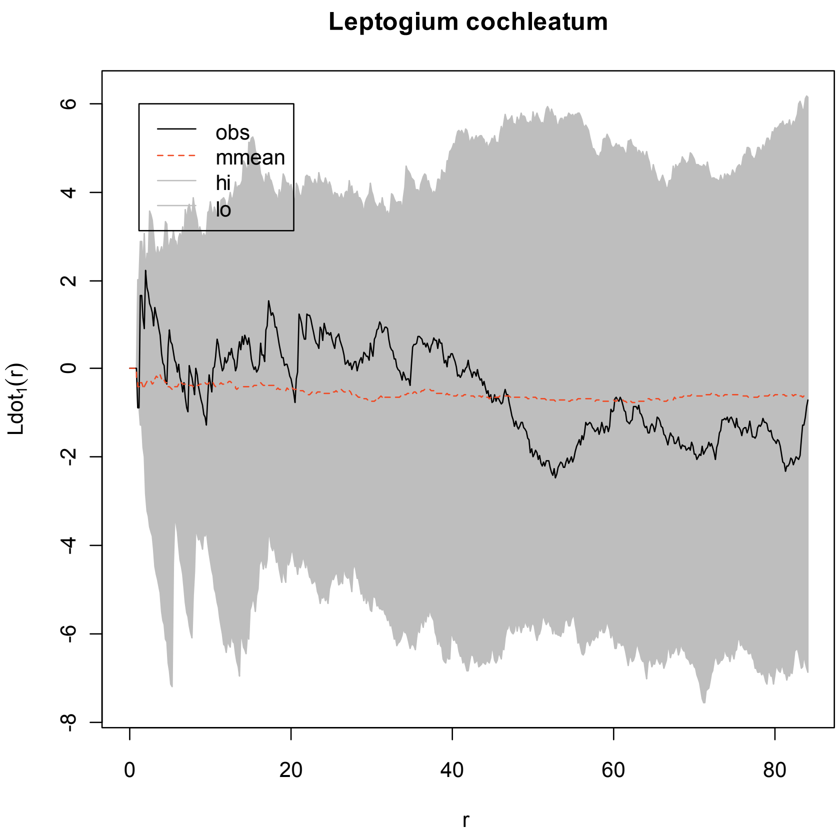

Degelia plumbea
obs
mmean
hi
lo
Ldot1(r)
3
2
1
0
-1
-2
-3
-4
0
20
40
60
80
r

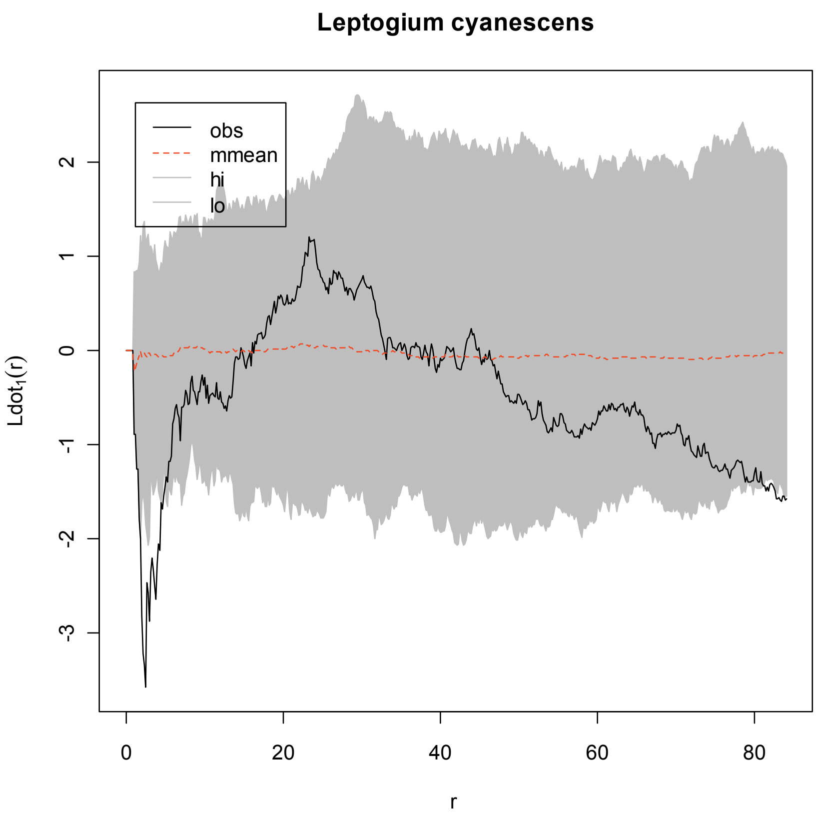
Fuscopannaria ignobilis

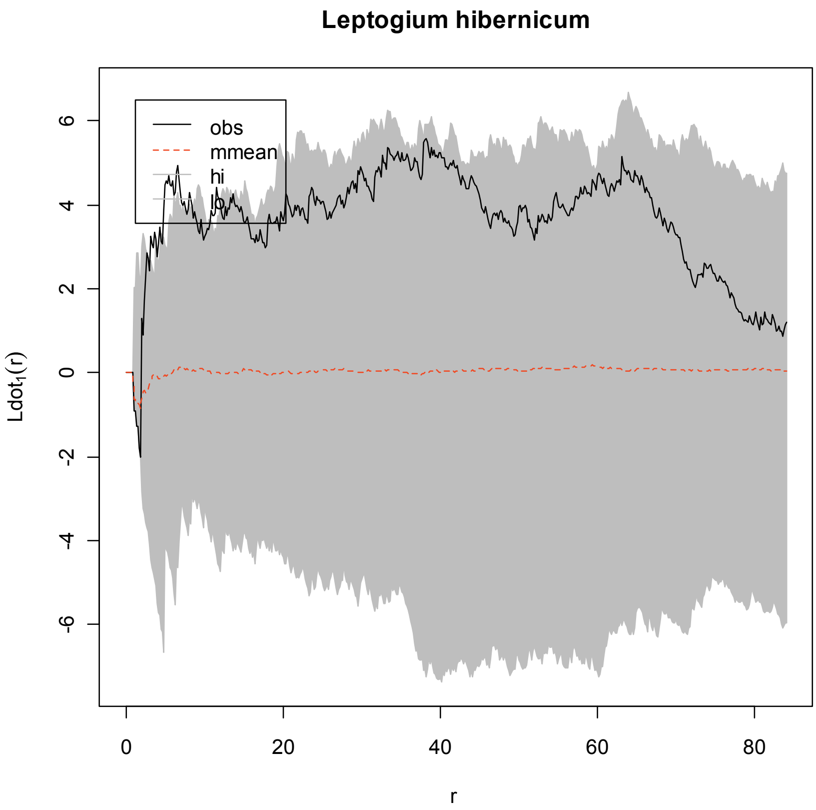


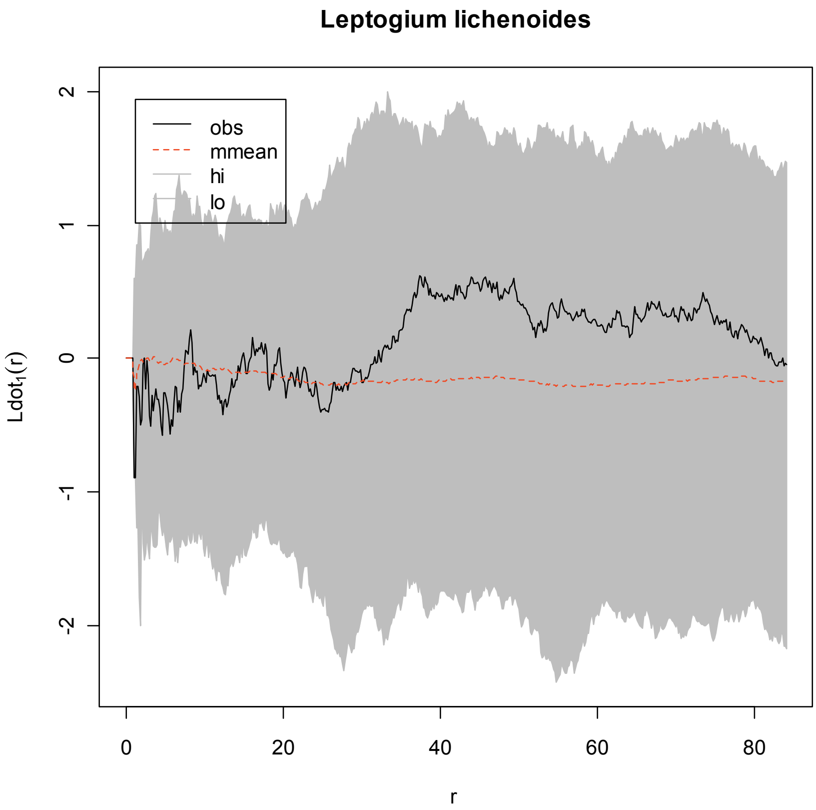
Leptogium burgessii

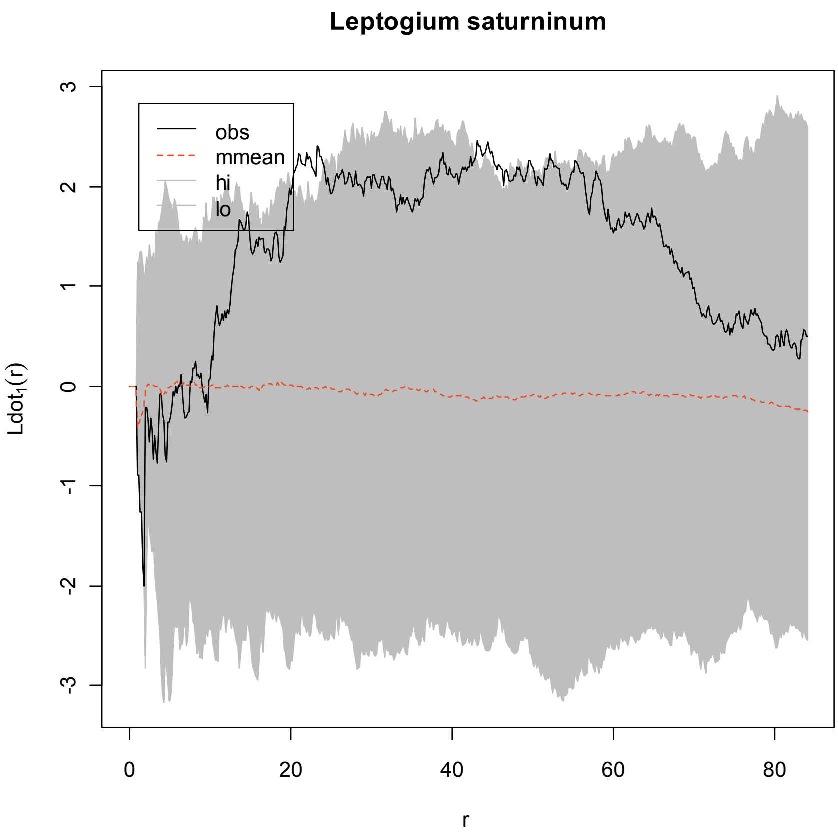


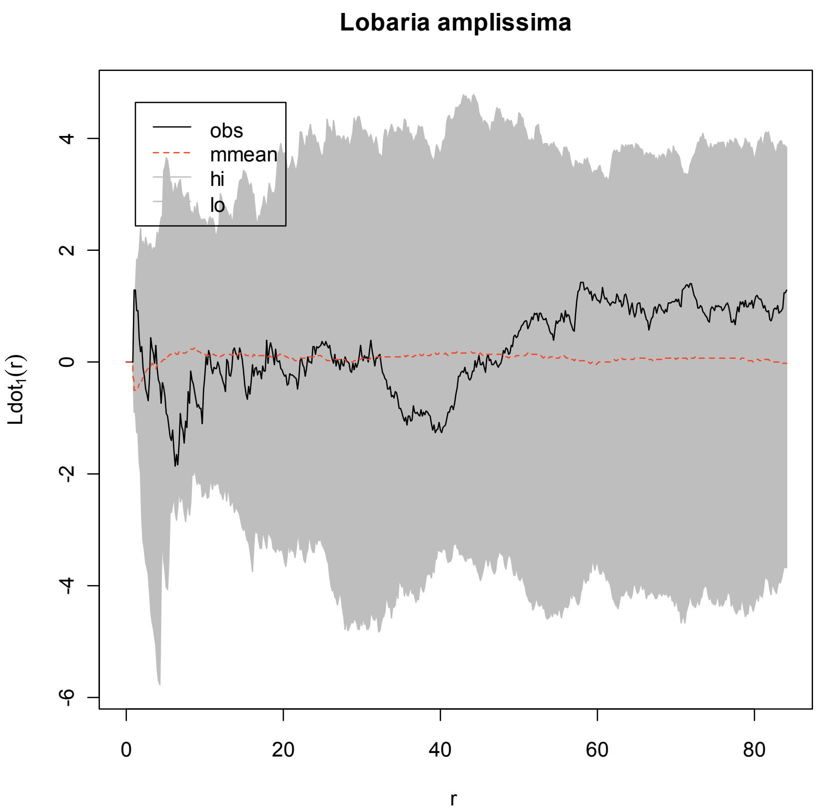

Leptogium cochleatum
obs
mmean
hi
lo
Ldot1(r)
r
0
20
40
60
80
6
4
2
0
-2
-4
-6
-8


Leptogium cyanescens
obs
mmean
hi
lo
Ldot1(r)
r
0
20
40
60
80
2
1
0
-1
-2
-3

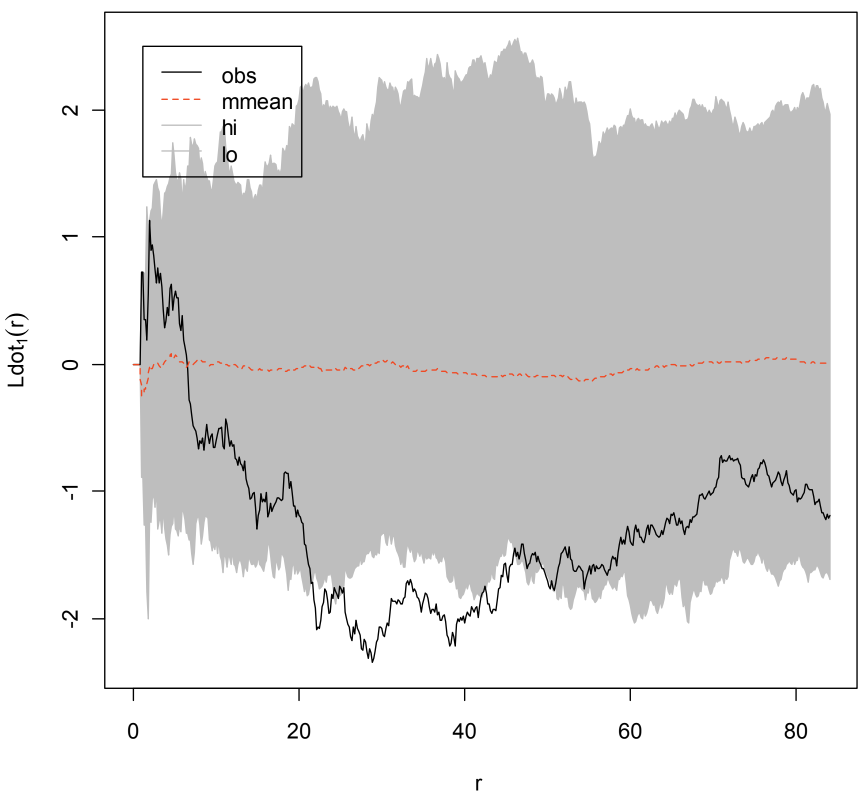

Leptogium hibernicum
obs
mmean
hi
lo
Ldot1(r)
6
4
2
0
-2
-4
-6
0
20
40
60
80
r


Leptogium lichenoides
obs
mmean
hi
lo
Ldot1(r)
2
1
0
-1
-2
0
20
40
60
80
r

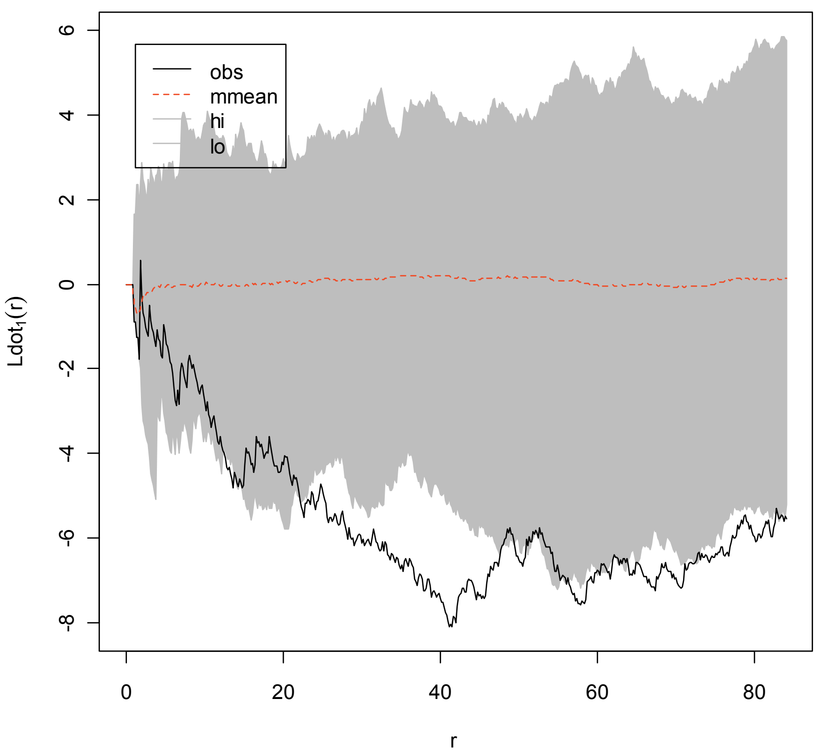

Leptogium saturninum
obs
mmean
hi
lo
Ldot1(r)
3
2
1
0
-1
-2
-3
0
20
40
60
80
r

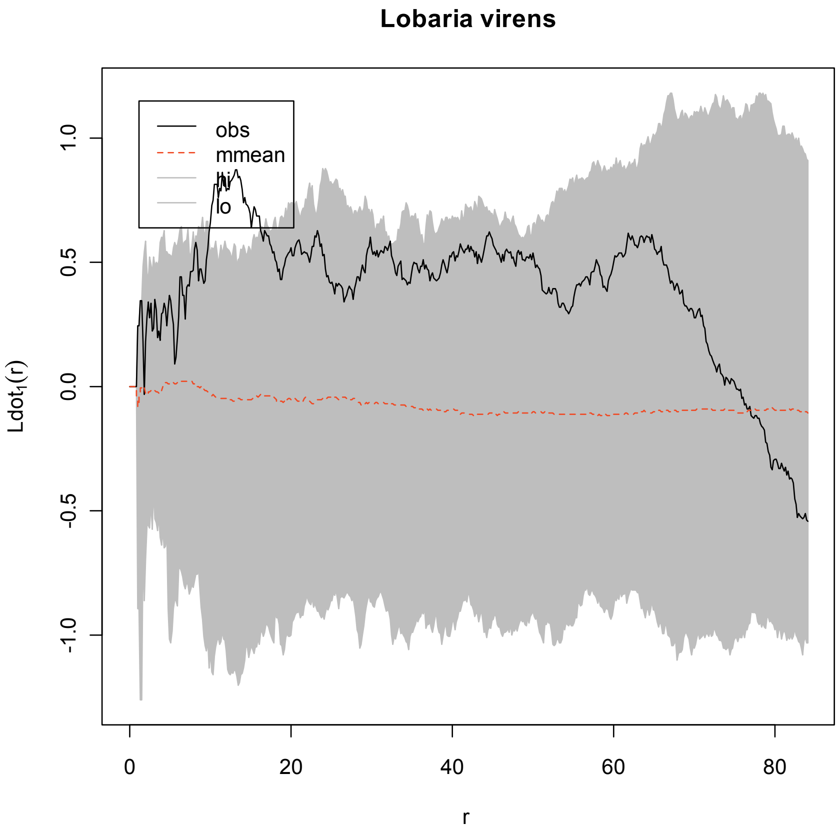

Lobaria amplissima
obs
mmean
hi
lo
Ldot1(r)
4
2
0
-2
-4
-6
0
20
40
60
80
r

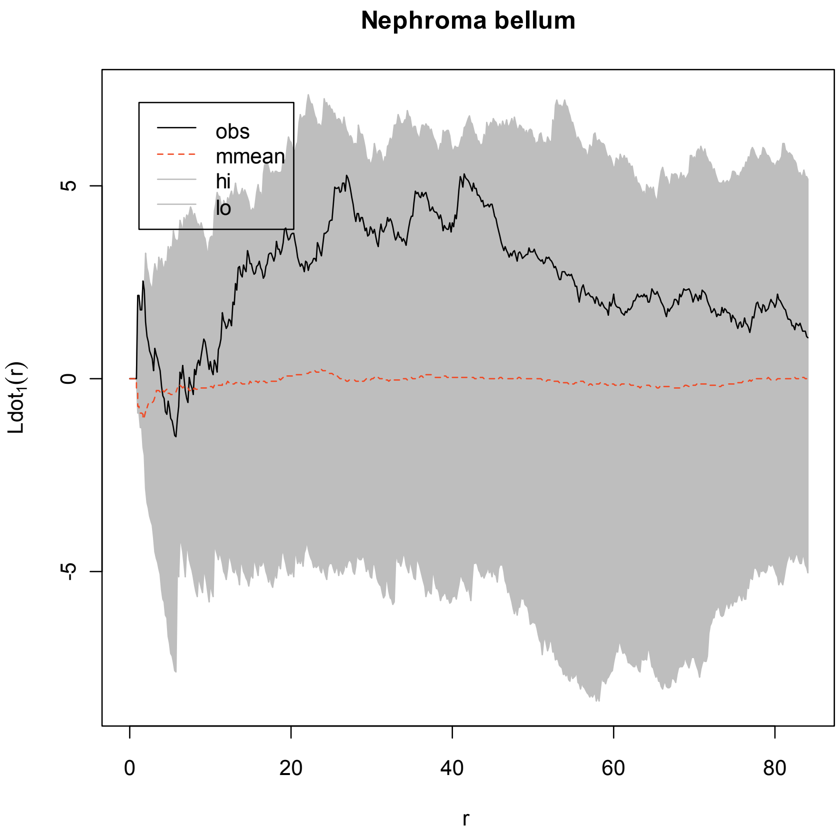
Lobaria pulmonaria

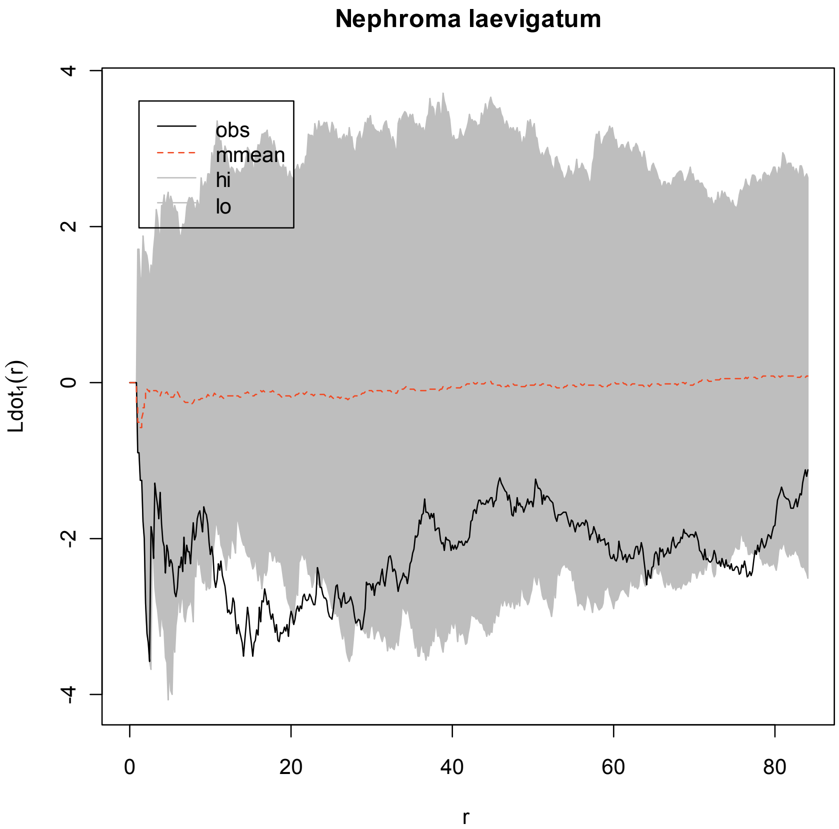


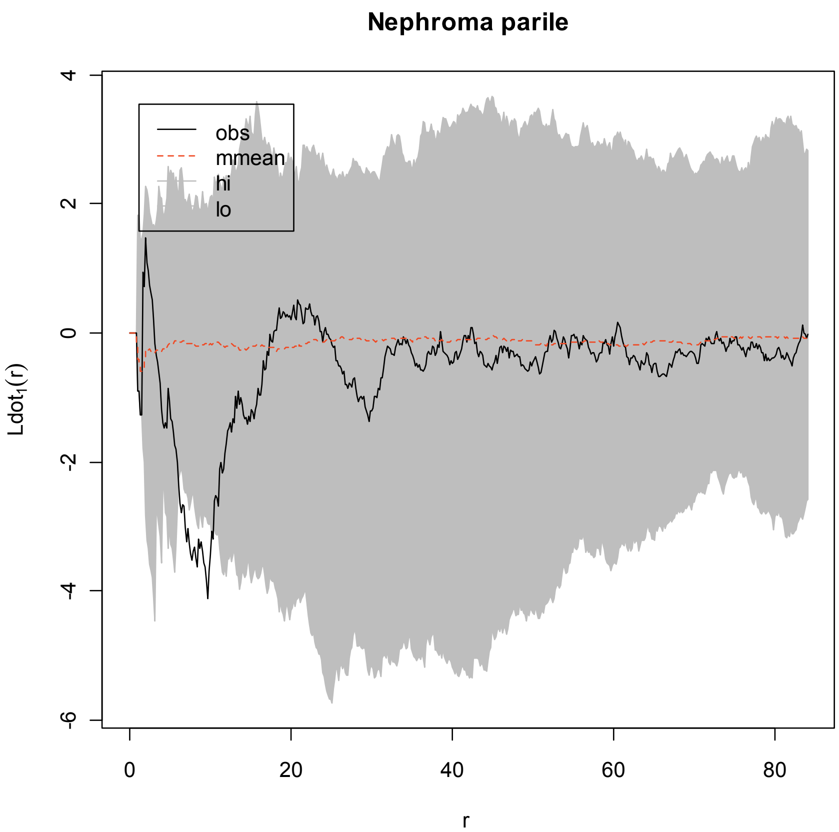
Lobaria scrobiculata

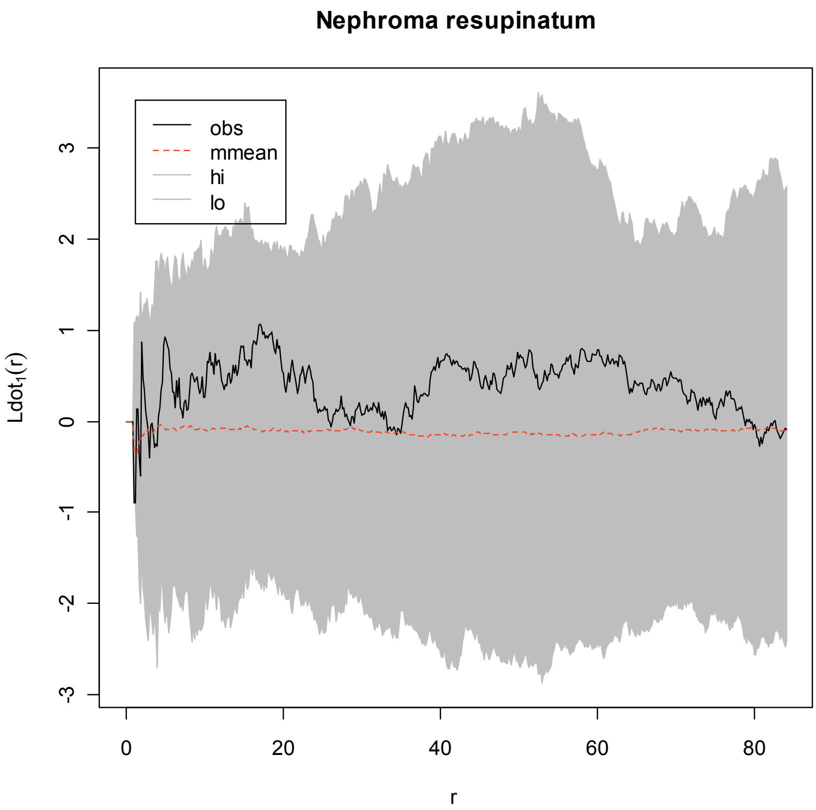


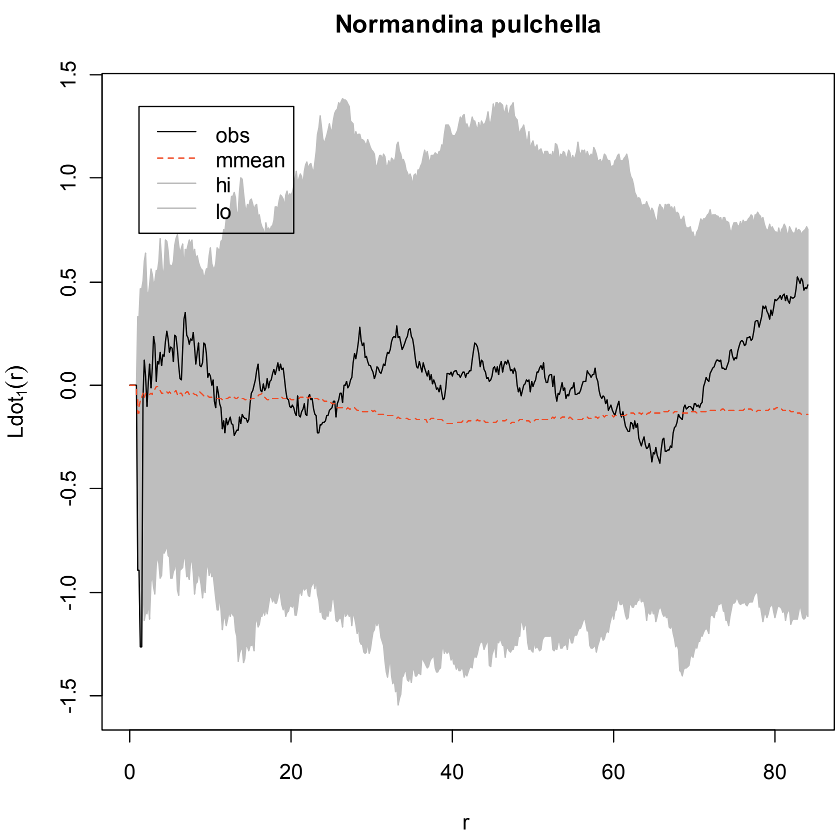

Lobaria virens
obs
mmean
hi
lo
1.0
0.5
0.0
-0.5
-1.0
$Ldot_1(r)$
0
20
40
60
80
r

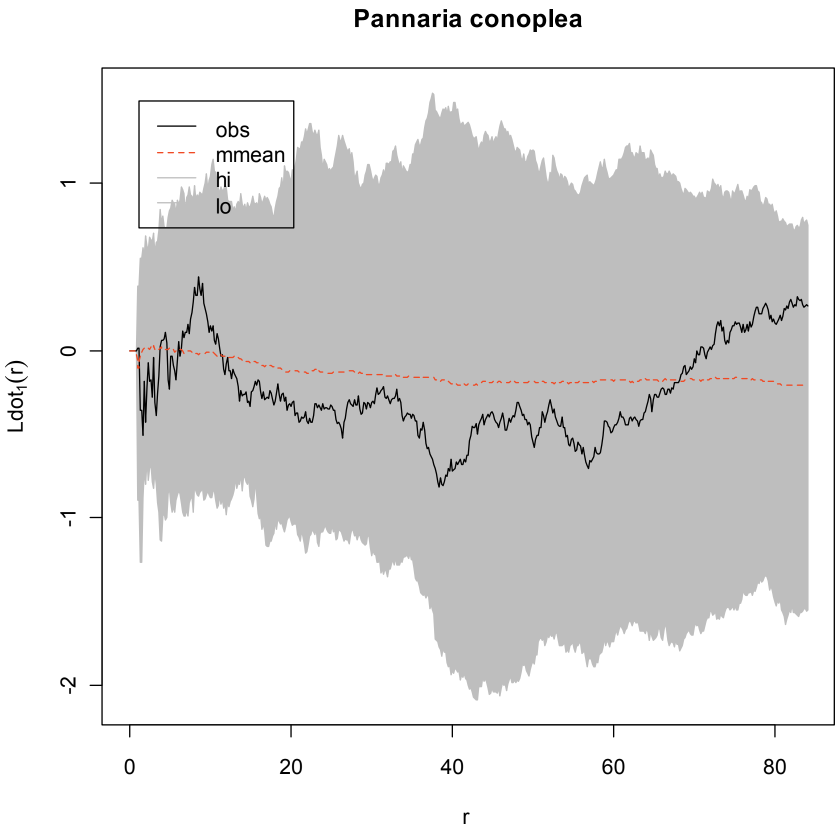

Nephroma bellum
obs
mmean
hi
lo
5
0
-5
$Ldot_1(r)$
0
20
40
60
80
r

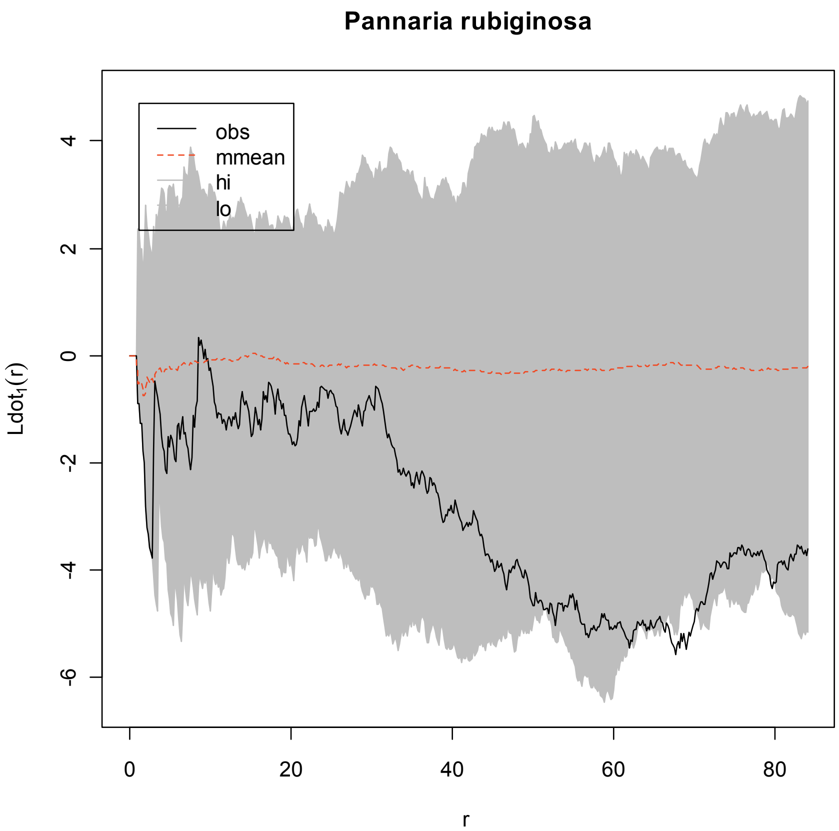

Nephroma laevigatum
obs
mmean
hi
lo
Ldot1(r)
4
2
0
-2
-4
0
20
40
60
80
r


Nephroma parile
obs
mmean
hi
lo
Ldot1(r)
4
2
0
-2
-4
-6
0
20
40
60
80
r

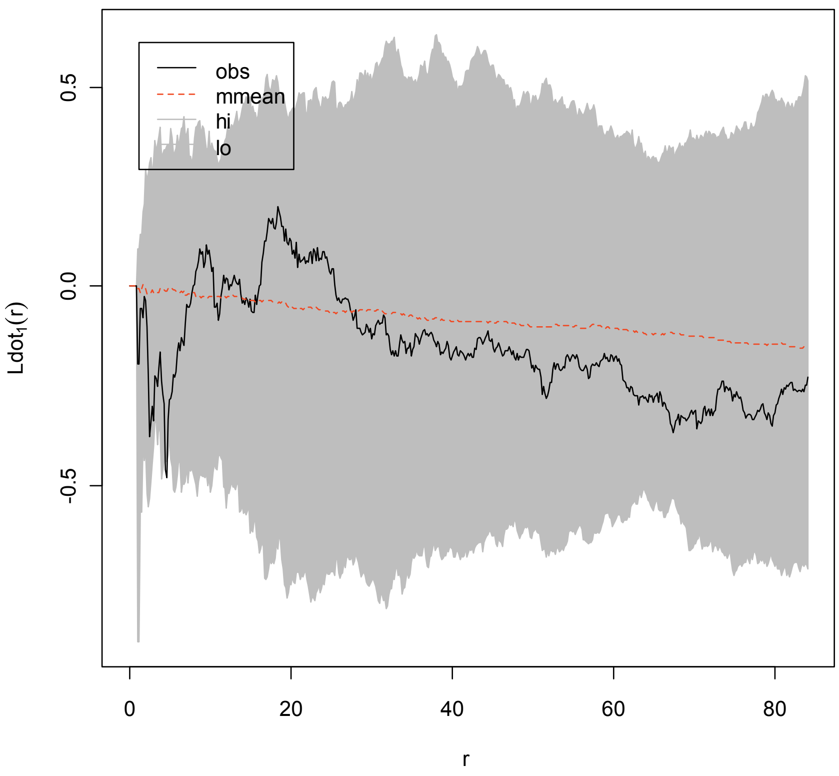

Nephroma resupinatum
obs
mmean
hi
lo
Ldot1(r)
3
2
1
0
-1
-2
-3
0
20
40
60
80
r


Normandina pulchella
obs
mmean
hi
lo
Ldot1(r)
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
0
20
40
60
80
r

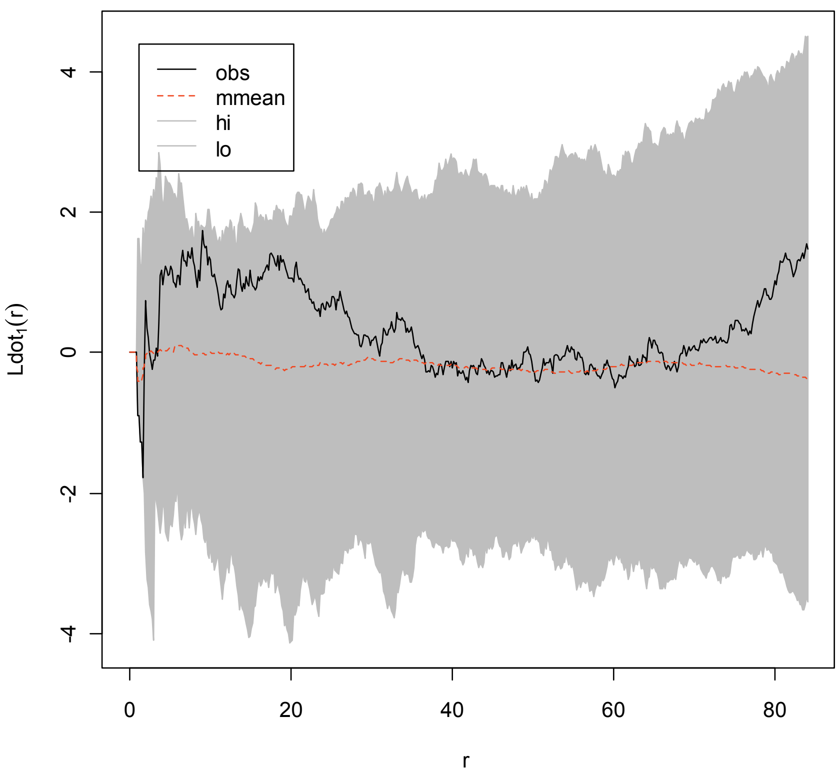

Pannaria conoplea
obs
mmean
hi
lo
Ldot1(r)
1
0
-1
-2
0
20
40
60
80
r


Pannaria rubiginosa
obs
mmean
hi
lo
Ldot1(r)
4
2
0
-2
-4
-6
0
20
40
60
80
r

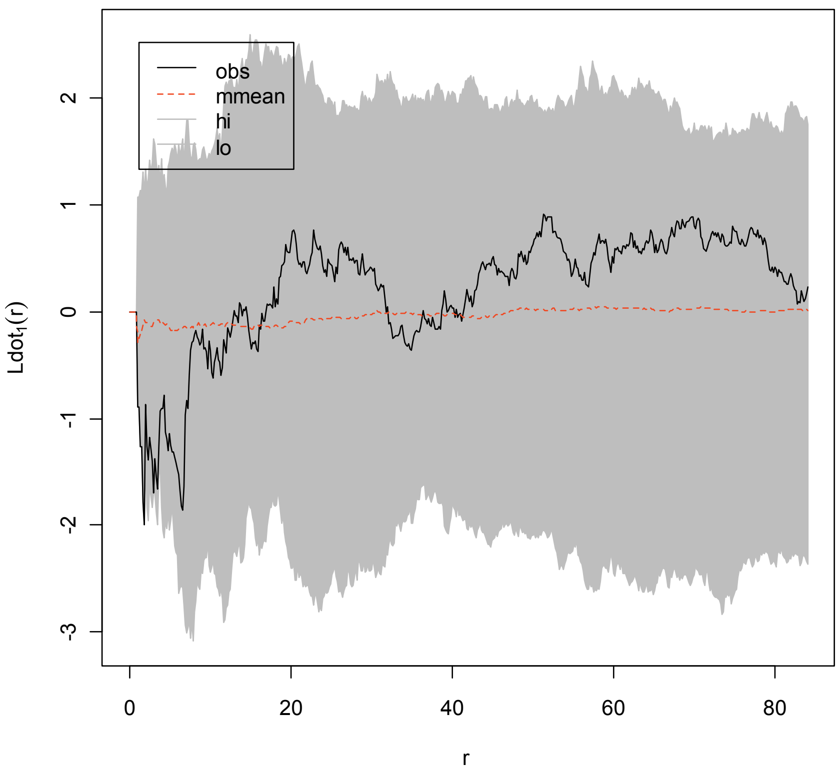
Parmeliella triptophylla



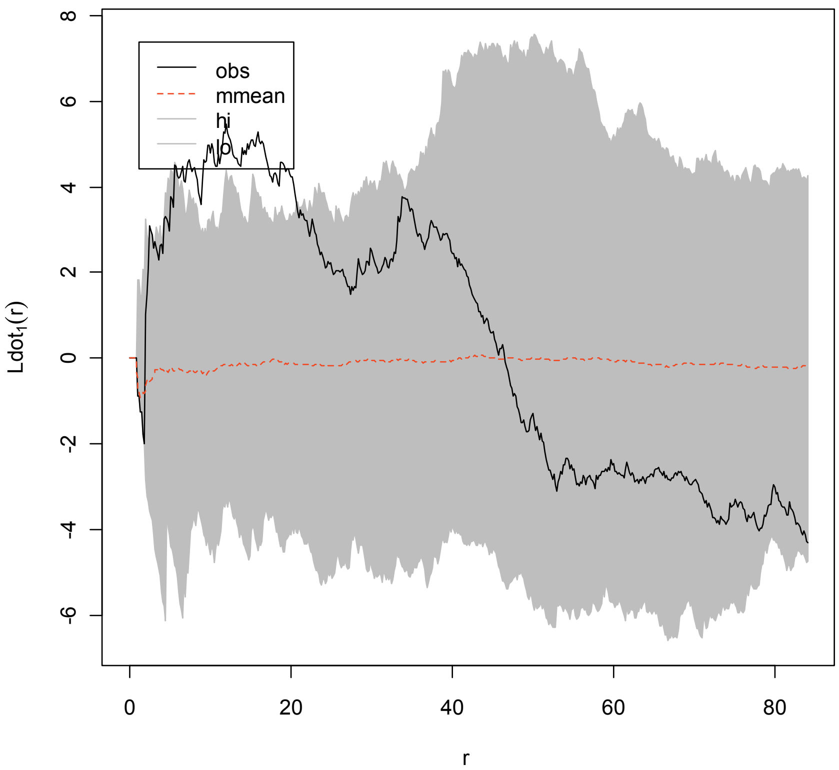
Peltigera collina



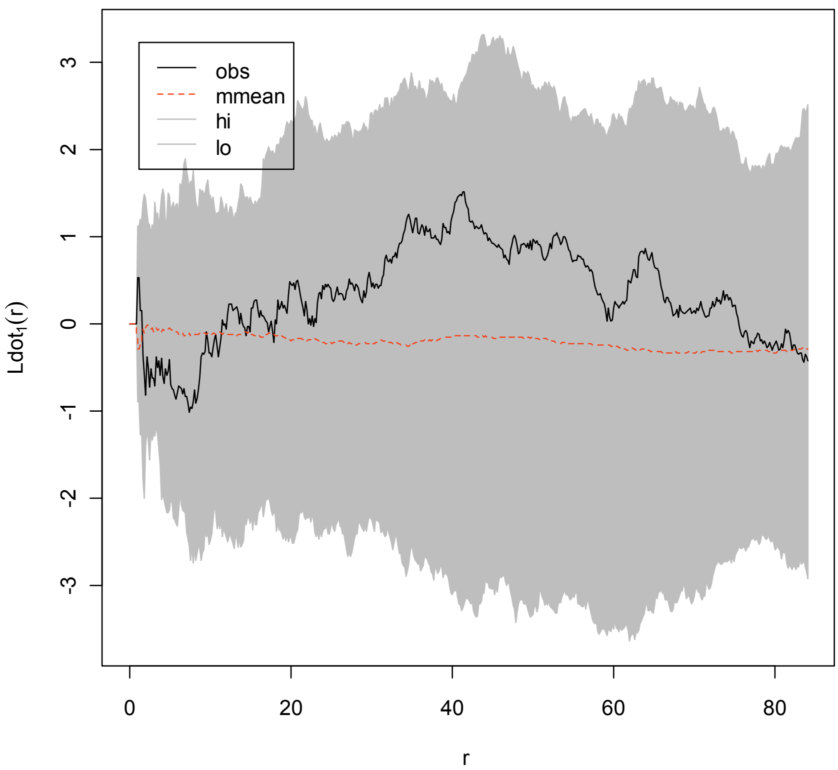
Peltigera horizontalis



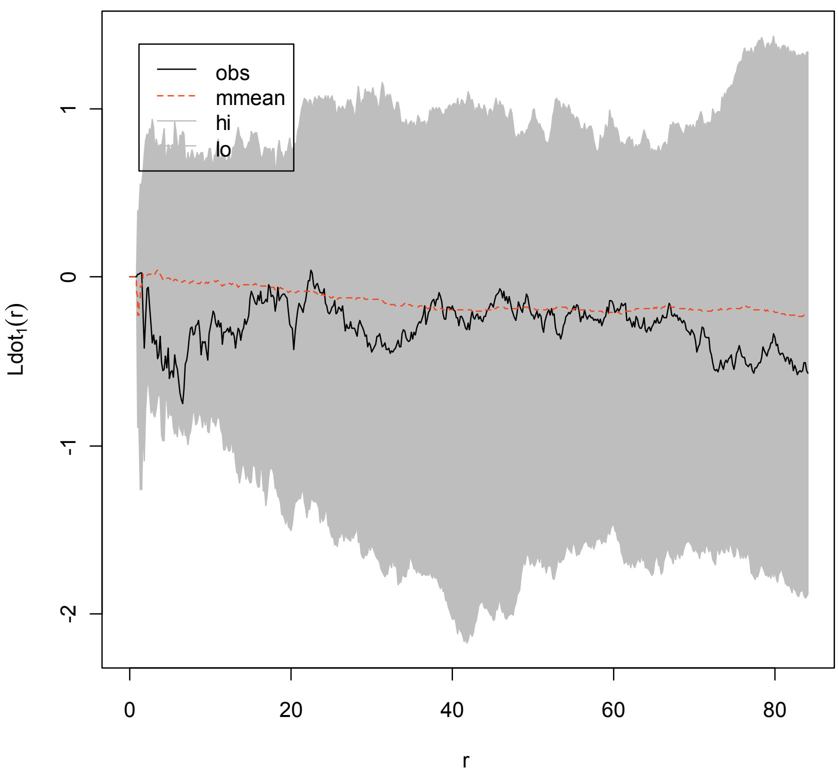
Peltigera malacea



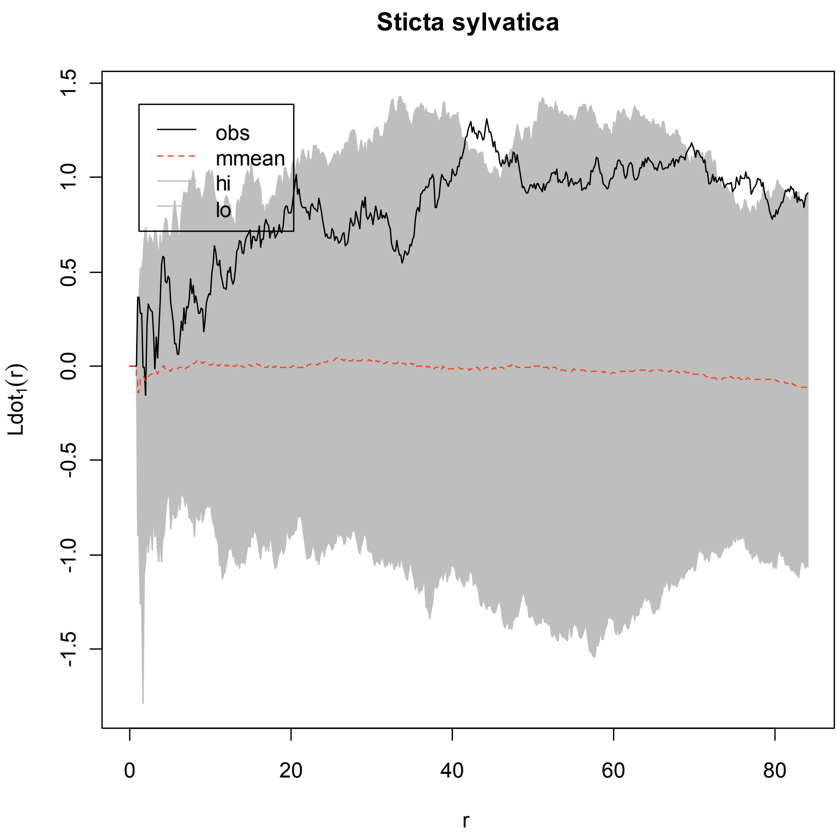
Peltigera membranacea



Peltigera praetextata




Sticta fuliginosa
obs
mmean
hi
lo
Ldot$_1$(r)
1
0
-1
-2
0
20
40
60
80
r


Sticta sylvatica
obs
mmean
hi
lo
Ldot$_1$(r)
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
0
20
40
60
80
r