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THE MINIMAL AREA OF A FOLIICOLOUS LICHEN COMMUNITY OF *WOESSIA VASAKII*

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Abstract: The minimal area of a foliicolous lichen community of *Woessia vasakii* in southern France (West Languedoc, Department of Gard) was studied by the method of the mean similarity coefficients of Sørensen and of Kulcinsky. The determination of the qualitative and quantitative minimal areas, which are *c.* 30–50 cm^2 and 50–80 cm^2, respectively, allows the phytosociological study of the foliicolous communities of southern France by the method of integral sampling.

Résumé: L'aire minimale d'un peuplement de lichens foliicoles à *Woessia vasakii* du sud de la France (Languedoc occidental, département du Gard) est étudiée qualitativement et quantitativement par la méthode des coefficients de similitude de Sørensen et de Kulcinsky. L'aire minimale qualitative est comprise entre 30 et 50 cm^2, la quantitative entre 50 et 80 cm^2, ce qui autorise l'étude, notamment phytosociologique, des peuplements foliicoles du sud de la France par la méthode de prélèvement intégral.

Introduction

The discovery of foliicolous lichens in southern France is quite recent. In this region, they become established essentially on persistent leaves and chlorophyllous twigs of *Buxus sempervirens*, more rarely on leaves of *Quercus ilex*, *Hedera helix* and on cladodes of *Ruscus aculeatus* (Bricaud 1996; Bricaud *et al.* 1991, 1993*a*, 1993*b*; De Sloover & Sérusiaux 1984). Despite the generally very low humidity of the French Mediterranean region, the foliicolous lichens, favoured by the microclimatic conditions of gorges, riparian zones, aven's‡ entrances and dolines in calcareous plateaux, form relatively rich communities in which phytosociological studies have been initiated (Bricaud 1996).

Roux (1981, 1990) described the key principles of vegetation sampling as it applies to lichenosociological studies. Recording of vegetation must be qualitatively (list of species) and quantitatively (coverage of each species) representative of the community under study. Only the method of integral sampling will satisfy both requirements. This consists of sampling an entire area at least equal to the quantitative minimal area of the community under study; the samples are then examined with great care in the laboratory. Until now, only the minimal areas of saxicolous-calcicolous (Roux & Rieux 1980; Roux 1981), corticolous (Rieux & Roux 1982; Khalifé & Roux 1986, 1987;

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‡A vertical shaft open to the surface.

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Roux 1990) and terricolous (Khalifé 1986) lichen communities have been determined in an objective way. The determination of the minimal area for a typical foliicolous lichen community of southern France was then essential before undertaking any study on foliicolous communities in this region.

Materials and Methods

Community studied

The study site (altitude 330 m) is located at 18 m deep in the aven of Trois-Trous, in the Méjannes-le-Clap parish, department of Gard, 30 km west of Rhône Valley. This location has a unique climate, considerably different from that of the surrounding calcareous plateau.

The plateau shows damaged bushes of *Viburno-Quercetum ilicis*, with *Quercus ilex, Arbutus unedo, Buxus sempervirens, Phillyrea latifolia* and *Viburnum tinus*. It is in the upper mesomediterranean zone with a humid ombroclimate (precipitation of *c.* 900 mm). The two main corticolous lichen communities present on *Quercus ilex* are the *Parmelietum caperato-perlatae* Delzenne van Haluwyn & Géhu 1978 (on trunks and branches) and the *Normandino-Frullanietum dilatatae* Delzenne van Haluwyn, Géhu & Wattez 1975 (on the lower part on the trunk).

At the bottom of the aven, vascular plants are represented by only a few species: *Asplenium scolopendrium, Buxus sempervirens, Hedera helix, Parietaria judaica*, and *Sambucus nigra*. The surrounding lichen communities show pronounced skiophytic and hygrophytic characteristics: *Encephalographetum elisae* Bricaud & Roux 1991 and communities of *Botryolepraria lesdainii* (Hue) Canals, Hernandez-Mariné, Gomez-Bolea & Llimona, on the aven's rock faces; *Opegraphetum vermicelliferae* Almborn 1948 and *Anisomeridio-Psoroglaenetum* Bricaud 1996 on *Sambucus nigra*. These communities are subject to a less variable microclimate than the one prevalent at the aven's entrance. Thus, in periods of strong north wind (mistral), the plateau is violently windswept, while there are almost no air movements at the bottom of the aven.

The community chosen belonged to the community of *Woessia vasakii*, which is frequent in southeastern France. It is developed inside the crown of *Buxus sempervirens* in the bottom of the aven. The sampled leafy branch had a surface area of 7 dm^2. According to observations carried out at the station at different periods of the year, it appears that boxwood trees can produce two annual growths, one in the spring during the month of May and one at the end of June or in the autumn.

Nomenclature

Authorities for the names of lichen, fungal and bryophyte species mentioned in the text are given in Table 1. Names of vascular plants follow Kerguélen (1993).

Data collection

Only leaves were considered because the epiphytic flora of the chlorophyllous twigs is quite different to that of the leaves. Chlorophyllous twigs have more lichens of the transgressive corticolous communities, especially of the *Anisomeridio-Psoroglaenetum* Bricaud 1996, and also more bryophytes. However, the area of the twigs, which is much smaller than the leaves, would not have been enough for a minimal area study.

Since the division into geometrical quadrats is impossible, as it is in the case when sampling on bark (Roux 1990), we considered a single boxwood leaf as an elementary unit of area plotting. The variability of leaf surfaces, which is statistically quite low (mean 1·08 cm^2, standard deviation 0·35, standard error 0·025, following 216 measurements), turns out to be compatible with the determination of the minimal area. For each leaf, we determined its age group according to the order number of *Buxus* shoot growth, as well as its area, coverage for each taxon, and the surface of bare substratum. Only leaves from the shoots of order numbers 4, 5 and 6 (i.e. 2 and 3 year old) are colonized by communities of *Woessia vasakii*; younger leaves, without lichens or showing only young sterile thalli, represent a different environment, and were not used in this study.

Calculation of the minimal area

The method used for the calculation of minimal area was developed by Roux (1981, 1990) and used several times for corticolous (Rieux & Roux 1982; Khalifé & Roux 1986, 1987), terricolous

(Khalifé 1986) or saxicolous (Roux & Rieux 1980; Roux 1981) lichen communities. The species-area curve is inadequate for a reliable determination of minimal area (Roux & Rieux 1980). The qualitative minimal area was determined by the method of Gounot & Calleja (1962), based on a comparison of four leaves or four groups of contiguous leaves by means of the qualitative similarity coefficient (S_S) of Sørensen (1948):

$$S_S = \frac{2c}{a+b}$$

where:
a=number of taxa in plot a
b=number of taxa in plot b
c=number of taxa in plots a and b

The quantitative minimal area was determined by the method of Coppejans (1977) by means of the similarity coefficient (S_K) of Kulcinsky (1927):

$$S_K = \frac{2\sum_{i=1}^{n} R_c}{\sum_{i=1}^{n} R_a + R_b}$$

where:
R_a=coverage of species i in plot a
R_b=coverage of species i in plot b
R_c=minimal value of the coverage of species i in plot a or in plot b

Since the total surface studied was 233 cm^2 (216 leaves), a comparison of four contiguous groups could be carried out if their leaf areas were ≤ 58 cm^2 (54 leaves). If the leaf area of each group exceeds this value then comparisons of only two contiguous groups were made, which is acceptable (Roux & Rieux 1980) since similarity coefficients were already stabilized for this area.

Results

Record of vegetation

The record of the epiphytic vegetation (Table 1 and Fig. 1) is characterized by a sparse coverage (31·64%), which is very common for foliicolous lichen communities in the French Mediterranean region. The lichens are largely dominant (29·94%), and are represented by 13 taxa. The record is entirely representative of the *Woessia vasakii* communities studied by Bricaud (1996) in the Gard region. In particular it shows (i) the dominance of species from the alliance of *Woession vasakii* Bricaud 1996 provisional alliance (all. prov.): *Woessia vasakii* (dominant), *Porina oxneri, Strigula smaragdula* and *S. minor*, (ii) a significant quantity of transgressives of *Fellhanerion bouteillei* Bricaud 1996 all. prov.: *Fellhanera bouteillei, Wentiomyces lichenicola* subsp. *bouteillei*, and (iii) that the record is particularly species rich (28), which is advantageous for the determination of the minimal area.

Species-area curve

The species-area curve (Fig. 2), which is logarithmic, does not show stability of the species number. Its interpretation turns out to be difficult and subjective, since its form varies with the scale chosen for the Y-axis (Roux &

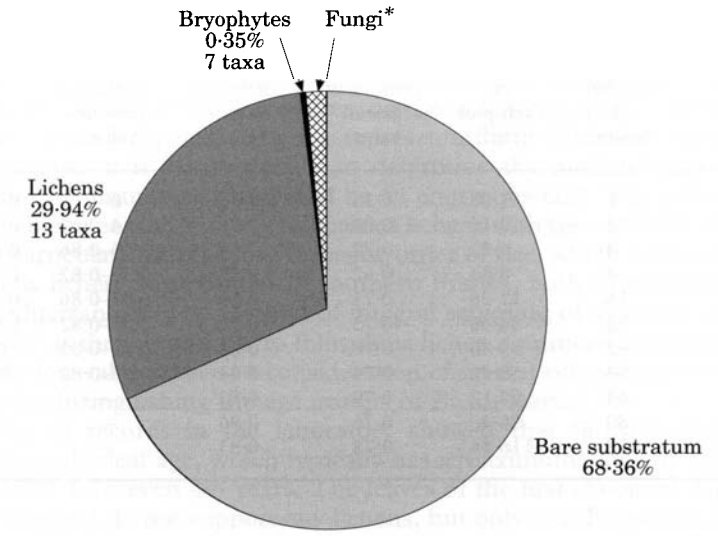
TABLE 1. *Record of the* Woessia vasakii *community*

Species	Mean coverage (%)
Lichens	
Anisomeridium nyssaegenum (Ellis & Everh.) R. C. Harris	0·02
Bacidia laurocerasi (Delise ex Duby) Zahlbr.	<0·01
Fellhanera bouteillei (Desm.) Vežda	5·82
Hyperphyscia adglutinata (Flörke) H. Mayrhofer & Poelt	0·35
Lepraria cf. *lobificans*	<0·01
Opegrapha varia Pers.	0·08
Physcia adscendens (Fr.) H. Oliver	0·56
Porina oxneri R. Sant.	0·01
Psoroglaena stigonemoides (Orange) Henssen	0·14
Raciborskiella minor (Vězda)	2·56
Strigula smaragdula Fr.: Fr.	1·00
Woessia vasakii (Vězda) Sérus.	19·33
Sterile, greenish, granular thallus	0·06
Lichenicolous fungi	
Dimerina cf. *candirae* (on *Woessia vasakii*)	0·18
Wentiomyces lichenicola (Hansf.) D. Hawksw. subsp. *bouteillei* Bricaud, Roux & Sérus. (on *Fellhanera bouteillei*)	0·13
Non-lichenicolous fungi	
Atichia glomerulosa (Ach. ex Mann.) Stein.	0·01
Dennisiella babingtonii (Berk.) Bat. & Cif.	0·35
Mycosphaerella buxicola (DC.) Tomilin	0·03
Schizothyrium cf. *pomi*	0·04
Pyrenomycete sp. 1	0·60
Pyrenomycete sp. 2	<0·01
Bryophytes	
Cololejeunea minutissima (Sm.) Schiffn.	0·01
Frullania dilatata (L.) Dum.	0·02
Metzgeria furcata (L.) Dum.	0·06
Orthotrichum affine Brid.	0·01
Orthotrichum species	0·02
Radula complanata (L.) Dum.	0·09
Rhynchostegiella tenella (Dicks.) Limpr.	0·13
Total area studied	233 cm^2
Total number of leaves studied	216
Mean area of leaves	1·08 cm^2
Bare substratum	68·36%
Coverage of cryptogams	31·64%
Total number of taxa	28 (incl. 13 lichens)

Rieux 1980). After rapid increase between 1 to 12 cm^2, it begins to level off beyond 50 cm^2.

Qualitative minimal area

The mean values of Sørensen's (S_s) similarity coefficient used in the determination of the qualitative minimal area are shown in Table 2 and Fig. 3. The mean values increase rapidly with increasing area between 1·1 and



*Non-lichenized lichenicolous fungi: 0·31%, 2 taxa
Non-lichenized non-lichenicolous fungi: 1·04%, 6 taxa

FIG. 1. Biological spectrum of the *Woessia vasakii* community.

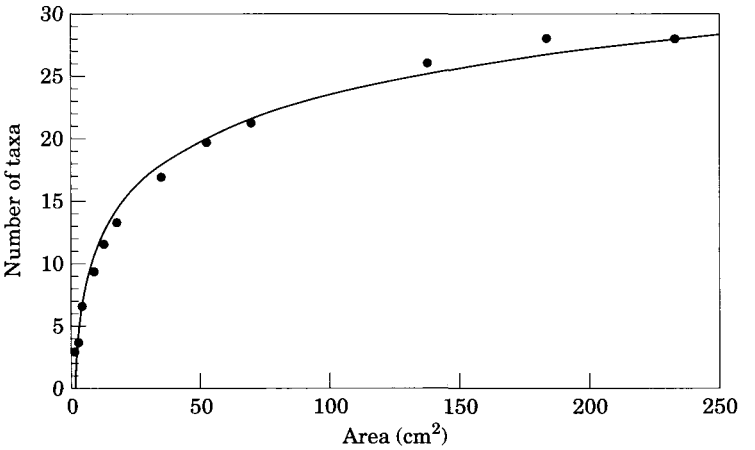


FIG. 2. Species-area curve of the studied *Woessia vasakii* community.

4·3 cm^2 (from a minimal value of 0·35 to a value of 0·72), then decrease (up to 8·6 cm^2) and finally stabilize around 30–50 cm^2 at a value slightly below 0·8. The qualitative minimal area is reached at between 30 and 50 cm^2.

TABLE 2. *Mean values of the similarity coefficients (of Sørensen and of Kulcinsky) according to the area of the compared plots*

Number of plots compared two by two	Number of leaves	Area of each plot (cm^2)	Sørensen coefficient (mean value)	Kulcinsky coefficient (mean value)	Sørenson coefficient (extreme values)	Kulcinsky coefficient (extreme values)
4	1	1·08	0·35	0·58	0–1	0·41–0·75
4	2	2·16	0·50	0·58	0·4–0·67	0·39–0·85
4	4	4·32	0·72	0·69	0·46–0·86	0·61–0·84
4	8	8·64	0·62	0·59	0·57–0·82	0·47–0·76
4	16	17·28	0·71	0·69	0·57–0·86	0·59–0·8
4	32	34·56	0·75	0·76	0·65–0·82	0·66–0·83
4	42	45·36	0·78	0·81	0·72–0·82	0·7–0·85
4	54	58·32	0·74	0·84	0·63–0·82	0·7–0·91
2	64	69·12	0·79	0·82	—	—
2	80	86·40	0·76	0·86	—	—
2	108	116·64	0·78	0·83	—	—

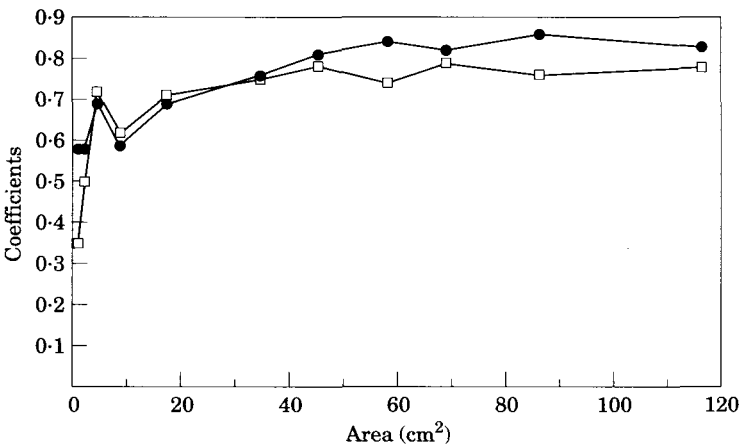


FIG. 3. Area-mean similarity coefficients (Sørensen —□— and Kulcinsky —●—) curves.

Quantitative minimal area

The relationship between the mean values of Kulcinsky's coefficient (Table 2) and sample area (Fig. 3) closely follow the values of Sørensen's coefficient up to an area of 34 cm^2, but stabilization is slower and occurs at a value slightly above 0·8. The quantitative minimal is between 50 and 80 cm^2.

Discussion

An area of 30–50 cm^2 is qualitatively (list of species) representative of the *Woessia vasakii* community, while an area of 50–80 cm^2 is quantitatively

(coverage of each species) representative. The minimal area of this foliicolous lichen community is much lower than that of crustose corticolous lichen communities for which the quantitative minimal area is between 100 to 200 cm^2 (Roux 1990). The value of the minimal area is mainly dependent on the size of thalli and, to a lesser degree, on the number of species (Roux 1990). Since the community studied here is representative of foliicolous communities of this region, it is not necessary to determine the minimal area of other foliicolous communities; this would be an enormous task. The present result is applicable to communities of foliicolous lichens with the same physiognomy, and, in particular, with thalli of the same order of size, which is the case for all foliicolous lichen communities in southern France, both Mediterranean and non-Mediterranean. The method of integral sampling of a surface of at least 50–80 cm^2 is then applicable to foliicolous lichen communities in this region. This very low value allowed a consideration of several sub-records in the same record, by distinguishing the age groups of *Buxus* leaves.

Studies of records in the laboratory showed that floristic composition depends on the leaf age, which typically has a maximum value of 3 years and more rarely 4, or even 4·5 years. The leaves of the first shoots of *Buxus* (less than 6 months) do not support any lichens, but only non-lichenized fungi, for example *Schizothyrium* cf. *pomi* and *Dennisiella babingtonii* (saprophytes). It is only on the second shoot (between 6 months and 1 year) that the first foliicolous lichens become established, while foliicolous communities are best developed only on leaves between 1·5 and 3 years old. Such methods allow the dynamics of the foliicolous communities to be described with great precision (Bricaud & Roux, unpublished).

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