Acta Bot. Croat. 54, 115 - 124

CODEN: ABCRA 2
ISSN 0365-0588

UDC 581.552 : 581.9 (45)=20
Original scientific paper

SPATIAL DISTRIBUTION OF INDIVIDUALS IN *SESLERIA ALBICANS-CAREX SEMPERVIRENS* GRASSLANDS

ERIKA PIGNATTI and *ELISA SPADARO*

(Department of Biology, University of Trieste)

Recived December 15, 1994

Spatial distribution of the individuals belonging to different species of the *Seslerio-Caricetum sempervirentis* in the Dolomites was investigated by means of 16 transects each of 2 metar lenght. Along each transect all individuals of vasculars plants growing along the axis were registered. The elaboration was carried out on the 13 species occurring most frequently, on the basis of binary association. The frequences observed differ in general significantly from a random distribution. In some cases there is the tendency for a species to occur more frequently in contact with individuals of certain species and avoids other species. In particular the two dominating species (*Sesleria albicans* and *Carex sempervirens*) seem to avoid each other and to be in contact with some preferential species. Consequently, in the community there is the tendency towards a differentiation of microniches. These relationships are explained as a consequence of growth form and characteristics of soil.

Introduction

Observing an alpine grassland or a meadow or a bush-land or a forest we recognize a whole set of individuals of different species which live together and form what is called a stand of an association in phytosociology.

We presume also and are inclined to think that among the species and individuals composition certain "rules" or competitions or preferences may reign in short and long terms besides historical factors.

We still know very little why and how species within a given community are able to grow together, mostly not in a casual way, but it is not easy to measure the "rules". One rather simple approach may be the transect method which is a tool to examine the sequence and spatial amplitude of species or individuals along a linear row. There is the necessity of an exact analysis.

This kind of problems has been studied by a few authors in different parts of the world: in the dry grassland of Switzerland, Ryser (1993) studied the importance of the vegetation gaps within the secondary niches in the communites; Arriaga et al. (1993) studied in the northwestern desert of Mexico the binary association between the Cacti species and the underlying vegetation; Kikvidze (1993) observed that, in the alpine-subnival vegetation of Central Caucasus, the association between the species is not casual; Okland (1994) points out that these kinds of research are easier in the bryophyte communites. Besides, two different work groups defined two mathematical models: Dale et al. (1991) proposed a mathematical model of formalization and Van der Maarel and Sykes (1993) proposed a model named "carousel" based on the weak temporal fluctations in the communities.

The spatial distribution of species in a Swiss *Seslerio-Caricetum sempervirentis* was investigated by Gigon (1971). Autoecological characters of the most frequent species are discussed as well as concurrence with the frame of a process of soil acidification.

As a consequence, some acidophilous species from the *Nardetum* are entering the *Seslerio-Caricetum*.

Our choice was a well known alpine/subalpine community in the Dolomites; *Seslerio-Caricetum sempervirentis*, an association on calcareous or dolomitic southern exposed slopes from about 2200-2400 m (Fig. 1). The dominant species which also give the name to the community are *Sesleria albicans* and *Carex sempervirens*. We also know that sometimes *Sesleria* is more abundant than *Carex* and sometimes vice versa. Why? Do they have preferences and in this case how do they behave in transects?

Materials and methods

In order to prove how species and population sequences behave within a given well defined community we made 16 linear transects of 2 meter length each. These transects were done on floristically homogeneous surfaces near Passo Falzarego, more or less in the centre of the Dolomites.

During the fieldwork we used nothing else but a string, a pencil and writing paper, and this was all.

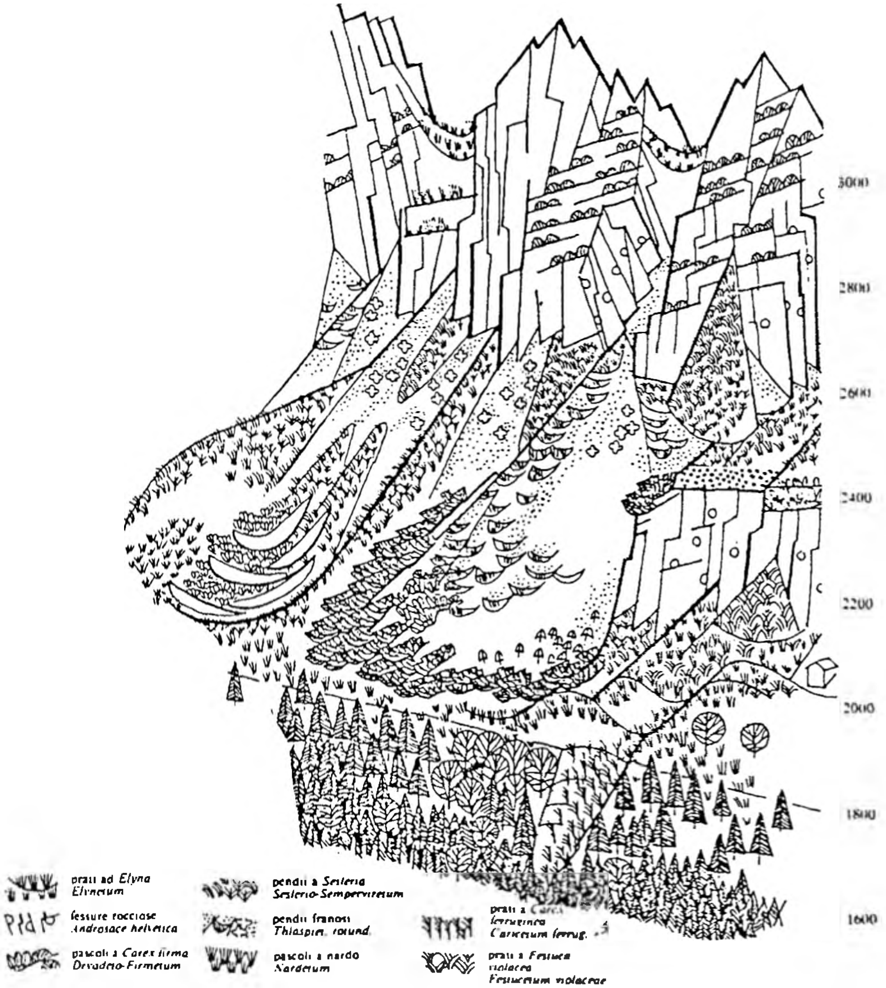

Fig. 1. Altitudinal belts on limeston (Resigl, Keller 1990)

The string was placed horizontally on the vegetation and every species/or individual of species corresponding to the string was registered in order to obtain the whole sequence within the two meter length. Every species was written down by abbreviation using one or two capital letters. In the chosen 16 transects of two meters each, we registered 76 species and 2248 individuals.

Carex sempervirens had the majority (313 individuals), followed by *Helianthemum alpestre* with 178 individuals, *Horminum pyrenaicum* (134). *Sesleria albicans* had 81 individuals.

For each transect we wrote down a list of linear sequences due to the occurrence of individuals in nature, defined by the symbol of each species. In order to be able to interprete these lists, we unified the data into 16 small tables (species name, symbols, number of individuals per species) (Fig. 2; Tab. 1) In this way it is possible to summarize how many times one species was found near another one.

Table 1. Synoptical data from the transect of Fig. 2.

SPECIES	CODE	PRESENCE	AVERAGE
Carex sempervirens	B	35	1.75
Homogyne discolor	EJ	24	1.2
Horminum pyrenaicum	E	18	0.9
Helianthemum alpestre	G	14	0.7
Sesleria albicans	A	14	0.7
Thymus polytrichus	CJ	9	0.45
Leucanthemum gr. vulgare	FE	8	0.4
Aster bellidiastrum	AD	6	0.3
Hippocrepis comosa	J	6	0.3
Selaginella selaginoides	EC	6	0.3
Anthyllis alpestris	C	5	0.25
Polygala alpestre	P	5	0.25
Gentiana verna	AB	4	0.2
Homogyne alpina	CU	4	0.2
Athamanta cretensis	EL	2	0.1
Galium anisophyllus	D	2	0.1
Hieracium villosum	AR	2	0.1
Senecio abrotanifolius	AJ	2	0.1
Aposeris foetida	FF	1	0.05
Campanula scheuchzeri	CB	1	0.05
Daphne striata	O	1	0.05
Gymnademia conopsea	DT	1	0.05
Lotus cornitulatus	DL	1	0.05
Nigritella miniata	ES	1	0.05
Pedicularis elongata	L	1	0.05
Ranunculus hybridus	Z	1	0.05
Soldanella alpina	CG	1	0.05
TOTAL SPECIES NUMBER 27		PRESENCE 175	

In our case the term "near" means contiguous, adjacent, close to each other sometimes even beneath the leaves of another species, using free spaces or "niches".

Let's give an example: in the sequence species X-Y-Z are adjacent, i.e. species X is contiguous to species Y, species Y is contiguous to Z , but species X and Z are not contiguous.

In order to obtain statistically comparable results and identify frequent combinations of two sequences oflten repeated in nature, we built 16 matrixes, using the species lists and occurrences (frequences). Also, triplets (3 species in a sequence together) were observed, but their occurrence is too variabte in the "texture" of the community. From the matrixes we compared the "observed" with the "expected" frequency.

TRANSECT 4

1- B. B. EJ. B. FE. B. G. E.
2- E. B. B. FE. ES. EJ. AD. AD. EJ.
3- E. E. C. G. AD. B.
4- EJ. EJ. EJ. B. G. G.
5- J. FE. G. EJ. EC. EJ. CU. EC. EC.
6- AJ. B. B. B. EJ. E. B. EJ. G. J. AB.
7- J. B. EJ. CU. EJ. B. B.
8- B. C. B. B. EJ. J. A. P. B. C. G. A. AB.
9- EL. CU. E. G. B. EJ. A.
10- AR. A. E. A. EJ. A. A.
11- AD. O. E. FE. EJ. AD. FE. EC. E.
12- D. P. A. AB. EJ. E. EC. C. EJ. EL.
13- AR. EJ. FE. D. L. B. B. CJ. E.
14- Z. J. CJ. FE. CJ. B. B. CJ.
15- E. CJ. B. B. B. EC. DT. P. P. B. B.
16- EJ. B. B. FE. A. P. G. CJ. A. EJ.
17- G. G. AD. E. G. CJ.
18- EJ. E. E. A. A. CB. A. G. AJ. B. G.
19- E. EJ. CU. FF. C. E. E. J. B.
20- CG. B. B. AB. DL. CJ. CJ. EJ.

Fig. 2. Example of sequence of the individuals in nature

Observed and expected frequency

1. Observed frequency is the ratio between the total number of occurrences of a certain couple of species within the 16 transects and the total contiguous pairs

tot pair 1/TOT CONTIGUOUS PAIRS

Example: *Carex sempervirens-Helianthemum alpestre* was the most frequent couple (39 times in 14 transects), followed by *Carex sempervirens-Horminum pyrenaicum* (31 times in 11 transects) and *Carex sempervirens-Aster bellidiastrum* (16 times in 11 transects).

For the couple *Carex sempervirens-Helianthemum alpestre* which was in direct contact and vicinity more frequent than others the ratio would be:

$$39/2232=0.0174$$

2. Frequency of one species is the ratio between the value of its absolute presence and all individuals in the 16 transects.

3. Expected frequency of the pair (X,Y) (the order is not important) is obtained by multiplying the frequency of X by the frequency of Y:

(X/TOT N° INDIVIDUALS) x (Y/TOT N° INDIVIDUALS)

The result has to be multiplied by two because the cases are X-Y and Y-X.

Following the last example:

Carex sempervirens had 313 individuals in 16 transects and *Helianthemum alpestre* only 178 individuals which means:

$$(313/2248) \times (178/2248)=0.0218$$

Applying these data for each pair of adjacent species we calculated the ratio between observed and expected frequency.

If the ratio is bigger than 1, the observed frequency consequently is bigger than the expected frequency, and in this case we assume that there is a positive "link" or an "association-trend" between the two species.

If the ratio is less than 1, observed frequency as a consequence is less than expected frequency, and in this case we assume a sort of "repulsion"among these species.

If the ratio is equal to 1, and the two frequences are equal, finding two species near each other can be interpreted randomly, which means their occurring together may be interpreted as "casual".

If the ratio is equal to 0, it means that in our transects we never observed these two species close together.

Further on we calculated the ratios of the 13 most frequently occurring species only. But do the two most frequent species have a positive link? Perhaps it is interesting to point out that the pair formed by *Carex sempervirens-Sesleria albicans* has a ratio equal to 0.22. Consequently we may assume that between these two species which are the most significant ones in the community structure there is maybe a certain "repulsion" or let us say in a more simple way: it seems that these two species do not like to grow very close to each other, a result we did not expect a priori (Figs. 3-4).

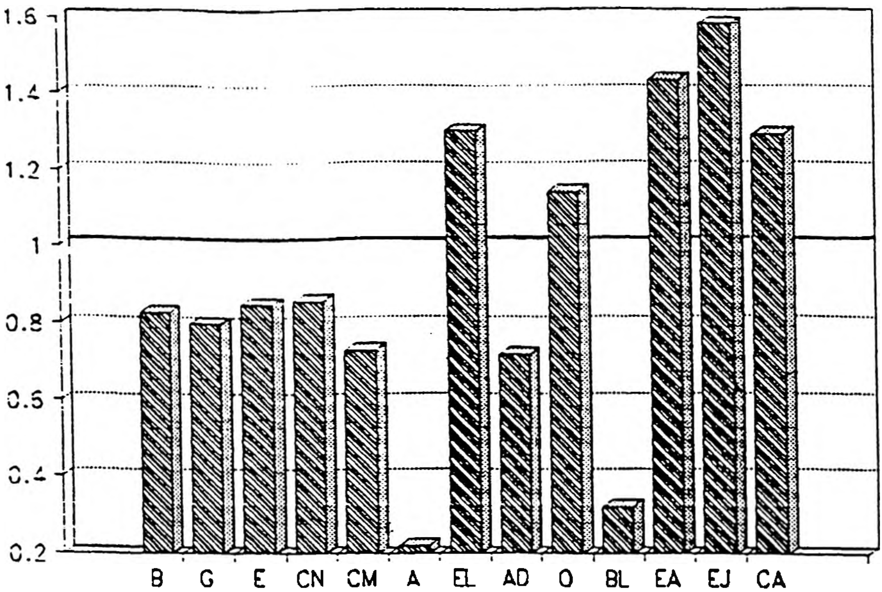

Fig. 3. This diagram represents the relation between *Carex sempervirens* and the other 13 speciea. The abbreviations using for each species are the same of Table 1. *Sesleria albicans* is defined by A.

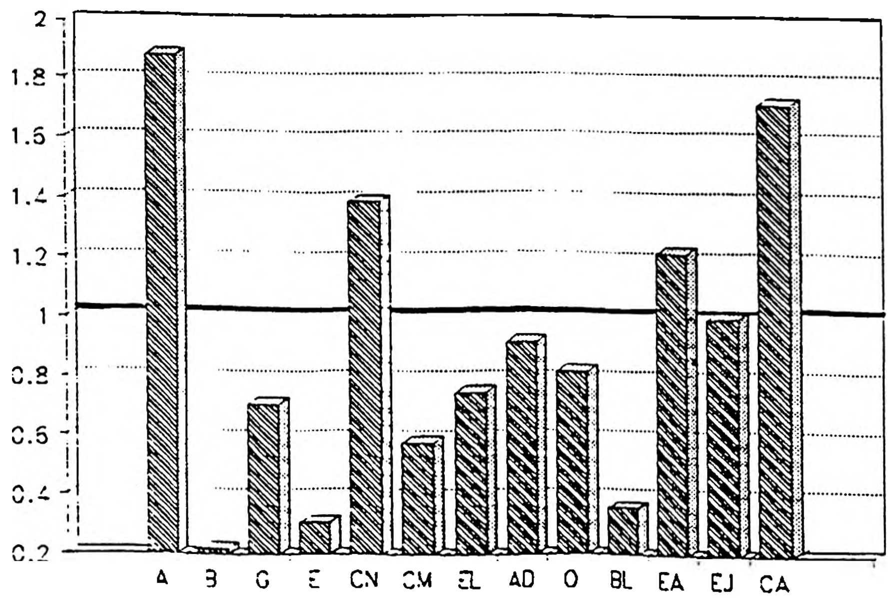

Fig. 4. This diagram represents the relation between *Sesleria albicans* and other 13 species. *Carex sempervirens* is defined by B.

Discussion

Do the combinations of species necessarily reflect ecological differences or rather differences of another kind?

One obvious fact is the mutual spatial exclusion of one species in regard to another one, i.e. where certain species/individuals are growing there certainly cannot grow other ones.

We observed this fact clearly with the three following species:

- *Carex sempervirens*
- *Dryas octopetala*
- *Sesleria albicans*

The first one grows in large dense patches. The last one is spreading by horizontal stolons, the second one is rather a pioneer species covering somehow the surface like a carpet (*Dryas*).

There are other species which can be found growing close to almost all species without any preferences and these are:

- *Phyteuma orbiculare*
- *Polygonum viviparum*

These two species are relatively small in size and small are their roots, consequently they do not need a large space; therefore they can grow easily everywhere among the others and even under the leaves of other species. This seems to be a first small result of our observation.

There is also a second one, i.e. let us call it "positive association" between *Carex sempervirens-Homogyne discolor-Daphne* striata and another positive one between *Sesleria albicans* and *Erica carnea.*

The first triple-set of species as we observed grows on deep soil, while the second couple of species grows mostly on gravelly, rather primitive soil, which can be assumed as occupying different ecological niches within a given area.

Summarizing it seems that there is a spatial surface distribution of individuals due to the growth form of certain species (and presumably to their root system distribution, which has not been observed along the transects) as well as a distribution due to ecological factors occupying different niches, as a whole contributing to the community structure.

The results of our transects are of course preliminary and by far not yet sufficient to propose common rules within a given association. Further fieldwork in different distributional areas of the same community and in other related vegetation types will be necessary in the future.

Conclusions

The spatial distribution of individuals of species composing *Seslerio-Caricetum sempervirentis* is mainly deviating from a random condition. This means that individuals are somehow ordered: In fact, two groups with positive association-links (*Carex sempervirens - Homogyne discolor - Daphne striata* on deep soil and *Sesleria albicans - Erica carnea* on gravelly soil) can be distinguished.

The microstructure of this vegetation seems to differ significantly from the macrostructure; as it is expressed by the vegetation table.

References

Arriaga L., Y. Maya, S. Diaz, J. Cancino, 1993: Association between cacti and nurse perenials in a heterogeneous tropical dry forest in northwestern Mexico. Jour. Veg. *4*:349-356.

Braun Blanquet J., 1964: Pflanzensoziologie. Springer - Verlag- Wien - New York

Erschbamer B., 1990: Substratabhängigkeit alpiner Rasengesellschaften - (Substrate dependence of Alpine grassland Communities). Innsbruck - Flora, 1990 - *184*:389-403.

Giacomini V., A. Pirola, E. Wikus, 1962: I pascoli di altitudine dello Spluga. Delpiura n. s.: 233-303

Giacomini V., A. Pirola, E. Wikus, 1962: Pascoli dell'Alta Valle di S. Giacomo. Flora et Vegetatio Italian Men. n.4: I pp. 256; 2 - Documenti cartografici e tab. Ginn. Elit. Sondrio.

Gigon A., 1971: Vergleich alpinen Rasen auf Silikat-u. auf Karbonaatboden. Veröff. Gebot. Inst. ETH Stiftung Rübel, Zürich *48*, 1-163.

Kikvidze Z., 1993: Plant species association alpine-subnival vegetation patches in the Central Caucasus. Jour. Veg. Sc. *4*:297-302.

Okland R. H., 1994: Patterns of bryophyte associations at different scares in a Norwegian boreal spruce forest. Jour. Veg. Sc. *5*:127-138.

Pignatti E. & S., 1974: Syntaxonomy of the *Sesleria albicans* - grasslands of the calcareous Alps. Vegetatio 30 / 1:5-14,1975.

Pignatti E. & S., 1975: Syntaxonomy of the *Sesleria varia* - Meadows of the calcareous Alps. Veg. 30,1:5-14 e tab.

Pignatti S., 1982: Flora d'Italia - 3 vol. - Edagricole, Bologna.

Pignatti Wikus E., 1987: Alpine grassland and effect of grazing. Vegetation Ec. & Creation of new Environments: 225-234. Tokai Univ. Press.

Reisigl H. & R. Keller, 1990: Fiori e ambienti delle Alpi. Arti Grafiche Saturnia, Trento.

Ryser P., 1993: Influences of neighbouring plants on seedling establishment in limestone grassland Jour. Veg. Sc. 4: 195-202.

Schönfelder P., 1972: Systematisch arealkundliche Gesichtspunkte bei der Erfassung historisch-geographischer Kausalitäten der Vegetation, erläutert am Beispiel des Seslerio-Caricetum sempervirentis in den Ostalpen. In Van der Maarel, Tüxen (eds). Grundfragen und Methoden in der Pflanzensoziologie. 279-290. Jung, Den Haag.

Sidney Siegel, 1956: Statistica non-parametrica per le scienze del comportamento. Edizioni Firenze.

Van der Maarel E. & M.T. Sykes., 1993: Small-scale plant species turnovers in a limestone grassland: the carousel model and some comments on the niche concept. Jour. Veg. Sc. *4*:179-188.

Wikus E., 1961: Die Vegetation der Lienzer Dolomiten (Osttirol). Tipografia Valbonesi, Forlĕ.

SAŽETAK

PROSTORNA RASPROSTRANJENOST JEDINKI NEKIH VRSTA PAŠNJAKA *SESLERIA ALBICANS - CAREX SEMPERVIRENS*

Erika Pignatti i Elisa Spadaro

(Zavod za biologiju Sveučilišta u Trstu)

Prostorna rasprostranjenost jedinki različitih vrsta koje rastu u zajednici *Seslerio-Caricetum sempervirentis* u Dolomitima proučavana je na temelju 16 transekata dužine 2 m. Na svakom transektu zabilježene su sve jedinke viših biljaka, koje su rasle duž osi transekta. Obrada je izvršena na 13 najčećih vrsta, upotrebljavajući metodu "binarne asocijacije", tj. brojenjem koliko puta jedinke jedne vrste rastu u dodiru s jedinkama iste vrste ili pak drugih vrsta. Rezultati pokazuju da u mnogo slučajeva zapažena učestalost znatno odstupa od slučajne rasprostranjenosti: jedinke pojedinih vrsta nastoje se udružiti ili razdružiti. Posebno valja istaknuti, da dvije dominantne vrste *Sesleria albicans* i *Carex sempervirens* nastoje ne rasti jedna blizu druge, pokazujući da imaju pratilice s kojima su češće u kontaktu. U sklopu zajednice javlja se dakle tendencija diferenciranja mikroniša. Ti se odnosi mogu objasniti pomoću oblika rasta i obilježja substrata.

Prof. Dr. Erika Pignatti
Elisa Spadaro
Dipartimento di Biologia dell' Università di Trieste
C. P. Università
I - 34127 Trieste, Italia