STUDIA GEOBOTANICA
4: 109-127, 1984

PHYTOSOCIOLOGY, ECOLOGY AND PHYTOGEOGRAPHY OF EPIPHYTIC LICHEN VEGETATION IN THE CALAMONE LAKE AREA (N-APENNINES, ITALY)

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Keywords: Lichens, Epiphytes, Apennines, Vegetation.

Abstract. Six community types of epiphytic lichen vegetation are reported from the Calamone Lake area (N-Apennines). Data analysis is based on multivariate methods. The ecological interpretation of the compositional variation was based on indirect gradient analysis. Each of the communities is well characterized in floristical, ecological and phytogeographical terms.

Introduction

This paper presents the results of a study on epiphytic lichen vegetation in the Calamone Lake area (Northern Apennines, province of Reggio Emilia, Italy). The main aims of the study are:

i) to analyze the floristical variation of epiphytic lichen vegetation in the survey area.
ii) to relate floristical variation to the variation of ecological factors.
iii) to study the correlation between ecology of epiphytic lichens and their distribution patterns in Europe.

The study is based on phytosociological relevés of epiphytic lichen vegetation. These have been submitted to methods of multivariate analysis (ordination and classification). The ecological interpretation of the elaboration of floristical data is based on indirect gradient analysis, with the indicator values proposed by Wirth (1980).

Description of the survey area

The survey area is located in the Northern Apennines, Province of Reggio Emilia, and corresponds with the immediate surroundings of the Calamone Lake, in the high Enza Valley. The lake, of glacial origin, is located at an elevation of 1408 m.

Palinological studies have been performed in the lake area (Bertolani-Marchetti et al., 1983). A brief history of previous biological research in the area is in Manzini (1983). No phytosociological study has been yet performed on the vegetation surrounding the lake, and a climatological station has been set up only in recent

SPECIES GROUP NR.	RELEVE GROUP NR.	1	1	1	1	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4	5	5	5	5	5	5	6	6	6	6						
	RELEVE NR.	3	3	3	1	3	3		1	1	3	1	3	2	2	2	2	2	2	2				1					1	1	1	1	1	2		3	2	3	2						
		2	1	3	0	4	5	5	4	3	8	5	7	8	7	5	6	4	3	0	3	2	1	2	8	9	4	7	7	8	1	9	6	9	6	0	2	6	1	1	2	3	4	5	6
7	Ramalina fraxinea	+	2	+	2																																			5					
7	Ramalina fastigiata	2	1	2	1																							+		1					+					5			1	2	
7	Evernia prunastri	1	1	1																																				4					
7	Anaptychia ciliaris	+	2		2		+	+																																4	2				
7	Ramalina farinacea	+	+																																					3					
4	Physcia orbicularis					+	+	1			+	1										+																			4	1			
4	Caloplaca holocarpa				+			+			+	+	+																											2	3				
2	Physcia aipolia	+					+		+			+	+																											2	3				
2	Candelaria concolor								+	+		+	+																												3				
2	Physcia adscendens					+	+						+																												2				
2	Hyperphyscia adglutinata								1	2																															2				
2	Candelariella aurella								+	+																															2				
4	Xanthoria parietina	+	+	+	+	1	1	1	2	1	1	+	1									+																		5	5	1			
4	Physconia pulverulacea	+		+								+																												3	1				
1	Arthonia punctiformis													1	2	1	2					+																				3			
1	Arthopyrenia punctiformis													1	1	2	1						+																			3			
1	Caloplaca cerina						+	+	+					+	+			1	+		+	+	+																		2	4			
2	Parmelia exasperata				+		+	+	2	2			+						+	+	+				+															2	4	2	1		
2	Lecanora chlarotera			+			+		+		+	1	+			+		+	1																					2	4	2			
7	Caloplaca ferruginea	+					+	+													+	+	+																	2	2	2			
1	Lecanora carpinea			+	+	+	+	1	1	1	1	1	1	2	2	+	1	2	3	3	1	2	2																	3	5	5			
4	Physcia stellaris	+	1	1	+	1	1	2	1	1	2	1	2	+	+			+	+	+		+																		5	5	3			
5	Pertusaria pertusa																							2	3	2	3	2	3	1	2	+	+						+				5	4	2
5	Pertusaria flavida																				+			2	1	1	2	1	1	1	+	+										1	5	3	
5	Pertusaria amara																							2	1	1	2		1	+	1							+	+				5	2	3
5	Ochrolechia pallescens							+																1	2	1	1	1							+				+		1		5	1	2

6	Pertusaria albescens																				+					2	1	1	1	+			+									1	4	2	
6	Fuscidea cyathoides																											1	1														2		
5	Buellia disciformis																							1	+					+													2	1	
6	Pertusaria hemisphaerica																									2			1														2		
6	Parmelia saxatilis																									+			1														2		
9	Lobaria pulmonaria																													3	2	3	3	3	2									5	
9	Peltigera collina																													1	+	+	2	+	+									5	
9	Lobaria amplissima																													2	1			2	2									4	
9	Lepraria incana																													+	+	+	+											4	
9	Parmeliella plumbea																																	+	1									2	
9	Nephroma resupinatum																																1	+										2	
9	Peltigera polydactyla																															2		+										2	
8	Pseudevernia furfuracea				1																						+									2	2	3	3	2			1		5
8	Platismatia glauca																																			2	2	2	2						5
8	Hypogymnia bitteri																																			1	2	1	1						5
8	Hypogymnia physodes																																				+	1	+						4
1	Lecidella elaeochroma	+	+	1				1	2	1	1	1	2	2	2	2	1	2	3	3	2	2	3	1		+	+	+							+					4	4	5	4	1	
6	Parmelia sulcata		+															+		1	1	+			1	+	1	+		+	+	1	1		+		+	2	1	2		2	3	4	3
5	Lecanora subfuscata			+	+	+							1				+			+	1	+	1	1	+		1	1	+						1					3	2	3	5	1	
6	Lecanora intumescens																	+		+	2		+	1	1	+		1	1	+	+				1							2	5	3	
5	Candelariella xanthostigma							1		1		+						1	+					+	+	+	+	+							+						2	1	5	1	
3	Parmelina pastillifera	+		+	1			+				1						+							1		+	1							1					4	2	1	3	1	
3	Parmelia glabratula			+	+	+						1						+	+						+			+												3	2	1	2		
2	Caloplaca aurantiaca					+			+																										+						2			1	
7	Usnea hirta	+																										+										+		2			1		2
1	Parmelia exasperatula												+			+																										1			
5	Lecanora pallida															+									+																	1	1		
8	Lecanora symmicta																																			+	+								3

Sporadic species: Rel. 31: Parmelia glabra (1); Rel. 15: Collema nigrescens (1); Rel. 27: Arthopyrenia laburni (1), Aspicilia mutabilis (1);Rel.24: Rinodina exigua; Rel. 1: Buellia griseovirens; Rel. 19: Cladonia fimbriata; Rel.6: Leptogium saturninum, Cetrelia cetrarioides; Rel. 29: Parmelia contorta.(When not otherwise specified, the cover is +)

Tab. 1 — Phytosociological releves ordered according to their sequence in the dendrogram of releves (Fig. 1).

times, so that reliable climatical data are not yet available. The woody vegetation surrounding the lake consists of almost pure *Fagus*-stands. Grazing by sheep, cattle and horses is frequent around the lake, and anthropic pressure by turists is increasing in recent times (Chiessi, 1983). The relevés for the present study were taken all on *Fagus*, in open or closed stands, between 1350 and 1550 m.

Data and methods

The data for the present study are 38 phytosociological relevés of epiphytic lichen vegetation (Tab. 1). They have been all taken on Fagus, as follows:
- isolated trees, base of the boles
- isolated trees, trunk at breast height.
- isolated trees, old crown branches.
- isolated trees, young branches.
- trees in woody stands, base of the boles.
- trees in woody stands, old crown branches.
- trees in woody stands, young branches.

Two relevés were taken on each bole, respectively at the north and south side of the trunk.

A further data source, utilized for the ecological and phytogeographical interpretation, are the indicator values and the phytogeographical diagnoses for the single species given by Wirth (1980).

Data analysis occurred in the following steps:

a) numerical classification of relevés and of species, in order to obtain floristically similar releve groups.
b) ordination of relevés, to detect compositional gradients.
c) concentration analysis of matrices of ecological data and relevé groups, in order to analyze the correlation between compositional variation in the data set and the variation of some main ecological factors.
d) concentration analysis of the matrix of phytogeographical data and relevé groups, to analyze the correlation between compositional/ecological variation in the data set, and the variation of phytogeographical affinities of the relevé groups.
e) reciprocal ordering of relevés and species, to extract a reduced number of indicator species.

Classification is based on Complete Linkage Clustering (Anderberg, 1973) and Correlation Coefficient (Orloci, 1978). Ordination is base on Principal Component Analysis (see Orloci, 1978). For Concentration Analysis see Feoli & Orloci (1979). For data analysis, I used the package of programs by Wildi & Orloci (1980).

Results

The dendrograms of relevés and species are respectively in Fig. 1 and Fig. 2. In the dendrogram of relevés (Fig. 1) 6 main releve groups are formed at a value of the Correlation Coefficient of 0.1. In the dendrogram of species (Fig. 2), 9 species groups are formed at a value of the Correlation Coefficient of − 0.3. The results of

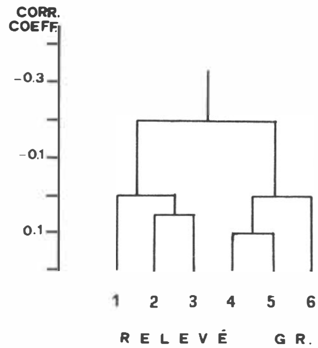

Fig. 1 — Dendrogram of the relevé groups.

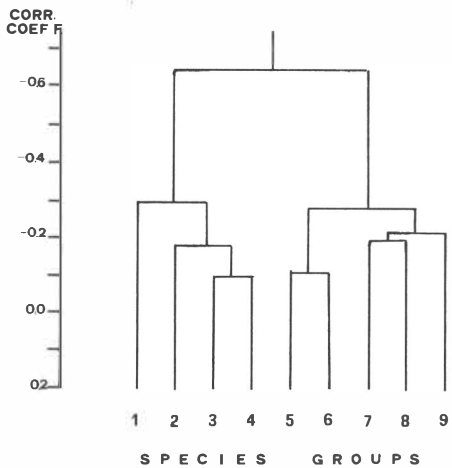

Fig. 2 — Dendrogram of the species groups.

AOC performed on the contingency table of relevé groups and species groups are visualized in Fig. 3. All of the relevé groups are significantly associated with at least one species group. This indicates that the six relevé groups may be interpreted as distinct vegetation types, each of them defined by a set of differential species.

The results of PCA performed on the data in Tab. 1 are in Fig. 4. The clustering of relevés obtained by the classification method (Fig. 1) is still recognizable in the ordination results. The first two Principal Components clearly separate relevé groups 1,2 and 3 (positive scores on the Ist Principal Component) from relevé groups 4 and 5 (negative scores). Relevé group 6 is separated from all the others on the 3rd Principal Component.

Tab. 2 (a-d) contains the occupancy rates of the species in classes of pH (a), light intensity (b), eutrophication of the substrate (c) and degree of humidity of the

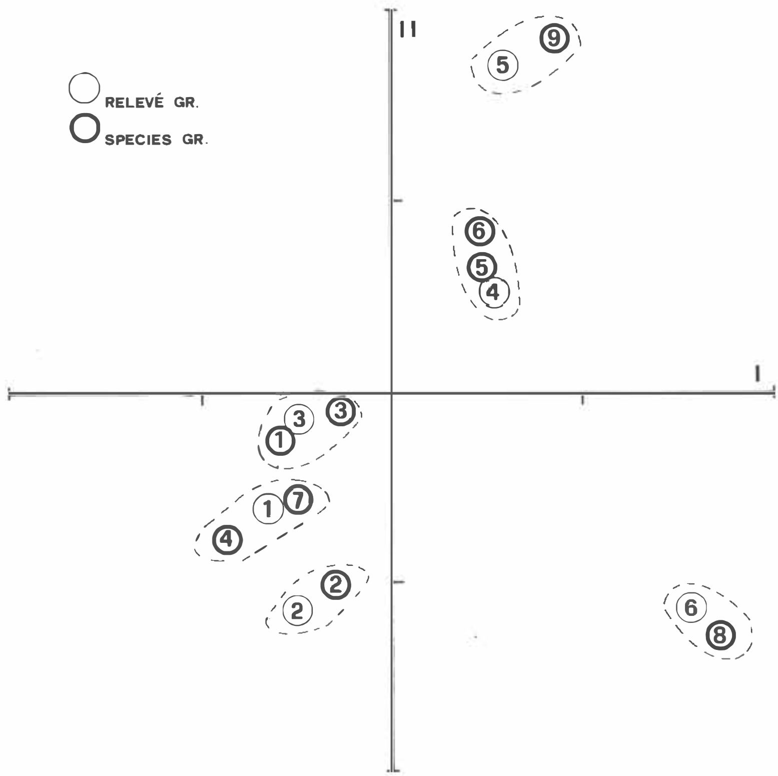

Fig. 3 — Arrangement of relevé and species group points according to the two Principal Components of AOC performed on the contingency table of species and relevé groups.

substrate (d), subdivided by relevé groups. The indicator values of the single species, that have been utilized to calculate the data in Tab. 2, are as in Wirth (1980). The data in Tab. 2 (a-d) have been submitted to AOC, in order to quantify the degree of correlation between relevé groups and some main ecological factors. The results are visualized in Fig. 5 (pH), 6 (light), 7 (nitrogen) and 8 (humidity). They may be summarized as follows: the relevé groups defined on floristical basis are strongly correlated with the variation of the considered ecological factors. They may be ecologically characterized as follows:

Relevé group 1: neutrophytic, photophytic, little nitrophytic, rather xerophytic.
Relevé group 2: neutro-basiphytic, rather photophytic, nitrophytic, xerophytic.
Relevé group 3: subneutrophytic, little photophytic, rather nitrophytic, xerophytic.
Relevé group 4: subacidophytic, rather skiophytic, little nitrophytic, rather higrophytic.
Relevé group 5: subacidophytic, skiophytic, anitrophytic, higrophytic.
Relevé group 6: acidophytic, rather photophytic, nitrophobic, mesophytic.

On the basis of these results, it is possible to interpret the ordination of Fig. 4 in

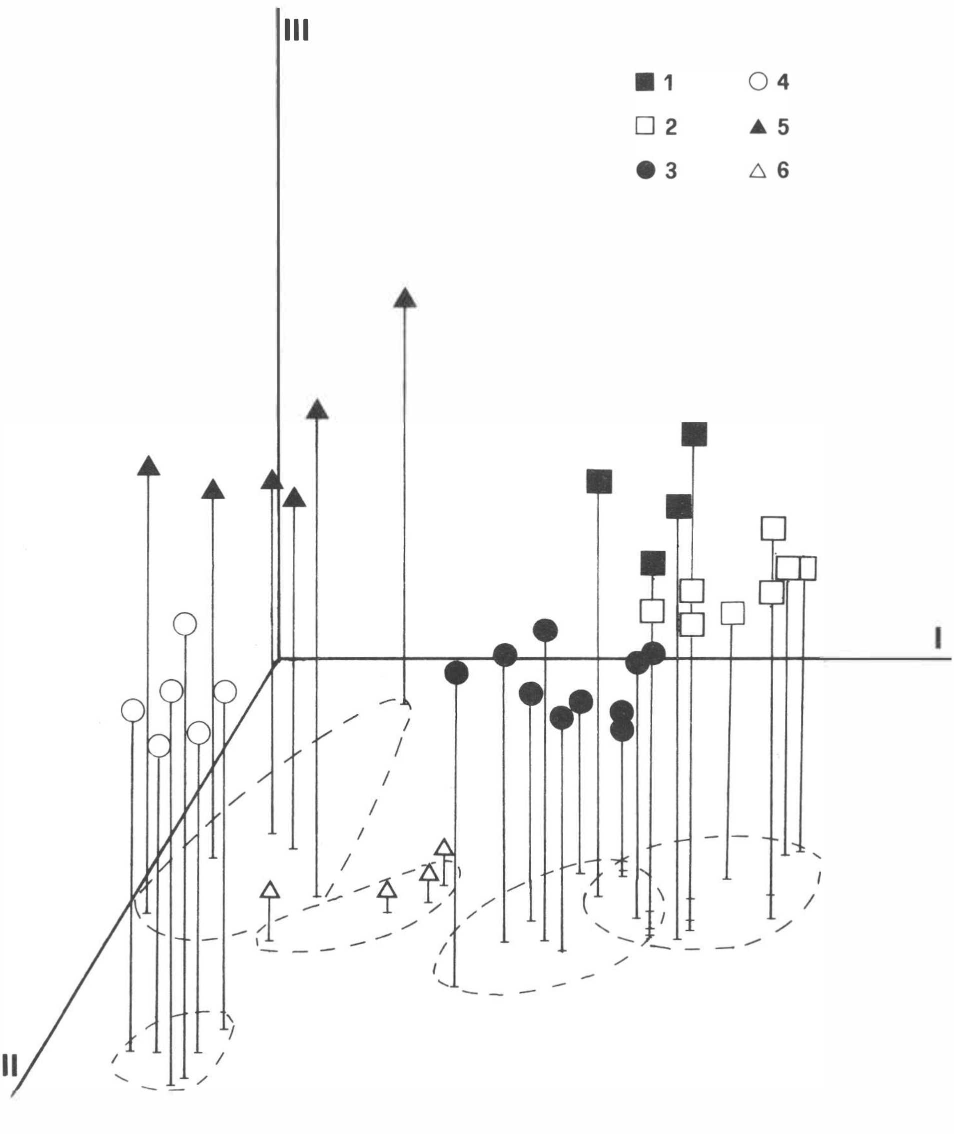

Fig. 4 — Arrangement of the relevé points according to the first three principal components of PCA performed on the data of Tab. 1. Symbols refer to relevé groups, numbered as in Tab. 1.

RELEVE GROUP Nr.	1	2	3	4	5	6
a)						
pH 3.4-4.0	9.0	....	1.2	8.6	69.5	15.7
pH 4.1-4.8	20.4	21.5	35.8	24.0	86.9	31.4
pH 4.9-5.6	77.2	58.8	74.0	99.0	74.0	88.5
pH 5.7-7.0	70.4	71.1	62.0	22.4	....	24.2
pH 7.1-8.5	11.3	26.4	2.4	....	....	....
b)						
Photophytic	52.2	44.0	18.5	4.1	5.3	8.6
Moderately photoph.	86.3	74.0	69.1	75.7	82.1	91.3
Slightly photoph.	45.5	64.0	77.7	65.7	78.5	91.3
Moderately skiophytic	....	....	4.9	31.5	36.3	8.6
c)						
Nitrophytic	4.5	33.3	3.7	....	....	....
Moderately nitroph.	50.0	69.3	65.4	30.4	19.6	8.6
Slightly nitroph.	97.7	96.0	72.8	56.5	62.5	39.1
Not nitrophytic	56.8	29.3	37.0	71.0	76.7	91.3
d)						
Moderately xerophytic	65.6	70.1	63.2	10.4	6.6	....
Slightly xerophytic	20.9	67.1	46.0	18.7	28.8	88.0
Mesophytic	15.6	14.9	10.2	47.9	66.6	47.2
Moderately hygrophytic	6.2	5.9	2.9	50.0	86.6	35.2

Tab. 2 — Occupancy rates in the classes of ecological factors, calculated as percents of the total occupancies in each relevé group. a) pH-classes; b) light intensity-classes; c) eutrophication classes; d) moisture classes.

ecological terms: the first Principal Component separates neutro- photo- nitro- and xerophytic stands (releve groups 1, 2, 3) from acido-, skio-, anitro- and hygrophytic stands (releve groups 4, 5). In general, acidity and eutrophication, are inversely correlated, whereas light intensity, degree of xerophytism, and eutrophication are positively correlated. The correlation between high light intensity and xerophytism is obviously due to higher evapotranspiration rates. The one between acidity and low light intensity is less obvious. The average acidity of *Fagus*-bark in natural conditions is 5.39 (Barkman, 1958). In the study area grazing by sheep, cattle and horses is frequent, and more intense in not-forested sites. This ensures a continuous apport of nitrogen to isolated trees, that is the main reason for higher pH values in photophytic stands. The separation of relevé group 6 from the others on the 3rd Principal Component is justified also in ecological terms: this relevé group is characterized by strongly acidiphytic species, that however, are rather photophytic and mesophytic. These results are in good agreement with the location of the relevés on the porophyte, that is as follows:

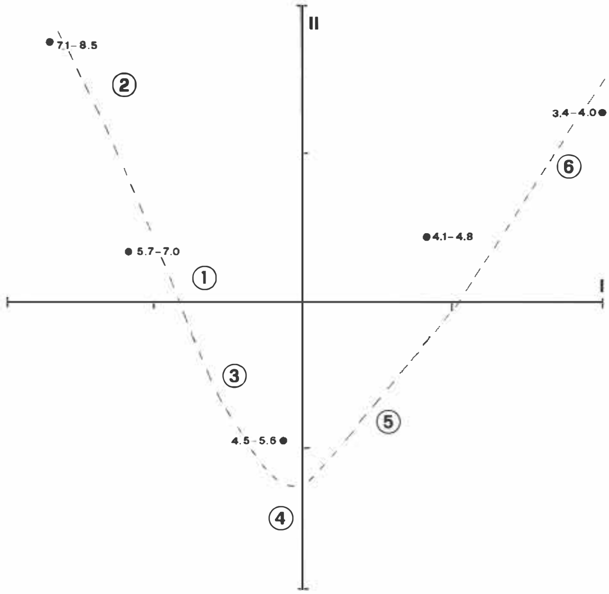

Fig. 5 — Arrangement of relevé group - and pH class - points according to the two first Canonical Variates in AOC performed on the data of Tab. 2a.

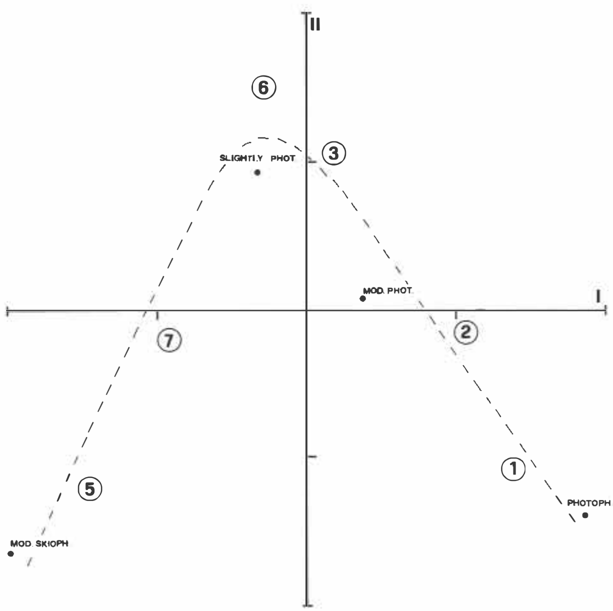

Fig. 6 — Arrangement of relevé group - and light intensity class - points according to the two first Canonical Variates of AOC performed on the data of Tab. 2b.

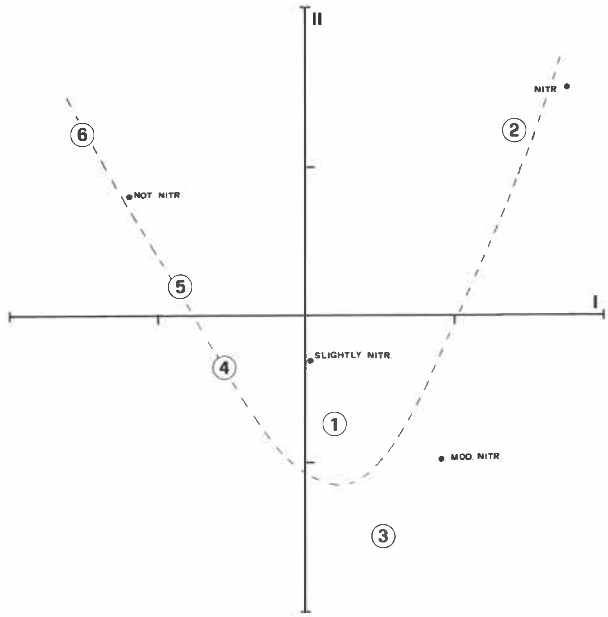

Fig. 7 — Arrangement of relevé group - and eutrophication class - points according to the two first Canonical Variates of AOC, performed on the data of Tab. 2c.

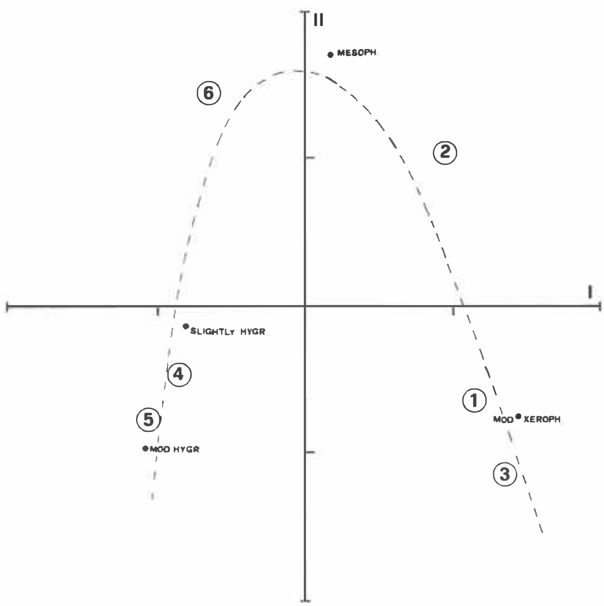

Fig. 8 — Arrangement of relevé group - and moisture class - points according to the first two Canonical Variates of AOC performed on the data of Tab. 2d.

Relevé group 1: old outer branches of isolated trees, mostly near the lake.
Relevé group 2: bole of isolated trees, near the base (higher accumulation of nitrogen), south-exposed...
Relevé group 3: young branches (smooth bark), mostly of isolated trees; indifferent to exposure.
Relevé group 4: bole of isolated trees (north exposed, at 1-2.5 m of height) or bole of trees in rather open stands (and then indifferent to exposure).
Relevé group 5: only on the bole old trees in woody stands, indifferent to exposure, mostly on epiphytic mosses (higher water availability).
Relevé group 6: Branches (indifferent to exposure) and high portions of the boles (at the north side) of isolated trees in strongly wind-exposed sites (near ridges).

The results of the reciprocal ordering of relevés and species are in Fig. 9 (a and b). Also in this case the relevé groups obtained by classification are recognizable in the ordination (Fig. 9a). The relevé points are arranged along a horse-shoe; their sequence is as follows: relevé groups 1, 2, 3, 4, 5, 6. It is not possible to interpret this sequence only on the basis of the variation of ecological factors. Fig. 10 reports the percentages in each relevé of 6 main growth form types (as in Barkman, 1958); the relevés are arranged according to their angular scores in Fig. 9a. The crustose growth form type (Fig. 10) is predominant at the center of the gradient, and decreases left- and rightwards. The Physcia-type (narrow-lobed, foliose) and the Ramalina-type (fruticose) tend to increase towards the left side of the gradient, whereas th Lobaria-type (broad-lobed, foliose) and the Anaptychia-type (fruticose) increase at the right side of the gradient. The crustose type is characteristic of pioneer stands, the fruticose type of well developed, mature stands. The arrangement of the relevés in Fig. 9a reflects two succesional trends, that occur in different ecological conditions. Relevé group 3 represents the pioneer lichen vegetation on young branches with smooth bark. On isolated trees (high light intensity, hence dominance of the narrow lobed foliose form) the succession evolves towards relevé group 2 where nitrogen accumulation is high (base of the boles), or towards relevé group 1 where this does not occur (high, old branches). On trees located in woody stands, where light intensity is lower (dominance of the broad lobed foliose type), the succession evolves towards relevé group 4 (boles, directly on bark) and relevé group 5 (boles, mostly on epiphytic mosses). Relevé group 6 could be considered as the expression of an azonal vegetation in the study area, bound to habitats with peculiar ecological conditions (exposure to strong winds). Fig. 11 reports the frequency of apothecia bearing species in the relevés arranged as in the ordination of Fig. 9a. Reproduction by spores is maximal in xerophytic, neutro-basiphytic and photophytic communities.

The results of the reciprocal ordering of species are in Fig. 9b. Most of the species in Fig. 9b have low scores on the two first canonical variates: they are either low-frequency species or species that are not strongly correlated with the successional-ecological gradient of Fig. 9a. In Fig. 9b only those species are named, that have high scores on the first two canonical variates. This allows to extract 23

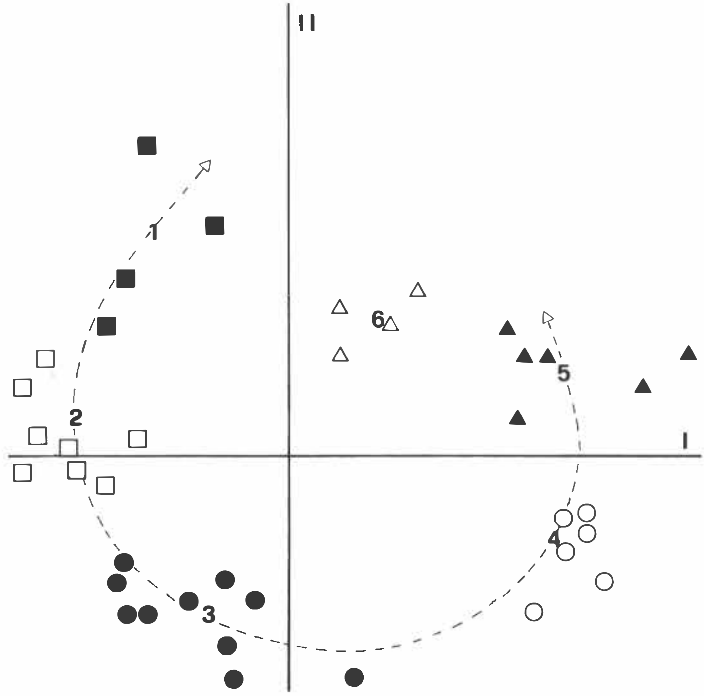

Fig. 9a — Arrangement of relevé points in the reciprocal ordering of relevés and species based on the data in Tab. 1. Symbols refer to relevé groups, as in Fig. 3.

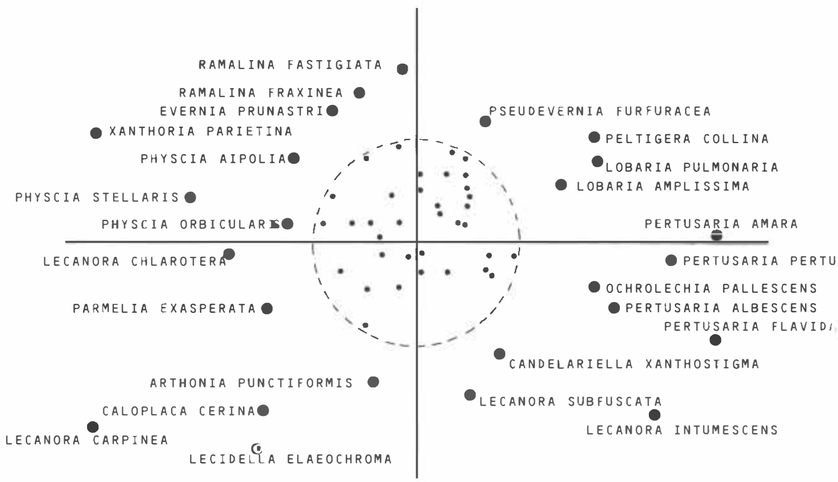

Fig. 9b — Arrangement of species points in the reciprocal ordering of relevés and species based on the data in Tab. 1. Only those species are named, that have high scores on the first two Canonical Variates.

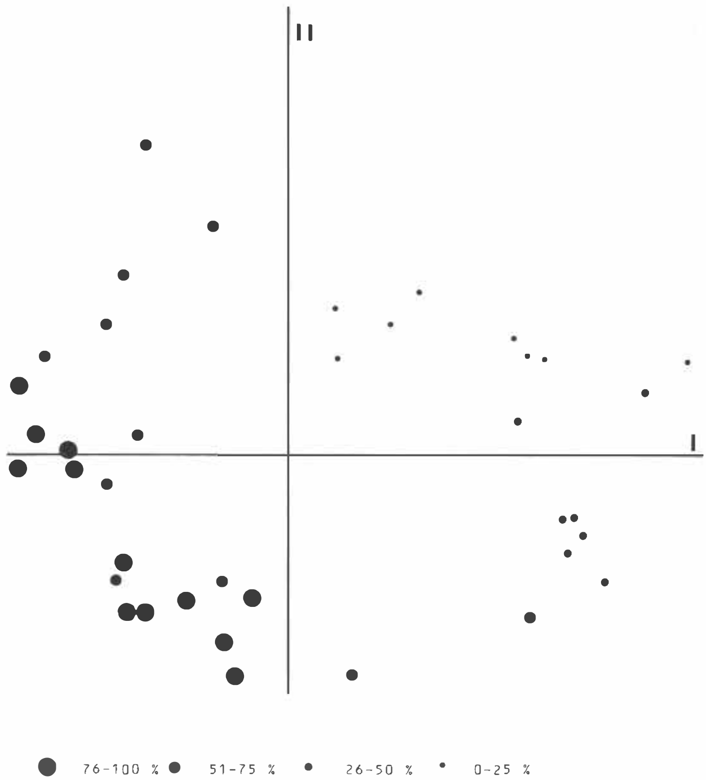

Fig. 10 — Frequency classes of apothecia-bearing species in the releves. The relevés are arranged as in Fig. 9a.

indicator species out of a total of 64. The indicator value of each species can be inferred from its position in respect with the relevé groups in Fig. 9a, and with the ecological characterization of the relevé groups given above.

Tab. 3 contains the occupancy rates of the species in the geographical subdivisions of Europe proposed by Wirth (1980), calculated as percents of the total occupancies for each relevé group. The data in Tab. 3 have been submitted to AOC in order to analyze the phytogeographical affinities of the relevé groups. The results are visualized in Fig. 12, where two main trends are evident:

a) the first canonical variate clearly reflects a trend in increasing aerohygrophytism, from relevé groups with high incidence of subcontinental species (relevé group 6) to relevé groups with high incidence of subatlantic and atlantic species (relevé groups 4,5). Noteworth is the fact that in relevé groups 4 and 5 most of the species whose ranges extend from boreal or central western Europe also occur in the mediterranean region, where, however are restricted to high elevations (Tab. 3). This is mainly due to the suboceanic conditions that characterize the montane belt of the mediterranean region (Walter & Straka, 1970).

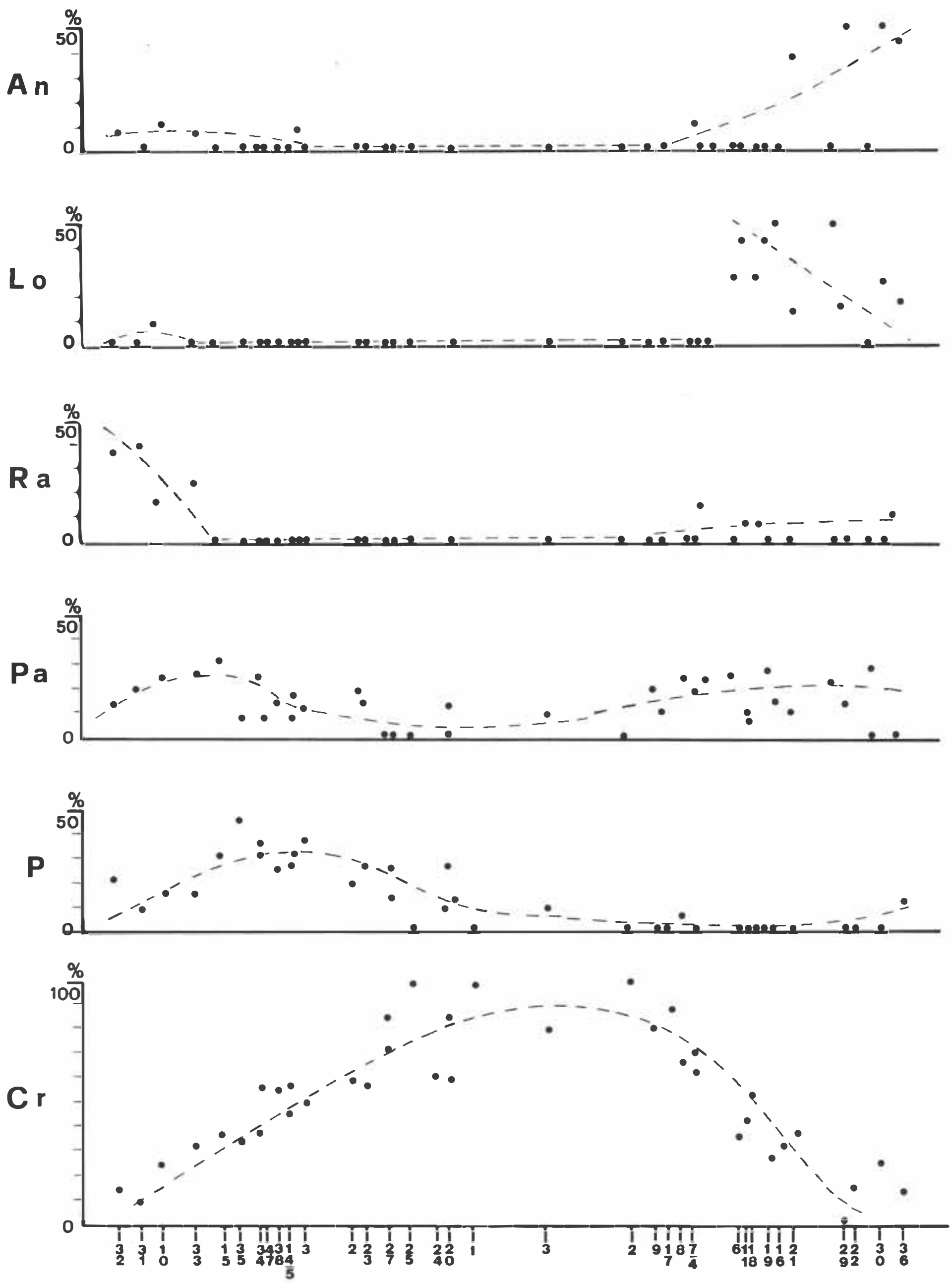

Fig. 11 — Percents of growth from types in the relevés, the latter ordered according to their angular scores in Fig. 9a (See Feoli & Feoli Chiapella, 1980) *Cr* = crustose; *P* = Physcia-type; *Pa* = Parmelia-type; *Lo* = Lobaria-type; *Ra* = Ramalina-type; *An* = Anaptychia-type.

Oper.Geogr.Unit	RELEVE GROUP NR. 1	2	3	4	5	6
ARCTIC	7.8	4.4	20.0	8.0	12.5	24.0
BOREAL ATL.	....	....	....	....	14.2	....
BOREAL SUBATL.	2.6	2.2	4.3	6.6	21.4	....
BOREAL SUBCONT.	....	....	....	....	....	16.0
BOREAL	62.3	48.8	75.7	32.0	26.7	80.0
SOUTH BOREAL ATL.	....	....	....	....	14.2	....
SOUTH BOREAL SUBATL.	3.9	4.4	4.3	6.6	21.4	4.0
SOUTH BOREAL SUBCONT.	....	....	....	....	....	16.0
C-EUROP. SUBATL.	10.3	11.1	4.3	24.0	50.0	4.0
C-EUROP. SUBCONT.	....	....	....	....	....	16.0
C-EUROP. MONTANE	....	2.2	....	....	....	....
C-EUROP.	89.6	86.6	95.7	54.6	35.7	80.0
SOUTH C-EUR. SUBATL.	7.8	8.8	4.3	24.0	48.2	4.0
SOUTH C-EUR. SUBCONT.	....	....	....	....	....	8.0
SOUTH C-EUR. MONTANE	....	2.2	5.7	9.3	1.8	36.0
SOUTH C-EUR.	92.2	88.8	90.0	53.3	50.0	60.0
SUBMEDIT. SUBATL.	2.6	8.8	4.3	17.3	21.4	....
SUBMEDIT. MONTANE	3.9	4.4	5.7	18.6	32.1	56.0
SUBMEDIT.	93.5	86.6	90.0	50.6	42.8	44.0
MEDIT. SUBATL.	....	....	....	....	1.8	....
MEDIT. MONTANE	7.8	20.0	10.0	32.0	55.3	36.0
MEDIT.	90.9	75.5	88.6	50.6	37.5	44.0

Tab. 3 — Percents of species occurring in different geographical subdivisions of Europe, calculated over the total occupancies of each relevé group.

b) The second canonical variate reflects a trend from high (negative scores) to low (positive scores) temperatures. At the negative extreme is the mediterranean region, at the positive extreme the subcontinental parts of boreal Europe. Relevé group 2 is the one whose species most extend into the mediterranean region, releve group is 6 the one whose species are mostly restricted to northern or Central Europe.

If interpreted on the basis of the previous ecological characterization of the relevé groups, these results show that there is a strong correlation between ecological requirements of the species and their distribution patterns. Relevé groups 4 and 5, taken in shady sites have the highest frequency of suboceanic species, whereas relevé groups 1, 2, 3, taken in strongly illuminated sites, have the highest incidence of southern species; relevé group 6, occurring on branches in wind-swept stations, is mostly composed by northern species.

We can conclude that the epiphytic lichen flora of an area tends to be organized in community-types with different ecology, in which species with similar distribution patterns are associated according to the prevailing ecological conditions.

Phytosociological interpretation

Relevé group 1: this relevé group corresponds well with the union *Ramalinetum fastigiatae* Duvigneaud (1942). The three faithful species, *Ramalina fraxinea, R.*

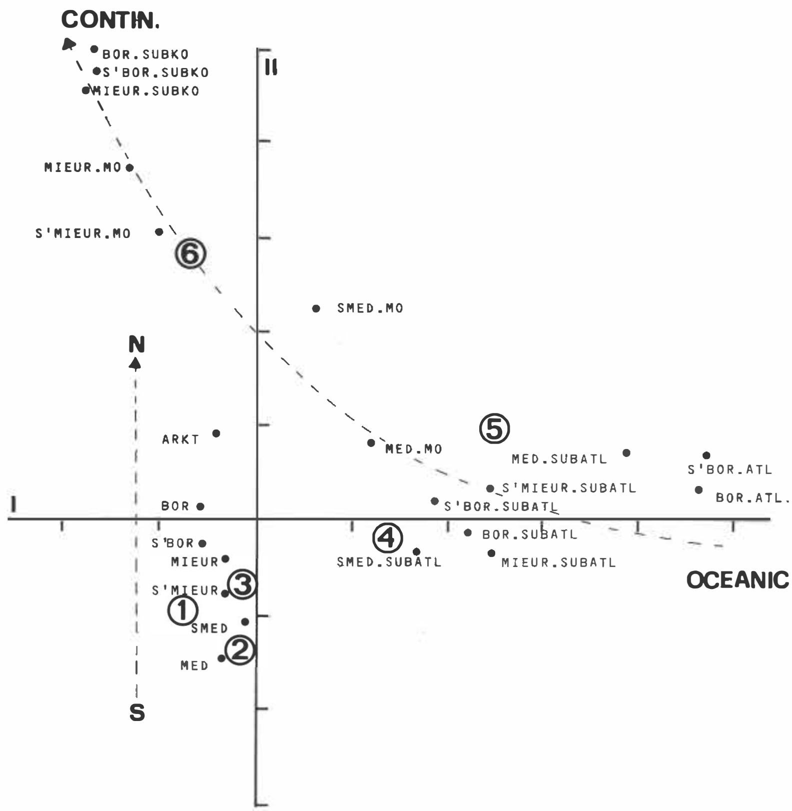

Fig. 12 — Arrangement of relevé group points and of geographical subdivisions of Europe according to the two first Canonical Variates of AOC, based on the data of Tab. 3.

fastigiata and *R. farinacea* are all constant in our data set. *Evernia prunastri* is considered by Barkman (1958) as differential within the Order *Physcietalia adscendentis* Mattick (1951) em. Barkman (1958). The ecological characterization given by Barkman (1958) for this union corresponds well with the one presented in the results. The union is known from Scotland and South Finland (Barkman, 1958) in Northern Europe, to South France (Rondon, 1951, 1953) and North East Italy (Nimis, 1983) in Southern Europe. I frequently observed well developed stands of the *Ramalinetum fastigiatae* in the montane belt of Central and Southern Italy.

Relevé group 2: this relevé group corresponds with the union *Physcietum adscendentis* Frey and Ochsner (1926). Of the faithful species (Barkman, 1958), the following are present in our data set: *Physcia aipolia, Physconia pulverulacea, Physcia stellaris.* Several variants of this union have been described (Barkman, 1958; Nimis & De Faveri, 1981). Our releves belong to the var. *Parmeliosum glabrae* Barkman (1958), characterized by the constant presence of *Physcia stellaris.* This variant is known for the lowland and colline zones of Central and Eastern Europe.

Relevé group 3: this relevé group belongs to the *Lecanoretum carpineae* s.l. The union *Lecanoretum carpineae* was subdivided by Barkman (1958) into three unions, that are considered as geographical vicariants. This subdivision has been criticized by Kalb (1970), above all as far as the choice of the differential species is concerned. Actually, it is impossible to include our relevés in any of the unions proposed by Barkman, since they contain species that are considered by Barkman as differential of all of the three unions. They are: *Lecanora pallida, Caloplaca cerina (Lecanoretum carpineae continentale), Candelariella xanthostigma, Lecanora intumescens (Lecanoretum carpineae montanum), Arthopyrenia punctiformis (Lecanoretum carpineae atlanticum).*

Relevé group 4: this relevé group corresponds well with the *Pertusarietum hemisphaericae* Klement (1955) (Syn.: *Pertusarietum amarae* Hilitzer, 1925 em. Barkman, 1958). The following faithful species are present in our data set: *Pertusaria hemisphaerica, Fuscidea cyathoides, Pertusaria pertusa.* The union has a subatlantic distribution in Europe, being known for South Scandinavia, Brittanny, the Netherlands (Barkman, 1958) and Germany (Klement, 1955). It has been recorded by Nimis (1983) in the Trieste Karst (NE Italy), where it is confined to deep dolines with a particularly humid microclimate. I frequently observed stands referrable to this union in the montane belt of southern Italy, so that its total distribution is probably subatlantic-mediterranean montane.

Relevé group 5: this relevé group fully corresponds with the *Lobarietum pulmonariae* Hilitzer (1925). Of the faithful species, the following are present in our data set: *Lobaria pulmonaria, Lobaria amplissima, Nephroma resupinatum, Peltigera collina, Cetrelia cetrarioides, Peltigera polydactyla* and *Parmeliella plumbea.* The distribution of this union in Europe is subatlantic-mediterranean montane (Nimis, 1982).

Relevé group 6: this relevé group corresponds with the *Pseudevernietum furfuraceae* Hilitzer (1925). This union is common in central Europe, mainly in the montane-subalpine belts, where it occurs on a variety of trees, mostly conifers. In the study area the *Pseudevernietum* is rare and localized in stations exposed to strong winds, and should be considered as azonal in respect with the prevailing climatical conditions.

Concluding remarks

The compositional variation of epiphytic lichen vegetation in the study area is strongly correlated with the variation of ecological factors. This is in its turn correlated with a variation of the frequencies of lichen species with given distribution patterns. Phytosociology, ecology and phytogeography may provide complementary tools to the causal approach in the study of epiphytic lichen vegetation.

Riassunto. La vegetazione lichenica epifita della zona del Lago Calamone (Appennino Settentrionale, Provincia di Reggio Emilia) è stata studiata sulla base di rilievi fitosociologici sottoposti a metodi di analisi multivariata. Sono state individuate le seguenti unioni di licheni epifiti:

a) *Ramalinetum fastigiatae,* sui rami di faggi isolati.
b) *Physcietum adscendentis,* alla base dei tronchi di faggi isolati.
c) *Lecanoretum carpineae,* su giovani rami di faggio.
d) *Pertusarietum hemisphericae:* sui tronchi di faggi isolati in esposizione Nord, sui tronchi di faggi in bosco, indifferente all'esposizione.
e) *Lobarietum pulmonariae:* sui tronchi di faggi in bosco, per lo più su muschi epifiti.
f) *Pseudevernietum furfuraceae:* su rami di faggio in zone fortemente esposte al vento.

Ogni comunità è stata caratterizzata ecologicamente sulla base di un'analisi indiretta di gradiente. I dati per l'interpretazione ecologica sono gli indici ecologici proposti da Wirth (1980). I risultati dell'analisi fitogeografica mostrano una forte correlazione tra ecologia ed affinità fitogeografiche delle varie comunità licheniche epifite.

Acknowledgements. I would like to thank Prof. D. Bertolani Marchetti (University of Modena) who invited me to carry out the present study, Dr. E. Chiessi and the Amministrazione Provinciale di Reggio Emilia for the kind assistence and financial support. The work has been supported also by a CNR grant to "Gruppo Biologia Naturalistica".

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