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The lichens of Italy – a phytoclimatical outline

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SUMMARY

This paper presents a phytogeographic synthesis based on the hitherto available information regarding the lichen flora of Italy, which consists of 2135 infrageneric taxa. Data are provided on the number of species known from 20 administrative regions; the best explored areas are northern Italy, the Tyrrhenian side of the peninsula, and Sardegna. The species have been subdivided into 13 phytoclimatical groups, based on their latitudinal and longitudinal ranges in Europe. The percent occurrences of each group in the total flora, and in the flora of each region have been calculated. The matrix of regions and of phytoclimatical groups has been submitted to classification and ordination. The results indicate that, besides the classical north-south partition of Italy, lichens also show a west-east partition of the peninsula, separating the Tyrrhenian side, with a more pronounced suboceanic climate, from the Adriatic side.

Introduction

The flora of Jatta (1909–1911), the only extant work providing an overview on the lichens of Italy, is strongly outdated, due to the subsequent developments of lichen taxonomy, and to the further lichenological research carried out in Italy during the last 70 years. The first author has prepared an annotated catalogue of the lichens of Italy (3). This is based on the screening of relevant literature, on data gathered by the author, and on the examination of many exsiccata; it includes the distribution of more than 2000 lichen species (excluding lichenicolous fungi) in 20 administrative subdivisions of the country, plus ecological and distributional notes for each species.

The great amount of information contained in the catalogue can be utilized for integrating the large body of phytogeographic knowledge regarding Italy (6, 7) with new data concerning lichens. These organisms differ from higher plants in having much wider distributional ranges; for this reason, a phytogeographic subdivision based on lichen data differs from that based on the distribution of vascular plants; in particular, lichens, being good indicators of relevant climatical factors, such as temperature and air humidity, can provide important informations on the phytoclimatical characteristics of a region (4). In this

paper we try to outline the main phytoclimatical features of Italy, as they appear from the hitherto known distribution of lichens within the country.

Data and Methods

The lichen flora of Italy has been subdivided into 13 phytoclimatical groups, on the basis of the latitudinal and longitudinal distribution of the species in Europe (see results section); this grouping mainly reflects the requirements for temperature and humidity; c. 15% of the species were not assigned to any group, due to insufficient knowledge of their distributional ranges.

Italy has been subdivided into 20 administrative regions (Fig. 1), which were utilized as Operational Geographic Units (OGUs) in the sense of Crovello (2). For each region the hitherto known lichen floras have been compiled, and the percent occurrences of the 13 phytoclimatical groups in the 20 floras have been calculated (Tab. 1).

The matrix of OGUs and phytoclimatical groups has been submitted to numerical classification, using Minimum Variance Clustering, and Cross Product without centering as a resemblance measure, to obtain a phytoclimatical subdivision of Italy based on clusters of regions. The same matrix has been submitted to reciprocal ordering (5) to reveal possible phytoclimatical trends. The analyses were carried out using the package by Wildi & Orloci (8).

In order to evaluate possible ecological differences among phytoclimatical groups, the percent occurrences of species growing on different substrata in the 13 phytoclimatical groups have been calculated (Tab. 2). The substrata are: calciferous rocks, siliceous rocks, calcareous soil, acid soil, acid bark, eutrophic or nutrient-enriched bark.

Results and Discussion

The hitherto known lichen flora of Italy consists of 2135 infrageneric taxa (infraspecific taxa have been used rather seldom, being less than 5% of the total). Most of



		N. of species	Area (Km ²)	Species Km ⁻²
1	VG - Venezia Giulia	431	212	2.033
2	Fr - Friuli	638	7.634	0.084
3	Ven - Veneto	900	18.364	0.049
4	TAA - Trentino-A. Adige	1.272	13.618	0.093
5	Lomb - Lombardia	1.055	23.856	0.044
6	Piem - Piemonte	898	25.400	0.035
7	VA - Valle d'Aosta	503	3.262	0.154
8	Emil - Emilia-Romagna	562	22.123	0.025
9	Lig - Liguria	790	5.416	0.146
10	Tosc - Toscana	921	22.992	0.040
11	Mar - Marche	187	9.693	0.019
12	Umbr - Umbria	47	8.456	0.005
13	Laz - Lazio	557	17.203	0.032
14	Abr - Abruzzi	335	15.232	0.022
15	Sar - Sardegna	1.002	24.090	0.042
16	Camp - Campania	501	19.347	0.026
17	Pugl - Puglia	383	19.347	0.020
18	Bas - Basilicata	216	9.992	0.022
19	Cal - Calabria	629	15.080	0.042
20	Sl - Sicilia	726	25.708	0.028

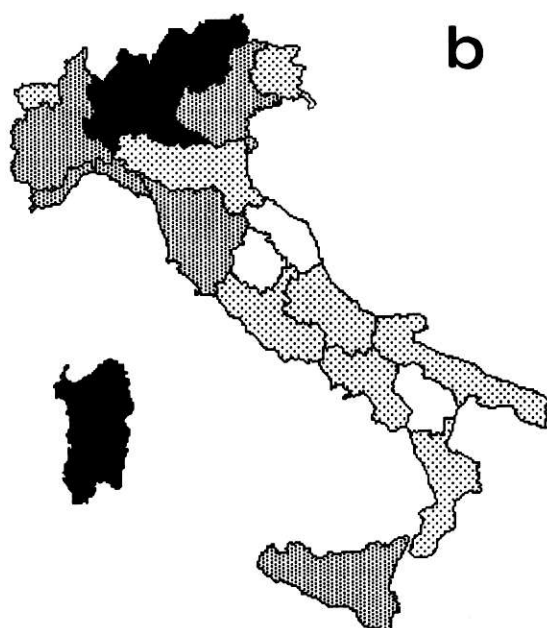
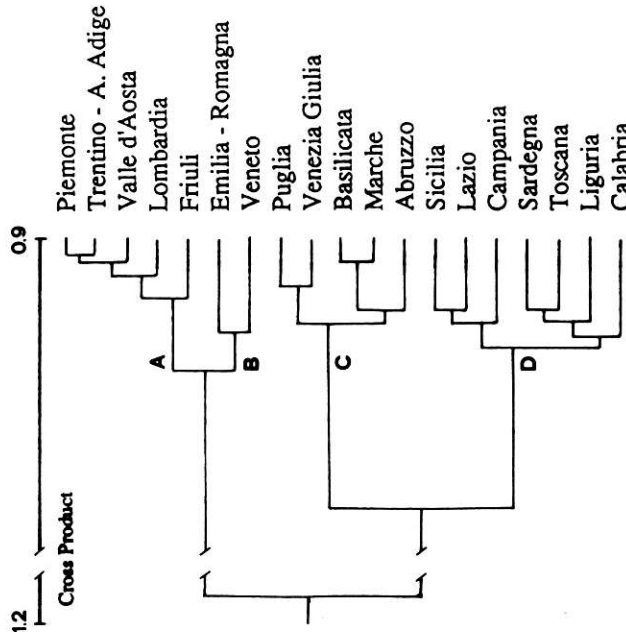


Fig. 1. Subdivision of Italy into 20 administrative regions, numbered as in the table (a); intensity of floristic exploration, expressed in terms of numbers of species per region (b), and per surface area (c); the data of the table have been subdivided into four classes.

Tab. 1. Percent occurrences of the 13 phytoclimatic groups in the 20 regions of Italy, grouped according to the dendrogram (see main text).

		Arctic - Alpine	Boreal - Montane	Northern Temp.	Southern Temp.	Widespr. Temp.	Submediterranean	Mediterranean	Southern Oroph.	Oceanic	Northern Subal.	Southern Subal.	Widespr. Subal.	Xeroph.
Italy		11.8	13.4	10.5	4.9	13.3	9.6	7.9	7.0	1.6	3.6	7.4	7.0	2.0
Piemonte		16.7	16.4	14.4	6.9	21.6	6.6	0.7	4.0	0.2	4.2	2.0	4.7	1.6
Trentino - A. Adige		16.0	17.6	13.0	6.2	18.4	7.9	1.7	6.7	0.3	3.5	1.8	5.3	1.6
Valle d'Aosta		17.8	17.3	12.4	6.1	25.5	4.7	1.2	5.4	0.0	2.6	0.5	4.0	2.8
Lombardia		16.1	16.6	15.2	6.6	20.7	8.0	1.2	1.2	0.4	2.9	3.0	6.5	1.6
Friuli		12.2	17.0	14.8	6.4	25.0	6.6	0.4	4.7	0.0	5.2	2.0	5.4	0.4
Emilia - Romagna		6.2	10.2	13.5	8.3	30.9	10.2	1.7	3.5	0.0	2.9	3.3	8.3	1.0
Veneto		8.7	13.2	13.9	8.2	24.2	12.2	1.5	2.5	0.4	2.9	3.3	8.7	0.5
Puglia		0.3	2.0	11.0	11.9	36.8	12.7	5.1	0.8	0.0	2.2	7.6	8.8	0.6
Venezia Giulia		0.0	3.2	10.0	13.8	35.6	20.9	3.2	0.5	0.0	0.7	3.4	7.4	1.2
Basilicata		0.5	4.2	10.6	9.7	47.7	9.2	3.2	0.9	0.5	1.4	3.7	8.3	0.0
Marche		2.0	8.2	11.2	10.7	42.9	6.6	1.0	0.5	0.5	4.1	5.1	7.1	0.0
Abruzzo		4.8	6.0	11.5	10.8	37.6	10.2	1.0	1.3	0.3	2.2	4.5	9.6	0.3
Sicilia		1.9	5.4	11.2	9.0	26.9	10.7	8.9	1.4	1.3	1.8	9.8	10.1	1.6
Lazio		0.6	2.9	10.5	9.1	30.7	11.8	7.4	0.6	1.0	1.4	13.0	10.5	0.6
Campania		1.3	5.5	13.1	10.1	33.1	10.7	3.6	0.6	0.2	1.9	8.9	10.1	0.8
Sardegna		3.9	8.4	11.0	7.3	19.4	10.4	12.1	3.2	1.3	2.2	10.2	7.9	2.6
Toscana		2.4	7.4	11.5	7.6	22.7	11.0	8.1	1.3	1.4	3.3	11.4	10.8	1.2
Liguria		3.1	7.7	10.3	9.1	24.9	12.7	6.8	2.2	0.4	2.1	9.6	8.9	2.1
Calabria		2.6	8.0	13.6	7.5	26.2	9.8	5.1	1.9	0.5	3.3	9.9	11.2	0.3

Tab. 2. Percent occurrences of the species belonging to the 13 phytoclimatic groups on different types of substrata, and number of species of each group.

	Arctic - Alpine	Boreal - Montane	Northern Temp.	Southern Temp.	Temperate	Submediterranean	Mediterranean	Southern Oroph.	Oceanic	Northern Subal.	Southern Subal.	Subatlantic	Xeroph.	
Calc. rock	13.2	6.6	11.9	45.2	22.7	52.5	19.2	41.8	0.0	2.9	9.9	3.0	5.3	374
Sil. rock	42.9	36.2	33.3	11.8	20.0	18.6	55.0	40.3	29.0	25.0	22.0	18.8	57.9	594
Acid bark	1.3	37.0	40.3	9.7	28.2	12.6	8.6	8.2	64.5	64.7	57.4	63.2	5.3	538
Eutroph. bark	0.4	0.4	2.0	18.3	14.1	11.5	5.3	0.0	0.0	0.0	5.0	3.8	0.0	100
Calc. soil	15.9	6.2	5.0	10.8	6.3	4.9	6.6	3.7	0.0	0.0	1.4	1.5	26.3	126
Sil. soil	26.1	13.6	7.5	4.3	8.6	0.0	5.3	6.0	6.5	7.3	4.2	9.8	5.3	179
Italy	226	257	201	93	255	183	151	134	31	68	141	133	38	1911

the species (50.6%) are preferentially saxicolous (31.1% on siliceous rocks, 19.5% on calciferous rocks). Epiphytic species (33.4%) occur mostly on acid substrata; only 5.3% prefer eutrophic or nutrient-enriched bark. Muscicolous and terricolous species are 16% of the total (6.6% on calcareous substrata, 9.4% on acid substrata). Compared with other European countries, Italy appears as a lichenologically rich country; this is due to its latitudinal extension through two bioclimatical zones (southern Temperate and Mediterranean), to the presence of cold orobiomes throughout the country, and to the wide variety of geological substrata.

The degree of lichenological exploration is far from being homogeneous (Fig. 1); northern Italy, with 1828 species, has been better explored; 1282 species are known for central Italy (including Sardinia), and only 995 for southern Italy. The best known region is Trentino-Alto Adige (South Tyrol), with 1212 species, the less explored is Umbria, with only 46 species. The Adriatic regions of the Peninsula have been investigated much less than the Tyrrhenian regions.

Fig. 2 shows the incidence of the 13 phytoclimatical groups in the 20 regional floras (data from Tab. 1). In the following, each group will be briefly commented on.

Group 1) Arctic-Alpine – species of the Arctic zone and of the Alpine (subalpine) belts of the European mountains. In Italy they are mostly bound to acid substrata, such as siliceous rocks (42.9%), and acid soil (26.1%). They make up 11.8% of the Italian lichen flora, and 16–18% of the floras of the central and western Alpine regions, where siliceous substrata are more common; they are much less frequent south of the Alps, with somewhat higher values in Abruzzi (4.8%), the region with the highest peaks of the Apennines.

Group 2) Boreal-Montane – species of the boreal zone, and of the oroboreal belt of the central and southern Euro-

pean mountains. They also are mostly bound to acid substrata, such as siliceous rocks (36.2%), acid bark and lignum (37%) and acid soil (13.6%); only 6.6% occurs on calcareous rocks. This element, which represents 13.4% of the Italian flora, is best represented in all regions of the north (16–17%), except Veneto (13.2%), that has the narrowest extension of mountain areas. Its importance decreases sharply southwards, but in Calabria, a humid, mountainous region, this element still reaches 8% of the flora. The sharp decrease, starting from the northern Apennines of Liguria and Emilia, corresponds well with the southern limit of the oroboreal vegetation belt dominated by *Picea abies*.

Group 3) Northern Temperate – species occurring from Central and southern Scandinavia to the Mediterranean mountains, and mostly bound to areas with beech forests as climax vegetation. They also tend to prefer acid substrata, such as acid bark (40.3%) and siliceous rocks (33.3%). This element constitutes 10.5% of the total flora, and is rather equally distributed throughout Italy (10–15% of the regional floras), with somewhat higher values in the northern regions; the percent values in the regional floras are generally higher than the value relative to the Italian flora, which indicates that these are widespread and common species.

Group 4) Southern Temperate – species extending from Central Europe to the lower mountains of the Mediterranean zone, and mostly bound to areas with zonal vegetation dominated by deciduous oaks; some occur also in southern Scandinavia, where, however, they are rare, and confined to relatively warm situations. Contrary to the previous elements, this tends to be most frequent on sub-neutral to basic substrata, such as calcareous rocks (45.2%), eutrophic bark (18.3%) and calcareous soil (10.8%). Although constituting only 4.9% of the Italian flora, this element is important in the central and southern

regions, especially on the Adriatic side of the Peninsula, which has less pronounced suboceanic conditions (more than 10% of the regional floras); its importance is obviously lower in the Alpine regions.

Group 5) Widespread Temperate – this is a rather heterogeneous group; it includes both species extending from the Arctic to the Mediterranean zones, and species

ranging from southern Scandinavia to the Mediterranean zone, with a wide altitudinal range, being present both in areas with beech forests and in those with deciduous oak forests. They show a slight preference for acid conditions, but many occur also on subneutral to basic substrata. This group constitutes ca 13% of the Italian flora, just as the Boreal-montane element, but its incidence in the regional



ARCTIC - ALPINE



BOREAL - MONTANE



NORTHERN TEMPERATE



SOUTHERN TEMPERATE



WIDESPREAD TEMPERATE



SUBMEDITERRANEAN



SOUTHERN EUROPEAN OROPHYTES



MEDITERRANEAN



OCEANIC

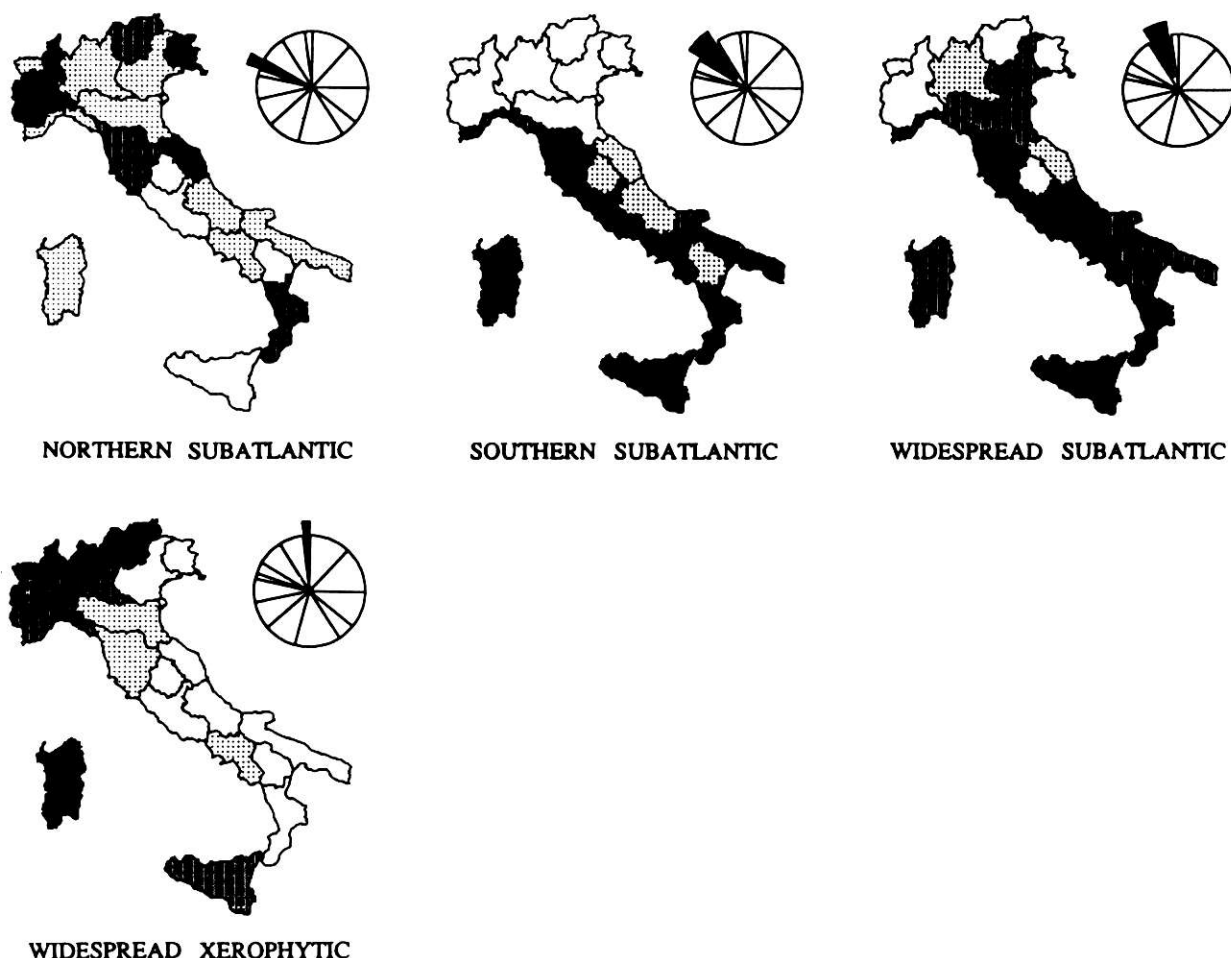


Fig. 2. Incidence of the 13 phytoclimatic groups in the 20 regions of Italy. The data of Tab. 1 have been subdivided into 4 classes. The percent of each group on the total flora of Italy is also indicated. For further details see main text.

floras is much higher, which indicates the presence of many common and widespread species; it has somewhat lower values in the Alpine regions of the north (18.4–25.5%), and higher values in lowland regions (e.g. Venezia Giulia, 35.6%) or in regions whose mountain flora has been not yet fully explored (Marche, 42.9% and Basilicata, 47.7%). It is remarkable that in Sardinia, a rather well-explored region, this element is only 19.4% of the local flora.

Group 6) Submediterranean – species ranging from southern Central Europe to the lower mountains of the Mediterranean zone (rarely with isolated outposts in warm areas of Central Europe); most of them (52.5%) occur on calciferous rocks, and there is no species growing on acid soil. This element constitutes 9.6% of the Italian flora, and 10–12% of the regional floras, with two exceptions: a) the Alpine regions of northwestern Italy (generally less than 10%), and b) the Venezia-Giulia region, a typically submediterranean, calcareous area with altitudes not exceeding 500 m (more than 20%).

Group 7) Southern European orophytes – species limited to upland areas of southern Central and southern

Europe, absent from Scandinavia. This group (7.9% of the Italian flora) includes several poorly known taxa; most of them are saxicolous, both on calcareous (41.8%) and siliceous (40.3%) substrata. Of course, they are most frequent in the Alpine regions, reaching more than 5% of the floras of South Tyrol and Valle d' Aosta, two regions which are mainly occupied by mountains.

Group 8) "Mediterranean" – this category is the most difficult to define. Whereas there are many species of vascular plants limited to parts of the Mediterranean region dominated by evergreen sclerophyllous vegetation, this case is extremely rare for lichens. Of course, there are several species which are more frequent in Mediterranean Italy than in other, climatically different parts of the country. However, in most cases their distributions are not limited to areas with a typical Mediterranean climate. Several "pseudomediterranean" taxa are actually southern European suboceanic lichens with a much broader range in tropical and subtropical regions, others are widely distributed in arid and semi-arid biota, encompassing several vegetation zones (1); a few "Mediterranean" species (e.g. *Physconia venusta*) are very rare within eu-Mediterranean

vegetation, being restricted to humid situations on the Mediterranean mountains. The species which could be most rightly called as “Mediterranean” have a Macaronesian-Mediterranean range; however, they are often difficult to distinguish from the southern subatlantic element. To these, a few species could be added, which have a broad disjunction, occurring in Mediterranean Europe and in other parts of the world with a Mediterranean climate (especially in California). On the whole, there is a sharp contrast between the richness of the Mediterranean phanerogamic flora, and the scarcity of truly Mediterranean lichens. This could be due to two main reasons: a) a summer drought period does not represent a sufficient selective pressure for the evolution of a truly Mediterranean lichen flora; b) the evolution of a Mediterranean climate-type in southern Europe is too recent for the evolution of a specialized lichen flora. Here, the category “Mediterranean” includes: a) several poorly known, especially silicolous coastal species, restricted to the Mediterranean region; b) all species with a Mediterranean-Macaronesian range not bound to a particularly humid climate; they mostly occur on siliceous substrata (there are no limestone outcrops in Macaronesia); c) a few species extending in different parts of the world with a Mediterranean climate. In Italy the “Mediterranean” element constitutes 7.9% of the flora, with highest incidence in the Tyrrhenian regions, from Liguria to Sicilia; the maximum is reached in Sardegna (more than 12%).

Group 9) Oceanic – these are strictly oceanic species, bound to a very humid climate, which in Europe are most frequent near the Atlantic coasts, and have scattered, rare occurrences in the most humid parts of the Mediterranean region. They are only 1.6% of the Italian flora, and are more frequent along the Tyrrhenian coasts, from Liguria to the islands surrounding Sicilia, and on the most humid mountains of the Peninsula and of the islands; most of them (64.5%) are epiphytic in primeval forests, many are very rare, and in danger of extinction.

Group 10) Northern subatlantic – species widespread in northwestern Europe, scattered in upland areas of southern central and southern Europe with a cold-humid climate; most of them are epiphytic (64.7%), the rest either occurs on siliceous rocks (25%) or on acid soil (7.3%). In Italy this element, which is only 3.6% of the total flora, occurs mostly in humid montane forests, both in the oroboreal belt of the Alps (where it is less frequent), and in humid beech forests, up to the mountains of Sicilia. It is somewhat more frequent in the north, especially in Friuli (5.2%), the Alpine region with the most pronounced cool-oceanic climate.

Group 11) Southern subatlantic – species whose ranges are centered in the parts of central and southeastern Europe with a suboceanic climate; in Italy they normally occur below the montane belt; many have subtropical or even tropical affinities. Also in this case, most of the species (57.4%) are epiphytic. This element makes up 7.4% of the Italian flora; it is very poorly represented in the more continental Alpine regions (1.8% in South Tyrol, 0.5% in Val d’Aosta), but it approaches 10% of the floras in all Tyrrhenian regions, from Liguria to Sicilia, being more

frequent in the lowlands near the coasts. Also in this group several species are rapidly declining, due to the destruction of the natural vegetation along the coasts.

Group 12) Widespread subatlantic – species whose ranges are centered in all parts of Europe with a suboceanic climate, with a rather broad latitudinal, and especially altitudinal range. In Italy they occur from the lowlands to the montane belt, and are mostly epiphytic, on acid bark (63.2%). This element makes up only 7% of the Italian flora, but includes several species which are very characteristic of the Tyrrhenian regions (up to more than 10% of the floras); the lowest incidence is in the central and western Alpine regions with a more continental climate.

Group 13) Widespread xerophytic – species with very wide ranges in arid to semi-arid regions. They are not an important part of the flora of Italy (2%), a country where truly arid climates are generally rare, even in the south.

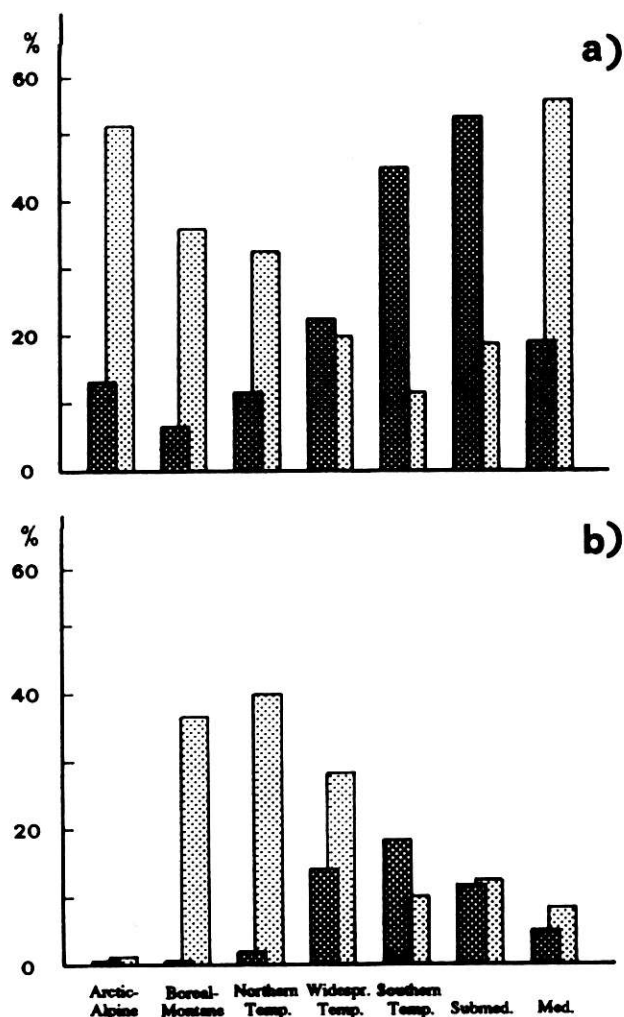


Fig. 3. Percent occurrences of some phytoclimatic groups, ordered according to decreasing latitudinal extension, on acid (light-shaded) and neutral-basic (dark-shaded) substrata; a) rocks, b) bark.

This element is somewhat more frequent in Valle d' Aosta, because of the local continental climate, and in Sardegna (mostly in some arid valleys of the Gennargentu Massive).

The ecological requirements of the phytogeographic elements are illustrated in Tab. 2, which reports the percent occurrences of the species of each group on different types of substrata. Fig. 3 shows that there is a clear acidity gradient from the south to the north: northern species tend to be most frequent on acid substrata, southern species on neutral or basic substrata; the only exception are the "Mediterranean" species, which are mostly bound to siliceous substrata; this, however, is mainly due to the fact that these species have mainly a Mediterranean-Macaronesian distribution, and that in Macaronesia the substrata are mainly siliceous.

The dendrogram of the regions, based on the phytogeographic spectra, is reported in Tab. 1; 4 main groups of regions are formed (A, B, C, D, see Fig. 4). The reciprocal ordering of regions and phytoclimatic elements is shown in Fig. 5. The regions are ordered along a typical horse-shoe in the space defined by the first two canonical variates, and almost all phytogeographic groups seem to be well related with a phytogeographic gradient, from the regions of the north to the Tyrrhenian regions, as follows:

Group A) *Alpine*: Friuli, Trentino-Alto Adige, Lombardia, Piemonte, Val d' Aosta. This group has obviously the highest incidence of northern species (Arctic-Alpine, Boreal-montane, and northern temperate elements); the most representative spectra of Alpine lichen floras are those of South Tyrol and Val d' Aosta. Group B) *intermediate*: Veneto and Emilia: the spectra are intermediate between those of groups A) and C); both regions are mainly oc-

cupied by lowlands and low hills; the northern part of Veneto hosts calcareous mountains (Dolomites), the southern part of Emilia is occupied by the northern Apennines. Group C) *submediterranean - Adriatic*: Venezia Giulia, Marche, Abruzzi, Puglia, Basilicata. These regions have the highest incidence of submediterranean and temperate species, whereas northern and western species are poorly represented. The most typical spectrum of a submediterranean region is that of Venezia Giulia. Group D) *Tyrrhenian*: Liguria, Toscana, Lazio, Campania, Calabria, Sardegna, Sicilia. The Tyrrhenian flora is characterized by the highest incidence of southern subatlantic, oceanic and "Mediterranean" species. The most representative spectra are those of Toscana and Sardegna.

The good separation of the Alpine part of Italy as an independent district corresponds well with the informations provided by the phanerogamic flora, whereas the east-west partition of the peninsula is much more clear in the case of lichens than in that of vascular plants, chiefly because the former are much more sensible to variations in air humidity.

Summarizing, the high lichen diversity of Italy is due to: A) a mainly temperate lichen flora without particular suboceanic affinities which is well represented in all regions (ca. 38% of the total, groups 4–6). B) a suboceanic to oceanic flora with subtropical affinities, bound to humid climates, which is most frequent along the western side of the Peninsula, in Liguria and in Sardegna (ca. 20% of the total, groups 9–12). C) a northern flora restricted to the highest mountains, most frequent on the Alps, and becoming progressively rarer southwards (ca. 25% of the total, groups 1–3). D) a rather poorly defined set of species whose hitherto known distribution is limited to the southern European mountains, which in Italy is found mostly in the Alps (7% of the total, group 7). E) another poorly defined element restricted to the lowlands and lower mountains of the Mediterranean region, sometimes extending to Macaronesia and to other Mediterranean areas of the world, which in Italy has a mainly Tyrrhenian distribution (ca. 7% of the total, group 8). F) a small set of widespread xerophytic species, occurring in the most arid parts of Mediterranean Italy (Sardegna, Sicilia), and in the driest parts of the central and western Alps (2% of the total, group 13). This picture reflects fairly well the climatic diversity of the country, from cold-alpine to warm-suboceanic climates, with a prevalence of warm-temperate, moderately humid climates, and with an overall scarcity of truly arid climate-types, despite the summer drought period of some regions of the south.



Fig. 4. Subdivision of Italy based on the results of the dendrogram shown in Tab. 1.

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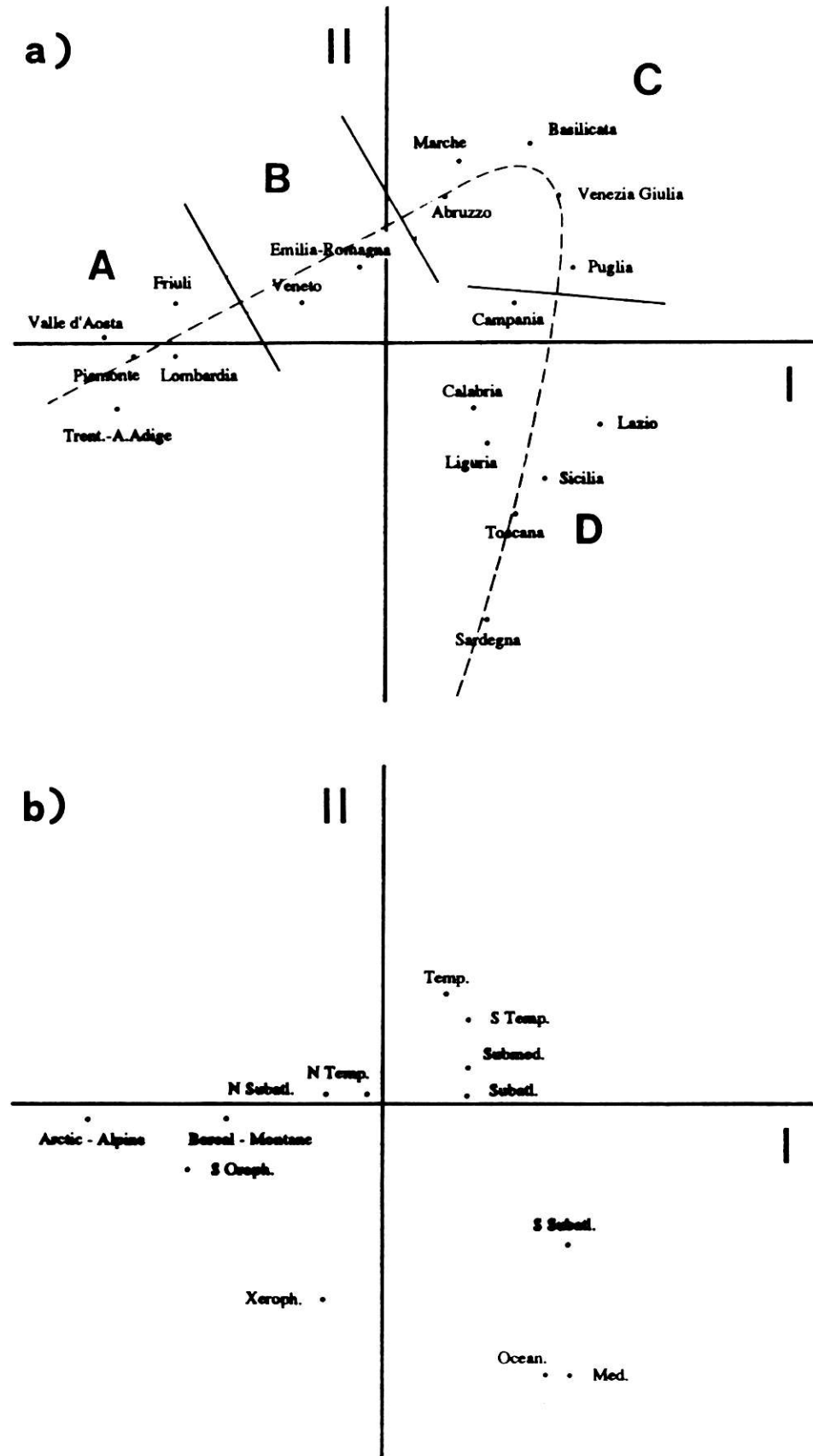


Fig. 5. Reciprocal ordering of the 20 regions (a) and of the 13 phytoclimatical groups (b), based on the data of Tab. 1.

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Key words: Flora, Italy, Lichens, Phytogeography.

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