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Chemistry and chorology of the genus Parmotrema Massal. (Lichenes, Parmeliaceae) in Italy *

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Chemotassonomia e corologia del genere Parmotrema (Licheni, Parmeliacee) in Italia. — 183 campioni di licheni appartenenti al genere *Parmotrema* raccolti in territorio italiano sono stati sottoposti a revisione sulla base di caratteri chimici e morfologici. L'analisi chimica è stata basata su tre tecniche principali: test cristallografici, cromatografia su strato sottile, cromatografia liquida ad alta risoluzione. I risultati hanno permesso di accertare la presenza di sette specie di *Parmotrema* nel territorio italiano e di determinarne i tipi di distribuzione. Esse sono: *P. arnoldii, P. crinitum, P. hypoleucinum, P. perlatum, P. reticulatum, P. robustum* e *P. stuppeum.* Tutte le specie presentano un massimo di frequenza in aree a clima suboceanico (in particolare lungo il litorale tirrenico e nella regione insubrica). La maggior parte sembra essere in forte regresso in Italia in conseguenza dell'azione antropica. I risultati dell'analisi chimica quantitativa (mediante HPLC) hanno permesso di rilevare una serie di sostanze nuove per le varie specie, presenti per lo più in piccole quantità.

Key words: Italy, Lichens, *Parmotrema.*

The large genus *Parmelia* Ach. (*Lichenes, Parmeliaceae*) has been recently split up into smaller genera, such as *Bulbotrix, Parmelina, Relicina, Xanthoparmelia* (Hale, 1974, 1976b), *Pseudoparmelia* (Hale, 1976a), *Allantoparmelia, Melanelia, Neofuscelia* (Esslinger, 1977, 1978), and *Parmotrema* (Hale, 1965, 1974). In our opinion, this splitting is not always justified, and we rather follow the opinion of Poelt & Vezda (1981), who leave the European species under *Parmelia*, with the exception of those included in *Allantoparmelia* and *Parmotrema.* The latter genus has been monographed by Hale (1965). At that time, the group was considered as subgenus *Amphigymnia* of the genus *Parmelia.* According to Hale (1965, see also Lawrey, 1980), *Parmotrema* includes around 180 species. They are primarily tropical, although approximately 15% are also found in temperate regions. The chemistry of the group has been investigated by Hale (1965) who reports a list of 23 different lichen substances. Eleven species are known from Europe (including Azores, Poelt &

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VEZDA, 1977). With a single exception, they are all secondary species (sensu POELT, 1970), in which sexual reproduction has been replaced by vegetative dispersal by means of soredia or isidia. This fact has been interpreted by LAWREY (1980) as a possible means of facilitating lichenization in habitats in which suitable algal-host diversity is low (see also TEHLER, 1982). The distribution of the single species in Europe is rather well known in Western Europe, whereas only few data are available for the southern part of the continent. All of the European *Parmotrema* — species are considered as being more or less western. The available distribution maps regard only *P. arnoldii, P. crinitum, P. perlatum* and *P. reticulatum* in the British Isles (SEAWARD & HITCH, 1982), *P. arnoldii* and *P. crinitum* in Scandinavia (DEGELIUS, 1935), and *P. perlatum, P. arnoldii, P. crinitum* in the Alps (SCHAUER, 1965).

As far as Italy is concerned, most of the available information dates back to the previous century, when the whole group was poorly understood. Of the 11 European species, 6 have been reported from Italy (3 of them in recent years, see HALE 1965), i.e. *P. arnoldii, P. crinitum, P. hypoleucinum, P. perlatum, P. reticulatum* and *P. stuppeum*. Most of them were known from a single locality, with the exception of *P. perlatum*, about which the literature reports, however, are rather dubious. After checking *Jatta*'s material in the Herbarium of Napoli, we discovered that he frequently confused *P. perlatum* with *Cetrelia cetrarioides* and less often with *P. reticulatum*, a rather disturbing fact, since he identified lichens for several other Italian lichenologists who where publishing floristic lists in the second half of the previous century.

During this century, the most valuable collections are those of SBARBARO (1956, specimens of Sbarbaro also cited by HALE, 1965). As a result, the knowledge of the whole group in Italy is extremely scanty.

The aim of this paper is a revision of the genus *Parmotrema* within the Italian territory, and the establishment of distribution patterns for the various species, in order to attain a better understanding of their chorology in the southern part of Europe, an area for which very little information is available in the literature.

The interest of the authors in lichen substances is also due to the fact that many of them have pharmacological properties. Some are well documented, such as the antibiotic activity against pathogenic bacteria and fungi. More recently, studies have been carried out on the antitumor activity of the polysaccharide components of lichens and of psoromic acid (NISHIKAWA et al., 1970; TAKAHASHI et al., 1974; NISHIKAWA et al., 1974). It seems also that some lichen polysaccharides have strong activating effects on macrophages and an inductive effect on interferon production (WAGNER, 1981). These substances, whose study is still in progress, could become an alternative for the chemotherapy and prophylaxis of infections and malignant tumors.

Materials and methods

Altogether, 183 herbarium specimens have been analyzed. They were from the following herbaria: Trieste (TSB, Herb. Nimis), Udine (MFU), Padova (PAD), Bologna (BOLO), Modena (MOD), Torino (TO), Genova (GDOR), Pavia (PAV), Firenze (FI), Roma (RO), Napoli (NAP), Cosenza, Palermo (PAL).

In order to interpret correctly the distribution maps of the various species, it must be pointed out that the extent of sampling differs considerably in different parts of Italy. The regions in which sampling is lowest are: Lombardy, Puglia (with exception of the Gargano Peninsula), Basilicata and Sicily. The list of specimens with locality quotation is in the appendix.

All the samples have been analyzed by thin layer chromatography (TLC). The chemical analysis followed the standard method for TLC of lichen substances discussed by CULBERSON & AMMAN (1979). The TLC method, however, does not always allow a good separation of the homologous depsides of the β- orcinole series (CULBERSON & CULBERSON, 1978; CULBERSON et al., 1979). In dubious cases we analyzed the samples by High-Performance Liquid Chromatography (HPLC). Thallus fragments (0.1 g) were extracted with warm (38 °C) acetone (10 ml) for 24h, filtrated, lyophilized, redissolved in 10 ml of pure methanol and refiltered. 5 µl were chromatographed on a 250 × 4 mm Biosil ODS-5S column with methanol- water- acetic acid mobile phases of 85:14:11 v/v/v/ at 1 ml/min at 500 psi. A Spectra-Physic (mod. SP 8700) liquid chromatograph equipped with a SP8440 Autocontrol UV-visible detector and a Mega Ser. Integrator data station was used. Detection wavelength: 254 nm. The amounts of lichen substances were obtained as relative percentages. The limit of detection was 0.003-0.004 µg, as the standard deviation of the linear regression, and the reproducibility of determination ranged within ± 2-5%. Microchemical crystal tests were also performed in some cases. The crystal tests were made according to the directions given by ASAHINA (1940) and EVANS (1943). Test substances for chromatographic analysis have been obtained by samples distributed in the exiccata of A. Vezda.

Results

The morphological and chemical analyses provided the means of recognizing 7 species of *Parmotrema*. They are: *P. arnoldii, P. crinitum, P. hypoleucinum, P. perlatum, P. reticulatum, P. stuppeum* and *P. robustum*. The latter species is new to the lichen flora of Italy.

The results of the quantitative analyses, with the retention times (HPLC) for the lichen substances found in the 7 species are reported in tab. 1. The use of HPLC provided confirmation of the presence of the most abundant substances present in each species as known from the previous literature, and showed the presence of further substances, occurring at much lower concentrations.

In the following, chemistry, ecology and distribution of each species are briefly discussed. Nomenclature follows POELT & VEZDA (1977), who also provide a key to the European species of the genus.

Parmotrema arnoldii (DR.) Hale

The substances with highest concentration in the thalli of *P. arnoldii* are: alectoronic acid, α-collatolic and usnic acids. Atranorin, hypostictic, connor-

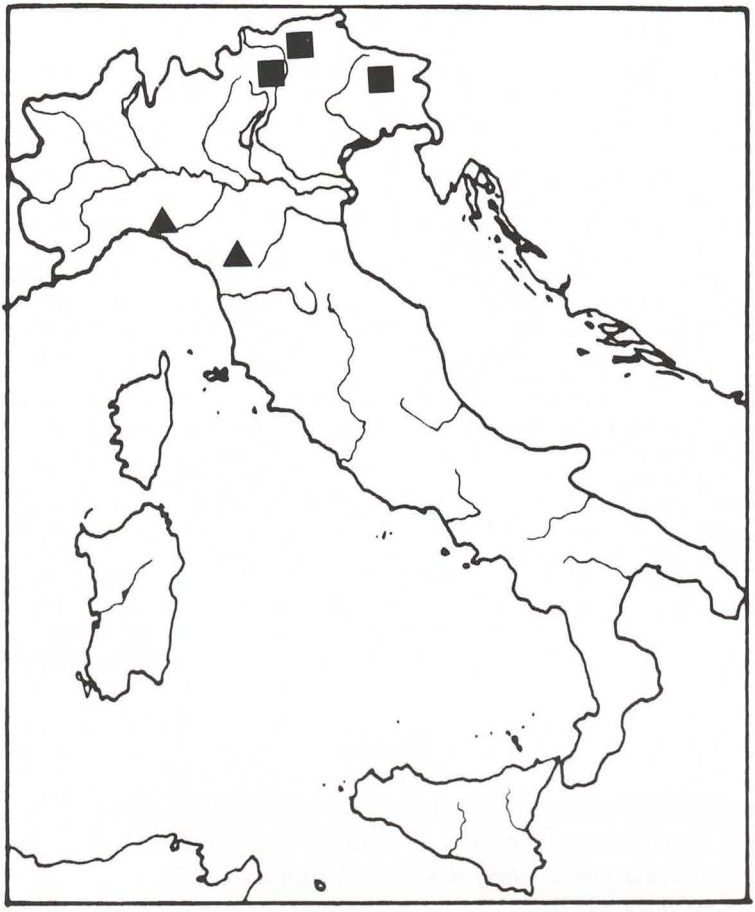

Fig. 1. - Distribution of the samples of *P. arnoldii* (quadrat) and *P. robustum* (triangles) in Italy.

stictic and norstictic acids do also occur in lower concentrations: these acids were never recorded in this species (CULBERSON, 1979). No traces of rhodophyscin, lecanoric and salazinic acids have been found by us: they were reported for this species by HALE (1965, rhodophyscin) and by SHAH (1954).

Parmotrema arnoldii is the rarest species of *Parmotrema* in Italy (fig. 1). It is known from two localities in South Tyrol and a single locality in the Carnic Alps, the Lake of Sauris, where it was first collected in a few specimens growing on the mossy bark of *Fagus, Abies* and *Salix* in a very humid site just above the Lake. During 1986 many old beech trees were cut in the same area: *Parmotrema arnoldii* proved to be one of the dominant and most common species between 4 and 12 meters high up on the boles. Such a kind of vertical

distribution is probably due to microclimatical variation within the forest, and is the cause of the apparent rarity of the species in that area. Its total distribution (HALE, 1965) includes Central, North and South America, and the Canary Islands (NIMIS, specimens in TSB). In Europe this species ranges from South Scandinavia (DEGELIUS, 1935), West England and West Ireland (SEAWARD & HITCH, 1982) to West France (DES ABBAYES, 1931, 1934) extending eastwards with isolated outposts in the northern Alps (FREY, 1959; ARNOLD, Lich. Monac. 492; SCHAUER, 1965: several localities and distribution map) up to the Carpathian Range (POELT & VEZDA, 1977). According to DES ABBAYES (1931) the species is common in Brittany, absent from the rest of France; the same applies for the British Isles, where it is rare, and confined to sites located along the western coasts (SEAWARD & HITCH, 1982). The species seems to be even more rare in Southwestern Europe (not cited in TAVARES, 1945), with just two reports from the mountains of Cantabria and Galicia, in Spain (SCHAUER, 1965). It seems that *P. arnoldii* could be considered as a relict species in Europe, since it is strongly menaced by air pollution and the destruction of old, natural woods with very humid microclimate, which are its optimal habitat.

Parmotrema crinitum (Ach.) Hale

The lichen substances present in the thalli of *P. crinitum* with highest concentration are: norstictic, hypostictic and menegazziaic acids. The following substances were also present in smaller concentrations: atranorin, connorstictic, cryptostictic, usnic, fumarprotocetraric, and physodalic acids. Until now, this species was known to contain only stictic acid, atranorin, pilosellic acid and salazinic acid (CULBERSON, 1979). Pilosellic acid was identified as stictic acid by HUNECK et al. (1973). Our results do not agree with the literature reports as far as the most abundant substance is concerned: stictic acid was present only in traces, whereas the most abundant substance was norstictic acid, which was not known from *P. crinitum*. The two substances, however, are difficult to separate by TLC. The retention times of the two substances in HPLC are very different.

P. crinitum is the only isidiate representative of the genus in Europe, and it was considered as the isidiate counterpart of *P. perlatum*, with a similar chemical content (prevalence of stictic acid). Notwithstanding the presence of norstictic acid recorded by us in *P. crinitum*, the two species are rather similar as far as their total chemical content is concerned (prevalence of stictic acid derivatives, see tab. 1). Its total distribution encompasses all of the four continents (HALE, 1965), with a broad climatical range, from tropical areas to temperate and even subboreal forests (DEGELIUS, 1935). In Europe the species

TAB. 1 — Quantitative composition (relative %) of the lichen substances contained in the thalli of the seven italian species of *Parmotrema*, analyzed by HPLC. tr = Retention Time. The unidentified substance is a derivative of protocetraric acid. The α- collatolic acid is present in two tautomeric forms.

SUBSTANCES	tr in min	P. perlatum	P. crinitum	P. reticulatum	P. arnoldii	P. robustum	P. hypoleucinum	P. stuppeum
Hypostictic acid	9.09	30.24	34.12	16.90	0.32	0.61	18.16	1.55
Hyposalazinic acid	9.77	—	—	—	—	—	—	—
Norstictic acid	10.16	35.22	30.56	—	2.17	0.92	30.36	21.65
Connorstictic acid	11.85	3.64	2.57	51.97	0.87	4.80	2.98	0.88
Cryptostictic acid	12.85	5.53	2.65	—	—	—	—	0.49
Atranorin	13.14	5.38	4.68	3.11	0.88	75.95	2.88	7.37
Usnic acid	14.20	0.87	1.85	0.83	17.36	1.24	37.67	—
Stictic acid	14.80	17.88	traces	1.07	—	2.08	1.66	—
Fumarprotocetraric acid	16.34	—	8.05	—	—	12.48	—	—
α-collatolic acid	16.77	—	—	—	8.76	—	—	—
α-collatolic acid	17.07	—	—	—	26.60	—	—	—
Salazinic acid	16.88	—	—	25.93	—	—	—	62.43
Protocetraric acid	18.25	—	—	—	—	1.92	2.62	—
Physodalic acid	20.26	1.02	1.35	0.16	—	—	3.45	2.14
Menegazziaic acid	21.32	—	13.15	—	—	—	—	—
Alectoronic acid	21.70	—	—	—	44.82	—	—	—
Unknown substance	26.50	0.22	1.02	—	1.98	—	—	3.08

ranges from Southernmost Scandinavia to Portugal (DEGELIUS, 1935). It is much more frequent in the western part of the continent, where it occurs also in lowlands (HARMAND, 1909; DU RIETZ, 1924; TAVARES, 1945; CLAUZADE & RONDON, 1953), and extends eastwards up to Poland (MOTYKA, 1926), the Carpathian Range and Transylvania (SUZA, 1933; SULMA, 1938), with scattered outposts in the mountains. There are several reports from the Southwestern and Northeastern Alps (FREY, 1959; SCHAUER, 1965, with distribution map). In Italy the species is rare, and its range (fig. 2) is restricted to the northern part of the country, along the outer prealpine chains with suboceanic climate and in the Ligurian Apennines. It is found both on the mossy bark of old trees in mature, humid beech forests, and on epilithic mosses.

Parmotrema hypoleucinum (Steiner) Hale

Usnic, norstictic and hypostictic acids are the three substances present in the highest concentration. Lower quantities of connorstictic, stictic, protoce-

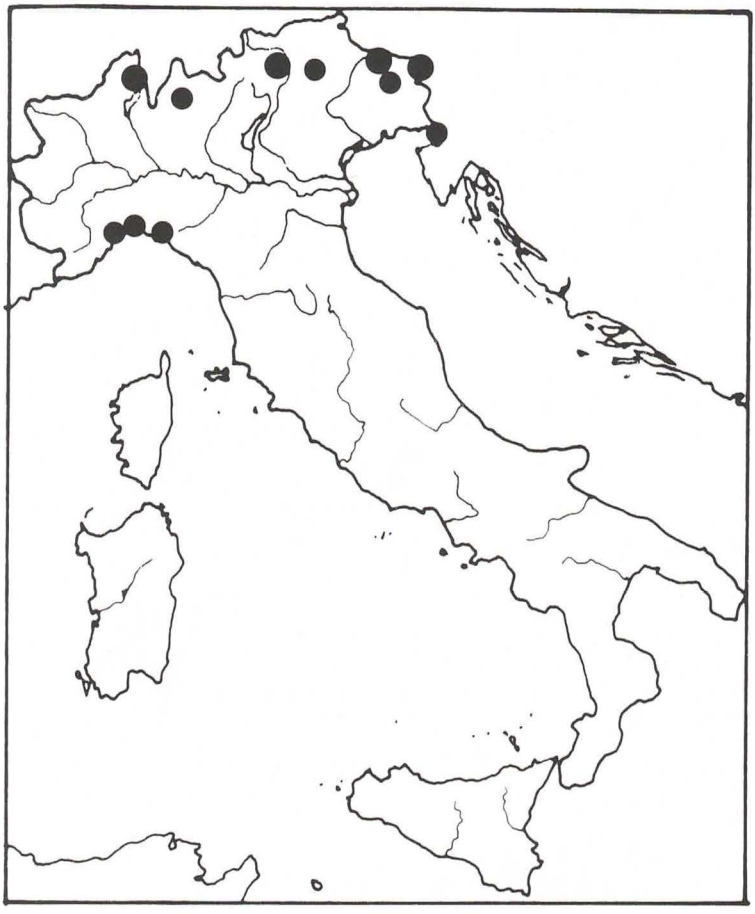

Fig. 2. - Distribution of the samples of *P. crinitum* in Italy.

traric and physodalic acids do also occur. The relatively high quantities of usnic acid are somewhat surprising, since this substance was never reported to occur in this species.

P. hypoleucinum belongs to the *P. perforatum* — group, which has recently been revised by CULBERSON & CULBERSON (1973). Formerly, this was considered as the sorediate counterpart of the sexual species *Parmelia perforata*, under the name of *Parmelia hypotropa*. CULBERSON & CULBERSON (1973) proved that *Parmelia perforata* can be divided into two morphologically similar taxa differing in chemistry and distribution, i.e. *P. perforata* s. str. and *P. preperforata* (CULBERSON, 1973); *Parmelia hypotropa* can be also subdivided into

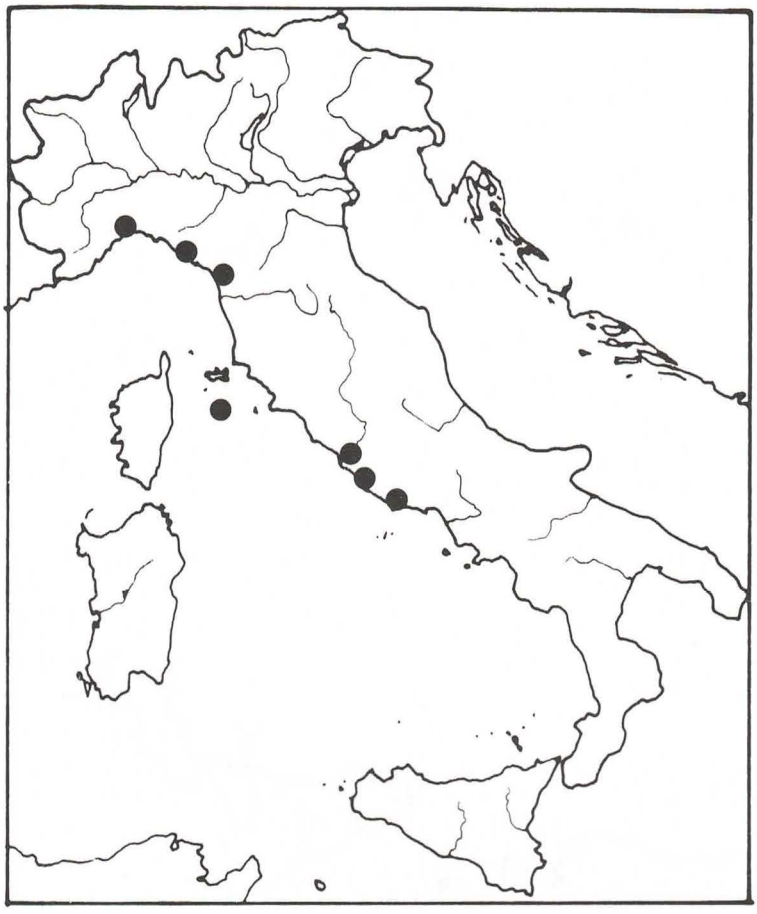

Fig. 3. - Distribution of the samples of *P. hypoleucinum* in Italy.

two separate species, i.e. *Parmelia hypotropa* s. str. and *Parmelia hypoleucina*; the latter is the secondary species of *Parmelia preperforata.*

P. hypoleucinum is a southern and western species in Europe: it is most common in Portugal, with scattered outposts in the Mediterranean Region (TAVARES, 1945; POELT & VEZDA, 1977). In Italy (fig. 3) the species has a distinct Tyrrhenian range, from Liguria to South Latium. Its ecological behaviour has been studied by NIMIS & SCHIAVON (1986): the species is most abundant in the high macchia dominated by *Erica arborea* on littoral sand dunes, and extends only a few Km towards the interior, with scattered specimens growing on old deciduous *Quercus* in the few remnants of coastal

deciduous forests in Central Italy. It is often associated with *P. reticulatum*, that, however, has a broader distribution in Italy.

Parmotrema perlatum (Ach.) Hale

The most abundant substances present in the thalli of *P. perlatum* are hypostictic, norstictic and stictic acids. Substances present in lower quantities are: connorstictic, cryptostictic, usnic and physodalic acids, and atranorin. Within *P. perlatum* it is possible to distinguish two chemical races, on the basis of the qualitative analysis (TLC): one contains always traces of usnic acid, often associated with physodalic acid, the other always lacks these substances. The race with usnic acid has also some morphological traits that differ from the typical *P. perlatum*: the thalli are stouter, sometimes with a greenish yellow tinge, and the soredia tend to become soon confluent (resembling *P. stuppeum*). No ecological or distributional differences could be detected between the two races within Italy.

P. perlatum is a widespread, pantemperate species reported from all continents (HALE, 1965). It is by far the most common species of the genus in Europe, where it ranges from Scandinavia (DEGELIUS, 1948) to the Mediterranean Region (SCHAUER, 1965, with distribution map). Among the European *Parmotrema* — species, *P. perlatum* is the one that more extends towards the east: it has been reported from Poland, Hungary and Rumania (SULMA, 1938), where it mostly occurs in the mountains. It has a predominantly western distribution in the British Isles, where it seems to have the same ecological requirements of *Parmelia caperata* (SEAWARD & HITCH, 1982, with distribution map). Formerly widespread also in Central Europe, it is now rapidly disappearing from many areas (WILMANNS, 1965) as a consequence of air pollution. The Italian range of the species (fig. 4) includes the whole of the country, with a clear frequency maximum along the western coasts and the outer prealpine chains with suboceanic climate. The species is mostly epiphytic, although it also grows on epilithic mosses, above all in areas with high air humidity. Its elevation ranges (with decreasing frequency) from sea level to ca. 1000 m. Although this is the species of *Parmotrema* that seems to be less restricted to areas with high air humidity, its suboceanic affinities are evident particularly in the eastern parts of its Italian range. According to NIMIS (1982) and NIMIS & LOI (1982) in the Trieste Karst *P. perlatum* is restricted to deep dolines with relatively high atmospheric humidity, being completely absent in the Karst Plateau. The ecological similarity with *Parmelia caperata* (SEAWARD & HITCH, 1982) is less evident in this area, where the latter species is most abundant outside the dolines, and hence less restricted to relatively high air humidity. The phytosociological indicator value of *P. perlatum* has been discussed by

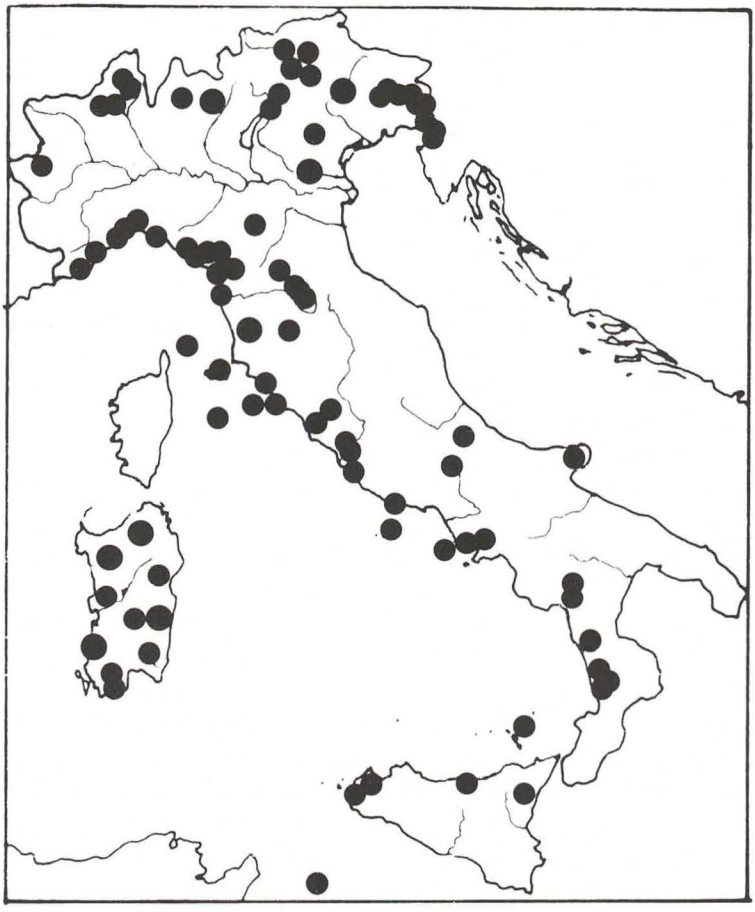

Fig. 4. - Distribution of the samples of *P. perlatum* in Italy.

various authors (for a review, see NIMIS & SCHIAVON, 1986): in our opinion the species cannot be considered as characteristic of any union, and it is better placed as a characteristic of the *Parmelion caperatae*, a foederatio including unions growing in deciduous forests of Central and Southern Europe with a subatlantic climate type.

Parmotrema reticulatum (Tayl.) Choisy

The most abundant substances are connorstictic and salazinic acids. Atranorin, hypostictic, stictic, usnic and physodalic acids do also occur in lower quantities. Up to now, only salazinic, norstictic, lecanoric and cetrataic acids were known for this species (CULBERSON et al., 1977; CULBERSON, 1979).

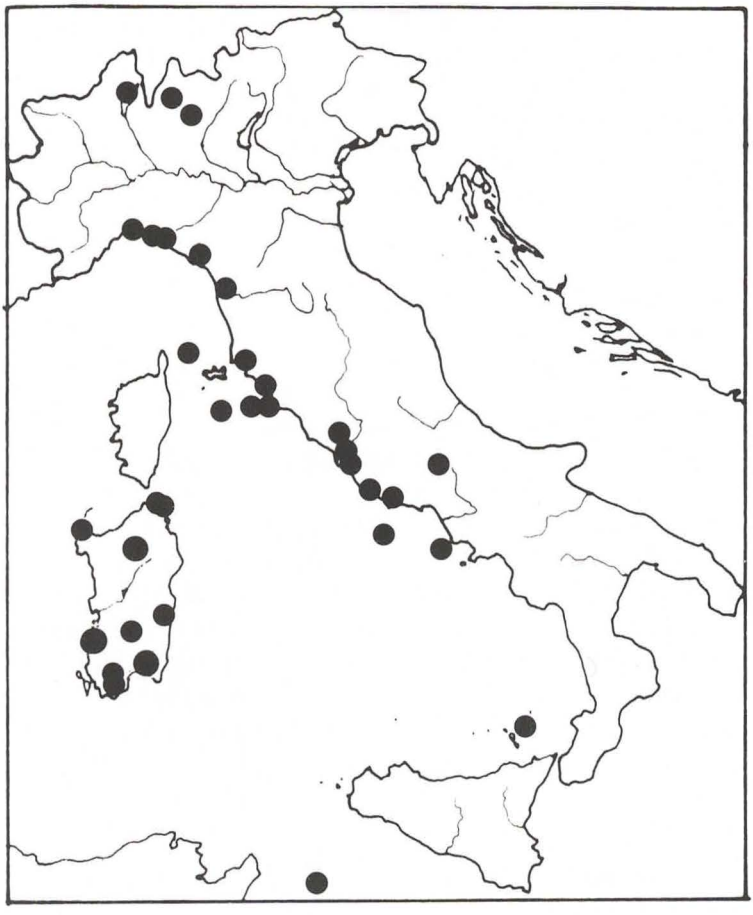

Fig. 5. - Distribution of the samples of *P. reticulatum* in Italy.

This is probably a pantemperate species known from all continents (HALE, 1965; SEAWARD & HITCH, 1982). In Europe its range seem to be intermediate between those of *P. perlatum* and *P. stuppeum*: it is absent from Scandinavia and mainly southern in the British Isles, becoming more frequent southwards in Western France and Portugal (TAVARES, 1945; SEAWARD & HITCH, 1982). Formerly it was also present in montane woods of Central Europe, where it is now apparently extinct (POELT & VEZDA, 1977; WIRTH, 1980); its easternmost European station lies in Yugoslavia.

In Italy, *P. reticulatum* has a distinctly western range (fig. 5), being most common along the Tyrrhenian coasts, with some ouposts in the suboceanic Insubric Region in the North. In peninsular Italy the species is almost always

restricted to the lowlands and low hills along the coasts, whereas in Sardinia it occurs frequently also in the interior, up to 700 m. *P. reticulatum* is mostly epiphytic, and is considered by NIMIS & SCHIAVON (1986) as characteristic of a union growing in humid evergreen mediterranean woods; the most frequent porophytes are *Quercus ilex, Quercus cerris* and *Quercus suber*; as most of the european *Parmotrema* — species it also grows on epilithic mosses, more rarely directly on rock, in particularly moist stations.

Parmotrema robustum (Degel.) Hale

Atranorin is by far the most abundant substance contained in the thalli of this species, followed by fumarprotocetraric acid. Traces of hypostictic, norstictic, connorstictic, usnic, stictic and protocetraric acids do also occur.

P. robustum is a hyperoceanic species, hitherto known from Portugal, West France and the British Isles, and from the Azores. FREY (1959) cites a specimen from Switzerland, adding that he is not completely sure whether it was actually collected from that area. The species should be characterized by the presence of protocetraric acid. Two samples collected in Italy in the last century proved to belong to this species, that is new to the lichen flora of the country. The two localities are located along the northern Tyrrhenian coasts (Fig. 1). One of the authors (Nimis) visited the locality in Liguria (S. Margherita Ligure) in search of this species, but could not find it. It cannot be excluded that *P. robustum*, that in Italy was clearly relict, disappeared from the Italian territory in the present century.

Parmotrema stuppeum (Tayl.) Hale

Salazinic and norstictic acids are the two most abundant substances. Atranorin is also present, with small quantities of hypostictic, hyposalazinic, connorstictic, cryptostictic and physodalic acids, plus an unidentified substance. Norstictic acid was never reported for this species (CULBERSON, 1979).

P. stuppeum is a pantemperate species, that is rather frequent in the mountains of Northern and Central America, and in Europe, less frequent in Africa and Asia (see map in HALE, 1965). According to POELT & VEZDA (1977) *P. stuppeum* has an european distribution resembling the one of *P. perlatum*, with the difference that the former has almost completely disappeared from the Central European mountains. The range of *P. stuppeum* in Italy (fig. 6) very much resembles the one of *P. hypoleucinum*, being restricted to the Tyrrhenian coasts. Also the ecology seems to be similar, since *P. stuppeum* frequently occurs together with *P. hypoleucinum* and *P. reticulatum* in littoral scrub vegetation (NIMIS & SCHIAVON, 1986).

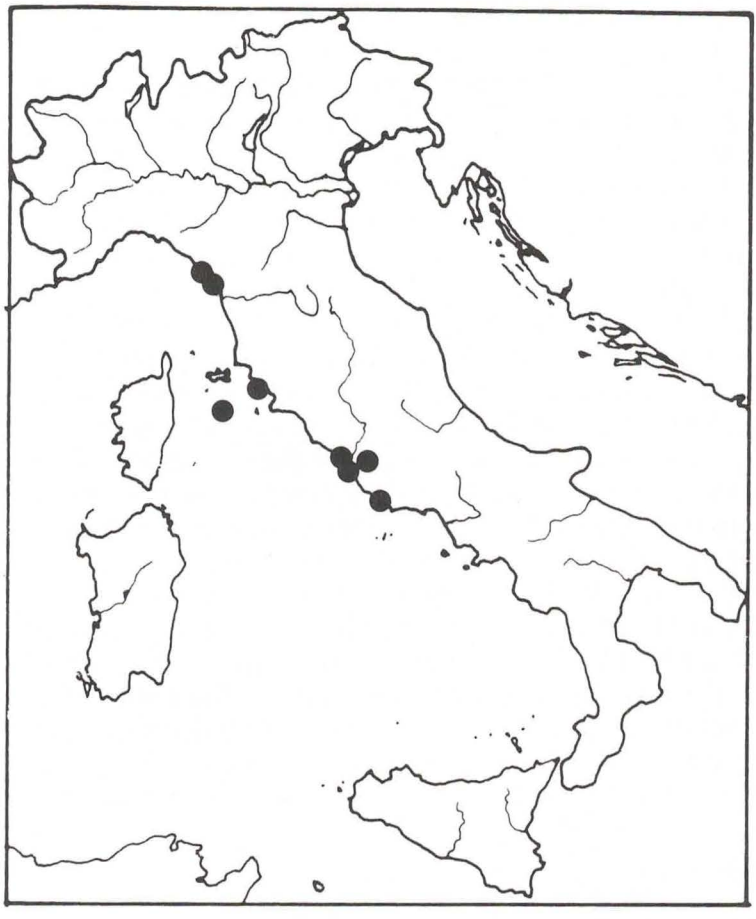

Fig. 6. - Distribution of the samples of *P. stuppeum* in Italy.

Conclusions

A first general remark concerns the chemical contents of the species as obtained hy HPLC. This method, which has a very high degree of accuracy, allowed us to confirm the prevalence of the diagnostic substances already known from the literature to occur in the various species, but also helped us to discover the presence of small amounts of other substances, hitherto never reported for the analyzed species. It seems that their chemical variability is much greater than hitherto suspected: most of these species are capable of synthesizing small quantities of substances that usually are considered as diagnostic for other species, although normally only a few compounds are

present in high concentration, and are easily detected by crystal tests or by TLC.

The second remark concerns the distribution patterns of the seven *Parmotrema* species within Italy: they confirm their oceanic or suboceanic affinities, since the greatest frequency of species and samples is along the Tyrrhenian coasts of Central Italy, an area that, despite the relatively low precipitation, is characterized by high air humidity and a climate that is transitional between the mediterranean and the subatlantic climate-types. The analogies between the climate of the Tyrrhenian coasts and that of Portugal have been already discussed by CORTI (1934), DE PHILIPPIS (1937) and GIACOBBE (1947), and the epiphytic lichen vegetation of the Tyrrhenian coasts is characterized by a high incidence of subatlantic species (NIMIS & SCHIAVON, 1986). Another area with a relatively high concentration of *Parmotrema*-samples is the Insubric Region in Northern Italy, that also has a warm-humid climate, whereas the outer prealpine chains with suboceanic climate (Carnic and Julian Pre-Alps) have a very poor *Parmotrema* flora, almost solely consisting of *P. perlatum*.

The seven species of *Parmotrema* found in Italy show three main distribution patterns:

1) Restricted to Northern Italy, mostly in the montane belt, within beech woods: *P. crinitum* and *P. arnoldii*.

2) Restricted to the Thyrrhenian coasts, in the lowlands: *P. hypoleucinum, P. stuppeum, P. robustum* (now probably extinct in Italy) and the present range of *P. reticulatum*.

3) Most frequent along the Tyrrhenian coasts, but extending with scattered outposts to all areas with suboceanic climate: *P. perlatum* and the past range of *P. reticulatum*.

All of the species are more or less endangered, with the exception of *P. perlatum*, that is still rather common. This is probably due not only to air pollution, but also to the destruction of natural habitats along the coasts, and the excessive exploitation of beech forests in the Alps.

Appendix

List of samples with Herbarium quotation

Parmotrema arnoldii

Trentino Alto Adige: Two localities in the map by SCHAUER (1965), probably from collections by Arnold. - **Friuli Venezia Giulia:** Lago di Sauris, 1000 m, su *Salix*, 9.1985, *Nimis* (TSB). - Tra il Lago di Sauris ed il P.so del Pura, 1300 m, su *Fagus* ed *Abies*. 9.1986, *Nimis* (TSB).

Parmotrema crinitum

Liguria: Varazze, sponda del torrente, 7.4.1943, *Gresino* (PAV). - Voltri, Canellone, su pietra, 15.6.1960, *Cevasco* (also cited by BAGLIETTO, 1857) (GDOR). - Chiavari (in BAGLIETTO, 1857). - **Lombardia:** Val Brembana (Bergamasco), *Rodegher* (FI). - **Trentino Alto Adige:** M. Mulatto, sopra Predazzo, 11.8.1886, *Arnold* (MOD). - **Friuli Venezia Giulia:** Carso Triestino presso Malchina, in dolina su Carpino, 150 m, 12.2.1981, *Nimis* (TSB). - Presso il Lago di Sauris (UD) 970 m, epifita, 9.8.1981, *De Faveri et Nimis* (TSB). - Laghi di Fusine, su *Picea*, 9.1986, *Nimis* (TSB). - Sopra Tualis (Comeglians-UD) 1500 m, su Picea, 8.1986, *Nimis* (TSB). See also map by SCHAUER (1965).

Parmotrema hypoleucinum

Toscana: Pisa, Tirrenia, pinicola prope mare, 11.9.1953, *Sbarbaro* (GDOR). - Isola di Montecristo, 1974, *Valcuvia-Passadore* (PAV). - Parco regionale di Migliarino, 3.5.1985, *Nimis* (TSB). - Pisa, *Vivante* (in HALE, 1965). - Between Pisa e La Spezia, *Hasselroth* (cit. in HALÉ, 1965). - Parco Regionale dell'Uccellina, su *Juniperus*, 5.1985, *Nimis* (TSB). - **Lazio:** Tenuta di Castelporziano, su *Quercus*, 16.1.1984, *Nimis* (TSB). - Sui tronchi al Regio Orto Botanico di Roma, 1877, *Canepa* (RO). - Castelfusano, 29.2.1880, *Tamburlini* (RO). - Parco Nazionale del Circeo, 12.1984, *Codogno* (TSB). - M. Cave presso Roma, *Cuboni*. (RO, NAP). - Sui tronchi al bosco di Castelmazzone (Roma), 10.2.1881, *Tamburlini* (RO).

Parmotrema perlatum

Piemonte: Giaveno, *Gola* (TO). - Valle Intrasca (Lago Maggiore), 8.1862, *Baglietto*. ECI 930 (TO, RO, MOD, FI). - Biasino, Lago d'Orta, *De Notariis* (MOD). - Serravalle Scrivia, *Ferrari* (MOD). - Lago Maggiore a Terzo di Stresa, 8.1860, *Figari* (FI). - **Lombardia:** Premosello in Val d'Ossola, 8.1887, *Rossi* (FI). - **Trentino Aldo Adige:** Auf Porphyrbloecken oberhalb Eppan bei Bozen, 9.1870, *Arnold* (BOLO). Several localities in DALLA TORRE & SARNTHEIN (1902). - **Veneto:** Ad abietes in collibus Euganeis, M. Rua, *Massalongo* (MOD). See also map by SCHAUER (1965). - **Friuli Venezia Giulia:** Bocche del Timavo a S. Giovanni, su *Fraxinus ornus*, 10 m, 2.1.1983, *Nimis* (TSB). - Bosco Romagno sotto Rocca Bernarda, UD, su *Quercus pubescens*, 8.6.1981, *Nimis* (TSB). - Carso Triestino, Dolina di Fernetti, 28.1.1980, *Nimis* (TSB). - Val del Torre a Vedronza, 460 m, su *Fraxinus excelsior*, 3,2.1980, *Nimis* (TSB). - Tra Castelmonte e Tribil inferiore, 650 m, su *Castanea*, 5.6.1981, *De Faveri et Nimis* (TSB). - Sedilis di Tarcento, 400 m, su ciliegio, 19.4.1981, *Nimis* (TSB). - Pielungo PN, 17.6.1982, *Loi* (TSB). - Tramonti di Sotto PN, su *Pinus sylvestris*, 14.10.1983, 600 m, *Nimis* (TSB). - Carso Triestino a Sales, su *Quercus pubescens* in dolina, 17.9.1983, *Nimis* (TSB). - Toppo PN, 11.1984, *Loi* (TSB). - Carso Triestino a Malchina, 170 m, 25.3.1985, *Nimis* (TSB). - Pinzano al Tagliamento PN, 200 m, 29.3.1985, *Loi* (TSB). - Trieste, M. Radio, 130 m, epilitico su arenaria, 15.6.1985, *Nimis*. - Usago PN, 2.1985, *Loi* (TSB). - Villanova delle Grotte, su *Fraxinus excelsior* 700 m, 26.6.1985, *Nimis* (TSB). - Meduno PN, 250 m, 2/1985, Loi (TSB). - Maniago PN, 280 m, su *Fraxinus*, 26.6.1985, *Nimis* (TSB). - Tarcento UD, 29.10.1978, *Nimis* (TSB). - **Liguria:** Vezzi (?), S. Giorgio, 28.1.1962, *Sbarbaro* (GDOR). - S. Margherita Ligure, 5.1833 (FI). - Varazze, su rupi al deserto, 28.3.1835, *Gresino* (PAV, FI). Ibid., su rupe muscosa, 11.1932, *Gresino* (PAV). - Ca' Nova, presso Imperia, 30.6.1974, *Terzo* (?) (PAV). - Val Graviaglia GE, su diaspro lungo il torrente Gambatesa, 19.3.1985 e 19.3.1985, *Modenesi* (TSB). - Monti di Reggio (?) in Liguria, 4.1855, *Caldesi* (RO). - Voltri, Torretta Baroni, 1852 (MOD). - Castagni sopra Voltri, 4.1891, *Fiori* (FI). - Voltri, su roccia Villa de Ferrari, 21.1.1869, *Cevasco* (GDOR). - Sui pini presso Monterosso, Lig. Orientale (MOD). - Arenzano, *Sbarbaro* (cit. in HALE, 1965). - M. della Guardia presso Genova, 7.1842 (RO). - Torriglia, *Almborn* (cit. in HALE, 1965). - **Emilia:** Monti di Reggio Emilia, 5.1855, *Caldesi* (BOLO). - Fornole, super rupes, 22.7.1819, *Bertoloni* (BOLO). - Lago Calamone 1200 m, *Nimis* (TSB). - **Toscana:** Isola di Montecristo, 1974, *Valcuvia Passadore* (PAV). - Parco Regionale di Migliarino, su *Quercus ilex*, 3.5.1985, *Nimis* (TSB). - Sarzana, ad truncos olearum (BOLO). - Bagni di Lucca, regione del Castagno, 8.1832 (FI). - Su castagni al

Convento del M. Argentale, 4.1845, *Ricasoli* (FI). - In insula Capraia ad rupes, 1837 (RO). - Sugli abeti al margine dell'abetina di Vallombrosa, 30.5.1877, *Berenger* (FI). - Su pero a Camaldoli, Licopoli (MOD). - Alpi Apuane, Valle di Montagnolo, 1863, *Berenger* (TO). - Parco Regionale dell'Uccellina, *Nimis* (TSB). - Sugli olivi nella villa... presso Firenze, 7.1861, *Caldesi* (FI). - Selva Pisana, 1885, *Beccari* (FI). - Portoferraio, *Bolzon* (FI). - Isola del Giglio, su rupi tra il porto e il Giglio Alto, 14.4.1885, *Levier* (FI). - M. Senario presso Firenze, 4.1867 (FI). - Radda in Chianti (FI). - **Lazio:** Tenuta Presidenziale di Castelporziano, su *Quercus ilex*, 16.1.1984, *Nimis* (TSB). - Isola di Zannone, *Anzalone* (RO). - Negli arbusti della macchia presso il mare a Castelporziano, 25.2.1962, *Ricci* (RO). - Sui lecci alla Valle dell'Inferno presso Roma, 30.12.1880, Tamburlini (MOD, RO). - Dintorni di Viterbo, 25.1.1892, *Mari* (RO). - Roma, all'Acqua Traversa, 15.2.1880, *Tamburlini* (RO, FI). - Bosco Modano (Roma), 14.2.1881, *Tamburlini* (RO). - Villa Doria Pamphili a Roma, *Sanguinetti* (RO). - Parco Nazionale del Circeo, *Nimis* (TSB). - Nelle faggete di Oriolo Romano, 450 m, 5.1962, *Anzalone* (RO). - Faggeta del M. Allumiere (M. della Tolfa), 10.1961, *Anzalone* (RO). - **Abruzzi-Molise:** Sui faggi del bosco di Pacentro, alla Majella, 7.1872. *Jatta* (RO, NAP). - Rocca del Parco Nazionale d'Abruzzo, *Ricci* (RO). - **Campania:** Sugli olmi presso Napoli, 3.1872, *Jatta* (RO). - Isola d'Ischia, *Jatta* (NAP). - In sylvis prope Neapolim, *Gasparini* (NAP). - S. Nicola, in insula Inarime, *Jatta* (NAP). - **Puglia:** Gargano, Foresta Umbra, su *Fagus*, 8-1986, *Ciccarelli* (TSB). - **Basilicata:** Ad pyros, Lagonegro, *Pomodoro* (NAP). - M. Raparo, *Giordano* (NAP). - M. Pollino sotto Sella Dolcedorme, 1400 m, su *Fagus*, 7.1979, *Nimis* (TSB). - **Calabria:** Catena Costiera preso Fiume Badia, 350 m, roccia metamorfica, 20.4.1985, *Puntillo* (TSB). - Vallone di Rovito, 350 m, su *Rosmarinus*, 25.1.1985, *Puntillo* (TSB). - Fagnano, Trifoglietti (CS), *Puntillo* (Cosenza). - Valle del Fiume Badia (CS), *Puntillo* (Cosenza). - **Sicilia:** Bosco Scuraci, Busseto Panizzolo 5.6.1977, *Raimondo* (PAL, TSB). - Erice. 10.1978, *Raimondo* (PAL, TSB). - Insula Panaria, *Zodda* 9.1902 (NAP). - Isola di Pantelleria, *Jatta*, in JATTA, 1891). - Vetta del M. Cofano, su *Quercus ilex*, 5.8.1973, *Raimondo* (PAL, TSB). - M. Etna, *Iosco* (TSB). - **Sardegna:** M. Ortobene, presso Nuoro. 800 m. on mossy rocks, 25.7.1985, *Nimis et Poelt* (TSB, GZU). - Giara di Gesturi, 500 m, 7.1985, on *Quercus suber*, *Nimis et Poelt* (TSB, GZU). - Road Capoterra-Santadi, Is Pauceris, 300 m, on *Quercus suber*, 18.7.1985, *Nimis et Poelt* (TSB). - M. Santo di Pula, *Gennari* (MOD). - Isili, 8.1912, *Colosi* (FI). - P.so del Limbara, su *Quercus suber*, 600 m, 5.86, *Nimis et Poelt* (GZU, TSB). - Lanusei, su Quercus pubescens, 600 m, *Nimis et Poelt* (GZU, TSB). - Nuraghe Losa, *Feige*. - M. Ferru (Oristano), on *Quercus ilex*, *Brunnbauer* (W).

Parmotrema reticulatum

Piemonte: Sulle quercie alle Riane, in valle Intrasca (Lago Maggiore), 8.1862, *Baglietto*, ECI 930 (MOD, GDOR accedit ad et immixtum cum *Parmotrema perlatum*). - **Lombardia:** Val Brembana (Bergamasco), *Rodegher* (FI). - Calice, in cunensi Provincia, su *Castanea*, in sylvis supra Nasso, 9.1831, *Bertoloni* (BOLO). - **Liguria:** Bosco Doria a Pegli, 23.3.1858, *Ardissone* (MOD). - S. Margherita Ligure, su olivi, 6.5.1843 (FI). - Costa S. Salvatore, presso Chiavari, su olivi, 10.1867, *Delpino* (FI). - **Toscana:** Pisa-Tirrenia, prope mare, 9.1953, *Sbarbaro* (GDOR). - Isola di Montecristo, 1974. *Valcuvia- Passadore* (PAV). - Supra Sarzana, in sylva Ramadi in Pratola a corticem *Quercus cerris*, *Bertoloni* (BOLO). - Sui castagni al convento del M. Argentale, 6.1845, *De Notaris* (RO). - Isola di Montecristo, 1974, *Valcuvia-Passadore* (PAV). - Su roccia granitica in insula Caprera (MOD). - Parco Regionale dell'Uccellina, *Nimis* (TSB). - Isola del Giglio, 2-3.1897, *Sommier* (FI). - Follonica, su cerro, 26.1.1891 (NAP). - **Abruzzi-Molise:** A Nord della Rocca del Parco Nazionale d'Abruzzo, *Ricci* (RO). - **Lazio:** Tenuta Presidenziale di Castelporziano, 16.7.1984, su *Quercus cerris*, *Nimis* (TSB). Parco Nazionale del Circeo, 400 m (Picco di Circe), su *Quercus ilex*, 4.1984, *Nimis* (TSB). - Sulle roccie di Pietra Manziana (Canale Monterano) presso Roma, 21.9.1927, *Lusina* (RO). - Isola di Ponza, *Nimis* (TSB). - **Campania:** Isola d'Ischia, *Jatta* (NAP). - **Sicilia:** Insula Panaria, 3.4.1902 (FI). - Pantelleria, Montagna Grande, 5.5.1981, *Loi* (TSB). - **Sardegna:** Road Capoterra-Santadi, Is Pauceris. 300 m, on *Quercus suber*. 18.7.1985, *Nimis et Poelt* (TSB). - Capo Falcone, su *Juniperus* a 130 m, 7.1985, *Nimis et Poelt* (TSB). - Giara di Gesturi, 500 m, on *Quercus suber*, 7.1985, *Nimis et Poelt* (TSB). -

Arcipelago della Maddalena, *Vaccari* (MOD). - Flumini Bina, *Canepa* (MOD). - M. Santo di Pula, *Canepa* (MOD). - Capo Orso, 150 m su granito, *Nimis et Poelt* (GZU, TSB). - Buggerru, su *Juniperus* presso il mare, 5.1985, *Nimis et Poelt* (GZU, TSB). - Foresta dei Sette Fratelli, *Wittmann & Pilsl* - Capo Falcone, on *Juniperus, Nimis et Poelt* (TSB).

Parmotrema robustum

Liguria: S. Margherita Ligure, sugli olivi, 9.1864, *Chierici* (FI). - **Toscana:** Sommità del M. Pisano alla Verruca, 5.1883, *Mari* (FI).

Parmotrema stuppeum

Liguria: Bonassola, sugli ulivi, *Sbarbaro* (in SBARBARO, 1956). - Arenzano, sugli olivi (in SBARBARO, 1956). - **Toscana:** Isola di Montecristo, su *Erica*, 1974, *Valcuvia-Passadore* (PAV). - Parco Regionale di Migliarino, su *Quercus ilex* in macchia litoranea, 3.5.1985, *Nimis* (TSB). - **Lazio:** Pietra Manziana, Canale Monterrano (Roma), 4.5.1900, *Pappi* (RO). - Macchia della Manziana presso Roma, 10.1961, *Anzalone* (RO). Parco Nazionale del Circeo, 5.1985, *Nimis* (TSB). - Tenuta di Castelporziano, su *Quercus ilex*, 5.1986, *Nimis* (TSB).

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Summary

The status of 183 samples of lichens belonging to the genus *Parmotrema*, collected in Italy, has been revised on the basis of morphological and chemical characters. Chemical analyses were carried out by microchemical crystal tests, thin layer chromatography (TLC) and high performance liquid chromatography (HPLC). Seven species of *Parmotrema* occur in Italy: *P. arnoldii, P. crinitum, P. hypoleucinum, P. perlatum, P. reticulatum, P. robustum* and *P. stuppeum*. Their distribution patterns within Italy differ, but have in common a clear frequency maximum in regions with a suboceanic climate. The results of the quantitative chemical analyses show the presence of traces of several substances that were never reported before from some of the species.