

# PHYTOGEOGRAPHICAL ANALYSIS OF THE LICHEN FLORA IN EL TELENO (NW IBERIAN PENINSULA)

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**Key words:** Phytogeography, Lichens, Iberian Peninsula, Saxicolous, Acidophytic.

**Abstract:** The saxicolous, acidophytic lichen flora of El Teleno Massif is analysed from the phytogeographical point of view, trying to characterize the different floristic contingents, floristic elements, affinities for the different bioclimatic belts and the different substrata. The synthesis is based on a list of 231 lichen taxa.

**Resumen:** La flora liquénica saxícola acidófila de el macizo de El Teleno (León, Noroeste de España) es analizada desde el punto de vista fitogeográfico, de forma que se intenta caracterizar los diferentes contingentes florísticos, elementos florísticos, afinidades por los diferentes pisos bioclimáticos y por los diversos substratos rocosos que aparecen en este territorio. Todo ello intenta ser un análisis pormenorizado del comportamiento ecológico mostrado por los 231 taxones que componen la flora liquénica del territorio, y que esto pueda servir para la mejor comprensión del comportamiento de los líquenes en otros territorios continentales.

## Introduction

The phytogeographical study of the lichen flora in an area such as El Teleno, situated in the northwest of the Iberian Peninsula, is made difficult by the shortage of knowledge concerning the distribution patterns of many species. Large parts of the Iberian Peninsula are still poorly-known from the lichenological point of view, and the Cantabrian Mountain Range, in which our survey area is included, is not an exception. On the other hand, in the literature there are several examples of "artificial" chorological centers, which clearly coincide with areas where lichenological studies were more intense.

The present analysis is primarily based on the total distribution of the species in Europe, following the concepts by Wirth (1980), Poelt (1969), Poelt & Vezda (1977, 1980), Clauzade & Roux (1985), Nimis & al. (1987) and Nimis & Poelt (1987).

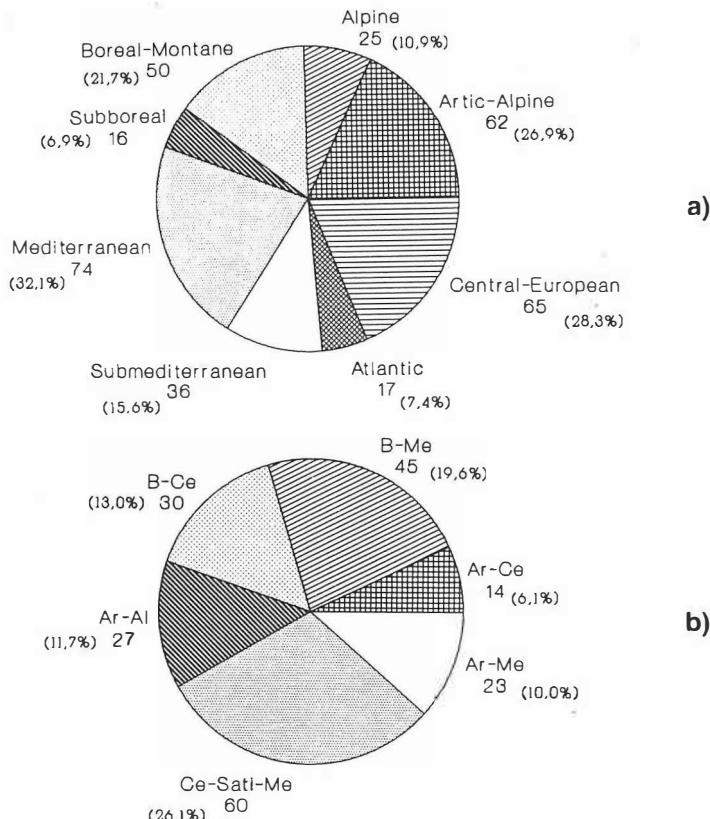
## Results

The total number of silicicolous species found in the survey area is 231 (Terron, 1991). A first attempt of phytogeographic analysis was based on the main distribution centers of the species, which were subdivided into 8 phytogeographic groups, according to the main vegetation zones of Europe in

which they are most frequent.

	Nr. sp.	%
Arctic-Alpine (Ar)	62	26.95
Central-European (Ce)	65	28.26
Mediterranean (M)	74	32.11
Boreal-montane (B)	50	21.73
Submediterranean (Sm)	36	15.65
Alpine (Al)	25	10.86
Atlantic (At)	17	7.39
Subboreal (SB)	16	6.95

From these results (Fig. 1a) the importance of the Mediterranean and Central European elements is evident; this is well in accordance with the survey area



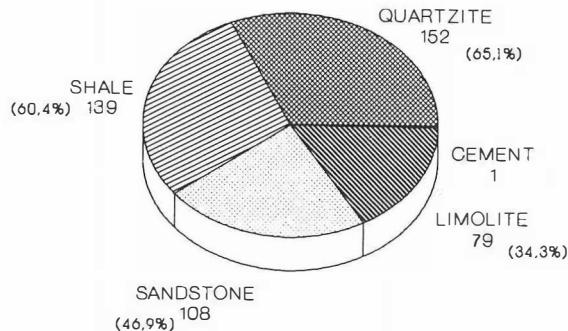
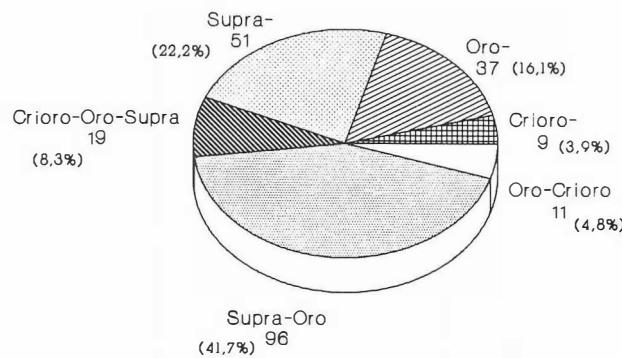
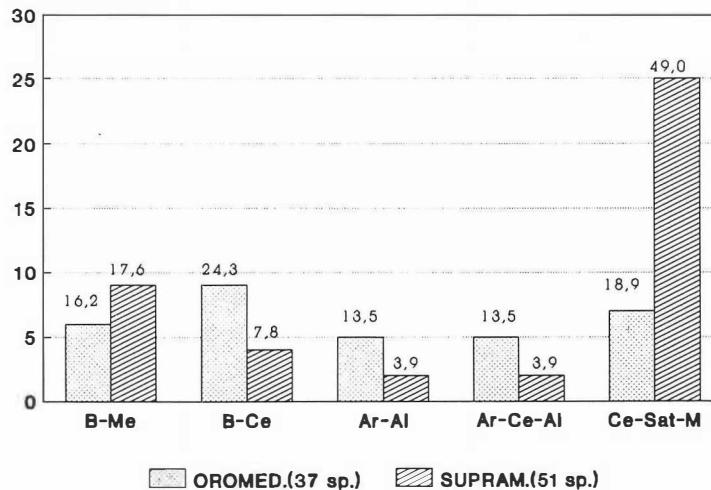


Fig. 1: percent occurrences of Floristic elements (a), floristic contingents (b), number of species for each element (d), in the silicicolous lichen flora of El Teleno, percent of contingent/elements in the oro- and supramediterranean belts (c), and number of species found in each substrate-type (e). For further explanations see text.

being situated in the Mediterranean region, following the concepts expressed by Rivas-Martinez (1987). The occurrence of a large number of Arctic and Boreal species is due to the fact that the study was carried out at high altitudes (1200-2185 m). The presence of a small group of Atlantic species indicates a certain influence of humid oceanic air masses, which is particularly pronounced in the southwestern slopes of the massif.

The previous subdivision of the species is only a first, rough attempt of phytogeographic analysis, as many species occur in more than one vegetation zone. Thus, a second attempt to group the species has been carried out on the basis of their occurrence in the main vegetation zones of Europe, following the diagnoses given by Wirth (1980). The results are as follows:

	Nr. sp.	%
Central European.subatl-Mediterr.	60	26.09
Boreal-Mediterranean	45	19.56
Boreal-C. European	30	13.04
Arctic-Alpine	27	11.73
Arctic-Mediterranean	23	10.00
Arctic-C. European	14	6.10

In this second subdivision (Fig. 1b) it is evident that the species reaching the Central European and Mediterranean zones are the majority. The Arctic-Alpine element is poorly represented, which indicates that in southern Europe this element needs higher altitudes than those found in the survey area.

It is possible to subdivide further our data set, on the basis of the occurrence of the different phytogeographic elements in two main altitudinal belts, the supramediterranean and the oromediterranean (Rivas-Martinez 1987). The results are as follows:

	Oromed. (37 sp.)		Supramed. (51 sp.)	
	sp.	%	sp.	%
Boreal-Mediterranean	6	16.21	9	17.64
Boreal-C. European	9	24.32	4	7.84
Arctic-Alpine	5	13.51	2	3.92
Arctic-C. European-Alpine	5	13.51	2	3.92
C. European.subatl.-Mediterranean	7	18.92	25	49.01

From these data (Fig. 1c) it is evident that the Arctic-alpine and the Boreal-montane elements are predominant in the oromediterranean belt, while in the supramediterranean belt the Central European subatlantic-Mediterranean element is most frequent.

Finally, we have subdivided the silicicolous lichen flora of the survey area on the basis of the occurrence of the species in different bioclimatic belts (Fig. 1d). Only 9 taxa are exclusive of the criomediterranean belt, which indicates that this belt is not well-developed in the survey area. The oromediterranean belt, on the contrary, is well-characterized by the presence of 37 exclusive taxa. Finally, the supramediterranean belt has 51 exclusive taxa. 19 taxa occur in the supra-oro- and criomediterranean belts, while 96 taxa occur both in the supra- and in the oromediterranean belts.

Finally, the species have been grouped according to their presence on different siliceous substrate-types (Fig. 1e). Noteworthy is the high number of taxa (79) which colonize limolite, which is a rather infrequent substratum in the survey area; they represent 43.35 % of the silicicolous lichen flora.

## Conclusions

Our results indicate that the phytogeographic characterization of the silicicolous lichen flora of the El Teleno is in agreement with the macroclimatic conditions, and especially with the regional bioclimatic features. Several Arctic-alpine and Boreal-montane species are restricted to higher altitudes, where they can survive under a Mediterranean climate. The great bulk of the species belong to the Mediterranean and Central European elements. The small group of Atlantic species indicates a weak Atlantic influence, especially on the southeastern slopes. A criomediterranean belt is evident, although not very pronounced, the most characteristic species being mostly limited to high-altitude areas with strong winds or heavy snowfalls. This agrees with the bioclimatic characterization given by Rivas-Martinez (1987), based on the vascular flora.

## Acknowledgements

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## LICHEN SUBSTANCES CONTENT OF SOME SPECIES OF *PARMELIA* ACH. (LICHENES) FROM EASTERN SPAIN

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**Keywords:** Lichens, Spain, Castelló, València, Chemotypes, TLC, *Parmelia*, Chemistry.

**Abstract:** 148 specimens of 20 species of *Parmelia* Ach. (lichens) from eastern Spain have been analyzed by TLC, in order to investigate chemical content and to identify chemotypes. This technique allowed us to confirm the occurrence of *P. protomatrae*, *P. delisei*, *P. loxodes* and *P. lusitana* in the territory, these species having often been confused with other related taxa. Interesting results are the occurrence of protocetraric acid in *P. soredians*, the identification of two chemically different groups in *P. pulla* and the presence of the chemotype lacking usnic and physodalic acids in *P. perlata*.

### Introduction

The lichen genus *Parmelia* is one of the most well-known and conspicuous among lichenized fungi. In the taxonomy of this group, chemical characters are important, and the genus is certainly one of the better investigated from a chemical point of view. However, in the Iberian Peninsula, only a few extensive studies on the chemistry of *Parmelia* were carried out until now (Rico 1989, Seriña 1990, Rico & al. 1992). As pointed out by Leuckert & Poelt (1978), southern Europe is an interesting area for chemical investigations, as it hosts a considerable number of chemotypes of several species. For these reasons, we planned a chemical study of some species of *Parmelia* collected in a well-delimited, typically Mediterranean area. The main aim of the present work was to identify the lichen substances occurring in all species of *Parmelia* found in this territory and, for chemically variable species, to assign the specimens to a given chemotype.

### Survey area

Sampling was carried out in the Serra d'Espadà and Serra Calderona, two areas with high diversity and abundance of species of *Parmelia*. This area (Fig. 1) includes the most extensive siliceous outcrops of eastern Spain, mainly quartz sandstones and argillites. The ecological peculiarity of these territories is determined not only by the parent materials but also by its closeness to the coast and by the incidence of north eastern, humid winds, determining a rather humid climate in some valleys, contrasting with the dryness of the south-facing hillsides. From a bioclimatic point

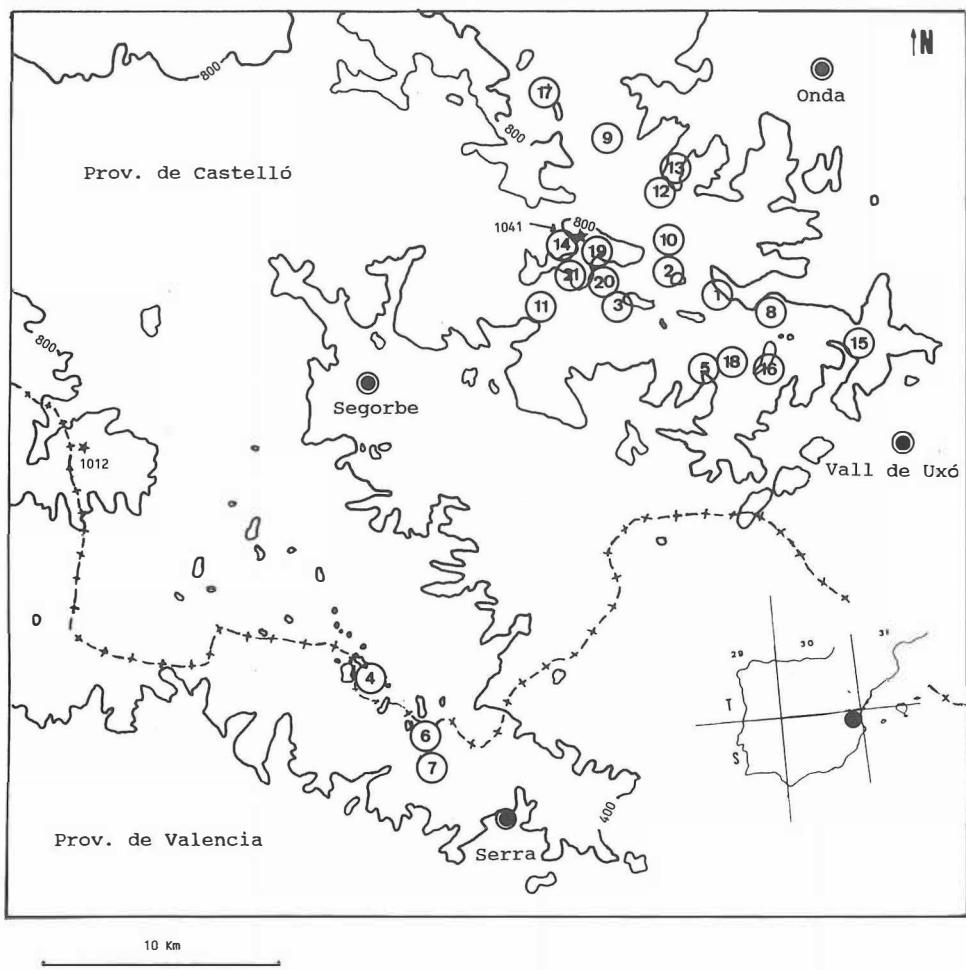


Fig. 1: Survey area with the distribution of the localities sampled.

of view, Espadà mountains are mostly included in the mesomediterranean belt, with subhumid ombroclimate, while Calderona mountains are principally distributed within the termomediterranean belt, with dry to subhumid ombroclimate (Rivas-Martínez, 1987). The most representative vegetation in the area is the cork-oak forest (*Asplenio onopteridis-Quercetum subericis*), disturbed areas being covered by a garrigue of *Cistus monspeliensis* and *Cistus salvifolius*, with a tree layer of *Pinus pinaster* (Costa, 1985).

In the following, we give the list of the investigated localities.

**CASTELLO:**

1. Eslida, camino l'Oret, 30SYK2918, 450 m
2. Ahín, los Noguerales, 30SYK2718, 725 m
3. Azuebar, Mosquera, 30SYK2517, 640 m
4. Gátova, Gorgo, 30SYK1302, 750 m
5. Chovar, Bco. del Carbón, 30SYK2915, 420 m
6. Eslida, Majadica, 30SYK3016, 650 m
9. Sueras, Bco. de Castro, 30SYK2424, 450 m
10. Ahín, Pico Batalla, 30SYK2719, 860 m
11. Almedíjar, 30SYK2217, 500 m
12. Alcudia de Veo, Alto de Pedralba, 30SYK2523, 600 m
13. Alcudia de Veo, Embalse de Benitandús, 30SYK2724, 450 m
14. Algimia de Almonacid, Bco. Agua Negra, 30SYK2320, 800 m
15. Alfondeguilla, Pico Femella, 30SYK3415, 500 m
16. Alfondeguilla, Pico Nevera, 30SYK3115, 800 m
17. Villamalur, Cerro Moro, 30SYK 2226, 640 m
18. Chovar, Pico Terraguán, 30SYK3016, 620 m
19. Almonacid, near Pico de Espadán, 30SYK2420, 920 m
20. Ahín, Ctra. Ahín-Almedíjar, 30SYK2518, 700 m
21. Ahín, La I bola, 30SYK2419, 800 m

**VALENCIA:**

6. Serra, Bco. del Saragutillo, 30SYJ1799, 550 m
7. Serra, Font del Berro, 30SYJ1699, 550 m

## Material and methods

148 samples of 20 species of *Parmelia*, 72 occurring on bark and 76 on rock, were analyzed. The analysis and identification of the lichen substances were carried out by thin layer chromatography (TLC). For the solvent systems and conditions we followed Culberson (1972, 1974), Culberson & Kristinson (1970), Culberson & al. (1981), Esslinger (1977) and White & James (1985).

Selected samples of the species studied are included in the following list of species:

*Parmelia acetabulum* (Necker) Duby - CASTELLO: Gátova, Gorgo, 30SYK1302, 750 m, on *Quercus suber*, 4.II.1984, V. Atienza, VAB-LICH. 0350.

*Parmelia caperata* (L.) Ach. - CASTELLO: Gátova, Gorgo, 30SYK1302, 750 m, on *Quercus suber*, 4.II.1984, V. Atienza, VAB-LICH. 0592.

*Parmelia delisei* (Duby) Nyl. - CASTELLO: Villamalur, Cerro Moro, 30SYK2226, 640 m, slates, 14.IX.1991, V. Calatayud, VAB-LICH. 2406/1.

*Parmelia fuliginosa* (Fr. ex Duby) Nyl. - CASTELLO: Ahín, Los Noguerales, 30SYK2718, 725 m, on *Quercus suber*, 22.II.1987, V. Atienza, A. Muñoz & M.J. Sanz, VAB-LICH. 1551.

*Parmelia glabra* (Schaer.) Nyl. - CASTELLO: Azuebar, Mosquera, 30SYK2517, 625 m, on *Quercus suber*, 12.IV.1987, A. Muñoz, VAB-LICH. 0591.

*Parmelia incolorata* (Parr.) Lettau - CASTELLO: Eslida, C<sup>a</sup> L'Oret, 30SYK2918, 450 m, on *Quercus suber*, 9.X.1986, A. Muñoz, VAB-LICH. 1572.

*Parmelia ixodes* Nyl. - CASTELLO: Villamalur, Cerro Moro, 30SYK2226, 640 m, slates, 14.IX.1991, V. Calatayud, VAB-LICH. 2412.

*Parmelia lusitana* Nyl. - CASTELLO: Alfondeguilla, Pico Femella, 30SYK3415, argillite, 500 m,

20.I.1990, V. Calatayud, VAB-LICH. 1611.

*Parmelia perlata* (Huds.) Ach. - CASTELLO: Ahín, Mosquera, 30SYK2518, 675 m, on *Quercus suber*, 28.IX.1986, A. Muñoz, VAB-LICH. 0403.

*Parmelia protomatrae* Gyelnik - CASTELLO: Azuebar, Mosquera, 30SYK2519, quartz sandstone, 660 m, 26.X.1990, V. Calatayud, VAB-LICH. 1820.

*Parmelia pulla* Ach. - CASTELLO: Azuebar, Mosquera, 30SYK2519, quartz sandstone, 660 m, 15.IV.1989, V. Calatayud, VAB-LICH. 1907.

*Parmelia quericina* (Willd.) Vainio - CASTELLO: Ahín, Los Noguerales, 30SYK2718, 725 m, on *Quercus suber*, 28.IX.1986, A. Muñoz, VAB-LICH. 0348.

*Parmelia somloensis* Gyelnik - CASTELLO: Azuebar, Mosquera, 30SYK2517, 625 m, on *Quercus suber*, 26.X.1990, S. Fos, VAB-LICH. 2172.; CASTELLO: Chovar, Bco. del Carbón: 30SYK2915, quartz sandstone, 620 m, 29.IX.1989, V. Calatayud, VAB-LICH. 1744.

*Parmelia soreadians* Nyl. - CASTELLO: Gátova, Gorgo, 30SYK1302, 750 m, on *Quercus suber*, 4.II.1984, V. Atienza, VAB-LICH. 0373. Chovar, 30SYK2915, 450 m, on *Quercus suber*, 21.II.1988, A. Muñoz, VAB-LICH. 0636.; CASTELLO: Alfondeguita, Pico Femella, 30SYK3415, argillite, 500 m, 20.I.1990, V. Calatayud, VAB-LICH. 1757.

*Parmelia subaurifera* Nyl. - VALENCIA: Serra, Bco. Saragutillo, YJ1799, 550 m, on *Quercus ilex*, 12.II.1987, V. Atienza, VAB-LICH. 1550. CASTELLO: Gátova, Gorgo, 30SYK1302, 750 m, on *Quercus suber*, 4.II.1984, V. Atienza, VAB-LICH. 0399.

*Parmelia subrudecta* Nyl. - CASTELLO: Algimia de Almonacid, Bco. de Agua Negra, 30SYK2320, 800 m, on *Quercus suber*, 17.VI.1989, E. Barreno & A. Muñoz, VAB-LICH. 1556.

*Parmelia sulcata* Taylor - VALENCIA: Serra, Bco. Saragutillo, YJ1799, 550 m, on *Pinus halepensis*, 20.I.1986, V. Atienza, VAB-LICH. 1561. CASTELLO: Ahín, Mosquera, 30SYK2518, 675 m, on *Quercus suber*, 22.II.1987, V. Atienza, A. Muñoz & M.J. Sanz, VAB-LICH. 0607.

*Parmelia tiliacea* (Hoffm.) Ach. - VALENCIA: Serra, Bco. Saragutillo, YJ1799, 550 m, on *Quercus suber*, 8.X.1986 F. Cuesta, VAB-LICH. 1564. CASTELLO: Sueras, Bco. de Castro, 30SYK2424, 450 m, on *Quercus suber*, 28.IV.1988, A. Muñoz, VAB-LICH. 0657.

*Parmelia tinctina* Maheu & A. Gillet - CASTELLO: Azuebar, Mosquera, 30SYK2517, quartz sandstone, 620 m, 15.IV.1989, V. Calatayud, E. Barreno, J.M. Sanz & A. Fos, VAB-LICH. 1639.

*Parmelia verruculifera* Nyl. - CASTELLO: Almedijar, 30SYK2217, 500 m, quartz sandstone, 14.IX.1991, V. Calatayud, VAB-LICH. 2407.

## Results

The results of the analyses are summarized in Tab.1.

## Conclusions

Our specimen of *Parmelia acetabulum* lacks salazinic acid and atranorin, as in other Mediterranean samples analyzed by Manrique & Crespo (1983).

Some specimens of *Parmelia caperata* can accumulate also atranorin. In the specimens where the method for identifying fatty acid was used, the presence of caperatic acid was observed.

Some specimens of *Parmelia fuliginosa* with partially developed isidia could be confused with *P. subaurifera*. However, in *P. fuliginosa*, rhodophyscin occur in the medulla (it can disappear in dead areas of the thallus!) and also the n.i.s. TE-12 is

Tab. 1: Lichen substances identified in the species of *Parmelia*. Abbreviations: AT-atranorin, NR-norstictic acid, CO-connorstictic acid, US-usnic acid, PR-protocetraric acid, FM-fumarprotocetraric acid, LE-lecanoric acid, GY-gyrofolic acid, RD-rhodophyscins, ST-stictic acid, CS-cryptostictic acid, CN-constictic acid, HS-hypostictic, SA-salazinic acid, CL-consalazinic acid, ES-stenosporic acid, DI-divaricatic acid, GL-glomellic acid, GO-glomelliferic acid, LU-lusitana unknown?, T12- not identified T12, N.I.S.-not identified substance; EPI-number of epiphytic samples analyzed; SAX- number of saxicolous samples.

	AT	NR	CO	US	PR	FM	LE	GY	RD	ST	CS	CN	HS	SA	CL	ES	DI	GL	GO	LU	T12	NIS	EPI	SAX
<i>P. acetabulum</i>	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	
<i>P. caperata</i>	±	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	10	7		
<i>P. delisei</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	1		
<i>P. fuliginosa</i>	.	.	.	.	.	.	+	+	+	.	.	.	.	.	.	.	.	.	+	.	5	.		
<i>P. glabra</i>	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.		
<i>P. incolorata</i>	.	.	.	.	.	.	.	±	.	.	.	.	.	.	.	.	.	.	.	.	1	.		
<i>P. loxodes</i>	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	1		
<i>P. lusitana</i>	.	.	.	+	.	.	.	.	.	+	+	+	+	.	.	.	.	+	.	.	5			
<i>P. perlata</i>	+	+	.	.	.	.	.	.	+	+	+	+	.	.	.	.	.	.	.	.	12	4		
<i>P. protomatrae</i>	.	.	.	+	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	12		
<i>P. pulla</i>	.	.	.	.	.	.	±	.	.	.	.	.	.	.	.	.	.	.	.	.	14			
<i>P. quercina</i>	+	.	.	.	.	+	.	.	.	.	.	.	.	.	.	+	+	.	.	.	3	.		
<i>P. somloensis</i>	.	+	.	+	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	1	5		
<i>P. sorensenii</i>	.	.	.	+	±	+	.	.	.	.	.	+	±	.	.	.	.	.	.	8	2			
<i>P. subaurifera</i>	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	9	.		
<i>P. subrudecta</i>	±	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	12	7		
<i>P. sulcata</i>	±	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	8	5		
<i>P. tiliacea</i>	+	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6			
<i>P. tinctina</i>	±	+	.	+	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	4			
<i>P. verruculifera</i>	.	+	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	+	.	3			

present. According to Esslinger (1977), these substances lack in *P. subaurifera*, but Rico (1989) found one specimen of *P. subaurifera* from central Spain with rhodophyscins.

According to Rico (1989), in *Parmelia glabra* there is a good correlation between the relative concentrations of lecanoric and gyrofolic acids and the substrata where the samples grow (epiphytes or saxicolous). In our samples, as in Esslinger (1977), only lecanoric acid occurs, with no traces of gyrofolic acid. However, we cannot give a conclusive opinion on this matter, since only a few specimens have been analyzed.

In *Parmelia sorensenii*, protocetraric acid occurs as accessory substance. According to Culberson (1969, 1970) and Hale (1976b) this substance seems to be very infrequent in *P. sorensenii*, but its occurrence has been also reported from other Mediterranean samples (Seriña, 1990), and from specimens of eastern Africa (Swinscow & Krog, 1988).

Chemical characters are very useful to separate *Parmelia protomatrae* from *P. somloensis*, since some specimens of both species can sometimes be confused. Our samples not only accumulate fumarprotocetraric acid (Hale, 1990), but also protocetraric acid, like in other samples from the Iberian Peninsula (Rico & al., 1992).

*Parmelia lusitana*, in comparison to the closely related species *Parmelia conspersa*, accumulates an unidentified orange-coloured substance after its development with sulfuric acid (*lusitana* unknown, Krog 1987), with a Rf in the three solvent systems (A, B y C) which is intermediate between those of stictic and norstictic acids, and norstictic acid is not present. This species is not rare in the territory, and probably it has been often reported from the Iberian Peninsula under *P. conspersa*.

Although Clauzade & Roux (1985) consider *Parmelia tinctina* as a subspecies of *P. conspersa*, in our opinion stable differences in morphology, chemistry and chorology support the status of species for this taxon, as suggested by other authors (Hale, 1964 ; Poelt & Vezda, 1981; Rico & al., 1992; Hale, 1990).

According to Hale (1976a), some authors have used the presence of rhizines in the apothecial margins to segregate *P. carporrhizans* Tayl. from *Parmelia quercina*. In the survey area, both taxa have been observed, but no chemical differences have been noted to support the segregation into two species. We prefer to consider *P. carporrhizans* as a morphotype of *Parmelia quercina*.

In our samples of *Parmelia verruculifera*, stenosporic acid occurs as main substance and divaricatic acid is also present, but in lower amounts. Moreover, other two n.i.s. are present.

Two chemical groups are separated in *Parmelia pulla*. In some samples divaricatic acid occurs as main substance, stenosporic acid being less abundant. However, in another group of samples the main substance is stenosporic acid. In one specimen, gyrophoric acid is also present as an accessory substance.

The lichen substances content is a good character for separating *Parmelia delisei* from *Parmelia pulla*. Although both species were often considered as species pairs (sensu Poelt 1972), it seems more natural to relate *Parmelia delisei* with *Parmelia loxodes* (Rico, 1989). In this sense *Parmelia delisei* should be considered as the primary species of *Parmelia loxodes*.

The examined samples of *Parmelia perlata* belong to the chemical race without usnic acid nor physodalic acid (Coassini-Lokar & al., 1987).

*Parmelia sulcata*, *Parmelia tiliacea* and *Parmelia somloensis* seem to be chemically very homogeneous.

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