

Luciana Zedda & Harrie Sipman

Lichens and lichenicolous fungi on *Juniperus oxycedrus* L. in Campu Su Disterru (Sardinia, Italy)

Abstract

Zedda, L. & Sipman, H.: Lichens and lichenicolous fungi on *Juniperus oxycedrus* L. in Campu Su Disterru (Sardinia, Italy). – *Bocconea* 13: 309-328. 2001. – ISSN 1120-4060.

The lichen flora on *Juniperus oxycedrus* L. in the ancient, montane holm-oak forest at Campu Su Disterru (Supramonte di Orgosolo, central-east Sardinia, Italy) has been investigated and 68 taxa of lichens plus 3 lichenicolous fungi were identified. The most remarkable findings are: *Ophioparma rubricosa* (Müll. Arg.) Ekman., new to Europe, and *Chaenotecopsis nana* Tibell, new to Italy. 8 species are reported for the first time from Sardinia: *Agonimia octospora* Coppins & P. James, *Calicium adspersum* Pers., *Caloplaca hungarica* Magnusson, *Chaenotheca phaeocephala* (Turn.) Th. Fr., *Hypocenomyce scalaris* (Ach. ex Lilj.) M. Choisy, *Lecanora argentata* (Ach.) Malme, *Lepraria umbricola* Tønsb. and *Rinodina archaea* (Ach.) Arnold. Many further species are rare in Italy and in Sardinia. The number of species exceeds that on *Quercus ilex* L. on the same site. This demonstrates the importance of a non-dominant tree species for the epiphytic lichen flora of a forest. A phytogeographical analysis shows that species with a wide distribution in temperate areas of Europe are dominant (Temperate element, 72 %). The Atlantic/Oceanic element comprises 13%, while few species belong to other elements: Arctic-alpine / Boreal-montane 3%, Mediterranean-montane 5% and Mediterranean 7%.

Introduction

The locality of Campu Su Disterru is situated in the Supramonte di Orgosolo, in the central-eastern part of Sardinia (Fig. 1) at an altitude of 940 m (map I.G.M.I. 1:25.000 F. 517 sez. IV; coordinates 40° 09' N, 9° 28' E).

The Supramonte di Orgosolo is a mountain area made up of mesozoic limestone, which reaches its highest altitude with the Monte Nuovo San Giovanni (1316 m a.s.l.). Calcareous plateaux, dolines and ravines are frequent all over the area (Chiappini 1977).

The climate is characterized by relatively high levels of precipitation amounting to more than 1100 mm yearly (Table 1). However, the high temperatures of the summer, the length of the dry period and the calcareous nature of the soil do not permit a good retention of the water. Winters are cool, with snow for short periods of time. In the closest meteorological station, Genna Silana, the annual average precipitation amounts to 1147 mm and the average monthly temperature is 11.7°C (Fig. 2).

Table 1. Values of precipitation and temperature from the meteorological station Genna Silana (1010 m a.s.l.). Source I.S.T.A.T. 1967-78.

	J	F	M	A	M	J	J	A	S	O	N	D	Y
P	136	124	127	95	71	24	7	19	49	132	161	202	1147
	1921-80												
T	4.1	4.2	6.3	8.5	13.2	17.4	21.4	21.2	17.3	12.7	8.7	5.1	11.7
	1930-80												

The area remained floristically unexplored until the last century (Moris 1837). Its vegetation is characterized by *facies* and sub-associations of the *Quercetum ilicis*, by formations with *Erica* sp. pl. and *Genista corsica* DC. and other with *Thymus herbarona* Lois. and *Helichrysum microphyllum* Cambess (Camarda 1976).

Arrigoni & Di Tommaso (1991) distinguished three different kinds of holm-oak wood for the central-eastern mountains of Sardinia, in which the present locality is included: the thermophytic *Pistacio-Quercetum ilicis* Brullo & Marcenò; the mesophytic *Viburno-Quercetum ilicis* (Br. Bl.) Riv. Martinez; the acidophytic *Viburno-Quercetum ilicis ericetosum* Molin.; the montane *Aceri monspessulani-Quercetum ilicis* Arrig. & Di Tomm.

Thanks to the isolation some patches of old forest still survive in the area. The forest of Campu Su Disterru is an example (Chiappini 1977, Arrigoni & al. 1985, 1990, 1991). Belonging to the *Aceri monspessulani-Quercetum ilicis* Arrig. & Di Tomm, it is made up of trees of *Quercus ilex* L., which can reach an age of 300-500 years and a diameter of the trunk up to 100 cm, mixed with ancient trees of *Juniperus oxycedrus* L., which are largely

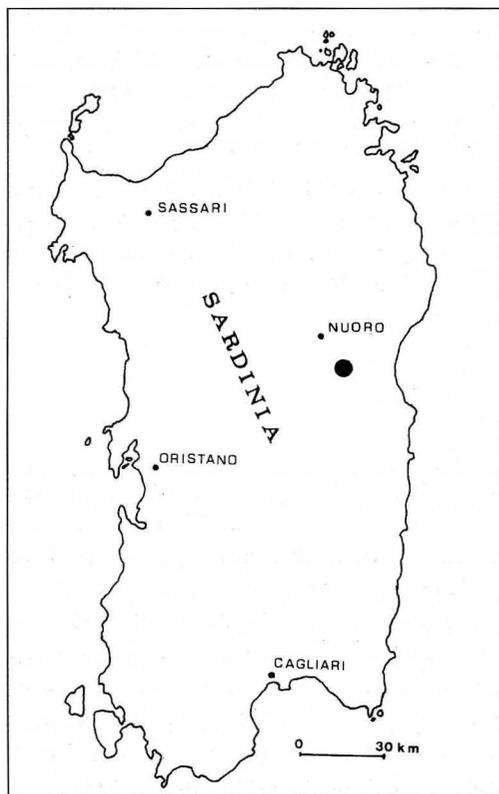


Fig. 1. Location of the study area.

dead, probably because in developed holm oak forests there are reduced light intensity conditions. Overgrazing, especially by pigs (Viola 1974), which interferes with the forest regeneration.

Juniperus oxycedrus L. is frequent in all the area as bush or tree. It can reach a height of 8-10 m and has a lengthwise slit bark which breaks off easily exposing its particularly hard wood. It is a heliophytic and xerophytic plant, widespread from sea level to the montane belt up to 1800 m. It grows very slowly, but thanks to its longevity it can reach a big size (Camarda & Valsecchi 1983). It is often a pioneer

species, which colonizes burned grounds much earlier than *Quercus ilex* L. e.g., probably because it is not grazed. In the study area specimens with a trunk diameter of 40-50 cm were observed, which could be more than 500 years old (Camarda, pers. comm.).

A search through the early botanical literature did not reveal any records of lichens in this locality. M. A. Piazza did not collect lichens in the Supramonte di Orgosolo during his stay in Sardinia (1748-1791), as reported in Terracciano (1914). Moris (1829) does not mention this locality for his collections, but it is true that for many lichens no locality is given. Baglietto (1879), whose work includes the earlier records of De Notaris and many other collectors, examined specimens from the close Gennargentu, but not from the Supramonte di Orgosolo. Colosi (1917) did not take into consideration this locality in his contribution to the knowledge of the lichen flora of Sardinia. Also the collections of Mameli (1921) do not include lichens of the Supramonte. Even Nimis & Poelt (1987) in their checklist of the lichens of Sardinia, as well Nimis & Tretiach (1993) and Tretiach (1997), do not mention collections from the examined area.

Material and methods

The examined material has been collected during a 3-hours field visit by the two authors in April 1997. Several trees of *Juniperus* have been analysed, with the aim of making a complete floristic list of the epiphytic lichens. Samples have been taken from all the parts of the tree (trunk, branches, twigs), in all expositions, as far as reachable from the ground. For the identification the following keys were used: Hafellner (1979), Tibell (1980, 1984), Clauzade & Roux (1985, 1987), Nimis (1987, 1992), Purvis & al. (1992), Nimis & Bolognini (1993), Nimis & al. (1993), Puntillo (1989), Giralt (1994), Wirth (1995), Ekman (1996). Thin Layer Chromatography (T.L.C.) has been used for some critical species, following the method of White & James (1985) and using the solvent G. The nomenclature follows Nimis (1993), with the exception of *Rinodina capensis* Hampe. The encountered species have been arranged into 5 phytogeographical groups, following mostly the classification of Nimis

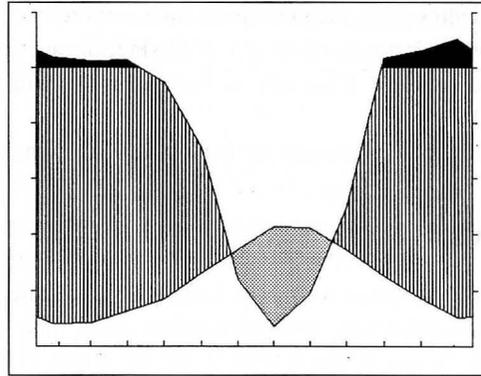


Fig. 2. Thermo-pluviometric diagram for the station Genna Silana (data from I.S.T.A.T. 1967-78).

(1996): 1) Arctic-alpine/Boreal-montane; 2) Temperate; 3) Atlantic/Oceanic; 4) Mediterranean-montane; 5) Mediterranean, on the basis of their distribution in Europe as reported by Clauzade & Roux (1987), Nimis & Poelt (1987), Wirth (1995) and Nimis (1993).

Voucher specimens are kept in B (leg. Sipman) and in the private herbarium of L. Zedda.

Annotated list

An annotated list of the lichens and lichenicolous fungi collected in the examined site is presented here with information about their ecology, in Sardinia and in Italy, as reported by Nimis & Poelt (1987) and by Nimis (1993), and their distribution in Europe based mainly on Nimis (1993) and Wirth (1995). A description of the specimens is included, only for those species whose identification was uncertain and for *Ophioparma rubricosa*, as it is new to Europe.

***Agonimia octospora* Coppins & P. James**

On mosses (*Frullaria*) on trunk (Sipman 40056).

This species seems to have a western distribution in Europe. In Italy it has been recorded only in Tuscany on *Castanea* (Nimis 1993). In Sardinia it has been probably overlooked by former collectors, as it appears to be rather frequent on old trees. Here it is reported for the first time from the island.

***Anaptychia ciliaris* (L.) Massal.**

Mainly on trunks (Sipman 40066).

Widespread throughout Europe, where it prefers isolated trees from the lowland to the montane belt (Nimis 1993). It is very frequent in the island, also on rock.

***Arthonia* cfr. *phlyctidicola* Vouaux in Pit. & Harm.**

A non-lichenized parasite on *Phlyctis argena* on trunk (Zedda 2239).

Ascospores 3-septate, 16-18 x 6 µm, 4/ascus. The identification is by Rikard Sundin (Stockholm), who indicated that it is not certain as the specimen presents much smaller spores than usual in *A. phlyctidicola*.

***Buellia griseovirens* (Sm.) Almb.**

On twigs (Sipman 40081, Zedda 2259).

Widespread from the Boreal zone to the Mediterranean mountains (Nimis 1993), most frequent in rather humid situations. In Sardinia it was found only once before, equally from a montane area.

***Calicium adpersum* Pers.**

Abundant on decorticated wood of erect trunks (Sipman 40035, Zedda).

This species is widespread from Southern Scandinavia to the Mediterranean mountains,

but seems to be rare in Italy where it is confined to upland areas with a humid climate (Nimis 1993). This represents the first record from Sardinia.

Caloplaca alnetorum Giralt, Nimis & Poelt

On twigs (in Sipman 40052).

Recently described by Giralt & al. (1992), this species appears to be rather frequent in montane areas of Sardinia. According to Nimis (1993), it grows mainly in the Alps and in the southern European mountains in humid areas and on rather nutrient-rich substrata.

Caloplaca ferruginea (Hudson) Th. Fr.

On bark of trunk (Sipman 40040).

A widespread species in temperate areas of both Hemispheres (Nimis 1993), frequent in Sardinia, especially in the uplands.

Caloplaca* cfr. *herbidella (Hue) Magnusson

On bark of twigs and trunks (Sipman 40036/39/40/48, Zedda 2267).

Widespread from the Boreal zone to the montane Mediterranean belt, mostly on acid bark (Nimis 1993). Our specimens deviate by their orange apothecia. They seem to agree with the unnamed taxon described by Nimis & Poelt (1987: 76) and Nimis (1993), which may represent an undescribed species.

Caloplaca holocarpa (Ach.) Wade

Mainly on twigs (Sipman 40082, Zedda 2264).

Widespread from the Arctic to the Mediterranean region, with a wide ecological amplitude (Wirth 1995). It was so far collected a few times in Sardinia, mostly at low altitudes.

Caloplaca hungarica Magnusson

On twigs and trunks (in Sipman 40079, Zedda 2241).

This lichen is mainly known from the montane belt of central Europe (Wirth 1995). It is here recorded for the first time from Sardinia, but it has probably been overlooked and it seems to be rather frequent in the island.

Candelariella vitellina (Hoffm.) Müll. Arg.

On mosses (*Frullaria*) on trunk (in Sipman 40056).

This species grows usually on rocks, but may occur also on bark or wood. It is widespread from the Arctic to the Mediterranean Region (Wirth 1995). It is widespread also in Sardinia, but mainly on rock or on epilithic mosses.

Catillaria chalybeia (Borrer) Massal.

On wood (Sipman 40046, Zedda 2231).

This normally epilithic lichen is widespread all over Europe and also in Italy (Nimis 1993). In Sardinia it was so far found only on rock.

Catillaria nigroclavata (Nyl.) Schuler

On twigs (in Sipman 40079, Zedda 2262).

Widespread from the South Boreal to the Mediterranean region, with a wide ecological amplitude (Wirth 1995). It has been collected rarely in Sardinia, exclusively in upland areas.

Chaenotecopsis nana Tibell

On hard wood of trunks (Zedda 2216).

This Boreal to Central European species occurs typically on the bark of coniferous trees in humid and shaded situations (Wirth 1995, Tibell 1984). This represents the first record from Italy.

Chaenotheca phaeocephala (Turn.) Th. Fr.

On wood of trunks (Zedda 2240).

C. phaeocephala has a wide distribution in the Hemiboreal-South Boreal zone in Europe. It occurs from sea level to 1000 m, mainly on wood of coniferous and deciduous trees (Tibell 1980). It is new to Sardinia.

Chrysothrix candelaris (L.) Laund.

On wood of trunks (Zedda 2243).

This lichen has a wide distribution from the Boreal to the subtropical regions of both Hemispheres. In Italy it occurs from the lowlands to the upper belt in humid situations (Nimis 1993).

Chrysothrix flavovirens Tønsberg

On trunks (Zedda 2236).

This is the second record from Italy. It has formerly been found on *Juniperus* in the locality of M. Arcosu (South Sardinia) by Tretiach & Nimis and reported as new to Italy (Tretiach 1997).

Cladonia fimbriata (L.) Fr.

On bark of trunk (Sipman 40053a).

A temperate species occurring on different substrata. In Sardinia it has been collected just a few times, mostly in montane areas.

Cladonia pyxidata (L.) Hoffm.

On mosses and bark of trunks (Sipman 40053, Zedda 2246).

Following Nimis (1993), we have decided to include all our samples under this name, although our material seems heterogeneous. It is a temperate species with a wide ecological tolerance, and it occurs on different substrata from the lowlands to the alpine belt.

Cladonia pseudopityrea Vainio

On mosses and bark of lower trunks (Sipman 40055, Zedda 2221).

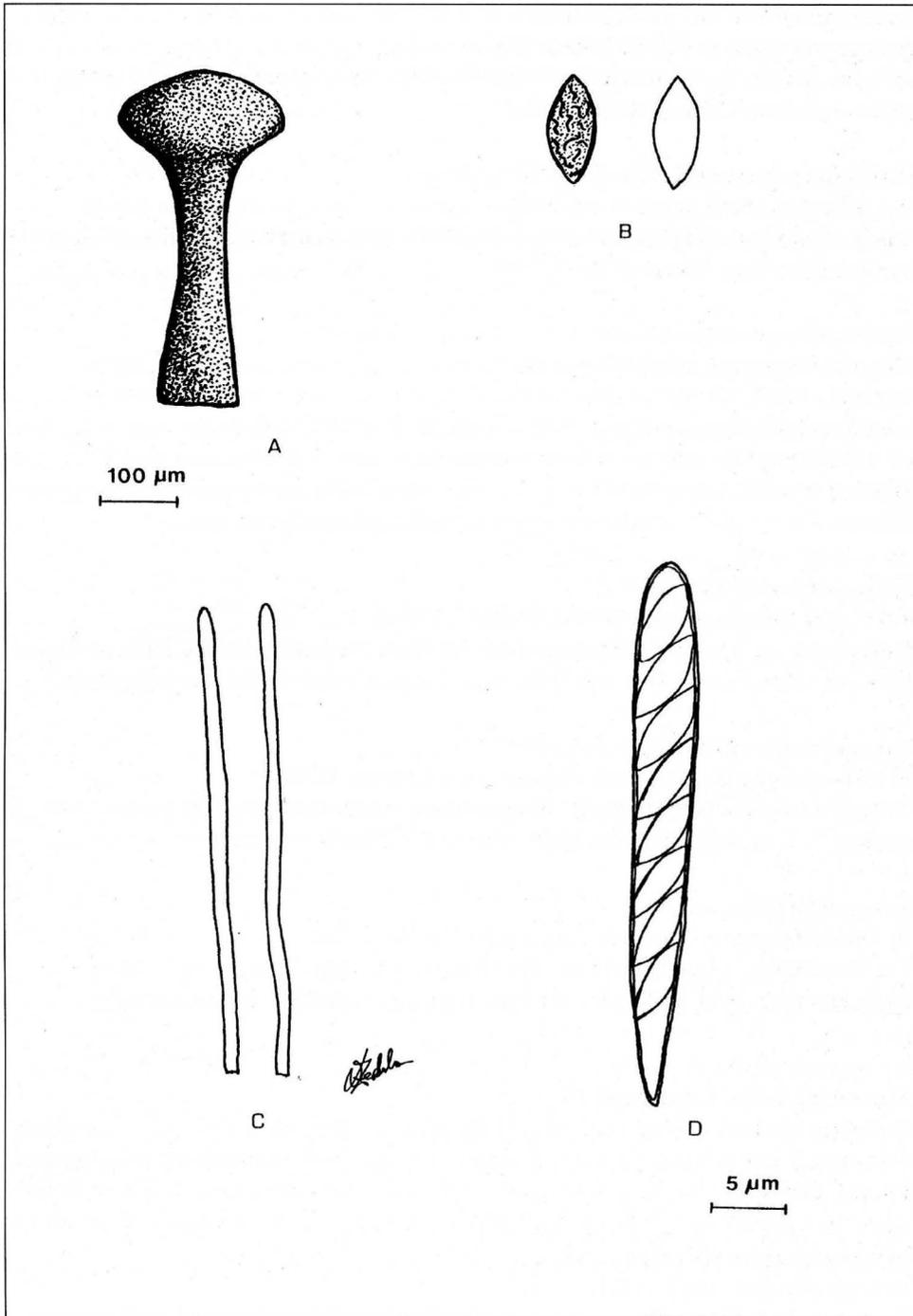


Fig. 3. *Chaenotecopsis nana* Tibell.: A) stalked apothecium; B) ascospores; C) paraphyses; D) ascus.

The distribution of this mediterranean lichen is poorly known, as it has been overlooked until recently (Ahti & Puntillo 1995). It grows mainly on wood and rarely on humus soil and it has already been found in Sardinia at M. Arbu, Nuoro (legit Ahti 1987). In Italy it is known only from Calabria and Sardinia.

Dactylospora parasitica (Floerke ex Sprengel) Zopf

This fungus has been found as a parasite on *Caloplaca ferruginea* (Sipman 40040). Usually on species of *Pertusaria* and *Ochrolechia* (Hafellner 1979). From Sardinia it has been recorded twice (Nimis & Poelt 1987).

Dactylospora* cfr. *pertusaricola (Willey ex Tuck.) Hafellner

The species has been found as a parasite on *Ophioparma rubricosa* (Zedda 2242). Apothecia small, rounded with a colourless hymenium, 60-65 μm high, with branched paraphyses and plurisporous asci (> 32 spores), 55-60 x 13-15 μm ; spores dark, uniseptate, 6-7 x 3.5-4 μm . This species is known so far from the U.S.A. (Massachusetts), where it grows on saxicolous species of *Pertusaria* (Hafellner 1979). As the ecology is completely different, it is not clear whether our specimen really belongs to this species.

Evernia prunastri (L.) Ach.

On twigs and trunks (Sipman 40070, Zedda 2227/54). *E. prunastri* has a wide distribution in the Northern Hemisphere and a wide ecological amplitude (Nimis 1993). It is one of the most common epiphytic lichens in Sardinia.

Hypocenomyce scalaris (Ach. ex Lilj.) M. Choisy

On bark of treebase and of trunk (Sipman 40034, Zedda 2229). Frequent on lignum and acid bark, throughout the Northern Hemisphere (Nimis 1993), it seems to be very rare in Sardinia and is reported here for the first time.

Hypogymnia farinacea Zopf

On bark and mosses of trunks (Sipman 40057, Zedda 2218). This species has a boreal-montane distribution, and grows mainly on conifers (Nimis 1993). It is not rare in Italy, but in Sardinia it has been recorded only once before.

Hypogymnia physodes (L.) Nyl.

On trunks (Sipman 40059, Zedda 2233). This lichen has a wide distribution and ecological range, and grows especially on acid substrata (Nimis 1993). In Sardinia it is frequent, but it has been recorded just a few times in montane areas.

Hypogymnia tubulosa (Schaer.) Havaas

On twigs (Sipman 40058, Zedda 2253). *H. tubulosa* has also a wide distribution in the Northern Hemisphere and prefers a humid climate (Nimis 1993). In Sardinia it is most frequent in the montane belt.

***Lecanora* cfr. *anopta* Nyl.**

On bark of trunks (Sipman 40045).

Thallus light yellowish-grey, not sorediate, K-, C-, P-, with pale brown to pink-brown apothecia, 0.4 - 0.8 mm wide, marginate when young, more or less convex and without margin at maturity; dark granules present in the margins. Epihymenium yellowish and granulous, with crystals. Hymenium 50 μm . Ascospores simple, 9 x 5 μm , 8/ascus. Our sample differs from the typical *L. anopta* in the colour of the apothecia, which are usually darker (red-brown or black-brown) and in the epihymenium which should be brown, olive-green or bluish and K+ green. In Italy this boreal-montane species has been found only in Veneto. It grows on decaying wood, rarely on acid bark, especially of conifers, in the montane and subalpine belt (Nimis 1993).

***Lecanora argentata* (Ach.) Malme**

On twigs (Zedda 2265).

This species has a wide holartic distribution and it is widespread in Italy, mainly in the montane belt (Nimis 1993). This represents the first record from Sardinia, but the species could have been overlooked in the past.

***Lecanora chlarotera* Nyl.**

On twigs (Sipman 40080, Zedda 2257).

A widespread lichen, with a wide ecological amplitude (Nimis 1993). It is frequent also in Sardinia.

***Lecanora dispersa* (L.) Sommerf. s.l.**

On wood of trunks (Zedda 2248).

This mainly epilithic lichen may occur also on wood and bark. It is widespread also in Italy (Nimis 1993). In Sardinia it has been collected on limestone up to now.

***Lecanora hypoptoides* (Nyl.) Nyl.**

On twigs (Zedda 2263).

This is a typical species of decaying wood, not frequent in Italy (Nimis 1993). Nimis & Poelt (1987) report it only from one locality in Sardinia, with some doubt about the identification.

***Lecanora meridionalis* Magnusson**

On wood of trunks (Zedda 2247).

L. meridionalis is very similar to *L. chlarotera*, but less frequent, and occurs mostly in open situations (Nimis 1993). It has been collected in Sardinia just a few times, but it seems to be common throughout the island.

***Lecidella elaeochroma* (Ach.) Choisy**

On twigs (Sipman 40050/83, Zedda 2256).

Widespread and very common in all the country, with a wide ecological amplitude (Nimis 1993).

Lepraria umbricola Tønsb.

On bark of tree base (Sipman 40054).

The species has been described only recently. For this reason its distribution in Italy is poorly known (Nimis 1993). This represents the first record from Sardinia. Our specimen has been analyzed by TLC, and contains thamnolic acid and traces of atranorin.

Leprocaulon microscopicum (Vill.) D. Hawksw.

On bark and epiphytic mosses (Zedda 2235).

This lichen grows mainly on soil and acid rocks, rarely on bark, and has a wide distribution (Nimis 1993). In Sardinia it has been hitherto collected only on soil or on thin soil layers in fissures of rocks.

Lethariella intricata (Moris) Krog

On trunks and branches (Sipman 40063, Zedda 2234).

This species grows mainly on acid substrata (rock and bark) and seems to be frequent in Sardinia. It occurs in the Mediterranean region, the Canary Islands and the Crimea (Nimis 1993).

Ochrolechia androgyna (Hoffm.) Arnold

On trunks (in Sipman 40039).

A circumboreal-montane lichen, more frequent in humid areas and in the uplands (Nimis 1993). In the island it seems to be restricted to montane areas.

Ophioparma rubricosa (Müll. Arg.) S. Ekman

On well-illuminated wood of a very old tree (Sipman 40038, Zedda 2242).

Thallus granular-verrucose, grey-yellowish, K-, C-, P-; soralia present, yellowish, more or less well delimited, rounded; apothecia dark red, max. 0.8 mm wide; excipulum 90 µm, with small crystals visible with polarized light; epithecium red, K+ blue-violet; hypothecium apparently grey by the presence of small crystals; paraphyses simple or branched, 2-3 µm wide; asci 35-40 x 7-12 µm; spores elongate, mostly 4-septate, 25-30 x 3-3.5 µm, 8/ascus. It contains atranorin, divaricatic, usnic and nordivaricatic acids.

The identification of our specimen was confirmed by Kalb who made the TLC analysis. This represents the first record for Europe. It differs from the european *Ophioparma ventosa* (L.) Norman by the aspect of the thallus, the smaller size of the spores and the epiphytic instead of saxicolous habitat. The presence of soralia seems to differentiate our material from the New World populations of *Ophioparma rubricosa*. Therefore it might deserve an own taxonomic status. According to Kalb & Steiger (1995) and Ekman (1996), the species is widespread from southern California to southern British Columbia in humid areas of the western slopes of the Rocky Mountains, mainly growing on conifers, and it is characteristic of dry, hard wood and acid bark.

Pannaria mediterranea Tavares

On mosses (*Frullaria*) of trunk (in Sipman 40056).

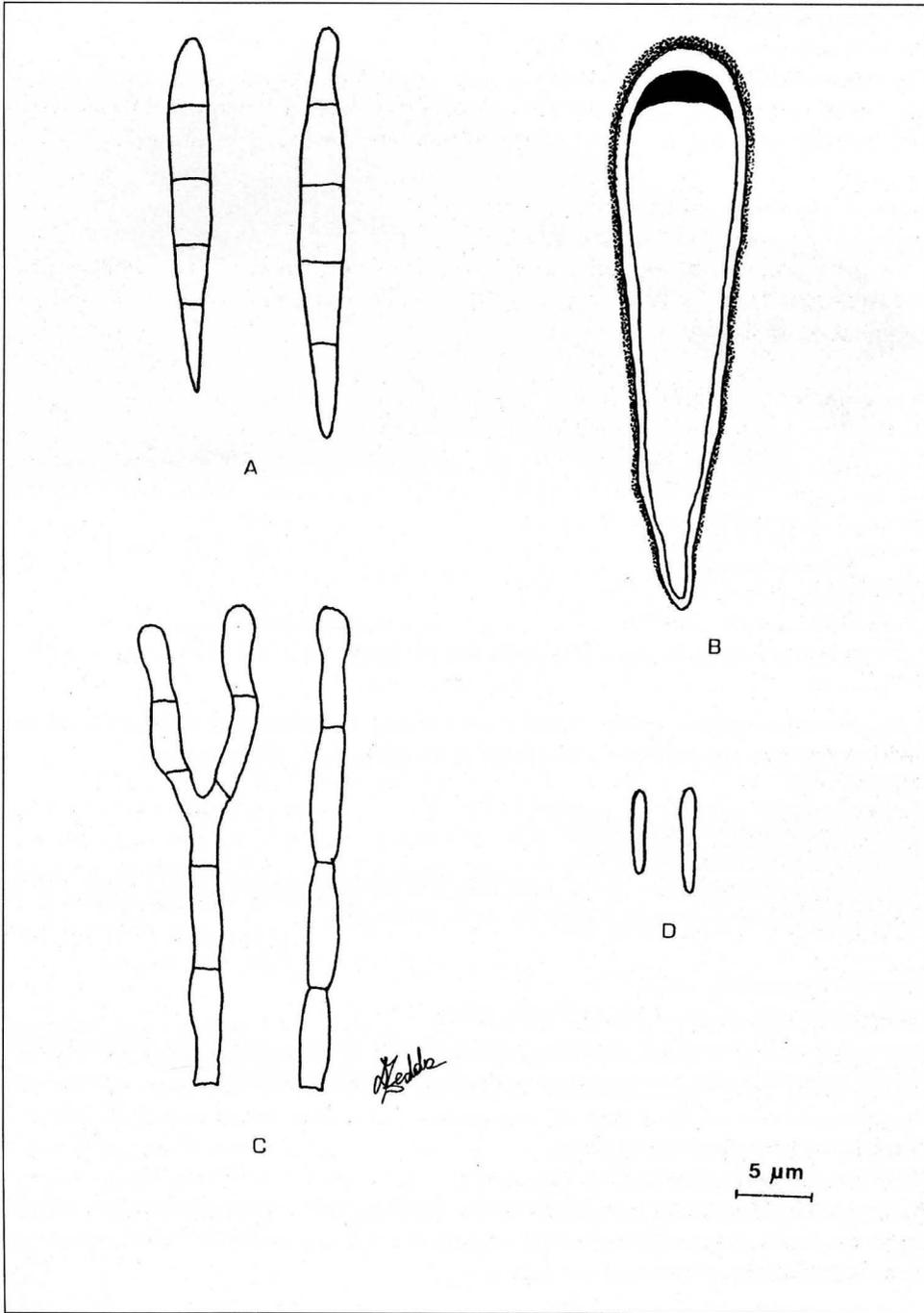


Fig. 4. *Ophioparma rubricosa* (Müll. Arg.) S. Ekman: A) ascospores; B) ascus; C) paraphyses; D) conidia.

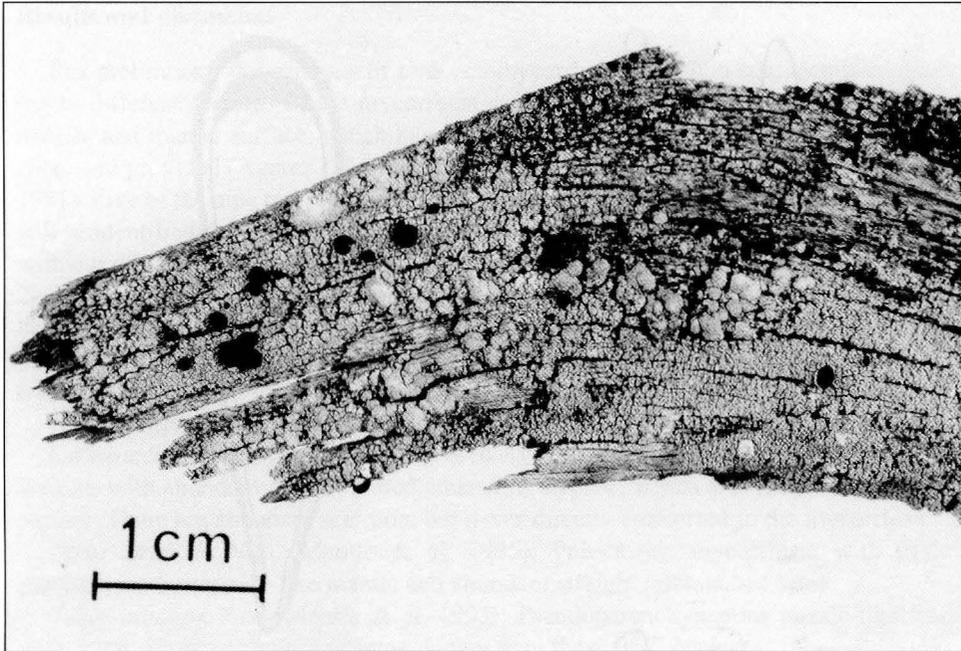


Fig. 5. Thallus of *Ophioparma rubricosa* (Müll. Arg.) S. Ekman.

A Mediterranean-atlantic species which grows mainly in undisturbed woodlands (Nimis 1993). It has been recorded just a few times in Sardinia, from montane areas.

Parmelia acetabulum (Neck.) Duby

On bark of trunks (Sipman 40069).

The species is widespread from the south Boreal to the Mediterranean zone (Nimis 1993). In Sardinia it is very common, especially in the mountains.

Parmelia caperata (L.) Ach.

On bark of trunks (Sipman 40072, Zedda 2237).

A common and widespread species occurring mainly in open woodlands (Nimis 1993). Also in Sardinia it seems to be frequent, mainly on *Quercus* species.

Parmelia elegantula (Zahlbr.) Szat.

On twigs and trunks (Zedda 2266/30).

Widespread from southern Scandinavia to the Mediterranean mountains, it occurs also in North and South America (Nimis 1993). It seems to be infrequent in Sardinia, as it has been collected only a few times.

Parmelia glabratula (Lamy) Nyl. subsp. *glabratula*

On twig (Sipman 40037).

The distribution of this lichen includes all Europe where it mainly grows on isolated trees (Nimis 1993). In the island it has been recorded just a few times, mainly in the mountains.

Parmelia laciniatula (H. Oliv.) Zahlbr.

On twigs (Zedda 2269).

Widespread from southern Scandinavia to the Mediterranean mountains. In Italy it is most frequent in the montane belt, in humid forests (Nimis 1993). Also in Sardinia it is frequent in the mountains.

Parmelia saxatilis (L.) Ach.

Abundant on trunks (Sipman 40061, Zedda 2217).

This species is widespread from the Arctic to the Temperate belt and it is most common on acid substrate in humid forests, especially in the montane belt (Nimis 1993). In Sardinia it seems to be restricted to the mountains.

Parmelia submontana Hale

On trunk (Sipman 40060).

Known mainly from the mountains of central and southern Europe, in humid situations (Nimis 1993). Also in Sardinia it is found in the mountains.

Parmelia sulcata Taylor

On trunks (Sipman 40064).

This species has an Arctic-Temperate distribution and grows mainly on acid substrata, especially in humid and shaded conditions (Nimis 1993). In Sardinia it is more common in montane areas.

Parmelia tiliacea (Hoffm.) Ach.

On twigs and trunks (Sipman 40071, Zedda 2251).

This lichen is widespread in Europe. In Italy it may be found from the lowlands to the lower montane belt, especially in the deciduous oak belt (Nimis 1993). It is one of the most common species in the island.

Pertusaria albescens (Hudson) Choisy & Werner

On trunks and twigs (Sipman 40033/73, Zedda 2270).

P. albescens is common in Temperate areas and grows mainly on acid substrata, in areas with a humid climate (Nimis 1993). In Sardinia it seems to be restricted to upland areas.

Pertusaria amara (Ach.) Nyl.

On mosses of trunks (Sipman 40074, Zedda 2244).

The species is widespread in the Northern Hemisphere. In Italy it occurs from the lowlands to the montane belt, especially in humid areas (Nimis 1993). In Sardinia it seems to be frequent, especially in the mountains.

Pertusaria caesioalba (Flotow) Nyl.

Abundant on bark of twigs, branches and trunks (Sipman 40076, Zedda 2271).

The species is very rare, and in Italy it has been recorded only once from Sardinia (Nimis & Poelt 1987). Its distribution is poorly known (Nimis 1993).

Pertusaria flavida (DC.) Laundon

On wood and bark of trunks (Sipman 40041, Zedda 2245).

The distribution of this lichen seems to be restricted to Europe, North Africa and Macaronesia, where it is frequent in deciduous and humid forests (Nimis 1993). It has been recorded a few times from Sardinia, mostly in the mountains.

Pertusaria hymenea (Ach.) Schaer.

On trunks (Sipman 40078).

Widespread in all of Europe, in Italy it mainly occurs in the lower montane belt (Nimis 1993). In Sardinia it has been recorded a few times on *Quercus* and *Castanea*.

Pertusaria pertusa (Weigel) Tuck.

On trunks and twigs (Sipman 40077, Zedda 2268).

This species is widespread in Europe and occurs in North Africa as well. It prefers montane woodlands, but is also found in the hills, especially in humid areas (Nimis 1993). In Sardinia it is widespread on various substrata.

Pertusaria slesvicensis Erichsen

On trunks and twigs (Sipman 40075, Zedda 2223).

This species occurs mainly in the Mediterranean region. In Italy it is rare, but locally abundant in Sardinia (Nimis 1993).

Phlyctis argena (Sprengel) Flotow

On trunks and twigs (Sipman 40042, Zedda 2238/55).

Widespread from oceanic Scandinavia to the mountains of the Mediterranean area, where it mainly occurs on smooth bark (Nimis 1993). It has been formerly recorded only twice from Sardinia, but it is surely more frequent.

Physcia semipinnata (Gmelin) Moberg

On twigs (Zedda 2260).

This lichen occurs mostly in southern Europe, especially in the Mediterranean region. In Italy it is widespread in open woods, in communities of the *Xanthorion* (Nimis 1993). In Sardinia it is rather common as well, especially on twigs and branches.

Physconia enteroxantha (Nyl.) Poelt

On trunks (Sipman 40044, Zedda 2219).

Widespread from northern Scandinavia to the Mediterranean region, it mainly grows on

nutrient-enriched substrata in rather open situations (Nimis 1993) and it is frequent in Sardinia, where it prefers *Quercus*-stands.

Physconia grisea (Lam.) Poelt subsp. *grisea*

On mosses of trunks (Zedda 2226).

In Europe the range of *P. grisea* goes from the southern Boreal to the Mediterranean zones. It grows on different substrata, especially when eutrophicated (Nimis 1993).

Physconia subpulverulenta (Szat.) Poelt v. *atlantica* Poelt

On bark and mosses of trunks (Zedda 2220).

This is a mediterranean lichen, mainly found in the montane belt. In Italy it seems to be present only in Sardinia (Nimis 1993).

Physconia venusta (Ach.) Poelt

On mossy trunks (Sipman 40067, Zedda 2225).

A mediterranean species occurring mainly in the montane belt, in areas with a humid climate (Nimis 1993). In Sardinia it has been reported only from montane areas.

Platismatia glauca (L.) W. Culb. & C. Culb.

On twigs and trunks (Sipman 40065, Zedda 2224/50).

The range of this species goes from the Boreal to the Mediterranean area. It grows on acid substrata, and in the Mediterranean region it is more frequent in the mountains (Nimis 1993). Also in Sardinia it is frequent in the uplands, on bark and rock.

Pseudevernia furfuracea (L.) Zopf

Abundant on twigs and trunks (Sipman 40062, Zedda 2232/52).

The species has a boreal-montane distribution. In the Mediterranean area it is restricted to the montane belt (Nimis 1993) and also in Sardinia it grows only in the mountains.

Pyrrhospora* cf. *elabens (Fr.) Hafellner

On wood and bark of trunks, in big exemplars (Sipman 40049, Zedda 2215).

Thallus strongly areolate-verrucose, pale grey or dark greenish-grey; medulla P+ red; apothecia lecideine, black, convex, 0.5-2 mm; epithecium brown, K+ brownish, dissolving; hymenium 40 µm; hypothecium colourless; ascospores simple, 9 × 3 µm; conidiospores 15 × 1 µm. The thallus appears to be different from that of the true *P. elabens*. For this reason our identification is not completely sure.

The species has a wide distribution in both Hemispheres. In Italy it seems to be rare and in Sardinia it has been recorded by Colosi (1917) on *Castanea* (Tonara) and by Nimis from M. Arcosu (Hafellner 1993).

Pyrrhospora quernea (Dickson) Koerber

On trunks (Zedda 2271).

This is a Mediterranean-atlantic species of humid areas (Nimis 1993). In Sardinia it has been collected just a few times on *Juniperus* and *Quercus suber*.

Rinodina archaea (Ach.) Arnold

On trunk (Sipman 40043).

This species occurs mainly in northern and central Europe, in montane areas, on broad-leaved trees and conifers. In Italy it seems to be rare and restricted to the North (Ropin & Mayrhofer 1993). The species is new to Sardinia.

Rinodina capensis Hampe

On twigs (Sipman 40051/79, Zedda 2261).

This seems to be a montane species with a distribution centre in the Alps (Nimis & Poelt 1987). It has been found rarely in Sardinia, mainly in the mountains.

Tephromela atra (Huds.) Haf. var. *atra*

On twigs (Sipman 40052, Zedda 2258).

This species has a wide distribution in both Hemispheres and a wide ecological amplitude. In Italy it is widespread and occurs mainly in humid areas (Nimis 1993). It is widespread and common in the island as well, also on rock.

Trapeliopsis flexuosa (Fr.) Coppins & P. James

On wood of trunks (Sipman 40047, Zedda 2272).

This lichen has probably a holarctic distribution and grows mainly on conifers and on wood. In Italy it seems to be common in the montane belt (Nimis 1993), but in Sardinia it has been collected only a few times.

Xanthoria parietina (L.) Th. Fr.

On trunks (Sipman 40068).

This lichen has a wide distribution and grows on different, especially nutrient-enriched substrata (Nimis 1993). It is widespread throughout Sardinia, with a wide ecological amplitude.

Results and conclusions

Altogether, 68 taxa of lichens plus 3 lichenicolous fungi were found on *Juniperus oxycedrus* L. in the locality of Campu Su Disterru (Orgosolo, Italy). The lichen flora of *Juniperus* appears richer than that of *Quercus ilex* L. in the same locality, (51 lichen species plus 1 lichenicolous fungus).

The quantitative difference between the two phorophytes could be explained by the greater age of the juniper trees, which may have colonized the place after a fire much earlier than the holm oaks. Furthermore, *Q. ilex*, which is an evergreen oak, has a very dense foliage, so that only little light reaches the trunk and the branches, while the juniper trees

have a more opened foliage. This fact could also explain why the deciduous oaks of central and northern Europe host more lichen species than *Q. ilex*. The lower light intensity under the holm-oaks is surely not favourable for the growth of more lichen species, especially in pure oak stands. This demonstrates the importance of having different phorophytes in the forest ecosystem for the biodiversity of lichens.

The significance of the lichen flora on *Juniperus oxycedrus* is not only quantitative, as several unusual taxa were found. Among the reported lichens *Ophioparma rubricosa* is new to Europe; however, the material may represent a new taxon. *Chaenotecopsis nana* has been found for the first time in Italy. Some species are newly recorded from Sardinia: *Agonimia octospora*, *Calicium adpersum*, *Caloplaca hungarica*, *Chaenotheca phaeocephala*, *Hypocenomyce scalaris*, *Lecanora* cfr. *anopta*, *Lecanora argentata*, *Lepraria umbricola*, *Rinodina archaea*. *Agonimia octospora*, *Caloplaca hungarica* and *Lecanora argentata* have probably been overlooked in the past, as they occur rather frequently in the island also on other phorophytes. A large number of species is very rare and has been collected only a few times in Italy, especially in Sardinia: *Chrysothrix flavovirens*, *Cladonia pseudopityrea*, *Lecanora hypoptoides*, *Lethariella intricata*, *Pertusaria caesioalba*, *Pertusaria slesvicensis* and *Pyrrhospora* cfr. *elabens*. *Hypogymnia farinacea* is common in Italy, but rare in Sardinia.

Three lichenicolous fungi were observed: *Arthonia* cfr. *phlyctidicola* on the thallus of *Phlyctis argena*, *Dactylospora* cfr. *pertusaricola* on *Ophioparma rubricosa* and *Dactylospora parasitica* on *Caloplaca ferruginea*. Two of them are probably new species, as they both differ in some important characters.

An analysis of the ecological spectrum, based on the information presented in the species list, shows, not surprisingly, that the greatest part of the species is characteristic for acid substrata, especially for conifers. Nevertheless, a small group of species preferring nutrient-enriched substrata has also been found (*Physcia semipinnata*, *Physconia enteroxantha*, *Physconia grisea*, *Xanthoria parietina*). Their presence is probably related to the grazing of pigs.

The greatest part of the species (Table 2. 6) belongs to the Temperate group (72 %). These species are more or less widely distributed in Europe. The Temperate element is the most frequent in the entire lichen flora of Sardinia, especially in the montane vegetation

Table 2. Percentage and number of species belonging to the different phytogeographical groups.

	%	Number of species
Arctic-alpine/Boreal-montane	3	2
Temperate	72	49
Atlantic/Oceanic	13	9
Mediterranean-montane	5	3
Mediterranean	7	5

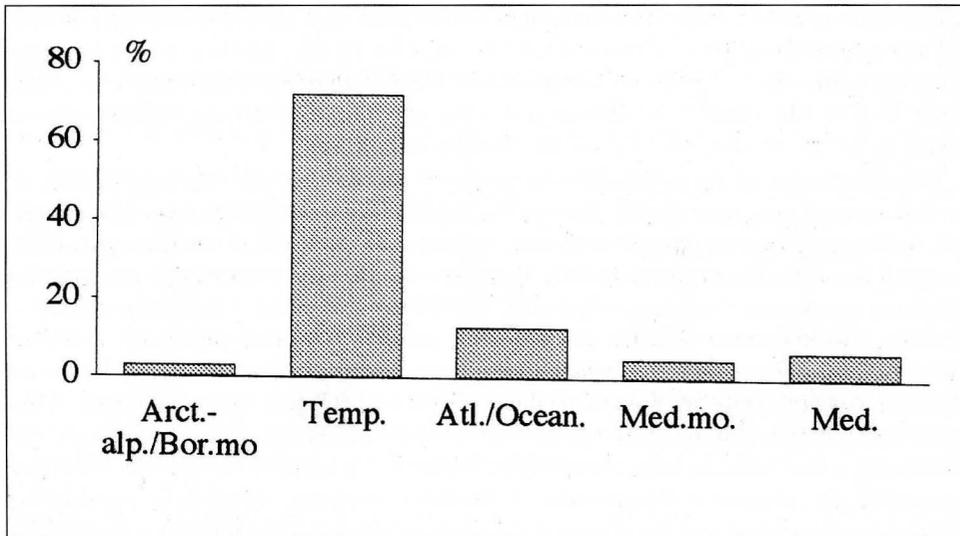


Fig. 6. Phytogeographical spectrum.

belt (Nimis & Poelt 1987, Nimis & Tretiach 1995). The Atlantic/Oceanic element is also well represented (13 %). This suggests that this element is an important component in the epiphytic montane lichen flora. The Mediterranean species amount to 7%, which is a bit lower than average for the island (12%). The Mediterranean-montane and the Arctic-alpine / Boreal-montane elements appear to contribute only little to the flora (5% and 3% respectively). These results seem to be correlated with the macroclimate of the area, which is characterized by high precipitation, but it is not humid enough to host more oceanic species and cold enough to house more Arctic-alpine / Boreal-montane elements. On the other hand the climate is probably not dry enough as to allow the occurrence of a greater number of Mediterranean species. *Ophioparma rubricosa* (Müll. Arg.) S. Ekman is attributed to the Mediterranean-montane element.

Acknowledgements

We wish to thank Prof. Ignazio Camarda (University of Sassari, Italy) for his comments on the manuscript, Dr. Klaus Kalb (Neumarkt, Germany) who checked our specimen of *Ophioparma rubricosa* and made a T.L.C. analysis of it, and Dr. Rikard Sundin (University of Stockholm, Sweden), who identified the parasitic species of *Arthonia*.

References

- Ahti, T. & Puntillo, D. 1995: The status of *Cladonia pseudopityrea*, an overlooked mediterranean lichen. — Pp. 155-160 in: Daniels & al. (ed.), *Flechten Follmann*. — Cologne.
- Arrigoni, P. V., Di Tommaso, P. L. & Mele, A. 1985: Le leccete delle montagne calcaree centro-orientali della Sardegna. — *Not. Fitosoc.* **22**: 49-58.

- , —, & — 1990: Caratteri fisionomici e fitosociologici delle leccete delle montagne calcaree della Sardegna centro-orientale. — *Boll. Soc. Sarda Sci. Nat.* **27**: 205-219.
- & — 1991: La vegetazione delle montagne calcaree della Sardegna centro-orientale. — *Boll. Soc. Sarda Sci. Nat.* **28**: 201-310.
- Baglietto, F. 1879: Lichenes Insulae Sardiniae recensit F. Baglietto. — *Nuovo Giorn. Bot. Ital.* **11**: 50-123.
- Camarda, I. & Valsecchi, F. 1983: Alberi e arbusti spontanei della Sardegna. — Sassari.
- 1976: Ricerche sulla vegetazione di alcuni pascoli montani del Marghine e del Supramonte di Orgosolo (Sardegna centrale). — *Boll. Soc. Sarda Sci. Nat.* **16**: 215-250.
- Chiappini, M. 1977: Aspetti geobotanici del "Supramonte" di Orgosolo. — *Collana Verde* **46**: 189-198.
- Clauzade, G. & Roux, C. 1985: Likenoj de Okcidenta Europo. Ilustrita Determinlibro. — *Bull. Soc. Bot. Centre-Ouest* (n. s.) **7**: 1-893.
- Clauzade, G. & Roux, C. 1987: Likenoj de Okcidenta Europo. Ilustrita Determinlibro. Suplemento 2a. — *Bull. Soc. Bot. Centre-Ouest* (n. s.) **18**: 177-214.
- Colosi, G. 1917 (1919): Contributo alla conoscenza dei licheni della Sardegna. — *Malpighia* **28**: 458-478.
- Ekman, S. 1996: The corticolous and lignicolous species of *Bacidia* and *Bacidina* in North America. — *Opera Botanica* **127**: 1-148.
- Giralt, M., Nimis, P. L. & Poelt, J. 1992: Studien über den Formenkreis von *Caloplaca flavorubescens* in Europa. — *Cryptogamie, Bryol., Lichénol.* **13**(2): 261-273.
- 1994: Key to the corticolous and lignicolous species of the genus *Rinodina* present in the Iberian Peninsula and Balearic Islands. — *Bull. Soc. linn. Provence* **45**: 317-326.
- Hafellner, J. 1979: *Karschia*. Revision einer Sammelgattung an der Grenze von lichenisierten und nichtlichenisierten Ascomyceten. — *Beihefte zur Nova Hedwigia* **62**: 1-248.
- 1993: Die Gattung *Pyrrhospora* in Europa. Eine erste Übersicht mit einem Bestimmungsschlüssel der Arten nebst Bemerkungen zu einigen außereuropäischen Taxa (lichenisierte *Ascomycotina*, *Lecanorales*). — *Herzogia* **9**: 725-747.
- I.S.T.A.T. 1967-78: Annuario di statistiche metereologiche **7-18**.
- Kalb, K. & Steiger, B. 1995: Rindenbewohnende Arten der Flechtengattung *Ophioparma* in Amerika. — *Bibliotheca Lichenologica* **58**: 191-198.
- Mameli, E. 1921: Licheni della Sardegna. — *Atti Ist. Bot. Lab. Critt. Pavia* (ser. 2) **17**: 159-173.
- Moris, J. H. 1829: *Stirpium Sardoarum Elenchus* **3**. — Taurini, Cagliari.
- 1837: *Flora Sardoia* **1**. — Torino.
- Nimis, P. L. 1987: I Macrolicheni d'Italia. Chiavi analitiche per la determinazione. — *Gortania* **8**: 101-220.
- & Poelt, J. 1987: Lichens of Sardinia. — *Studia Geobotanica* **7**(1).
- 1992: Chiavi analitiche del genere *Caloplaca* Th. Fr. in Italia (*Lichenes, Teloschistaceae*). — *Not. Soc. Lich. Ital.* **5**: 9-28.
- 1993: The Lichens of Italy. An annotated catalogue. — Torino.
- & Bolognini, G. 1993: Chiavi analitiche del genere *Lecanora* Ach. in Italia. — *Not. Soc. Lich. Ital.* **6**: 29-46.
- , —, Castello, M. & Tretiach, M. 1993: Il genere *Physcia* s. lat. - Nono Corso di Lichenologia. — Università degli Studi di Trieste e Soc. Lich. Ital. (unpublished).
- & Tretiach, M. 1993: A contribution to lichen floristics in Italy. — *Boll. Mus. Reg. Sci. Nat. Torino* **11**(1): 1-45.
- & — 1995: The lichens of Italy - a phytoclimatical outline. — *Crypt. Bot.* **5**: 199-208.
- 1996: Towards a checklist of Mediterranean lichens. — *Boccone* **6**: 5-17.
- Puntillo, D. 1989: Chiavi analitiche delle *Caliciales* italiane. — *Webbia* **43**(1): 145-168.

- Purvis, O., W., Coppins, B. J., Hawksworth, D. L., James, P. W. & Moore, D. M. (ed.) 1992: The Lichen Flora of Great Britain and Ireland. — London.
- Ropin, K. & Mayrhofer, H. 1993: Zur Kenntnis corticoler Arten der Gattung *Rinodina* (lichenisierte Ascomyceten) in den Ostalpen und angrenzenden Gebieten. — *Herzogia* **9**: 779-835.
- Terracciano, A. 1914: La "Flora Sardoia" di M. A. Piazza di Villafranca redatta con i suoi manoscritti. — *Mem. Acc. Sc. Torino* **64(2)**: 1-54.
- Tibell, L. 1980: The lichen genus *Chaenotheca* in the Northern Hemisphere. — *Symb. Bot. Upsal.* **13(1)**: 1-65.
- 1984: A reappraisal of the taxonomy of *Caliciales*. — *Beihft. zur Nova Hedwigia* **79**: 597-713.
- Tretiach, M. 1997: Additions to the Italian lichen flora. — *Webbia* **51(2)**: 391-403.
- Viola, F. 1974: Primo contributo allo studio dell'ecosistema lecceta di Supramonte: le popolazioni di erbivori domestici. — *Monti Boschi* **4**: 3-21.
- White, F. J. & James, P. W. 1985: A new guide to microchemical techniques for the identification of lichen substances. — *Bull. Br. Lichen Soc.* **57** (suppl.): 1-41.
- Wirth, V. 1995: *Flechtenflora*. 2. Auflage. — Stuttgart.

Adress of the authors:

L. Zedda, H. Sipman: Botanical Garden and Botanical Museum, Königin-Luise-Str. 6-8, D-14191 Berlin - Germany.