Botanica Complutensis 35: 5-14. 2011 ISSN: 0214-4565
http://dx.doi.org/10.5209/rev_BOCM.2011.v35.1

Ramalina carminae (Ascomycota: *Ramalinaceae*), a new species from Europe

Rosario Arroyo, Estela Seriñá and Elena Araujo[1]

Abstract: Arroyo, R.; Seriñá, E. & Araujo, E. 2011. *Ramalina carminae* (Ascomycota: *Ramalinaceae*), a new species from Europe. *Bot. Complut.* 35: 5-14.

Ramalina carminae is described as new to science. The new species is found in several localities in Portugal and Spain and in one locality in Sardinia (Italy). It is characterized by a fruticose thallus with profuse soralia, irregular shape, twisted branches and by the presence of variolaric acid as the only compound in the medulla.

Key words: Iberian Peninsula, new species, *Ramalina*, taxonomy, secondary chemistry, variolaric acid.

Resumen: Arroyo, R.; Seriñá, E. & Araujo, E. 2011. *Ramalina carminae* (Ascomycota: *Ramalinaceae*), una especie nueva de Europa. *Bot. Complut.* 35: 5-14.

Ramalina carminae se describe como nueva para la ciencia. Esta nueva especie se ha encontrado en varias localidades de España y Portugal así como en Cerdeña (Italia). Se caracteriza por su talo fruticuloso, sólido, irregular y abundantemente ramificado, lacinias de forma irregular frecuentemente tortuosas y abundantemente sorediadas desde la base, con gran diversidad en la morfología de los soralios. Químicamente esta nueva especie queda caracterizada por el ácido variolárico como único metabolito secundario en la medula.

Palabras clave: Península Ibérica, nueva especie, *Ramalina*, taxonomía, metabolitos secundarios, ácido variolárico.

INTRODUCTION

The genus *Ramalina* Ach. is a cosmopolitan and very species-rich lichen genus. It comprises *c.* 200 species according to Fletcher *et al.* (2009). It is regarded as one of the taxonomically most difficult genera of macrolichens because most of its species are quite variable in their morphology, probably due to environmental modifications, and many of them show also variability in their secondary metabolites. There have been made several approaches to the knowledge of this genus, considering not only the morphology of the species, but also their anatomy and secondary metabolites, being the later essential in the comprehesion of this genus (Krog & James 1977, Krog & Østhagen 1980, Stevens 1987, Bartsch 1992, Kashiwadani & Kalb 1993, Blanchon *et al.* 1996, Bannister & Blanchon 2003, Aptroot & Bungartz 2007, Aptroot & Schumm 2008).

The high intraspecific chemical variability of some of its species is not correlated with a morphological variation. In the past, this led to the description of a number of infraspecific and even specific taxa, that were subsequently treated as chemical strains or chemotypes. In Europe and America key studies were made in the *Ramalina farinacea* group (Culberson 1966, Hawksworth 1968, Krog & James 1977, Bowler & Rundel 1978, Krog & Østhagen 1980) and the *R. siliquosa* group (Culberson 1967, Culberson & Culberson 1967, Hawksworth 1976, Sheard & James 1976, Søchting 1976, Krog & James 1977, Santesson 1984, Clauzade & Roux 1985).

In the Iberian Peninsula this genus has been widely studied, from a morphological and a chemical point of view and many contributions to the Iberian Lichenological Flora are presented (Arroyo & Manrique 1988, Arroyo & Manrique 1989, Arroyo *et al*. 1991, Arroyo 1993, Arroyo *et al*. 1995, Álvarez *et al*. 2001).

The morphological variability which characterizes some species of this genus, such as the *Ramalina polymorpha* group, has caused many problems in order to unders-

[1] Departamento de Biología Vegetal I, Facultad de Biología, Universidad Complutense, E-28040 Madrid, Spain. *rarroyoc@bio.ucm.es; serina@bio.ucm.es*

Recibido: 26 mayo 2011. Aceptado: 21 junio 2011

tand it. From Acharius (1810) to the present, numerous studies have dealt with the taxonomy of this group which includes *Ramalina polymorpha* (Ach.) Ach., *R. capitata* (Ach.) Nyl., *R. protecta* H. Magn., *R. strepsilis* (Ach.) Zahlbr. and *R. digitellata* Nyl. In some cases this taxa can be distinguished morphologically, however intermediate forms often appear, which has led to a permanent discussion over its taxonomic position. Some authors (Krog & James 1977, Krog & Østhagen 1980) recognized a single species *Ramalina polymorpha* (Ach.) Ach. with different morphotypes, but this synthetic approach has not been accepted by other authors who have recognized in the group two species: *Ramalina polymorpha* (Ach.) Ach. and *R. capitata* (Ach.) Nyl. (Santesson 1984, Sancho 1988, Nimis & Poelt 1987).

This two species were recognized in the chemical and morphological study of the *Ramalina polymorpha* group in Spain (Arroyo *et al*. 1991) which was based on 891 specimens. This study also suggested to treat the different morphotypes observed among *R. capitata*, which is a very polymorphic species, especially in the Mediterranean area, as varieties. Nimis (1993) gave an infraspecific range to this morphotypes: *R. capitata* (Ach.) Nyl. var. *capitata*, *R. capitata* var. *protecta* (Magnusson) Nimis and *R. capitata* var. *digitellata* (Nyl.) Nimis.

In the present work, mainly based on material collected by the authors, we describe a new species from Portugal, Spain and Sardinia (Italy). The new species is associated to the different varieties which, according to Nimis (1993) we accept among *R. capitata*. We will refere to these varieties as *Ramalina capitata* complex.

MATERIALS AND METHODS

The first material studied (67 specimens) was collected by the authors on several field trips in the Tiermes archaeological site, at Montejo de Tiermes (SW of the province of Soria, Spain). We have done the *Ramalina* genus revision (year 2007) in different national and international herbaria and we found two specimens from Sardinia (Italy) and three from Portugal, which are identical in its morphology as well as in its chemical composition to those presented in this work. 140 specimens collected by the authors and other different collectors between 1967 and 1990 in different Spanish locations were provisionally included into the *Ramalina capitata* complex as atypical specimens. All this samples as well as recent collections (37 specimens) have been assimilated to this new species.

All specimens (249) deposited in BCN, LEB, MACB, MAF, PO and TSB, were examined with standard techniques by using stereoscopic and compound microscopes. A short-list was examined and photographed using a Nikon SMZ 1500 stereomicroscope and a Nikon Eclipse 80i microscope fitted with bright field (BF) and differential interference contrast (DIC), both coupled to a Nikon DXM 1200F digital camera. To combine successive photographs at different focal levels we used the free Public Domain software CombineZ5 by Alan Hadley (http://www.hadleyweb.pwp.blueyonder.co.uk).

Secondary metabolites of all specimens were identified by thin-layer chromatography (TLC) using solvent systems A, B, C (Culberson & Kristinsson 1970, Culberson *et al.* 1981, Huneck & Yoshimura 1996, Orange *et al.* 2001). *Ochrolechia parella* (MACB 60317) was used as standard for the variolaric acid. Measurements (width of the branches and diameter of the soredia) were calculated by using 10 samples of each morphotype in the complex and the results are given as minimum value observed (in brackets) followed by average value obtained and maximum value observed (in brackets).

RESULTS

Ramalina carminae R. Arroyo & E. Seriñá sp. nov.

Thallo saxicolo, erecto, caespitoso vel subpendulo, rigido, usque ad 6 cm longo, cinereoflavescente. Laciniae applanatae, irregulariter divisae, ramificatione intricate, rugulosostriatae et pro parte majore dichotomae. Soraliis numerosae lateralia et terminalia, sorediis granulosi. Apotheciis ignotis. Thallo K-; medulla K+, KC+ P-; UV-. Acidi variolarici et usnici continens.

Typus: **SPAIN**: **Soria**: Montejo de Tiermes (Archaeological Site), UTM: 30T48721 457519, 1150 m alt., N-NW exposure, sandstone, 28 August 2007, *M. J. Pérez Alonso* (Arroyo 4284) (100.000 MACB-holotypus; H, MA, UPS-isotypi) (Figs. 1-6).

Thallus shrubby, erect to subpendulous or rarely caespitose, rigid, yellow green to almost whitish in some areas which usually belong to branching points or changes in the branches width; profusely and irregularly branched. *Branches* with a matt and irregularly grooved surface, with veins projected specially in the lower face, irregularly shaped, frequently twisted and intermixed, giving a frayed appearance, of 1-6 cm length, (0.45-)0.78(-1.25) mm width in the base and up to (0.25-)0.58(-1.37) mm in the apices, showing a non-gradual variation and being common the expansion of the apices; cracks are common and they are frequently sorediate. Highly sorediate, especially in the upper part and particularly in the apical expansions. *Soralia* scattered, with a great morphological diversity, more diffuse in the apical parts, with trend toward labriform, or under the thin finger-shaped branches, more rarely capitate or helmet-shaped. Marginal and laminar soralia are better delimitated, more or less excavated. Some marginal soralia are clearly deeply concave. Others take a funnel-shape covered in soredia and other capitate soralia, mainly

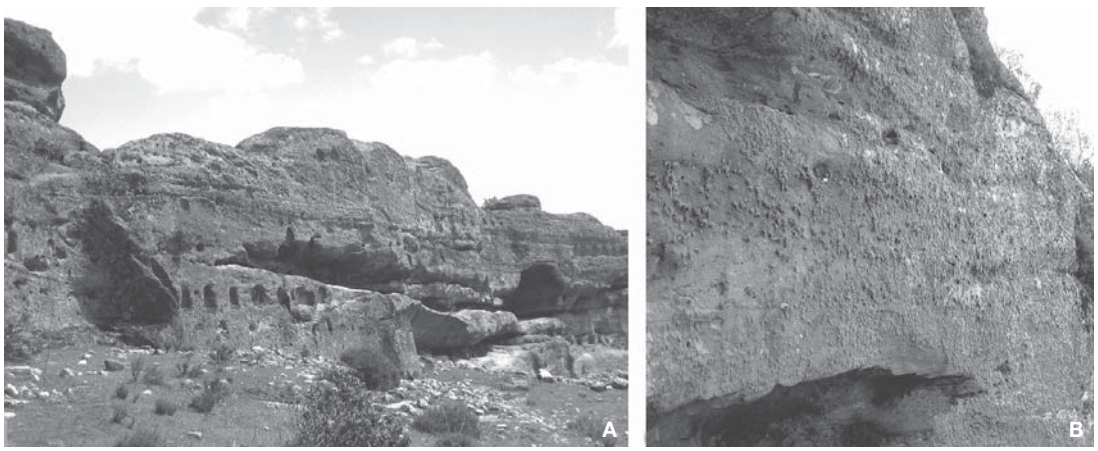

Fig. 1– Type locality of *Ramalina carminae,* Montejo de Tiermes (Soria, Spain). **A**: showing general aspect of the locality with the drilled rock by Romans; **B**: detail of the species habitat, vertical wall.

apical, arise from thin branches by way of peduncle, almost whitish. *Soredia* granular, of 50-80 µm diam. *Pseudocyphellae* sparse and oval. *Apothecia* and *pycnidi*a not seen (Figs. 2-3).

Anatomy.–Like most of the species in *Ramalina*, it also characteristically shows a distinctly two-layered cortex. The outer *cortex* (paraplectenchymatous), 7-12 µm thick. The inner layer *chondroid cylinder* (mechanical tissue prosoplechtenchymatous) forming a more or less continuous layer of uneven width, 60-250 µm thick, sometimes filling the entire cross section of a branch. *Medulla* lax (Fig. 4).

Chemistry.–Cortex K-, C+ and KC+ weakly yellowish, P-, UV-. Medulla and soralia: K+ weakly yellowish, KC+ orange, P-, UV-. All specimens show a great chemical uniformity, containing variolaric acid as the only compound in the medulla and usnic acid in the cortex.

Etymology.–The name of this species is given in honour to Mª del Carmen Cabeza Menéndez (Carmina, 1917-2007), mother of this work's first author. She always felt very proud of the fact that one of her daughters was dedicated to the study of something as thrilling as lichens and *Ramalina* genus.

Habitat and distribution.–The description of *Ramalina carminae* is mainly based on herborized material collected from the Tiermes archaeological site (Soria, Spain) at an altitude of 1150 m, on sandstones (type locality). These populations grow preferentially on vertical walls with N-NW exposure, protected from direct wind incidence, where *R. carminae* reaches a great cover; only some specimens of scarce developement were found on bird perches. In that locality *Ramalina carminae* grows together with the *R. capitata* complex, especially with *R. capitata* var. *protecta*, appearing frequently intermixed, so *R. carminae* may go unnoticed. Other associated species in this locality, like *Ramalina farinacea* (L.) Ach. and saxicolous *Evernia prunastri* (L.) Ach., are less common (Fig. 1). From the presence of this taxon in other Spanish localities, it can be conclude that its habitat is the saxicolous one and it grows on acid rocks in mountainous areas. The new species is most frequently found at altitude range from 1200 to 2000 m. The lowest altitude (650 m) corresponds to Beira Alta (Portugal) and the highest one (2500 m) to Peñones de San Francisco, Sierra Nevada, Granada (Spain). Although there have been found some specimens over exposed siliceous rocks, *Ramalina carminae* is more frequent on sheltered rocky areas or on vertical walls protected from direct wind and rain. As for the distribution of *Ramalina carminae*, it seems to be a taxon of some mountains in the Mediterranean Region. At the present time this new species was found in several mountainous localities in Beira Alta (Portugal) and Almería, Ávila, Granada, Guadalajara, Madrid, Soria and Teruel (Spain) in the Iberian Peninsula, as well as in Sardinia (Italy) (Fig. 5).

Observations.–In the morphological range of *Ramalina carminae* we found two morphotypes; one of them, less usual, belongs to small rosette-shaped thallus up to 2 cm diam. and 0.5 cm tall, which can be caespitose; laciniae flat, richly dichotomously branched, distal parts fan-shaped branched; these distal parts, which do not twist or do it slightly, have granular soralia on the tips. This morphotype was found on stone, in a cave of Puerto de la Morcuera (Madrid, Spain) at 1450 m. In this locality, but out-

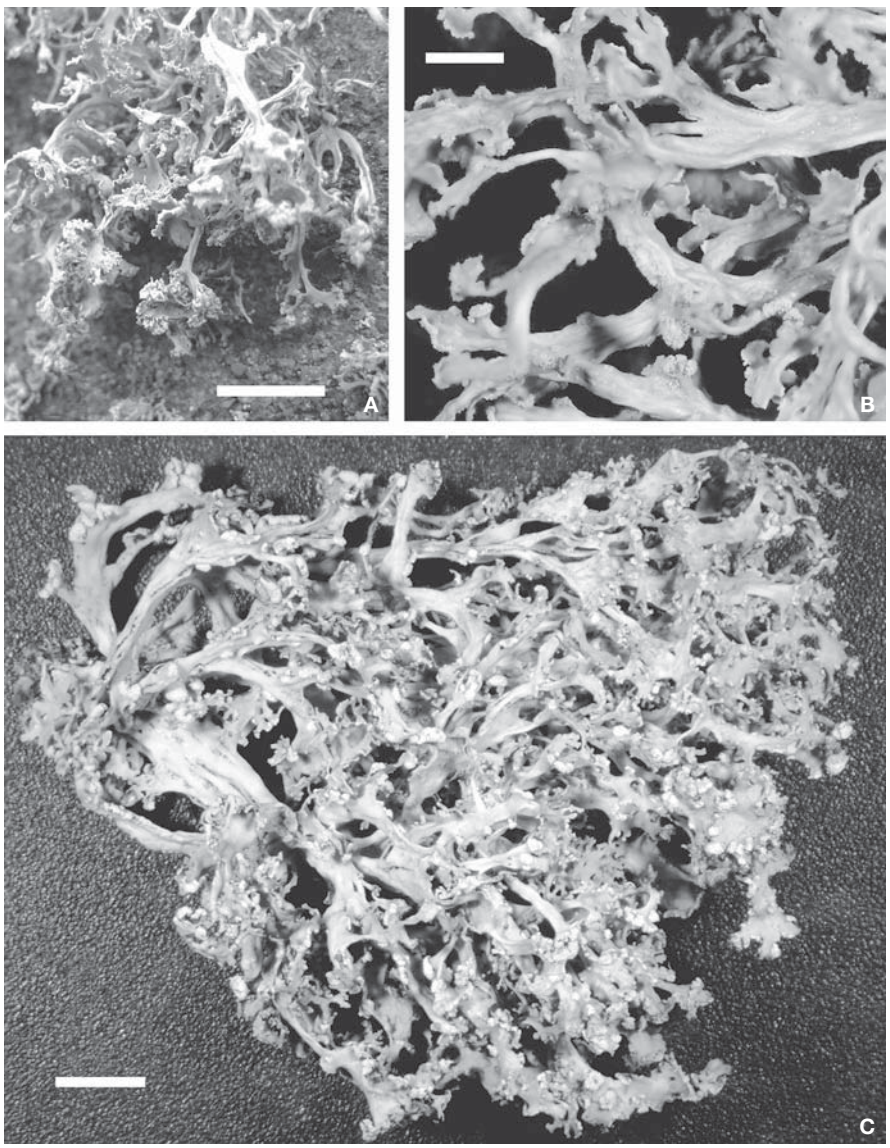

Fig. 2– Habit of *Ramalina carminae.* **A**: habit in the type locality (Montejo de Tiermes); **B**: detail of soralia (LEB 6943a); **C**: habit of holotype. Scales: **A** and **C** = 5 mm; **B** = 2 mm.

side the cave, we found the first described morphotype, more common, erect to subpendulous and with a great morphological diversity of soralia, coexisting with different varieties of *R. capitata* and saxicolous *R. pollinaria* (Westr.) Ach. The small rosette-shaped morphotypes of *R. carminae* may recall *R. capitata* var. *digitellata* in its palmately branched finger-shaped apices of the laciniae. We studied the type material of *R. digitellata* Nyl. and we found differences in the branching appearance and in the curvature of the apices of the lacinae. Furthermore, *R. capitata* var. *digitellata* as well as *R. polymorpha* and the different varieties of *R. capitata* lack medullary substances, only some specimens contain norstictic acid (Arroyo *et al.* 1991) which causes the K+ red reaction in medulla and soralia. This reaction was also noticed by Magnusson (1956), when he described *R. protecta.* However *R. carminae* always contains variolaric acid, a very important character for the differentiation of this taxon.

The remaining samples from the other iberian localities presented in this work, were previously included into

Fig.3– Habit and soralia of *Ramalina carminae* (part of the holotype). Scale = 5 mm.

the *R. capitata* complex as atypical specimens with great profusion of soralia and a chemical compound with Rf (3:2:2) class as the only secondary metabolite (Arroyo *et al.* 1991). This material matches from a morphological, anatomical and chemical point of view with the description of this new species, that is why we assimilate all this specimens to *R. carminae*. Differences in the morphology of the soralia between the three varieties that we accept in the *R. capitata* complex are shown in Fig. 6.

Possible confusions with *R. capitata* var. *protecta* are due to the presence of some helmet-shaped soralia in *R. carminae*, but the rest of their morphological and chemical features are completely different. There are other probable confusion, reflected in the material of different herbaria (three specimens from Portugal, one of them stored in the Herbarium of the University of Oporto (PO) and two more stored in the Herbarium of the University of León (LEB 6943) Spain) that we have reviewed, between *R. carminae* and *R. pollinaria* (Westr.) Ach. and *R. subfarinacea* (Nyl. ex Cromb.) Nyl. Morphological as well as chemical characters of both taxons clearly differ from those of *R. carminae*. The specimens of *R. carminae* with abundant soralia may recall *R. pollinaria*, but in case of doubt a chemical test is decisive, because *R. pollinaria* always contains evernic and obtusatic acids. Confusions with *R. subfarinacea* are less probable despite the presence of some marginal soralia with granular soredia in *R. carminae.* In their morphology as well as in their chemical composition and habitat, they are very different taxa. The specimens from Sardinia (two saxicolous samples) analyzed by Dr. S. Bartsch and stored in (TSB) Herbarium Universitatis Tergestinae (Trieste, Italy) did not have any specific identification. The main differences between *R. carminae* and similar taxa are shown in Table 1.

Variolaric acid (orcinol depsidone) is a compound generally known in crustose lichens and frequent in *Ochrolechia* and *Pertusaria* (Zedda 1999). This compound has the peculiarity of having the ether bond in 3' position instead of 5', an exception in the biosynthesis of lichen depsidones. In the chemical analysis by TLC, a pale bluish-grey spot is observed after dilute sulphuric acid and heat in solvent A, and a pale yellowish (almost colourless) in B and C with Rf classes (3:2:2) which coincides with the unknown substance SDAM1 of *Ramalina farinacea* of the centre of Spain (Arroyo & Manrique 1988). In *Ramalina*, variolaric acid is a very infrequent compound, only reported in *R. farinacea* from Norway, Sweden and Spain (Mallorca Island) (Tønsberg 1982) and from Italy (Zedda 1999) and always as an accessory substance. In *Ramalina*, we also detected this compound in the Iberian Peninsula specimens of several chemotypes of *Ramalina farinacea* and in a chemotype of *R. subfarinacea* (Arroyo *et al.* unpublished). It was always occasional and an accessory substance in all cases. However we have not detected variolaric acid in the few specimens of saxicolous *R. farinacea* which grow close to *R. carminae*. The new spe-

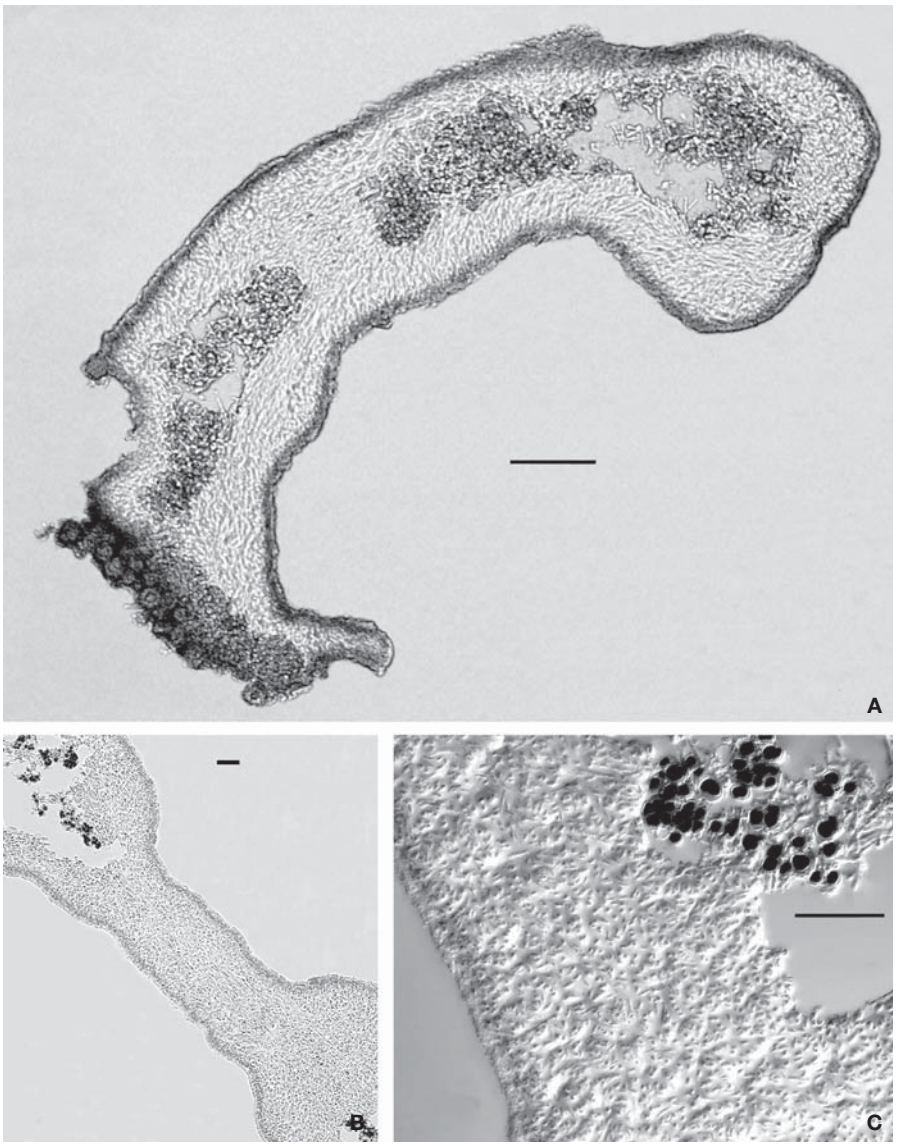

Fig. 4– Anatomy. Transversal sections of the thallus *Ramalina carminae* (in lactophenol blue) (*Arroyo* 4267.5); **A**: close apices area with incipient soralia; **B**: intermediate zone of the thallus showing white predominant chondroid tissue and scarce algal cells; **C**: detail of the chondroid tissue. Scales: **A** and **B** = 100 μm; **C** = 50 μm.

cies is, so far, the only species of the genus with variolaric acid as the only major medullary compound.

There is an important variation in the anatomical structure of *R. carminae* throughout the thallus (Fig. 4); some areas lack medulla and algal cells, differing only in the outside and inside cortex and they can match with a branching point or being interspersed in the laciniae; other areas show a clear predominance of the inner cortex embedded together with algal cells and medullary hyphae as isolated groups in the chondroid cylinder. There are also areas with the typical anatomical structure of *Ramalina*, with an inner cortex of uneven width, like a sort of "waves", algal layer more or less continuous and a loose medulla. The areas sticking out of the branches like "veins" match with a great growth of the inner cortex and a lack of algal cells. It is strange the wholly interruption of the chondroid cylinder, a frequent feature in other species of the genus *Ramalina* like *R. fastigiata, R. fraxinea* or *R. polymorpha* s.str. We have not observed chondroid strands embedded in the medulla, as it happens in *R. capitata* var.

Fig. 5– Distribution map of *Ramalina carminae* in the Iberian Peninsula. One dot may represent several localities. The point corresponding to Beira Alta (Portugal) has not been represented since it does not have enough information to assign coordinates.

capitata or in *R. capitata* var. *protecta,* species associated to *R. carminae*. The anatomy of *R. carminae* may recall *R. tortuosa*, a species which is also intricatelly branched that may superficially resemble certain eroded forms of *R.capitata* complex. However this species contains salazinic acid in the medulla and it is not known outside the Canary Islands (Østhagen & Krog 1976; Krog & Østhagen 1980).

The morphological and anatomical features that characterize *R. carminae* clearly differ from those that characterize the different associated taxa. Besides, these differences are correlated to the presence of variolaric acid, a very infrequent compound in the genus. We consider that the specimens we present can not be treated as a chemotype of one of the varieties that we recognized in *R. capitata*, since this concept is related to a chemical differentiation of morphologically indistinguishable individuals of a same species (Hawksworth 1976). Based on the correla-

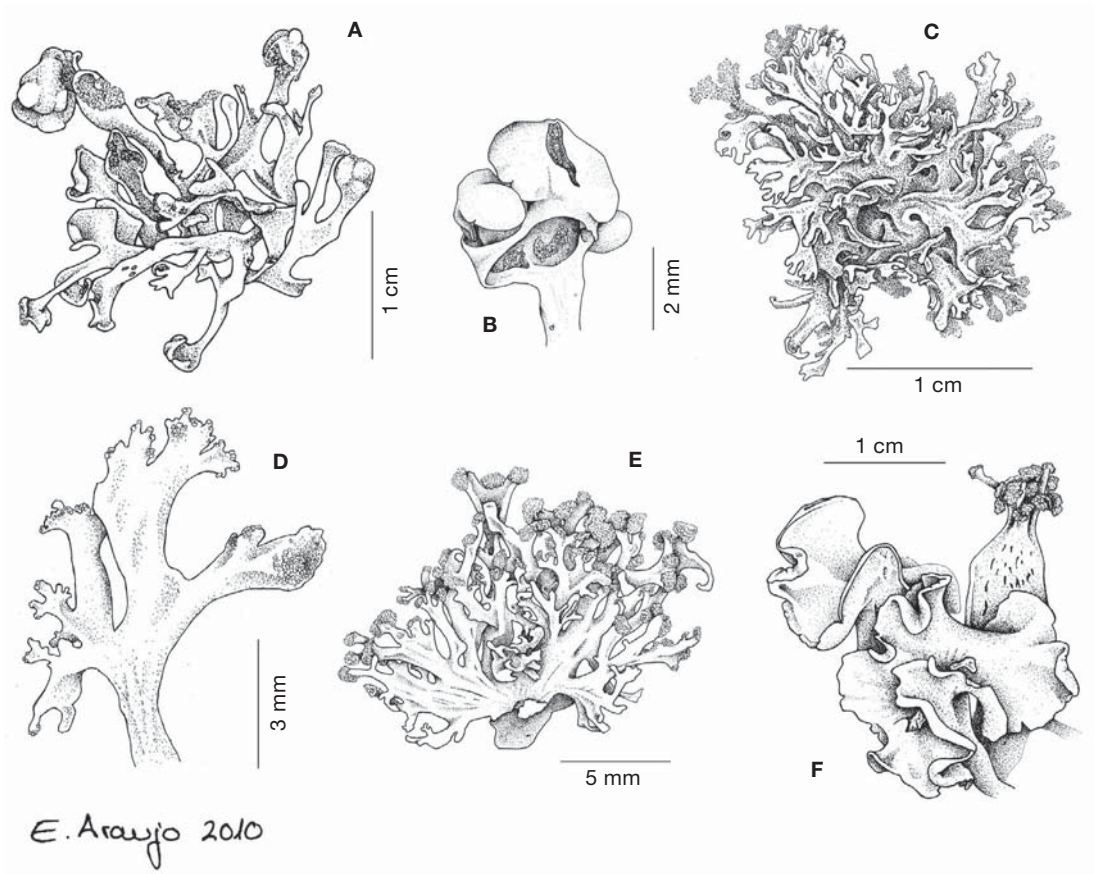

Fig. 6– Habit and soralia of *Ramalina capitata* complex; **A** and **B**: *Ramalina capitata* var. *protecta* (*Arroyo* 641); **C** and **D**: *R. capitata* var. *digitellata* (isotype H-37460); **E** and **F**: *R. capitata* var. *capitata* (lectotype H-1805; *Arroyo* 4386). Scales: **A** = 1 cm; **B** = 2 mm; **C** = 1 cm; **D** = 3 mm; **E** = 5 mm; **F** = 1 cm.

Tabla 1
Main differences between *Ramalina carminae* and similar taxa

Character		*R. carminae*	*R. capitata* var. *capitata*	*R. capitata* var. *protecta*	*R. capitata* var. *digitellata*
Branches width:	Basal	(0.45-) 0.78 (-1.25 mm)	(087-) 1.78 (-3.62) mm	(1.00-) 2.05 (-3.50) mm	(0.87-) 1.30 (-1.75) mm
	Middle	(0.42-) 0.85 (-1.20) mm	(0.75-) 1.65 (-3.75) mm	(0.75-) 2.25 (-3.50) mm	(1.12-) 1.46 (-1.75) mm
	Apical	(0.25-) 0.58 (-1.37) mm	(0.70-) 1.008 (-2.37) mm	(0.50-) 1.50 (-2.62) mm	(0.50-) 0.85 (-1.12) mm
Branching		Irregularly branched, frequently twisted	Regularly and palmately branched	Regularly and pallmately branched	Regularly and palmately branched
Soralia distribution		Scattered throughout the thallus	Apical	Apical	Apical
Soralia morphology		Great morphological diversity	Predominantly capitate or subcapitate, some labriform	Predominantly helmet-shaped	Under thin finger-shaped branches
Soredia		50-80 µm	80-120 µm	40-60 µm	50-60 µm
Apothecia		Not seen	Rare, terminal-subterminal	Rare, terminal-subterminal	Not seen
Anatomy		Variation throughout the thallus Chondroid strands embedded in the medulla not seen	Continuous inside cortex of uneven width Chondroid strands embedded in the medulla	Continuos inside cortex of uneven width Chondroid strands embedded in the medulla	Discontinuous inside cortex of uneven width Chondroid strands embedded in the medulla not seen
Chemistry		Variolaric and usnic acids	Usnic acid (exceptionally norstictic acid)	Usnic acid (exceptionally norstictic acid)	Usnic acid (exceptionally norstictic acid)
Habitat		Sheltered acid rocks 1200-2000 (2500) m	Exposed acid rocks (100-) 1000-15000 (-2500) m	Predominantly on sheltered acid rocks (100-) 1000-15000 (-2500) m	Predominantly on sheltered acid rocks (100-) 1000-15000 (-2500) m

tion between the morphological, chemical and anatomical differentiation, we recognize *R. carminae* as a new species.

From the different sites where *R. carminae* was collected, only in the populations of Montejo de Tiermes (Soria) there were specimens parasited with *Lichenoconium usneae* (Anzi) D. Hawksw., *Phaeosporobolus usneae* R. Sant. and *Tremella ramalinae* Diederich (S. Pérez Ortega, per. comm.).

Additional specimens examined. **ITALY: Sardinia:** 1250 m, esquistos, *P.L. Nimis* 1989, nº 307 B&L (1992) (TSB); 1300 m, esquistos, *P.L. Nimis* 1989, nº 304 B&L (1992) (TSB). **PORTUGAL: Beira Alta:** 650 m, granitos, (PO 5246L). *Trás-Os-Montes*: 29T6861 4645, Montesinho, 1280 m, *A. Terrón* 2006, granitos, bird perches (LEB 6943). **SPAIN: Almería:** *Bacares*: 30S542 4119, Sierra de los Filabres, Merendera, 1984 m, *J.M. Egea* 1978, (Arroyo 1561, 1563,1564) MUB 1019 (BCN); *Gergal*: 30S534 4118, Sierra de los Filabres, Piedra del Sombrero, 1900 m, *J.M. Egea* 1982, (Arroyo 2685, 2687) (BCN). **Ávila:** 30T319 4471, *Sierra de Gredos*: Navarredonda de Gredos, 1600 m, *R. Arroyo* & *J.J. Pérez* 1988, (Arroyo 3237-3240, 3242, 3243, 3245-3251, 3253-3262, 3264-3266) (MACB 102148, 102150-102154); 30T 3055 44593, Risco Negro, (Circo de Gredos), 2300 m, *L.G. Sancho* 1982, (Arroyo 809-812, 814, 816) (MACB 102147, 102149). **Granada:** *Guadix*: 30S531 4118, Sierra de Baza, Piedra del Deseo, 1900 m, *J.M. Egea* 1979, (Arroyo 1555-1559) MUB 1018 (BCN); *Sierra Nevada*: 30S468 4107, Peñones de San Francisco, 2500 m, *J.M. Egea* 1980, (Arroyo 1566, 1567, 1569, 1570) MUB 1020 (BCN). **Guadalajara:** 30T59938 449553, *Parque Natural Alto Tajo*: Chequilla, 1360 m, *E. Araujo & T. Camarero* 2009, [Arroyo 4336 (1-3)] (MACB 102138). **Madrid:** 30T455 4545, *Montejo de La Sierra*: Hayedo de Montejo, 1300 m, *R. Arroyo* 1986, (Arroyo 243, 245, 247-251) (MACB 102156, 102157). 30T407 4511, *Sierra de Guadarrama*: La Peñota, 1600 m, *L.G. Sancho* 1978, (Arroyo 765-772) (MACB 102158); 30T402 4497, El Escorial, Monte Abantos, 1754 m, *R. Arroyo* & *J. J. Pérez* 1988, (Arroyo 2491-2530, 2532-2544) (MACB 102140-102145); 30T431 4519, Puerto de la Morcuera, 1450 m, *A. Pintado* 2006, s/n (MAF); *A. Pintado & R. Arroyo* 2006 [Arroyo 4327, 4328, 4330, 4331 (1,2), 4332(1-5)] (MACB 102132-102136). 30T42 451, Manzanares El Real, La Pedriza de Manzanares (al pié de Cabezas de

Hierro), 1900 m, granitos protegidos, *E. Manrique* 1986, (Arroyo 699-704) (MACB 102146). **Soria:** 30TVL8479, *Montejo de Tiermes*: pared vertical, arcillas rojas expuestas, 1200 m, *I. Pérez* 1987, (Arroyo 1828,1830) (MACB 102155); 30T48721 4575195, Yacimiento Arqueológico, areniscas protegidas, 1150 m, *M. J. Pérez* 2007, [(Arroyo 4221 (3-11)] (MACB 102121); *R. Arroyo, E. Seriñá, & E. Araujo* 2008, [Arroyo 4266´(2), 4267´(1-6), 4268´(1-4), 4269´(1-6), 4270´(1-8), 4271´(2-7), 4272´(1-7), 4273(1-7), 4274(1-4), 4275(1-4), 4276(5)] (MACB 102122-102131, 102139); *E. Araujo & M. Cervera* 2009, [Arroyo 4335(1-9)] (MACB 102137). **Teruel:** *Sierra de Albarracín*: Orihuela del Tremedal, 1500 m, *X. Llimona* 1986, (Arroyo 1927-1936) (BCN 625); 30TXK159808, Noguera de Albarracín hacia Orihuela del Tremedal, área recreativa Peña del Castillo, pitón diacítico, 1580 m, *R. Arroyo, E. Seriñá & E. Araujo* 2010 (MACB 102058-102064); 30TXK143874, Orihuela del Tremedal, Santuario Ntra. Sra. del Tremedal, cuarcitas, 1725 m, *R. Arroyo, E. Seriñá & E. Araujo* 2010 (MACB 102066-102070); 30TXK197845, Bronchales, hacia Noguera, cuarcitas, 1606 m, *R. Arroyo, E. Seriñá & E. Araujo* 2010 (MACB 102076).

ACKNOWLEDGEMENTS

The authors are grateful to Mª José Pérez Alonso for collecting the first specimens in Montejo de Tiermes (type locality). Víctor J. Rico is thanked for helping with the photographic subjet and for his valuable comments. We would like to express our thanks to P. L Nimis and Elisa Folhadela for providing the possibility of checking the material in the Herbaria (TSB) Herbarium Universitatis Tergestinae (Trieste, Italy) and (PO) University of Oporto. Blanca González helped with her advices in staining microscopy. Pradeep K. Divakar is gratefully acknowledged for revising the English text. This research was supported by a grant from the Spanish DGICYT (CGL2004-04795-C04-01/BOS and CGL2007-66734-C03-01/BOS).

BIBLIOGRAPHY

Acharius, E. 1810. *Lichenographia universalis.* Göttingen.

Álvarez, J.; Paz-Bermúdez G. & Sánchez Biezma M. J. 2001. Estudio quimiotaxonómico del género *Ramalina* Ach. (Lecanorales, Ascomycotina) en Galicia (NW de España). *Cryptog., Mycol.* 22 (4): 271-287.

Aptroot, A. & Bungartz, F. 2007. The lichen genus *Ramalina* on the Galapagos. *Lichenologist* 39(6): 519-542.

Aptroot, A. & Schumm, F. 2008. Key to *Ramalina* species known from Atlantic islands, with two new species from the Azores. *Sauteria* 15: 21-57.

Arroyo, R. & Manrique, E. 1988. Estudios químicos en *Ramalina farinacea* (L.) Ach. del centro de España. *Anales Jard. Bot. Madrid* 45(1): 53-59.

Arroyo, R. & Manrique, E. 1989. Estudios químicos del género *Ramalina* Ach. en el centro de la Península Ibérica. *Anales Jard. Bot. Madrid* 46(1): 307-315.

Arroyo, R.; Seriñá, E. & Manrique, E. 1991. Estudio químico y morfológico de *Ramalina polymorpha* grex en España. *Acta Bot. Malac.* 16(1): 165-174.

Arroyo, R. 1993. El género *Ramalina* Ach. en la Península Ibérica: química, quimiotaxonomía, morfología, anatomía y distribución. Editorial de la Universidad Complutense de Madrid.

Arroyo, R.; Seriñá, E. & Manrique, E. 1995. *Ramalina elegans* (Lichenes *Ramalinaceae*) a taxon which has been mistaken for *Ramalina calicaris* and *R. fastigiata* in the Iberian Peninsula. *Crypt. Bot.* 5: 22-27.

Bannister, J. M. & Blanchon, D. J. 2003. The lichen genus *Ramalina* Ach. (*Ramalinaceae*) on the outlying islands of the New Zealand geographic area. *Lichenologist* 35(2): 137-146.

Bartsch, S. 1992. *Chemotaxonomische Untersuchungen an mediterranen und makaronesischen Arten der Gattung* Ramalina *unter besonderer Berücksichtigung der fruchtenden Formen*. Diplomarbeit, Freie Universität Berlin.

Blanchon, D. J.; Braggins, J. E. & Stewart, A. 1996. The lichen genus *Ramalina* in New Zealand. *J. Hatt. Bot. Lab.* 79: 43-98.

Bowler, P. A. & Rundel, P. W. 1978. The *Ramalina farinacea* complex in North America: Chemical, Ecological and Morphological variation. *Bryologist* 81: 386-403.

Clauzade, G. & Roux, C. 1985. *Likenoj de okcidenta Europo*. *Ilustrita Determinlibro*. Bulletin de la Societé Botanique du Centre-Ouest. Nouvelle Serie, Numero Special 7.

Culberson, W. L. 1966. Chimie et taxonomie des lichens du groupe *Ramalina farinacea* en Europe. *Rev. Bryol. Lichenol.* 34: 841-851.

Culberson, W. L. 1967. Analysis of chemical and morphological variation in the *Ramalina siliquosa* species complex. *Brittonia* 19: 333-352.

Culberson, W. L. & Culberson, C. F. 1967. Habitat selection by chemically diferentiated races of lichens. *Science* 158: 1195-1197.

Culberson, C. F. & Kristinsson, H. D. 1970. A standardized method for the identification of lichen products. *J. Chromatography* 46: 85-93.

Culberson, C. F.; Culberson, W. L. & Johnson, A. 1981. A standardized TLC analysis of ß-orcinol depsidones. *Bryologist* 84: 16-29.

Fletcher, A.; James, P. W & Purvis, O. W. 2009. *Ramalina*. En: C. W. Smith, A. Aptroot, B. J. Coppins, A. Fletcher, O. L. Gilbert, P. W. James & P. A. Wolsely (Eds.), *The Lichens of Great Britain and Ireland*: 781-787. The British Lichen Society, London.

Hawksworth, D. L. 1968. A note on the chemical strains of the lichen *Ramalina subfarinacea*. *Bot. Notiser* 121: 317-320.

Hawksworth, D. L. 1976. Lichen chemotaxonomy. En: D. L. Brown, D. L. Hawksworth & R. H. Bayley (Eds.), *Licheno-*

logy: Progress and Problems: 139-184. Academic Press. London & New York.

HUNECK, S. & YOSHIMURA, I. 1996. *Identification of Lichen Substances*. Springer-Verlag, Berlín.

KASHIWADANI, H. & Kalb, K. 1993. The genus *Ramalina* in Brazil. *Lichenologist*, **25**:1-31.

KROG, H. & JAMES, P. W. 1977. The genus *Ramalina* in Fennoscandia and the British Isles. *Norw. J. Bot.* 24: 15-43.

KROG, H. & ØSTHAGEN, H. 1980. The genus *Ramalina* in the Canary Islands. *Norw. J. Bot.* 27: 255-296.

MAGNUSSON, A. H. 1956. New European Lichens. *Bot. Notiser* 109(2): 143-152.

NIMIS P. L. 1993. *The lichens of Italy*. Museo Regionale di Scienze Naturali Torino.

NIMIS, P. L. & POELT, J. 1987. The lichens and lichenicolous fungi of Sardinia (Italy), an annotated list. *Studia Geobotanica* 7, Suppl. 1: 1-269.

ORANGE, A.; JAMES, P. W. & WHITE, F. J. 2001. *Microchemical methods for the identification of Lichens*. British Lichen Society. London.

ØSTHAGEN, H. & KROG, H. 1976. Contribution to the lichen flora of the Canary Islands. *Norw. J. Bot.* 23: 221-242.

SANCHO, L. G. 1988. La vegetación liquénica ornitocoprófila de espolones en el alto Sistema Central español. *Acta Bot. Barc.* 37: 223-236

SANTESSON, R. 1984. *The Lichens of Sweden and Norway.* Stockholm and Upsala. Swedish Museum of Natural History.

SHEARD, J. W. & JAMES. P. W. 1976. Typification of the taxa belonging to the *Ramalina siliquosa* species aggregate. *Lichenologist* 8: 35-46.

SØCHTING U. 1976. The *Ramalina siliquosa* aggregate on the Danish Island of Bornholm. *Bot. Tidsskrift* 71: 87- 94.

STEVENS, G. N. 1987. The lichen genus *Ramalina* in Australia. *Bull. Brit. Mus.* (*Natural History*), *Botany series* 16: 107-223.

TØNSBERG, T. 1982. Variolaric acid, a depsidone new to the *Physciaceae* and *Ramalinaceae*. *Lichenologist* 14(3): 279-280.

ZEDDA, L. 1999. Studies on the epiphytic *Ramalina farinacea* (L.) Ach. complex (Lichens) in Sardinia (Italy). *Webbia* 54(1): 133-147.