

Candelariella boleana, a new epiphytic species from southern and central Europe (Candelariaceae, Ascomycota)

by

Javier Etayo¹, Zdenek Palice^{2,3} and Toby Spribille⁴

¹Navarro Villoslada 16, 3°, 31003 Pamplona, Navarra, Spain

²Institute of Botany, Academy of Sciences of the Czech Republic,
CZ-25243 Průhonice, Czech Republic

³Department of Botany, Faculty of Natural of Sciences, Charles University,
Benátská 2, CZ-12801 Praha, Czech Republic

⁴Albrecht-von-Haller Institute for Plant Sciences, University of Göttingen, Untere Karspüle 2,
D-37073 Göttingen, Germany; current address: Institute of Plant Sciences,
University of Graz, Holteigasse 6, A-8010 Graz, Austria

With 3 figures

Etayo, J., Z. Palice & T. Spribille (2009): *Candelariella boleana*, a new epiphytic species from southern and central Europe (Candelariaceae, Ascomycota). - Nova Hedwigia 89: 545–552.

Abstract: The new species *Candelariella boleana* is described from Europe (Greece, Slovakia, and Spain). It is characterized especially by its spherical ascospores in polyspored asci.

Key words: Candelariales, epiphytic lichens, Europe, Greece, Slovakia, Spain.

Introduction

Candelariella Müll.Arg. comprises the crustose and squamulose species of the family Candelariaceae Hakulinen 1954. All Candelariaceae are characterized by their lemon to egg yellow, K- colour owing to the presence of calycin and other pigments, such as pulvic acid lactone and vulpinic and pulvinic acids (Geyer 1985) forming small granules in the cortex of the upper thallus and epihyemium; a thalline or proper margin in the apothecia; and asci of the *Candelaria*-type, similar to *Lecanora*-type asci, with eight to many, simple to 1-septate, colourless ascospores per ascus. More detailed features are recorded in Westberg (2005, 2007a, b, c). Some species however possess a grey thallus, or are lichenicolous with a highly reduced thallus (e.g., *C. lichenicola*; Westberg 2007a). Many species furthermore appear to begin their life cycle as parasites or parasymbionts.

The genus *Candelariella* includes around 50 species world-wide. Several molecular phylogenetic studies (Wedin et al. 2005, Hofstetter et al. 2007, Miadlikowska et al. 2007) have demonstrated that Candelariaceae belong to a basal group of Lecanoromycetes recently raised to the level of order, as Candelariales Miadl., Lutzoni & Lumbsch (Hibbett et al. 2007).

Patellaria vitellina (Hoffmann 1794), from Germany, was the first description of a lichen belonging to this genus. *Candelariella* was monographed by Hakulinen (1954) for northern Europe. The taxonomy of this genus has remained relatively stable over the intervening 55 years (Rondon 1966, Poelt & Vězda 1976, 1977, Harris & Buck 1978, Clauzade & Roux 1985, Purvis et al. 1992). Along with the exploration of previously poorly known areas, several new species have been added during the last two decades: Nimis et al. (1989) described *C. faginea* from *Fagus* in Italy; Thor & Wirth (1990) described *C. viae-lacteae* from *Populus*, *Pinus* and an unrecognized deciduous tree from Greece and Hungary; and Khodosovtev et al. (2004) described *C. boikoi* from the steppe shrub *Halocnemum strobilaceum* in the southern Ukraine and Astrakhan region of Russia and a shrub in the botanical garden of Almaty, Kazakhstan. Recently, Vondrák et al. (2008) reported the New World and Australasian *C. antennaria* as new to Europe from Crete. Recently Westberg (2007a, b, c) studied the genus in the western United States, describing several new species.

Working on Crete two years earlier, the third author, writing in Spribille et al. (2006), reported as '*Candelariella* sp. 1' a taxon with spherical ascospores which appeared to be undescribed, and subsequently collected the species on the Greek mainland in the Pindos Mountains. In both cases material was scant, and he refrained from publishing the species formally. He later learned that the same species was recognized by the first author as early as 1993 in material from Spain, and collected by the second author in Slovakia in 2007. We describe it here as a new species.

Materials and methods

Characteristics of the apothecia and thallus were investigated by light microscopy on hand-cut sections, mounted in water and/or 10% KOH (hereafter K), and stained with I_{Lugol} (Merck 1.09261). Photos were taken with a Zeiss AxioCam MRc5 digital camera mounted on a Leica Wild M3Z stereo dissecting scope and digitally optimized using CombineZM freeware. Microscopic measurements were made at 1000× magnification in water and are given as smallest single measurement- largest single measurement. Thin layer chromatography (TLC) followed the standardized methods outlined by Culberson (1972) with modifications following Culberson & Johnson (1982).

The species

Candelariella boleana Etayo, Palice & T.Sprib., **sp. nov.**

Figs 1, 2

MYCOBANK NUMBER: MB 513429

Thallus granulosus, citrinus, 0.05–0.15 mm crassus. Algae unicellulares, 9–20 µm crassae, ad Chlorococcaceae pertinentes. Apothecia rotundata, basi leviter constricta, lecanorina, 0.2–0.4 mm in diametro, discus flavidus, planus vel convexus. Hypothecium hyalinum; hymenium 60–70 µm altum.

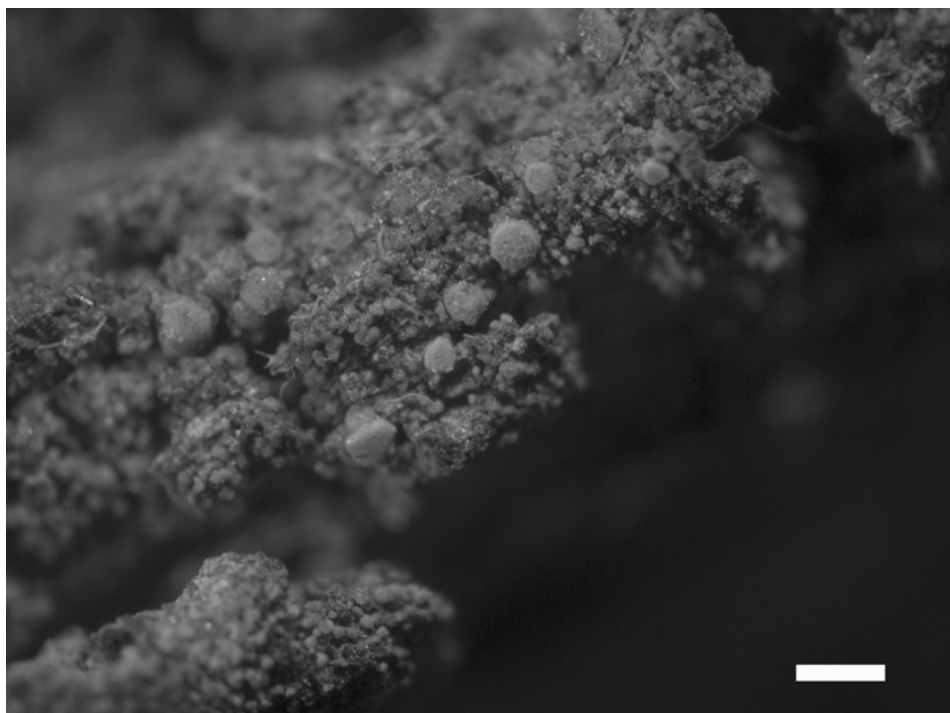


Fig. 1. *Candelariella boleana*. Habit (Spribille 13250). Scale bar = 0.5 mm.

Epihymenium granulis-luteis tectum. Asci late ellipsoidei, tholis distinctis instructi, I+ coerulescentes, 35–52 × 14–20 µm, 16–32 sporas continentes. Ascosporae globulares, hyalinae, 4–5.5 µm magnae.

TYPUS: Spain, Huesca, Central Pyrenees, Biescas, valle de Asieso, Barranco de Sta. Elena, 30TYN2126, *Pinus sylvestris* trunk, 1100 m, 5 August 1993, J.Etayo 13812 & A.Gómez-Bolea (BCC-Lich. -holotypus, herb. Etayo - isotypus).

Thallus of scattered, small, yellowish to greenish, convex granules, 0.05–0.15 mm diam., not forming a rimose crust, lacking prothallus; algae *Chlorococcaceae*, individual cells 9–20 µm diam.. Apothecia 0.2–0.4 mm diam., scattered to aggregated, flat to convex when old, bright yellow, with yellow pruina; margin persistent to evanescent with clusters of algae (5–10 µm diam.) in lower part. Hypothecium colourless. Epihymenium yellow-brown, granular. Hymenium 60–70 µm tall, colourless, I+ blue. Paraphyses simple or scarcely branched, not or slightly swollen at the apices, 2–2.5 µm thick. Asci clavate, 35–52 × 14–20 µm, with 16–32 spores, *Candelaria*-type. Ascospores colourless, globose, simple, uniguttulate, 4–5.5 µm diam. Conidiomata not seen.

CHEMISTRY: pulvinic acid only detected by TLC.

REMARKS: *Candelariella boleana* is the only species known in the genus with orbicular spores, 16–32 per ascus, and can thus be easily distinguished all other species, including other corticolous and polysporous species such as *C. lutella* (Vain.) Räsänen,

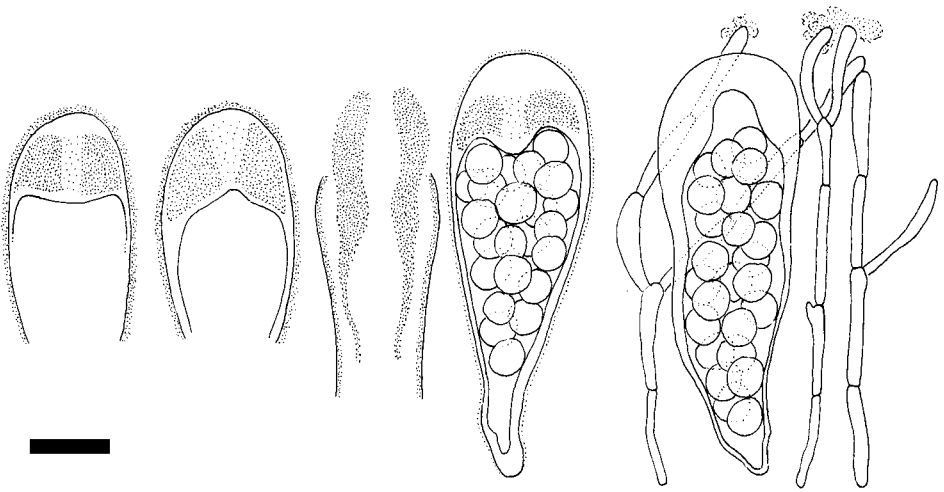


Fig. 2. *Candelariella boleana*. Asci at different stages of development, in Lugol's solution; ascospores in ascus and paraphyses (from holotype). Scale bar = 10 µm.

C. vitellina (Hoffm.) Müll.Arg. and *C. xanthostigma* (Ach.) Lettau. These species have typically ellipsoidal spores. Its yellowish colour makes it difficult to confuse with other polysporic species with similarly shaped ascospores. Similar ascospores can be found in *Biatoridium monasteriense* J. Lahm ex Körber, but that species differs in several additional features, especially the ascus-type, number of spores per ascus (c. 100), and their size, 2.5–3.5 µm diam. (Hafellner 1994). Perhaps some samples that have been determined as this species by European lichenologists belong to *C. boleana*. Alstrup (1993) described a new species in the *Lecanora fuscescens* group from Greenland, *L. polysphaeridia* with identical ascospores and number per ascus, but the ascus-type and colour of thallus and apothecia are different, as well as the ecology (dry twigs and leaves of *Cassiope*). Among the corticolous and polysporous *Candelariella* species, *C. boleana* differs from all presently known species in its spherical ascospores.

Candelariella boleana is the second species of *Candelariaceae* to be recognized that has spherical spores. The only other species known to have these kinds of ascospores is *Candelaria sphaerobola* Poelt & Reddi, a microfoliose species from eastern Nepal (Poelt & Reddi 1969). *C. sphaerobola* differs primarily in its completely different gross thallus morphology (foliose versus granular-crustose in *C. boleana*).

Based on a phylogenetic study using ITS rDNA sequence data (Westberg et al. 2007), the genus *Candelariella* as currently circumscribed appears to be paraphyletic. The three remaining genera of *Candelariaceae* (*Candelaria*, *Candelina*, *Placomaronea*) are nested within *Candelariella*. The mutual relationships of single monophyletic groups within *Candelariaceae* remain unresolved. So far molecular data appear to be only partially congruent with morphology. The relationship of *C. boleana* to other *Candelariella* species remains unknown, but based on overall

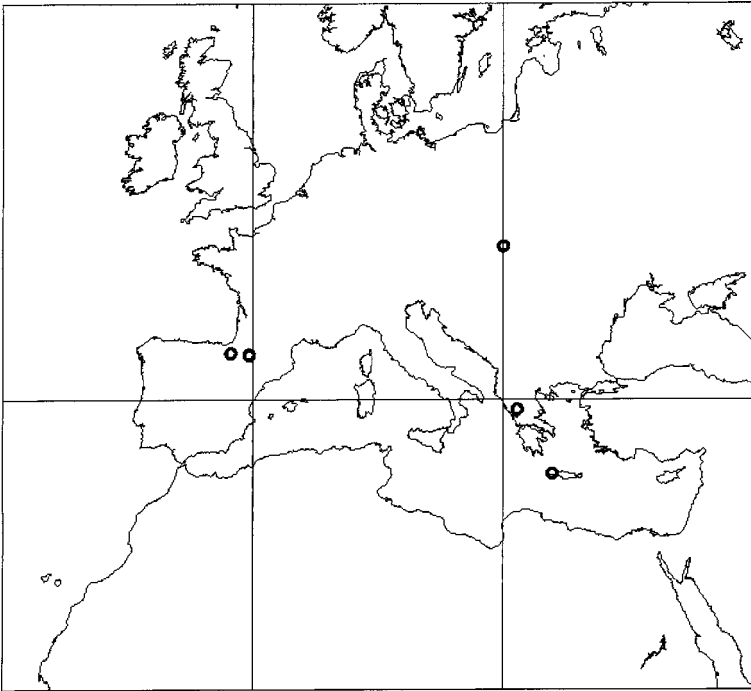


Fig. 3. Known distribution of *Candelariella boleana*.

gross morphology and anatomy, it appears *C. boleana* could be related to the type species of the genus, *C. vitellina* (see Westberg et al. 2007) with preserved proper margin, polysporous asci and finely granulose to areolate thallus. This however should be confirmed by molecular studies.

HABITAT AND DISTRIBUTION: *Candelariella boleana* is known from a small number of widely disjunct localities in Europe (Fig. 3). In the Spanish Pyrenees (Huesca and Navarra), it has been found in *Pinus sylvestris* and *Quercus* woods at elevations of 850 to 1200 m. In Greece it was found on *Cupressus sempervirens* and *Juniperus foetidissima* at elevations of 1050 to 1150 m. In Slovakia the species was collected twice on the same locality on bark of *Quercus* in a well-lit xerothermic oak wood (*Quercus dalechampii* and *Q. polycarpa* dominating) on limestone bedrock in National Park Muránska planina (Western Carpathians) at approximately 550 m. This extraordinary region hosts or used to host several southern lichen species with otherwise more southern distributions. The putative northernmost European distributional limit is reached here by, e.g., *Calicium montanum*, *Caloplaca adriatica*, *Leptogium hildenbrandii*, *Physconia servitii* and *Rinodina polysporoides* (Pišút 1990, Guttová & Palice 2005, Palice et al. 2006). In Slovakia and Spain, associated lichens occurring with *Candelariella boleana* include *Acrocordia gemmata*, *Agonimia tristicula*, *Amandinea punctata*, *Buellia griseovirens*, *Caloplaca cerina* s.lat., *C. flavorubescens*, *C. holocarpa* s.lat., *Candelariella vitellina*, *C. xanthostigma*,

Catillaria nigroclavata, *Lecanora pulicaris*, *Lecidea nylanderi*, *Lecidella elaeochroma* s.lat. (incl. var. *soralifera*), *Pertusaria albescens* and *Scoliciosporum umbrinum*. *C. boleana* has been probably overlooked on account of its small size, but even so, it is likely not a common species. *C. boleana* was collected once in northern Greece in 2005, but during two weeks of collecting in the same area the following year, it was not found again. Also, despite knowing of the species, in the case of the first author for over fifteen years, we have seen only eight collections. Slovak specimens were growing side by side with occasionally fertile specimens of *C. xanthostigma*, and it is possible that these two species may occur more frequently together. The new species may well be hidden in herbaria intermingled with that species.

Candelariella boleana is named in honour of the lichenologist and friend Dr. Antonio Gómez-Bolea. The word “boleana” also recalls the Spanish word “bola”, or ball, much like the ascospore shape of *C. boleana*.

ADDITIONAL MATERIAL EXAMINED: GREECE: Crete, Levka Ori, trail S of Omalos from Xiloskalo towards Gingilos, 35°18'N, 23°54'E, T.Spribile 13250 (GZU); *ibid.*, S.Abrahamczyk s.n. (B); Epirus, Arta prefecture, road between Voulgareli and Agnanta, on side road up the W slopes of Tsouma Katí, 39°23'N, 21°07'E, T.Spribile 16418 (GZU); SLOVAKIA: W Carpathians, Muránska planina, Poludnica nature reserve, N-S oriented crest S of Maretkiná game-keeper-house, 48°45'N, 20°01'E, A.Guttová, J.Halda & Z.Palice 11452 (PRA, BG, UPS); *ibid.*, P.Czarnota, A.Guttová, J.Halda & Z.Palice 12471 (PRA, SAV); SPAIN: Navarra, Aranarache, 30TWN6337, J.Etayo 10106 (hb. Etayo); Huesca, Biescas, hayedo de Betato, 30TYN1931, J.Etayo & A.Gómez-Bolea (Hb. Etayo 12718).

Acknowledgements

We thank Sergio Pérez-Ortega (Madrid) for comments on an earlier version of the manuscript. Walter Obermayer (Graz) helped improve the photos. Greek collections were made in the course of excursions organized and led by Erwin Bergmeier of the University of Göttingen, Germany. Slovak specimens originated from annual field trips organized by Anna Guttová (Bratislava). ZP acknowledges support by the Academy of the Czech Republic (AV0Z60050516) and the Ministry of Education, Youth and Sports of the Czech Republic (no. 0021620828). Christian Printzen (Frankfurt am Main) prepared the distribution map.

References

- ALSTRUP, V. (1993): News on lichens and lichenicolous fungi from the Nordic countries. - *Graphis Scripta* **5**: 96–104.
- CLAUZADE, G. & C. ROUX (1985): Likenoj de Okcidenta Eùropo. Illustrita Determinlibro. - *Bull. Soc. Bot. Centre-Ouest, Nouv. Sér., Num. Spéc.* **7**: 1–893.
- CULBERSON, C.F. (1972): Improved conditions and new data for the identification of lichen products by a standardized thin-layer chromatographic method. - *J. Chromatography* **72**: 113–125.
- CULBERSON, C.F. & A. JOHNSON (1982): Substitution of methyl *tert.*-butyl ether for diethyl ether in the standardized thin-layer chromatographic method for lichen products. - *J. Chromatography* **238**: 483–487.
- GEYER, M. (1985): Hochdruck-Flüssigkeits-Chromatographie (HPLC) von Flechten - Sekundärstoffen. - Doctoral dissertation. University of Essen, Essen.
- GUTTOVÁ, A. & Z. PALICE (2005): Lišajníky Národného parku Muránska planina III - Cigánka. - *Reussia* **1**, Suppl. 1/2004: 5–40.

- HAFELLNER, J. (1994): On *Biatoridium*, a resurrected genus of lichenized fungi (*Ascomycotina*, *Lecanorales*). - *Acta Bot. Fennica* **150**: 39–46.
- HAKULINEN, R. (1954): Die Flechtengattung *Candelariella* Müller Argoviensis, mit besonderer Berücksichtigung ihres Auftretens und ihrer Verbreitung in Fennoskandien. - *Ann. Bot. Soc. Zool. Bot. Fenn.* "Vanamo" **27/3**: i–vi + 1–127.
- HARRIS, R.C. & W.R. BUCK (1978): Lichens of the Mackinac Straits Region. II. *Candelariella* Müll. Arg. - *Mich. Bot.* **17**: 155–161.
- HIBBETT, D.S., M. BINDER, J.F. BISCHOFF, M. BLACKWELL, P.F. CANNON, O.E. ERIKSSON, S. HUHDORF, T. JAMES, P.M. KIRK, R. LÜCKING, H.T. LUMBSCH, F. LUTZONI, P.B. MATHENY, D.J. MCLAUGHLIN, M.J. POWELL, S. REDHEAD, C.L. SCHOCH, J.W. SPATAFORA, J.A. STALPERS, R. VILGALYS, M.C. AIME, A. APTROOT, R. BAUER, D. BEGEROW, G.L. BENNY, L.A. CASTLEBURY, P.W. CROUS, Y.C. DAI, W. GAMS, D.M. GEISER, G.W. GRIFFITH, C. GUEIDAN, D.L. HAWKSWORTH, G. HESTMARK, K. HOSAKA, R.A. HUMBER, K.D. HYDE, J.E. IRONSIDE, U. KÖLJALG, C.P. KURTZMAN, K.H. LARSSON, R. LICHTWARDT, J. LONGCORE, J. MIADLIKOWSKA, A. MILLER, J.-M. MONCALVO, S. MOZLEY-STANDRIDGE, F. OBERWINKLER, E. PARMASTO, V. REEB, J.D. ROGERS, C. ROUX, L. RYVARDEN, J.P. SAMPAIO, A. SCHÜSSLER, J. SUGIYAMA, R.G. THORN, L. TIBELL, W.A. UNTEREINER, C. WALKER, Z. WANG, A. WEIR, M. WEISS, M.M. WHITE, K. WINKA, Y.-J. YAO & N. ZHANG (2007): A higher-level phylogenetic classification of the Fungi. - *Mycol. Res.* **111**: 509–547.
- HOFFMANN, G.F. (1794): *Descriptio et adumbratio plantarum e classe cryptogamica Linnaei, quae Lichenes dicuntur 2.* - Leipzig.
- HOFSTETTER, V., J. MIADLIKOWSKA, F. KAUFF & F. LUTZONI (2007): Phylogenetic comparison of protein-coding versus ribosomal RNA-coding sequence data: A case study of the Lecanoromycetes (Ascomycota). - *Mol. Phylog. Evol.* **44**: 412–426.
- KHODOSOVITSEV, A., S. KONDRATYUK & I. KÄRNEFELT (2004): *Candelariella boikoi*, a new lichen species from Eurasia. - *Graphis Scripta* **16**: 11–15.
- MIADLIKOWSKA J., F. KAUFF, V. HOFSTETTER, E. FRAKER, M. GRUBE, J. HAFELLNER, V. REEB, B.P. HODKINSON, M. KUKWA, R. LÜCKING, G. HESTMARK, M.G. OTALORA, A. RAUHUT, B. BÜDEL, C. SCHEIDEGGER, E. TINDAL, S. STENROOS, I. BRODO, G.B. PERLMUTTER, D. ERTZ, P. DIEDERICH, J.C. LENDEMER, P. MAY, C.L. SCHOCH, A.E. ARNOLD, C. GUEIDAN, E. TRIPP, R. YAHR, C. ROBERTSON & F. LUTZONI (2007) ['2006']: New insights into classification and evolution of the Lecanoromycetes (Pezizomycotina, Ascomycota) from phylogenetic analyses of three ribosomal RNA- and two protein-coding genes. - *Mycologia* **98**: 1088–1103.
- NIMIS, P.L., J. POELT & D. PUNTILLO (1989): *Candelariella faginea* spec. nov. (Lichenes, Candelariaceae) eine bemerkenswerte neue Art einer schwierigen Gattung aus Südeuropa. - *Nova Hedwigia* **49**: 274–280.
- PALICE, Z., A. GUTTOVÁ & J.P. HALDA (2006): Lichens new for Slovakia collected in the National Park Muránska planina (W Carpathians). - In: LACKOVIČOVÁ, A., A. GUTTOVÁ, E. LISICKÁ & P. LIZON (eds.), *Central European lichens - diversity and threat*, p. 179–192, Mycotaxon Ltd., Ithaca.
- PIŠŮT, I. (1990): Nachträge zur Kenntnis der Flechten der Slowakei 12. - *Zborn. Slov. Múz. Prír. Vedy, Bratislava* **36**: 9–13.
- POELT, J. & B.V. REDDI (1969). *Candelaria* und *Candelariella*. Lichenes, Candelariaceae (Flechten des Himalaya 4). - *Khumbu Himal.* **6**: 1–16.
- POELT, J. & A. VĚZDA (1976). *Candelariella plumbea* und *C. rhodax* sp. novae, zwei neue Arten der europäischen Flechten-Flora. - *Folia Geobot. Phytotax.* **11**: 87–92.

- POELT, J. & A. VĚZDA (1977). Bestimmungsschlüssel europäischer Flechten. Ergänzungsheft I. - Bibl. Lichenol. **9**: 1–258.
- PURVIS, O.W., B.J. COPPINS, D.L. HAWKSWORTH, P.W. JAMES & D.M. MOORE (eds.) (1992): The Lichen flora of Great Britain and Ireland. - Natural History Museum Publications, London.
- RONDON, Y. (1966): Une espece nouvelle de lichen: *Candelariella oleaginescens* nov. spec. - Rev. Bryol. Lichénol. **34**: 831–832.
- SPRIBILLE, T., M. SCHULTZ, O. BREUSS & E. BERGMEIER (2006): Notes on the lichens and lichenicolous fungi of western Crete (Greece). - Herzogia **19**: 125–148.
- THOR, G. & V. WIRTH (1990): *Candelariella viae-lacteeae*, a new lichen species from Europe. - Stuttg. Beitr. Naturk., Ser. A **445**: 1–4.
- VONDRÁK, J., A. GUTTOVÁ & H. MAYRHOFER (2008): A further contribution to the knowledge of lichen-forming and lichenicolous fungi in Crete. - Herzogia **21**: 105–124.
- WEDIN, M., E. WIKLUND, A. CREWE, H. DÖRING, S. EKMAN, Å. NYBERG, I. SCHMITT & H.T. LUMBSCH (2005): Phylogenetic relationships of Lecanoromycetes (Ascomycota) as revealed by analyses of mtSSU and nLSU rDNA sequence data. - Mycol. Res. **109**: 159–172.
- WESTBERG, M. (2005): The lichen genus *Candelariella* in western North America. - Department of Ecology. Plant Ecology and Systematics. Lund University.
- WESTBERG, M. (2007a): *Candelariella* (Candelariaceae) in western United States and northern Mexico: the species with biatorine apothecia. - Bryologist **110**: 365–374.
- WESTBERG, M. (2007b): *Candelariella* (Candelariaceae) in western United States and northern Mexico: the polysporous species. - Bryologist **110**: 375–390.
- WESTBERG, M. (2007c): *Candelariella* (Candelariaceae) in western United States and northern Mexico: the 8-spored, lecanorine species. - Bryologist **110**: 391–419.
- WESTBERG, M., U. ARUP & I. KÄRNEFELT (2007): Phylogenetic studies in the *Candelariaceae* (lichenized Ascomycota) based on nuclear ITS DNA sequence data. - Mycol. Res. **111**: 1277–1284.

Received 22 May 2009, accepted in revised form 9 June 2009.