

# *Endohyalina*, the genus in the Physciaceae to accommodate the species of the *Rinodina ericina*-group

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**Abstract** The genus *Endohyalina* is characterized by crustose, autonomous, or obligately lichenicolous thalli, lecideine apothecia with a hymenium often more or less interspersed with oil droplets and a brown hypothecium, *Bacidia*-type asci, small *Dirinaria*-type ascospores developing with type B ontogeny, bacilliform conidia and containing diploicin as the major secondary metabolite. The genus is based on four species previously included in *Rinodina*—*R. ericina* s. lat., *R. insularis*, *R. interjecta* and *R. kalbii*—and on two lichenicolous species from the Canary Islands described here as new, *Endohyalina brandii* and *E. diderichii*. The generic type, *Endohyalina rappii*, is reduced to synonymy with *E. ericina* whereas *E. circumpallida* is excluded from the genus and returned to *Buellia* s. lat. Except for the thalline growth form and the common lichenicolous habit, the diagnostic characters of *Endohyalina* are akin to those of *Diploicia*. New chemical data on *Endohyalina insularis* and *E. kalbii* are reported,

and a simple method for determining the secondary chemistry of lichenicolous fungi is provided.

**Keywords** Generic recircumscription · Lichenicolous species · Lecanoromycetes · New combinations · New species

## Introduction

All the species of the *Rinodina ericina*-group treated in the present paper are considered to be congeneric. They are characterized as autonomous lichens with a crustose thallus or obligately lichenicolous species with an epikapylic to endokapylic thallus, by containing diploicin and related substances (except for *R. kalbii* Giralt & Matzer), an often more or less interspersed hymenium, and by having short bacilliform conidia. Further, all possess small *Dirinaria*-type or similar ascospores, with pronounced internal wall thickenings (= rinodinoid ascospores), developing with type B ontogeny (where apical wall thickenings become distinct before the septum develops), *Bacidia*-type asci, lecideine apothecia and a brown hypothecium. Because of this combination of diagnostic characters, the generic position of these species has oscillated between *Buellia* s. lat. and *Rinodina* (Ach.) Gray.

Hafellner (1979) transferred *Buellia saxatilis* f. *insularis* Arnold into *Rinodina* on the base of its rinodinoid ascospores. Since then, many authors (e.g., Rambold et al. 1994; Giralt 2001; Mayrhofer and Lambauer 2004; Sheard 2004; Kaschik 2006) have discussed its generic position. The same ascospore character induced Kalb and Hafellner (1992) to describe *R. madeirensis* Kalb & Hafellner as a *Rinodina*. Giralt and Matzer (1994) pointed out that the most reliable features to distinguish *Buellia* from *Rinodina* were those of the ascospores and retained *R. kalbii* and *R. madeirensis* in *Rinodina*.

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Subsequently, Giralt (2000) transferred *Buellia ericina* (Nyl.) Jatta to *Rinodina* for the same reason.

Giralt (2000, 2001) considered all the above species to be closely related and noted that they may belong to an undescribed genus in the Physciaceae, since none of the hitherto known crustose genera within this family possessed the same combination of characters (i.e., rinodinoïd ascospores, type B ontogeny, *Bacidia*-type asci, lecideine apothecia and brown hypothecium), or to the placodioid genus *Diploicia* A. Massal. If this was so, *Diploicia* would have to be recircumscribed to include microlichen species with independent or lichenicolous habit (with crustose or endokapylic thalli). At the time, Giralt (2000) provisionally retained the species in *Rinodina* in the expectation that further taxa might well be found with the same diagnostic characters.

Subsequently, three additional species have been found to belong to the *R. ericina*-group, namely *Buellia interjecta* Müll. Arg., transferred to *Rinodina* by Mayrhofer et al. (1992) because of its rinodinoïd ascospores, and the two lichenicolous species described in this paper.

In our opinion, the new data described in the present work confirm that the species of *R. ericina*-group are congeneric and should be accommodated in a genus other than *Buellia* s. lat. or *Rinodina*: either (1) a new genus of Physciaceae, or (2) the recircumscribed genus *Diploicia*.

However, when revising the 15 generic segregates of *Buellia* s. lat. erected by Marbach (2000), especially those containing diploicin, it became apparent that *Endohyalina rappii* (Imshaug ex R.C. Harris) Marbach could belong to the *R. ericina*-group. A detailed study of the type specimen and additional material established that *E. rappii* is conspecific with *Rinodina ericina*. As *E. rappii* is the type species of *Endohyalina* Marbach, the “new genus” in the Physciaceae [see (1) above] to include the species of the *R. ericina*-group already exists, namely the genus *Endohyalina*. Alternatives (1) and (2) are further discussed below.

Further alternative solutions to the problem include (3) to maintain the species of the *R. ericina*-group in the genus *Rinodina*, a solution discredited by the fact that molecular data clearly indicate that *R. insularis* belongs to the *Buellia*-group rather than to the *Physcia*-group (Helms et al. 2003; Kaschik 2006; Wedin et al. 2002), or (4) to retain these species in the polyphyletic *Buellia* s. lat., an option which does not resolve the taxonomic position of these well-delimited taxa but obscures them in the heterogeneous assembly that comprises *Buellia* s. lat.

(1) The case for accommodating the species of the *Rinodina ericina*-group in the genus *Endohyalina*

A wide range of thalline forms is observed within the Physciaceae, where typically crustose, placodioid with

distinct radiate-plicate marginal lobes, squamulose, foliose, umbilicate, and fruticose representatives are known. Apart from thallus morphology, microscopic characters of the asci, ascospores, hymenium, and conidia as well as chemistry have been used to segregate the genera of Physciaceae. Even after considering all these characters, the species of the *R. ericina*-group cannot be clearly assigned to any of the known genera of Physciaceae as they are currently defined.

The combination of a crustose (autonomous) or an epikapylic to endokapylic (lichenicolous) thallus, *Dirinaria*-type ascospores with pronounced wall thickenings (rinodinoïd ascospores), ascospore-ontogeny of type B, *Bacidia*-type asci, lecideine apothecia with a poorly developed proper exciple (*aethalea*-type), a brown hypothecium, bacilliform conidia, and the presence of diploicin (except for *R. kalbii*) exclude the species of the *R. ericina*-group from the following genera of Physciaceae:

1. The clearly delimited genus *Buellia* de Not. *nom. cons.* or *Buellia* s. str. (= *Hafellia* Kalb, H. Mayrhofer & Scheid., cf. Gams 2004), with the generic type *B. disciformis* (Fr.) Mudd and all the species previously accommodated in *Hafellia* (and several other *Buellia*) are characterized by the typically large, *Callispora*-type ascospores with variable septation (from uniseptate to muriform) which develop with a particular ontogeny (distinct from types A and B) where subapical wall thickenings become distinct before the septum is inserted and the hymenium is strongly interspersed with oil droplets. In addition, they exhibit a very well-developed proper exciple which is not of the *aethalea*-type. Although some species contain diploicin (*B. demutans* (Stirt.) Zahlbr., *B. capitatis-regum* W. A. Weber, *H. desertica* Marbach, *B. dissa* (Stirt.) Zahlbr., *Buellia oidalea* (Tuck.) Tuck, *B. oidaliella* A. Nordin, *B. parastata* (Nyl.) Zahlbr., *B. procellarum* A. Massal., *B. pseudotetrapla* (Pusswald) Elix, *B. reginae* Bungartz, and *B. tetrapla* (Nyl.) Müll. Arg.), their morphological characters readily distinguish them from the *R. ericina*-group.
2. The genera *Rinodina*, *Rinodinella* H. Mayrhofer & Poelt and *Mobergia* H. Mayrhofer & Sheard, with *Lecanora*-type asci, lecanorine apothecia, and a colorless hypothecium.
3. The genera *Amandinea* M. Choisy ex Scheid. & H. Mayrhofer and *Tetramelas* Norman, with ascospores with slight internal wall thickenings or without thickenings (not rinodinoïd) developing with type A ontogeny.
4. The placodioid genera *Australiaena* Matzer, H. Mayrhofer & Elix and *Dimelaena* Norman, are separated from the *R. ericina*-group, the former by its lecanorine to biatorine apothecia, *Lecanora*-type asci, and filiform conidia; and the latter by its cryptoleca-

norine apothecia and *Buellia*-type ascospores developing with ontogeny of type A. Another placodioid genus is the sterile (and for this reason not discussed here) *Coscinocladium* Kunze, included in the Physciaceae after molecular phylogenetic methods (Crespo et al. 2004). The genus *Diploicia* is discussed below.

5. Among the other genera of Physciaceae with an alternative thalline growth form—i.e., umbilicate, foliose or fruticose—the *R. ericina*-group only shows affinities with *Dirinaria* (Tuck) Clem. and *Pyxine* Fr. Both have *Dirinaria*-type ascospores (ontogeny of type B), but foliose thalli provided with organs of attachment, lack hymenial oil droplets, and have somewhat lecanorine apothecia (see Awasthi 1975).
6. Among the 15 crustose segregates of *Buellia* s. lat. erected by Marbach (2000), only the genera *Sculptolumina* Marbach and *Cratiria* Marbach may be distantly related to the *R. ericina*-group since they include at least some members with rinodinoid ascospores (see Marbach 2000, table 5/1: p. 42–44). Nevertheless, the generic types of *Sculptolumina* and *Cratiria*, [*S. japonica* (Tuck.) Marbach and *Cratiria lauricassiae* (Fée) Marbach, respectively] clearly differ from the *R. ericina*-group, the former by the large *Mischoblastia*-type ascospores, the presence of several quinones and anthraquinones, and the filiform conidia (Sheard et al. 2008; Giralt et al. 2009), and the latter by the triseptate ascospores, the presence of norstictic acid, and the alternative proper exciple which is paler in the central part (Marbach 2000; Nordin 2000; Giralt and Nordin 2002).
7. Currently, the genus *Endohyalina* includes two species, the generic type *E. rappii* and *E. circumpallida* (H. Magn.) Marbach (Marbach 2000). Our observations on the type of *E. rappii* have shown that it exhibits exactly the same features which are diagnostic of *Rinodina ericina*, and for this reason we consider the two taxa to be conspecific. The genus *Endohyalina* is recircumscribed here to accommodate the additional species of the *R. ericina*-group, but *E. circumpallida* is excluded from the genus and reverts to *Buellia* s. lat. Thus, we consider *Endohyalina* to include four previously known species, *E. ericina* s. lat. (= *E. rappii*; *R. madeirensis*), *E. insularis*, *E. interjecta*, and *E. kalbii*, and two new lichenicolous species described below (*E. brandii* and *E. diederichii*). Undoubtedly, the genus *Endohyalina* is related to the clade B, subclade III [family Pyxinaceae (Fr.) Stiz.] as inferred by the genetic analyses of Helms et al. (2003), a clade which includes the genera *Diploicia*, *Dirinaria*, and *Pyxine*, all characterized by small *Dirinaria*-type ascospores with an ontogeny of type B, *Bacidia*-type asci, brown hypothecia, and lecideine to somewhat lecanorine apothecia (Awasthi 1975). They are separated from each other by alterna-

tive growth forms of the thallus, being placodioid in *Diploicia*, and foliose in the latter two genera. The inclusion of the genus *Diploicia* within this clade is doubtful (Crespo et al. 2004).

- (2) The case for not accommodating the species of the *Rinodina ericina*-group in the genus *Diploicia*

The genus *Diploicia* includes three species, *D. canescens* (Dicks.) A. Massal., *D. subcanescens* R.G. Werner and *D. africana* (Tuck.) Matzer, H. Mayrhofer & Rambold (Elix et al. 1988; Matzer et al. 1997; Kalb and Elix 2007). All three are non-lichenicolous, have large, thickly placodioid thalli with radiating marginal lobes and often form rosettes. Additional diagnostic characters include the lecideine apothecia, hymenia containing oil droplets, brown hypothecia, *Bacidia*-type asci, *Dirinaria*-type ascospores with type B ontogeny, and bacilliform conidia. Chemically, they contain the depsidone diploicin (and biosequentially-related substances) and atranorin in the cortex. Other lichen products reported for the genus include gyrophoric acid, secalonic acids A, B, C, and an unknown secalonic acid derivative.

Thus, except for the placodioid thallus and the non-lichenicolous behavior, the diagnostic characters of *Diploicia* are consistent with those exhibited by the species of *Endohyalina* (= *Rinodina ericina*-group).

Nevertheless, *Endohyalina* is not considered synonym of *Diploicia* for the following reasons:

1. At present there is no genus within the Physciaceae which includes species with different thalline growth form [except for the polyphyletic *Buellia* s. lat. which includes species with both crustose and effigurate thalli with marginal lobes (e.g., *Buellia* cf. *epigaea*; Trinkaus and Mayrhofer 2000; Trinkaus et al. 2001)]. Indeed, authors have segregated genera solely on the basis of their different thalline growth forms [e.g., *Buellia tesserata* Körb. with a subeffigurate thallus and *Dimelaena radiata* (Tuck.) Müll. Arg. with a placodioid thallus, Rico et al. 2003; the foliose/subfruticose *Anaptychia* Körb. from the fruticose *Tornabea* Østh.].
2. Many genera in the Physciaceae are separated solely by one distinguishing character [e.g., *Rinodinella* from *Rinodina*, by the different ascospore-type; *Hyperphyscia* from *Phaeophyscia* Moberg, by the different conidia; *Physcia* (Schreb.) Michx from *Phaeophyscia* by the presence of atranorin in the cortex; *Heterodermia* from *Physcia*, by the different cortex anatomy; *Dirinaria* from *Pyxine*, by the different organs of attachment of the thallus].

Hence, we refrain from modifying the circumscription of the genus *Diploicia*, one of the better-delimited genera within the Physciaceae, to incorporate species which

exhibit significant variations in thalline growth form and nutritional behavior.

## Materials and methods

This study was based on herbarium material present in BCN, G, NY, and the private herbaria of M. Brand, P. Diederich, K. Kalb, and the second author (P. van den Boom). Lichen morphology was examined by standard techniques using stereo and compound microscopes. The terminology used follows Poelt and Vězda (1984) for describing the thalline growth form of lichenicolous species, Rambold et al. (1994) for the asci, Scheidegger (1993) and Bungartz et al. (2004, 2007) for the proper exciple, and Giralt (2001) for the ascospore- and ontogeny-types.

Chemical constituents were identified by high performance liquid chromatography (HPLC) (Elix et al. 2003). The method used to detect the secondary substances present in the lichenicolous species is as follows: (1) analysis of a sample of the lichenicolous species including the thallus of the parasited host, and (2) analysis of the same thallus of the host but free of the lichenicolous species. Thus, the substances detected in (1) but absent from (2) belong to the lichenicolous species.

## Results

### Emended description of the genus *Endohyalina*

*Endohyalina* Marbach **emend.** Giralt, van den Boom & Elix

*Type species Endohyalina ericina* (Nyl.) Giralt, van den Boom & Elix [syn. *Endohyalina rappii* (Imshaug ex R.C. Harris) Marbach, see below]

Thallus lichenicolous, endokapylic to epikapylic on several crustose or fruticose hosts or autonomous and crustose; algae, when present, chlorococcoid. Apothecia lecideine, immersed to sessile, black, small. Excipulum proprium poorly developed, *aethalea*-type (Scheidegger 1993; Bungartz et al. 2007) with a dark outer part with hyphae with  $\pm$ swollen cells and a paler to colorless inner part with hyphae similar in structure and orientation to the paraphyses. Hymenium  $\pm$ inspersed with oil droplets or not. Hypothecium pale to dark brown. Asci *Bacidia*-type (Giralt and Matzer 1994; Giralt 2001). Apical cells of the paraphyses  $\pm$ enlarged, with brown caps. Ascospores brown at maturity but with the ends paler, always one-septate and small, ellipsoid or fusiform, with internal wall thickenings mostly of the *Dirinaria*-type, but also grading into the

*Milvina*-, *Physconia*- or *Pachysporaria*-type; ontogeny of type B (apical internal wall-thickenings appearing before the septum is inserted; Giralt 2001); torus present or not; spore surface smooth to microrugulate. Conidia bacilliform.

*Chemistry* Diploicin, fulgidin and isofulgidin; dechlorodiploicin, caloploicin, brialmontin 1, atranorin, or secalonic acids present.

*Ecology and distribution* Lichenized thalli are corticolous or rarely lignicolous, usually growing on bark of coniferous trees (*Juniperus*, *Pinus*) and of phorophytes with rough bark (*Calluna*, *Erica*, *Tamarix*). Lichenicolous thalli grow on crustose (*Aspicilia*, *Lecanora*) or fruticose (*Ramalina*) species present on silicicolous substrata. The genus is predominantly oceanic and mainly restricted to the Temperate European Atlantic regions and to the Mediterranean and Macaronesian regions. It is particularly well represented in coastal habitats. The type species, *Endohyalina ericina*, extends from these areas south to the Atlantic subtropical (Alabama, Florida) and tropical (Brazil) regions where it usually occurs on mangroves, whilst *E. insularis*, the most widely distributed species of the genus, shows a distribution similar to that of *Diploicia canescens* (see Kalb and Elix 2007).

*Discussion* The species included in the here-recircumscribed genus *Endohyalina* can be segregated in three different groups. The group including the type species *E. ericina* and *E. diderichii*, characterized by a whitish thallus, composed of verrucae or granules, a  $\pm$ inspersed hymenium, weakly enlarged apical cells of the paraphyses and fusiform ascospores; the group including *E. brandii*, *E. insularis* and *E. interjecta*, with a brown thallus (when present), composed of subsquamulose areolae, an hymenium lacking oil droplets, strongly enlarged apical cells of the paraphyses and ellipsoid ascospores. Finally, *E. kalbii* differs from both groups by the continuous, ochraceous thallus lacking secondary metabolites and the presence of secalonic acids in the proper exciple.

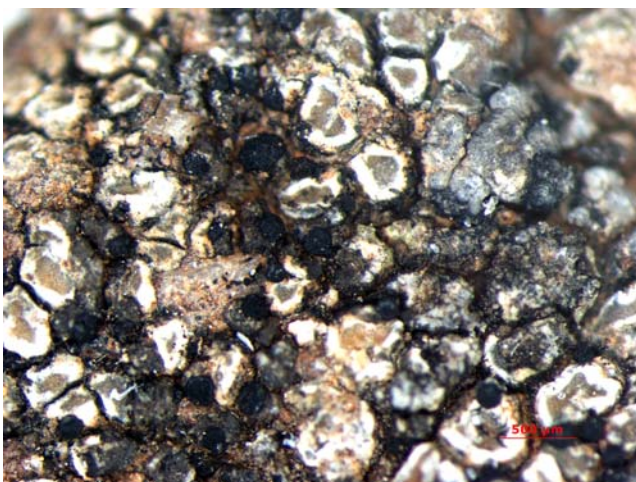
### Key to the species of *Endohyalina*

- 1 Thallus autonomous, not lichenicolous . . . . . 2
- 2 Thallus whitish, composed of discrete to continuous verrucae; hymenium inspersed with few to numerous oil droplets; ascospores fusiform, 10–18 $\times$ (4.5–)5–6(–6.5)  $\mu$ m . . . . . *E. ericina*
- 2\* Thallus ochraceous or brown; hymenium without oil droplets; ascospores ellipsoid . . . . . 3
- 3 Thallus ochraceous, continuous, lacking crystals (polarized light); ascospores 11–16 $\times$ (5–)6–8  $\mu$ m,

- with rounded lumina (*Pachysporaria*-type); proper exciple K+ yellow (secalonic acids) . . . . . *E. kalbii*
- 3\* Thallus brown, discontinuous, composed of subsquamulose areolae, containing crystals (polarized light); ascospores 10–12(–14)×4.5–5.5 μm, not of *Pachysporaria*-type; proper exciple K- . . . . . *E. interjecta*
- 1\* Thallus obligately lichenicolous . . . . . 4
- 4 On *Ramalina*; hymenium interspersed with abundant oil droplets; thallus absent or composed of discrete, minute, whitish to pale grayish granules; apical cells of the paraphyses up to 4 μm diam.; ascospores fusiform . . . . . *E. diderichii*
- 4\* Not on *Ramalina*; hymenium not interspersed; thallus absent or when present not as above, brown; apical cells of the paraphyses 5–6 μm diam.; ascospores ellipsoid . . . . . 5
- 5 On *Lecanora rupicola* agg.; thallus commonly absent; apothecia immersed in the thallus of the host to adnate, up to 0.7 mm diam.; ascospores 11–17×5.5–9 μm; hypothecium dark brown . . . . . *E. insularis*
- 5\* On *Aspicilia intermutans*; thallus present; apothecia sessile, up to 0.3 mm diam.; ascospores 11–13(–14)×6–7(–7.5) μm; hypothecium pale reddish brown . . . . . *E. brandii*

## The species

*Endohyalina brandii* Giralt, van den Boom & Elix sp. nov.  
Fig. 1



**Fig. 1** Habit of *Endohyalina brandii* Giralt, van den Boom & Elix, lichenicolous on *Aspicilia intermutans* (holotype). Scale bar 500 μm

**Diagnosis** Lichen lichenicola, *Endohyalinae insularis* similis, sed thallos lichenum *Aspiciliae intermutantis* incolens, thallo epikapylico bene evoluto, apotheciis 0.1–0.2(–0.3) mm, sessilibus, hypothecio albido rubro-fusco, ascosporis 11–13(–14)×6–7(–7.5) μm, conidiis bacilliformibus, 3–4×1 μm, diploicinum, isofulgidinum et caloploicinum continens.

**Type** Macaronesia, Canary Islands, Tenerife, near col in road Santiago-Masca, on Miocene volcanic rocks in open *Euphorbia–Chamaecytisus* vegetation, on *Aspicilia intermutans*, 900 m, 28°13.5'N, 16°49.4' W, 14.04.1986, M. Brand 13680 (L-holotypus, isotype-hb. Brand).

Obligately lichenicolous on *Aspicilia intermutans* (Nyl.) Arnold. Thallus rarely absent (endokapylic), normally epikapylic, subsquamulose, areolate and inducing necrotic spots in the host. Areolae small, smooth, brown, rather thick, up to 150 μm, with abundant crystals insoluble in K. Epinecral layer (8–)15–25 μm; cortex 10–20 μm, outermost external part brownish-green pigmented, K+ pale violet; algal layer 80–100 μm thick, with chlorococcoid algae 10–18 μm diam.; medulla absent to 20 μm thick, I-. Apothecia lecideine, adnate to sessile, black, 0.1–0.2(–0.3) mm diam., becoming hemispherical. Proper margin thin, not persistent. Disc plane but soon becoming convex. Excipulum proprium 30–50 μm wide. Hymenium 40–60 μm high, not interspersed. Hypothecium pale reddish brown 70–150 μm deep. Epihymenium dark brown. Apical cells of the paraphyses up to 6 μm diam. Ascospores ellipsoid, *Dirinaria*-type 11–13(–14)×6–7(–7.5) μm, smooth at ×1,000, spore ends ±slightly paler, torus present or not. Inner wall-thickenings angular (*Dirinaria*-type) in young ascospores, nearly disappearing (*Milvina*- or *Physconia*-type) in mature ascospores. Ascospore ontogeny of type B. Conidia bacilliform, 3–4×1 μm.

**Etymology** The new species is named in honor of the collector, the lichenologist Maarten Brand, for his outstanding work on lichens and lichenicolous fungi in Europe and the Canary Islands.

**Detailed chemical results** Hb. Brand-13675: (1) *Aspicilia intermutans* + *Endohyalina brandii*: norstictic acid (major), connorstictic acid (trace), thuringione (minor), diploicin (minor), caloploicin (trace), isofulgidin (trace); (2) *A. intermutans*: norstictic acid (major), connorstictic acid (minor), thuringione (minor or trace).

Thus, *E. brandii* contains diploicin (minor), isofulgidin (trace) and caloploicin (trace).

**Ecology and distribution** This species is lichenicolous on *A. intermutans* and is only known from the type locality in Tenerife and from one additional locality in El Hierro. In the

type locality, the lichen community growing on Miocene volcanic rocks includes *Catillaria chalybeia* (Borrer) A. Massal., *Diploschistes bisporus* (Bagl.) J. Steiner, *Lecanora gangaleoides* Nyl., *Lecidella viridans* (Flot.) Körb., *Neofuscelia loxodes* (Nyl.) Essl. s.l., *N. verruculifera* (Nyl.) Essl., *Pertusaria corallina* (L.) Arnold, *Rhizocarpon geminatum* Körb. and *R. polycarpum* (Hepp.) Th. Fr.

**Discussion** *Endohyalina brandii* is well characterized by the typically epikapylic, areolate, rather thick, brown thallus, the small (0.1–0.3 mm diam.) lecideine apothecia, the absence of hymenial oil droplets, the pale hypothecium, the broad apical cells of the paraphyses and the ellipsoid ascospores. Apart from growing on the *Lecanora rupicola* agg. and usually lacking a thallus (endokapylic), *E. insularis* is distinguished by the larger (up to 0.7 mm diam.), initially immersed apothecia, the larger ascospores, and the darker hypothecium. *Endohyalina interjecta*, apparently not lichenicolous but closely associated with *Rhizocarpon geographicum* (L.) DC., has a dark brown hypothecium and narrower ascospores.

*Endohyalina brandii*, like *E. interjecta*, can be mistaken for *Buellia badia* (Fr.) A. Massal. because of its brown subsquamulose thallus and its lichenicolous (or apparently lichenicolous behavior). However, *B. badia* can be distinguished by the *Buellia*-ascospores developing with type A ontogeny. Previous records of *B. badia* could refer to both *Endohyalina* taxa.

**Additional specimens examined** Canary Islands, Tenerife, near col in road Santiago-Masca, on Miocene volcanic rocks in open *Euphorbia–Chamaecytisus* vegetation, on *Aspicilia intermutans*, 900 m, 28°13.5'N, 16°49.4' W, 14.04.1986, M. Brand 13675 (topotype-hb. Brand). El Hierro, N of Frontera, 1 km SW of El Matorral, small (secondary) road to Los Llanillos, Hoya de los Morotes, S side of road, field with small valley and volcanic outcrops, 55 m, 26.03.2009, P. & B. van den Boom 41974 (hb v.d. Boom).

***Endohyalina diderichii* Giralt, van den Boom & Elix sp. nov.** Fig. 2

**Diagnosis** Lichen lichenicola, *Endohyalinae ericinae* var *ericinae* similis, sed thallos lichenum *Ramalinae* incolens, thallo endokapylico vel epikapylico, debiliter evoluto, e granulis minutis; apotheciis minoribus et apotheciis juvenilibus in hospitis thallo immersis.

**Type** Macaronesia, Canary Islands, Lanzarote, SW of Haria, Valle del Malpaso NW slope in valley with volcanic outcrops and *Pinus* trees, on N sloping rock, 515 m, 29° 07.8'N, 13°31.2'W, 07.03.2003, on *Ramalina bourgeana*



**Fig. 2** Habit of *Endohyalina diderichii* Giralt, van den Boom & Elix, lichenicolous on *Ramalina bourgeana* (holotype). Scale bar 500µm

Mont. ex Nyl., P. & B. van den Boom 30459 (Holotype-GZU, isotype-hb. van den Boom).

Obligately lichenicolous on *Ramalina* sp. pl. Thallus absent (endokapylic) to epikapylic, crustose, discontinuous, composed of minute, whitish to pale grayish granules, including crystals insoluble in K. When well developed, the infection produces a brownish color of the cortex of the host. Algae chlorococcoid, 8–15 µm diam. Apothecia lecideine, immersed in the thallus of the host, becoming sessile and constricted at the base, 0.1–0.2(–0.3) mm diam. Proper margin thick, prominent, persistent or not. Disc plane to subconvex, black. Excipulum proprium 30–40 (–50) µm wide. Hymenium colorless, interspersed with oil droplets, 50–60 µm high. Hypothecium brown, up to 100 deep. Apical cells of the paraphyses 2–4 µm diam. Ascospores fusiform, of *Dirinaria*-type, (10–)12–15(–17) × 5–6(–7) µm, smooth at ×1,000, spore-ends paler, torus absent. Ascospore ontogeny of type B. Conidia not seen.

**Etymology** The new species is named in honor of the collector, the lichenologist Paul Diederich, for his exceptional contributions to the study of lichenicolous fungi worldwide.

**Detailed chemical results** Hb. Boom-26191: (1) *Ramalina* sp. + *Endohyalina diderichii*: salazinic acid (major), protocetraric acid (major), convirensic acid (minor), usnic acid (minor), diploicin (minor), isofulgidin (trace), brialmontin 1 (trace); (2) *R.* sp.: salazinic acid (major), protocetraric acid (trace), norstictic acid (trace), consalazinic acid (minor), usnic acid (trace).

**Type-Hb.** Boom-30459: (1) *Ramalina bourgeana* + *E. diderichii*: salazinic acid (major), protocetraric acid (trace), consalazinic acid (minor), usnic acid (trace), diploicin (minor), fulgidin (trace), isofulgidin (minor), brialmontin 1 (trace), dechlorodiploicin (trace); (2) *R. bourgeana*: sala-

zinic acid (major), protocetraric acid (trace), consalazinic acid (minor), usnic acid (trace).

Thus, *E. diderichii* contains diploicin (minor), isofulgidin (trace), fulgidin (trace or absent), dechlorodiploicin (trace or absent) and brialmontin 1 (trace).

**Ecology and distribution** *E. diderichii* has been found to be lichenicolous on *Ramalina* sp. pl. growing on rocks. It is known from the type locality in Lanzarote, from one locality in Fuerteventura, the eastern and drier Canary Islands, and from two additional localities, one in El Hierro and the other one in Tenerife. The type locality is rich in epiphytic lichens especially on branches of *Pinus* trees. The volcanic outcrops on which the new species was found are rather poor in lichens but the following have been recorded: *Physcia adscendens* (Fr.) H. Olivier, *Ramalina decipiens* Mont. and *Roccella fusciformis* (L.) DC.

**Discussion** *Endohyalina diderichii* is characterized by its whitish to pale gray, minutely granulose thallus, its hymenium densely interspersed with oil droplets, its weakly enlarged apical cells of the paraphyses, and its fusiform ascospores. It is closely related to *E. ericina* but differs in its endokapylic or epikapylic lichenicolous habit, its minutely granulose thallus and its smaller apothecia.

In the field, *E. diderichii* may readily be mistaken for *Catillaria mediterranea* Hafellner, a lichenicolous species which is common on *Ramalina* species in the Canary Islands. *C. mediterranea* has similarly sized, black lecidine apothecia. However, the ascospores are hyaline and c.  $6.5 \times 2.5 \mu\text{m}$ , and this species lacks secondary substances.

**Additional specimens examined:** Canary Islands, Fuerteventura, N of Betancuria, S side of road to mirador, near crossing with main-road, SW exposed rocky slope, 400 m from entrance along path, 550 m, 28°26.2'N, 14°02.8' W, 03.03.2001, P. & B. v. d. Boom (hb. Boom-26191). El Hierro, SW of Valverde, along road HI-1 to Tiñor, mirador W of La Calderata, E exposed slope, with crumbling steep rock and steep vertical volcanic outcrops, including overhanging branches of *Rumex lunaria*, 800 m, 29.03.2009, P. & B. van den Boom 42543 (hb v.d. Boom). Tenerife, Anaga, along main road from Las Mercedes to Chamorga, 0.5 km crossing with road to San Andrés, 28°32'45"N, 16°13'W, 730 m, over rocks on ridge along road, on *Ramalina* sp., 19.07.2007, P. Diederich 16515 & D. Ertz (hb. Diederich).

***Endohyalina ericina* (Nyl.) Giralt, van den Boom & Elix var. *ericina*, comb. nov.**

**Basionym** *Lecidea ericina* Nyl., Flora 61: 452 (1878); *Buellia ericina* (Nyl.) Jatta, Syll. Lich. Ital.: 397 (1900);

*Rinodina ericina* (Nyl.) Giralt, Lichenologist 32: 312 (2000). Type: France, Corsica, Ajaccio, super corticem *Ericae arboreae*, 1878, Norrlin (H-holotype!).

**Synonym** *Rinodina madeirensis* Kalb & Hafellner, Herzogia 9: 87 (1992). Type: Macaronesia, Madeira, Levada of Queimadas, near Caldero Verde, on old *Cryptomeria*, 900 m, 1990, K. Kalb & A. Kalb (hb. Kalb 23731-holotype!).

**New synonym** *Endohyalina rappii* (Imshaug ex R.C. Harris) Marbach, Biblioth. Lichenol. 74: 205 (2000); *Buellia rappii* Imshaug ex R.C. Harris, Some Florida lichens: 74 (1990). Type: U.S.A., Florida, Franklin County, along US 98 ca. 5 mi E of jct with Fla. Hwy 65, W of town of Carrabelle; oak scrub near Gulf of Mexico, 01.12.1988, R.C. Harris 23166 (NY-holotype!).

**Further information and illustrations** Kalb and Hafellner (1992, Abb. 2: 57; Abb. 17–18: 102) and Giralt and Matzer (1994, Fig. C: 324), sub *R. madeirensis*; Imshaug (1951), Hale and Culberson (1956) and Harris (1988, 1990), sub *Buellia rappii*; Giralt (2000, 2001, plate XVIII C: 160) and van den Boom et al. (2009, Fig. 3: 433), sub *Rinodina ericina*; Marbach (2000, Abb. 93 & 94: 206–207, sub *Endohyalina rappii*).

Thallus autonomous, composed of discrete to continuous verrucae, whitish to pale grayish. Apothecia lecidine, sessile, 0.2–0.5(–0.7) mm diam. Proper margin thick, persistent. Disc plane to subconvex. Excipulum proprium 30–45  $\mu\text{m}$  wide. Hymenium colorless, 50–70  $\mu\text{m}$  high, usually interspersed with numerous oil droplets. Hypothecium dark brown. Apical cells of the paraphyses 3–4(–5)  $\mu\text{m}$  wide. Ascospores fusiform, *Dirinaria*-type, (10–)11–13(–18)  $\times$  (4.5–)5–6(–6.5)  $\mu\text{m}$ , smooth at  $\times 1,000$ , spore-ends paler, torus absent. Ascospore ontogeny of type B. Conidia bacilliform, (5–)6–7  $\times$  1  $\mu\text{m}$ .

**Chemistry** Thallus K<sup>+</sup> yellow, PD<sup>+</sup> faintly yellow. Containing diploicin (major), atranorin (minor), isofulgidin (minor), fulgidin (trace) and one additional unknown substance (Giralt 2000). According to Marbach (2000), *E. rappii* contains atranorin and diploicin.

**Ecology and distribution** *Endohyalina ericina* is an oceanic species, occurring locally along the Atlantic coast of Europe as far north as Ireland and of America as far south as Brazil. It is widespread in Macaronesia but in the Mediterranean region it is known only from Corsica (type locality).

**Discussion** Of the species treated, *E. ericina* is very similar to *E. diderichii* but differs in its better developed, non-lichenicolous thallus which sometimes develop soralia (var.

*boomii*). Both taxa have whitish to pale grayish thalli, interspersed hymenia, weakly enlarged apical cells of the paraphyses and fusiform ascospores.

*Additional specimens examined* U.S.A.: Florida, Lake County, Ocala National Forest, N of Forest Serv. Rd. 552, 0.2 mi E of Forest Serv. Rd. 544, 1.1 mi E of Co. Rd. 445, ca. 2 mi W of Alexander Springs; dwarf oak scrub, 1988, W.R. Buck 16782 (NY). Duval County, Big Talbot Island State Park, ca. 0.7 mi S of northern boundary of Park; coastal oak scrub; on branch of *Lyonia ferruginea*, 1987, W.R. Buck 15516 (NY). Duval County, Big Talbot Island State Park, along trail to “scrubby Bluff”, 1.1 mi from N end of park, 2.2 mi from S end of park; oak scrub grading into coastal hammock, on *Quercus*, 1988, R.C. Harris 23920 & W.R. Buck 16941 (NY). BRAZIL: São Paulo: Município Moji Guaçu, Bairro Martinho Prado Jr., Reserva Biológica de Moji-Guaçu, Cerradao, 560 m, 20.08.1995, B. Marbach & M. Marcellii 1128 (hb. Kalb). Praia de Peruibe bei Itanhaém, in einer Mangrove, 1 m, 1978, K. Kalb 28656 & G. Plöbst (hb. Kalb). In einer dichten Mangrove, 2 m, 1980, K. Kalb 28657, 28658, 28661 (hb. Kalb). Ilha Comprida von Cananea, in einer Mangrove, 1 m, 1979, K. Kalb 28660 (hb. Kalb). Rio Itagararé, etwa 20 km E von Bertioga, in einer Mangrove an *Laguncularia racemosa*, 1 m, 1980, K. Kalb 28659, 28662 (hb. Kalb).

See also specimens examined in Giralt and Matzer (1994, under *Rinodina madeirensis*) and in Giralt (2000, under *R. ericina*).

***Endohyalina ericina* Giralt, van den Boom & Elix var. *boomii* (Giralt) Giralt, van den Boom & Elix, **comb. nov.****

*Basionym* *Rinodina ericina* var. *boomii*, Lichenologist 32: 313 (2000). Type: Portugal, Algarve, N of Albufeira, 1 km N of Alte, E slope along path, orchard with *Ceratonia*, *Olea*, *Prunus dulcis* and calcareous outcrops, 400 m, on *Ceratonia siliqua*, 1993, P. v.d Boom (BCN-van den Boom 14934 holotype!).

*Further information and illustrations* Giralt (2000, 2001).

*Description* This variety differs from *E. ericina* var. *ericina* by the presence of discrete, bluish-gray soralia, up to 0.5 mm diam.

*Ecology and distribution* At present, known only from two localities in southern Portugal. It seems to be a maritime taxon because in both sites it was found growing close to the sea.

*Specimens examined* See Giralt (2000, 2001).

***Endohyalina insularis* (Arnold) Giralt, van den Boom & Elix, **comb. nov.****

*Basionym* *Buellia saxatilis* f. *insularis* Arnold, Verhandl. Zool.-Bot. Ges. Wien 46: 119 (1896); *Rinodina insularis* (Arnold) Hafellner, Beih. Nova Hedwigia 62: 87 (1979). Type: South Tirol, Plan, 1895, Arnold (M-holotype, not seen).

*Further information and illustrations* Hafellner (1979, Abb. 8: 89), Mayrhofer and Poelt (1979), Mayrhofer (1984), Triebel et al. (1991), Rambold and Triebel (1992), Nimis (1993), Matzer et al. (1994), Rambold et al. (1994), Giralt and Llimona (1997, Fig. 1E: 176), Giralt (2000, 2001), Mayrhofer and Moberg (2002: 104), Hafellner (2004), Mayrhofer and Lambauer (2004), Sheard (2004), Kaschik (2006, Fig. 83: 126).

This species is obligately lichenicolous on the *Lecanora rupicola* agg. Thallus endokapyllic to very rarely epikapyllic and then visible only around the apothecia, brown. Apothecia lecideine, immersed in the thallus of the host to adnate, 0.2–0.4(–0.7) mm diam. Proper margin thin, becoming excluded. Excipulum proprium 40–60 µm wide. Hymenium 50–70(–80) µm high, not interspersed. Hypothecium dark brown, with stipe. Apical cells of the paraphyses up to 5(–6) µm, with a brown cap. Asci *Bacidia*-type. Ascospores ellipsoid, *Dirinaria*-type, 11–15(–17) × 5.5–7.5 (–9) µm, microrugulate at ×1,000 spore-ends paler, torus absent. Ascospore ontogeny of type B. Conidia not seen.

*Detailed chemical results* BCN-hb. Barbero-180: (1) *Lecanora rupicola* agg. + *Endohyalina insularis*: atranorin (minor), chloroatranorin (minor), diploicin (major), isofulgidin (trace), fulgidin (trace); (2) *L. rupicola*: atranorin (major), chloroatranorin (minor).

BCN-hb. Barbero-181: (1) *L. rupicola* + *E. insularis*: atranorin (minor), chloroatranorin (minor), diploicin (major), isofulgidin (trace), dechlorodiploicin (trace), fulgidin (trace); (2) *L. rupicola*: atranorin (major), chloroatranorin (minor).

Hb. Boom-20602: (1) *L. rupicola* + *E. insularis*: atranorin (major), chloroatranorin (minor), caloploicin (minor), diploicin (trace); (2) *L. rupicola*: atranorin (major), chloroatranorin (minor).

BCN-hb. Barbero-179: (1) *L. rupicola* + *E. insularis*: atranorin (minor), chloroatranorin (minor), diploicin (major), isofulgidin (trace), dechlorodiploicin (trace), fulgidin (trace).

Thus, *E. insularis* contains diploicin (usually as major), isofulgidin (trace), fulgidin (trace), dechlorodiploicin (trace or absent) and caloploicin (minor or absent). This is the first report of the secondary chemistry of this species.

*Ecology and distribution* *Endohyalina insularis* is obligately lichenicolous on species of the *Lecanora rupicola* agg.



and is distributed world-wide. It has been reported from northern to southern Europe (Mayrhofer 1984, Abb. 53: 426), North America (Sheard 2004: 478) Australasia, South America (Kaschik 2006, figs. 84, 85 & 86: 127–128) and Macaronesia. Its distribution is coincident with that of *Diploicia canescens* (Kalb and Elix 2007).

*Discussion Endohyalina insularis* is characterized by the typically endokapylic thallus, the large apothecia immersed in the thallus of the host, the lack of hymenial oil droplets, the large apical cells of the paraphyses, the dark hypothecium and the ellipsoid ascospores (see under *E. brandii* and *E. interjecta*).

*Specimens examined* FRANCE: Ardennes, Chooz, rochers de Petit-Chooz sur la rive droite de la Meuse, face au pont, IFBL: J5.35, affleurement de roches de l'Emsien supérieur (Grauwacke de Hierges), sur *Lecanora rupicola* s. str., 30.04.1999, P. Diederich 16367 (hb. P. Diederich). SPAIN: Catalunya: Barcelona, Maresme, Dosrius, Can Massuet-El Far, 375 m, 28.02.1987, M. Barbero 179, 180, 181, 192, 193 (BCN). Girona, 1,3 km NE of Meranges, 0.5 km further from crossing to Malniu/Feixa, S sloping *Pinus* forest with shaded acid outcrops, 200 m, 42°27.30'N, 1°48.00'W, 14.08.1998, P. & B. v.d. Boom 20602 (hb. v.d. Boom).

See also Giralt (2001).

***Endohyalina interjecta* (Müll. Arg.) Giralt, comb. nov.**

*Basionym Buellia interjecta* Müll. Arg. Flora 55: 499 (1872); *Lecidea interjecta* (Müll. Arg.) Stizenb., Ber. Thät St. Gall. Naturw. Ges. 1880–81: 481 (1882); *Rinodina interjecta* (Müll. Arg.) H. Mayrhofer, Sheid. & Sheard, Nord. J. Bot. 12: 452 (1992).

*Type* France, Dept. Savoie, Salève near Geneva, above Pas de l'Échelle, 30.08.1872, J. Müller (G-holotype!).

*Further information and illustrations* Mayrhofer et al. (1992, Fig. 2: 452).

Thallus autonomous, areolate to subsquamulose, thick, brown. Apothecia lecideine, subimmersed to adnate, 0.2–0.5 mm diam.; medulla I-. Proper margin thin, not persistent. Disc convex to hemispherical, black. Excipulum proprium 10–20 µm wide. Hymenium 60–80 µm high, not interspersed. Hypothecium brown with stipe. Apical cells of the paraphyses (4–)5–6 µm diam. Ascospores of *Dirinaria*-type, 10–12(–14)×4.5–5.5 µm, microrugulate at ×1,000, spore-ends paler, torus developed; ascospore ontogeny of type B. Conidia bacilliform, 5–6×1 µm.

*Chemistry* At present, this species is only known from the type collection and there is insufficient material for chemical analyses. Nevertheless, crystals are visible in the cortex and especially in the medulla under polarized light. These crystals are of two forms: very small crystals which dissolve in K to give a yellowish solution (probably atranorin) and become yellow with PD; and larger crystals which neither are soluble in K nor give a yellow color in PD (diploicin?).

*Ecology and distribution* Only known from the type locality, in the mountains near Genève (France), growing on granitic boulders among thalli of *Rhizocarpon geographicum*.

*Discussion* The ascospores of the type material develop with type B ontogeny, a feature not mentioned in the excellent description of *Rinodina interjecta* given by Mayrhofer et al. (1992). This character clearly indicates that this species belongs to *Endohyalina* as described above.

*Endohyalina interjecta* is characterized by the autonomous, brown, rather thick, subsquamulose thallus, the subimmersed to adnate apothecia, the hymenium lacking oil droplets, the large apical cells of the paraphyses, and the ellipsoid ascospores with a torus. Among the other species of *Endohyalina*, it is close to *E. brandii* and *E. insularis*, but the latter species differs in their obligately lichenicolous habit and wider ascospores.

***Endohyalina kalbii* (Giralt & Matzer) Giralt, van den Boom & Elix, comb. nov.**

*Basionym Rinodina kalbii* Giralt & Matzer, Lichenologist 26: 328 (1994). Type: Italy, Sardinia, Sassari, Badesi Mare, on littoral sand dunes, 10 m, on *Tamarix*, 1986, J. Poelt & P.L. Nimis (TSB-holotype!).

*Further information and illustrations* Giralt and Matzer (1994, Figs. 1A, 2B & 5: 320, 322 & 329), Rambold et al. (1994, Fig. 1: 34), Giralt et al. (1996), Giralt (2000).

Thallus autonomous, crustose, continuous, smooth, brownish, lacking crystals (polarized light). Apothecia lecideine, adnate to sessile, up to 1 mm diam. Proper margin thick, persistent. Disc concave to subconvex, black. Excipulum proprium 40–50(–70) µm wide. Hymenium 60–80 µm high, not interspersed. Hypothecium pale to dark reddish brown. Apical cells of the paraphyses up to 6 µm diam. Asci of *Bacidia*-type. Ascospores of *Dirinaria*-type, with lumina angular when young, becoming rounded when mature (= *Pachysporaria*-type), (11–)12–16×(5–)6–8 µm, smooth to microrugulate at ×1,000, torus not or poorly developed. Ascospore ontogeny of type B. Conidia bacilliform, 5–6×1 µm.

**Chemistry** The two specimens analysed by HPLC contain: secalonic acid A (major), and an unknown secalonic acid (trace). These substances are present in the excipulum (crystals under polarized light) and must be responsible of the K<sup>+</sup> yellow reaction of the excipulum proprium, already mentioned in Giralt and Matzer (1994) and Giralt (2001).

The secondary chemistry of *E. kalbii* has not been reported previously.

**Ecology and distribution** This is a maritime species with a Mediterranean–South Atlantic distribution, including Macaronesia. It usually occurs in the salt-spray belt growing on old, rough bark associated with ±nitrophilous species.

**Discussion** *Endohyalina kalbii* differs from the other species of *Endohyalina* by its alternative chemistry, as it contains the bisxanthone secalonic A rather than diploicin (and related substances). An additional feature found only in this species is the lumina of its *Dirinaria*-type ascospores that become rounded and *Pachysporaria*-type at maturity. Despite these differences, the other diagnostic characters of *E. kalbii* fit within the concept of the genus *Endohyalina* established here.

**Additional specimens examined** SPAIN: Balearic Islands, Menorca, Ciutadella, Cala Morell, near Ses Coves, 30 m, on *Pinus halepensis* and *Juniperus phoenicea*, 1.07.1993, Boqueras et al. (BCN, three specimens). PORTUGAL: Algarve, WNW of Sagres, Cabo de São Vicente, coastal area with low calcareous outcrops and mixed shrubs, on *Juniperus phoenicea*, 28.04.2004, P. & B. van den Boom 32394 (hb. v.d. Boom).

See also the specimens examined listed in the several references from Giralt given above.

Excluded species

***Buellia circumpallida*** H. Magn. *Ark. Bot.* 3(10): 379 (1954)

**Basionym** *Endohyalina circumpallida* (H. Magn.) Marbach, *Biblioth. Lichenol.* 74: 202 (2000). Type: U.S.A., Hawaii, Hanalei, on smooth bark, 1910 (not seen).

**Further information and illustrations** Tuckerman (1888, sub *Buellia amphidextra*); Magnusson (1954), Imshaug (1951), Hale and Culberson (1956) and Harris (1988, Fig. 1–2: 41), sub *B. amphidexia*; Marbach (2000, Abb. 91 & 92: 204, sub *Endohyalina circumpallida*).

**Discussion** *Buellia circumpallida* lacks the combination of main diagnostic characters described above for the genus *Endohyalina* (namely the *aethalea*-type excipulum; *Diri-*

*naria*-type ascospores; ontogeny type B; diploicin). Like many other species of *Buellia* s. lat., it possesses a crustose thallus which contains atranorin, has lecideine apothecia, a brown hypothecium, *Bacidia*-type asci and ascospores without inner wall thickenings, developing after an ontogeny of type A. For these reasons it is retained in *Buellia*.

As the specific name describes, the excipulum proprium of *B. circumpallida* is very characteristic and unknown elsewhere in Physciaceae. It is clearly structured in three different parts somewhat like a ladder. The outermost part (10–15 µm) is brown pigmented, composed of hyphae with ±swollen cells. The central part (up to 40 µm wide) is colorless, composed of relatively few, thick-walled hyphae, up to 3 µm wide, embedded in an amorphous matrix (I-) which includes oil droplets. Finally, the innermost part (10–15 µm wide) is also dark brown pigmented but has hyphae radiating from the dark hypothecium. The few colorless hyphae of the central part are like the steps of the ladder that connect the brown outermost and innermost parts. No crystals are observed in the excipulum under polarized light.

In fact, the generic name *Endohyalina* given by Marbach (2000) refers better to this species than to *E. ericina* (= *E. rappii*), the species he chose as the generic type. Another interesting character of *Buellia circumpallida* is the presence of a reddish pigment (K<sup>+</sup> yellow-orange) between the paraphyses tips at the epihymenium level. Further, the ascospores are very thin walled and pale brown pigmented, similar to those of *Buellia schaeereri* De Not. or *Rinodinella* H. Mayrhofer & Poelt species.

**Specimens examined** BRAZIL: Mato Grosso, zwischen Jaciara und Sao Vicente, etwa 100 km ostsüdöstlich von Cuiba, in einem Cerrado, 750 m, 2.07.1980, K. Kalb 28665 (hb. Kalb). São Paulo, Rio Itaguapé, etwa 20 km östlich von Bertioaga; in einer Mangrove an *Laguncularia racemosa*, 1 m, 13.04.1980, K. Kalb 28668, 28669 (hb. Kalb). Ilha de Santo Amaro, kurz vor Bertioaga, etwa 20 km nordöstlich von Santos; in einer Mangrove, 1 m, 21.10.1978, K. Kalb 28667 & G. Plöbst (hb. Kalb); Praia de Peruibe bei Itanhaém; in einer dichten Mangrove, 2 m, 09.07.1980, K. Kalb 28664 (hb. Kalb). Praia Grande südlich von São Paulo, in einer Mangrove, 2 m, 18.12.1978, K. Kalb 28666 & D. Hannak (hb. Kalb). MASKARENEN: La Réunion, Forêt de Bébou, wenige Kilometer NW von la Plaine-des-Palmistes. Sentier Botanique. TROPISCHER BERG-PRIMÄRWALD, 21°08'S, 55°35'30"E, 1,300 m, 31.08.1991, K. & A. Kalb 25201 (hb. Kalb).

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