

Saxicolous species of the genus *Rinodina* (lichenized Ascomycetes, Physciaceae) in southern Africa

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Keywords: biogeography, flora, lichenized Ascomycetes, Physciaceae, *Rinodina*, southern Africa, taxonomy

ABSTRACT

A revision of saxicolous species of the genus *Rinodina* (Ach.) Gray (lichenized Ascomycetes, Physciaceae) in southern Africa is presented. The study area covers the following countries: Angola, Namibia, Republic of South Africa, Lesotho, Swaziland, Zimbabwe, and Mozambique. Fifteen *Rinodina* species are treated in detail, and three of them are new to science: *Rinodina longisperma* Matzer & H. Mayrhofer, *R. scabridula* Matzer & H. Mayrhofer, and *R. striatitunicata* Matzer & H. Mayrhofer. The general part of the study includes information on the most important characters of the species with a special focus on ascospore types and ontogeny, and biogeographical notes are also given. A key to the species is provided. All the species are described in detail with notes on their ascus characters, spermogonial apparatus, and chemical characteristics, and their substrate and general distribution are indicated. The descriptions are accompanied by illustrations of the ascospores. Except for *Rinodina oxydata* s.l., the distribution of all the species in southern Africa and other parts of Africa respectively, is mapped. Several names were referred into synonymy, including *Rinodina almbornii* H. Mayrhofer, a synonym of *R. confragosula* (Nyl. in Cromb.) Müll. Arg., and *R. depressa* (Vain.) Zahlbr. and *R. albicans* H. Mayrhofer which are synonymous to *R. huillensis* Vain. A separate section encompasses nine excluded species.

INTRODUCTION

The cosmopolitan genus *Rinodina* (Ach.) Gray comprises about two hundred species (Hawksworth *et al.* 1983), and its species taxonomy is still not settled satisfactorily, particularly in the southern hemisphere. This became obvious, once again, during the preparation of the present work, a re-assessment of saxicolous species occurring in southern Africa. Type material of all critical species and, to the best of our knowledge, almost all relevant collections were examined. Nevertheless, the present study should be seen as an actual inventory rather than an ultimate revision. Given the vastness of the study area, there are relatively few collections of saxicolous *Rinodina* species, and most of them come from the Cape Province in the Republic of South Africa. Type specimens of some species are scant or damaged, several species are still known from a few collections only, and thus the extent of their variation is difficult to estimate. This is particularly problematical in cases where species which are separated by slight morphological differences only, have been described. Morphologically and chemically, many of the saxicolous *Rinodina* species in southern Africa do not exhibit 'exciting characters', and great similarities can be observed between several species. Therefore, determination of specimens has often proved to be rather difficult. In the material studied, several *Rinodina* species were detected which are most probably undescribed. Not all of them are included in the present study, as they are often known from a single locality only, and their relationships to already described and similar species could not be resolved.

However, despite the problems indicated above, many new results are presented in this paper. Several names of

taxa are referred into synonymy, and three new species are introduced. The importance of minute characters such as ascospore ornamentation and length of spermatia for the circumscription of single species is documented. The first data on the biogeographical affinities of saxicolous *Rinodina* species occurring in southern Africa are presented.

MATERIAL AND METHODS

Standard light microscope techniques and standard tests for thallus chemistry (tlc, spot tests for colour reactions) were employed. Descriptions of ascus apices are based on observations in dilute original Lugol's solution (MERCK 9261) without pretreatment with KOH (K). For the testing of the N (= HNO₃)-reaction of the blue-green to blackish pigment, longitudinal sections of thalli, apothecia, and/or spermogonia respectively, were directly mounted in this medium.

THE STUDY AREA

The main focus of this study was on species occurring in extratropical southern Africa, mainly including Namibia, the Republic of South Africa, Lesotho, and Swaziland. Some specimens from adjacent countries (Angola, Zimbabwe, Mozambique) were also studied. However, as already mentioned above, most of the specimens examined were from the Republic of South Africa, mainly from the Cape Province. For comparative purposes it was also necessary to study saxicolous *Rinodina* species described or mentioned from other parts of Africa, mainly including the islands of Pagalu (Annobón) and São Tomé & Príncipe in the Atlantic Ocean, and the island of Socotra in the Indian Ocean.

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MS. received: 1995-03-15.

MORPHOLOGY, ANATOMY AND CHEMISTRY

A short survey is given here of the most important characters of the species treated in detail.

Thallus and prothallus

Thalli in *Rinodina* species are usually crustose or crustose to squamulose. The formation of blastidia is the most important character for the separation of *R. scabridula*. The presence or absence of a distinct prothallus should not be overestimated in the circumscription of species.

Chemistry

Only a few species contain secondary lichen substances which are detectable by thin-layer chromatography (tlc). *Rinodina huillensis* is the only species with gyrophoric acid (and, in part, other secondary compounds) and is well characterized by the C+ red reaction in the medulla of the thallus. The thalli of *R. confragosa*, *R. oxydata s.l.*, and *R. substellulata* give a K+ yellow reaction. The main lichen compound in these taxa is atranorin.

Pigments

A blue-green to blackish pigment was often found to be located in parts of the thallus, apothecia (proper exciple, epihymenium), and/or in the spermogonia of six species: *R. confragosula*, *R. huillensis*, *R. oxydata s.l.*, *R. striatitunicata*, *R. substellulata*, and *R. subtristis*. The pigment reacts N+ red, K-, and HCl+ blue after pretreatment with K. It is most probably identical to the pigment which was described as 'Lecideagrün' by Bachmann (1890), and it occurs also in other genera of the Physciaceae, e.g. in *Buellia* De Not. (Scheidegger 1993, as 'pigment A').

An interesting and unique character is the K+ yellowish to orange reaction in the hypothecium, the epihymenium (here not always), and in spermogonia (not always) of *R. reagens*, which is due to the presence of a green-yellow pigment.

Apothecia

In the genus *Rinodina*, a great variation in apothecial types can be observed, and even within single species or specimens, the formation of apothecia can be variable. Apothecia are cryptolecanorine, lecanorine (in addition to the thalline margin a proper margin may be developed), and/or lecideine. Apothecia which appear to be lecideine in surface view may contain (dead) algal cells in the exciple (e.g. in *R. oxydata s.l.*, *R. subtristis*, *R. teichophiloides*).

Asci

Most of the species have asci which can be described as corresponding to the Lecanora type (compare e.g. Honegger 1978; Rambold *et al.* 1994), but some variation in the formation of ascus tips can be observed. In *R. oxydata s.l.*, the asci correspond to the Lecanora type but

show tendencies towards the Bacidia type (see e.g. Hafellner 1984; Rambold *et al.* 1994). The axial body in several species is often more or less indistinct (e.g. in *R. geesteranii*, *R. huillensis*, *R. longisperma*, *R. oxydata s.l.*, *R. subtristis*) or even not observable (e.g. in *R. longisperma*) under the light microscope. In *R. huillensis*, the axial body may be surrounded by a tube-like structure, and the same phenomenon could be observed in several other species after pretreatment with KOH.

Ascospores

The most important characters for the separation and identification of *Rinodina* species are those of the ascospores. For terms used in the description of ascospores occurring in *Rinodina* (and other genera of the Physciaceae) see Poelt & Mayrhofer (1979); revised compilations of ascospore types were published by Hafellner *et al.* (1979), Mayrhofer & Poelt (1979) and Mayrhofer (1982, 1984a). With the increasing knowledge on possible formation types in the ascospores of Physciaceae, it became necessary to modify the classification systems for spores by subsequent authors. For a better understanding, the most important changes are briefly outlined here.

1. The presence vs. absence of a torus (i.e. a dark belt in the region of a spore septum) is not always a reliable character for the definition of spore types. For instance, within several species a torus can clearly be observed in some of the ascospores under the light microscope, but is indistinct or even not visible in others (e.g. in *Rinodina fimbriata*, *R. microlepidea*, *R. striatitunicata*, *R. substellulata*); the same has been reported for other genera and species of the Physciaceae (e.g. *Amandinea petermannii*; see Matzer *et al.* 1994b). Scheidegger (1993: 333) pointed out that within *Buellia* closely related species may differ considerably in their torus while, on the other hand, species with only slight affinities to each other may have a similar torus. Consequently, a distinction of spore types which is solely based on the presence or absence of a torus cannot be recommended. This mainly concerns the following ascospore types: Beltramia type (incl. *Buellia* type) and Physconia type (incl. *Dubyana* and *Sicula* type); in both cases the terms which have been introduced first into the literature should be used (for dates of introduction see Mayrhofer 1982). Such a procedure has been applied already by Matzer & Mayrhofer (1993), Scheidegger (1993), and, in part, by Rambold *et al.* (1994).

2. Original definitions of single spore types have been modified or improved; the most important case in this context is the Dirinaria type. It was introduced by Mayrhofer (1982: 315) for ascospores lacking a torus and with internal wall thickenings of the Physcia, *Mischoblastia*, and/or intermediate types. In subsequent studies, the mode of spore ontogeny in this spore type (apical internal spore wall thickenings appear **before** the septum is inserted) was used more or less implicitly as the major character for the definition of the Dirinaria type (Giralt & Matzer 1994; Giralt *et al.* 1995; Rambold *et al.* 1994), or this peculiar ontogeny was stressed as being a very important character (Giralt 1994; Giralt & Mayrhofer 1994a, b, 1995). In the present study this concept of the Dirinaria type is adopted.

Within the species treated in detail in the present study, the following ascospore types were observed:

Beltramia type (incl. *Buellia* type): spores without internal wall thickenings, *Buellia distrata*.

Physconia type (incl. *Dubyana* and *Sicula* type): spores with \pm pronounced septal wall thickenings, apical thickenings less pronounced or lacking, spore lumina at their distal ends (i.e. near to the spore ends) rounded, *R. longisperma*.

Physcia type: septal and apical wall thickenings well developed, spore lumina at their distal ends concave, torus usually developed, in young spores the septum is inserted before wall thickenings become distinct, *R. confragosa*, *R. confragosula*, *R. scabridula*, *R. sp. 1*.

Milvina type: similar to the *Physcia* type, but particularly the apical wall thickenings are less pronounced, spore lumina at their distal ends flattened to slightly concave, *R. confragosula*, (*R. geesteranii*), *R. huillensis*, *R. scabridula*, *R. substellulata*, *R. subtristis*, *R. sp. 1*.

Mischoblastia type: septal and apical wall thickenings strongly pronounced, *R. oxydata s.l.*, *R. reagens*, *R. teichophiloides*.

Pachysporaria type: wall thickenings strongly developed around the lumina which are \pm rounded, *R. confragosula*, (*R. geesteranii*), *R. huillensis*, *R. longisperma*, *R. microlepidea*, *R. reagens*, *R. scabridula*, *R. substellulata*, *R. subtristis*, *R. teichophiloides*.

Tunicata type: spores with a markedly thickened outer wall layer, *R. striatitunicata*.

Dirinaria type: when mature similar to the *Physcia* type (septal and apical wall thickenings well developed, spore lumina at their distal ends concave), but usually lacking a torus and with a different spore ontogeny: in young spores the septum is laid down after the formation of apical wall thickenings, *R. gennarii*, (compare also *R. geesteranii*).

As can be seen from this compilation, in most of the species the ascospores could not clearly be assigned to a single spore type. Most of the spores encountered belong to the *Pachysporaria* or *Milvina* type. In contrast to all other species treated in detail, the insertion of the septum in ascospores of *R. geesteranii* may occur before or after internal wall thickenings become distinct.

Spermogonial apparatus

The spermogonial apparatus in all species studied in this respect is typical of the genus *Rinodina*. Therefore,

we give here a general description which is not repeated in the species accounts:

Spermogonia immersed in the thallus, with the upper parts prominent or not, in longitudinal section \pm globose, ellipsoid, cupuliform, or flask-shaped. Spermatiophores septate, composed of spermatiogenous cells. Spermatiogenous cells intercalary and terminal; intercalary cells \pm cylindrical and with a lateral projection below the upper transverse septum; terminal cells \pm flask-shaped or oblong-conical and with an apical projection; spermatia are formed on the lateral and apical projections. Spermatia bacilliform, hyaline, non-septate.

The spermatiophores correspond to type VI of Vobis (1980, as 'Conidiophoren'). For illustrations of spermatiophores and spermatiogenous cells respectively, see Matzer *et al.* (1994a) and Mayrhofer *et al.* (1993). The spermogonial apparatus of *R. longisperma* is basically of the same type as described above, but it differs in the way that intercalary spermatiogenous cells could be observed only exceptionally.

BIOGEOGRAPHICAL NOTES

According to the present, rather incomplete data, saxicolous species of *Rinodina* from southern Africa show four different biogeographical elements or affinities. Particularly noteworthy is the high incidence of endemism.

1. Endemic element: this is the dominant element and includes ?*R. confragosula* (a record from New Caledonia seems to be dubious), *R. geesteranii*, *R. huillensis*, *R. longisperma*, *R. microlepidea*, *R. scabridula*, *R. striatitunicata*, *R. subtristis*, *R. teichophiloides*, and *R. sp. 1*. Most of these species have been found only in the Republic of South Africa and, in part, in adjacent countries, while *R. huillensis* and *R. subtristis* are known to extend further north to Angola.
2. African element: *R. substellulata* is known to occur in the Cape Province but also on some tropical islands adjacent to the African continent (Principe, Annobón, and Socotra).
3. New Zealand–South African element: an interesting distribution pattern is shown by *R. reagens* which has been found in New Zealand and in the Cape Province in South Africa.
4. Cosmopolitan element: this comprises *R. confragosa*, *R. gennarii*, and *R. oxydata s.l.*

Key to saxicolous *Rinodina* spp. in southern Africa

- 1a Medulla of thallus C+ red (containing gyrophoric acid); ascospores of *Pachysporaria* type, occasionally grading into *Milvina* type, small protrusions of lumina towards septum and/or spore ends may be present, (10–)12–18 (–24) \times (6–)7–10(–12) μm 5. *R. huillensis*
- 1b Medulla of thallus C–:
- 2a Thallus K+ yellow; (atranorin usually detectable by tlc):
- 3a Ascospores of *Physcia* type, (15–)16–27 \times 8–13 μm 1. *R. confragosa*
- 3b Ascospores not of *Physcia* type:
- 4a Ascospores of *Pachysporaria* type, occasionally grading into *Milvina* type, 14–20 \times 7–12 μm ... 12. *R. substellulata*
- 4b Ascospores usually of *Mischoblastia* type, rarely with tendencies towards *Pachysporaria* type, 11–25 \times (7–) 8–13 μm 8. *R. oxydata s.l.*

- 2b Thallus K-; (lacking atranorin):
- 5a Ascospores of Tunicata type, internal wall thickenings corresponding to Physcia type, mature spores with striate ornamentation, $(16-)\text{17-27} \times (10-)\text{11-17} \mu\text{m}$ 11. *R. striatitunicata*
- 5b Ascospores not of Tunicata type, mature spores without striate ornamentation:
- 6a Hypothecium (always), epihymenium and spermogonia (not always) in longitudinal section distinctly K+ yellowish to orange; ascospores with internal wall thickenings of Mischoblastia type, occasionally grading into Pachysporaria type, torus absent, $22-31 \times 10-19 \mu\text{m}$; on calcareous rocks 9. *R. reagens*
- 6b Hypothecium, epihymenium, and spermogonia K-:
- 7a Thallus partially blastidiate, blastidia usually situated at margins of thallus areolae; ascospores of Milvina, Pachysporaria or Physcia type, or intermediate between these types, $(12-)\text{15-20}(-24) \times (6-)\text{7-10}(-13) \mu\text{m}$ 10. *R. scabridula*
- 7b Thallus smooth or with an irregular surface but not blastidiate:
- 8a In young ascospores septum is inserted **after** formation of internal apical wall thickenings, spores lacking a torus in all stages of ontogeny:
- 9a Ascospores of Dirinaria type, in young spores septum is always inserted **after** formation of internal apical wall thickenings, spores $(11-)\text{12-17} \times (5-)\text{6-9} \mu\text{m}$; hymenium $60-80 \mu\text{m}$ tall; thallus thin, occasionally inconspicuous, crustose, areolate or \pm effuse, smooth; apothecia often numerous and crowded 4. *R. gennarii*
- 9b Ascospores with internal wall thickenings which intervene between Pachysporaria and Milvina type, ontogeny of spores apparently irregular; in young spores the septum is inserted before or after internal wall thickenings become distinct, spores $14-21(-24) \times 8-13(-15) \mu\text{m}$; hymenium $100-115 \mu\text{m}$ tall; thallus thick, crustose to slightly squamulose, areolate, large areolae and squamules with an irregular surface 3. *R. geesteranii*
- 8b In young ascospores septum is inserted **before** formation of internal wall thickenings, torus in mature spores present or absent:
- 10a Ascospores without torus but intense brown pigmentation in septal region may simulate presence of a torus:
- 11a Ascospores at first with internal wall thickenings of Mischoblastia type, then corresponding to Pachysporaria type, $(16-)\text{20-32} \times 10-18 \mu\text{m}$, in young spores septum is inserted before internal wall thickenings become distinct, torus absent but intense brown pigmentation in septal region may simulate presence of a torus; apothecia to 0.8 mm diam. 14. *R. teichophiloides*
- 11b Ascospores with internal wall thickenings which intervene between Pachysporaria and Milvina type, $14-21(-24) \times 8-13(-15) \mu\text{m}$, ontogeny of spores apparently irregular; in young spores septum is inserted before or after internal wall thickenings become distinct, spores always without intense brown pigmentation in septal region which may simulate presence of a torus; apothecia to 0.5 mm diam. 3. *R. geesteranii*
- 10b Ascospores usually with distinct torus (in some spores torus may be indistinct):
- 12a Ascospores of Physcia type, rarely grading into Milvina type, $11-17 \times 6-9 \mu\text{m}$ 15. *R. sp. 1*
- 12b Ascospores not of Physcia type or, when of Physcia type usually distinctly larger:
- 13a Apothecia small, to 0.3 mm diam., cryptolecanorine; ascospores small, similar to Pachysporaria type or \pm of Physconia type, occasionally with strongly pronounced apical internal wall thickenings, partly with protrusions of lumina to spore ends and/or septum, spores $10-16(-18) \times 6-10(-12) \mu\text{m}$; spermatia comparatively long, $(4-)\text{6-9} \times 1.0-1.5 \mu\text{m}$ 6. *R. longisperma*
- 13b Not with this combination of characters; spermatia up to $5 \mu\text{m}$ long:
- 14a Thallus whitish, yellowish, ochraceous; apothecia to 0.4 mm diam., lecanorine, rarely cryptolecanorine, disc light brown to dark brown or blackish; ascospores of Pachysporaria type, $(13-)\text{15-19}(-20) \times 8-15 \mu\text{m}$ 7. *R. microlepidea*
- 14b Not with this combination of characters; apothecia becoming larger (to 0.8 mm diam.):
- 15a Thallus often greyish (also grey-brown, brown, occasionally whitish due to presence of a pruina); apothecia to 0.8 mm, usually cryptolecanorine (rarely lecanorine or lecideine), disc usually purely black (rarely dark brown); ascospores very variable in formation of internal wall thickenings; Pachysporaria, Milvina, or intermediate types, occasionally also of Physcia type or spore lumina irregularly biconical in shape, spores $14-32 \times 7.5-16.0 \mu\text{m}$ 2. *R. confragosula*
- 15b Thallus brown to ochraceous; apothecia to 0.7 mm diam., usually lecideine or lecanorine (occasionally cryptolecanorine), disc dark reddish brown to black; ascospores of Pachysporaria type, occasionally grading into Milvina type, $(15-)\text{16-23} \times 8-16 \mu\text{m}$ 13. *R. subtristis*

1. *Rinodina confragosa* (Ach.) Koerb. in Systema lichenum Germaniae: 125 (1855).

For synonyms and typification see Mayrhofer & Poelt (1979) and Mayrhofer (1984a).

Thallus thin to thick, crustose to squamulose, continuous and areolate or composed of discrete areolae which may be \pm wart-like, whitish, pale grey to ochraceous; prothallus absent or present and then it may be strongly developed, brown to black. *Chemistry*: thallus K+ yellow, P \pm yellowish; tlc: atranorin, chloratranorin (not always), zeorin (not always), in the material from southern Africa an unidentified compound (rf-classes 6/6/6) was found.

Apothecia to 1.5 mm diam., lecanorine, in addition to thalline margin a proper margin may be developed, usually sessile, rarely adnate, disc brown to black, plane to convex. *Epihymenium* $5-20 \mu\text{m}$ tall, brown. *Hymenium* $80-110 \mu\text{m}$ tall. *Hypothecium* to $200 \mu\text{m}$ deep, hyaline. *Paraphyses* $1-3 \mu\text{m}$, apices $3-5 \mu\text{m}$ wide. *Asci* corresponding to Lecanora type, usually 8-spored. *Ascospores* (Figure 1B) of Physcia type, septum in young spores inserted before internal wall thickenings become distinct, torus developed, spores finely scabrid, without septal swellings in KOH, $(15-)\text{16-27} \times 8-13 \mu\text{m}$. *Spermogonia* (in material from southern Africa) immersed in thallus, ostiolar region blackish. *Spermatia* $4.0-5.5 \times 1.0-1.5 \mu\text{m}$.

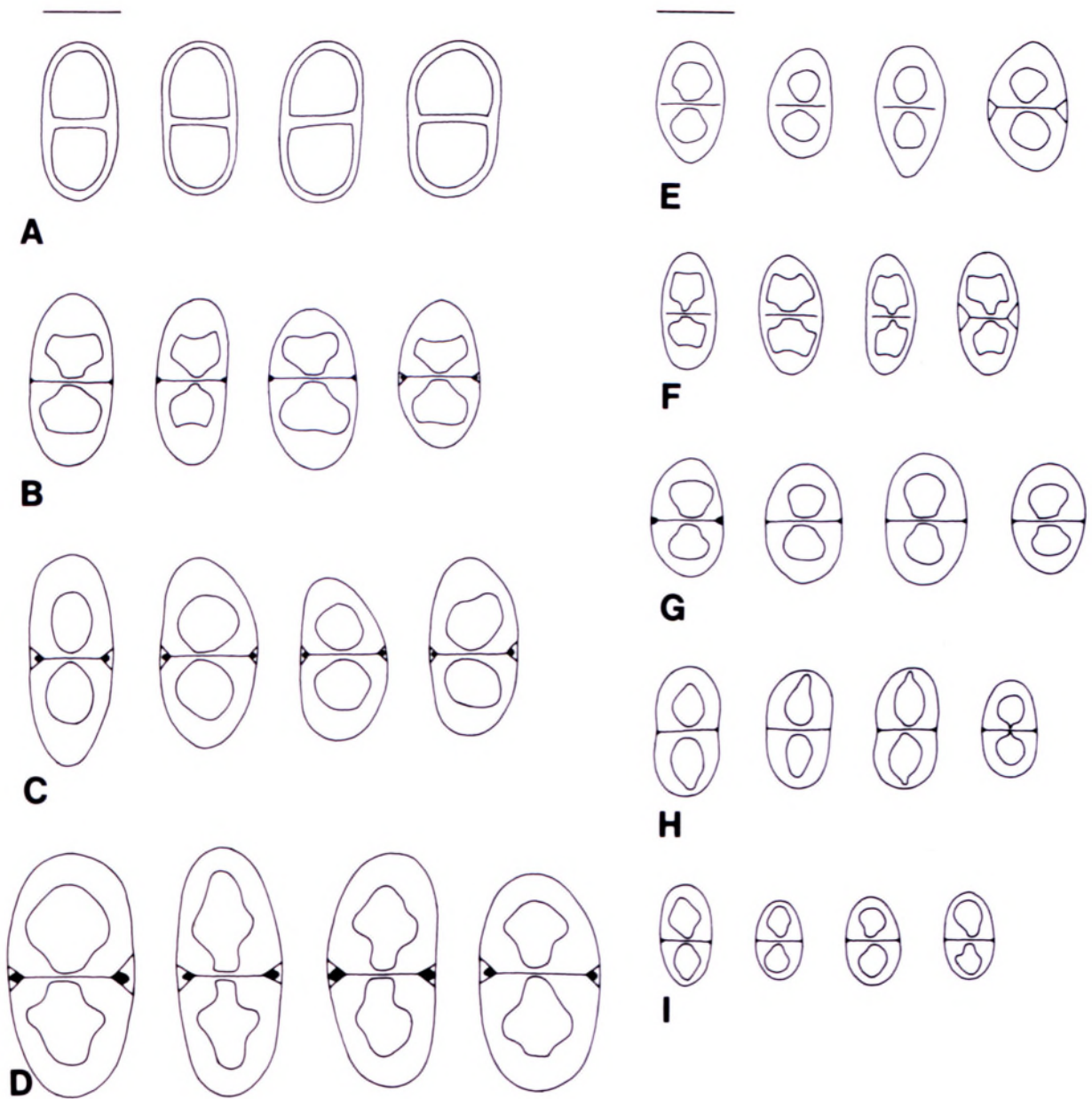


FIGURE 1.—Ascospores of southern African *Buellia* and *Rinodina* species. A, *Buellia distrata*, lectotype (BM); B, *Rinodina confragosa*, Zimbabwe, Lundi River, 27-6-1963, Kofler s.n. (LD); C, *R. confragosula*, isotype (BM); D, *R. confragosula* (PRE 2089b); E, *R. geesteranii*, holotype (L); F, *R. gennarii*, Almborn 1249 (GZU); G, *R. huillensis*, Brusse 4462 (PRE); H, *R. huillensis*, Rambold 7389 (M); I, *R. longisperma*, holotype (PRE). Scale bars: 10 μ m.

Rinodina confragosa is a widespread species in Europe including adjacent Asia (e.g. Fox & Purvis 1992; Giralt & Barbero 1995; Mayrhofer 1984a (distribution map); Mayrhofer & Poelt 1979; Nimis 1993; Santesson 1993), but it is hitherto only known from two localities in southern Africa (Zimbabwe and Western Cape; Figure 2). It is also reported from Australia (McCarthy 1991) and North America (e.g. Egan 1987). The record of *Lecanora confragosa* (= *Rinodina confragosa*) from São Tomé (Insula Caprarum, H-NYL 29006) by Nylander (1887, 1889) and Stizenberger (1890) actually refers to a taxon of the *Rinodina oxydata* group (see under *R. oxydata* in the present study, Table 1). In the area studied, *R. confragosa* grows on quartzitic rocks (including quartzitic sandstone); the specimen from Zimbabwe was associated with a *Peltula*

sp. and cyanobacteria indicating that this habitat more or less regularly receives liquid water.

Among the species treated in the present study, *Rinodina confragosa* can be recognized easily by the K+ yellow thallus reaction and by the ascospores of Physcia type. As far as thallus formation is concerned, the species shows a wide range of variation in Europe, from thinly crustose to only slightly squamulose (these morphotypes are also present in southern Africa) to very thick and then with \pm wart-like to squamulose areolae; the thallus is continuous and rimose-cracked or composed of discrete areolae, and a prothallus may be absent or strongly developed. Variability can also be observed in chemistry, and different chemical races appear

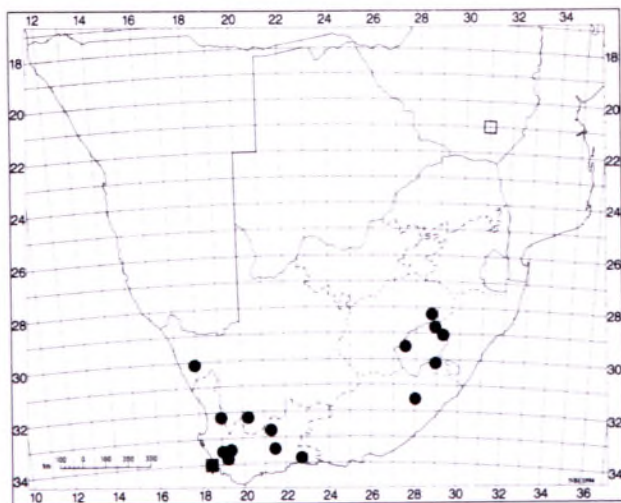


FIGURE 2.—Known distribution of *Rinodina confragosula* in southern Africa. □; and of *R. confragosula*, ●. Two collection localities of *R. confragosula* could not be located in detail and are therefore not mapped: Lesotho, Mamerthes; KwaZulu-Natal, Drakensberg, on ridge of the Sugar Loaf near The Cavern.

to exist (Hecklau *et al.* 1981; Mayrhofer & Leuckert 1985).

Vouchers from southern Africa: *Almborn* 1834 (LD); *Kofler s.n.* (LD).

2. *Rinodina confragosula* (Nyl. in Cromb.) Müll.Arg. in *Revue Mycologique* (Toulouse) 9: 79 (1887). Type: Western Cape, Table Mtn, Cape of Good Hope, 9-1874, A.E. Eaton *s.n.*, Venus Transit Expedition (BM, lecto., designated by Mayrhofer: 400 (1984a); BM, iso.); (H-NYL 28565, iso.), not seen, compare Mayrhofer (1984a: 400).

Lecanora confragosula Nyl. in *Cromb.*: 172 (1876b).

Rinodina almbornii H.Mayrhofer: 374 (1984a). Type: Western Cape, Dist. Paarl, Paarl Rock near summit, 2300 ft, 26-9-1953, O. Almborn 5540 (LD, holo.; GZU, iso.).

Thallus crustose, rimose-areolate, some areolae occasionally in the form of small squamules, greyish, grey-brown, brown, occasionally whitish due to presence of a pruina; in longitudinal section outermost layer of the phenocortex is brown or, particularly in areolae which bear an apothecium, (blackish to) blue-green; prothallus absent or present, black. *Chemistry*: no lichen substances detectable by tlc.

Apothecia to 0.8 mm diam., cryptolecanorine, more rarely lecanorine or becoming lecideine and then adnate, occasionally contiguous, disc black, rarely dark brown, occasionally whitish pruinose, the disc may be surrounded by a small edge of white pruina, disc slightly concave, plane, or convex. *Exciple*: where a proper exciple is developed it is brown and blackish to blue-green in parts or dominantly blue-green. *Epiphymenium* 10–30(–35) μm tall, entirely brown to olivaceous, brown to olivaceous and blue-green in parts, or dominantly blue-green with brown to olivaceous spots. *Hymenium* 70–120(–130) μm tall. *Hypothecium* to 250 μm deep, hyaline; adjoining parts of the thallus to the hypothecium may be blue-green. *Paraphyses* 1–5 μm , apices 3–6 μm wide. *Asci* corresponding to *Lecanora* type, with 8 or less spores. *Ascospores* (Figure 1C, D) with internal wall thickenings of *Pachysporaria* or

Milvina type, or intermediate between these two types, occasionally also of *Physcia* type or spore lumina irregularly biconical in shape, septum in young spores inserted before internal wall thickenings become distinct, torus developed, spores finely scabrid, without septal swellings in KOH, 14–32 \times 7.5–16.0 μm . *Spermogonia* immersed in the thallus, with the upper parts prominent or not, often contiguous, ostiolar region black or brown; in longitudinal section at base and laterally hyaline, rarely pale brownish, above brown to olivaceous and/or blackish to blue-green. *Spermatia* (3)–4–5 \times 1.0–1.5 μm .

Chemical reaction of the blue-green pigment in the thallus, apothecia, and spermogonia: N+ red.

Rinodina confragosula grows on hard siliceous rocks such as granite, sandstone, and quartzite. It is known with certainty only from the Republic of South Africa and Lesotho where it was found to be widely distributed at altitudes between 450 m and 3 080 m (Figure 2). The specimen cited from Concepcion in Argentina (Müller Argoviensis 1889) represents a *Rinodina* species for which an appropriate name is not available at present. A record from New Caledonia was given by Müller Argoviensis (1887).

R. confragosula is a quite variable species in several respects (see description). It can be recognized best by the usually black apothecia, the presence of a blue-green, N+ red pigment in the phenocortex, apothecia, and spermogonia, and by the absence of lichen substances detectable by tlc. Within a single specimen, the range of spore size is often significantly smaller than given in the description of the species above, but in other specimens the range was found to be 18–31 \times 10–16 μm (PRE 2089b), 20.0–27.5 \times 9–11 μm (Brusse 2547), and 22–32 \times 10.5–16.0 μm (Brusse 4575).

Other saxicolous species occurring in the study area and showing close similarities with *R. confragosula* include *R. longisperma*, *R. microlepidea*, and *R. subtristis*. *Rinodina longisperma* is distinguished from *R. confragosula* by smaller apothecia and ascospores, and by longer spermatia. The separation of *R. confragosula* from *R. microlepidea* and *R. subtristis* respectively, is discussed in detail under both the latter species.

The differences used for the delimitation of *Rinodina almbornii* from *R. confragosula* by Mayrhofer (1984a) are considered to fall within the variability of *R. confragosula*. Mayrhofer (1984a) pointed out that *R. confragosula* is closely related to *R. kozukensis* (Vain.) Zahlbr. which was described from Japan by Vainio (1921, as *Melanaspicilia kozukensis*). The relationship of these two species will be discussed in a forthcoming paper.

Rinodina argentiniana Müll.Arg. (Argentina, Concepcion, 1882, Lorentz, G, holo.!) differs from *R. confragosula* by having ascospores lacking a torus and by a different type of spore ontogeny (internal apical wall thickenings appear before the spore septum is inserted). The record of *R. argentiniana* from Lesotho (summit of Masiti Mountain, 6300 ft, 1929–30, Hewitt, TRH) by Mayrhofer (1984a) actually refers to *R. confragosula*. According to the material available, *R. argentiniana* does not occur in the study area.

One of the specimens cited by Mayrhofer (1984a) under *Rinodina depressa* could not be determined with certainty, and it is treated here under *R. cf. confragosula*: Western Cape, Van Rhynspass, Van Rhynsdorp, *Van der Byl 766* (W).

Vouchers: *Almborn 4567* (GZU, LD), *4847* (LD), *5540* (PRE), *s.n.* (GZU); *Brusse 2547, 2633, 3136, 3282, 3397, 4575, 4625, 5557* (PRE); *O'Connor CH 2220* (PRE); *Hean (PRE 2089b)*; *Hewitt s.n.* (TRH); *Van der Plank, CH 4568* (PRE); *Schelppe 1110* (GZU); *Triebel & Rambold 7896* (GZU), *7901* (M).

3. *Rinodina geesteranii* H. Mayrhofer in Journal of the Hattori Botanical Laboratory 55: 412 (1984a). Type: Western Cape, Wynberg Flats, SE of Cape Town, on granite outcrop near dusty road, 19-12-1949, *R.A. Maas Geesteranus 14669* (L, holo.!, GZU, iso.!).

Thallus thick, crustose to slightly squamulose, areolate, brown, covered by a white pruina in parts, large areolae and squamules with an irregular surface; thallus occasionally associated with cyanobacteria; prothallus dark brown, blackish, well developed, at margin of thallus distinctly effigurate. *Chemistry*: no lichen substances detectable by tlc (Mayrhofer & Leuckert 1985).

Apothecia to 0.5 mm diam., cryptolecanorine or lecanorine and then adnate, rarely with a lecideine appearance, disc blackish, plane. *Epiphytenium* 10–20 μm tall, brown. *Hymenium* 100–115 μm tall. *Hypothecium* to 120 μm deep, usually hyaline. *Paraphyses* 1–4 μm , apices 4–5(–6) μm wide. *Asci* corresponding to Lecanora type, axial body often difficult to observe, asci often with 8 but also with less spores. *Ascospores* (Figure 1E) with internal wall thickenings intermediate between Pachysporaria and Milvina type, ontogeny of spores apparently irregular: septum in young spores inserted before or after internal wall thickenings become distinct, torus absent, spores finely scabrid, without septal swellings in KOH, 14–21(–24) \times 8–13(–15) μm . *Spermatogonia* immersed in the thallus, ostiolar region blackish. *Spermatia* \pm 3–4 \times 1–2 μm .

Rinodina geesteranii is only known from the type locality on the Cape Peninsula where it was collected on hard quartzitic rocks (Figure 3). It is associated with other lichen species, most commonly with *Peltula euploca* (Ach.) Poelt in Pišut, suggesting that the locality is more or less regularly wetted by rain or dripping water (compare notes on the ecology of *Peltula euploca* in Büdel 1987: 58). This view is also supported by the fact that the thallus of *R. geesteranii* is partly associated with cyanobacteria; green algae containing lichens which have connections with free-living cyanobacteria occur exclusively at localities which receive liquid water (Poelt & Mayrhofer 1988).

R. geesteranii is characterized mainly by the thickly crustose to slightly squamulose thallus, and by the ascospores lacking a torus and with internal wall thickenings intermediate between Pachysporaria and Milvina type. Three other saxicolous *Rinodina* species with ascospores lacking a typical torus are known to occur in the study area, viz. *R. gennarii*, *R. reagens*, and *R. teichophiloides*. In *R. teichophiloides*, torus-like structures may be developed (see account of *R. teichophiloides* in the present study). *Rinodina gennarii* is separated from *R. geesteranii* mainly by a thin

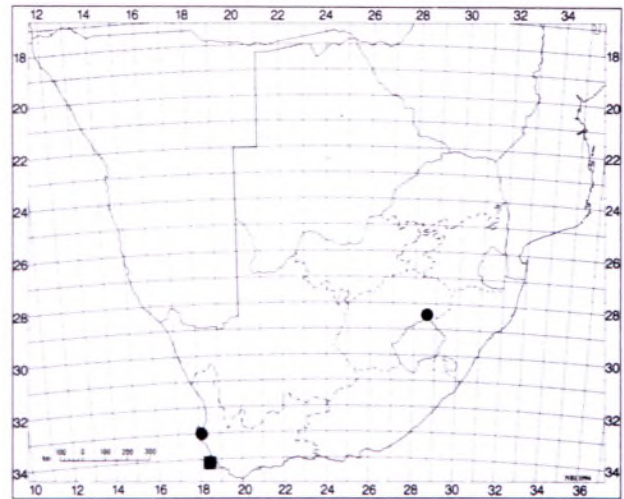


FIGURE 3.—Known distribution of *Rinodina geesteranii*, \square ; and of *R. gennarii* in southern Africa, \bullet .

thallus and ascospores with internal wall thickenings of Physcia type, and *R. reagens* and *R. teichophiloides* differ from *R. geesteranii* by the usually larger ascospores with internal wall thickenings of Mischoblastia or Pachysporaria type. In ascospore type and size close similarities can be observed between *R. geesteranii* and *R. argentiniana* Müll. Arg. (G, holo.!). The latter was described from Argentina by Müller Argoviensis (1889). Both the species are only known from their type collections (for *R. argentiniana* see the discussion of *R. confragosula* in the present work). *R. argentiniana* is distinguished by the thinner, exclusively crustose thallus and larger apothecia (to 0.75 mm in diameter).

4. *Rinodina gennarii* Bagl. in Commentario della Società Crittogamologica Italiana 1: 17 (1861). Type: Italy, Liguria occidentale, alle falde del monte Faiallo dell' Apennino sopra Voltri, *Baglietto s.n.* (WU, iso.), not seen.

Synonyms: see Sheard (1967, under *Rinodina subexigua*), Mayrhofer & Poelt (1979), Mayrhofer (1984a).

The following description is based only on the specimens cited below.

Thallus thin, occasionally inconspicuous, crustose, areolate or \pm effuse, smooth, whitish, grey, ochraceous; prothallus absent. *Chemistry*: no lichen substances detectable by tlc.

Apothecia to 0.5 mm diam., often numerous, crowded, lecanorine or rarely lecideine, adnate to sessile, disc dark brown, a narrow brown border-line between disc and thalline margin may be present, disc plane to strongly convex. *Epiphytenium* 10–15 μm tall, brown. *Hymenium* 60–80 μm tall. *Hypothecium* to 150 μm deep, hyaline. *Paraphyses* 1–4(–5) μm , apices 3–6 μm wide. *Asci* corresponding to Lecanora type, 8-spored. *Ascospores* (Figure 1F) of Dirinaria type, septum in young spores inserted after the formation of internal apical wall thickenings, torus absent, spores smooth or finely scabrid, with or without septal swellings in KOH, (11–)12–17 \times (5–)6–9 μm . *Spermatogonia* not observed.

Rinodina gennarii is widespread in temperate regions of the northern and southern hemisphere and is found on

a wide variety of substrata (e.g. Fox & Purvis 1992; Mayrhofer 1983, 1984a; Mayrhofer & Poelt 1979; Nimis 1993; Santesson 1993). The species is here recorded for South Africa where it occurs on granitic and quartzitic rocks from low to high altitudes (Figure 3).

This species is characterized mainly by ascospores of Dirinaria type and the numerous, often crowded, small apothecia. Giralt & Mayrhofer (1995) did not observe marked differences between *R. gennarii* and the corticolous/lignicolous *R. oleae* Bagl. However, we refrain here from putting *R. gennarii* into the synonymy of *R. oleae*. *R. gennarii* and *R. oleae* are tentatively treated as a pair of closely related, similar species of which one is saxicolous and the other corticolous/lignicolous. Further observations, including detailed data on distribution and ecology are necessary to decide whether this concept can be maintained or not.

Rinodina gennarii and *R. oleae* are not the only example for vicarious species within the genus. Another corresponding pair of species is formed by the saxicolous *R. beccariana* Bagl. and the corticolous *R. roboris* (Duf. ex Nyl.) Arnold var. *roboris* (Mayrhofer *et al.* 1993). Furthermore, within *R. oxydata* s.l., almost all representatives are saxicolous with the exception of *R. euskadiensis* A. Crespo & M.B. Aguirre which is based on corticolous material (Crespo & Aguirre 1984; Giralt & Matzer 1994).

Vouchers from southern Africa: *Almborn* 1227, 1250, 5020 (LD), 1249 (GZU, LD); *Triebel & Rambold* 6714 (M, under *Buellia* sp.), 6732 (M, under *Rinodina* sp.), 8399 (M).

5. *Rinodina huillensis* Vain. in Catalogue of African Plants collected by F. Welwitsch 2,2: 413 (1901). Type: Angola, Huilla [= Huila] (3800 ad 5500 ped.s.m.), ad rupes juxta cataractam Ferrão prope Lopollo, 1860, *Welwitsch* 50 (*TUR-V* 8736, holo.).

Buellia depressa Vain.: 415 (1901). *Rinodina depressa* (Vain.) Zahlbr.: 510 (1931). Type: Angola, Pungo Andongo, Pedra de Cazella, ad rupes et lapides gneissaceas, 1857, *Welwitsch* 64 (*TUR-V* 9112, lecto.), designated by Mayrhofer (1984a: 403); Pungo Andongo, ad rupes et lapides dispersas mont. Praesidii, Febr. 1857, *Welwitsch* 61 *pr. p.* (BM, para.); Pungo Andongo, ad rupes et lapides dispersas, Febr. 1857, *Welwitsch* 64 *pr. p.* (BM, para.); Pungo Andongo, Pedra de Cazella, ... [text illegible] ... , 1857, *Welwitsch* 481 *pr. p.* (BM, para.).

Rinodina albicans H. Mayrhofer: 373 (1984a). Type: Western Cape, Dist. George, 7 miles E of G., on rocks in a ravine, 14-8-1953, *O. Almborn* 2387 (LD, holo.).

Thallus usually thin, crustose, rimose-areolate, more rarely effuse, brown, grey-brown, grey, rarely whitish, pale ochraceous; phenocortex of apothecia-bearing areolae is brown, olivaceous, blackish, olivaceous to blackish pigment reacts N+ red; prothallus absent or present, black. **Chemistry:** medulla C+ red; tlc: gyrophoric acid (often together with lecanoric and orsellinic acid), 5-O-methylhiassic acid was detected in a single specimen.

Apothecia to 0.8 mm diam., cryptolecanorine, or lecanorine or more rarely lecideine and then adnate, occasionally a proper margin is developed, disc dark reddish brown, dark brown, black, plane to convex. **Proper exciple** in its outer parts brown or olivaceous to blackish and then N+ red. **Epithemium** 10–20 µm tall, reddish brown, brown, occasionally dirty olivaceous and then N+ red in

part. **Hymenium** 70–120 µm tall. **Hypothecium** to 150 µm deep, hyaline. **Paraphyses** 1–4 µm, apices 3–5(–6) µm wide. **Asci** corresponding to Lecanora type, axial body easy to observe or indistinct, sometimes surrounded by a tube-like structure, asci usually with 8 but also with less than 8 spores. **Ascospores** (Figure 1G, H) of Pachysporaria type, occasionally grading into Milvina type, small protrusions of lumina towards septum and/or spore ends sometimes present, septum in young spores inserted before internal wall thickenings become distinct, torus developed, spores smooth to finely scabrid, without septal swellings in KOH, (10–)12–18(–24) × (6–)7–10(–12) µm. **Spermatogonia** immersed in thallus, partly somewhat raised, ostiolar region (dark) red-brown to blackish. **Spermatia** 3–6(–7) × 1.0–1.5 µm.

Rinodina huillensis is a widespread species in southern Africa and is so far known from Angola, the Republic of South Africa, and Swaziland. It occurs on granite, quartzitic rocks and sandstone at a range of altitudes (Figure 4).

Among the saxicolous *Rinodina* species known to occur in the study area, *R. huillensis* alone contains gyrophoric acid in the thallus (medulla C+ red), often accompanied by lecanoric and orsellinic acid. It is a well-known phenomenon in many lichens that in addition to gyrophoric acid, at least traces of lecanoric and orsellinic acid can be found (e.g. Schreiner & Hafellner 1992: 22). Further saxicolous species of *Rinodina* containing gyrophoric acid occur outside southern Africa, but these are distinguished from *R. huillensis* by several characters (Matzer *et al.* 1994a). In a single specimen of *R. huillensis*

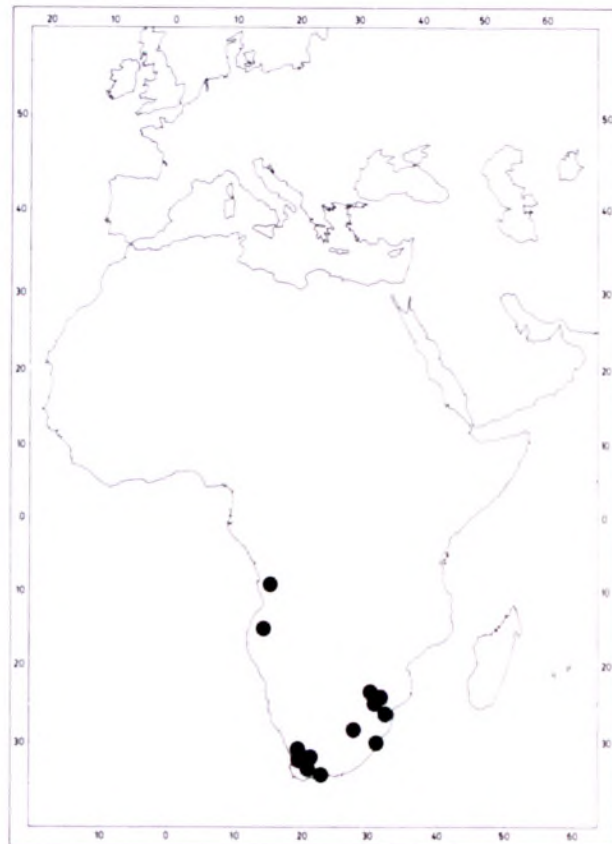


FIGURE 4.—Known distribution of *Rinodina huillensis*.

(Brusse 4497, PRE) 5-O-methylhiascic acid was detected. This lichen compound was also reported from *Rinodina tephrae* (Tuck.) Herre, a northern hemisphere species which differs chemically from *R. huillensis* by the presence of zeorin (Mayrhofer *et al.* 1992).

Re-examination of the types of *Rinodina albicans* and *R. depressa* revealed that these names are synonyms of *R. huillensis*. Vainio (1901) described *R. huillensis* and *R. depressa* (as *Buellia depressa*) in the same publication; *R. huillensis* is selected here as the correct name as it was mentioned first in Vainio's paper and appropriate generic classification was applied. The statement of Mayrhofer & Leuckert (1985) that *R. depressa* does not contain lichen substances is based on the following specimen: Republic of South Africa, Roggeveld Mountains, Brusse 3265 (PRE). We studied this specimen, and it may represent a *Rinodina* species but cannot be identified with certainty as the ascospores are badly developed. From its external morphology it can be concluded that it is not *R. huillensis*. One of the specimens (Van der Byl 766, W) cited under *R. depressa* by Mayrhofer (1984a) is treated as *Rinodina cf. confragosula* in the present paper. Several specimens mentioned by Mayrhofer (1984a) under *R. huillensis* do not belong to this species: one from Angola (Humpata Plateau, 6-2-1960, Degelius, GZU) refers to *R. subtristis* whereas the other one from the same country was not examined. The material from Namibia (Haifischbucht, Fincke, W) represents *Rinodina longisperma*, a species newly described in the present study. The specimen from the Northern Province (Transvaal, Louis Trichardt, 8-10-1953, Almborn, LD) was selected as the isotype of *Rinodina scabridula* in the present work. Another specimen from Mpumalanga (Eastern Transvaal) was also cited: Dist. Pilgrims Rest, 4 miles SE of P. R., on rocks near the road, 22-10-1953, Almborn (LD). We examined two specimens held in LD which are labelled as indicated above but with different collection numbers: Almborn 7831 actually represents *R. huillensis* whereas the crustose lichen species in Almborn 7836 has hyaline ascospores and does not belong to the Physciaceae. The collection of *R. huillensis* from (Orange) Free State (Ladybrand, Maas Geesteranus 6534, L, LD) was cited under *Rinodina microlepeida* by Mayrhofer (1984a).

Vouchers: Almborn 4579 (LD, under *Arthonia* sp.), 7831, 7865, 8615 (LD), 6168 (PRE); Brusse 1688, 3703 (GZU), 1634 (PRE, under *Rinodina substellulata*), 1688, 1764, 2773, 2947, 3581, 3655, 4453, 4462, CH 4628 (PRE), 4497 (GZU, PRE); Van der Byl 756 (W); J. Hafellner & A. Hafellner, 30651 (Hafellner); Maas Geesteranus 6534 (L, LD); Triebel & Rambold 7353 (GZU, M), 7389 (M).

6. *Rinodina longisperma* Matzer & H. Mayrhofer sp. nov.

Thallus saxicola, crustaceus, rimosi-areolatus, griseus ad brunneus, interdum pruinosis. Apothecia ad 0.3 mm in diametro, cryptolecanorina; disci fusci ad atrii, plani. Epiphymentia 5–15 μm alta, brunnea. Hymenia 50–90 μm alta. Hypothecia ad 100 μm alta, hyalina. Paraphyses 1–3(–4) μm crassae, apicibus (2–)4–5(–6) μm crassis. Asci tholis similibus typo generis '*Lecanora*' instructi. Ascospores 10–16(–18) \times 6–10(–12) μm magnae, typo Pachysporaria vel Physconia similes, toro evoluto. Spermogonia

in thallo immersa. Spermata bacilliformia, (4–)6–9 \times 1.0–1.5 μm magna.

TYPE.—Namibia, 2216 (Otjimbingwe): 10–20 km S of Windhoek, Auasberge, Regenstein Farm, gorge behind fort, (—DC), on quartzite, 26-3-1984, F. Brusse 4264 (PRE, holo., with *Cercidospora* sp. and *Dactylospora* sp.; GZU, iso.).

Thallus crustose, rimose-areolate, grey, grey-brown, brown, occasionally whitish pruinose; prothallus occasionally developed, dark brown, black. Chemistry: no lichen substances detectable by tlc.

Apothecia to 0.3 mm diam., cryptolecanorine, disc dark reddish brown, dark brown to blackish, partly with a small border line of white pruina, plane. Epiphymentium 5–15 μm tall, brown. Hymenium 50–90 μm tall. Hypothecium to 100 μm deep, hyaline. Paraphyses 1–3(–4) μm , apices (2–)4–5(–6) μm wide. Asci corresponding to *Lecanora* type, axial body often indistinct or not observable, asci usually 8-spored. Ascospores (Figures 1I; 5A) similar to *Pachysporaria* type or \pm of *Physconia* type, occasionally with strongly pronounced apical internal wall thickenings, partly with protrusions of lumina to spore ends and/or septum, septum in young spores inserted before internal wall thickenings become distinct, torus small but well distinct, spores smooth, without septal swellings in KOH, 10–16(–18) \times 6–10(–12) μm . Spermogonia immersed in thallus, ostiolar region grey, brown, blackish. Spermatiophores septate; spermatogenous cells usually terminal, rarely intercalary; terminal spermatogenous cells flask-shaped, forming spermata apically; intercalary spermatogenous cells with a lateral projection below upper transverse septum with spermata formed on lateral projections. Spermata (4–)6–9 \times 1.0–1.5 μm .

Rinodina longisperma is so far known from quartzitic rocks including sandstone from Namibia and the Republic of South Africa (Figure 6).

Rinodina longisperma can be recognized best by a set of characters including the small and cryptolecanorine apothecia, the small ascospores similar to *Pachysporaria* or *Physconia* type, and, particularly, by the relatively long spermata (hence the epithet '*longisperma*'). The bulk of *Rinodina* species in which spermata have been observed possess spermata with length measurements from 3 to 6 (to 7) μm , whereas in *R. longisperma* they are (4–)6–9 μm long. In addition, peculiarities could also be observed in the spermatogenous apparatus of *R. longisperma*. Most of the *Rinodina* species studied in this respect have many terminal and intercalary spermatogenous cells (e.g. see 'morphology and anatomy' in the general part of the present study; Matzer *et al.* 1994a: 108, fig. 8). In *R. longisperma* most of the spermatogenous cells are terminally arranged, whereas those with an intercalary position could be observed only exceptionally.

One of the specimens of *R. longisperma* from Namibia (Haifischbucht, Fincke, W) was included in *R. huillensis* by Mayrhofer (1984a).

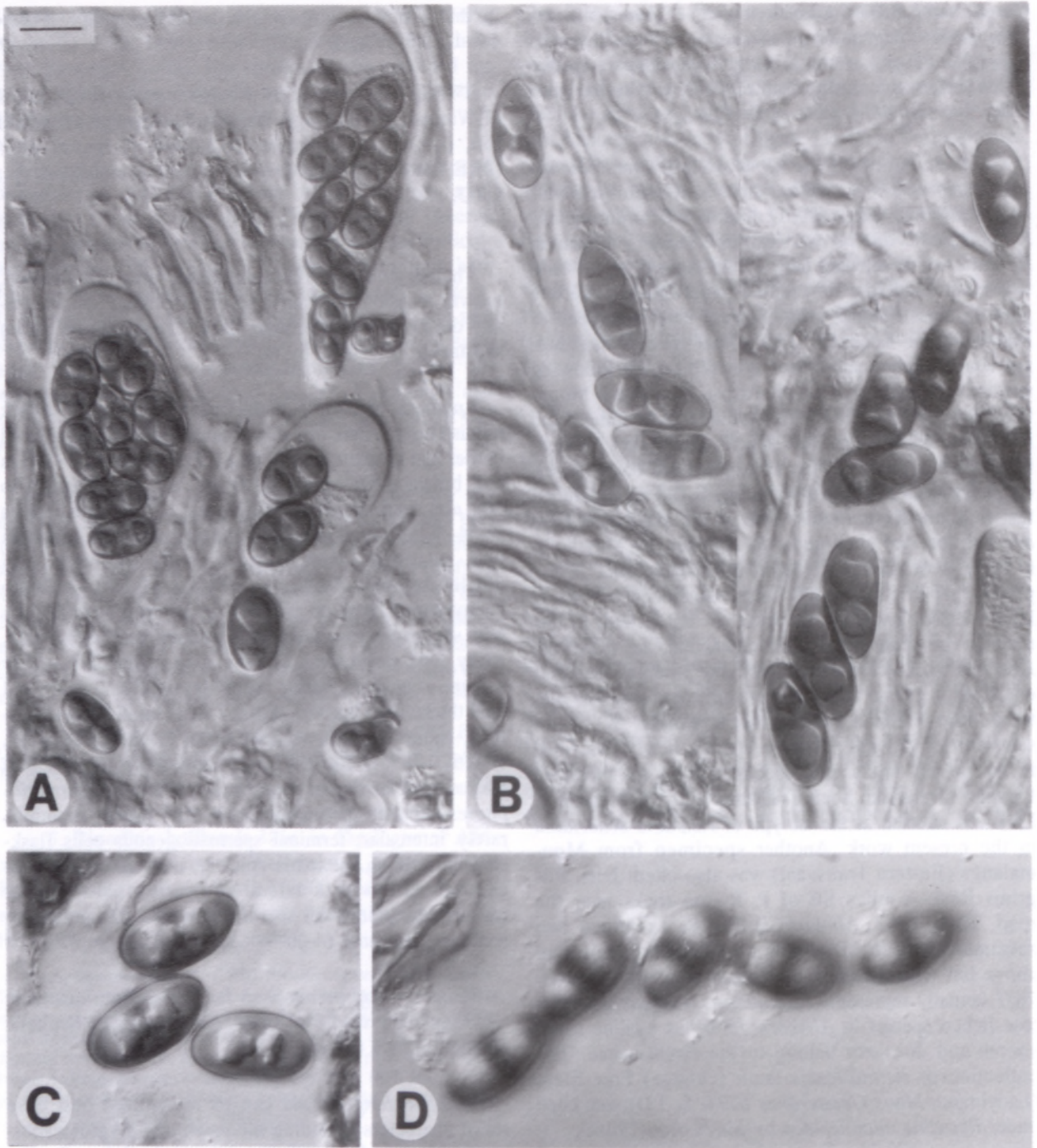


FIGURE 5.—Ascospores of southern African *Rinodina* species. A, *R. longisperma*, holotype (PRE); B, *R. scabridula*, holotype (GZU); C, D, *R. striatitunicata*, holotype (GZU); D, ascospores in surface view showing their striate ornamentation. Scale bar: 10 μ m.

Specimens examined:

NAMIBIA.—2016 (Otjiwarongo): 7 km S of Otjiwarongo, (-DA), 21-3-1984, *Brusse 4210* (PRE). 2017 (Waterberg): Waterberg plateau, (-AD), 23-3-1984, *Brusse 4246* (PRE). Haifischbucht, grid. ref. unknown, *Fincke s.n.* (W).

NORTHERN CAPE.—3123 (Victoria West): Dist. Victoria West, Three Sisters, (-CC), 2-10-1953, *Almborn 5779* (LD).

7. *Rinodina microlepidea* Müll.Arg. in *Flora* 71: 206 (1888). Type: Mpumalanga, Eastern Transvaal, Lydenburg, *Wilms 76* (G, holo.!).

Lecanora microlepidea (Müll.Arg.) Stizenb.: 209 (1890).

Thallus thin, crustose, rimose-areolate, continuous or composed of discrete areolae, whitish, yellowish, ochraceous; prothallus not distinct. *Chemistry*: no lichen substances detectable by tlc.

Apothecia to 0.4 mm diam., lecanorine, rarely cryptolecanorine, disc light brown to dark brown or blackish, \pm plane. *Epihymenium* 5–20 μ m tall, brown. *Hymenium* \pm 90–100 μ m tall. *Hypothecium* to 180 μ m deep, hyaline. *Paraphyses* 1–3 μ m, apices 3–4 μ m wide. *Asci* corresponding to *Lecanora* type, usually 8-spored. *Ascospores* (Figure 7A) of *Pachysporaria* type, septum in young spores probably inserted before internal wall thickenings

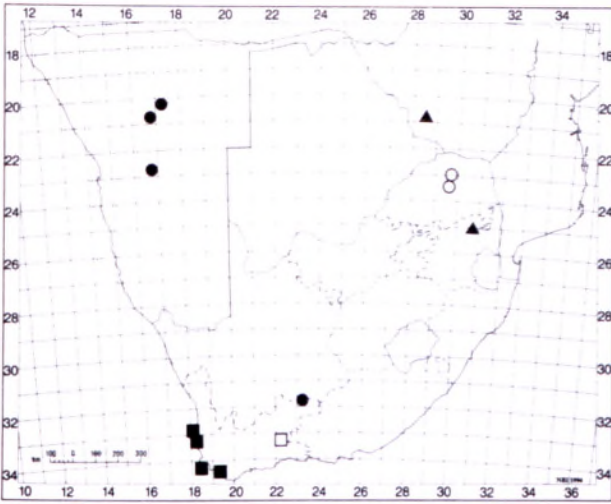


FIGURE 6.—Known distribution in southern Africa: *Rinodina longisperma*, ●, [locality of *Fincke s.n.* (W) could not be located exactly and is therefore not mapped: SWA/Namibia, Haifischbucht]; *R. microlepidea*, ▲; *R. reagens*, ■; *R. scabridula*, ○; and *R. striatitunicata*, □.

become distinct, torus small (not always distinct), spores smooth to finely scabrid, (13–)15–19(–20) × 8–15 μm. *Spermogonia* immersed in thallus, ostiolar region pale, brown. *Spermatia* 4–5 × 1.0–1.5 μm.

In its present circumscription, the species is known only from single localities in the Republic of South Africa and Zimbabwe where it grows on hard siliceous rocks (Figure 6).

The status of *Rinodina microlepidea* is rather vague. The description given above is based only on two rather scant specimens and thus, not all characters (e.g. ascus type, behaviour of ascospores in potassium hydroxide) could be studied in full detail. Unfortunately, the type collection is in a very poor condition, and the apothecia in particular are very old or damaged. Therefore, no statements can be given on the variability of *R. microlepidea* and only one further specimen which looks more or less similar to the type is accepted as belonging to that taxon. The distinction between *Rinodina subtristis* and *R. microlepidea* is problematical. According to the material available, the former species is separated by larger apothecia (to 0.7 mm diam.) and the coloration of the thallus: brown or ochraceous instead of whitish, yellowish to ochraceous. Like *R. microlepidea* and *R. subtristis*, other *Rinodina* species in the study area are characterized by the lack of secondary lichen substances and ascospores of *Pachysporaria* or similar types. This includes *R. confragosula*, *R. longisperma*, and *R. scabridula*. *Rinodina confragosula* differs from *R. microlepidea* mainly by its larger apothecia (to 0.8 mm diam.) and by ascospores which are rather variable in the formation of internal wall thickenings (*Pachysporaria*, *Milvina*, *Physcia*, or intermediate types or the spore lumina are irregularly biconical) and exhibit a broader size range (14–32 × 7.5–16.0 μm). *Rinodina longisperma* is separated from *R. microlepidea* mainly by its often smaller ascospores, 10–16(–18) × 6–10(–12) μm, and longer spermatia, 5–9 μm. *Rinodina scabridula* can easily be distinguished by the formation of blastidia on the thallus.

The following specimens were included in *R. microlepidea* by Mayrhofer (1984a), but for a range of reasons a new settlement is proposed here: (Orange) Free State, Ladybrand, *Maas Geesteranus* 6534 (L, LD) belongs to *Rinodina huillensis*. The specimen from (Orange) Free State, Dist. Trompsburg, 2-10-1953, *Almborn* 5809 (LD) which is cited by Mayrhofer (1984a) with the date '2-10-1954', collection number '5808', and herbarium 'L' represents a *Rinodina* sp. The ascospores are usually 2-celled but exceptionally also 3-celled spores could be observed. The *Rinodina* species from the Western Cape, Calitzdorp-Kruisrivier, *Maas Geesteranus* 6711 (L) differs from *R. microlepidea* by the type of spore ontogeny in the way that internal wall thickenings appear before the septum is inserted. The ascospores of this specimen resemble those of *R. geesteranii*, but differences exist in the morphology of the thallus.

Voucher: *Kofler s.n.* (LD).

8. *Rinodina oxydata s.l.*

Rinodina oxydata s.l. is distributed world-wide. The following description is based on material from southern Africa only. For further explanations see the discussion given below.

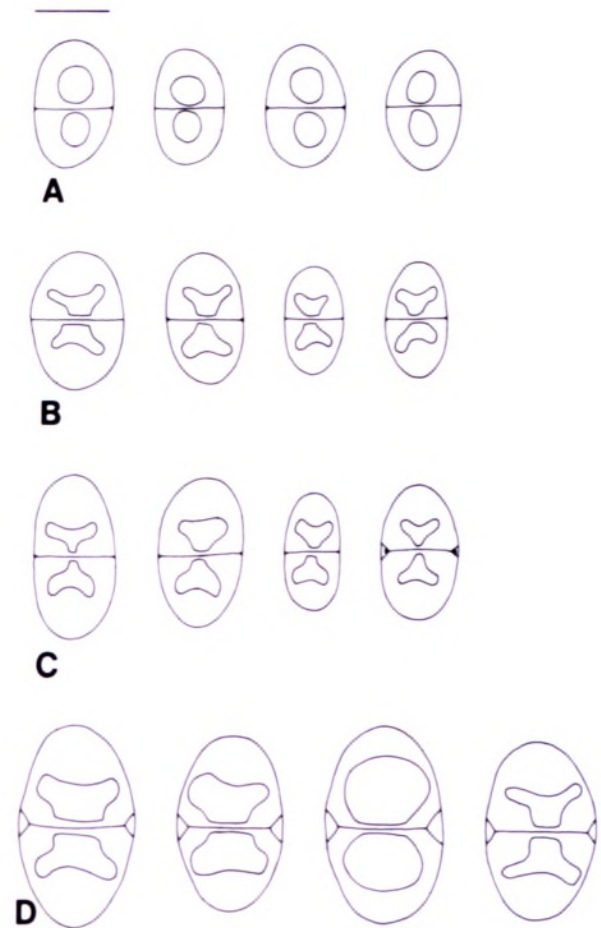


FIGURE 7.—Ascospores of southern African *Rinodina* species. A, *R. microlepidea*, holotype (G); B, *R. oxydata s.l.*, [holotype of *R. minima*] (LD); C, *R. oxydata s.l.*, *Almborn* 7104 (LD); D, *R. reagens*, *Hafellner* 30655 (herb. Hafellner). Scale bar: 10 μm.

Thallus thin, crustose, areolate, continuous, yellowish, pale ochraceous, pale greyish; prothallus absent or present, blackish. *Chemistry*: thallus K+ yellow; tlc: atranorin (not found in *Rinodina minima*; see below).

Apothecia to 0.4 mm diam., cryptolecanorine, lecanorine, or with a lecideine appearance (algal cells may be enclosed in the exciple), when lecanorine or lecideine then adnate, disc dark reddish brown to blackish, proper margin black, disc usually plane. *Proper exciple* in its outer layer with an olivaceous, blue-green to blackish pigment which reacts N+ red, in addition a brown pigment (N-) may be present. *Epihymenium* 10–20 µm tall, brown. *Hymenium* 70–100 µm tall. *Hypothecium* to ± 80 µm deep, hyaline. *Paraphyses* 1–4 µm, apices 3–6 µm wide. *Asci* corresponding to Lecanora type, with tendencies towards Bacidia type, axial body may be indistinct, asci often with 8 but also with less spores. *Ascospores* (Figure 7B, C) usually of *Mischoblastia* type, rarely with tendencies towards *Pachysporaria* type, septum in young spores inserted before internal wall thickenings become distinct, torus delicate, spores smooth or finely scabrid, with or without slight septal swellings in KOH, 11–25 × (7–)8–13 µm. *Spermogonia* immersed in thallus, occasionally slightly raised, ostiolar region dark reddish brown to blackish. *Spermatia* (3–)4–5 × 1.0–1.5 µm.

In the study area, *Rinodina oxydata* s.l. is known only from three localities (Mozambique, Transvaal, Table Mountain) where it grows on schistic and quartzitic rocks.

The name *Rinodina oxydata* is commonly applied to lichens exhibiting the following set of characters: thallus thinly crustose or thick and nearly squamulose, occasionally evanescent, containing atranorin (K+ yellow), apothecia showing a wide variety from cryptolecanorine, lecanorine to lecideine, ascospores (usually) of *Mischoblastia* type. Particularly, in thallus formation, in the apothecial type, and, in part, in ascospore size, a wide range of variability can be observed. Many binomials have been introduced for lichens with characters mentioned above, but none of these names can be used unequivocally unless a thorough revision of the *R. oxydata* group on a world-wide scale has been carried out (see Table 2). Such a revision should also include *R. substellulata*, a species with ascospores of *Pachysporaria* type occasionally grading into *Milvina* type, but in all other characters displaying close similarities with *R. oxydata*. All characters used for

the delimitation of species (thallus formation, apothecial type, ascospore size) are not constant and show various transitional states, especially when many specimens are analyzed. On the other hand, it seems to be premature to put all these names into synonymy of *R. oxydata* (A.Massal.) A.Massal. As a consequence, the description given above includes all *R. oxydata*-like lichens known from southern Africa, and a survey on the 'species' known from that region is given in Table 1 below.

Rambold *et al.* (1994) argued for a possible re-establishment of the generic name *Mischoblastia* A.Massal. which may be based on *Rinodina oxydata*. The most important characters mentioned to be characteristic for *Mischoblastia* are: asci corresponding to Bacidia type, ascospores of *Mischoblastia* type, presence of an aeruginose, N+ red pigment in the exciple. However, it should be stressed here that all these characters do not justify a separation of *Mischoblastia* from *Rinodina* (Ach.) Gray; this is evident from the following observations: 1, asci of *R. oxydata* (and of species which are considered to be closely related to *R. oxydata*) exhibit a considerable range of variation and correspond either to Bacidia type or to Lecanora type, or are more or less intermediate between these two types; 2, the presence of *Mischoblastia* type ascospores cannot be an argument as the formation of pronounced internal wall thickenings is one of the most important characters of the genus *Rinodina*; 3, an aeruginose, N+ red pigment occurring in the exciple and/or in the epihymenium is known not only from *R. oxydata* and related species but also from other *Rinodina* species: e.g. *R. beccariana* Bagl. (Mayrhofer *et al.* 1993), *R. canariensis* Matzer, H.Mayrhofer & P.Clerc (Matzer *et al.* 1994a), *R. confragosula* (Nyl. in Cromb.) Müll.Arg. (see present study), and *R. trachytica* (A.Massal.) Bagl. & Car. (Mayrhofer *et al.* 1992).

Specimens examined

MOZAMBIQUE.—Sul do Save, Dist. Maputo (Lourenço Marques), 8 km E of Impamputo, on rocks near road, 18-10-1953, *Almborn* 7102, holotype of *Rinodina minima* (LD); same locality, 18-10-1953, *Almborn* 7104 (LD).

NORTHERN TRANSVAAL.—On granite from the Lebombo in Transvaal, *Wilms* s.n., holotype of *Rinodina detecta* (ZT).

WESTERN CAPE.—Cape of Good Hope, Table Mtn, September 1874, *Eaton* s.n., Venus Transit Expedition (BM, associated with the lectotype of *Rinodina subtristis*).

TABLE 1.—*Rinodina oxydata*-like lichens known to occur in southern Africa; for further explanations see the discussion in the text

Species	Ascospore type and size	Known distribution	Important literature
<i>R. detecta</i> (Stizenb.) Zahlbr. (1931)	Intermediate between the <i>Mischoblastia</i> and <i>Pachysporaria</i> type, ± 19–25 × 10–15 µm	South Africa: Transvaal (only known from the scant holotype)	Mayrhofer (1984a)
<i>R. minima</i> H.Mayrhofer (1984a)	<i>Mischoblastia</i> type, 11–20(–23) × (7–)8–13 µm	Mozambique (with certainty only known from the holotype*)	Mayrhofer (1984a)
? <i>R. oxydata</i> (A.Massal.) A.Massal. (1854)	<i>Mischoblastia</i> type, ± 17–25 × 9–14 µm	in the present circumscription world-wide	Mayrhofer & Poelt (1979); Sheard (1967)

* A second specimen was cited by Mayrhofer (1984a: 440): São Tomé & Príncipe: Insula Caprarum sin. Guineensis, Ilha das Cabras, 1887, *Newton* (H-NYL 29006). It is in a rather bad condition and differs from the holotype by a comparatively thick thallus which is composed of more or less discrete areolae.

TABLE 2.—Selection of 'species' which have to be considered in the course of a revision of the *Rinodina oxydata* group

Species	Important literature
<i>R. detecta</i> (Stizenb.) Zahlbr.	Mayrhofer (1984a)
<i>R. euskadiensis</i> A.Crespo & M.B.Aguirre	Crespo & Aguirre (1984); Giralt & Matzer (1994)
<i>R. fimbriata</i> Körb.	Mayrhofer & Poelt (1979)
<i>R. minima</i> H.Mayrhofer	Mayrhofer (1984a)
<i>R. minutula</i> Müll.Arg.	Mayrhofer (1984a)
<i>R. moziana</i> (Nyl.) Zahlbr.	Mayrhofer (1984a)
<i>R. oxydata</i> (A.Massal.) A.Massal.	Mayrhofer & Poelt (1979); Sheard (1967); present study
<i>R. schweinfurthii</i> Müll.Arg.	Mayrhofer (1984a)
<i>R. substellulata</i> Müll.Arg.	Mayrhofer (1984a); present study
<i>R. vezdae</i> H.Mayrhofer	Mayrhofer (1984a)

9. *Rinodina reagens* Matzer & H.Mayrhofer in Acta Botanica Fennica 150: 116 (1994). Type: New Zealand, Southland, Waiu River Valley, Clifden N Tuatapere, 167°42'E, 46°02'S, limestone, 22-9-1981, H. Mayrhofer 2186, associated with *Rinodina bischoffii*, (GZU, holo.!, M, Mayrhofer, iso!).

Exs.: Plantae Graecenses Lichenes 433, as *Rinodina teichophila*.

Icons: Matzer & Mayrhofer (1994).

Thallus crustose to somewhat squamulose, rimose areolate, continuous or of discrete areolae, brown to ochraceous, smooth but sometimes covered in part by a (?lichenized) cyanobacterium (*Gloeocapsa* sp.) resulting in a coarsely warty appearance, occasionally associated with additional, filiform cyanobacteria (*Scytonema* sp.); prothallus indistinct. *Chemistry*: no lichen substances detectable by tlc.

Apothecia to 1.7 mm diam., cryptolecanorine or lecanorine and then adnate, disc reddish brown, dark brown to black, often with a narrow, pale reddish brown borderline between disc and thalline margin, plane to convex, thalline margin persistent, entire or slightly crenate. *Epiphymenium* 10–30 μ m tall, brown or yellowish brown, K- or K+ yellowish to orange. *Hymenium* 100–150 μ m tall. *Hypothecium* to 180 μ m deep, entirely hyaline, hyaline and green-yellow in parts, or entirely green-yellow, K+ yellowish to orange. *Paraphyses* 1–4 μ m, apices to 6 μ m wide. *Asci* corresponding to Lecanora type, 8-spored or with fewer spores. *Ascospores* (Figure 7D) with internal wall thickenings of Mischoblastia type, occasionally grading into Pachysporaria type, septum in young spores inserted before internal wall thickenings become distinct, torus absent, spores finely scabrid, with septal swellings in KOH, 22–31 \times 10–19 μ m. *Spermogonia* immersed in thallus, with a reddish brown, dark brown or blackish ostiolar region; in longitudinal section reddish brown to brown above, otherwise hyaline to green-yellow, K- or K+ yellowish to orange. *Spermatia* (3.5–)4.0–4.5(–5.5) \times 1.5–2.0 μ m.

This species is hitherto known from the Western Cape in southern Africa (Figure 6) and a few inland locations

in New Zealand (Matzer & Mayrhofer 1994). In the study area it is confined to calcareous sandstone.

A detailed discussion of the species was provided just recently by Matzer & Mayrhofer (1994) and thus, only a few notes are given here. *Rinodina reagens* is mainly characterized by the presence of a green-yellow pigment in the hypothecium, epiphymenium, and in the spermogonia, which reacts K+ yellowish to orange. This pigment is not known from any other *Rinodina* species. The large ascospores without a torus are also a distinctive character which separates the taxon from almost all other *Rinodina* species known to occur in the study area. Similar spores are found in *Rinodina teichophiloides* which is closely related to *R. reagens*. These sympatric species are confined to different substrates. In South Africa *R. reagens* grows on calcareous sandstone, whereas *R. teichophiloides* is restricted to hard siliceous rocks.

Vouchers from southern Africa: *Brusse* 2874, 3852 (PRE); *J. Hafellner* & *A. Hafellner*, 30654, 30655 (Hafellner).

10. *Rinodina scabridula* Matzer & H.Mayrhofer sp. nov.

Thallus saxicola, crustaceus, rimosi-areolatus, brunneus ad griseus, blastidia formans. *Apothecia* ad 0.45 mm in diametro, lecanorina ad lecideina, immersa vel adnata; disci brunnei ad atri, plani ad convexi. *Epiphymenia* 5–20 μ m alta, brunnea. *Hymenia* 60–90 μ m alta. *Hypothecia* ad 150 μ m alta, hyalina. *Paraphyses* 1–3 μ m crassae, apicibus 3–5 μ m crassis. *Asci* tholis similibus typo generis '*Lecanora*' instructi. *Ascospores* (12–)15–20(–24) \times (6–)7–10(–13) μ m magnae, typo Milvina, Pachysporaria vel Physcia similes, toro evoluto. *Spermogonia* in thallo immersa. *Spermatia* bacilliformia, \pm 4–5 \times 1.0–1.5 μ m magna.

TYPE.—Northern Province (Transvaal), Dist. Zoutpansberg, Louis Trichardt, near the 'The Punch-bowl', \pm 4500 ft, on sandstone rocks, 8-10-1953, O. Almborn 6169 (GZU, holo.); 6168 (LD, iso.).

Thallus crustose, rimose-areolate, partially blastidiate, brown, grey-brown, or grey, occasionally associated with cyanobacteria; blastidia brown to dark brown, coralline when well developed, usually situated at margin of thallus areolae, rarely at thallus margin of apothecia; prothallus indistinct. *Chemistry*: no lichen substances detectable by tlc.

Apothecia to 0.45 mm diam., cryptolecanorine, or lecanorine to lecideine and then adnate, disc dark brown to blackish, plane to slightly convex, proper margin dark brown to blackish. *Epiphymenium* 5–20 μ m tall, brown. *Hymenium* 60–90 μ m tall. *Hypothecium* to 150 μ m deep, hyaline. *Paraphyses* 1–3 μ m, apices 3–5 μ m wide. *Asci* corresponding to Lecanora type, often with 8 but also with less spores. *Ascospores* (Figures 5B; 8A) of Milvina, Pachysporaria or Physcia type, or intermediate between these types, septum in young spores inserted before internal wall thickenings become distinct, torus well developed, spores smooth to finely scabrid, without septal swellings in KOH, (12–)15–20(–24) \times (6–)7–10(–13) μ m. *Spermogonia* immersed in thallus, ostiolar region blackish, somewhat raised. *Spermatia* \pm 4–5 \times 1.0–1.5 μ m.

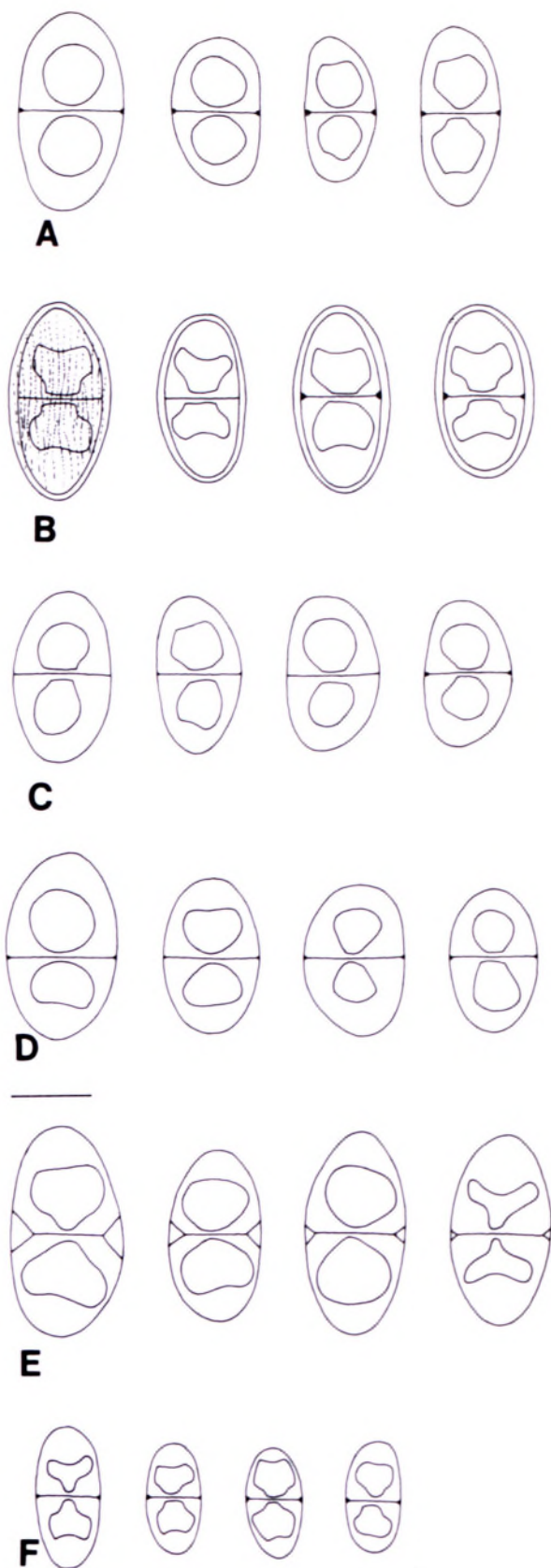


FIGURE 8.—Ascospores of southern African *Rinodina* species. A, *R. scabridula*, holotype (GZU); B, *R. striatitunicata*, holotype (GZU), on left spore striate ornamentation is indicated; C, *R. stellulata*, holotype (G); D, *R. subtristis*, lectotype (BM); E, *R. teichophiloides*, holotype (ZT); F, *R. sp. 1*, *Almborn 10610* (LD). Scale bars: 10 μ m.

Rinodina scabridula is known hitherto from two localities in the Northern Province (northern Transvaal) where it occurs on sandstone and granitic rocks (Figure 6).

Rinodina scabridula is characterized mainly by the formation of blastidia (for this term see Poelt 1980 and Giralt *et al.* 1993a, as 'Blastidien') usually at the margins of thallus areolae, and by its ascospores which are of Milvina, Pachysporaria, Physcia or intermediate type. To determine the species, careful observations are necessary as blastidia are not formed by all thallus areolae and thus, parts of the thalli are smooth. Consequently, confusion with *Rinodina subtristis* (see present study) may be possible.

Other blastidiate, saxicolous *Rinodina* species have already been described: *R. obnascens* (Nyl.) Oliv. is a European lichen-parasitic species which is recorded growing on species of *Acarospora*, *Aspicilia*, and *Rhizocarpon* (e.g. Mayrhofer 1984a, 1987; Mayrhofer & Poelt 1979; Nimis 1993; Nimis *et al.* 1987). *Rinodina furfurea* H. Mayrhofer & Poelt which is so far known only from the type locality in South Tirol is separated from *R. scabridula* by usually shorter ascospores lacking a torus (Mayrhofer & Poelt 1979). *Rinodina blastidiata* Matzer & H. Mayrhofer is a maritime species occurring on coastal rocks in southeastern Australia and in New Zealand. It is distinguished by rather large spores (16–32 \times 9–15 μ m) lacking a torus and with internal wall thickenings of Mischoblastia type, occasionally grading into Pachysporaria type (Matzer & Mayrhofer 1994). For blastidiate *Rinodina* species growing on bark or wood see the studies of Giralt *et al.* (1993b, 1995) and Ropin & Mayrhofer (1995).

The specimen which has been selected as the isotype of *R. scabridula* in the present work was treated under *R. huillensis* by Mayrhofer (1984a).

Specimen examined

NORTHERN PROVINCE.—2329 (Pietersburg): 20 km S of Mara West Road near turnoff to Dendron, Farm Commissie Draai, grid. ref. unknown, 950–1 000 m, 23–29-1-1981, *Brusse 1628* (PRE).

11. *Rinodina striatitunicata* Matzer & H. Mayrhofer sp. nov.

Thallus saxicola, crustaceus, rimosi-areolatus, interdum effusus, brunneus ad griseus. Apothecia ad 0.7 mm in diametro, lecanorina ad lecideina, immersa vel adnata; disci atri, plani ad convexi. Epithymenia 10–20 μ m alta, brunnea ad olivacea, N– vel N+ rubescens. Hymenia 90–120 μ m alta. Hypothecia ad 170 μ m alta, hyalina. Paraphyses 1–3(–4) μ m crassae, apicibus (2–)3–5(–6) μ m crassis. Ascitholis similibus typo generis '*Lecanora*' instructi. Ascospores (16–)17–27 \times (10–)11–17 μ m, ad typum Tunicata pertinentes, parietibus striatiformiter sculpturatis, toro non vel bene evoluto.

TYPE.—Western Cape, 3322 (Oudtshoorn): by the road from Oudtshoorn to Prince Albert, near Ombinda Karambi 7.5 km NW of the Cango Caves, (–AC), 33°23'30", 22°08'45"E, \pm 740 m, Karoo vegetation on an E-exposed slope of a hill, 20-2-1992, *J. Hafellner & A. Hafellner 30650* (GZU, holo.).

Thallus crustose, rimose-areolate, occasionally effuse, dark brown, rarely grey, occasionally somewhat rusty and rough; in longitudinal section with or without a blue-green pigment which reacts N+ red; prothallus absent. *Chemistry*: no lichen substances detectable by tlc.

Apothecia to 0.7 mm diam., cryptolecanorine, or lecanorine to lecideine and then adnate, disc \pm black, plane to convex, proper margin black. *Epihymenium* 10–20 μ m tall, brown to dirty olivaceous (when dirty olivaceous N+ reddish). *Hymenium* 90–120 μ m tall. *Hypothecium* to 170 μ m deep, hyaline. *Paraphyses* 1–3(–4) μ m, apices (2–)3–5 (–6) μ m wide. *Asci* corresponding to *Lecanora* type, with 8 or less spores. *Ascospores* (Figures 5C, D; 8B) of *Tunicata* type, internal wall thickenings corresponding to *Physcia* type, septum in young spores inserted before internal wall thickenings become distinct, torus well developed to indistinct, mature spores with striate ornamentation, (16–)17–27 \times (10–)11–17 μ m. *Spermogonia* not found.

Rinodina striatitunicata is only known from two localities in the Western Cape near the Cango Caves. It grows on volcanic conglomerate and sandstone situated in Karoo vegetation (Figure 6).

As indicated by the epithet, *Rinodina striatitunicata* is characterized mainly by ascospores of *Tunicata* type with peculiar striate ornamentation. The sculpture on the spore surface is elongate and more or less parallel (compare Scheidegger 1993: 335). In order to recognize the ornamentation in ascospores of *R. striatitunicata*, more or less mature or overmature spores must be studied carefully under the light microscope at a magnification of \times 1000 or more; young ascospores are more or less smooth.

Other saxicolous *Rinodina* species with *Tunicata* type ascospores are *R. calcarea* (Arnold) Arnold, *R. tunicata* H. Mayrhofer & Poelt (compare Mayrhofer & Poelt 1979), and *R. filsonii* H. Mayrhofer (Mayrhofer 1984b). They differ from *R. striatitunicata* in several respects and, as far as the ascospores are concerned, mainly by a microrugulate (sculpture less than 1 μ m in size, circular to elongate and irregularly arranged) instead of a striate ornamentation.

The thallus of *R. striatitunicata* varies in consistency and colour according to the rock mineralogy: a rough and rusty morphotype was found on volcanic conglomerate (*Almborn* 4320), whereas dark brown (to grey in small parts) and compact thalli occur on sandstone (*Hafellner* 30649 and 30650).

One specimen of *R. striatitunicata* (*Hafellner* 30649) is associated closely with small patches of another, probably undescribed *Rinodina* species which is distinguished by its pale thallus and characters of the ascospores.

Specimens examined

WESTERN CAPE.—3322 (Oudtshoorn): Dist. Oudtshoorn, 5 miles N of Cango Caves, (–AC), 31-8-1953, *Almborn* 4320 (LD); by the road from Oudtshoorn to Prince Albert, near Ombinda Karambi 7.5 km NW of the Cango Caves, (–AC), 33°23'30"S, 22°08'45"E, \pm 740 m, 20-2-1992, J. Hafellner & A. Hafellner 30649 (Hafellner, associated with *Rinodina* sp.).

12. *Rinodina substellulata* Müll.Arg. in Proceedings of the Royal Society of Edinburgh 11: 461 (1882). Type: Ins. Socotra, Wadi Keschin, 650 m, 1881, *Schweinfurth* s.n. (G, holo!).

Lecanora substellulata (Müll.Arg.) Stizenb.: 209 (1890).

Rinodina quintana (Henriq. in Nyl.) Zahlbr.: 546 (1931). *Lecidea quintana* Henriq. in Nyl.: 24 (1889). *Lecanora quintana* (Henriq. in Nyl.) Nyl. in Hue: 55 (1891). Type: São Tomé & Príncipe, Insula Principis, 1888, *Quintas* s.n. (H-NYL 28854, holo!).

Rinodina quintana var. *obscurior* (Nyl.) Zahlbr.: 546 (1931). *Lecidea quintana* var. *obscurior* Nyl.: 6 (1896). Type: Equatorial Guinea, Ins. Guineensis, Annobón [= Pagalu], 1892, F. Newton s.n. (H-NYL 10450, holo!).

Thallus thin, crustose, areolate or effuse, pale yellowish or pale ochraceous; prothallus absent or present, blackish. *Chemistry*: thallus K+ yellow; tlc: atranorin.

Apothecia to 0.6 mm diam., cryptolecanorine, or lecanorine or lecideine and then adnate to sessile, disc brown, dark reddish brown to blackish, plane to strongly convex, proper margin black. *Proper exciple* dark brown, in addition a blue-green, N+ red pigment is often present. *Epihymenium* 10–20 μ m tall, brown, occasionally blackish green and N+ red in parts. *Hymenium* 90–110 μ m tall. *Hypothecium* to 200 μ m deep, hyaline. *Paraphyses* 1–3 μ m, apices 3–5(–6) μ m wide. *Asci* corresponding to *Lecanora* type, often with 8 but also with less than 8 spores. *Ascospores* (Figure 8C) of *Pachysporaria* type, occasionally grading into *Milvina* type, septum in young spores inserted before internal wall thickenings become distinct, torus often indistinct, sometimes not observable, spores smooth to finely scabrid, without septal swellings in KOH, 14–20 \times 7–12 μ m. *Spermogonia* not found.

Rinodina substellulata is known with certainty from some islands adjacent to the African continent (Príncipe and Annobón in the Atlantic Ocean; Socotra in the Indian Ocean), and from the Northern Province (northern Transvaal) and the Western Cape in the Republic of South Africa (Figure 9). It grows on hard siliceous rocks (including quartzitic rocks, sandstone, and basalt). Further records are given from Costa Rica (Stizenberger 1893), Indonesia (Mayrhofer 1984a), and Australia (Mayrhofer 1984b).

R. substellulata is characterized mainly by the K+ yellow thallus reaction (indicating atranorin) and ascospores of *Pachysporaria* type which may show tendencies towards *Milvina* type. The species is closely related to taxa of the *Rinodina oxydata* group. *Rinodina oxydata* and related species (see account of *R. oxydata* in the present study) differ from *R. substellulata* mainly by having ascospores of *Mischoblastia* type. *Rinodina beccariana* var. *lavicola* (J. Steiner) Matzer & H. Mayrhofer (Mayrhofer et al. 1993) shares several similarities with *R. substellulata* (e.g. K+ yellow thallus reaction, lecideine apothecia, presence of a blue-green, N+ red pigment in the apothecia, *Pachysporaria* type ascospores) but is separated by chemical and morphological characters: the thallus is grey to brown and contains zeorin, the apothecia are up to 1 mm in diameter, and the ascospores exhibit a wider size range (14–25 \times 7–14 μ m). In addition, the ecology and distribution of both taxa is different, with *R. beccariana* var. *lavicola* occurring on volcanic rocks near the coast or on

low coastal mountains in Macaronesia and in the Mediterranean region.

Vouchers: *Almborn 3762* (LD, GZU); *Brusse 1536, 1634* (PRE).

13. *Rinodina subtristis* (Nyl. in Cromb.) H. Mayrhofer in Journal of the Hattori Botanical Laboratory 55: 464 (1984a). Type: Western Cape, Cape of Good Hope, Table Mtn, September 1874, A.E. Eaton s.n., Venus Transit Expedition, (BM, lecto!, associated with *Rinodina oxydata*), designated by Mayrhofer (1984a: 464); (*H-NYL 9329*, iso.), not seen.

Lecidea subtristis Nyl. in Cromb.: 21 (1876a). *Buellia subtristis* (Nyl. in Cromb.) Zahlbr.: 421 (1931).

Thallus thin, crustose, rimose-areolate to effuse, brown or ochraceous; prothallus occasionally present, brown. *Chemistry*: no lichen substances detectable by tlc.

Apothecia to 0.7 mm diam., lecideine or lecanorine, adnate to sessile, occasionally cryptolecanorine, disc dark reddish brown to black, plane to convex, proper margin black. *Proper exciple* dark brown to black, in addition often with a blue-green, N+ red pigment; dead algal cells may be present. *Epithemium* 10–20 μm tall, reddish brown, brown, occasionally (dirty) blue-green and then partly N+ red. *Hymenium* $\pm 80 \mu\text{m}$ tall. *Hypothecium* $\pm 150 \mu\text{m}$ deep, hyaline. *Paraphyses* 1–3(–4) μm , apices (3–)4–6 μm wide. *Asci* corresponding to Lecanora type, axial body occasionally indistinct, asci often with 8 but also with less spores. *Ascospores* (Figure 8D) of Pachysporaria type, occasionally grading into Milvina type, septum in young spores inserted before internal wall thickenings become distinct, torus small but well distinct, spores smooth to finely scabrid, without septal swellings in KOH, (15–)16–23 \times 8–16 μm . *Spermogonia* immersed in thallus, raised, ostiolar region red-brown to blackish. *Spermatia* 3–4 \times 1.0–1.5 μm .

Rinodina subtristis was originally known only from the Cape of Good Hope (Crombie 1876a, b; as *Lecidea subtristis*) but can now be reported also from other regions of the Republic of South Africa and from Angola (Figure 9). The species grows on hard quartzitic rocks (including quartzitic sandstone).

In addition to *R. subtristis*, there are several other *Rinodina* species in the study area which are characterized by the lack of secondary lichen compounds detectable by thin-layer chromatography and by the presence of Pachysporaria type ascospores with a torus, viz. *R. longisperma*, *R. microlepidea*, *R. scabridula*, and *R. confragosula*. The problematic separation of *R. subtristis* from *R. microlepidea* is discussed under the latter species in the present work. Distinctive characters of *R. longisperma* include the small cryptolecanorine apothecia, the small ascospores in which the spore lumina may have small protrusions, and the comparatively long spermatia. *Rinodina scabridula* is mainly distinguished by the formation of blastidiate thalli. The separation of *R. subtristis* from *R. confragosula* is based on a set of characters: grey thalli are often found in *R. confragosula* but never in *R. subtristis*; the apothecia of *R. confragosula* are usually purely black and cryptolecanorine but dark reddish brown to black and lecideine or lecanorine in *R. subtristis*; the as-

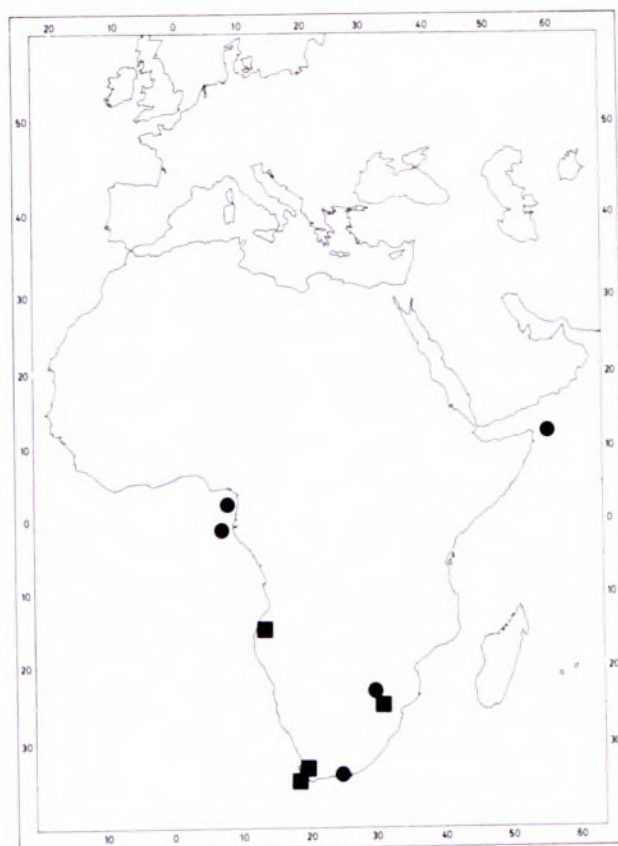


FIGURE 9.—Known distribution of *Rinodina substellulata* in Africa, ●; and *R. subtristis*, ■.

cospores of *R. confragosula* are very variable in the formation of internal wall thickenings (Pachysporaria, Milvina, Physcia, or intermediate types, or spore lumina irregularly biconical in shape) and in length (14–32 μm), the spores of *R. subtristis* are usually of Pachysporaria type and 15–23 μm long.

Three *Rinodina* species which were described from West African islands share close similarities with *R. subtristis*, viz. *R. praefinita* (Nyl.) Zahlbr. (Nylander 1887, as *Lecanora praefinita*) and *R. subanceps* (Nyl.) Zahlbr. (Nylander 1887, as *Lecanora subanceps*) from São Tomé & Príncipe, and *R. newtonii* H. Mayrhofer (Mayrhofer 1984a) from Annobón (= Pagalu). All these species and *R. subtristis* are known only from single or at best a few specimens, and thus statements whether these taxa are really well separated, cannot be made without some hesitation. Under this precondition, *R. praefinita* is distinguished from *R. subtristis* by smaller ascospores ($\pm 13\text{--}17 \times 7\text{--}10 \mu\text{m}$), and *R. subanceps* differs by the thick, more or less squamulose thallus. A well-developed thallus and ascospores with an indistinct torus are characteristic for *R. newtonii*. A detailed study of the relationships between these taxa is beyond the scope of the present work and was not carried out. Mayrhofer & Leuckert (1985) recorded the presence of zeorin in a specimen of *R. subanceps* from Annobón (*H-NYL 28964*), but lichen compounds could not be detected by recent tlc-analyses in the holotype from the island of Cabras (São Tomé & Príncipe, *H-NYL 28965*) and in another specimen from Annobón (*H-NYL 28514*).

One of the specimens now regarded as belonging to *R. subtristis* was treated under *R. huillensis* by Mayrhofer (1984a): Angola, Humpata Plateau, 6-2-1960, *Degelius* (GZU).

Vouchers: *Almborn* 1720 (LD); *Brusse* 2719 (PRE); *Degelius* s.n. (GZU); *Schaefer* CH 1935 (PRE).

14. ***Rinodina teichophiloides*** (*Stizenb.*) *Zahlbr.* in *Catalogus lichenum universalis* 7: 557 (1931). Type: Western Cape, supra saxa quartzosa schistosa ad Muizenberg in Promontorio Bonae Spei, *MacOwan* 126 (ZT, holo.!).

Lecanora teichophiloides *Stizenb.*: 212 (1890).

Thallus thinly crustose to somewhat squamulose, occasionally evanescent, effuse to rimose-areolate, light greenish grey, grey-brown, dark brown, ochraceous, occasionally associated with cyanobacteria; prothallus absent or present, brown. *Chemistry*: no lichen substances detectable by tlc.

Apothecia to 0.8 mm diam., often with a lecidine appearance or lecanorine, immersed to adnate, (dead) algal cells sometimes present in the proper margin, disc black or dark brown, plane to convex. *Epihymenium* 10–30 μ m tall, dark brown. *Hymenium* 90–130 μ m tall. *Hypothecium* to 150 μ m deep, hyaline, light yellow to yellowish brown. *Paraphyses* 1–2 μ m, apices to 3–5 μ m wide; enlarged, to \pm 6 μ m wide 'oil cells' occasionally present in paraphyses. *Asci* corresponding to *Lecanora* type, 2- to 8-spored. *Ascospores* (Figure 8E) at first with internal wall thickenings of *Mischoblastia* type, then corresponding to *Pachysporaria* type, septum in young spores inserted before internal wall thickenings become distinct, torus absent but sometimes simulated by intense brown pigmentation in the septal region, spores finely scabrid, often with septal swellings in KOH, (16–)20–32 \times 10–18 μ m. *Spermogonia* immersed in thallus, raised, ostiolar region dark reddish brown to blackish. *Spermatia* \pm 4–5 \times 1.0–1.5 μ m.

Rinodina teichophiloides is a characteristic species of maritime localities in the Cape Province (Figure 10). It grows on hard siliceous rocks such as quartzitic sandstone, on inclined, vertical and overhanging rock faces. Occa-

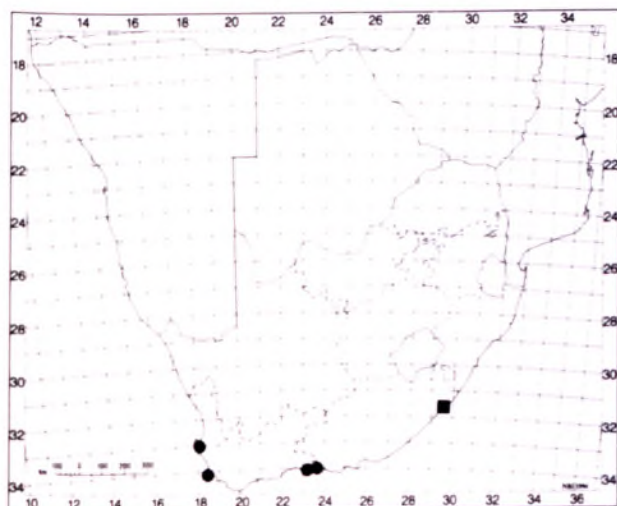


FIGURE 10.—Known distribution of *Rinodina teichophiloides*, ●; and *Rinodina* sp. 1, ■.

sionally cyanobacteria were found growing at the margin of well-developed thallus areolae.

Rinodina teichophiloides was discussed in detail recently by Matzer & Mayrhofer (1994). Since then, additional material has become available and some annotations can be given on the morphology of the species. Apothecia with a lecidine appearance in surface view may contain (dead) algal cells in the proper exciple. Paraphyses with 'oil cells' (oil paraphyses, compare Poelt & Pelleter 1984) were observed in some specimens. The ascospores lack a typical torus but intense pigmentation in the septal region may simulate the presence of a torus. *Rinodina teichophiloides* can best be recognized by the often rather thin thallus, by apothecia often appearing to be lecidine, the large ascospores with internal wall thickenings of *Mischoblastia* or *Pachysporaria* type, and by the often coloured hypothecium which lacks a distinct colour change in potassium hydroxide. It is closely related to *R. reagens*, a species which also occurs in the Cape Province. The latter can easily be distinguished by the presence of a K⁺ reactive pigment in the hypothecium and—not always—in the epihymenium and in the spermogonia. Both the species also differ in substrate ecology (see discussion of *R. reagens* in the present study).

Vouchers: *Almborn* 926, 1235, 1262, 1280, 1320 (LD), 11498 (GZU, LD); *J. Hafellner* & *A. Hafellner*, 30656, 30658, 30659, 30661 (*Hafellner*), 30662 (GZU); *Kärnefelt* 8647–26 (LD); *Sipman* 20287 (B); *Triebel* & *Rambold* 7708, 8156, 8186, 8190, 8204, 8227, 8230 (M), 8156 *dupl.* (GZU), 8419 *dupl.* (GZU, M).

15. *Rinodina* sp. 1

Thallus crustose, effuse to areolate, continuous or composed of \pm discrete areolae, whitish, pale greyish, pale brownish, areolae partly convex; prothallus absent. *Chemistry*: no lichen substances detectable by tlc.

Apothecia to 0.45 mm diam., lecanorine, sessile, in addition to the thalline margin a proper margin is occasionally developed, disc brown to blackish, plane or concave, proper margin brown. *Epihymenium* 10–15 μ m tall, brown. *Hymenium* 60–70 μ m tall. *Hypothecium* to \pm 70 μ m deep, hyaline. *Paraphyses* 1–3 μ m, apices 2–5 μ m wide. *Asci* corresponding to *Lecanora* type, often with 8 but also with less than 8 spores. *Ascospores* (Figure 8F) of *Physcia* type, rarely grading into *Milvina* type, septum in young spores inserted before internal wall thickenings become distinct, torus small but well distinct, spores smooth to finely scabrid, without septal swellings in KOH, 11–17 \times 6–9 μ m. *Spermogonia* not found.

The species is known only from a single locality in the Eastern Cape (Figure 10).

The above description is based on the single collection cited below. In Mayrhofer (1984a) this specimen was included in *Rinodina interpolata* (*Stirt.*) *Sheard*, but we have some doubts whether it really belongs to that species. *Rinodina interpolata* usually occurs in Europe on more or less vertical or overhanging surfaces of cliffs mainly in coastal sites but also in inland localities (e.g. *Fox* & *Purvis* 1992; *Mayrhofer* 1984a; *Mayrhofer* & *Poelt* 1979; *Santesson* 1993; *Sheard* 1973); it was also recorded from the Antarctic region (see *Lindsay* 1973). A definite statement

on the occurrence of *R. interpolata* in southern Africa only seems possible after extensive field studies and collecting of more material. Only a few significant differences between *Rinodina* sp. 1 and *R. interpolata* can be observed: the ascospores in *R. interpolata* are also of Physcia type but, particularly when older, often grade into Physconia type; in several specimens of *R. interpolata*, zeorin could be detected by tlc (hitherto unpublished data; Leuckert & Mayrhofer 1984). For a description of *R. interpolata* see Fox & Purvis (1992), Mayrhofer & Poelt (1979), and Sheard (1973).

Voucher: *Almborn 10610* (LD, associated with *Lichenodiplis lichencola*).

EXCLUDED SPECIES

This section includes saxicolous species from southern Africa which were referred to the genus *Rinodina* by various authors, and *Rinodina* species which were erroneously recorded from the study area.

1. ***Buellia distrata*** (Nyl.) Zahlbr. in *Catalogus lichenum universalis* 7: 357 (1931). Type: Western Cape, Cape of Good Hope, Table Mtn, September 1874, *E.A. Eaton s.n.*, Venus Transit Expedition (BM, lecto.!) designated by Mayrhofer (1984a: 405), (BM, iso.!), (*H-NYL 9309*, iso.), not seen.

Lecidea distrata Nyl. in *Cromb.*: 179 (1876b). *Rinodina distrata* (Nyl.) C.W. Dodge: 167 (1971).

Thallus thin, crustose, areolate, light yellowish; prothallus blackish, between the areolae well developed. *Chemistry*: thallus K+ yellow, C-, P-; medulla K-, C+ orange, P-.

Apothecia to 0.3 mm diam., cryptolecanorine, disc black, plane. *Epithemium* 10–15 µm tall, brown, olivaceous to dirty greenish, N+ red. *Hymenium* 90–110 µm tall. *Hypothecium* to 100 µm deep, hyaline. *Paraphyses* 1–4 µm, apices 3–5 µm wide. *Asci* corresponding to *Bacidia* type, usually with 8, rarely with less spores. *Ascospores* (Figure 1A) of *Beltramia* type, torus absent, spores scabrid, ± 17–22 × 9–12 µm. *Spermogonia* not observed.

Buellia distrata is known only from the type specimens collected on Table Mountain on quartzitic rocks.

This species has ascospores which lack internal wall thickenings, therefore it cannot be placed within *Rinodina* as was done formerly (e.g. Dodge 1971; Mayrhofer 1984a). Alternative placements could be in either *Amandinea* Choisy ex Scheid. & H. Mayrhofer or *Buellia* De Not., two genera which are separated mainly by their spermatia: long, filiform, and curved in *Amandinea* and short, bacilliform, and straight in *Buellia* (e.g. Matzer & Mayrhofer 1993; Matzer *et al.* 1994b; Scheidegger 1993). As spermogonia are not present in the material of *Buellia distrata* now available, the best solution seems to retain the existing name of this taxon.

2. ***Buellia permodica*** (Stizenb.) Zahlbr. in *Catalogus lichenum universalis* 7: 387 (1931). Type: Western

Cape, supra saxa arenaria prope Muizenberg in Promontorio Bonae Spei, *MacOwan s.n.* (?ZT, holo.); not seen, citation after Stizenberger (1891: 168).

Lecidea permodica Stizenb.: 168 (1891).

This species was not validly transferred into the genus *Rinodina* by Dodge (1971) as reference to the basionym was omitted (ICBN, Art. 33.2.). Judging by the small spores mentioned in the protologue the species probably does not belong to *Rinodina*.

3. ***Rinodina argentiniana*** Müll.Arg. in *Flora* 72: 511 (1889).

See discussion of *Rinodina confragosula* in the present study.

4. ***Rinodina atroalbida*** (Nyl.) C.W.Dodge in *Beihfte zur Nova Hedwigia* 38: 165 (1971).

Lecanora sophodes var. *atroalbida* Nyl.: 7 (1869). *Rinodina sophodes* var. *atroalbida* (Nyl.) Zahlbr.: 552 (1931).

This taxon was described from Port Natal (Durban) in the Republic of South Africa. According to Mayrhofer (1984a) the type cannot be located.

5. ***Rinodina bicolor*** Zahlbr. in *Annales de Cryptogamie Exotique* 5: 272 (1932). Type: ?Swaziland, Mbabana, ad lapides siliceos, *V. Lebzelter s.n.* (W, holo.); not seen, citation after Zahlbruckner (1932: 273).

According to Mayrhofer (1984a) this species belongs to the genus *Buellia*.

6. ***Rinodina conspersa*** Müll.Arg. in *Flora* 72: 511 (1889). Type: Paraguay, Cerro Lambare prope Asuncion, 1882, *Lorentz s.n.* (G, lecto., iso.); not seen, citation after Mayrhofer (1984a: 484, 485).

Lecanora conspersa (Müll.Arg.) Stizenb.: 236 (1895).

The records of this species from the Zambezi River (Stizenberger 1895; Doidge 1950) are based on material of *Rinodina oxydata* (Mayrhofer 1984a).

7. ***Rinodina deminutula*** (Stizenb.) Zahlbr. in *Catalogus lichenum universalis* 7: 508 (1931). Type: Western Cape, supra saxa arenaria in Monte Leonis prope Cape Town, *MacOwan s.n.* (ZT, holo.); not seen, citation after Stizenberger (1890: 211).

Lecanora deminutula Stizenb.: 210 (1890).

Mayrhofer (1984a) pointed out that the scant type is in a poor condition and a treatment of the species is not possible.

8. ***Rinodina microphthalma*** A.Massal. in *Memorie del Reale Istituto Veneto di Scienze, Lettere ed Arti* 10: 61 (1861).

This species was described from the Cape Province. According to the protologue it probably belongs to *Buellia*. The name *Rinodina microphthalmia* was treated as a synonym of *Lecanora microps* Stizenb. by Stizenberger (1890), and of *Buellia verruculosa* Mudd by Zahlbruckner (1931).

9. ***Rinodina procellarum*** (A.Massal.) H.Mayrhofer in Beihefte zur Nova Hedwigia 79: 522 (1984b). Type: Western Cape, Caput Bonae Spei, *Wawra s.n.* (VER, holo.); not seen, citation after Mayrhofer (1984b) and Sheard (1992).

Buellia procellarum A.Massal.: 64 (1861). *Hafellia procellarum* (A.Massal.) H.Mayrhofer & Sheard in Sheard: 87 (1992).

Modern taxonomic concepts clearly suggest that this species should be included in the genus *Hafellia* Kalb, H.Mayrhofer & Scheid. (Sheard 1992).

ACKNOWLEDGEMENTS

We would like to thank the directors and curators of the herbaria who have sent type and other material on loan: B, BM, G, GZU, H, L, LD, M, PRE, TRH, TUR, W, ZT, and Dr J. Hafellner (Graz) for the provision of specimens from his private herbarium. Many thanks are also due to Dr D. Triebel and Dr G. Rambold (both Munich) who have kindly selected and provided relevant material for the present study. We are grateful to Prof. Dr C. Leuckert (Berlin) for his help with the identification of 5-O-methylhiascic acid in *Rinodina huillensis*, to Prof. Dr J. Poelt (Graz) and Prof. Dr J.W. Sheard (Saskatoon) for critical reading of the manuscript, to Dr M. Giral (Barcelona) for valuable comments and, especially, to Dr G. Kantvilas (Hobart) for correcting the English text. The 'Fonds zur Förderung wissenschaftlicher Forschung (Projekte P8500-BIO and P10514-BIO)' is acknowledged for financial support.

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