

# New records of corticolous lichens for South America and Brazil

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**Background and aims** – The corticolous microlichens are the greatest group of lichens in the world and also the least known. For this reason intensive studies on this group are seriously needed. Based on this necessity, the main objective of this paper is to present new records of corticolous microlichen species for South America, Brazil, the Southern region of Brazil and the state of Rio Grande do Sul.

**Methods** – The species were collected in three different forest types: native Araucaria forest, Atlantic rainforest and riparian forests from the Pampa Biome.

**Key results** – A total of 43 new records of corticolous microlichen species are here presented. Six species are new reports for South America: *Cryptothelium cecidiogenum* Aptroot & Lücking, *Distopyrenis composita* R.C.Harris, *Graphis pseudocinerea* Lücking & Umaña, *Herpothallon echinatum* Aptroot, Lücking & Will-Wolf, *Lecanora thysanophora* R.C.Harris and *Psoroglaena stigonemoides* (Orange) Henssen. Two species are new records for Brazil: *Pyrenula dissimulans* (Müll.Arg.) R.C.Harris and *Rinodina conradii* Körb., while four are new occurrences for the state of Rio Grande do Sul: *Graphis elongata* Zenker, *Graphis furcata* Fée, *Graphis longula* Kremp. and *Haematomma africanum* (Steiner) Dodge. Thirty-one new records are as well reported here for the Southern region of Brazil.

**Conclusion** – The high number of new crustose species records of this study greatly contributes to the current knowledge on lichens. Additionally, our study highlights the importance of conserving all kinds of forest environments, since they are important areas for lichen establishment and dispersion.

**Key words** – Microlichens, Pampa Biome, native Araucaria forest, Atlantic rainforest.

## INTRODUCTION

The total number of lichenized fungi worldwide is estimated to range between 13,500 and 20,000 species, with over 50% known as Ascomycota (Kirk et al. 2008). Some authors report that possibly around 50% from the total of lichen species are tropical species (Sipman & Aptroot 2001, Feuerer & Hawksworth 2007). There is a serious lack of knowledge on this taxonomic group, since information about species distribution and ecological parameters may sometimes omit important data about rare species that compose a significant proportion of tropical lichen species richness (Cáceres et al. 2007, 2008a, 2008b).

The corticolous microlichens are the biggest group of lichens and also the least known. Intensive studies on this group are needed, which makes the compilation of taxonomic keys a difficult job for researchers and also prevent researchers to identify and include this material in their surveys or ecological studies (Lücking et al. 2009).

According to Lücking et al (2009) it is estimated that there are approximately 4,900 lichen species in Brazil. Marcelli (2008) reports 2,874 lichen species, being 49.4% from the group of crustose lichens. In the last decades, studies on corticolous microlichens were intensified in Brazil, especially in the Northeastern and Southern regions (Marcelli 1992, Cáceres 2007, 2008a, 2008b, Dal-Forno & Eliasaro 2010, Käffer et al. 2011, Martins & Marcelli 2011, Cáceres et al. 2012, 2013a, 2013b, 2013c, 2013d, 2013e, Aptroot & Cáceres 2013, Aptroot et al. 2013a, 2013b, Koch et al. 2013, Lima et al. 2013a, 2013b, 2013c, Menezes et al. 2013a, 2013b, 2013c).

For the state of Rio Grande do Sul, Southern Brazil, a total of 412 crustose species are reported (Spielmann 2006). There are also more recent studies that report some new records for this state: Käffer et al. (2010) reported 26 new occurrences of crustose lichens for an urban area in the city of Porto Alegre; Koch et al. (2013) recorded 174 lichen species, being 65.1% crustose lichens, in an area of Atlantic rainforest; and Käffer (2013) presented eleven new records in a re-

gion of native Araucaria forests. The main objective of this paper is to present new records of corticolous microlichen species for South America, Brazil, the Southern region of Brazil, and the state of Rio Grande do Sul.

## MATERIAL AND METHODS

### Study area

The lichen collections were made between 2008 and 2013 in the cities of Maquiné, Santana do Livramento and São Francisco de Paula, all located in the state of Rio Grande do Sul, Southern Brazil (fig.1). In Maquiné, the study area was characterized by closed tropical rainforests, corresponding to the Southern limit of distribution of the Atlantic Rainforest. In Santana do Livramento, the prevailing vegetation is grassland, but there are also some forest areas. These forest areas are mainly along the rivers (riparian forests), but there are also some small patches in the grassland matrix and some forests in the slopes (Backes 2012, Andrade 2013). Meanwhile, the study area in the city of São Francisco de Paula comprises a transition zone among native Araucaria forest, Atlantic rainforest and high altitude grassland (Koch et al. 2012). According to the updated Köppen-Geiger classification, the climate in these areas is classified as Cfa type (C – Temperate; f - without dry season; and a - with hot summers) (Peel et al. 2007).

### Sampling and identification

The lichen samples were collected on tree trunks of phorophytes found on the edge of the forest patches, inside the forest areas or sometimes on isolated trees.

For lichen species identification, we used stereoscopic and optical microscopes to analyse the samples and the an-

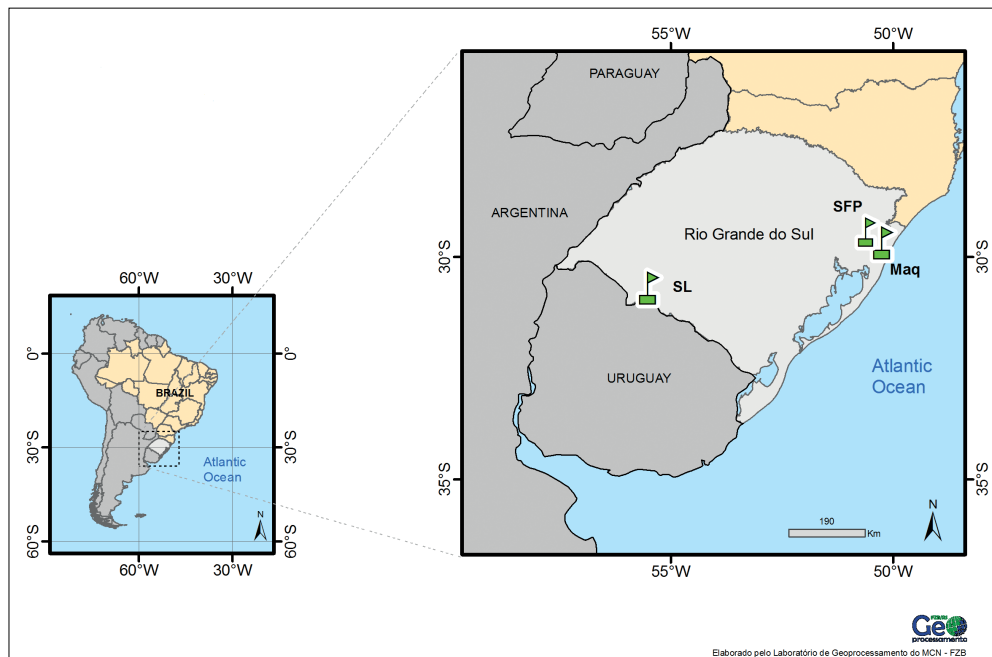
atomical sections of the thallus and the reproductive structures. We made some colour spot tests with potassium hydroxide 20% (KOH) and the Lugol's solution (I reaction) in order to determinate the presence of substances and/or reactions in the cortex, hymenium, ascus and ascospores. The collected lichen material can be found in the Herbarium Prof. Dr. R.H. Alarich Schultz at the Museum of Natural Sciences of the Fundação Zoobotânica do Rio Grande do Sul (HAS).

## RESULTS

A total of 43 corticolous microlichen species were recorded, distributed over seventeen families and 25 genera. Six species are new records for South America: *Cryptothelium cecidiogenum*, *Distopyrenis composita*, *Graphis pseudocinerea*, *Herpothallon echinatum*, *Lecanora thysanophora* and *Psoroglaena stigonemoides*. Two species are new records for Brazil: *Pyrenula dissimulans* and *Rinodina conradii*, while four are new occurrences for the state of Rio Grande do Sul: *Graphis elongata*, *Graphis furcata*, *Graphis longula* and *Haematomma africanum*. For the Southern region of Brazil a total of 31 new records were reported (table 1, figs 2–5).

The genera with the greatest number of species were *Graphis* (nine) and *Malmidea* (four). The families with the highest number of representatives were Graphidaceae (fourteen), followed by Ramalinaceae, Malmideaceae and Trypetheliaceae, these last with four species each.

The greatest number of new records was found in the city of Santana do Livramento, with twenty species, while in Maquiné were eighteen species, and two species in São Francisco de Paula.



**Figure 1** – Location of the cities where the species were collected. SL = Santana do Livramento, SFP = São Francisco de Paula, Maq = Maquiné.

**Table 1 – New records of corticolous microlichens for South America, Brazil, Southern region of Brazil and the state of Rio Grande do Sul.**

SL = Santana do Livramento, SFP = São Francisco de Paula, Maq = Maquiné, RS = state of Rio Grande do Sul.

Family/Species	New occurrence	Locality		
		SL	SFP	Maq
<b>Arthoniaceae</b>				
<i>Herpothallon echinatum</i> Aptroot, Lücking & Will-Wolf	South America			x
<b>Caliciaceae</b>				
<i>Hafellia bahiana</i> (Malme) Sheard	Southern Brazil	x		
<b>Coenogoniaceae</b>				
<i>Coenogonium nepalense</i> (G.Thor & Vězda) Lücking, Aptroot & Sipman	Southern Brazil	x	x	
<i>Coenogonium siquirrense</i> f. <i>denticulatum</i> Rivas Plata & Lücking	Southern Brazil			x
<b>Graphidaceae</b>				
<i>Diorygma antillarum</i> (Vain.) Nelsen, Lücking & Rivas Plata	RS			x
<i>Diorygma pruinosum</i> (Eschw.) Kalb., Staiger & Elix	RS	x		
<i>Graphis elongata</i> Zenker	RS			x
<i>Graphis furcata</i> Fée	RS			x
<i>Graphis glauconigra</i> Vain.	Southern Brazil	x		
<i>Graphis longula</i> Kremp.	RS			x
<i>Graphis pinicola</i> Zahlbr.	Southern Brazil			x
<i>Graphis pseudocinerea</i> Lücking & Umaña	South America			x
<i>Graphis puiggarii</i> (Müll.Arg.) Lücking	Southern Brazil	x		
<i>Graphis subdisserpens</i> Nyl.	Southern Brazil	x		
<i>Graphis tenella</i> Ach.	Southern Brazil	x		x
<i>Hemithecium balbisii</i> (Fée) Trevis.	Southern Brazil			x
<i>Phaeographis crispata</i> Kalb & Mathes-Leicht	Southern Brazil			x
<i>Phaeographis kalbii</i> Staiger	Southern Brazil			x
<b>Gyalectaceae</b>				
<i>Ramonia microspora</i> Vězda	Southern Brazil	x		
<b>Lecanoraceae</b>				
<i>Haematomma africanum</i> (Steiner) Dodge	RS	x		
<i>Lecanora thysanophora</i> R.C. Harris	South America	x		
<b>Malmideaceae</b>				
<i>Malmidea flavopustulosa</i> (M.Cáceres & Lücking) M.Cáceres & Kalb	Southern Brazil			x
<i>Malmidea fuscella</i> (Müll.Arg.) Kalb & Lücking	Southern Brazil	x		x
<i>Malmidea gyalectoides</i> (Vain.) Kalb & Lücking	Southern Brazil			x
<i>Malmidea hypomela</i> (Nyl.) Cáceres & Lücking	Southern Brazil	x		
<b>Monoblastiaceae</b>				
<i>Anisomeridium albisedum</i> (Nyl.) R.C.Harris	Southern Brazil	x		
<i>Anisomeridium leptospermum</i> (Zahlbr.) R.C.Harris	Southern Brazil	x		x
<b>Physciaceae</b>				
<i>Rinodina conradii</i> Körb.	Brazil	x		
<b>Pilocarpaceae</b>				
<i>Calopadia pruinoso</i> Lücking & Chaves	Southern Brazil	x		
<b>Porinaceae</b>				
<i>Trichothelium angustiporum</i> M.Cáceres & Lücking	Southern Brazil	x		

**Table 1 (continued)** – New records of corticolous microlichens for South America, Brazil, Southern region of Brazil and the state of Rio Grande do Sul.

Family/Species	New occurrence	Locality		
		SL	SFP	Maq
<b>Pyrenulaceae</b>				
<i>Distopyrenis composita</i> R.C.Harris	South America			x
<i>Pyrenula dissimulans</i> (Müll.Arg.) R.C.Harris	Brazil	x		
<b>Ramalinaceae</b>				
<i>Bacidia chapadensis</i> Malme	Southern Brazil	x		
<i>Bacidiospora microphyllina</i> Kalb	Southern Brazil			x
<i>Bacidiospora silvicola</i> (Malme) Kalb	Southern Brazil			x
<i>Bapalmuia lafayetteana</i> (Vain.) Kalb & Lücking	Southern Brazil	x		
<b>Roccellaceae</b>				
<i>Bactrospora jenikii</i> (Vězda) Egea & Torrente	Southern Brazil	x		
<b>Thelenellaceae</b>				
<i>Aspidothelium scutelliscarpum</i> Lücking	Southern Brazil			x
<i>Thelenella paraguayensis</i> Malme	Southern Brazil		x	
<b>Trypetheliaceae</b>				
<i>Astrothelium crassum</i> (Fée) Aptroot	Southern Brazil	x		
<i>Astrothelium variolosum</i> (Ach.) Müll.Arg.	Southern Brazil	x		
<i>Cryptothelium cecidiogenum</i> Aptroot & Lücking	South America			x
<b>Verrucariaceae</b>				
<i>Psoroglaena stigonemoides</i> (Orange) Henssen	South America	x		x



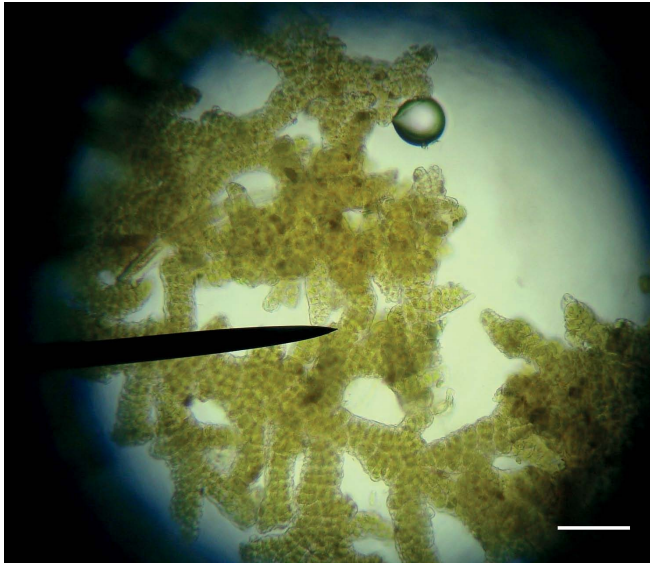
**Figure 2** – *Coenogonium nepalense* (G.Thor & Vězda) Lücking, Aptroot & Sipman, occurrence in Southern Brazil. Scale bar = 1 mm.



**Figure 3** – *Diorygma pruinatum* (Eschw.) Kalb., Staiger & Elix, occurrence in Rio Grande do Sul. Scale bar = 1 mm.



**Figure 4** – *Graphis glauconigra* Vain., habitus. Scale bar = 1 mm



**Figure 5** – Detail of the thallus of *Psoroglaena stigonemoides* (Orange) Henssen, under microscope. Scale bar = 1 mm.

## DISCUSSION

The expressive number of corticolous microlichen species recorded for the Southern region of Brazil shows the serious need of more studies on this group. Ahmadjian (1993) estimates that 73% of the lichen species form crustose thalli. Even representing the majority of the lichen species, this group is one of the least known groups of lichens, especially in tropical and subtropical regions.

The species reported as new records for South America have various geographic distributions in North America, Central America, Asia, Europe and/or Oceania. The species *Psoroglaena stigonemoides* (Orange) Henssen, can be highlighted for having micro-filamentous thalli and also a wide occurrence in European countries (GBIF 2013). In our study, this species occurred with highest frequency in the Atlantic rainforests in the city of Maquiné. In this region, *P. stigonemoides* was registered in areas of closed forests of intermediate and later succession stages, where the luminosity was weak and the humidity was higher (Koch et al. 2013). In the region of Santana do Livramento, *P. stigonemoides* was found associated with the thalli of *Phyllopsora buettneri* (Müll.Arg.) Zahlbr., in more conserved riparian forest patches.

Regarding the species reported as new occurrences to Brazil, *Pyrenula dissimulans* is already known from Guyana (GBIF 2013), while *Rinodina conradii* has a wide distribution, being cited in Asia, Europe, America and Oceania (GBIF 2013). Both species were found in riparian forests, with low frequency and coverage in the analysed areas. Aptroot et al. (2013b) report that many species of *Pyrenula* are restricted to undisturbed forests, mainly in tropical regions, but also in temperate zones. These authors also affirm that the Neotropical region is certainly the diversity hotspot for this genus.

The species recorded for the first time in the state of Rio Grande do Sul, *Graphis elongata*, *G. longula* and *G. furcata* were already referred for areas of sandbank forests on the shore of Paraná, another state from Southern Brazil (Dal-Forno 2009). Meanwhile, *Haematomma africanum* was reported for the states of Bahia, Minas Gerais, Rio de Janeiro, São Paulo and Santa Catarina (Marcelli 1998, Aptroot 2002, Gumboski & Eliasaro 2011). In our study, *Graphis* species were found both in initial stages of Atlantic forest succession, as in more shaded riparian forests, while *Haematomma africanum* was found on tree trunks on the edges of riparian forest patches.

The microlichen species with new records for the Southern region of Brazil mostly also occur in Northern, North-eastern and Southeastern Brazil, in areas with the Cerrado and Caatinga biomes (Malme 1935, Marcelli 1992, 1998, Aptroot 2002, Lücking & Cáceres 2004, Cáceres 2007, Menezes et al. 2011). In our study we can also highlight *Diorygma antillarum* (Vain.) Nelsen, Lücking & Rivas Plata and *Graphis glauconigra* Vain. which occurred in 50% and 42%, respectively, of the riparian forest areas in the city of Santana de Livramento.

In recent years, the study of microlichens was intensified in Brazil (Dal-Forno & Eliasaro 2010, Aptroot et al. 2013a, 2013b, Cáceres et al. 2012, 2013a, 2013b, 2013c, 2013d, 2013e, Lima et al. 2013a, 2013b, 2013c) with the description of many new species to science. However, most of these papers concern the Northern and Northeastern regions of Brazil and few studies were recently made on microlichens from the Southern region.

## Conclusions

The great number of new crustose species records of this study greatly contributes to the current knowledge of lichen distribution and ecological characteristics, and the results can also be used for further studies on lichens. Additionally, our study strengthens the importance of conserving all kinds of forest environments, including the forest patches in grassland matrixes, which are important areas for lichen establishment and dispersion.

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