

A new checklist of lichenised, lichenicolous and allied fungi reported from South Africa

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Background: The last comprehensive list of lichenised, lichenicolous and allied fungi reported from South Africa was published in 1950. A checklist is important to provide basic information on the extent of the diversity, and to provide the most recent name and classification.

Objective: To present a list of all the lichenised, lichenicolous and allied fungi reported from South Africa.

Methods: The list presented is entirely literature based and no attempt has been made to check the report of any taxa or their status by checking the specimens upon which they are based. Firstly, all taxa that were not reported from within the modern boundaries of South Africa were excluded. Next, the *Recent literature on lichens* database was searched for literature on South African lichens since 1945 and all references checked for new species or new reports, which were then added to the list. These names were then checked against Index Fungorum to ensure that the most current name was being used. Finally, the list was rationalised by excluding all synonyms and dubious infraspecific taxa.

Results: The current list includes 1750 taxa in 260 genera from mainland South Africa, with an additional 100 species and 23 genera from the sub-Antarctic Prince Edward Islands, which are treated separately. The replacement name *Verrucaria dagolavii* Fryday is proposed for *Verrucaria umbilicata* Øvstedal.

Conclusion: It is estimated that, when fully explored, the lichen biota of South Africa will consist of somewhere between 2500 and 3000 taxa.

Introduction

History of the exploration of the lichen biota of South Africa

A checklist of South African lichens was last produced by Ethel Doidge in her monumental work on South African fungi (Doidge 1950). This has been partially updated online by Feuerer (2013) but is incomplete because it includes literature reports up to only 2002, and even before that there are numerous taxa that are not included: many of the macrolichens are included but for microlichens the list is far less complete. Feuerer's list also failed to acknowledge that Doidge's 'South Africa' covered a much larger area than the present country, including all of southern Africa up to the 15th parallel; that is, not only Lesotho and Swaziland but also Namibia, Botswana, Zimbabwe, most of Mozambique, along with southern Angola, Zambia and Malawi.

In the introduction to his paper on the lichens of high altitude in South Africa, Almborn (1987) was optimistic concerning the future of South African lichenology. He reported renewed interest in the lichen biota with the preparation of a 'lichen flora' and anticipated the publication of the first volume within a few years. However, he acknowledged that many groups were poorly studied and it was difficult to find competent lichenologists to work on them. Unfortunately the same is true today; genera such as *Buellia*, *Lecanora*, *Lecidea* and *Usnea* have received very little attention in the country and are in desperate need of revision, some records dating back to the end of the 18th century.

An account of the investigation of the lichen biota of South Africa was published by Thomas and Bhat (1995, 1996) and Thomas, Bhat and Weber (1997), and work since then has been rather patchy, with most recording being carried out by visiting European lichenologists (see Schultz, Zedda & Rambold 2009) who tended to concentrate on their specialist genera or groups. A notable exception to this was the work of Franklin Brusse of the National Herbarium in Pretoria who, from 1985 to 1994, published over 30 papers (see references to Online Appendix 1) describing new species from the country and often including new reports of other species. Brusse worked mainly with the Parmeliaceae, but also described many new crustose species and genera. Strangely, the

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only area of South Africa where all groups have been studied is the Prince Edward Islands, which have been the subject of an intensive study by Øvstedal and Gremmen (2001, 2007), although undoubtedly much more remains to be discovered there as well.

Unfortunately, none of these visiting lichenologists took the time to compile a lichen checklist for the country and the dispersed nature of the literature and the fact that new reports were often added to the end of a paper describing new, unrelated species meant that some species have been reported as new to South Africa (or southern Africa) on more than one occasion.

Research methods and materials

The list includes lichens, lichenicolous fungi (indicated with *) and other allied fungi that, although neither lichenised or lichenicolous, are often studied by lichenologists (indicated with †).

The list presented here is entirely literature based and no attempt has been made to check the report of any taxon or its status by checking the specimen upon which it is based. Many reports are based on 19th (or even 18th) century collections made by Europeans and named after European species and, without examining the original collection (which is outside the scope of this present study), there is no way of knowing to which species the collection should properly be referred. In particular, investigation in Australia, where many species have also been reported, has shown that the species present there are often distinct taxa. For example, Elix and Johnston (1988) separated *Punctelia subflava* (Taylor) Elix & J. Johnston, described from Australia, from the northern hemisphere *Punctelia rudecta* (Ach.) Krog., and Elix (1993) separated *Xanthoparmelia masonii* Elix from *Xanthoparmelia neopropagulifera* (Gyeln.) Hale from South America. Without similar investigation of the South African taxa it is uncertain to which species the South African reports refer or, indeed, whether they represent a distinct taxon.

Using Feuerer's list as a base, the first task was to go through Doidge's list and exclude all those taxa that were not reported from within the modern boundaries of South Africa. Next, the *Recent literature on lichens* database (Culberson *et al.* 2014) was searched for literature on South African lichens since 1945 and all references checked for new species or new reports, which were then added to the list. This resulted in the addition of over 350 taxa that were not included in Feuerer's list. These names were then checked against Index Fungorum (Index Fungorum Partnership 2014) to ensure that the most current name was being used. However, it was felt that including the recent splits in the Teloschistales (Arup, Søchting & Frödén 2013) and Collemaataceae (Otálora, Jørgensen & Wedin 2014) would have been confusing and so these have not been used – although these names are included (in bold) as synonyms. Finally, this list was rationalised by excluding all synonyms and dubious infraspecific taxa.

Synonyms are included (in italics) below the species name to which they are referable. Infraspecific taxa, especially when these are pre-1950 records, are generally not reported as separate taxa but are included as synonyms preceded with 'INC.'. However, where a taxon has been reported only as an infraspecific taxon, the name is preceded by 'AS'. For example, *Anaptychia obesa* Zahlbr. has been reported from South Africa only as *A.obesa* f. *caesiocrocata* Zahlbr., so *Anaptychia obesa* is included in the list with AS: *A.obesa* f. *caesiocrocata* Zahlbr. as a synonym.

Results

South African lichen collections

South African lichen collections are scattered throughout numerous herbaria. A major collection is housed in the National Herbarium in Pretoria (PRE), which includes the Bolus Herbarium lichen collection (BOL) that was recently transferred from Cape Town, but collections also exist in European herbaria; most importantly the extensive collections of Almborn in Lund (LD) and Stizenberger in Zurich (ZT). Type material of taxa described from South Africa is even more widely scattered with collections being housed, not only in those herbaria already mentioned, but also in herbaria throughout Europe: London (BM), Munich (M), Stockholm (S), Trondhiem (TRH), Turku (TUR), Uppsala (UPS), Vienna (W); as well as North America: Cambridge, Massachusetts (FH), Durham, North Carolina (DUKE) and Washington, DC (US).

The current list

The current list includes 1750 species and one variety (see below) in 260 genera from mainland South Africa (Online Appendix 1). This includes nine species of lichenicolous fungi in five genera and seven allied fungi (see above) in five different genera. Only one genus (*Arthonia*) contains both lichenised and lichenicolous fungi, and no genera contain lichenised and allied fungi or lichenicolous and allied fungi. Four subspecies are included in the list, but for only one of these (*Ramalina inflata* subsp. *perpusilla*) is the typical variety also reported. Six varieties are also reported but these are all the typical varieties and the varietal name is only included to distinguish them from other varieties that have not been reported from South Africa.

The subantarctic Prince Edward Islands are treated separately (Online Appendix 3). One hundred and twenty-two species in 63 genera have been reported from these islands, and of these only 22 species and 43 genera have also been reported from mainland South Africa. Consequently, including these islands adds a further 100 species and 20 genera to the total for South Africa.

One new combination is made:

Verrucaria dagolavii Fryday **nom. nov.**

Mycobank: MB 810620

Verrucaria umbilicata Øvstedal, S. *African Journal of Botany. Afr. J. Bot.* 67(4): 569. 2001 (nom. illegit.), non *Verrucaria umbilicata* Hoffm., *Deutschl. Flora*: 171. 1796.

The new epithet honours Dag Olav Øvstedal for his work on the lichen biota of the Subantarctic.

Names that have been used for South African taxa but are illegitimate because they are later, heterotypic homonyms are included in Online Appendix 2.

The genus *Blastenia*, as understood here, has been synonymised with *Caloplaca*, but the South African taxa appear to have been overlooked. Recently, Arup *et al.* (2013) reorganised the Teloschistales into over 30 genera, of which *Blastenia* is one – although with a different circumscription. Unfortunately, Arup *et al.* (2013) did not include the South African species previously referred to *Blastenia* in their analysis and so their generic placement in their system is unknown. Rather than create several new, probably superfluous, names in *Caloplaca*, the species are retained here in *Blastenia* pending further work.

Discussion

South Africa is a biodiversity hotspot (Schnitzler *et al.* 2011) with a vascular plant flora in excess of 21 000 species, but the current lichen checklist compiled here contains only 1750 taxa, which is a meager number when compared with, for example, the 1838 taxa reported from Great Britain (Feuerer 2013), which is only one fifth of the size.

Doidge (1950) reported 1159 species from 'South Africa' (Almborn 1966) but, as noted above, this encompassed much of southern Africa and so included 106 species not reported from within the current boundaries of the country (see Online Appendix 4). Consequently, only 1053 lichen species in Doidge's list were from South Africa. Feuerer (2013) listed 1728 taxa but this included the 106 non-South African taxa listed by Doidge (1950) as well as numerous infraspecific taxa of dubious taxonomic status. When these are removed, Feuerer's list adds a further 330 species, bringing the total to 1383. The current list adds a further 367 species, making a total of 1750.

Crous *et al.* (2006) estimated that the lichen biota of South Africa, when fully explored would amount to some 2000 taxa. However, this estimate is based on a comparison with the numbers reported from similar areas, which assumes that the lichen biota of these other areas is completely known, which is almost certainly not the case. A more realistic estimate of the potential total lichen biota of the country can be made by comparison with other areas that have been extensively inventoried. The recording of the lichen biota of an area invariably begins with the reporting of macrolichens (foliose and fruticose species), whereas the microlichens (crustose species), which are generally much more difficult to collect and identify, are only recorded when a more thorough investigation is undertaken. Consequently,

an incompletely recorded lichen biota will be under-representative of microlichens and be weighted towards macrolichens. However, when an area is intensively studied it is found that macrolichens comprise only approximately one third of the total lichen biota (Lendemer, Harris & Tripp 2013; Spribille *et al.* 2010) and so a better estimate of the total lichen biota is obtained by multiplying the number of macrolichens reported by three. Even this is probably an underestimate because it makes the almost certainly incorrect assumption that the macrolichen biota of the area is completely known. The known South Africa lichen biota reported here contains significantly more macrolichens (928) than microlichens (822), suggesting that the biota is very incompletely known and that when fully explored the total lichen biota should approach 3000 taxa and that in excess of 1000 microlichens remain to be discovered. However, the number of macrolichens is heavily inflated by the plethora of *Xanthoparmelia* species reported – a total of 353 species, more than one fifth of the total reported lichen biota. Many of these have been described from a single collection, often from South Africa, and it remains to be seen whether these are all good species or if some are better recognised at a lower taxonomic rank. Even if the number of *Xanthoparmelia* species is reduced by 100, which seems unlikely, this still suggests a total lichen biota of c. 2500 species with c. 900 microlichens still to be discovered.

As with many other areas, it is the saxicolous crustose species that are most under-reported. For example, in the introduction to his work on the lichens of the Blouberg Mountains, Brusse (1991) states that 'saxicolous lichens are very abundant here, with the southern aspect of many boulders being completely covered by a mosaic of crustose lichens' but does not mention any by name although he goes on to mention several foliose taxa. Also seriously under-recorded are lichenicolous fungi, only nine species (in five genera) having been reported. Clearly, there is much more to be discovered in the South African lichen biota – even conservative estimates such as that by Crous *et al.* (2006) suggest that hundreds of species remain to be discovered. The hope therefore is that the publication of this new checklist will encourage renewed investigation of the lichen biota of South Africa – especially by local researchers.

Conclusion

The lichen biota of South Africa is poorly known, as only 1750 taxa have been reported and many groups and genera, especially amongst the microlichens, are lacking a modern revision. It is estimated that, when fully explored, the lichen biota of South Africa will consist of somewhere between 2500 and 3000 taxa.

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Competing interests

The author declares that he has no financial or personal relationships which may have inappropriately influenced him in writing this article.

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