

Rust fungi (Pucciniales) of southern Africa

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The last comprehensive checklist of rust fungi (Pucciniales; Basidiomycota) of southern Africa was published in 1950 by Ethel Mary Doidge, and included 468 species. An updated listing is provided here, including all published records of rust fungi from Angola, Botswana, Eswatini (formerly Swaziland), Lesotho, Mozambique, Namibia, South Africa and Zimbabwe, and their recorded hosts. A total of 631 taxa of rust fungi are recorded, on 1 355 host plant taxa. *Sphaerophragmium senegaliae* A.R.Wood, *Maravalia neomimusops* A.R.Wood and *Aecidium afrocanthii* A.R.Wood are newly described. New combinations made are *Milesina silvae-knysnae* (R.Berndt) A.R.Wood and *Elateraecium celastrineae* (Cooke & Massee) A.R.Wood. *Endophyllum austroafricanum* (Henn.) A.R.Wood represents a new combination and has been raised to species level. *Endophyllum rhamni-prinoides* (Thüm.) A.R.Wood (currently known as *Endophyllum macowanii* Pole-Evans) and *Endophyllum conyzae-scabridae* A.R.Wood (currently known as *Endophyllum macowanianum* (Thüm.) A.R.Wood) are new names provided for species with illegitimate names.

Keywords: southern Africa, biodiversity, Basidiomycota, Pucciniomycetes, neomycetes, biotrophic fungi, indigenous fungi.

Introduction

The rust fungi (Basidiomycota, Pucciniomycetes, Pucciniales) are a diverse group of environmentally and economically important biotrophic plant pathogenic fungi (Aime et al. 2018). The last comprehensive checklist of rust fungi of southern Africa, which included all known records from southern Angola, Botswana, Eswatini (formerly Swaziland) Lesotho, Mozambique, Namibia, South Africa and Zimbabwe, and all recorded host plants, was by Ethel Mary Doidge (Doidge 1950) in *Bothalia*. Since then, Berndt (2008a) provided a checklist of the rust fungi from South Africa, Botswana and Namibia (but without host records). Doidge (1950) listed 468 species of rust fungi, while Berndt (2008a) recorded 546, and McTaggart et al. (2017) recorded 572. Both these latter lists included various species names that are considered to be synonyms according to Species Fungorum (<http://www.speciesfungorum.org>), and they did not include all species recorded from the region. In the list provided here, there are 631 taxa of rust fungi recorded from southern Africa, from 1 355 host plant taxa. The list includes 78 species considered to be alien (neomycetes), either as naturalised pathogens of introduced plants (crops and weeds), or invasive pathogens and attacking plants indigenous to the region. Also included are four species that have been deliberately introduced for the biological control of alien invasive plants. The current list aims to provide a comprehensive record of all rust fungi recorded in southern Africa up to the end of 2023, providing the first comprehensive updated listing since Doidge (1950), together with a comprehensive host list and a guide to the literature concerning the rust fungi included.

In compiling her list, Doidge drew on many sources (including literature and herbarium specimens), as well as her own comprehensive taxonomic

investigations (Doidge 1927, 1928, 1939, 1941, 1948a, 1948b) of southern African rust fungi. One of the sources she drew on was Hopkins (1938), a similar checklist for Zimbabwe. Since Doidge (1950), many changes in nomenclature, as well as to generic and family concepts of the rust fungi, have occurred. In addition, there are a substantial number of new distribution records and new species recorded from the region. This checklist was compiled from published records as a means of summarising current knowledge on the taxonomy and biodiversity of the region's rust fungi. No attempt has been made to verify the published identity of the rust fungi or host plant species, however, all publications cited do list specimens examined, allowing for subsequent corrections to be included. Angola was included because Doidge (1950) included species recorded by Hennings (1903). All records found for Angola were also included here for completeness.

Of all the countries included in this checklist, only the rust fungi in South Africa and Zimbabwe are relatively well known, with 526 and 169 species, respectively. Only one rust fungus is recorded from Lesotho, 6 each from Botswana and Eswatini, 39 from Angola, 36 from Mozambique and 68 from Namibia. South Africa's and Zimbabwe's fungal flora are the best known because there is a history of active mycologists and plant pathologists in these countries. Both countries also have a long history of producing plant disease lists, namely those of Doidge (1924), Doidge and Bottomley (1931), Doidge et al. (1953), Gorter (1977, 1981, 1982) and Crous et al. (2000) in South Africa; and Hopkins (1938, 1950), Whiteside (1966), Rothwell (1983) and Masuka et al. (1998) in Zimbabwe. These lists were consulted but are not cited unless they are the sole record of a species occurring in the region. Because these lists do not provide details of the specimens used to make the record, any changes in taxonomy can't be followed. Literature that provides taxonomic and specimen details was preferred as the source for species recorded here. Another shortfall of these lists of South African plant diseases, is that they do not give a comprehensive listing of pathogens of indigenous plants. This results from decisions made about which host plants to include in Doidge and Bottomley (1931), only indigenous plants considered at that time to be of economic importance (timber, fodder, medicinal, poisonous or ornamental) were included, and therefore many pathogens recorded from other plant species were excluded. These excluded records mostly continued to be excluded in all publications up to and including Crous et al. (2000).

Doidge (1950) gives a comprehensive historical account of the mycological exploration of the region, including the rust fungi. Halvor Gjærum has since then made a notable contribution to the knowledge of rust fungi indigenous to the region (see the various publications

under his name), with the description of 15 new species and a further 27 previously unrecorded species from southern Africa. Mechthilde Mennicken (Mennicken & Oberwinkler 2004, Mennicken et al. 2003, 2005a, 2005b, 2005c) and Reinhard Berndt (Berndt 2007, 2008a, 2008b, 2009, 2010, 2020, Berndt & Uhlman 2006, Berndt & Wood 2012, Berndt et al. 2008, Ritschel et al. 2007) and their co-workers, significantly increased the knowledge of rust fungi in the west of the region. Together they described 51 new species and recorded an additional 33 from Namibia and South Africa. As a result, the number of rust fungi known from Namibia increased from 16 to 68. More distribution records and new species remain to be found as many areas remain poorly collected. In particular, Mozambique and Angola should yield many more records.

The circumscription of rust families and genera have a convoluted history; however, a degree of order was brought to rust taxonomy by Cummins and Hiratsuka (1983, 2003) whose taxonomic scheme was based on the morphology of teliospores and spermogonia. Subsequently, it has been shown that various of their families and genera are polyphyletic (Aime 2006, Aime et al. 2017, 2018), and a new taxonomic scheme has been proposed (Aime & McTaggart 2021) based on phylogenetic data and morphology. This latest taxonomy has been followed in the current list.

Methods

Old and new literature was searched for records of rust fungi occurring in southern Africa. Farr and Rossman (2024) (initially <http://nt.ars-grin.gov/fungaldatabases/>, now <https://fungi.ars.usda.gov/>) was a useful source of distribution data about various species included. Old literature was sourced from the CyberLiber web page in CyberTruffle (<http://www.cybertruffle.org.uk/eng/index.htm>), the Biodiversity Heritage Library (<http://www.biodiversitylibrary.org/>), and JSTOR (<https://www.jstor.org>).

This checklist consists of two parts (Supplement 1 and 2). The first is a list of all rust fungi recorded from southern Africa, and the second a list of all their host plants, recorded in alphabetical order according to family, genus and species. The entries in Supplement 1 are presented in the order: rust species and authority, [synonyms published after Doidge (1950), refer to this publication for older synonyms], family of host plant(s), genus/genera of host plant(s), references, distribution and spore stages recorded (based on their morphology). Rust species occurring on plants not indigenous to southern Africa (alien, including crop plants and naturalised alien plants) are indicated by 'A' appearing at the beginning of the entries, and are in

purple. The authorities are according to Index Fungorum (<http://www.speciesfungorum.org>), which is also a useful resource to check the current status of many species.

Doidge (1950) served as the starting point of this checklist, her list was copied and then all changes to nomenclature and new records published subsequent to that work are listed, with the page number of the specific record. Spore stages present for each species were determined from the references listed. Additionally, for widespread species, details were obtained from Arthur (1962) and Wilson and Henderson (1966). Where available, literature on various aspects of the biology of the species is included. For listings of earlier literature and synonyms, Doidge (1950) should be consulted, however, for completeness an attempt was made to include all published names with type specimens collected in southern Africa. Abbreviations indicating distribution are: A = Angola, B = Botswana, L = Lesotho, M = Mozambique, N = Namibia, SA = South Africa, SZ = Eswatini (formerly Swaziland), and Z = Zimbabwe. The type of pustule (spore) morphology is indicated with the notation of O, I, II, III and X for spermogonia, aecia (aeciospores), uredinia (urediniospores), telia (teliospores) and mesospores (this last in *Puccinia* only), respectively. In a few cases where uredinia associated with spermogonia differ to those not associated, this is denoted by I^a, II^a. Endocyclic species are denoted with Iⁱⁱⁱ. Autoecious species are indicated with all known spore types within one set of parentheses e.g., (O, I, II, III), and heteroecious species are indicated by using two sets of parentheses e.g., (O, I) (II, III). For heteroecious species, the name of the aecial stage (gametothallus) is given in brackets, as well as an entry similar to the above, after the end of the entry on the telial stage (sporothallus). Additional notes are given after the species entry.

In Supplement 2, the host entries are listed in the order: plant family, plant species and authority, rust species, reference(s). Host plants not indigenous (alien) to southern Africa are indicated by “*” at the beginning of the entry. The taxonomy of the host plants was initially according to Germishuizen and Meyer (2003), though where possible more recent synonyms have been applied. The Plant List (<http://www.theplantlist.org/>) and more recently WorldFloraOnline (<http://www.worldfloraonline.org/>) were useful resources to verify plant names and authorities, as well as to find current names for some of those used in the older literature. Note that the plant taxonomy used follows that according to WorldFloraOnline and not the names as used in Plants of southern Africa (<https://posa.sanbi.org/sanbi/Explore>). Some host names may therefore differ to the name commonly used currently in South African

literature. Only one resource of those available was chosen to ensure consistency. Host plant family names are according to the Angiosperm Phylogeny Group (APG IV) (2016), Stevens (2001 onwards) and WorldFloraOnline (<http://www.worldfloraonline.org/>).

Results

A total of 631 rust taxa occur in southern Africa, including 550 species indigenous to the region, and a further 78 that have been accidentally or deliberately introduced (Figure 1–3). Three unidentified species (in *Puccinia* and *Uredo*) have also been listed, possibly representing new taxa. These represent a total of 47 genera, with representatives in 5 suborders and 10 families recognised in Aime and McTaggart (2021).

The generic limits for various rust genera are still not certain as phylogenetic data from their type species are not yet available, therefore species have only been reassigned where DNA sequence data is available to confirm their generic placement. As far as possible, various species of *Uredo* and *Aecidium* have been assigned to suborders based on morphology or DNA sequence data. It is likely that new genera will be described in the future to accommodate various species that are currently of uncertain placement.

Compared to Doidge (1950), many more genera are recognised and the number of species recognised within many genera has increased (Table 1), particularly in *Hemileia*, *Phakopsora sensu lato*, *Ravenelia sensu lato*, *Endophyllum*, *Puccinia* and *Uromyces*. Despite many species of *Uredo* being assigned to teleomorph species, the total number recognised (35) is similar to that in Doidge (1950) (40) due to more species being recorded. The only genus with a reduction in species recognised is *Aecidium* (93 to 76), mainly due to a number being recognised as endocyclic (a total of 9 species in this list compared to one in Doidge, 1950), as well as a few that have been linked to their sporothallus.

The rust fungi of southern Africa have been recorded on a total of 1 355 host plant taxa in 84 families, including both indigenous and alien plants. The host families with the greatest number of host species are the Asteraceae, Poaceae and Fabaceae accounting for almost 40% (Table 2) as is common for rust fungi elsewhere. More unusually, the Iridaceae and Rubiaceae include many host species (Table 2). Many host species have only been identified to genus level, and occasionally some only to a family, due to generic limit changes in plant taxonomy. Recollecting these rust fungi and identifying their host plants is required.

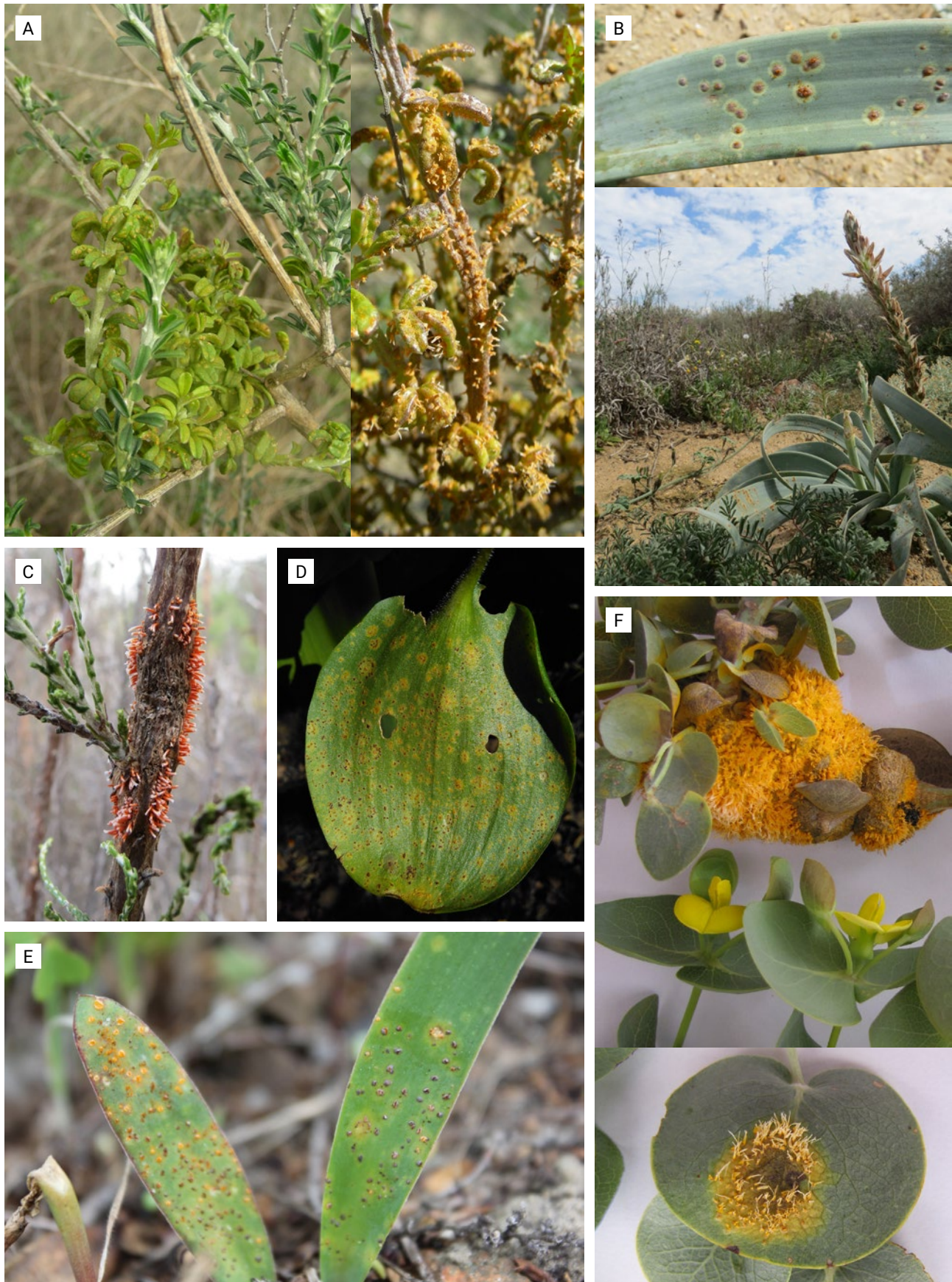


Figure 1. Examples of rust fungi indigenous to southern Africa: A, witches' broom with aecia of *Aecidium wiborgiae* on *Wiborgia obcordata*; B, uredinia of *Puccinia polycampta* on leaves of *Trachyandra falcata*; C, aecidioid-telia of *Endophyllum elytropappi* on galled stems of *Elytropappus rhinocerotis*; D, spermogonia, aecia, uredinia and telia of *Uromyces eriospermi* on abaxial leaf of *Eriospermum* sp.; E, uredinia and telia of *Uromyces lachenaliae* on *Lachenalia unifolia*; F, stem gall and leaf pustule of aecia of *Aecidium resinicola* on *Rafnia amplexicaulis*.

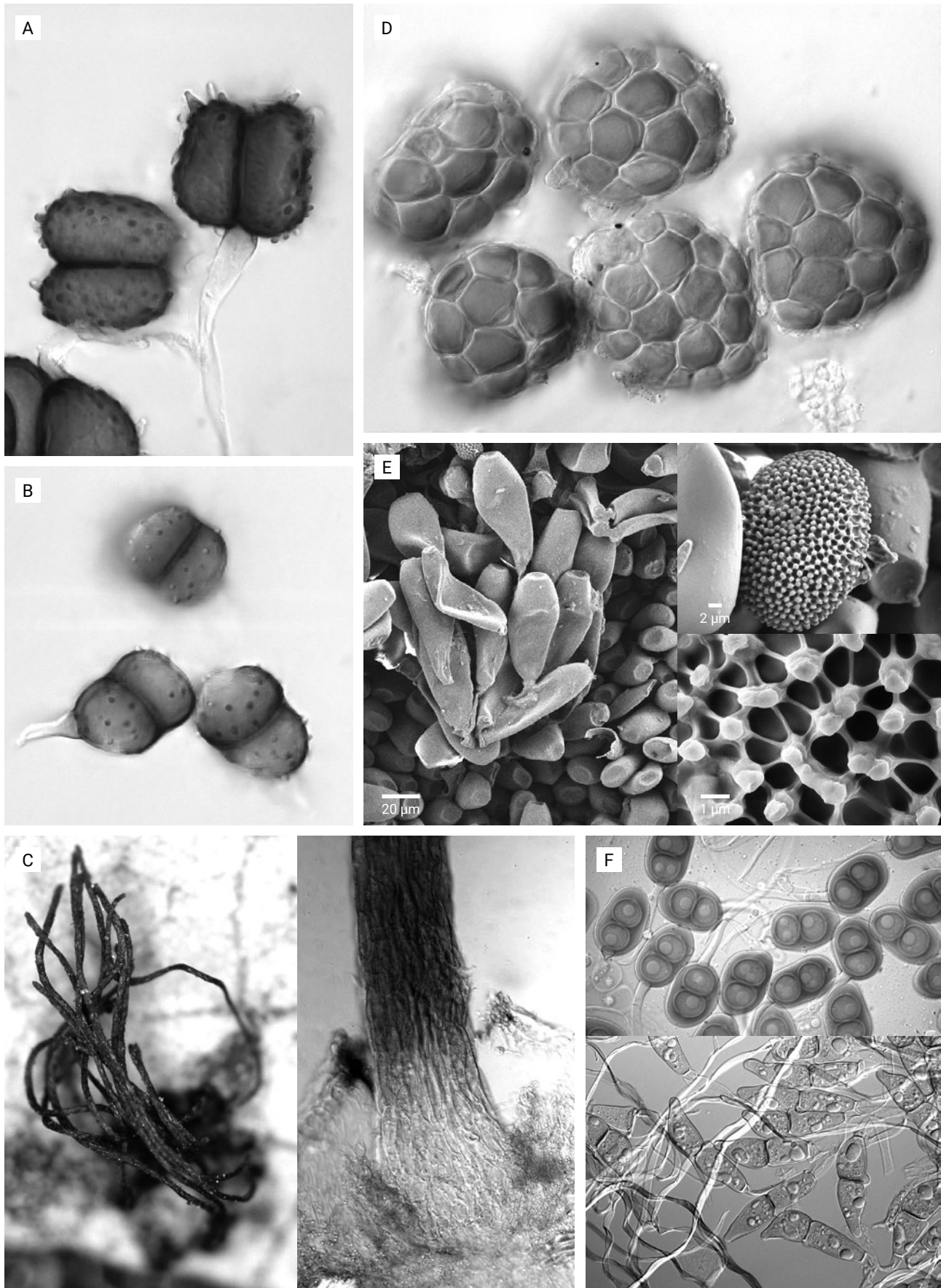


Figure 2. Teliospores of various genera of rust fungi from southern Africa: A, *Diorchidium woodii*; B, *Puccorchidium popowiae*; C, telial horns of *Crossopsora gilgiana* (left) and cross-section of base of horn in telium (right); D, *Cephalotelium macowanianum*; E, *Maravalia mimusops* teliospores in a telium, urediniospore (top right) and detail of ornamentation of urediniospore (bottom right); F, *Puccinia cf. asparagi* on top and *Puccinia berkheyaephila* on bottom.

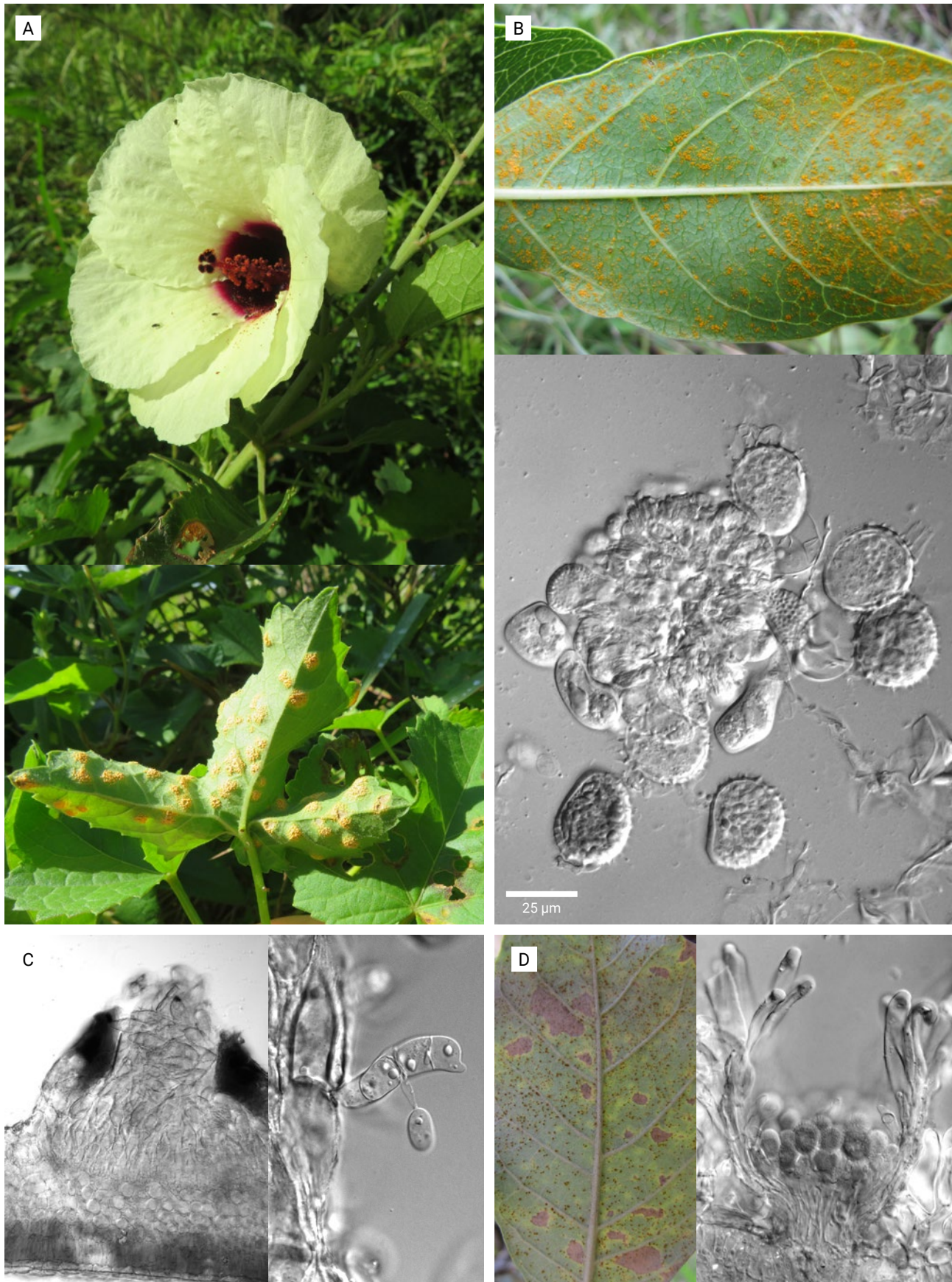


Figure 3. Examples of rust fungi indigenous to southern Africa: A, aecidioid-telia of *Endophyllum mpenjatiense* on its host plant *Hibiscus calyphyllus*; B, suprastomatal uredinia of *Hemileia woodii* on *Vangueria bowkeri* (top) and a uredinium with sporogenous cells and urediniospores of *Hemileia wakefieldii* (bottom) (top view of whole uredinium with spores around the edges); C, cross-section through a telium of *Skierka robusta* (left) and teliospores of which one has germinated producing a metabasidium with one basidiospore (right); D, uredinia of *Crossopsora brachylaenae* on *Brachylaena rotundata* (left) and cross-section through a uredinium (right).

Table 1. Comparison between genera and number of species of the rust fungi (Pucciniales) recognised in Doidge (1950) and in this checklist. Genera without a footnote are unassigned with undetermined affinities

Doidge (1950)		This checklist	
<i>Aecidium</i>	93	<i>Aecidium</i> ^a	81
		' <i>Aecidium</i> ' ^b	4
		<i>Angiopsora</i> ^a	2
		<i>Angusia</i> ^b	1
		<i>Austropuccinia</i> ^a	1
		<i>Bubakia</i> ^b	2
<i>Caeoma</i>	2	<i>Cephalotelium</i> ^b	5
<i>Cerotelium</i>	1	<i>Cerotelium</i> ^b	1
<i>Coleosporium</i>	3	<i>Coleosporium</i> ^c	4
<i>Cronartium</i>	2	<i>Crossopsora</i> ^a	7
		<i>Cumminsina</i>	1
		<i>Cystotelium</i> ^b	1
		<i>Didymopsorella</i>	1
		<i>Dietelia</i> ^a	1
<i>Diorchidium</i>	2	<i>Diorchidium</i> ^b	2
		<i>Elateraecium</i> ^d	2
<i>Endophyllum</i>	1	<i>Endophyllum</i> ^a	9
<i>Hamaspora</i>	1	<i>Hamaspora</i> ^a	1
<i>Hemileia</i>	6	<i>Hemileia</i> ^d	12
<i>Kuehneola</i>	1	<i>Kuehneola</i> ^a	1
		<i>Macuropyxis</i> ^a	1
		<i>Maravalia</i> ^b	2
<i>Masseeëlla</i>	1	<i>Masseeëlla</i> ^b	1
<i>Melampsora</i>	5	<i>Melampsora</i> ^c	10
<i>Milesina</i>	2	<i>Milesina</i> ^c	4
		<i>Miyagia</i> ^a	1
		<i>Neoravanelia</i> ^b	1
		<i>Newinia</i> ^b	1
		<i>Phakopsora</i> ^b	8
		' <i>Phakopsora</i> ' ^a	3
<i>Phragmidium</i>	1	<i>Phragmidium</i> ^a	2
<i>Puccinia</i>	158	<i>Puccinia</i> ^a	247 (+1) ^e
<i>Pucciniastrum</i>	1	<i>Pucciniastrum</i> ^c	2
<i>Puccinosira</i>	1	<i>Puccinosira</i> ^a	2
		<i>Puccorchidium</i> ^a	1
		<i>Quasipucciniastrum</i> ^c	1
<i>Ravenelia</i>	22	<i>Ravenelia s.l.</i> ^b	31
<i>Schroeteriaster</i>	2		
<i>Skierka</i>	1	<i>Skierka</i> ^f	1
<i>Sphaerophragmium</i>	2	<i>Sphaerophragmium</i> ^a	4
		<i>Spumula</i> ^b	1
		<i>Stomatisora</i> ^a	1
		<i>Trachyspora</i> ^a	1
		<i>Tranzschelia</i> ^b	1
<i>Uredinopsis</i>	1	<i>Uredinopsis</i> ^c	1
<i>Uredo</i>	40	<i>Uredo</i> ^a	37 (+2) ^e
		' <i>Uredo</i> ' ^d	1
		' <i>Uredo</i> ' ^b	3
		' <i>Uredo</i> '	2
		<i>Uredopeltis</i> ^b	6
<i>Uromyces</i>	89	<i>Uromyces</i> ^a	104
		<i>Uromycladium</i> ^b	3
<i>Uropyxis</i>	2	<i>Uropyxis</i> ^b	1

^aGenera included in the Urediniaceae. ^bGenera included in the Raveneliaceae. ^cGenera included in the Melampsoriaceae. ^dGenera included in the Mikronegeriaceae. ^eNumber of unidentified species recorded in southern Africa. ^fGenera included in the Skierkiaceae.

Table 2. The fifteen plant families with the greatest number of species recorded as host plants (both indigenous and alien) of the southern African rust fungi

Host family	Number of host taxa	Host family	Number of host taxa	Host family	Number of host taxa
1 Asteraceae	195	6 Rubiaceae	54	11 Malvaceae	27
2 Poaceae	176	7 Cyperaceae	41	12 Acanthaceae	23
3 Fabaceae	169	8 Lamiaceae	35	13 Aizoaceae	24
4 Iridaceae	96	9 Euphorbiaceae	32	14 Geraniaceae	21
5 Asparagaceae	67	10 Xanthorrhoeaceae	29	15 Rosaceae	21

Taxonomy

New species

1. *Sphaerophragmium senegaliae*

A.R. Wood, sp. nov.

HOLOTYPE: SOUTH AFRICA, **KwaZulu-Natal:** Hluhluwe-iMfolozi Park, Hilltop camp, on *Senegalia brevispica* (Harms) Seigler & Ebinger (Fabaceae), 25 Jul. 2018, A.R. Wood 988 (PREM 63114); GenBank: 28S = OQ215083

MycoBank: MB 836557.

Description

Spermogonia and aecia not observed. *Uredinia* scattered on pinnules, tiny, 0.1–0.2 mm, erumpent, surrounded by paraphyses which barely extend beyond torn epidermis. *Urediniospores* produced on pedicels, ellipsoid, oval, obovoid to pyriform, $28\text{--}45 \times 15\text{--}20\text{ }\mu\text{m}$ (mean $36.3 \times 17.4\text{ }\mu\text{m}$), light brown, 2 equatorial germ pores (often 1 distinct and 1 indistinct), wall sparsely echinulate, spines $1\text{--}3\text{ }\mu\text{m}$ (mean $2.6\text{ }\mu\text{m}$) apart, walls $1\text{--}2\text{ }\mu\text{m}$ thick, apex slightly thickened $3\text{--}5\text{ }\mu\text{m}$ thick. *Paraphyses* more or less curved, cylindrical or slightly clavate, 1 septate, united basally, $35\text{--}65 \times 10\text{--}15\text{ }\mu\text{m}$, walls $4\text{--}6\text{ }\mu\text{m}$ thick but frequently no lumen present as entire width thickened. *Teliospores* produced in *uredinia*, becoming dominant; spherical, dark brown, 6–9 cells, typically 8 cells, $37\text{--}52 \times 33\text{--}48\text{ }\mu\text{m}$ (mean $45.8 \times 40.8\text{ }\mu\text{m}$), walls on outer cell surfaces $2\text{--}3\text{ }\mu\text{m}$, internal cell walls $1\text{--}2\text{ }\mu\text{m}$, $24\text{--}42$ tri- to sexfurcate projections per spore (with 2 or 3 primary branches each with 1, 2 or 3 hooks on these branches), $5\text{--}16(20)\text{ }\mu\text{m}$ long (mean $11.4\text{ }\mu\text{m}$), pedicel persistent, up to $80\text{ }\mu\text{m}$ long, $6\text{--}8\text{ }\mu\text{m}$ wide, wall $1\text{ }\mu\text{m}$ thick. Figure 4A–4F.

Etymology

Named for the genus of the host plant, *Senegalia*.

Diagnosis

Similar to *Sphaerophragmium dalbergiae* but distinguished by different host, larger *urediniospores* and longer *teliospore* projections.

Notes

Using the morphological key to species in Monoson (1974), this specimen keys to *S. dalbergiae* Dietel, and to *S. fimbriatum* Mains in Lohsomboon et al. (1994). It

differs from the former species by larger *urediniospores* with thickened apices and distinct germ pores, and longer *teliospore* projections, and from the latter by larger and more thickened paraphyses, *urediniospores* with less thickened apices and only 2 distinct germ pores, and the *teliospores* with longer projections. The combination of *urediniospores* and *teliospores* present in the same paraphysate pustules, *urediniospores* with 2 germ pores and thickened apices, *teliospores* with ~ 8 cells and projections up to $16\text{ }\mu\text{m}$ long and 3– to 6-furcate, is unique in the genus (Monoson 1974, Lohsomboon et al. 1994). A sequence (OQ215083) of the nuclear large subunit (28S) region of the ribosomal DNA repeat has been published (Wood & Aime 2024).

2. *Maravalia neomimusops*

A.R. Wood, sp. nov.

= *Uromyces mimusops* Cooke fide Doidge (1927), *Bothalia* 2(1a): 15, pro parte.

HOLOTYPE: SOUTH AFRICA, **North West:** Paaskraal, Magaliesberg, on *Mimusops zeyheri* Sond. (Sapotaceae), 31 Oct. 1998, S. Naser (PREM 56225, II + III);

MycoBank: MB 836558.

Description

Spermogonia and aecia not observed. *Uredinia* hypophyllous, single 0.25–1.0 mm or several forming a ring to 2 mm diam., dark brown, subepidermal, erumpent, paraphysate, densely packed with hyphal elements that are interpreted as spore initials and pedicels originating from columnar sporogenous cells each with many initials. *Urediniospores* globose to ellipsoid, usually flattened on opposite sides so that they are bilaterally symmetrical, apex rounded, base rounded or attenuate, $27\text{--}45 \times 20\text{--}28\text{ }\mu\text{m}$; wall bilaminar, inner wall golden-brown, smooth, $2\text{--}3(5)\text{ }\mu\text{m}$, outer wall hyaline, reticulate verrucose, with smooth area (or verrucae reduced in size) in centre of flattened sides, $1\text{--}2\text{ }\mu\text{m}$; germ pores 1 or 2, consistent in number for individual collections, indistinguishable if not in median view. *Teliospores* produced in *uredinia* apparently from same spore initials as *urediniospores*, leptosporic, clavate, apex rounded, base gradually attenuate, light yellow-brown, $(45\text{--})50\text{--}65(83) \times 17\text{--}30\text{ }\mu\text{m}$, large apical germ pore, wall $1.0\text{--}1.5\text{ }\mu\text{m}$ thickening to $2\text{--}3\text{ }\mu\text{m}$ around the germ pore. Figure 5A–K.

Etymology

Previously confused with *Maravalia mimusops*, hence the ‘new species of *Maravalia* on *Mimusops*’.

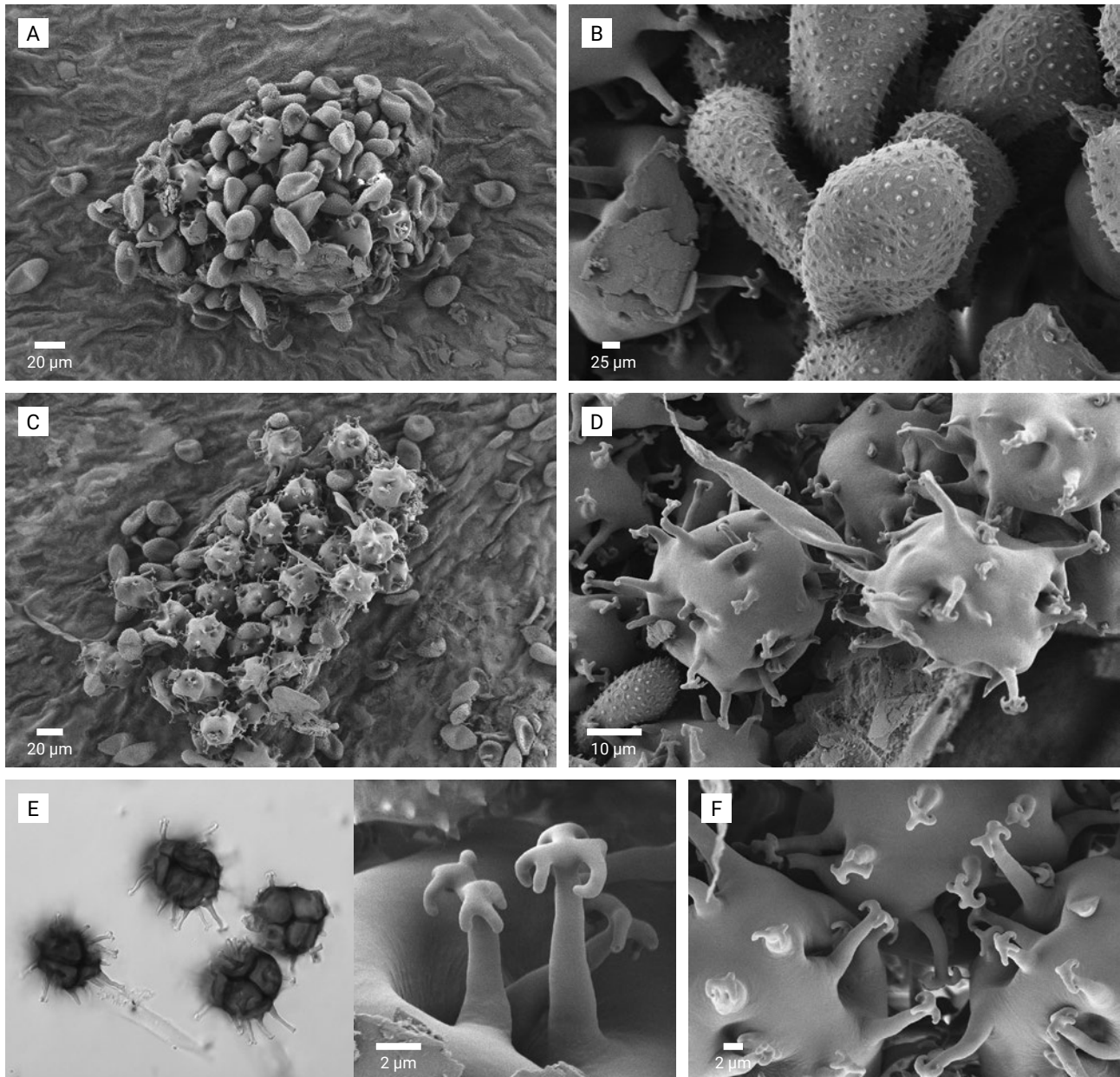


Figure 4. *Sphaerophragmium senegaliae*, A, uredinium; B, urediniospores; C, telium; D, teliospores; E, teliospores (left), showing detail of projections (right); F, teliospore projections.

Diagnosis

Similar to *Maravalia mimusops* but differs in smaller pustules and urediniospores with 2 basal germ pores.

Specimens examined

SOUTH AFRICA, North West: De Kroon, Brits, on *Mimusops zeyheri*, 12 Feb. 1926, Malherbe (PREM 12807, II only); Kloof, Rustenburg, on *Mimusops zeyheri*, 27 Oct. 1928, L. Kresfedder (PREM 23629, II + few III); Kromrivier, 9 miles [14 km] from Buffelspoort, on *Mimusops zeyheri*, 14 Dec. 1938, E.M. Doidge & A.M. Bottomley (PREM 32740, II only); Zilkatsnek, Magaliesberg, on *Mimusops zeyheri*, 18 Nov. 1953, A. Meeuse (PREM 40673, II only); Easter Kloof, Magaliesberg,

on *Mimusops zeyheri*, 30 Aug. 2010, A.R. Wood 786 (PREM 63121, II + few III). **Gauteng:** Klein Wonderboom, Magaliesberg, Pretoria, on *Mimusops zeyheri*, 20 Apr. 1932, H.O.D. Mogg 12425 (PREM 26367, II only). **Limpopo:** University of Limpopo, Ga-Mankoeneng, E of Polokwane, on *Mimusops zeyheri*, 7 Mar. 2019, M. Shadrack (PREM 63201, II only); University of Limpopo, Ga-Mankoeneng, E of Polokwane, on *Mimusops zeyheri*, 8 Jun. 2019, M. Shadrack (PREM 63203, II only).

Notes

Maravalia mimusops (Cooke) Y.Ono (from Africa) and *M. aulica* (Syd.) Y.Ono (from India), both on species of *Mimusops* (Sapotaceae), are the only species currently

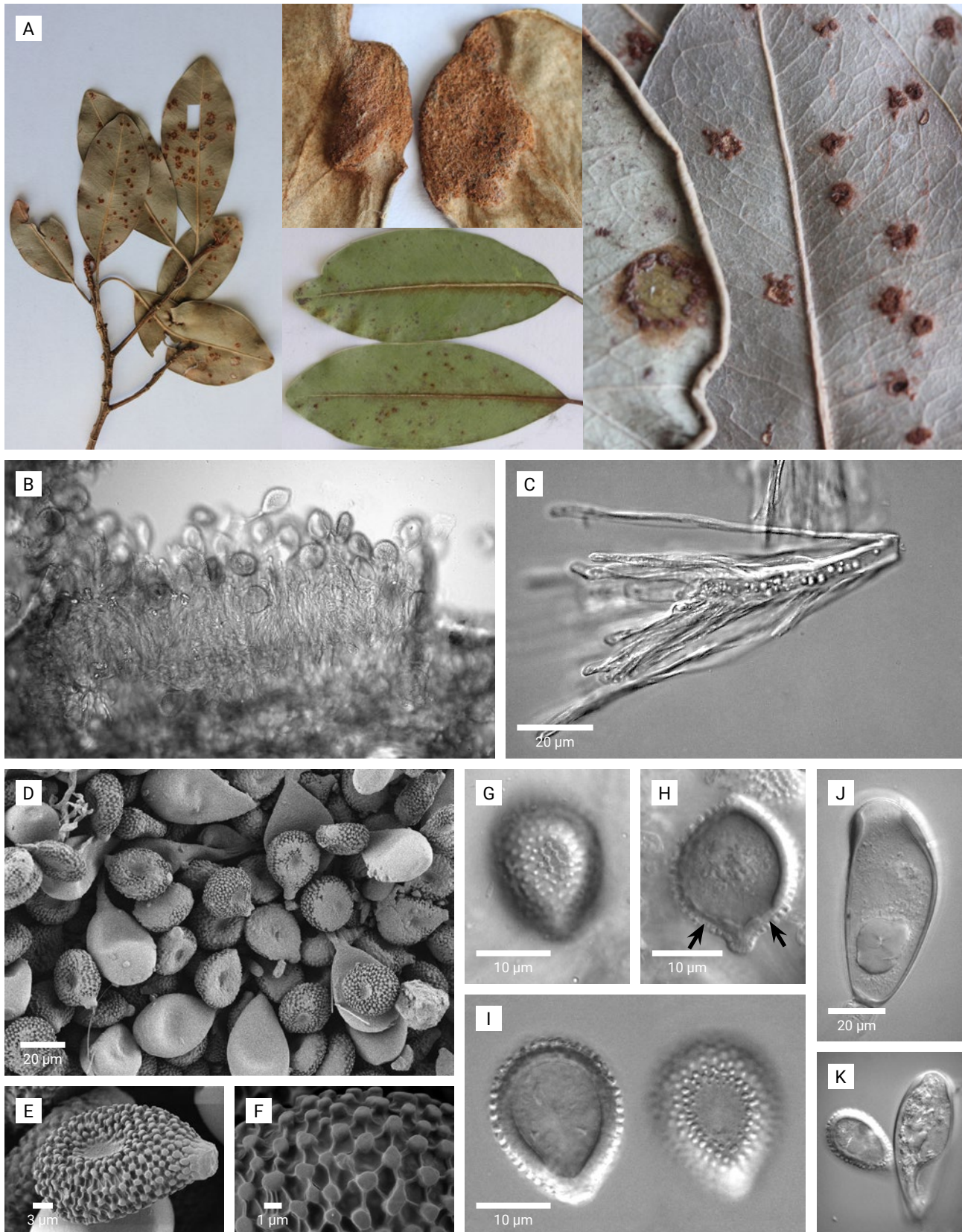


Figure 5. *Maravalia neomimusops*, A, habit on *Mimusops zeyheri*, left showing holotype with uredinia in which teliospores were found, middle with uredinia and for comparison insert showing large group of uredinia (uredinioid-aecia) of *S. mimusops* on hypotrophic areas on *Mimusops afra*, right comparison of size between *M. mimusops* on *Mimusops afra* (leaf on left) and *M. neomimusops* on *Mimusops zeyheri*; B, cross-section through uredinium showing densely packed pedicels; C, hyphal sporogenous cell with numerous thin pedicels attached along sides and apex; D, uredinium with scattered teliospores; E, urediniospore with equatorial smooth area; F, detail of reticulate verrucose ornamentation of urediniospore; G, surface view of urediniospore showing ornamentation; H, median view of urediniospore showing two germ pores (arrows); I, urediniospore in median and surface view showing equatorial smooth area; J, teliospore showing large apical germ pore; K, comparison of size of teliospore and urediniospore.

recognised within *Maravalia* to have urediniospores with a bilaminate wall and verrucose ornamentation (Cummins 1950, Ono 1984). They are distinguished by the urediniospores being verrucose with one germ pore in the former, and striately verrucose with two germ pores in the latter (Cummins 1950). All collections made in southern Africa have been considered until now to be *M. mimosops* (Doidge 1927, 1950, Cummins 1950, Ono 1984). Although morphologically very similar, there are consistent differences between collections from South Africa made on *Mimosops afra* E.Mey. ex A.DC. (note corrected orthography of the name following Art. 61.6, Turland et al. 2025) and those on *Mimosops zeyheri* Sond. On *Mimosops afra*, spermogonia are present with amphiphylous uredinia (uredinoid aecia) of which many occur on slightly hypotrophic areas up to 2 cm wide, other hypophyllous pustules occur on round discoloured spots with the pustules forming one to several rings 2–6 mm wide. These latter pustules may have either both urediniospores and teliospores, or exclusively teliospores. The urediniospores have only one germ pore and no smooth area (though Ono, 1984, states there is one near the hilum). On *Mimosops zeyheri*, no spermogonia have been observed, all uredinia are hypophyllous and smaller (up to 2 mm wide), and teliospores infrequently produced (none were found in most specimens observed). The urediniospores had either 1 or 2 germ pores, more commonly the latter, and two equatorial smooth areas. The urediniospore dimensions are similar on both host species, but those on *Mimosops zeyheri* tend to be shorter and rounder ($27\text{--}45 \times 20\text{--}28 \mu\text{m}$ ($n = 40$) vs. $35\text{--}46 \times 20\text{--}26 \mu\text{m}$ ($n = 20$) ($30\text{--}43 \times 16\text{--}25 \mu\text{m}$ in Cummins 1950) on *Mimosops afra*; average length $34.0 \pm$ standard error (s.e). $0.63 \mu\text{m}$ vs. $40.4 \pm$ s.e. 0.64 ; average length: width ratio $1:1.42 \pm$ s.e. 0.034 vs. $1:1.78 \pm$ s.e. 0.044). Because these differences are consistent, those on *Mimosops zeyheri* are here described as a new species, *Maravalia neomimosops*. The holotype (PREM 56225) was selected as it is the only specimen with teliospores in any number.

Maravalia aulica is similar to this new species, both having small uredinia and specimens are frequently without telia. Both have two germ pores in the urediniospores (Cummins 1950, Ono 1984). However, this species has spermogonia and the urediniospores (uredinoid aeciospores) are striately verrucose with a single bald patch towards the base (Ono 1984) (no spermogonia and two equatorial bald patches in *M. neomimosops*). All three species have teliospores that are morphologically almost identical and can't be readily distinguished.

Doidge (1927) stated there are 2 or 3 germ pores per urediniospore in *M. mimosops*, whereas Cummins (1950) and Ono (1984) stated there is only one. This discrepancy may be explained by the fact that Doidge used specimens from both *Mimosops afra* and *Mimosops zeyheri* for her description. Thus, her description

of urediniospores may have been influenced by those from *Mimosops zeyheri* (PREM12807), which is here recognised as a distinct species usually having two germ pores though in some specimens only one occurs. It was observed that germ pores were easily distinguishable only when they were in cross-section in median view on the sides of the spores, thus it would be hard to distinguish whether a spore had one or three germ pores. It is possible that those collections, such as the holotype, which were observed to have only one distinct germ pore, may have had three. Alternatively, Doidge (1927) may have come to the wrong conclusion. Specimens of *M. mimosops* (on *Mimosops afra*) examined were found to have only one germ pore, confirming the observations of Cummins (1950) and Ono (1984).

3. *Aecidium afrocanthii*

A.R.Wood, sp. nov.

HOLOTYPE: SOUTH AFRICA, **Eastern Cape:** Grahamstown Municipal Nature Reserve, S of Grahamstown, on *Afrocanthium mundianum* (Cham. & Schltdl.) Lantz (Rubiaceae), 27 Jan. 2000, A.R. Wood 166A (PREM 63113).

Mycobank: MB 836559.

Description

Spermogonia, uredinia and telia not observed. *Aecia* aecidium-like, yellow, single to small groups (1–4), occasionally groups coalesce to form larger groups, not on leaf spots, usually on abaxial leaf surface occasionally on adaxial surface, subepidermal, often deep-seated within leaf mesophyll, cupulate, peridium not extending beyond leaf epidermis, $150\text{--}280 \mu\text{m}$ diam. *Peridial cells* irregular angulate rhomboid, $16\text{--}29 \times 14\text{--}26 \mu\text{m}$, side wall $2\text{--}4 \mu\text{m}$ thick, inner wall coarsely verrucose to ridged, $3\text{--}5 \mu\text{m}$ thick, outer wall smooth to weakly verrucose, $1\text{--}2 \mu\text{m}$ thick. *Aeciospores* angular globose, $16\text{--}20(28) \times 14\text{--}20 \mu\text{m}$, wall verrucose on upper portion grading to finely verrucose on lower portion, the verrucae not evenly sized, wall uniformly $1 \mu\text{m}$ thick. Figure 6A–C.

Etymology

Named for the genus of the host plant, *Afrocanthium*.

Diagnosis

Differs from other African species on Rubiaceae by no spermogonia, aecia single to small groups (1–4) and not protruding beyond leaf epidermis so that infections are inconspicuous, aeciospore wall uniformly $1 \mu\text{m}$ thick.

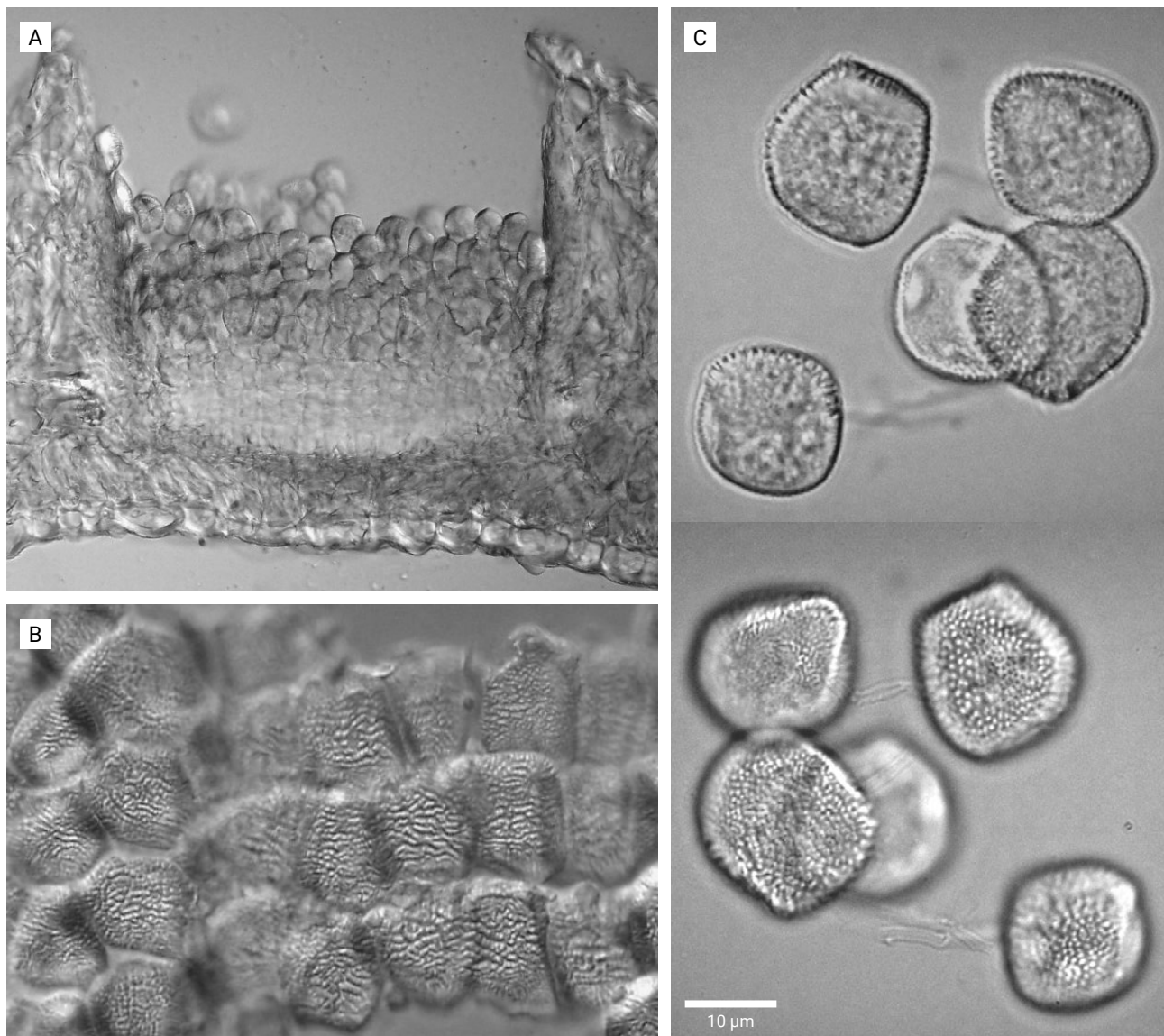


Figure 6. *Aecidium afrocanthii*, A, cross-section through a deep-seated aecidium showing catenulate production of aeciospores and the bounding peridium that typically does not extend beyond the leaf epidermis; B, peridial cells; C, median and surface views of aeciospores.

Specimens examined

SOUTH AFRICA, Western Cape: Garden Route National Park, Goudveld Forest Station, Knysna, on *A. mundianum*, 6 Jul. 2000, A.R. Wood 195 (PREM 63142); Garden Route National Park, Wilderness, on *A. mundianum*, 20 Feb. 2002, A.R. Wood 364 (PREM 63145); Newlands Forest, Cape Town, on *A. mundianum*, 23 Jul. 2009, A.R. Wood 757 (PREM 63155); Fynbos Retreat, Gansbaai, on *A. mundianum*, 20 Feb. 2016, A.R. Wood 967 (PREM 63165, GenBank: 28S = OQ214983, 18S = OQ215127, CO3 = OR789143).

Notes

This species differs from *Aecidium plectroniae* Cooke (considered to be the aecial stage of *Puccinia versicolor* Dietel & Holw.), which occurs on the same host, by the

lack of spermogonia, aeciospore apex not thickened and its inconspicuous habit (*A. plectroniae* produces circles of aecia surrounding spermogonia, on leaf spots up to 1 cm diam., and aeciospore apices thickened to 5 µm). *Aecidium baumianum* Henn., also occurring on the same host, is largely identical to *A. plectroniae* except spermogonia are not recorded, and therefore also differs from this new species by thickened aeciospore apices and habit. A total of 13 *Aecidium* species have been described from Africa on hosts in the Rubiaceae, but none have the combination of characters given in the diagnosis. A sequence of the nuclear large subunit (28S) region (OQ214983) and small subunit (18S) region (OQ215127) of the ribosomal DNA repeat, and the cytochrome c oxidase subunit 3 (CO3) (OR789143) of the mitochondrial DNA have been published (Wood & Aime 2024).

New combinations

1. ***Elateraecium celastrineae*** (Cooke & Massee) A.R.Wood, *comb. nov.*, *Uredo celastrineae* Cooke & Massee, *Grevillea* 17 (no. 83): 70 (1889).

TYPES: SOUTH AFRICA, **KwaZulu-Natal**, Durban, on *Salacia kraussii* (Harv.) Harv. (Celastraceae), Oct. 1888, J.M. Wood 4028 [K (M) 147679, holo.; PREM 359 and 991, iso.].

MycoBank: MB 836560.

Description

Spermogonia scattered or forming concentric circles in large chlorotic spots up to 3 cm diam., subepidermal,

flask-shaped, deep seated within leaf cortex, 100–175 μm wide, 200–274 μm high. Aecia erumpent, hypophyllous, blistering most of the leaf surface, epidermis remaining intact for long periods, contents appearing as a bright orange (when fresh) to light yellow (old specimens) fluffy mass due to presence of elaters. Peridial cells loosely connected, globose, 19–25 $\times$ 15–21 μm ; wall 2 μm thick, very finely verruculose, veruculae $\pm$ 1 μm apart. Elaters modified persistent hyphae, thin walled, hyaline, irregularly branched, with simple septa, varying in width 4–8 μm . Aeciospores fusiform, 40–66 $\times$ 14–20 μm ; wall granular-verrucose, 2 μm thick. Figure 7A–7E.

Specimens examined

SOUTH AFRICA, **KwaZulu-Natal**: Durban, on *Salacia kraussii* (Harv.) Harv. (Celastraceae), Oct. 1888, J.M. Wood 4028 (holotype K(M) 147679, isotypes PREM

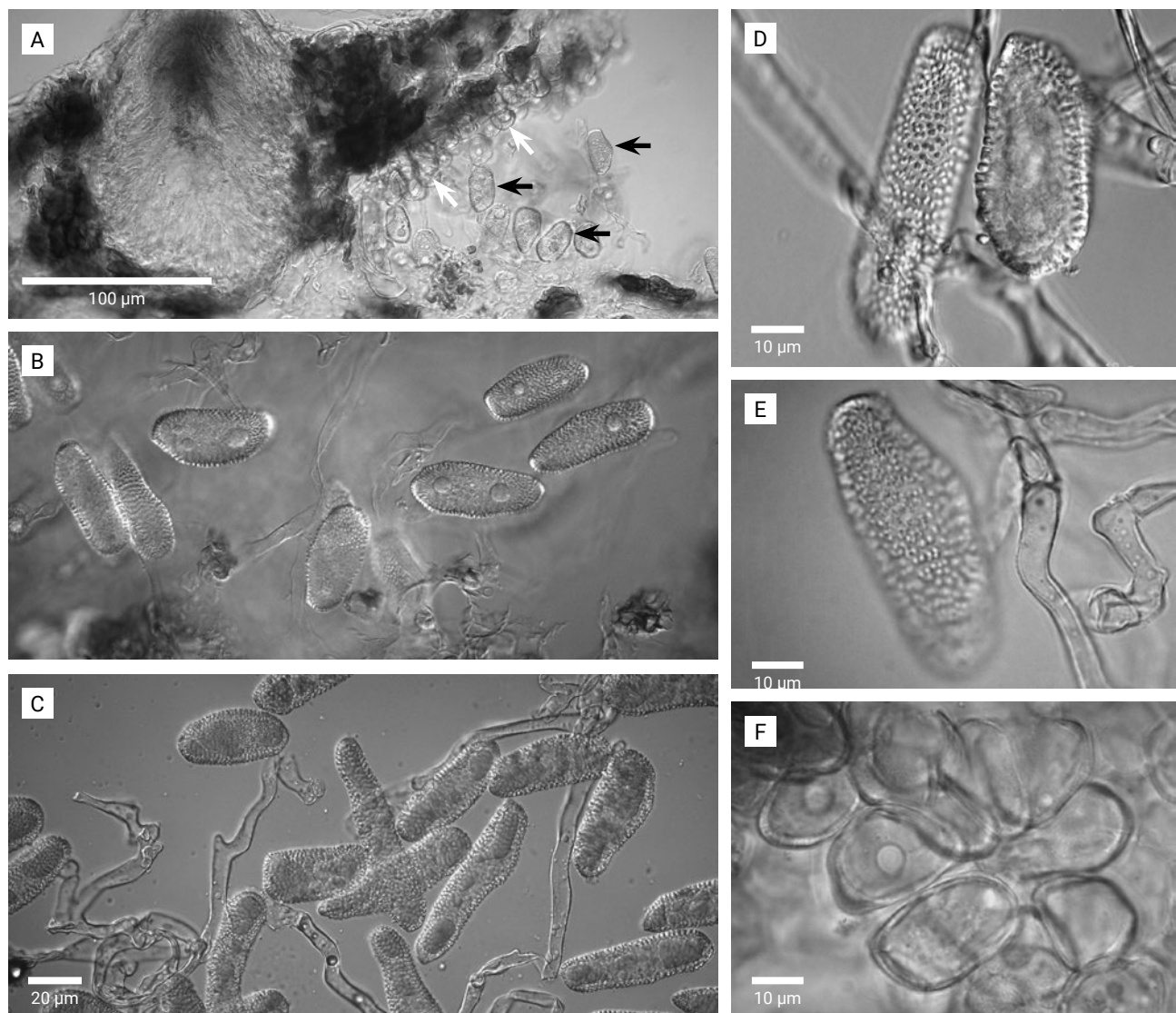


Figure 7. *Elateraecium celastrineae*, A, cross-section through deep-seated spermogonium and edge of an aecium showing peridial cells (white arrow) and aeciospores (black arrow); B, aeciospores; C, aeciospores and elaters; D, aeciospores showing coarse verrucose ornamentation; E, aeciospore showing ornamentation and septate elaters; F, peridial cells.

359 and 991); St Lucia, on *S. kraussii*, 19 Mar. 2020, A.R. Wood 1073 (PREM 63115).

Notes

Sydow and Sydow (1924) considered that the urediniospores as originally described in Cooke (1889) were in fact peridial cells, and described in addition structures they interpreted as aeciospores. They were thus correct in interpreting the life stage of this rust as aecial not uredinial, but otherwise their interpretation is incorrect, the structures they thought were peridial cells are the aeciospores, and what they assumed were aeciospores are in fact the peridial cells. Doidge (1927) regarded this species as 'insufficiently known', noting that the material in PREM was 'practically destroyed by insects and is quite unfit for study'. She, like the Sydows before her, did not recognise the nature of this rust fungus. The old material is in fact in very good condition, with aeciospores and elaters present in large quantities. This species has been recently collected again, the first new record in 132 years.

This is the second species of *Elateraecium* known from South Africa, the other being *E. natalense* Gjørøum & D.A.Reid (Gjørøum and Reid 1983), on *Salacia leptoclada* Tul., distinguished by smaller aecia. *Elateraecium callianthum* (Syd.) Gjørøum & D.A.Reid is described from *Salacia senegalensis* (Lam.) DC. in Sierra Leone.

So far, the telial stage (Hiratsukamyces-like) has not been found for any of the African species.

2. *Endophyllum austroafricanum*

(Henn.) A.R.Wood stat. & comb.

nov., *Aecidium mikaniae* Henn. f.

austroafricanum Henn., Bot. Jahrb.

38: 105 (1907) (as 'austroafricana').

TYPE: TANZANIA, **Amani**: East Usambara Mountains, Sept. 1903, *Eichelbaum* 104, (B, holo., not seen, likely destroyed in World War II). MycoBank: MB 836561.

Description

Spermogonia not produced, aecia and uredinia not observed. *Telia* aecidium-like, numerous on small swellings on stems or petioles, or few in a cluster on lower leaf surfaces without any hypertrophy. *Teliospores* aecidioid, catenulate, ellipsoid, ovoid or angular-spherical, $17\text{--}24 \times 14\text{--}20 \mu\text{m}$; wall finely and densely verruculose, with several refractive granules $2\text{--}4 \mu\text{m}$ diam., wall $1 \mu\text{m}$ thick; germinating to form a thin-walled 3-celled metabasidium with two basidiospores produced on sterigmata from the two distal cells, basidiospores thin walled, ovoid, $13\text{--}17 \times 8\text{--}10 \mu\text{m}$. Otherwise as for *Aecidium mikaniae* Henn. Figure 8.



Figure 8. Germinated aecidioid-teliospores of *Endophyllum austroafricanum* showing 1–3-celled metabasidia, sterigmata (white arrows) and basidiospores (black arrows).

Specimen examined

SOUTH AFRICA, **KwaZulu-Natal**: Hilton, on *Mikania capensis* DC. (Asteraceae), 16 Jun. 2009, A.R. Wood 756 (PREM 62322).

Notes

Hennings (1907) stated that this form of *Aecidium mikaniae* differed from the nominal form, which occurs in South America, only in having slightly larger spores. The nominal form is now considered to be the gametothallus of *Puccinia mikaniae* H.S.Jacks. & Holw. (Hennen et al. 2005). This appears to be the first collection of this rust fungus since the type was collected in the East Usambara Mountains, Tanzania, in 1903. However, it may be more common than this suggests – Whiteside (1966) reported *Dietelia portoricensis* (Whetzel & Olive) Buriticá & J.F.Hennen (as *Endophylloides protoricensis* Whetzel & Olive) from Zimbabwe, but this species is otherwise only known from South America and the Caribbean, and this record may rather represent *E. austroafricana*. Aecidioid-teliospores germinating on water agar (2% w/v) in Petri dishes produced sterigmata and basidiospores, proving that this is an endocyclic form (Figure 8), and therefore it is raised to species rank and transferred.

3. **Milesina silvae-knysnae**

(R.Berndt) A.R.Wood, comb. nov.,
Milesia silvae-knysnae R.Berndt,
in Mycol. Prog. 7: 14, 2008.

TYPE: SOUTH AFRICA, **Western Cape**, N of Wilderness, Seven Passes Rd., Woodville Big Tree, 27 Oct. 2004, R. Berndt & E. Uhlmann, (PREM 59737, holo., not examined).

MycoBank: MB856041.

Morphology as described by Berndt (2008b). Use of *Milesina* is recommended over *Milesia* (Aime et al. 2018).

Newly recorded species
for South Africa

1. **Aecidium jasminicola** Henn., in Engler, Die Pflanzenwelt Ost-Afrikas und der Nachbargebiete, Teil C: 53 (1895).

Description

Spermogonia not produced, uredinia and telia not observed. Aecia hypophyllous or on stems, hypotrophic, cupulate, few to many, not arranged in rings, crowded,

peridium not or only slightly exerted, yellow. Aeciospores globular to ellipsoid, $14\text{--}26 \times 10\text{--}18 \mu\text{m}$ (18–24 $\times$ 15–18 μm in Hennings 1895), hyaline, wall 1 μm thick, closely verruculose.

Specimen examined

SOUTH AFRICA, **KwaZulu-Natal**: Pigeon Valley Nature Reserve, Durban, on *Jasminum breviflorum* Harv. (Oleaceae), 26 Jun. 2019, A.R. Wood 1051 (PREM 63119).

Notes

Aecidium longaense Henn., also on *Jasminum* in Africa, differs from *A. jasminicola* by presence of spermogonia, aecia opposite spermogonia, hypophyllous, arranged in circles, peridium emerging from leaf, lacerated; aeciospores yellow, smooth walled and smaller (15–18 $\times$ 13–17 μm , vs. 18–24 $\times$ 15–18 μm in *A. jasminicola*) (Hennings 1895, 1903). The aeciospores of the specimen from South Africa included aeciospores that spanned the range of both species [14–21(–26) $\times$ 10–18 μm], but in other respects matched the description for *A. jasminicola* rather than *A. longaense*. Figure 9A, 9B.

2. **Coleosporium plumeriae**

Pat. [as ‘plumierae’], Bulletin
de la Société Mycologique de
France 18(2): 178 (1902).

Description

Uredinia only present, hypophyllous. Urediniospores subglobose, ellipsoid or angular, 25–37 $\times$ 19–25 μm , wall coarsely verruculose, 1 μm thick, with large to small verruculae and bald patches so that the wall is 2–3 μm in total.

Specimen examined

SOUTH AFRICA, **Eastern Cape**: Qolora River Mouth, Kei Mouth, E of East London, on *Plumeria* sp. (Apocynaceae), 2 Feb. 2021, A.R. Wood 1123 (PREM 63271).

Notes

This species was first recorded from South Africa by a sequence of the large subunit (28S) of the ribosomal DNA repeat deposited in GenBank (KR110056) by W. Maier. Its presence is here confirmed. Elsewhere in Africa this fungus has been recorded in Nigeria (Hernández et al. 2005) and has spread through much of the world where its host plant is a commonly grown garden plant (Kakishima et al. 2017).

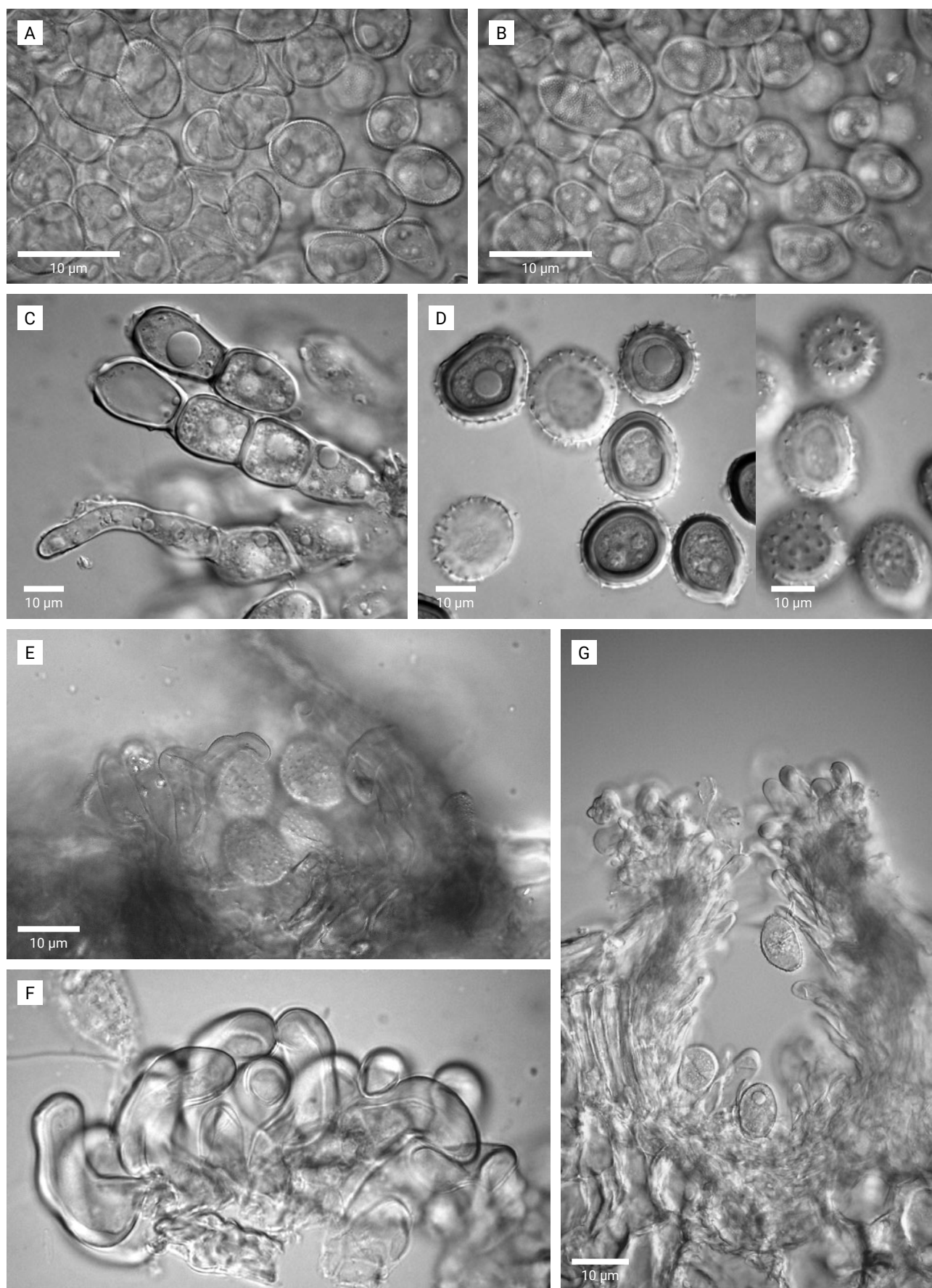


Figure 9. *Aecidium jasminicola*, A, median view of aeciospores; B, surface view of aeciospores. *Newinia kigeliae*, C, telia consisting of chains of cells, the terminal cell on the lowest chain producing a metabasidium; D, median and surface view of urediniospores showing sparse echinulation. *Phakopsora setariae*, E, cross-section through subepidermal uredinium; F, paraphyses. *Uredo dombeyicola*, G, cross-section through uredinium.

3. **Newinia kigeliae** Eboh,
Mycologia 75(2): 316 (1983).

Description

Spermogonia, uredinia and telia on lesions 2–5 mm in diameter, amphiphylous, brown. *Spermogonia* type 7. *Uredinia* subcuticular or subepidermal, with few long and thin-walled paraphyses scattered through the pustule. *Telia* subepidermal, no paraphyses. *Urediniospores* globose to ovoid, $19\text{--}25 \times 17\text{--}20 \mu\text{m}$, sparsely echinulate, $3\text{--}4 \mu\text{m}$ thick. *Teliospores* consisting of 4–12 cells in chains, cells separated by transverse septa, each cell globose to ovoid, $17\text{--}30 \times 13\text{--}17 \mu\text{m}$, wall $1 \mu\text{m}$ thick. Figure 9C, 9D.

Specimens examined

SOUTH AFRICA, **Limpopo**: Skukuza nursery, Skukuza, Kruger National Park, on *Kigelia africana* (Lam.) Benth. (Fabaceae), 8 Feb. 2022, A.R. Wood 1200 (PREM 63384); **KwaZulu-Natal**: Twinstreams nursery, Mtinzini, on *Kigelia africana* (Lam.) Benth. (Fabaceae), 3 Mar. 2022, A.R. Wood 1206 (PREM 63385).

4. **Phakopsora setariae** Cummins,
Bulletin of the Torrey Botanical
Club 83: 223 (1956).

Description

Uredinia small, erumpent, often covered by remnants of leaf epidermis, surrounded by paraphyses. *Paraphyses* curved, thick walled. *Urediniospores* ellipsoid, echinulate, spines $1\text{--}3 \mu\text{m}$ apart, $20\text{--}32 \times 16\text{--}21 \mu\text{m}$, wall $1 \mu\text{m}$ thick, germ pores indistinct. *Telia* not observed. Figure 9E, 9F.

Specimen examined

SOUTH AFRICA, **KwaZulu-Natal**: Palmiet Nature Reserve, Durban, on *Setaria megaphylla* (Steud.) T.Durand & Schinz (Poaceae), 27 Jun. 2019, A.R. Wood 1058 (PREM 63116).

5. **Puccinia aframomi** Hansf.,
Proceedings of the Linnean Society
London 161: 176 (1949).

Description

Urediniospores $21\text{--}32 \times 14\text{--}17 \mu\text{m}$, light brown to honey-coloured, wall $1.5\text{--}2 \mu\text{m}$ thick, 2 equatorial germ pores, sparsely echinulate. *Teliospores* $23\text{--}33 \times 13\text{--}18 \mu\text{m}$, constricted at septum, wall $1 \mu\text{m}$ thick, hyaline,

apex occasionally thickened $2\text{--}3 \mu\text{m}$. *Pedicels* not persistent. Figure 10A, 10B.

Specimen examined

SOUTH AFRICA, **Mpumalanga**: Lowveld National Botanical Garden, Nelspruit, on *Aframomum alboviolaceum* (Ridl.) K.Schum. (Zingiberaceae), 13 Dec. 2010, A.R. Wood 810 (PREM 63118).

Notes

The host plant does not occur naturally in South Africa, but does so in Mozambique, Zambia and elsewhere in tropical Africa. The specimen collected was on cultivated plants, and it is likely to be found on this species where it grows naturally. This species has been recorded on other species of *Aframomum* in Malawi, Uganda and Nigeria (Farr & Rossman 2024).

6. **Puccinia arechavaletae** Speg.,
Anales de la Sociedad Científica
Argentina 12(1): 67 (1881).

Description

Spermogonia, aecia and uredinia not present. Microcyclic, leptosporic. *Telia* amphigenous or on stems, not on leaf spots, expanding with age, forming circles of small dark brown pustules up to 10 mm diameter, turning light grey after spores germinate, neighbouring telia coalescing, may be slightly hypotrophic. *Teliospores* mostly two-celled, one-celled spores in low to moderate quantities, the proportions differing between collections, two-celled spores globoid, ellipsoid or oblong, $20\text{--}31 \times 14\text{--}24 \mu\text{m}$, not constricted at septum, lateral walls $1.5\text{--}3 \mu\text{m}$, apex slightly thickened $2.5\text{--}4 \mu\text{m}$, honey-brown, one-celled spores similar $20\text{--}24 \times 15\text{--}20 \mu\text{m}$, pedicels persistent, thin walled up to $60 \mu\text{m}$, often obliquely inserted, some diorchidioid.

Specimens examined

SOUTH AFRICA, **KwaZulu-Natal**: Durban, University of KwaZulu-Natal, Westville campus, on *Cardiospermum grandiflorum* Sw. (Sapindaceae), 25 Jun. 2019, A.R. Wood 1044 (PREM 63171); Hayfields, Pietermaritzburg, on *Cardiospermum grandiflorum*, 16 Feb. 2021, A.R. Wood 1130 (PREM 63273). **Mpumalanga**: E of Nelspruit along N4, on *Cardiospermum grandiflorum*, 28 Feb. 2020, A.R. Wood 1069 (PREM 63191). **Limpopo**: Letsitele, on *Cardiospermum grandiflorum*, 13 Mar. 2019, A.R. Wood 1062 (PREM 63184); Louis Trichardt, on *Cardiospermum grandiflorum*, 25 Feb. 2020, A.R. Wood 1068 (PREM 63190); Tzaneen, on *Cardiospermum halicacabum* L., 13 Mar. 2019, A.R.

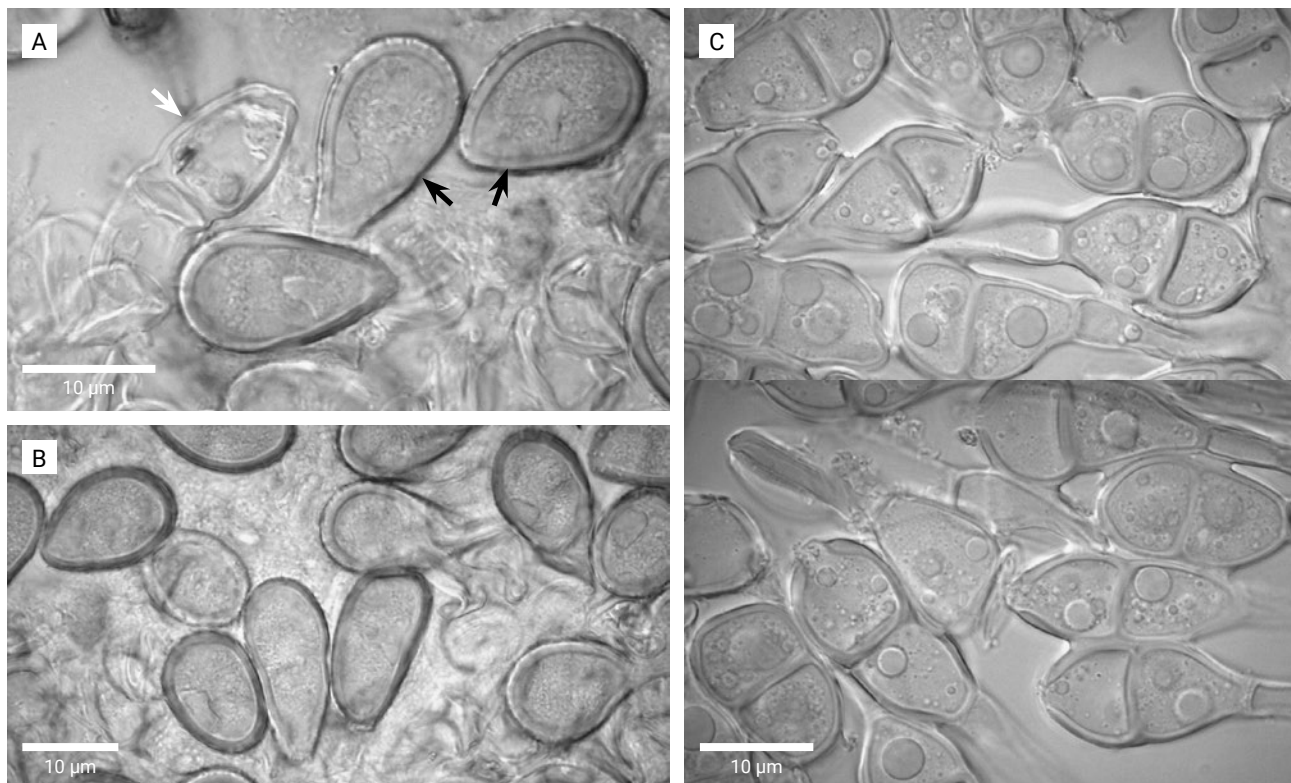


Figure 10. *Puccinia aframomi*, A, urediniospores (solid arrows) and thin-walled teliospores (white arrow); B, urediniospores. *Puccinia exilis* var. *hibisci*, C, teliospores.

Wood 1077 (PREM 63189). **Eastern Cape:** Port St John's, on *Cardiospermum grandiflorum*, 8 Oct. 2018, I. Patterson (PREM 63202).

Notes

Puccinia arechavaletae has been investigated for possible release as a biological control agent against the alien invasive plant *Cardiospermum grandiflorum* (Fourie & Wood 2018, 2019). However, an indigenous congeneric plant was found to be susceptible (*C. corindum* L.), and therefore the culture being studied within the plant pathogen quarantine facilities in Stellenbosch was destroyed in 2012. This rust fungus was first observed in 2018 in the field in KwaZulu-Natal. The pathway of introduction of this rust is unknown, it is one of a number of rust fungi recorded as introduced accidentally in the last few decades, a reminder that microbes are constantly being unintentionally carried across international borders.

7. ***Puccinia exilis* P.Syd. & Syd. var. *hibisci*** Grove, Bulletin of Miscellaneous Information, Kew: 270 (1916).

Description

Spermogonia, aecia and uredinia not present. Microcyclic, leptosporic. *Telia* erumpent, in groups up to 5 mm

diam. *Teliospores* 27–41 × 15–18 µm, walls tinged with light yellow, thin, 1 µm thick at sides, apex 1–2 µm, germ pore at apex, distinct. *Pedicels* > 100 µm, thin walled, hyaline, persistent. Figure 10C.

Specimens examined

SOUTH AFRICA, KwaZulu-Natal: Pigeon Valley Nature Reserve, Durban, on *Hibiscus surattensis* L. (Malvaceae), 26 Jun. 2019, A.R. Wood 1052 (PREM 63117).

8. ***Uredo dombeyicola* Cummins**, Bulletin of the Torrey Botanical Club 87(1): 41 (1960).

Description

Spermogonia, aecia and telia not observed. *Uredinia* small, subepidermal in origin, erumpent, surrounded by paraphyses that form an emergent palisade around the uredinia. *Urediniospores* ellipsoid, echinulate, spines 1–3 µm apart, (17–)22–33 × 16–21 µm, wall 1.0–1.5 µm thick, germ pores indistinct. Figure 9C.

Specimens examined

SOUTH AFRICA, KwaZulu-Natal: University of KwaZulu-Natal, Westville campus, Durban, on *Dombeya*

tiliacea (Endl.) Planch. (Malvaceae), 27 Jun. 2019, A.R. Wood 1059 (PREM 63185).

Notes

Uredo dombeyae, on the same host, is readily distinguished by the heavily thickened urediniospore walls.

Taxonomic notes

1. *Puccinia kalchbrenneriana* De Toni, Syll. fung. (Abellini) 7(2): 661 (1888).

= *Puccinia ornithogali* Kalchbr., in Kalchbrenner & Cooke, Grevillea 9, 49: 21 (1880). *nom. illegit.*, Art. 53.1 (later homonym of *Puccinia ornithogali* Hazsl.).

= *Puccinia drimiae* Van der Bijl, South African Journal of Science 23: 284 (1926), *stat. nov.*

Specimens examined

SOUTH AFRICA, **Western Cape**: De Hoop Nature Reserve, E of Bredasdorp, on *Drimia altissima* (L.f.) Ker Gawl (Asparagaceae), 18 Aug. 2001, A.R. Wood 349 (PREM 62319); Die Plaas farm, Ouplaas, E of Bredasdorp, on *Drimia altissima*, 14 Oct. 2009, A.R. Wood 759 (PREM 62318).

Doidge (1927) provides the most complete descriptions for *P. kalchbrenneriana* and *P. drimiae*. The descriptions are almost identical, though *P. drimiae* apparently differed by having occasional mesospores and slightly thicker teliospore walls (3–4 µm, compared to 2.0–2.5 µm in *P. kalchbrenneriana*). At that time, rust fungi on different host plant genera were considered as distinct even if morphologically very similar, *P. drimiae* was known on *Drimia* and *P. kalchbrenneriana* on *Urginea*. However, currently the latter plant genus is considered a synonym of the former. Collections of a rust fungus on *Drimia altissima*, the type host of *P. kalchbrenneriana* had teliospores that fitted the descriptions of both species. Teliospores 40–58 × 22–34 µm, wall 2–4 µm thick, occasional mesospores present (31–38 × 22–28 µm, wall 2 µm thick). Therefore, *P. drimiae* is best considered a synonym of *P. kalchbrenneriana*.

2. *Endophyllum rhamni-prinoides* (Thüm.) A.R. Wood, *stat. & comb. nov.*

Aecidium rhamni J.F.Gmel. f. *rhamni-prinoides* Thüm., Flora 60: 411 (1877) (as *Aecidium rhamni* Pers. f. *rhamni prinoides* Thümen); Types: SOUTH AFRICA, **Eastern Cape**, 'Boschberg' [Bosberg], Somerset East, on *Rhamnus prinoides* L'Hér. (Rhamnaceae),

Oct. 1876, P. MacOwan 933 (PREM20761, lecto.); **Western Cape**, Saasveld College, George, on *Rhamnus prinoides* L'Hér. (Rhamnaceae), 6 May 2003, A.R. Wood 517 (PREM57835 holo-epitype; K(M)122449, BPI871504 iso-epitypes); GenBank: 28S = OQ215013.

= *Aecidium elegans* Dietel, Hedwigia 28: 180 (1889) (*nom. illegit.*, Art. 53.1, a later homonym of *Aecidium elegans* Berk. & M.A. Curtis), currently recognised as *Uromyces elegans* (Berk. & M.A. Curtis) Lagerh.).

= *Endophyllum macowanianum* Pole-Evans, Report of the Transvaal Department of Agriculture 1906–1907: 165 (1908) (*nomen nudum*) (non *Endophyllum macowanianum* (Thüm.) A.R. Wood).

= *Endophyllum macowanii* Pole-Evans [as 'macowani'], Report of the South African Association for the Advancement of Science 6(6): 252 (1909) (*Nom. illegit.*, Art. 36 of Vienna rules then valid).

= *Endophyllum elegans* (Dietel) Pole-Evans, Annals of the Bolus Herbarium 2(4): 188 (1918).

Mycobank: MB 856043.

Etymology

Named for its host plant, *Rhamnus prinoides*.

Diagnosis

Telia aecidium-like, aecidioid-teliospores endocyclic, on *Rhamnus prinoides*. As described by Pole-Evans (1918).

Notes

Pole-Evans (1909) showed that the species collected by Peter MacOwan, first recorded by Thümen then described by Dietel as *Aecidium elegans*, should be transferred to *Endophyllum* and renamed it in honour of its collector as *Endophyllum macowanii*. However, the Vienna rules of Botanical Nomenclature had come into effect from 1 Jan. 1908, and therefore this name was invalidly published as it did not have a Latin diagnosis accompanying this new name [Art. 36]. Because of this, Pole-Evans (1918) published the name *Endophyllum elegans* providing a Latin description. This combination has been ignored since. Unfortunately, the basionym of this name is invalid as it is a later homonym of an existing name, making this combination also invalid. Therefore, a new name is provided, using the first name given for this species. A full description is provided by Pole-Evans (1918), and further details of spore germination in Wood (2004). The

lectotype is MacOwan's collection listed in Dietel (1889), and an epitype is provided.

Pole-Evans first gave notice of his intention to make the above name change, but in doing so unintentionally published the name *Endophyllum macowanianum*, a nomen nudum ('I propose to describe and name this fungus as *Endophyllum MacOwanianum*, n.sp.' Pole-Evans 1908, p. 165). This fungus is different to the species currently known as *Endophyllum macowanianum* (Thüm.) A.R.Wood, as it was clearly identified as occurring on *Rhamnus prinoides* L'Hér. (Rhamnaceae) and was thought to possibly be the alternate stage of crown rust (Pole-Evans 1908). However, despite this name simply being a manuscript name invalidly published, it still renders the later name an invalid homonym, and a new name is provided. *Endophyllum macowanianum* Pole-Evans was not considered to be a published name by earlier workers and therefore was ignored in all subsequent publications (e.g. Pole-Evans 1909, 1918, Doidge 1950) and remained obscure.

3 ***Endophyllum conyzae-scabridae*** A.R.Wood, *sp. nov.*

Type: SOUTH AFRICA, **Eastern Cape**, 'Boschberg' [Bosberg], Somerset East, on *Conyza scabrida* DC. (Asteraceae) [incorrectly identified as *Erigeron ivifolius* Sch.Bip. (= *Conyza ivifolia* (L.) Less., as '*Conyza ivaefolia* Less.')] 1874, *P. MacOwan 1037* (PREM20753, lecto.).

= *Aecidium macowanianum* Thüm., Flora, Regensburg 58: 380 (1875).

= *Endophyllum macowanianum* (Thüm.) A.R.Wood, South African Journal of Botany 70(4): 667 (2004) (nom. illegit., Art. 53.1, a later homonym of *Endophyllum macowanianum* Pole-Evans, a nomen nudum).

MycoBank: MB 856044.

Diagnosis

Telia aecidium-like, aecidioid-teliospores endocyclic, spore wall uniformly thin, on *Conyza* species.

Etymology

Named for one of its host species, *Conyza scabrida* (Asteraceae).

Notes

Doidge (1927) and Wood (2004) listed *P. MacOwan 1037* (PREM20753) as the type.

Aecidium macowanianum f. *conyzae-pinnatilobatae* Thüm. was raised to species rank in Sydow and Sydow (1924), differing from the above species in having a thickened apical wall.

4 ***Puccinia satyrii*** P.Syd. & Syd., Monographia Uredinearum (Lipsiae) 1(4): 594 (1903) [1904]

= *Puccinia aurea* G.Winter, Flora, Regensburg 67(14): 260 (1884), nom. illegit., Art. 53.1, a later homonym of *Puccinia aurea* Spreng. [now known as *Alodius podophylli* (Schwein.) Arthur].

Jørstad (1956) recognised that these described species were conspecific and used the older name. However, this is an illegitimate name, and therefore *P. satyrii* should be used as the first legitimate name available for this species.

5 ***Ravenelia peglerae*** Pole-Evans, in Doidge & Pole-Evans, The Annals of the Bolus Herbarium 2(3): 111 (1917).

= *Ravenelia peglerae* Doidge, Bothalia 2(1a): 146 (1927) Nom. illegit., Art. 53.1.

It is uncertain why Doidge described this species after Pole-Evans had done so, and using the same specimens as he had used, but the correct authority was given in Doidge (1950). The original description seems to have been lost since.

Corrected identifications

Several rust fungi were listed as occurring in southern Africa by Doidge (1950), but subsequently were found to be based on incorrectly identified specimens. These, and their correct identifications, are:

Phragmidium violaceum (R. Schultz) G.Winter now correctly identified as *Kuehneola uredinis* (Link) Arthur (Van Reenen 1995).

Puccinia kuehnii (Krüg.) Butler now correctly identified as *Puccinia melanocephala* Syd. & P.Syd. (Gorter 1982).

Puccinia luxuriosa Syd. now correctly identified as *Puccinia vilfae* Arthur. & Holw. (Cummins & Greene 1961).

Puccinia tosta Arthur now correctly identified as *Puccinia kakamariensis* Wakef. & Hansf. (Cummins & Greene 1961).

Uromyces bidentis Lagerh. now correctly identified as *Uromyces bidenticola* (Henn.) Arthur (see note under *Uromyces bidenticola* in Supplement 1).

Excluded species

Melampsora puccinioides G.Winter, Hedwigia 24: 22 (1885).

Sydow and Sydow (1915) listed *M. puccinioides* as an excluded species from *Melampsora*. They stated that the 'teliospores' described were not observed, only urediniospores were found and they did not belong to *Melampsora*. It is possible that this species may actually be *Phakopsora nyasalandica*, as *Phakopsora* species were frequently assigned to *Melampsora* or *Schroeteria* in the early literature. Unfortunately, no specimen of this species has so far been traced, to determine if this supposition is correct. It is best to consider *M. puccinioides* as a doubtful species.

Aecidium flustra Berk., Grevillea 20 (no. 96): 110 (1892).

This name was published with no description, the only information given was that the host was an *Aster* species, and that there were specimens from Valparaíso (Chile) and Natal (now KwaZulu-Natal, South Africa) (Anon. 1892). Sydow and Sydow (1924) give a description, presumably based on the Chilean specimen. This differs substantially from the South African specimen, which Doidge (1927) described as *A. woodianum*. *Aecidium flustra* therefore does not occur in South Africa.

Puccinia vernoniae Cooke, Grevillea 10 (no. 56): 126 (1882).

This name is a later homonym of *P. vernoniae* Schwein. from N. America and is therefore illegitimate. Sydow and Sydow (1904) state that it is not possible to correctly determine the identity of this species as the sori are too immature. It is best regarded as a doubtful species.

Puccinia torosa Thüm., Mycothecia Universalis, cent. 18: no. 1725 (1880).

Described from South African material where the host (*Arundo donax* L.) is an introduced alien weed, this rust species is not known in the host's native range. This species is likely only a variant of *Puccinia phragmitis*, which is one of several rust fungi occurring on this host in its native range. Cummins (1971) notes that it differs from *P. phragmitis* only in having slightly broader spores. It is best regarded as a doubtful species.

Puccinia salviae Unger, Über den Einfluss des Bodens auf die Vertheilung der Gewächse: 218 (1836).

This species is known from South Africa from a single specimen identified by Kalchbrenner (1882). Urediniospores occurred in this specimen, yet *P. salviae* is microcyclic (Baxter 1955), and the specimen probably represents *Puccinia salviae-runcinatae*. Therefore, this species is regarded as not occurring in South Africa.

The following two species have structures which appear to be type 4 spermogonia, this type of spermogonium is not associated with *Caeoma*-type aecia (Sato & Sato 1985). Both are best regarded as doubtful species:

Caeoma heteromorphae Doidge, Bothalia 2: 190 (1927). Figure 11A, 11B.

Specimens examined

SOUTH AFRICA, **Free State**, Braamhoek, Gumtree, Ficksburg District, on *Heteromorpha arborescens* (Spreng.) Cham. & Schltdl. (Apiaceae), 1935, *M. Vels* (PREM 28509); **KwaZulu-Natal**, Drakensberg, on *Heteromorpha arborescens*, 1940, *Mrs Gore Brown* (PREM 32780).

Two specimens of this fungus are listed in Doidge (1927). PREM 28509 is morphologically as described by Doidge (1927) from the type specimen. However, the spores in the supposed aecia are not catenulate nor verrucose as expected for *Caeoma*, all spores are of the same age throughout the structure, the spores are closely bound to one another, no spore producing layer of fungal cells (hymenium) is discernible, and no hyphae are visible in the surrounding plant tissue. It appears that all spores originate by division of a common matrix throughout the pustule, with wall deposition of all spores occurring simultaneously. This species appears to belong to a chytrid-like fungus rather than the Pucciniales. It is uncertain whether the spermogonia-like structures belong to this chytrid-like fungus. In contrast, PREM 32780 is different, having only phakopsoroid uredinia and is therefore not the same fungus as PREM 28509.

Caeoma lichtensteiniae Doidge, Bothalia 4(1): 229 (1941). Figure 11C, 11D.

Specimens examined

ZIMBABWE, **Salisbury**, host not determined (Apiaceae?), Dec. 1919, *F. Eyles* 1966 (PREM 14009, holotype).

Doidge (1941) described structures that were interpreted as spermogonia and aecia without peridia for this

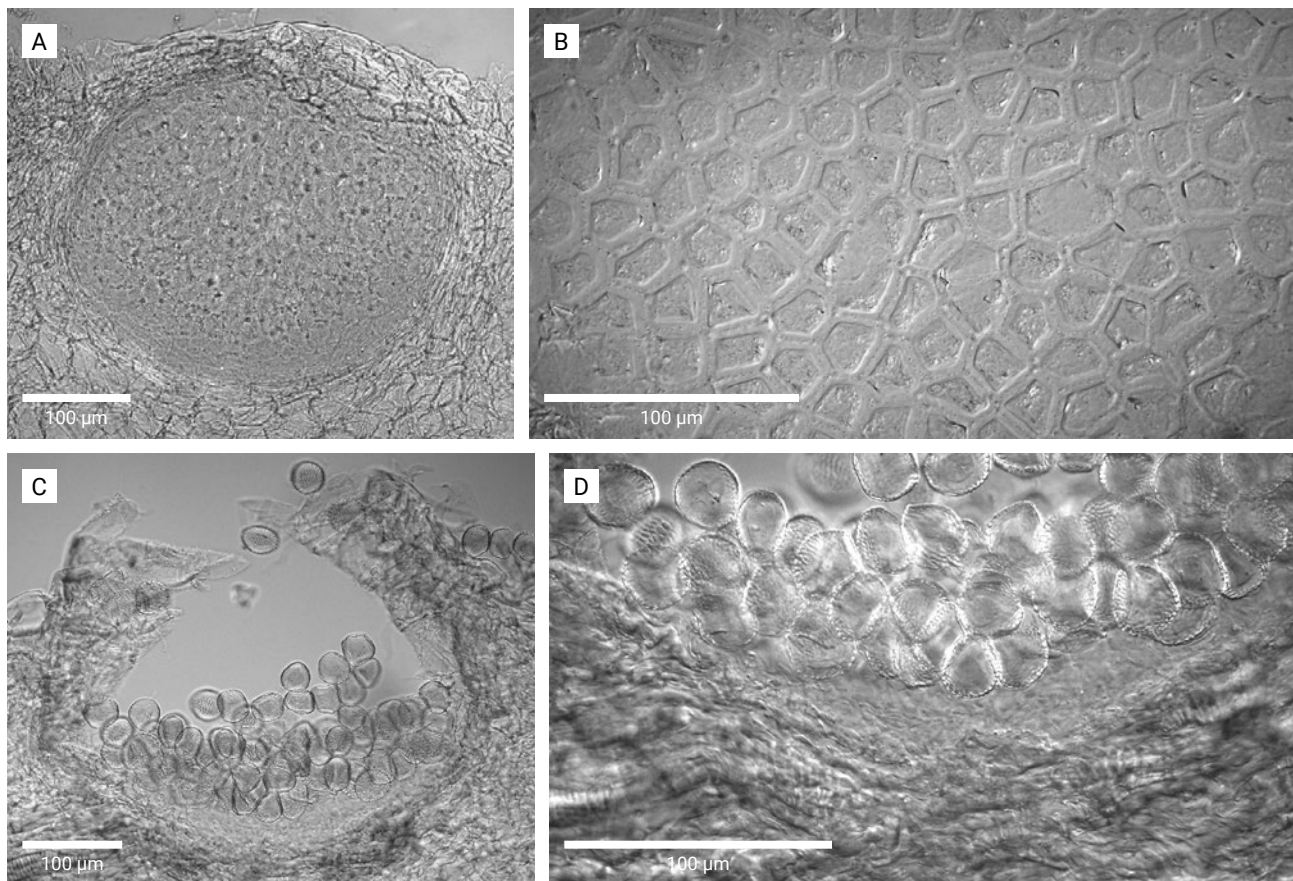


Figure 11. *Caeoma heteromorphae*, A, cross-section through a pustule; B, spores. *Caeoma lichtensteiniae*, C, cross-section through a pustule; D, spores.

fungus. The spores present have large, smooth, rounded verrucae. However, no spore producing hymenium is apparent and what appears to be a layer of fungal cells surrounding the spores has disintegrated. This species may not belong to the Pucciniales. It is uncertain whether the spermogonia-like structures belong to this fungus, though they are sometimes adjacent. The identity of the host plant is not certain. Originally identified as *Lichtensteinia* sp. (Doidge 1941), no species in this genus of the Apiaceae are known from Zimbabwe (Mapaura & Timberlake 2004). Additional material is required to determine the true identity and host of this fungus.

Discussion

This checklist brings together the dispersed literature on a diverse and ecologically important group of pathogenic fungi, to provide baseline information on the biodiversity of these fungi in southern Africa. By summarising what is known, several areas of study for future work are indicated. Future taxonomic studies are needed of various species described in the 1800's and early 1900's to bring them in line with changed concepts of what constitutes a species. Botswana, Lesotho, Mozambique and Eswatini need to be explored, as

well as continued exploration of northern and western South Africa and Namibia, to improve knowledge on biodiversity, distribution and host plants of the indigenous rust fungi.

The species recorded from southern Africa were evaluated as to whether they are indigenous or alien (neomycetes), with 78 considered alien (Table 3). Berndt (2008a) considered only 32 as alien. Most of these species are widespread crop pathogens, or pathogens of alien host plant species grown as horticultural subjects or which have become weeds in the region. However, some occur on both alien and indigenous plant species, and therefore a subjective decision was made as to whether these were widespread species (cosmopolitan) or had been introduced from elsewhere in the world and then spread to indigenous plants. Two are considered to be invasive and alien, in that they are new-association parasites of indigenous plant species, namely *Puccinia lagenophorae* (Scholler et al. 2011) and *Austropuccinia psidii* (Roux et al. 2013, 2016), and likely are impacting on their new host's population dynamics. Several cereal rust fungi are a threat to one highly localised indigenous grass (Pretorius et al. 2015). The rate at which rust fungi are invading southern Africa appears to be accelerating, a total of 13 were first recorded between 1946 and 1990 (average 0.382 species per year), whereas 20 have been first recorded

from 1991 until the present (average 0.625 species per year). Of interest is that there are a few rust fungi that have been described from alien plants in southern Africa and which are not known from any indigenous plant, e.g. *Phakopsora myrtacearum* (Maier et al. 2016), *Dietelia cardiospermi* (Berndt & Wood 2012) and *Uromyces capensis* (Doidge 1927). The status of these is uncertain but are herein considered indigenous until proven otherwise. One species was first described from Australia, where it was introduced, before being discovered in its native range in South Africa (*Puccinia ursinae*, Shivas 1991).

Four species have been deliberately introduced as biological control agents of alien invasive plants: *Puccinia eupatorii* (on *Eupatorium macrocephalum*), *Puccinia xanthii* var. *parthenii-hysterophori* (on *Parthenium hysterophorus*), *Uromycladium morrisii* (on *Acacia saligna*), and *Uromycladium woodii* (on *Paraserianthes lophantha*). Attempts were made to establish another species, *Prospodium transformans*, on *Tecoma stans*, but it did not successfully establish and therefore is not present in the region (Wood 2014). A number of species were accidentally introduced over time and may contribute to the biological control of their alien hosts: *Melampsora ricini* (on *Ricinus communis*), *Puccinia abrupta* var. *partheniicola* (on *Parthenium hysterophorus*), *Puccinia arechavaletae* (on *Cardiospermum grandiflora*), *Puccinia malvacearum* (on *Malva parviflora*, *Malva pusilla*), *Puccinia cannae* (on *Canna indica*), *Puccinia xanthii* (on *Xanthium strumarium*) and *Uromyces bidenticola* (on *Bidens pilosa*). One indigenous rust has been recorded as occasionally impacting on an alien invasive weed – *Kuehneola uredinis* is an outbreak species on *Rubus* sect. *Cuneifolii* (Wager 1947).

Several rust fungi from South Africa have been introduced to other parts of the world, becoming problem pathogens of some widely grown ornamental plants. These include *Puccinia pelargonii-zonalis* (on *Pelargonium* hybrids, which include *P. zonale* in their parentage), *Uromyces aloes* (on *Aloe* spp.), and *U. transversalis* (on *Gladiolus* spp. and hybrids) (Farr & Rossman 2024).

Of concern is that other than traditional morphological taxonomy, almost no research has been carried out on indigenous rust fungi despite plant pathogens being important components of ecosystems. Very little work has been done on proving the life cycles of the species by cultural studies, most of which was done approximately a century ago (Pole-Evans 1909, 1923a, 1923b, Putterill 1918). After the first *Endophyllum* species was recorded (Pole-Evans 1909), a century passed before eight more species of *Endophyllum* were added (Berndt & Wood 2012, Wood 1997, 2004, Wood & Crous 2005a, this publication). Cultural and microscopic studies were done to determine the life cycle of the microcyclic *Uromyces aloes* (Putterill 1918), and later the heteroecious life cycle of *Puccinia tristachyae*

(Pole-Evans 1923b). After almost a century had passed, the second indigenous heteroecious species was identified by cultural and molecular studies, Boshoff et al. (2022a) demonstrated the full life cycle of *Puccinia digitariae* on *Digitaria eriantha* the gametothallus of which occurs on *Solanum* species. Recently, *Aecidium oxalidis* was identified by molecular data as the gametothallus of *Uromyces ixiae* (Wood & Aime 2024). All other heteroecious species known to occur in southern Africa are either alien or widespread throughout Africa and Europe or Asia. Other than these few above-mentioned species, the assumed life cycles of southern Africa's indigenous rust fungi have been based solely on association of various spore stages on the same leaves or plants. Where life cycles have been determined by cultural studies, these have been undertaken by workers in Asia, Europe or the Americas.

Biological and epidemiological studies have only been undertaken on *Uromyces rumicis* (Morris 1982a), *Endophyllum osteospermi* (Morris 1982b, Wood 2002a, Wood et al. 2004, Wood & Crous 2005b) and *Puccinia digitariae* (Rey & Garnett 1985, 1988). Ultrastructural studies have been undertaken on *Puccinia digitariae* (Rey & Garnett 1983) and *Uromyces transversalis* (Ferreira & Rijkenberg 1989, 1990, 1991, Ferreira et al. 1990).

Thus, studies have been conducted by South African mycologists on some aspect of the biology of a total of only eight out of the ± 460 (1.7%) rust fungi indigenous to South Africa. As far as the author is aware, no study on the biology of any of the species indigenous to the other southern African countries has been conducted in these countries. In contrast, numerous studies have been undertaken on alien rust fungi pathogenic on crops.

Berndt (2008a) provided an analysis of the floristic and distribution relationships of southern African rust fungi. A high proportion of the rust fungi recorded from southern Africa are either endemic to the region ($\pm 44\%$) or are more widespread in Africa ($\pm 20\%$). The remainder are 'subcosmopolitan' (particularly some species of *Puccinia* and *Uromyces*), pantropical or paleotropical (Berndt 2008a). One of the four genera of rust fungi endemic to Africa is restricted to the area covered by this list, *Cumminsina*, which is currently known only from a single specimen collected in Angola (Von Petrak 1955). Two species of *Stomatisora* are known, one from South Africa (*S. psychotriicola*), and the other from West Africa (Wood et al. 2014). The other African endemic genera are known only from West Africa, *Sphenorchidium* (Beenken & Wood 2015), and East Africa, *Joerstadia* (Gjærum & Cummins 1982). Interestingly a number of small genera have a disjunct distribution between southern Africa (or Africa) and southeast Asia or India, including *Didymoporella*, *Elateraecium*, *Newinia* and *Puccorchidium*.

The Pucciniaceae (in the sense of Aime 2006, Aime et al. 2018, Aime & McTaggart 2021) form the largest

Table 3. Rust fungi occurring in southern Africa and considered to be alien to the region (neomycetes), having been accidentally or deliberately introduced. The alien and indigenous host plants on which they have been recorded in the region are listed

Name	Natural Distribution	Alien hosts	Indigenous hosts
<i>Angiopsora apoda</i>	Tropical Africa	<i>Cenchrus clandestinus</i> , <i>C. alopecuroides</i>	
<i>Austropuccinia psidii</i> ^a	S America	<i>Backhousia citriodora</i> , <i>Myrtus communis</i>	<i>Eugenia</i> spp., <i>Heteropyxis natalensis</i>
<i>Cerotelium fici</i> ^a	Asia	<i>Ficus carica</i>	<i>Ficus cordata</i>
<i>Coleosporium plumeriae</i>	Asia	<i>Plumeria</i> sp.	
<i>Hemileia vastatrix</i>	Tropical Africa	<i>Coffea arabica</i> , <i>C. liberica</i>	
<i>Melampsora allii-populina</i>	Europe, Asia	<i>Populus deltoides</i>	
<i>Melampsora coleosporioides</i>	Asia	<i>Salix babylonica</i>	
<i>Melampsora euphorbiae</i>	Europe, Asia	<i>Euphorbia helioscopia</i> , <i>E. heterophylla</i> , <i>E. peplus</i>	<i>Euphorbia kraussiana</i> , <i>E. striata</i>
<i>Melampsora hypericorum</i>	N hemisphere	<i>Hypericum androsaenum</i>	
<i>Melampsora laricis-populina</i>	Europe, Asia	<i>Populus deltoides</i> , <i>P. nigra</i> , <i>P. wislizenii</i> ,	
<i>Melampsora lini</i>	N hemisphere	<i>Linum usitatissimum</i>	<i>Linum africanum</i>
<i>Melampsora medusae-populina</i>	New Zealand	<i>Populus deltoides</i>	
<i>Melampsora ricini</i> ^b	Mediterranean	<i>Ricinus communis</i>	
<i>Miyagia pseudosphaeria</i>	Europe	<i>Sonchus oleraceus</i>	
<i>Phakopsora desmum</i>	Africa	<i>Gossypium</i> sp.	
<i>Phakopsora nishidana</i>	Asia	<i>Ficus carica</i>	
<i>Phakopsora pachyrhizi</i>	Asia	<i>Glycine max</i> , <i>Phaseolus vulgaris</i> , <i>Pueraria lobata</i>	<i>Psoralea pinnata</i>
<i>Phragmidium mexicanum</i>	N America	<i>Potentilla indica</i>	
<i>Phragmidium mucronatum</i>	Europe, Asia	<i>Rosa</i> hybrids	
<i>Puccinia abrupta</i> var. <i>parthenicola</i> ^b	Americas	<i>Parthenium hysterophorus</i>	
<i>Puccinia allii</i>	N hemisphere	<i>Allium cepa</i> , <i>A. sativum</i>	<i>Allium synnotii</i>
<i>Puccinia antirrhini</i>	N America	<i>Antirrhinum majus</i> , <i>Linaria</i> sp.	
<i>Puccinia arachidis</i>	S America	<i>Arachis hypogea</i>	
<i>Puccinia arechavaletae</i> ^b	S America	<i>Cardiospermum grandiflorum</i> , <i>C. halicacabum</i>	<i>Cardiospermum corindum</i> (≡ <i>C. alatum</i>)
<i>Puccinia asparagi</i>	Europe	<i>Asparagus officinalis</i>	
<i>Puccinia brachypodii</i> var. <i>poae-nemoralis</i>	Europe	<i>Poa annua</i>	
<i>Puccinia cannae</i> ^b	S America	<i>Canna indica</i>	
<i>Puccinia carthami</i>	N hemisphere	<i>Carthamus tinctorius</i>	
<i>Puccinia chrysanthemi</i>	Europe	<i>Chrysanthemum coronarium</i> , <i>C. morifolium</i>	

^aSpecies highlighted in dark orange are considered to be alien invasive microorganisms, being new association pathogens of indigenous plant species and negatively impacting their health. Species highlighted in light orange are pathogens of crop plants.

^bPathogens of alien invasive plants listed in the NEM:BA regulations that were accidentally introduced by unknown pathways.

^cPathogens of alien invasive plants listed in the NEM:BA regulations that were deliberately introduced as biocontrol agents.

Table 3. Rust fungi occurring in southern Africa and considered to be alien to the region (neomycetes), having been accidentally or deliberately introduced. The alien and indigenous host plants on which they have been recorded in the region are listed (continued)

Name	Natural Distribution	Alien hosts	Indigenous hosts
<i>Puccinia coronata</i>	Europe, Asia	<i>Avena</i> spp., <i>Lolium multiflorum</i> , <i>L. perenne</i> , <i>Poa annua</i>	<i>Chloris virgata</i> , <i>Trisetopsis imberbis</i>
<i>Puccinia cyani</i>	Europe	<i>Centaurea cyanus</i>	
<i>Puccinia cymbopogonis</i>	SE Asia	<i>Cymbopogon citratus</i>	
<i>Puccinia eupatorii</i> ^c	S America	<i>Campuloclinium macrocephalum</i>	
<i>Puccinia graminis</i>	Europe	<i>Arrhenatherum elatius</i> , <i>Avena</i> spp., <i>Bromus rigidus</i> , (<i>Cymbopogon citratus</i> ?), <i>Dactylis glomerata</i> , <i>Festuca elatior</i> , <i>Hordeum</i> spp., <i>Lolium perenne</i> , <i>L. temulentum</i> , <i>Secale cereale</i> , <i>Triticum aestivum</i> , × <i>Triticosecale schlanstedtense</i>	<i>Agrostis lachnantha</i> , <i>Polypogon strictus</i> , <i>Secale africanum</i> , <i>Thinopyrum distichum</i>
<i>Puccinia helianthi-mollis</i> (= <i>Puccinia helianthi</i>)	N America	<i>Helianthus annuus</i>	
<i>Puccinia hemerocallidis</i>	Asia	<i>Hemerocallis</i> hybrids	
<i>Puccinia hieracii</i>	N hemisphere	<i>Cichorium intybus</i> , <i>Hypochaeris radicata</i>	
<i>Puccinia hordei</i>	N hemisphere	<i>Bromus pectinatus</i> , <i>Hordeum murinum</i> , <i>H. vulgare</i> , <i>Vulpia bromoides</i> , <i>V. myuros</i>	
<i>Puccinia horiana</i>	Europe	<i>Chrysanthemum morifolium</i>	
<i>Puccinia hyptidis-mutabilis</i>	N America	<i>Hyptis pectinata</i>	
<i>Puccinia iridis</i>	Europe, Asia	<i>Iris germanica</i>	
<i>Puccinia lagenophorae</i>	Australia	<i>Calendula officinalis</i> , <i>Senecio vulgaris</i>	Numerous Asteraceae, mainly annuals (see Scholler et al. 2011)
<i>Puccinia malvacearum</i>	S America	<i>Alcea rosea</i> , <i>Anisodonteia triloba</i> , <i>Malva parviflora</i> , <i>M. pusilla</i>	
<i>Puccinia melanocephala</i>	New Guinea	<i>Saccharum officinarum</i> , <i>S. spontaneum</i>	
<i>Puccinia menthae</i>	N hemisphere	<i>Mentha arvensis</i> , <i>M. spicata</i>	<i>Mentha longifolia</i>
<i>Puccinia oenotherae</i>	N America	<i>Oenothera</i> spp.	
<i>Puccinia oxalidis</i>	Americas	<i>Oxalis latifolia</i>	<i>Oxalis semiloba</i>
<i>Puccinia penicillariae</i>	Tropical Africa	<i>Cenchrus americanus</i>	
<i>Puccinia polygoni-amphibii</i>	N hemisphere	<i>Polygonum tomentosum</i>	<i>Persicaria acuminata</i>
<i>Puccinia polypogonis</i>	Europe	<i>Polypogon monspeliensis</i>	
<i>Puccinia polysora</i>	S America	<i>Zea mays</i>	
<i>Puccinia porri</i>	Europe	<i>Allium ampeloprasum</i> , <i>A. fistulosum</i>	
<i>Puccinia purpurea</i>	Africa	<i>Sorghum</i> × <i>drummondii</i> , <i>S. virgatum</i>	<i>Sorghum arundinaceum</i> , <i>S. bicolor</i>

^aSpecies highlighted in dark orange are considered to be alien invasive microorganisms, being new association pathogens of indigenous plant species and negatively impacting their health. Species highlighted in light orange are pathogens of crop plants.

^bPathogens of alien invasive plants listed in the NEM:BA regulations that were accidentally introduced by unknown pathways.

^cPathogens of alien invasive plants listed in the NEM:BA regulations that were deliberately introduced as biocontrol agents.

Table 3. Rust fungi occurring in southern Africa and considered to be alien to the region (neomycetes), having been accidentally or deliberately introduced. The alien and indigenous host plants on which they have been recorded in the region are listed (continued)

Name	Natural Distribution	Alien hosts	Indigenous hosts
<i>Puccinia recondita</i>	Cosmopolitan	<i>Bromus pectinatus</i> , <i>B. rigidus</i> , <i>Hordeum intermedium</i> , <i>H. murinum</i> , <i>Secale cereale</i>	<i>Secale africanum</i> (also various genera elsewhere in Africa)
<i>Puccinia sorghi</i>	S America	<i>Zea mays</i>	
<i>Puccinia striiformis</i>	Europe, Asia	<i>Bromus pectinatus</i> , <i>Triticum aestivum</i>	<i>Secale africanum</i>
<i>Puccinia triticina</i>	Cosmopolitan	<i>Aegilops cylindrica</i> , <i>Triticum aestivum</i> , × <i>Tritico-secale schlanstedtense</i>	
<i>Puccinia xanthii</i>	N America	<i>Helianthus annuus</i> , <i>Xanthium strumarium</i>	
<i>Puccinia xanthii</i> var. <i>parthenii- hysterophori</i> ^c	Americas	<i>Parthenium hysterophorus</i>	
<i>Puccinia</i> sp.	Unknown	<i>Eryngium planum</i>	
<i>Pucciniastrum epilobii</i>	N hemisphere	<i>Fuchsia</i> spp.	
<i>Pucciniastrum minimum</i>	N America	<i>Vaccinium corymbosum</i>	
<i>Ravenelia mesilliana</i> ^b	Americas	<i>Senna bicapsularis</i>	
<i>Tranzschelia discolor</i>	N hemisphere	<i>Prunus</i> spp.	
<i>Uredo cajani</i>	India	<i>Cajanus cajan</i>	
<i>Uromyces appendiculatus</i>	N hemisphere	<i>Phaseolus acutifolius</i> , <i>P. coccineus</i> , <i>P. vulgaris</i>	<i>Vigna unguiculata</i>
<i>Uromyces betae</i>	Europe	<i>Beta vulgaris</i>	
<i>Uromyces bidenticola</i>	S America	<i>Bidens pilosa</i>	
<i>Uromyces dianthi</i>	N hemisphere	<i>Dianthus barbatus</i> , <i>D. caryophyllus</i>	<i>Dianthus crenatus</i> , <i>Dianthus zeyheri</i>
<i>Uromyces euphorbiae</i>	Americas	<i>Euphorbia prostrata</i>	<i>Euphorbia inaequilatera</i> , <i>Euphorbia natalensis</i>
<i>Uromyces limonii</i>	N hemisphere	<i>Limonium platyphyllum</i>	
<i>Uromyces polygoni-avicularis</i>	N hemisphere	<i>Polygonum aviculare</i> , <i>Polygonum tomentosum</i>	
<i>Uromyces rumicis</i>	Europe	<i>Rumex crispus</i> , <i>R. nepalensis</i>	<i>Emex australis</i> , <i>Rumex woodii</i>
<i>Uromyces striatus</i>	Europe	<i>Medicago</i> spp.	
<i>Uromyces trifolii</i>	N hemisphere	<i>Trifolium</i> sp.	
<i>Uromyces trifolii-repentis</i>	N hemisphere	<i>Trifolium repens</i> , <i>T. resupinatum</i>	
<i>Uromyces viciae-fabae</i>	N hemisphere	<i>Pisum sativum</i> , <i>Vicia fabae</i> , <i>V. lens</i>	
<i>Uromycladium</i> sp.	Australia	<i>Acacia mearnsii</i>	
<i>Uromycladium morrisii</i> ^c	Australia	<i>Acacia saligna</i>	
<i>Uromycladium woodii</i> ^c	Australia	<i>Paraserianthes lophantha</i>	

^aSpecies highlighted in dark orange are considered to be alien invasive microorganisms, being new association pathogens of indigenous plant species and negatively impacting their health. Species highlighted in light orange are pathogens of crop plants.

^bPathogens of alien invasive plants listed in the NEM:BA regulations that were accidentally introduced by unknown pathways.

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proportion of the rust flora (76 %). Most of the remainder of the diversity is made up of a tropical element, consisting of the Mikronegeriinieae (2.4 %) and the families other than Pucciniaceae of the Uredinineae (13.2 %) (Berndt 2008a). With the addition of *Endophyllum austroafricana*, South Africa currently has a total of nine species of *Endophyllum*, representing 21 % of the total number of species known within this genus.

The northern temperate Melampsorineae make up only 3.6 % of the flora, half of which are alien in southern Africa (10 of 21 species). Only urediniospores have been recorded in southern Africa for the majority of these species, both indigenous and alien. This is true of the four species endemic to South Africa, *Coleosporium hedyotidis*, *C. hewittiae*, *Milesina nervisequa* and *M. silvae-knysnae*, and several species with a temperate Northern Hemisphere and South African disjunct distribution including *Coleosporium clematidis* (autoecious), *Milesina blechni* (heteroecious), *M. nervisequa* (heteroecious), *Pucciniastrum agrimoniae* (autoecious) and *Uredinopsis pteridis* (heteroecious).

The conservation status of the majority of species cannot presently be determined due to a lack of distribution data for them. Currently only some species, which have been found to be widespread and/or common, could be listed as being 'of Least Concern'. For instance, *Cephalotelium macowanianum* is likely the most common and widespread species in the country, as its host plant *Vachellia karoo* is one of the most widespread trees in the region. For many, they have only been collected once or a few times, but whether this is an artefact of a lack of collecting effort, or whether they actually are rare and should be on a red list, is not yet known. These biotrophic pathogens are commonly ephemeral in patches of their host plants, their populations increasing or decreasing due to fluctuations in rainfall and other climatic factors. Therefore, the fragmentation of the natural environment is likely to lead to at least some becoming rarer or extinct, as their

host populations decline and occur only in small discrete conserved areas. Rust fungi, as well as other groups of biotrophic pathogenic fungi, may therefore be another group of organisms that can function as indicator species of the integrity and sustainability of conserved areas or landscapes. These fungi can be collected, preserved using standard herbarium specimen techniques (i.e., low cost and simple technology), and generally identified rapidly if their host is correctly identified and using basic microscopy. This checklist will assist in the identification of these species.

The rust fungi of southern Africa are a diverse and important component of the local ecosystems. Further collecting and taxonomic studies are needed to determine the complete diversity and species distributions. However, much more research is required to confirm their life histories, their full host range, and to elucidate the impacts on their host plant's population dynamics and influence on ecosystem functioning.

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Supplementary Material

Supplementary material has not been edited, designed or proofread by SANBI Graphics & Editing as approved by the two Editors-in-Chief.

Supplement 1

Checklist of rust fungi (Pucciniales, Basidiomycota) recorded as occurring in southern Africa, including South Africa, Angola, Botswana, eSwatini (formerly Swaziland), Lesotho, Mozambique, Namibia and Zimbabwe.

<http://dx.doi.org/10.38201/abc.v55.14>

Supplement 2

Checklist of host plants of the rust fungi (Pucciniales, Basidiomycota) recorded as occurring in southern Africa, including South Africa, Angola, Botswana, eSwatini (formerly Swaziland), Lesotho, Mozambique, Namibia and Zimbabwe.

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