

New species of *Phakopsora* (Basidiomycota, Uredinales) from Cameroon, South Africa and Brazil

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Berndt R., Freire F., Piątek M. & Wood, A. R. (2007) New species of *Phakopsora* (Basidiomycota, Uredinales) from Cameroon, South Africa and Brazil. – *Sydowia* 60 (1): 15–24.

Phakopsora dissotidis, *Ph. melhaniae*, and *Ph. merremiae* are described as new rust species on *Dissotis thollonii* var. *elliotii* (Melastomataceae), *Melhania didyma* (Sterculiaceae) and *Merremia aegyptia* (Convolvulaceae) from Cameroon, South Africa and Brazil, respectively. *Ph. merremiae* is the teleomorph stage of *Uredo merremiae* and the first species of *Phakopsora* reported on a member of Convolvulaceae. Melastomataceae is a new host family for *Phakopsora* as well.

Key words: *Dissotis*, *Melhania*, *Merremia*, *Physopella*, rust fungi

Phakopsora Dietel is a large genus of rust fungi distributed in warm regions of the world. Originally reserved for species whose teliospores are arranged irregularly in compact crusts (Cummins & Hiratsuka 1983) it was later united with *Physopella* Arthur by Cummins & Hiratsuka (2003) whose members have teliospores arranged in more or less regular rows. Several rust species originally described as *Phakopsora* were later assigned to other rust genera like *Uredopeltis* or *Cerotelium*. On the other hand there are rusts that might be amalgamated with *Phakopsora* like the genus *Batis-topsora* Dianese, Medeiros & Santos (Dianese *et al.* 1993). Besides differences in the morphology of the telia (Mains 1934, Berndt 2005) *Phakopsora* exhibits a considerable variability with regard to morphology of the uredinia which are classified in different anamorph genera according to the construction of their sterile bounding structures (Ono *et al.* 1992, Buriticá & Hennen 1994).

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Because of the complicated synonymy and the fact that the name *Physopella* has been ambiguously used as both a teleomorph and an anamorph genus for certain uredinia (Ono *et al.* 1992) it is not easy to present a reliable species number of *Phakopsora*. Presently we know of about 110 species on hosts in 31 plant families, four of them monocotyledonous, the remaining dicots. Most of the host families are only known to be host to one to several *Phakopsora* species and only the Euphorbiaceae, Poaceae, Asteraceae and Fabaceae are each parasitized by a considerable number of species.

In the present paper we describe three new species of *Phakopsora* on members of the Sterculiaceae, Melastomataceae and Convolvulaceae. Members of the latter two families have not been known hitherto to be host to any *Phakopsora* species.

Materials and Methods

Infected plant organs were observed with a Zeiss Stemi SV8 stereo microscope. Spores and hand sections obtained from herbarium material were mounted in lactophenol and gently heated to boiling. The preparations were examined with an Olympus BX51 compound microscope and micrographs taken with a ColorView IIIu camera. The 'Cell*B' software package (Software Imaging System G.m.b.H) was used to capture and edit micrographs and to measure details of spore walls and their ornament. In the latter case, measurements are given to 0.1 μm while ordinary measurements made by the use of an ocular micrometer scale are given to 0.5 μm . At least 30 spores were measured for each spore stage, the arithmetic means are given in brackets. Names of herbaria are abbreviated by their acronyms according to Index Herbariorum (Holmgren *et al.* 1990). HUYI is the mycological herbarium of the University of Yaoundé 1, Yaoundé, Cameroon.

Taxonomy

Phakopsora dissotidis R. Berndt & M. Piątek **sp. nov.** – Figs. 1–4.
MycoBank no.: MB 511614

Etymology. – Named after the host genus *Dissotis*.

Spermogonia et aecia non visa. Uredinia subepidermalia, in pagina abaxiali foliorum sparsa vel laxe aggregata, bullata, rotundata, straminea, saepe brunneo marginata, peridio unistratosa ex cellulis crasse tunicatis composito praedita; urediniosporae obovoideae, ellipsoideae vel subclavatae, 20–29 μm \times 13–17 μm (medium 23.3 μm \times 15.3 μm), pariete subhyalino, stramineo vel pallidissime brunneo, ca. 1 μm crasso, plusminusve aequaliter – etsi nonnihil densiore hilum versus – echinulato spinis delicatis, inter se ca. (1.0) 1.3–2.3 μm distantibus, poris germina-

tionis obscuris, sparsis. Telia subepidermalia, sparsa inter uredinia in pagina abaxiali foliorum, crustacea, applanata, ca. 150–300 μm diam., primum castanea, deinde brunneo-nigra vel nigra; teliosporae dense et irregulariter aggregatae, 2–4 superpositae, cylindricae, subrhombicae vel irregulariter formatae, 14–23 μm \times 8–11 μm (medium 19.0 μm \times 9.7 μm), pariete levi, dilute brunneo usque ad dilute castaneo in soris vetioribus, ca. 0.5–1 μm crasso, apicaliter vix incrassato, sed incrassato usque ad 2–3 μm in apice teliosporarum exteriorium.

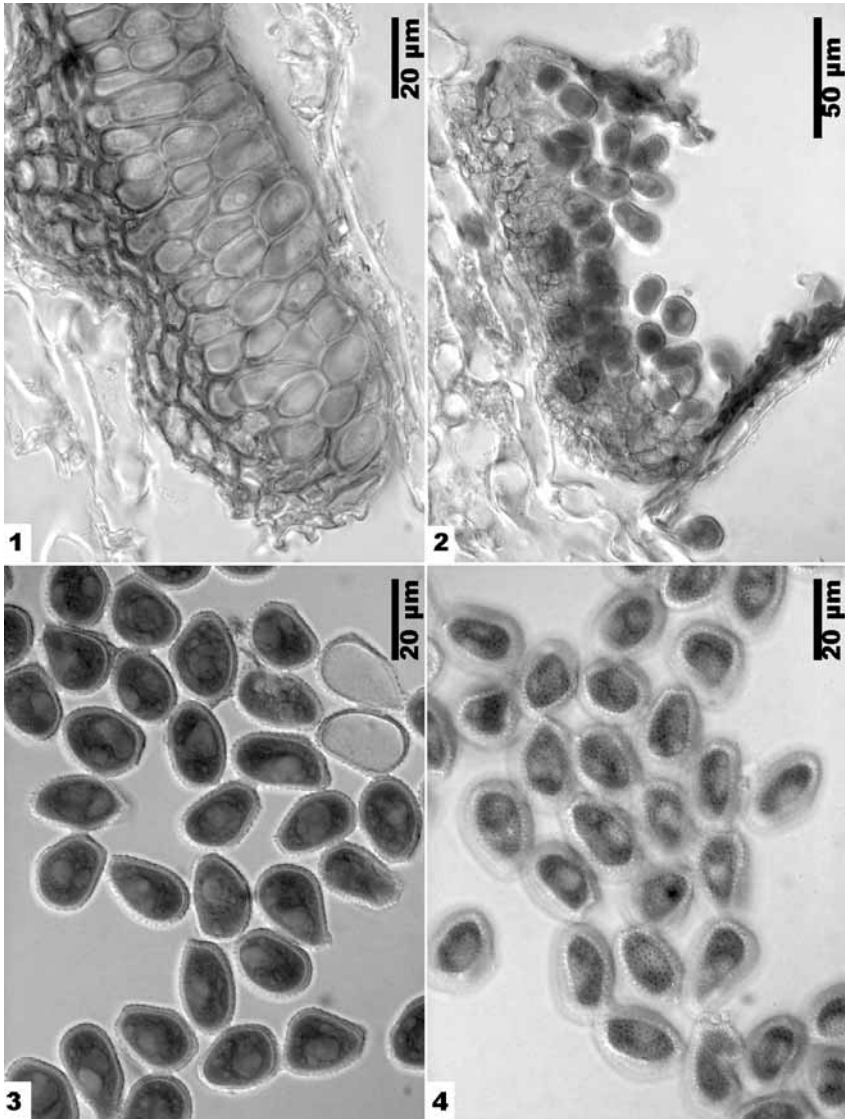
In foliis *Dissotidis thollonii* Cogn. ex Büttner var. *elliottii* (Gilg.) Jacq.-Fél. (Melastomataceae).

Spermogonia and aecia not seen. Uredinia subepidermal, scattered or in small groups on abaxial side of leaves, bullate, rounded, straw-coloured, often with a brown border, peridiate by a dome-shaped peridium composed of a single layer of thick-walled cells; urediniospores obovoid, ellipsoid or subclavate, 20–29 μm \times 13–17 μm (arithmetic mean 23.3 μm \times 15.3 μm), spore wall subhyaline, straw-coloured to very pale brown, ca. 1 μm thick, more or less evenly echinulate – though somewhat more densely towards the hilum – by fine spines ca. (1.0) 1.3–2.3 μm apart, germ pores obscure and number unknown, scattered. Telia subepidermal, scattered among the uredinia on abaxial leaf side, crust-like, flat, ca. 150–300 μm in diam., first chestnut brown, later becoming blackish-brown or black; teliospores in 2–4 indistinct ‘layers’, densely and irregularly aggregated and wedged among each other, cylindrical to subrhomboid or irregularly shaped due to mutual pressure, 14–23 \times 8–11 μm (arithmetic mean 19.0 \times 9.7 μm), spore wall smooth, light brown to light chestnut brown in older sori, ca. 0.5–1 μm thick, hardly thickened apically, only in uppermost spores thickened to 2–3 μm .

On leaves of *Dissotis thollonii* Cogn. ex Büttner var. *elliottii* (Gilg.) Jacq.-Fél. (Melastomataceae).

Holotype (KRAM F-56619). – Cameroon, ca. 15 km S of Bamenda, 05°52'13.3"N / 10°09'03.8"E, alt. ca. 1800m, on *Dissotis thollonii* var. *elliottii* (det. J. P. Ghogue), leg. A. L. Njouonkou, J. Piątek, M. Piątek, C. Vánky and K. Vánky, 8 Mar 2007 (isotypes in HUYI and Z+ZT).

Only a few rust fungi are known from Melastomataceae: *Puccinia chaetogastrae* Lagerh. and *Uredo monochaeti* F. Kern & Thurst. occur in South America, *Didymopsora africana* Cummins, *Puccinia necopina* Grove, and *Pucciniosira dissotidis* in Africa, *Aecidium memecyli* Thirum. in India. The only rust of *Dissotis* species known so far are *Didymopsora africana* and *Pucciniosira dissotidis*. They form spermogonia and aecidium-like telia with catenulate, puccinioid teliospores which cannot be confused with the telia of *Ph. dissotidis*. *Aecidium dissotidis* Cooke, *Uredo dissotidis* Cooke and *U. dissotidis-longicaudae* P. Henn. described from *Dissotis*, too, were



Figs. 1–4. *Phakopsora dissotidis*: 1. Subepidermal telium. 2. Subepidermal uredinium with peridium (arrow) composed of thick-walled cells. 3. Urediniospores, optical section. 4. Urediniospores, view of spore surface showing the rather dense and fine echinulation.

studied by Sydow & Sydow (1924) and considered as synonyms of *Puccinosira dissotidis*.

The species here described is the first member of the genus *Phakopsora* on the host family Melastomataceae. Its peridiate uredinia are of *Milesia*-type. It is notable that there is another undescribed fungus in the type specimen of *Ph. dissotidis* belonging to the genus *Pseudocercospora* (anamorphic Dothideomycetes, Ascomycota).

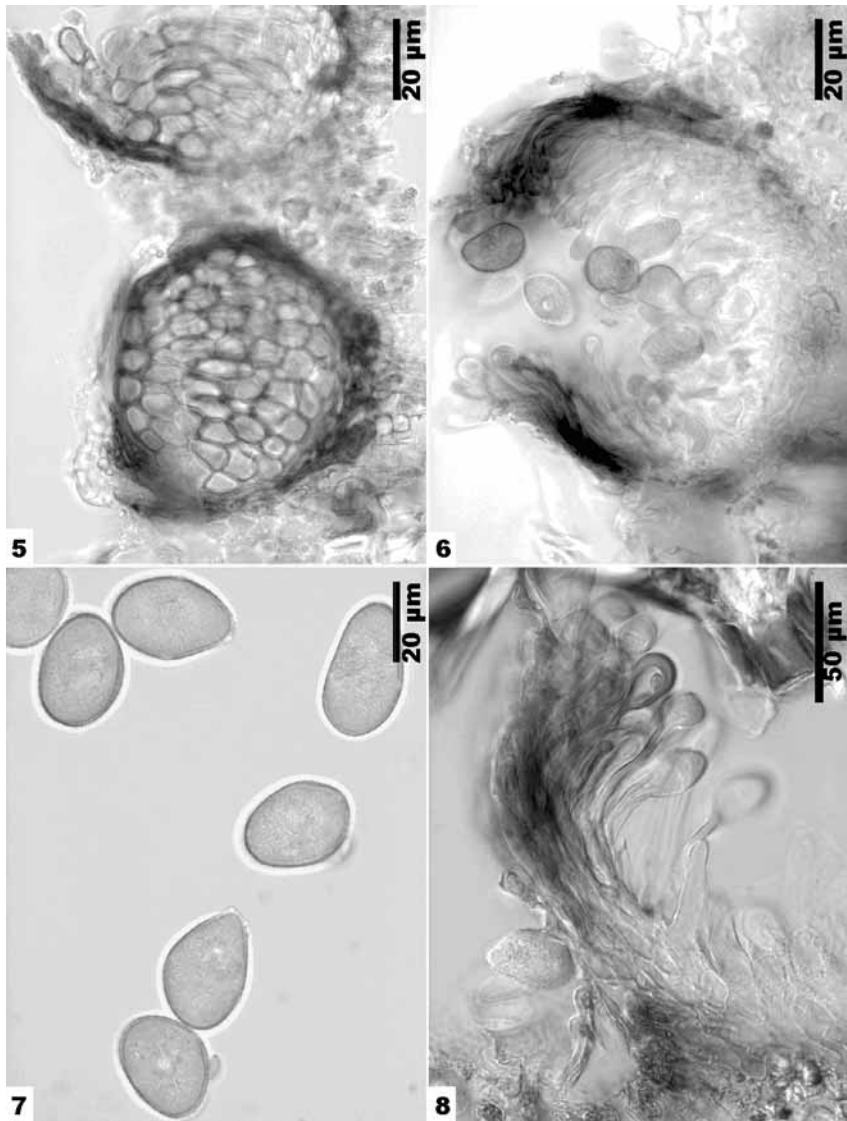
Phakopsora melhaniae R. Berndt & A. R. Wood **sp. nov.** – Figs. 5–8.
MycoBank no.: MB 511615

Etymology. – Named after the host genus *Melhania*.

Spermogonia et aecia ignota. Uredinia in foliis amphigena, praecipue abaxialia, ca. 100–200 μm diam., subepidermalia, semiimmersa, valde concava, paraphysibus copiosis, cylindricis, spathulatis vel subcapitatis, usque ad 60 μm longis, apicaliter 6–12 μm latis cum pariete 2–8 μm crasso, subhyalino ad dilute spadiceo, cincta; urediniosporae obovoideae, anguste obovoideae, plus rarius ellipsoideae vel subclavatae, 25–37(40) $\mu\text{m} \times 16$ –21 μm (medium 30.5 $\mu\text{m} \times 18.6 \mu\text{m}$), pariete vix 1 μm crasso, dilute brunneo, aequaliter echinulato spinis delicatis inter se ca. 1.6–2.5 μm distantibus, poris germinationis obscuris, verosimiliter 5–8, paene aequatorialibus ad paene sparsis, praecipue circa aequatorem vel in parte superiori sporarum dispositis. Teli in pagina abaxiali foliorum, obscure olivacea ad obscure brunnea, crustacea, subepidermalia et profunde immersa, in sectione transversali subcirculares vel ellipticae, usque ad 150 μm diam.; teliosporae unicellulares, sessiles, dense et irregulariter aggregatae, 5–7 superpositae, late ellipsoideae, ellipsoideae vel irregulariter subrhombicae, 16–26 $\mu\text{m} \times 10$ 8–12 μm (medium 20.3 $\mu\text{m} \times 10.3 \mu\text{m}$), pariete levi, pallide brunneo, castaneo in sporis distalibus, ca. 1 μm crasso, apicaliter incrassato usque ad 2 μm .

In foliis *Melhaniae didymae* Eckl. & Zeyh. (Sterculiaceae).

Spermogonia and aecia unknown. Uredinia predominantly on abaxial surface of leaves, ca. 100–200 μm diam., subepidermal, semi-immersed into host tissue and strongly concave, bounded by a dense fringe of numerous cylindrical, spathulate or subcapitate paraphyses up to 60 μm long, apically 6–12 μm wide, with a subhyaline to light reddish brown wall which is 2–8 μm thick at the apex; urediniospores obovoid, narrowly obovoid, more rarely ellipsoid or subclavate, 25–37(40) $\mu\text{m} \times 16$ –21 μm (arithmetic mean 30.5 $\mu\text{m} \times 18.6 \mu\text{m}$), spore wall scarcely 1 μm thick, light brown, evenly echinulate by fine spines ca. 1.6–2.5 μm apart, germ pores obscure, probably 5–8 in variable position from nearly equatorial to almost scattered, but most often arranged in a more or less equatorial band or in the distal half of the spore. Teli abaxially on leaves, forming dark olivaceous to dark brown, inconspicuous crusts, subepidermal and deeply immersed into host tissue, in section from nearly circular to transversely elliptic, up to 150 μm diam.; telios-



Figs. 5–8. *Phakopsora melhaniae*: **5.** Telia semi-immersed into leaf host tissue. The telium at the bottom developed from a uredinium. **6.** Strongly concave uredinium bound by copious cylindrical to subcapitate paraphyses. **7.** Urediniospores, optical section. **8.** Part of the sterile border of a uredinium showing several layers of paraphyses deriving from a tangled hyphal base.

pores one-celled, sessile, irregularly and densely aggregated to 5–7 'layers', broadly ellipsoid, ellipsoid or irregularly subrhomboid, 16–25 $\mu\text{m} \times 8$ –12 μm (arithmetic mean 20.3 $\mu\text{m} \times 10.3 \mu\text{m}$), spore wall smooth, pallid brown, light chestnut brown in uppermost spores, ca. 1 μm thick, slightly thickened to 2 μm apically.

On leaves of *Melhania didyma* Eckl. & Zeyh. (Sterculiaceae).

Holotype (PREM 59854). – South Africa, Kwa Zulu-Natal, Utrecht, Balele Nature Reserve, 27°37'S / 30°20'E, on *Melhania didyma*, leg. A. R. Wood (no. 638), 21 Mar 2006 (isotype in Z+ZT).

Two other *Phakopsora* species are known on members of Sterculiaceae: *Ph. byttneriae* Cummins & Jørst., reported on *Byttneria* in Madagascar and China, which differs by smaller urediniospores and paraphyses of different morphology, and *Ph. sterculiae* Nag Raj, Govindu & Thirum. on *Sterculia* from India which has according to the description erumpent uredinia and narrower urediniospores which are reputedly catenulate.

As far as we know, *Ph. melhaniae* is the first rust reported from the genus *Melhania*. Its uredinia can be assigned to the *Physopella*-type.

***Phakopsora merremiae* R. Berndt & F. Freire sp. nov.** – Figs. 9–12.
Mycobank no.: MB 511616

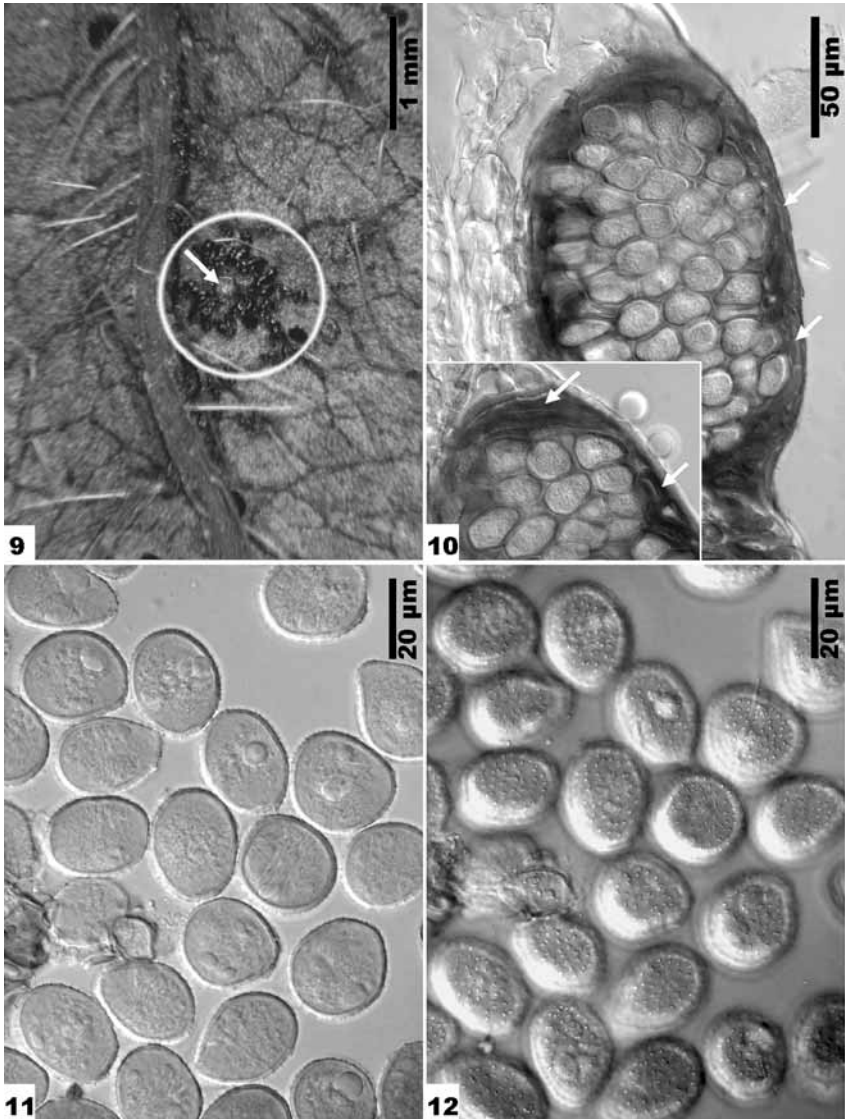
Etymology. – Named after the host plant genus, *Merremia*.

Anamorph. – *Uredo merremiae* R. Berndt, Mycologia 91:1052. 1999.

Spermogonia et aecia ignota. Uredinia in pagina abaxiali foliorum sparsa, subepidermalia, ca. 150–250 μm diam., peridio unistrato, tholiformi, ex cellulis isodiametricis, moderate crasse tunicatis composito praedita; urediniosporae obovoideae, late ellipsoideae vel – rariter – subglobosae, 23.5–30 $\mu\text{m} \times 18$ –23 μm (medium 26.9 $\mu\text{m} \times 20.8 \mu\text{m}$), pariete aequaliter 1–1.5 μm crasso, stramineo, spinis acutis et moderate delicatis, inter se 1.5–2.5 μm distantibus echinulato, poris germinationis obscuris, ca. 5, plusminusve aequatorialibus vel fere sparsis. Telia praecipue in pagina abaxiali foliorum, saepe circum uredinia centralia aggregata, verosimiliter subcuticularia vel intraepidermalia nascentia vel in urediniis obsoletis formantia, coracina ad nigro-brunnea, crustacea et bullata, ca. 110–120 μm diam., vix confluentia et deinde magniora, sori singuli lateraliter et distaliter cellulis crasse tunicatis, anguste luminatis, plusminusve compressis circumdatis (teliosporae aberrantes?); teliosporae unicellulares, sessiles, irregulariter et dense aggregatae, 4–6(8) superpositae, forma irregulari, subcylindricae, late ellipsoideae, cuneatae vel subrhomboideae, 18–31 $\mu\text{m} \times 12$ –17 μm (edium 25.0 $\mu\text{m} \times 14.6 \mu\text{m}$), pariete levi, dilute brunneo ad castaneo, ca. 1 μm crasso, in apice non vel paulum incrassato (usque ad 3 μm).

In foliis *Merremiae aegyptiae* Urb. (Convolvulaceae).

Spermogonia and aecia unknown. Uredinia scattered on abaxial side of leaves, subepidermal, ca. 150–250 μm diameter, with a



Figs. 9-12. *Phakopsora merremiae*: **9.** Telia (within white ring) surrounding a central uredinium (arrow) on abaxial side of host leaf. **10.** Telium bordered distally and laterally by compressed and thick-walled cells (arrows). The inset shows a part of another section. **11.** Urediniospores, optical section. **12.** Urediniospores, view of spore surface showing the delicate echinulation.

one-layered dome-shaped peridium composed of moderately thick-walled, more or less isodiametric cells; urediniospores obovoid, broadly ellipsoid, more rarely subglobose, $23.5\text{--}30\ \mu\text{m} \times 18\text{--}23\ \mu\text{m}$ (arithmetic mean $26.9\ \mu\text{m} \times 20.8\ \mu\text{m}$), spore wall evenly $1\text{--}1.5\ \mu\text{m}$ thick, straw-coloured, evenly echinulate by slender, sharp spines ca. $1.5\text{--}2.5\ \mu\text{m}$ apart, germ pores very indistinct, about 5, more or less equatorial to almost scattered. Telia predominantly abaxial on leaves, often surrounding a central uredinium, probably subcuticular or intraepidermal, or developing from obsolete uredinia, shiny black to blackish brown, crustose and bullate, ca. $110\text{--}120\ \mu\text{m}$ in diam., only slightly confluent and then larger, single sori surrounded laterally and distally by thick-walled, more or less compressed, sometimes elongated cells (modified spores?); teliospores one-celled, sessile, irregularly arranged and densely aggregated, spore chains with 4–6(8) spores, spores irregularly shaped, subcylindrical, broadly ellipsoid, wedge-shaped or diamond-shaped, $18\text{--}31\ \mu\text{m} \times 12\text{--}17\ \mu\text{m}$ (arithmetic mean $25.0\ \mu\text{m} \times 14.6\ \mu\text{m}$), spore wall smooth, light brown to light chestnut brown, ca. $1\ \mu\text{m}$ thick, not or slightly thickened (to $3\ \mu\text{m}$) at their distal end.

On leaves of *Merremia aegyptia* Urb. (Convolvulaceae).

Holotype (UB 20871). – Brazil, Ceará State, São Benedito County, Inhuçu District, at road CE 323, $4^{\circ} 05' 57''\text{S} / 40^{\circ} 52' 54''\text{W}$, alt. ca. 900 m a.s.l., on *Merremia aegyptia*, leg. F. Freire, 10 Dec 2006 (isotype in Z+ZT).

This is the first *Phakopsora* species known on a member of the family Convolvulaceae. Comparing the present rust with *Uredo merremiae* described on *M. cf. aegyptia* in Venezuela we could not find major differences between their uredinia and therefore regard *U. merremiae* as a synonym of *Ph. merremiae*. The peridiate uredinia can be classified in the anamorph genus *Milesia* F. B. White.

The telia of *Ph. merremiae* are surrounded by a layer of thick-walled, slightly compressed cells with a narrow lumen which are smaller than the teliospores. These cells may represent modified teliospores and could offer some protection to the normal teliospores. We do not know another *Phakopsora* showing this character. Telia developed either from old uredinia or from telial primordia which most often surrounded uredinia. We could not find out with certainty whether the telial primordia developed under the cuticle of the host epidermis or within the epidermal cells.

Another rust fungus occurring on *M. aegyptia* is *Coleosporium ipomoeae* (Schwein.) Burrill. It is also present on the type specimen of *Ph. merremiae*. These species can hardly be confused as *C. ipomoeae* has non-peridiate uredinia with 'catenulate' urediniospores

and orange, wax-like telial crusts composed of a single layer of teliospores developing internal basidia.

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Jahr/Year: 2008

Band/Volume: [60](#)

Autor(en)/Author(s): Berndt Reinhard, Freire F., Piatek Marcin, Wood Alan R.

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