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## New smut fungi (Ustilaginomycetes) from Australia

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Fourteen new species of smut fungi from Australia are described and illustrated: *Cintractia bulbostylidis* R.G. Shivas and K. Vánky (type on *Bulbostylis barbata*); *C. lipocarphae* K. and C. Vánky and R.G. Shivas (type on *Lipocarpa microcephala*); *Moreaua arthrostylidis* K. Vánky and R.G. Shivas (type on *Arthrostylis aphylla*); *M. fimbristylidis* K. Vánky and R.G. Shivas (type on *Fimbristylis dichotoma*); *Sporisorium gibbosum* K. and C. Vánky and R.G. Shivas (type on *Digitaria gibbosa*); *S. nervosum* K. and C. Vánky and R.G. Shivas (type on *Sehima nervosum*); *S. operculatum* K. and C. Vánky and R.G. Shivas (type on *Mnesithea formosa*); *S. queenslandicum* K. and C. Vánky and R.G. Shivas (type on *Sehima nervosum*); *S. whiteochloae* K. Vánky and McKenzie (type on *Whiteochloa cymbiformis*); *Tilletia chionachnes* K. and C. Vánky and R.G. Shivas (type on *Chionachne cyathopoda*); *T. kimberleyensis* K. Vánky and R.G. Shivas (type on *Chionachne cyathopoda*); *T. lineata* R.G. Shivas and K. Vánky (type on *Arundinella nepalensis*); *T. whiteochloae* R.G. Shivas and K. Vánky (type on *Whiteochloa cymbiformis* and *W. capillipes*); and *Ustilago chloridis* K. and C. Vánky and R.G. Shivas (type on *Chloris lobata*).

**Key words:** new species, taxonomy.

### Introduction

The collection and examination of Australian smut fungi during the previous five years has resulted in descriptions of several new genera and numerous new species (Vánky and Websdane, 1995, 1996; Vánky, 1997a, 1997b, 1997c, 1998; Shivas and Vánky, 1997; Vánky, Bauer and Begerow, 1997; Walker and Shivas, 1998; Walker, 2001).

In March and April 2000, a four week survey specifically for smut fungi was completed across northern Australia, covering regions in Queensland, the Northern Territory and Western Australia. This and other recent collections in northern Australia have led to the discovery of further new species of Ustilaginomycetes, 14 of which are described in this paper.

## Materials and methods

Pressed and dried specimens of smut infected plants were used for studies of sorus structure and spore morphology. For light microscope (LM) studies and spore measurements, dried spores were rehydrated in lactophenol by gently heating to boiling point. For scanning electron microscope (SEM) studies, dried spores were dusted on double-sided adhesive tape, mounted on a specimen stub, sputter-coated with gold-palladium, *ca.* 20 nm, and examined in a SEM at 10 kV.

## Taxonomy

*Cintractia bulbostylidis* R.G. Shivas and K. Vánky, **sp. nov.** (Figs. 1, 4-5)

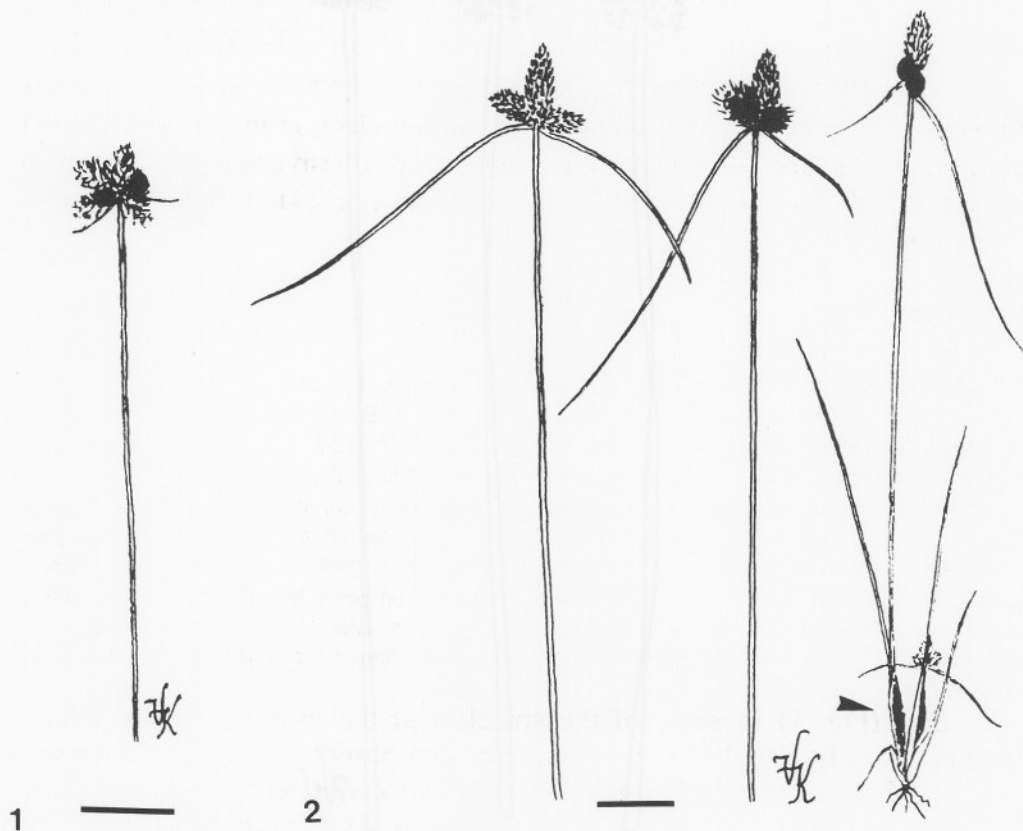
Typus in matrice *Bulbostylis barbata* (Rottb.) C.B. Clarke (det. A.A. Mitchell), Australia, Northern Territory, Gurrumura, 12°35'45" S, 136°13'53" E, 17.XII.1998, leg. R.G. Shivas [**Holotype** in BRIP 25454, **isotype** in Herbario Ustil. Vánky, HUV 18973].

*Sori* in nonnullis spiculorum inflorescentiae, sicut corpora nigra, globosa, dura, diametro 1–2 mm, e sporis agglutinatis composita, primum glumis cooperta, quorum pars basalis forte destructa, serius superficie pulverea. *Sporae* e latere compressae, in conspectu faciali circulares vel late ellipticae, 8–10 × 8–11 µm, in conspectu laterali ellipticae, latitudine 5.5–8 µm, flavidobrunneae; pariete inequali, 0.5–1 µm crasso, in lateribus complanatis tenuiori, in LM minute, clare punctato, in SEM subtiliter, irregulariter reticulato, imago obliqua sporarum levis.

*Sori* (Fig. 1) in some of the spikelets of the inflorescence as black, globose, hard bodies, 1–2 mm in diameter, composed of agglutinated spores, first covered by glumes of which the basal part may also be destroyed, later naked with a powdery surface. *Spores* (Figs. 4, 5) laterally compressed, in facial view circular or broadly elliptic, 8–10 × 8–11 µm, in lateral view elliptic, 5.5–8 µm wide, yellowish-brown; wall uneven, 0.5–1 µm thick, thinner on the flattened sides, in LM minutely, brightly punctate, in SEM finely, irregularly reticulate; spore profile smooth.

On *Cyperaceae*: *Bulbostylis barbata* (Rottb.) C.B. Clarke (*Fimbristylis barbata* (Rottb.) Benth., *Abildgaardia wallichiana* (Schultes) K. Lye), Australia. Known only from the type collection.

There are no species of *Cintracta* reported to occur on *Bulbostylis*. On *Fimbristylis* four *Cintracta* species are known: **1.** *C. axicola* (Berk.) Cornu, **2.** *C. fimbristylicola* Pavgi and Mundk., **3.** *C. mitchellii* K. Vánky, and **4.** *C. fimbristylis-miliaceae* (Henn.) S. Ito. *C. bulbostylidis* differs from the first three species in the smaller size of its spores. Under light microscopy the brightly punctate spores of *C. bulbostylidis* are apparently smooth which differs from *C. fimbristylis-miliaceae* which has prominently echinulate-reticulate spores. A further collection of a *Cintractia* sp. on *Bulbostylis barbata*, different from *C.*



**Figs. 1, 2.** *Cintractia bulbostylidis* and *C. lipocarphae*. **1.** Sori of *Cintractia bulbostylidis* in some of the spikelets of *Bulbostylis barbata* (from holotype). **2.** Sori of *Cintractia lipocarphae* in the spikes and sometimes also in the basal part of the stems (arrowhead) of *Lipocarpha microcephala* (from holotype). To the left is a healthy plant. Bars = 1 cm.

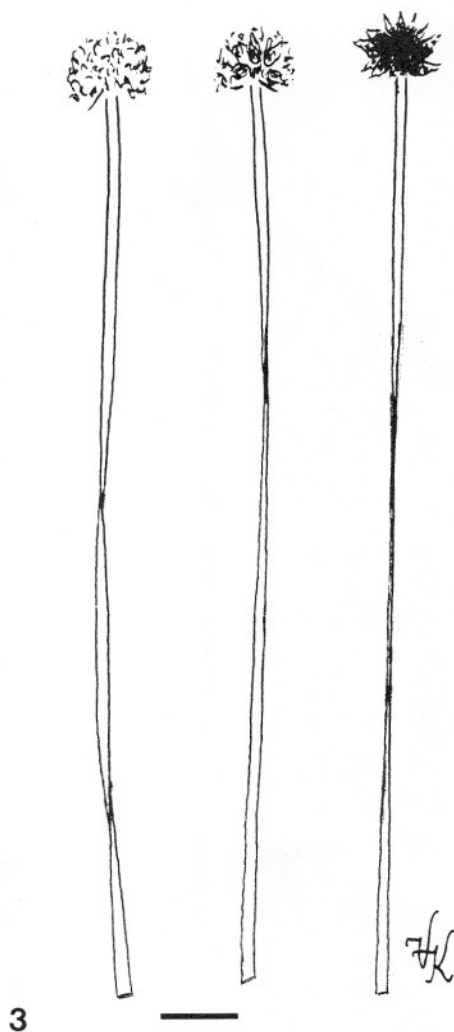
*bulbostylidis*, collected near Alice Springs in the Northern Territory is under investigation.

***Cintractia lipocarphae* K. and C. Vánky and R.G. Shivas, sp. nov.**

(Figs. 2, 6-7)

Typus in matrice *Lipocarpha microcephala* (R. Br.) Kunth (det. D. Albrecht), Australia, Northern Territory, 130 km NNW urbe Alice Springs, Stuart Highway, 22°38' S, 133°22' E, alt. cca. 660 m, 26.III.2000, leg. C. and K. Vánky [**Holotype** in BRIP 26927, **isotype** in Herbario Ustil. Vánky, HUV 19180, et in Vánky, Ust. exs. no. 1086].

*Sori* in partibus diversis plantae nutrientis, plerumque in capitulo uno vel nonnullis capitulis (spicis) inflorescentiae eiusdem sese continentes, praecipue pars una tantum capituli eiusdem affecta. In spicis sori evolutionem ipsorum incipientes axem et plus-minus etiam

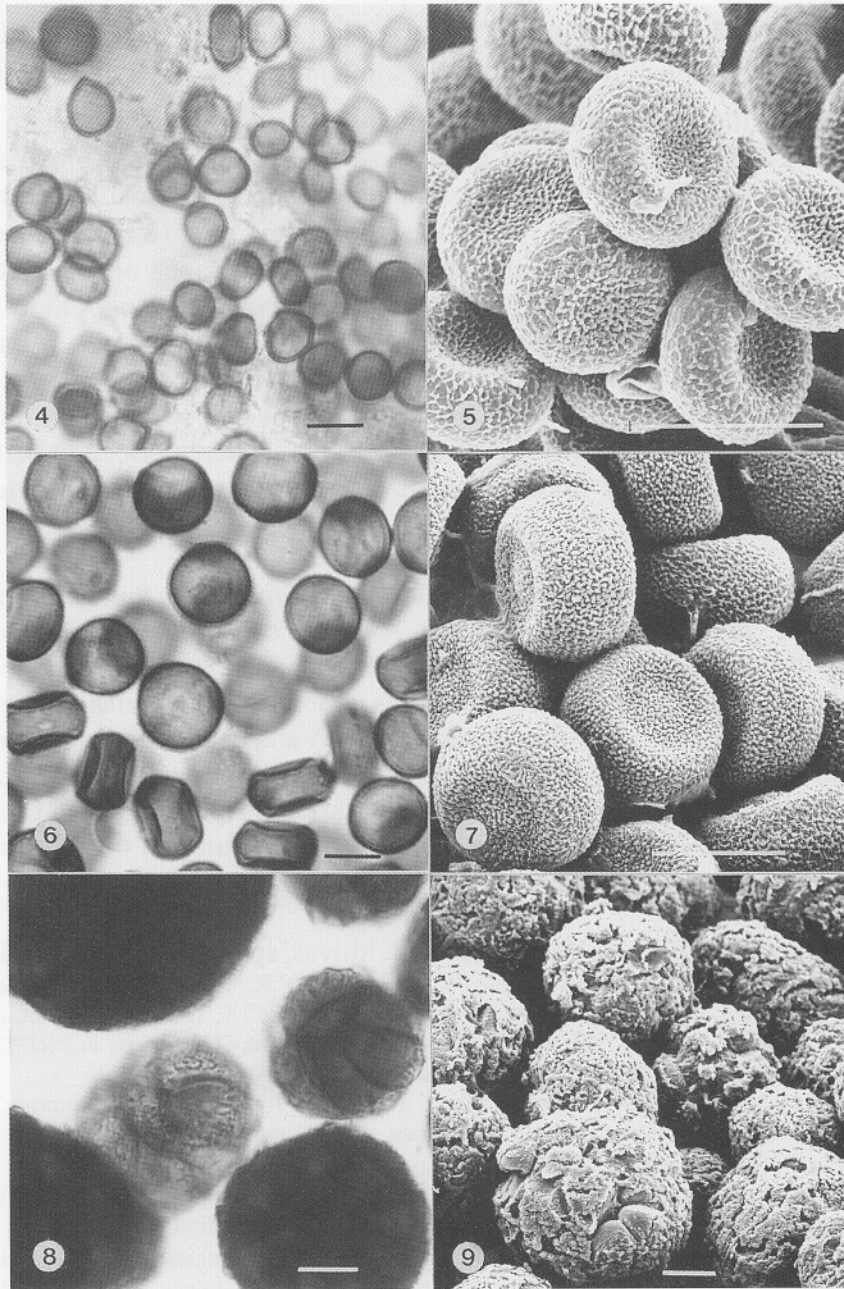


**Fig. 3.** Sori of *Moreaua arthrostylidis* in the flowers of *Arthrostylis aphylla* (from holotype). To the left is a healthy inflorescence. Bar = 1 cm.

flores occupantes. Sori juveniles peridio tenui, albido vel pallide brunneo, e telis et plantae nutrientis et fungi eformato obtecti, atque multitudine bractearum eiusdem capituli absconditi. Sori maturi intecti, globoidei, 1–2 mm diametro, nigri, compacti, superficie pulverei. Nonnunquam in parte basali caulis evolventes intumescencias fusiformes 1–1.5 × 3–15 mm formantes, primo residuis telarum viridium plantae nutrientis et particularum albidarum fungalium obtecti. *Sporae* globosae vel subglobosae, raro late ellipsoidales, (10–)11–15(–16) × 11–16(–17) μm, e latere compressae (8–10.5 μm latae), flavidobrunneae; pariete cca. 0.8 μm crasso, in lateribus depressis parum tenuiori, leniter, dense punctato usque verruculoso; imago obliqua sporarum levis usque aspera.

*Sori* (Fig. 2) in different parts of the host plants, usually restricted to one or several heads (spikes) of an inflorescence, occasionally only part of a head is affected. In the spikes, sori start to develop from the floral axis comprising also more or less the flowers. Young sori are covered by a thin, whitish or pale





**Figs. 4-9.** *Cintractia* and *Moreaua* spores. 4, 5. Spores of *Cintractia bulbostylidis* in LM and SEM (from holotype). 6, 7. Spores of *C. lipocarphae* in LM and SEM (from holotype). 8, 9. Spore balls of *Moreaua arthrostylidis* in LM and SEM (from holotype). Bars = 10  $\mu$ m.

brown peridium, formed of host and fungal tissues, and also hidden by the many bracts in a head. Mature sori are naked, globose, 1–2 mm in diameter, black, compact with powdery surface. Sometimes, sori may develop in the basal part of the stems forming fusiform swellings 1–1.5 × 3–15 mm long, covered initially by remnants of green host tissues and also whitish fungal elements. *Spores* (Figs. 6, 7) globose or subglobose, rarely broadly ellipsoidal, (10–)11–15(–16) × 11–16(–17) µm, laterally compressed (8–10.5 µm wide), yellowish-brown; wall c. 0.8 µm thick, somewhat thinner on the flattened sides, finely, densely punctate to verruculose; spore profile smooth to rough.

On *Cyperaceae*: *Lipocarpha microcephala* (R. Br.) Kunth, Australia. Known only from the type collection.

*Lipocarpha* R. Br. is a small genus of c. 35 species, widely distributed in the tropical and subtropical regions of both hemispheres (Goetghebeur and Borre, 1989). *Cintractia lipocarphae* is the first smut fungus reported on *Lipocarpha*.

The senior author revised the smut fungi of *Juncaceae*, *Restionaceae* and *Cyperaceae* possessing dark reddish- or blackish-brown, more or less permanent spore balls, composed of spores only (Vánky, 2000b). He concluded that *Tolyposporium* Woronin ex Schröter is a monospecific genus restricted to host plants in *Juncaceae*. *Restiosporium* K. Vánky, and the monospecific *Websdanea* K. Vánky are restricted to plants in the *Restionaceae*, whereas similar smut fungi on *Cyperaceae* belong to the genus *Moreaua* T.N. Liou and H.C. Cheng, with 24 known species. Two additional fungi of this group were recently discovered in Australia.

***Moreaua arthrotylidis* K. Vánky and R.G. Shivas, sp. nov.** (Figs. 3, 8–9)

Typus in matrice *Arthrotylis aphylla* R. Br. (det. P.R. Sharpe), Australia, Northern Territory, 190 km E urbe Darwin, Arnhem Highway, 12°44'24" S, 132°19'14" E, alt. cca. 50 m.s.m., 18.III.2000, leg. R.G. Shivas, I.T. Riley, C. and K. Vánky [**Holotype** in BRIP 26902, **isotype** in Herbario Ustil. Vánky, HUV 19261, et in BPI 748210].

*Sori* in superficie organorum floralium internorum (ovariorum, filamentorum), eam massa glomerulorum sporarum primum agglutinata, deinde granuloso-pulverea, nigra cooperti, glumis omnino obtecti. *Glomeruli sporarum* globosi, ovoidei, parum irregulares, 25–50 × 25–60 µm, flavidobrunnei usque atro-chocolatabrunneas, opaci, e sporis (2–)5–25 (vel pluribus ?), arcte haerentibus, pressione non separabilibus compositi. *Sporae* forma et magnitudine variae, irregulares, in conspectu faciali subpolyangulares, angulares vel elongatae, 8–15 × 10–19 µm, in aspectu opticali mediano subcuneiformes vel subtriangulares, 8–16 µm longae, flavidobrunneae sive chocolatabrunneae; pariete in superficie libera 2.5–5 µm crasso, dense, prominenter verrucoso, crebro duae vel nonnullae verrucae confluentes in seribus brevibus, ordinationem irregularem superficiei sporarum efficientes; pariete in lateribus contactis tenui (ca. 0.8 µm), levi.

*Sori* (Fig. 3) on the surface of inner floral organs (ovaries, filaments) covering them with a first agglutinated, later granular-powdery, black mass of spore balls, completely hidden by the glumes. *Spore balls* (Figs. 8, 9) globose, ovoid to slightly irregular, 25–50 × 25–60 µm, yellowish-brown to dark chocolate-brown or opaque, composed of (2–)5–25 (or more ?) firmly adhering spores which do not separate at pressure. *Spores* (Figs. 8, 9) variable in shape and size, irregular, in surface view subpolyangular, angular or elongated, 8–15 × 10–19 µm, in optical median view subcuneiform or subtriangular, 8–16 µm long, yellowish-brown to dark chocolate-brown; wall on the free surface 2.5–5 µm thick, densely, prominently verrucose, often two or several warts fuse into short rows giving an irregular pattern to the spore surface, wall on contact sides thin (c. 0.8 µm), smooth.

On *Cyperaceae*: *Arthrostylis aphylla* R. Br., Australia. Known only from the type collection.

***Moreaua fimbristylidis* K. Vánky and R.G. Shivas, sp. nov.** (Figs. 10, 13–14)

Typus in matrice *Fimbristylis dichotoma* (L.) Vahl (det. D. Albrecht), Australia, Northern Territory, 34 km ESE urbe Alice Springs, Ross Highway, 2.3 km on road to Todd River, 23°45' S, 134°09' E, alt. cca. 450 m.s.m., 25.III.2000, leg. C. and K. Vánky [**Holotype** in BRIP 26924, **isotype** in Herbario Ustil. Vánky, HUV 19178, et in Vánky, Ust. exs. no. 1085. **Paratypus** in matrice *Fimbristylis schoenoides* (Retz.) Vahl (det. P.R. Sharpe), Australia, Queensland, Barney View, November 1957, leg. R.F.N. Langdon (ut "*Tolyposporium*" sp. nov. ?), BRIP 8013, **isoparatypus** in HUV 18977].

*Sori* in superficie organorum floralium internorum (ovariorum, filamentorum), eam massa glomerulorum sporarum primum agglutinata, deinde granuloso-pulverea, nigra cooperti, glumis omnino obtecti. *Glomeruli sporarum* subglobosi, ovoidei, late ellipsoideales, plerumque parum irregulares, 30–70 × 40–100 µm, atro-rufobrunnei, olivaceobrunnei usque subopaci, e sporis 20 usque 100(?), arcte haerentibus, pressione non separabilibus compositi. *Sporae* forma et magnitudine variae, irregulares, in conspectu faciali subpolyangulares, angulares vel elongatae, 6.5–13 × 9–20 µm, in aspectu opticali mediano cuneiformes vel subtriangulares, radialiter distributae, 6.5–20(–24) µm longae, rufobrunneae sive olivaceobrunneae; pariete in superficie libera 1.5–2.5(–3) µm crasso, dense, prominenter verrucoso, crebro duae vel nonnullae verrucae confluentes, pariete in lateribus contactis tenui (ca. 0.5 µm), levi.

*Sori* (Fig. 10) on the surface of inner floral organs (ovaries, filaments) covering them with a first agglutinated, later granular-powdery, black mass of spore balls, completely hidden by the glumes. *Spore balls* (Figs. 13, 14) subglobose, ovoid, broadly ellipsoidal, usually slightly irregular, 30–70 × 40–100 µm, dark reddish-brown, olivaceous-brown to subopaque, composed of 20–100(?) tightly adhering spores which do not separate at pressure. *Spores* (Figs. 13, 14) variable in shape and size, irregular, in surface view subpolyangular, angular or elongated, 6.5–13 × 9–20 µm, in optical median view cuneiform or subtriangular, arranged radially, 6.5–20(–24) µm long, reddish-brown or olivaceous-brown; wall on the free surface 1.5–2.5(–3) µm



Fig. 10. Sori of *Moreaua fimbristylidis* in all flowers of an infected *Fimbristylis dichotoma* (from holotype). To the left is a healthy inflorescence. Bar = 1 cm.

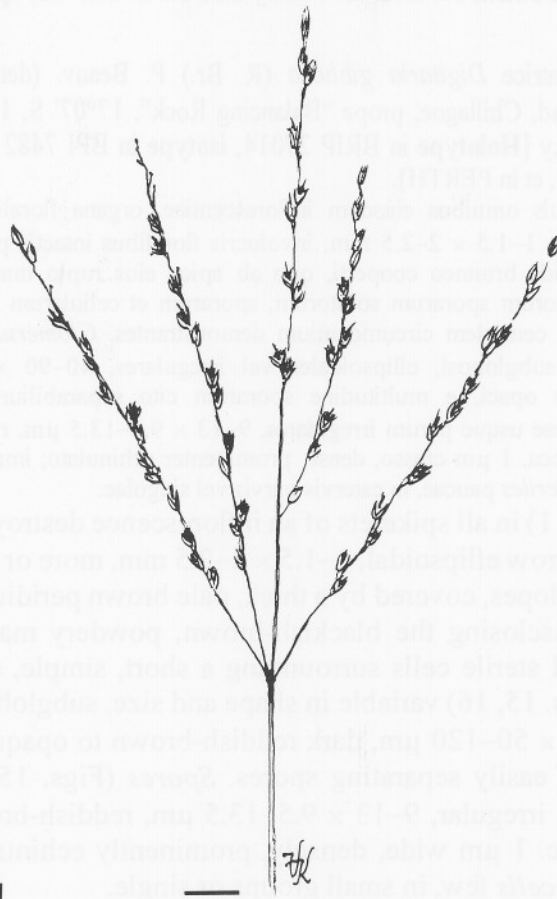
thick, densely, prominently verrucose, often two or several warts confluent, wall on contact sides thin (c. 0.5  $\mu\text{m}$ ), smooth.

On *Cyperaceae*: *Fimbristylis dichotoma* (L.) Vahl, and *F. schoenoides* (Retz.) Vahl, Australia.

The morphology of the sori and spores of the type and paratype specimens is similar, except for a slight variation in the colour of the spores. In the type specimen the spores are olivaceous-brown, whereas in the paratype the spores are mostly reddish-brown.

In its appearance, *Moreaua fimbristylidis* is similar to *M. mauritiana* (Syd.) K. Vánky (type on *Fimbristylis* sp., = *F. ovata* (Burm. f.) Kern, det. K.





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**Fig. 11.** Sori of *Sporisorium gibbosum* in the spikelets of *Digitaria gibbosa* (from holotype). Bar = 1 cm.

Vánky; Mauritius), from which it differs in the larger size of the spore balls and spores, as well as in the number of the spores in the balls. In *M. mauritiana* the spore balls measure 15–40 × 20–50(–60) μm and are composed of 2–16 spores which, in optical median view, are mainly triangular, up to 16 μm long.

**Key to species of *Moreaua* on *Fimbristylis***

- 1. Spore balls 20–50(–60) μm long, composed usually of 2–16 spores; spores up to 16 μm long ..... *M. mauritiana*
- 1. Spore balls 40–100 μm long, composed usually of 20–100(?) spores; spores up to 20(–24) μm long ..... *M. fimbristylidis*

***Sporisorium gibbosum* K. and C. Vánky and R.G. Shivas, sp. nov.**

(Figs. 11, 15-16)

Typus in matrice *Digitaria gibbosa* (R. Br.) P. Beauv. (det. B.M. Waterhouse), Australia, Queensland, Chillagoe, prope "Balancing Rock", 17°07' S, 144°32' E, 4.III.2000, leg. C. and K. Vánky [Holotype in BRIP 27014, isotype in BPI 748211, in Herbario Ustil. Vánky, HUV 19186, et in PERTH].

*Sori* in spiculis omnibus eiusdem inflorescentiae, organa floralia intima destruentes, anguste ellipsoidales, 1–1.5 × 2–2.5 mm, involucris floralibus intactis plus-minus absconditi, peridio crasso, pallide brunneo cooperti, quo ab apice eius rupto massam nigrobrunneam, pulveream glomerulorum sporarum solutorum, sporarum et cellularum sterilium, columellam brevem, simplicem, centram circumdantium demonstrantes. *Glomeruli sporarum* forma et magnitudine varii, subglobosi, ellipsoidales vel irregulares, 40–90 × 50–120 μm, atro-rubrobrunnei usque opaci, e multitudine sporarum cito separabilium compositi. *Sporae* subglobosae, ovoideae usque parum irregulares, 9–13 × 9.5–13.5 μm, rubrobrunneae; pariete parum inaequaliter cca. 1 μm crasso, dense, prominenter echinulato; imago obliqua sporarum serrulata. *Cellulae steriles* paucae, in catervis parvis vel singulae.

*Sori* (Fig. 11) in all spikelets of an inflorescence destroying the innermost floral organs, narrow ellipsoidal, 1–1.5 × 2–2.5 mm, more or less hidden by the intact floral envelopes, covered by a thick, pale brown peridium which ruptures from its apex disclosing the blackish-brown, powdery mass of loose spore balls, spores and sterile cells surrounding a short, simple, central columella. *Spore balls* (Figs. 15, 16) variable in shape and size, subglobose, ellipsoidal or irregular, 40–90 × 50–120 μm, dark reddish-brown to opaque, composed of a great number of easily separating spores. *Spores* (Figs. 15, 16) subglobose, ovoid to slightly irregular, 9–13 × 9.5–13.5 μm, reddish-brown; wall slightly unevenly thick, c. 1 μm wide, densely, prominently echinulate; spore profile serrulate. *Sterile cells* few, in small groups or single.

On *Poaceae*: *Digitaria gibbosa* (R. Br.) P. Beauv., Australia. Known only from the type collection.

***Sporisorium operculatum* K. and C. Vánky and R.G. Shivas, sp. nov.**

(Figs. 12, 17-18)

Typus in matrice *Mnesithea formosa* (R. Br.) de Koning and Sosef (conf. B.K. Simon), Australia, Queensland, Chillagoe, prope "Balancing Rock", 17°07' S, 144°32' E, 4.III.2000, leg. C. and K. Vánky [Holotype in BRIP 27015, isotype in Herbario Ustil. Vánky, HUV 19190].

*Etymology*: *operculatus*, -a, -um (Latin) = operculate, referring to the operculate spores.

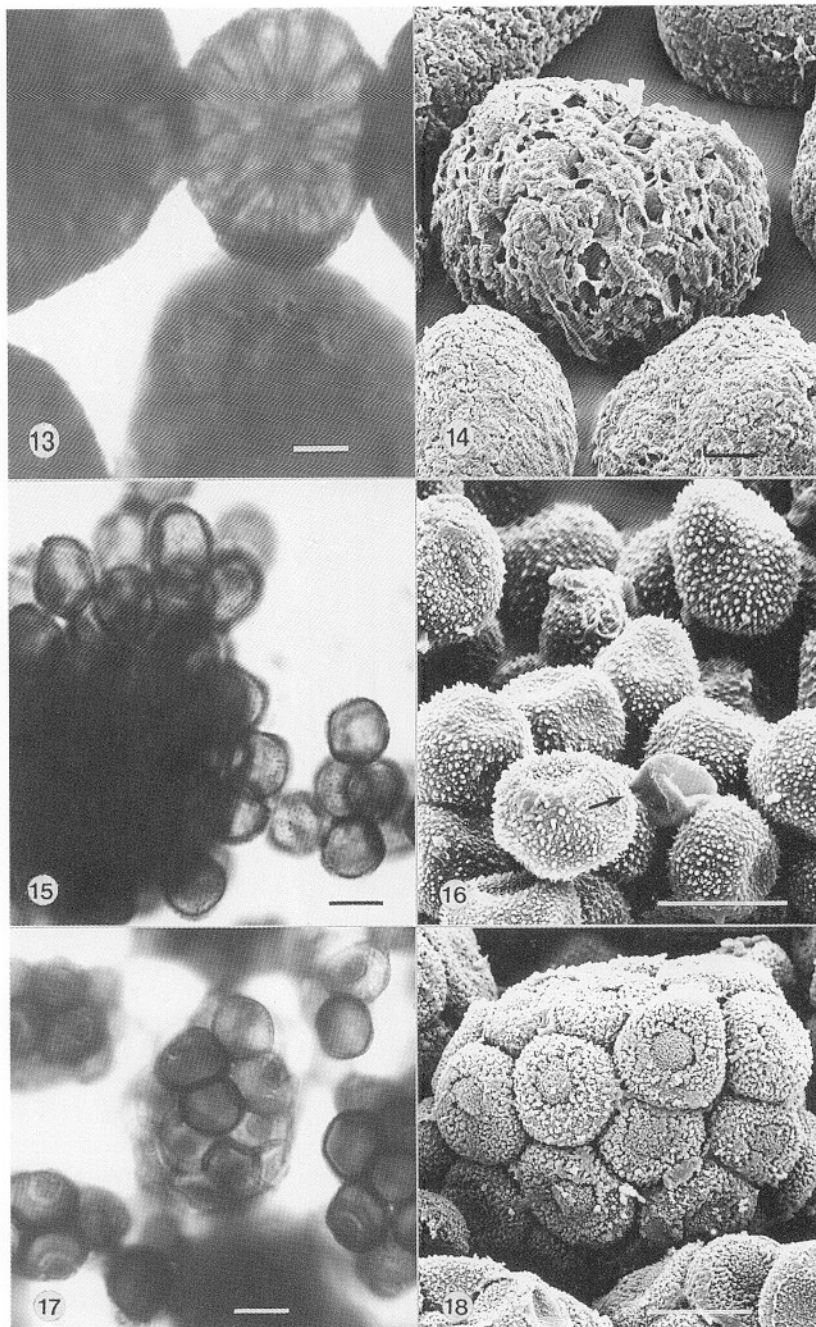
*Sori* totum racemum destruentes, longe cylindrici, cca. 1 × 15–20 mm, per vaginam folii terminalis clausi et peridio crasso, brunneo cooperti, quo irregulariter rupto massam nigrobrunneam, granulosam-pulveream glomerulorum sporarum, columellam longam, filiformem circumdantem ostendentes. *Glomeruli sporarum* globoidei, ellipsoidales, elongati usque parum irregulares, (25–)30–50 × 35–60 μm, atro-rubrobrunnei usque subopaci, e sporis 15–50(?), pressu dissolventibus compositi. *Sporae* subglobosae, ellipsoidales usque subpolyedriter irregulares, 9.5–13.5 × 10.5–16(–17) μm, flavido-usque atro-rubrobrunneae;



**Fig. 12.** A hidden sorus of *Sporisorium operculatum* destroying the whole raceme of *Mnesithea formosa* (from holotype). To the left is a healthy inflorescence. Bar = 1.5 cm.

sporae internae pariete aequaliter crasso (cca. 0.5  $\mu\text{m}$ ), leniter dense punctato-verruculoso; sporae externae pariete inaequaliter crasso (0.8–1.5  $\mu\text{m}$ ), maxime crasso ad angulos et ad superficiem liberam, grosse verrucosam-echinulatam. In superficie libera pars restricta 3–4(–5)  $\mu\text{m}$  crassa parietis sporae annulo angusto, tenui, pallido, diametro 5–6.5  $\mu\text{m}$  circumdata, haec pars parietis sporae humectae sicut obturamentum vel claustrum foraminis (operculum) prorumpens. *Cellulae steriles* non observatae.

*Sori* (Fig. 12) destroying the whole raceme, long cylindrical, c. 1  $\times$  15–20 mm, enclosed by the terminal leaf sheath and covered by a thick, brown peridium which ruptures irregularly disclosing the blackish-brown, granular-powdery mass of spore balls surrounding a long, filiform columella. *Spore balls* (Figs. 17, 18) globoid, ellipsoidal, elongated to slightly irregular, (25–) 30–50  $\times$  35–60  $\mu\text{m}$ , dark reddish-brown to subopaque, composed of 15–50(?) spores which separate by pressure. *Spores* (Figs. 17, 18) subglobose, ellipsoidal



**Figs. 13-18.** *Moreaua* and *Sporisorium* spores. **13, 14.** Spores balls of *Moreaua fimbristylidis* in LM and SEM (from holotype). **15, 16.** Spore balls (partly disintegrated), spores and a sterile cell (arrow) of *Sporisorium gibbosum*, in LM and SEM (from holotype). **17, 18.** Spores of *Sporisorium operculatum* in LM and SEM (from holotype). Note the rounded operculum on the free surface of the outer spores. Bars = 10  $\mu$ m.



to subpolyhedrally irregular, 9.5–13.5 × 10.5–16(–17)  $\mu\text{m}$ , yellowish- to dark reddish-brown; wall of the inner spores evenly thick (c. 0.5  $\mu\text{m}$ ), finely, densely punctate-verruculose, that of the outer spores unevenly thick (0.8–1.5  $\mu\text{m}$ ), thickest at the angles and on the free, coarsely verrucose-echinulate surface. On the free surface, a narrow, thin, light ring of 5–6.5  $\mu\text{m}$  diam. surrounds the thicker spore wall (3–4(–5)  $\mu\text{m}$ ) which is pushed outward like a plug or a lid (operculum) when the spores are rehydrated. *Sterile cells* not seen.

On *Poaceae*: *Mnesithea formosa* (R. Br.) de Koning and Sosef, Australia. Known only from the type collection.

#### Two new *Sporisorium* on *Sehima* (*Poaceae*)

On *Sehima* three *Sporisorium* species are known: 1. *S. sehimae* (M.S. Patil) K. Vánky, type on *Sehima nervosum*, India, 2. *S. sehimicola* K. Vánky, type on *Sehima ischaemoides*, Zimbabwe, and 3. *S. sulcati* (M.S. Patil) K. Vánky, type on *Sehima sulcatum*, India (comp. Vánky, 2000a:186–190). Two further *Sporisorium* species were recently collected in Australia, both on *Sehima nervosum*.

#### *Sporisorium nervosum* K. and C. Vánky and R.G. Shivas, *sp. nov.*

(Figs. 19, 22–23)

Typus in matrice *Sehima nervosum* (Rottler) Stapf, Australia, Queensland, 14 km S oppid. Lakeland, 15°59' S, 144°50' E, alt. cca. 410 m.s.m., 5.III.2000, leg. C. and K. Vánky [Holotype in BRIP 27019, isotype in Herbario Ustil. Vánky, HUV 19182, et in Vánky, Ust. exs. no. 1088].

*Sori* in spiculis omnibus et sessilibus et pedicellatis eiusdem inflorescentiae, involucria floralia intacta relinquentes, cylindrici vel subfusiformes, 0.8–1 × 6–10 mm, involucri floralibus partim obtecti, peridio pallide brunneo, crasso cooperti quo longitudinaliter in locis nonnullis rupto massam nigrobrunneam, granulosam-pulveream glomerulorum sporarum columellam simplicem, compactam, filiformem circumdantium ostendentes. *Glomeruli sporarum* globoidei, ovoidei, elongati vel parum irregulares, 20–35 × 25–50(–55)  $\mu\text{m}$ , rubrobrunnei, satis permanentes, e sporis 10–40 (vel pluribus ?) compositi. *Sporae* rotundatae, subpolyedriciter irregulares, ellipsoidales, elongatae, raro subglobosae, 8–11 × 9.5–12(–13.5)  $\mu\text{m}$ , flavidobrunneae, spora externa atriores, interna dilutiores; pariete aequaliter crasso, 0.5–0.8  $\mu\text{m}$  (excepto ornamento), superficies libera verrucis duris, 0.5–1  $\mu\text{m}$  altis instructa, latera contacta et spora interna levis. *Cellulae steriles* non observatae.

*Sori* (Fig. 19) in all sessile and pedicelled spikelets of an inflorescence, leaving intact the floral envelopes, cylindrical or subfusiform, 0.8–1 × 6–10 mm, partly hidden by the floral envelopes, covered by a pale brown, thick peridium which ruptures longitudinally in several places disclosing the blackish-brown, granular-powdery mass of spore balls surrounding a simple, stout, filiform columella. *Spore balls* (Figs. 22, 23) globoid, ovoid, elongated or slightly irregular, 20–35 × 25–50(–55)  $\mu\text{m}$ , reddish-brown, rather permanent, composed of 10–40(or more?) spores. *Spores* (Figs. 22, 23)



**Figs. 19, 20.** Sori of *Sporisorium* species. **19.** Sori of *Sporisorium nervosum* in all spikelets of an inflorescence of *Sehima nervosum* (from holotype). **20.** Sori of *S. queenslandicum* destroying the whole raceme of *Sehima nervosum* (from holotype). The younger sori beneath is still enclosed by the leaf sheath and covered by a whitish peridium which ruptures transversally in regular intervals corresponding to the destroyed spikelet pairs. In the middle is a healthy inflorescence. Bar = 1 cm.

rounded, subpolyhedrally irregular, ellipsoidal, elongated, rarely subglobose, 8–11 × 9.5–12(–13.5) µm, yellowish-brown, outer spores darker, inner spores lighter; wall evenly thick, 0.5–0.8 µm (excluding the ornamentation), free surface provided with coarse, 0.5–1 µm high warts, contact sides and inner spores smooth. *Sterile cells* not seen.

On *Poaceae*: *Sehima nervosum* (Rottler) Stapf, Australia. Known only from the type collection.

*Sporisorium nervosum* resembles *S. sulcati* (M.S. Patil) K. Vánky (type on *Sehima sulcatum* (Hackel) A. Camus, India). However, *S. sulcati* has spore balls 20–50 × 30–70(–100) µm which are composed of more spores, the spore wall is unevenly thick, 1–2(–2.5) µm, thickest at the angles, and the free surface of the spores is very finely punctate.

***Sporisorium queenslandicum* K. and C. Vánky and R.G. Shivas, sp. nov.**

(Figs. 20, 24–25)

Typus in matrice *Sehima nervosum* (Rottler) Stapf, Australia, Queensland, 14 km S oppid. Lakeland, 15°59' S, 144°50' E, alt. cca. 410 m.s.m., 5.III.2000, leg. C. and K. Vánky [Holotype in BRIP 27020, isotype in BPI 748213, Herbario Ustil. Vánky HUV 19181, IMI 384514, et in PERTH].

*Sori* racemum totum destruentes, longe cylindrici vel fusiformes, 1–1.5 × 30–60 mm, primo vagina folii terminalis absconditi et peridio tenui, cinerascanti cooperti, serius exserti, peridio discesso, massam atrobrunneam, pulveream glomerulorum sporarum laxorum, sporarum et cellularum sterilium dispergentes, columellam longam, crassam, simplicem, flagelliformem, nonnunquam ramulis paucis brevibus lateralibus instructam relinquentes. *Glomeruli sporarum* e sporis multis formati, fugaces. *Sporae* globosae, subglobosae, ellipsoidales, magnitudine variae, 5.5–9 × 5.5–10 µm, flavidobrunneae; pariete aequaliter crasso (ca. 0.5 µm), leniter, dense punctato usque echinulato; imago oblique sporarum levis usque leniter serrulata. *Cellulae steriles* in catervis minoribus vel majoribus, cellulae singulae variae, subglobosae, ellipsoidales vel irregulares cum lateribus deplanatis, 5–16 × 5–16(–20) µm, hyalinae usque pallide flavidobrunneae; pariete tenui (ca. 0.5 µm), levi.

*Sori* (Fig. 20) destroying the whole raceme, long cylindrical or fusiform, 1–1.5 × 30–60 mm, first hidden by the terminal leaf sheath and covered by a thin, greyish peridium, later protruding, the peridium flakes away and the dark brown, powdery mass of loose spore balls, spores and sterile cells is scattered leaving behind a long, stout, simple, flagelliform columella, sometimes with a few short lateral branches. *Spore balls* of many spores, ephemeral. *Spores* (Figs. 24, 25) globose, subglobose, ellipsoidal, variable in size, 5.5–9 × 5.5–10 µm, yellowish-brown; wall evenly thick (c. 0.5 µm), finely, densely punctate to echinulate, spore profile smooth to finely serrulate. *Sterile cells* (Figs. 24, 25) in smaller or larger groups, single cells variable, subglobose, ellipsoidal or irregular with flattened sides, 5–16 × 5–16(–20) µm, hyaline to pale yellowish-brown; wall thin (c. 0.5 µm), smooth.

On *Poaceae*: *Sehima nervosum* (Rottler) Stapf, Australia. Known only from the type collection.

**Key to the smut fungi on *Sehima***

- 1. Sori in the leaves as dark spots. Spores embedded in the host tissue..... *Entyloma dactylidis*
- 1. Sori not in the leaves. Spores pulverulent ..... 2
- 2. Sori destroying the whole inflorescence, 3–6 cm long. Spores 5.5–10.5  $\mu\text{m}$  long..... *Sporisorium queenslandicum*
- 2. Sori restricted to the spikelets, less than 1.5 cm long. Spores larger ..... 3
- 3. Spore balls ephemeral. Sterile cells present ..... *Sporisorium sehimicola*
- 3. Spore balls rather persistent. Sterile cells absent ..... 4
- 4. Sori in some sessile spikelets. Columella 5–7. Spore balls 50–160(–200)  $\mu\text{m}$  long ..... *Sporisorium sehimae*
- 4. Sori in all sessile and pedicelled spikelets. Columella 1. Spore balls smaller ..... 5
- 5. Spore balls 30–70(–100)  $\mu\text{m}$  long. Spore wall uneven, 1–2(–2.5)  $\mu\text{m}$  thick, free surface finely punctate ..... *Sporisorium sulcati*
- 5. Spore balls 25–50(–55)  $\mu\text{m}$  long. Spore wall even, 0.5–0.8  $\mu\text{m}$  thick, free surface coarsely verruculose ..... *Sporisorium nervosum*

**Two new smut fungi on *Whiteochloa* (*Poaceae*)**

*Whiteochloa* C.E. Hubb. is a small genus, closely related to *Panicum*, in the subfamily *Panicoideae*, tribe *Paniceae*, subtribe *Setariinae* (Clayton and Renvoize, 1986:286), with six known species, restricted to Australia (Simon, 1993: 175). No smut fungus has yet been reported on *Whiteochloa*.

***Sporisorium whiteochloae* K. Vánky and McKenzie, sp. nov.**

(Figs. 21, 26–27, 28)

Typus in matrice *Whiteochloa cymbiformis* (Hughes) B.K. Simon, Australia, Western Australia, Kimberley Region, Kununurra, Fishfarm Road, 15°46' S, 128°44' E, 26.VI.1998, leg. et comm. R.H. Eichner [Holotype in PDD 69082, isotype in BRIP 26823, HUV 18641, PERTH 5172373, et in Plant Pathology Herb., Dept. of Primary Industry and Fisheries, Berrimah, Northern Territory, Australia].

*Sori* in spiculis, ovoidei, cylindrici, plerumque cum apice acuto, saepe parum curvati, 1–1.5  $\times$  1.5–4 mm, organa omnia floralia occupantes, glumam tantum primam, quandoque etiam glumam secundam intacte relinquentes. Sori peridio crasso, pallide flavido-brunneo cooperti, quo irregulariter rupto massam nigram primo agglutinatam, serius granulati-pulveream glomerulorum sporarum et columellam simplicem, centralem, longitudine soro aequalem ostendentes. Sori forte ramum lateralem paniculi partim vel etiam totaliter occupantes, si magnitudine valde evoluti. *Glomeruli sporarum* ovoidei, elongati vel parum irregulares, raro

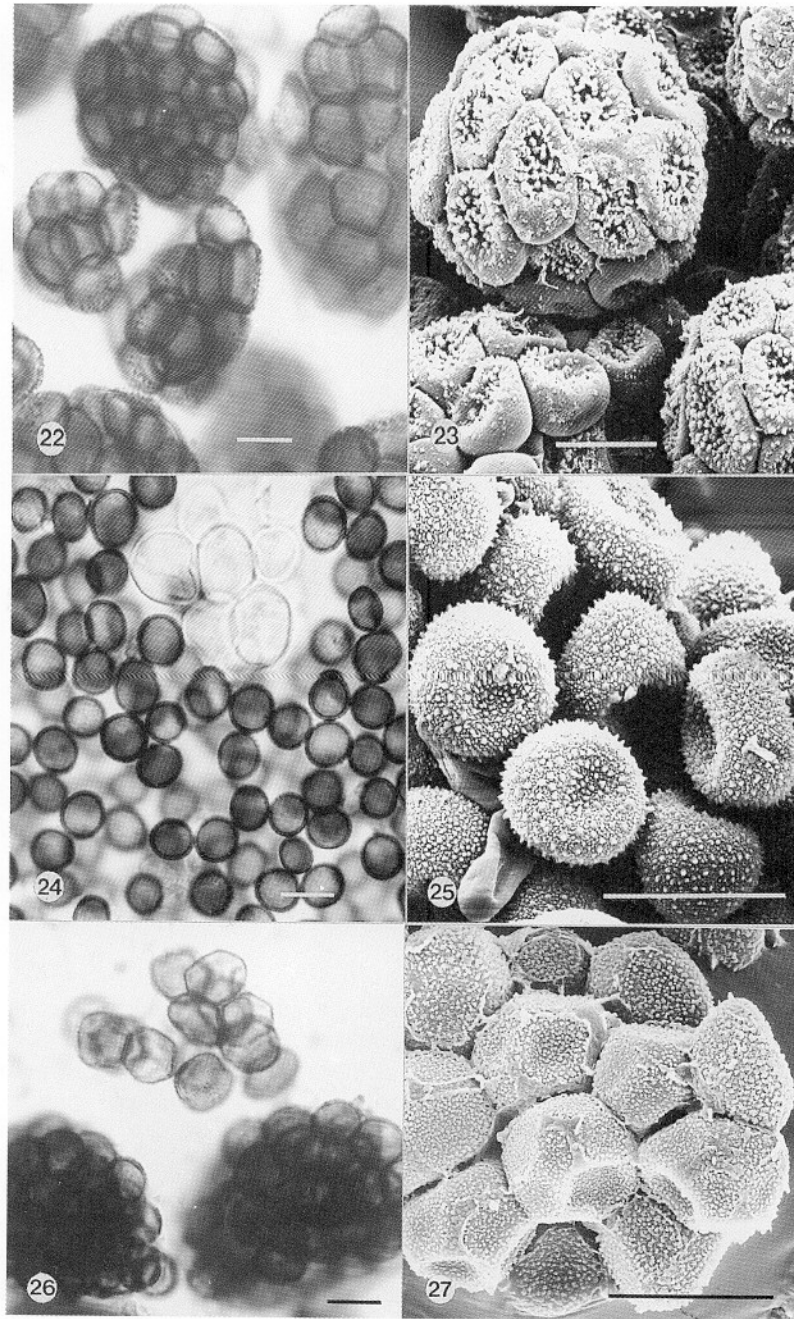




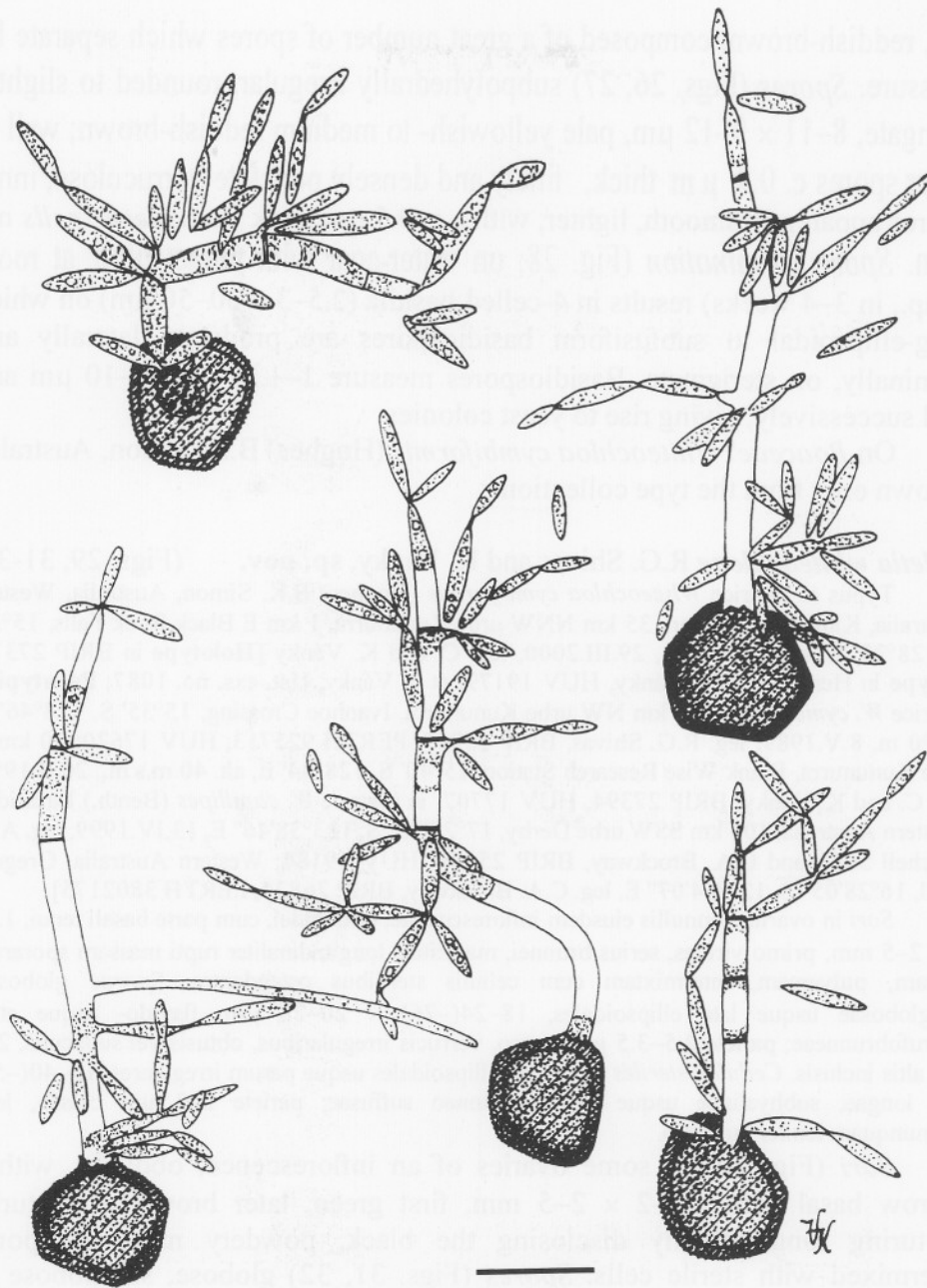
**Fig. 21.** Sori of *Sporisorium whiteochloae* in the spikelets or in the panicle branches of *Whiteochloa cymbiformis* (from holotype). Enlarged are two spikelets with sori. Bars = 1 cm and 2 mm for enlargement.

subglobosi, 25–70 × 40–130 μm, subrufo-brunnei, e multitudine sporarum compressione discessarum compositi. *Sporae* subpolyedriter irregulares, rotundae usque parum elongatae, 8–11 × 9–12 μm, pallide flavido-usque mediocriter subrufo-brunneae; pariete sporarum externarum cca. 0.8 μm crasso, leniter et dense punctato-verruculoso; sporae internae conspicue leves, pallidiores, pariete cca. 0.5 μm crasso. *Cellulae steriles* non observatae. *Germinatio sporarum* cum basidiis 4-cellularibus, cum basidiosporis in sterigmatibus evolutis, longe ellipsoidalibus usque subfusiformibus, lateraliter et terminaliter productis, magnitudine 1–1.5(–2) × 3–10 μm. Basidiosporae successive pullulantes, colonias fermentorum erigentes.

*Sori* (Fig. 21) in the spikelets, ovoid, cylindrical, usually with acute tip, often slightly curved, 1–1.5 × 1.5–4 mm, comprising all floral organs leaving only the first, sometimes also the second glume intact. Sori covered by a thick, pale yellowish-brown peridium which ruptures irregularly disclosing the black, first agglutinated, later granular-powdery mass of spore balls, and a simple, central columella of the length of the sorus. Sori may comprise part or whole of a lateral branch of the panicle when much larger in size. *Spore balls* (Figs. 26, 27) ovoid, elongate or slightly irregular, rarely subglobose, 25–70 × 40–130



**Figs. 22-27.** *Sporisorium* spores. 22, 23. Spore balls and spores of *Sporisorium nervosum* in LM and SEM (from holotype). 24, 25. Spores and sterile cells of *Sporisorium queenslandicum* in LM and SEM (from holotype). 26, 27. Spore balls and spores of *Sporisorium whiteochloae* in LM and SEM (from holotype). Bars = 10  $\mu$ m.



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**Fig. 28.** Germinating spores of *Sporisorium whiteochloae* (on water agar with tetracycline at room temperature after 3-4 weeks) with septate, mostly 4-celled basidia on which ovoid to fusiform basidiospores were produced on sterigmata, laterally and terminally, or exceptionally hyphae were born (from holotype). Bar = 10  $\mu$ m.

$\mu\text{m}$ , reddish-brown, composed of a great number of spores which separate by pressure. *Spores* (Figs. 26, 27) subpolyhedrally irregular, rounded to slightly elongate,  $8\text{--}11 \times 9\text{--}12 \mu\text{m}$ , pale yellowish- to medium reddish-brown; wall of outer spores c.  $0.8 \mu\text{m}$  thick, finely and densely punctate-verruculose, inner spores apparently smooth, lighter, with a c.  $0.5 \mu\text{m}$  thick wall. *Sterile cells* not seen. *Spore germination* (Fig. 28; on water-agar with tetracycline, at room temp., in 3–4 weeks) results in 4-celled basidia ( $2.5\text{--}3 \times 30\text{--}50 \mu\text{m}$ ) on which long-ellipsoidal to subfusiform basidiospores are produced laterally and terminally, on sterigmata. Basidiospores measure  $1\text{--}1.5(2) \times 3\text{--}10 \mu\text{m}$  and bud successively, giving rise to yeast colonies.

On *Poaceae*: *Whiteochloa cymbiformis* (Hughes) B.K. Simon, Australia. Known only from the type collection.

***Tilletia whiteochloae*** R.G. Shivas and K. Vánky, **sp. nov.** (Figs. 29, 31–32)

Typus in matrice *Whiteochloa cymbiformis* (Hughes) B.K. Simon, Australia, Western Australia, Kimberley Region, 35 km NNW urbe Kununurra, 1 km E Black Rock Falls,  $15^{\circ}39' \text{S}$ ,  $128^{\circ}39' \text{E}$ , alt. 35 m.s.m., 29.III.2000, leg. C. and K. Vánky [**Holotype** in BRIP 27374, **isotype** in Herbario Ustil. Vánky, HUV 19179, et in Vánky, Ust. exs. no. 1087; **Paratypi** in matrice *W. cymbiformis*, 12 km NW urbe Kununurra, Ivanhoe Crossing,  $15^{\circ}35' \text{S}$ ,  $128^{\circ}46' \text{E}$ , alt 20 m, 8.V.1989, leg. R.G. Shivas, BRIP 26997, PERTH 925713, HUV 17620; 20 km N urbe Kununurra, Frank Wise Research Station,  $15^{\circ}40' \text{S}$ ,  $128^{\circ}44' \text{E}$ , alt. 40 m.s.m., 20.II.1996, leg. C. and K. Vánky, BRIP 27394, HUV 17707; in matrice *W. capillipes* (Benth.) Lazarides, Western Australia, 100 km SSW urbe Derby,  $17^{\circ}20'15'' \text{S}$ ,  $123^{\circ}38'46'' \text{E}$ , 13.IV.1999, leg. A.A. Mitchell 5691 and C.A. Brockway, BRIP 25588, HUV 19184; Western Australia, Gregory Well,  $16^{\circ}28'05'' \text{S}$ ,  $122^{\circ}54'07'' \text{E}$ , leg. C.A. Brockway, BRIP 26824, PERTH 3802175].

*Sori* in ovariis nonnullis eiusdem inflorescentiae, obovoidei, cum parte basali tenui,  $1.5\text{--}2 \times 2\text{--}5 \text{ mm}$ , primo virides, serius brunnei, maturitate longitudinaliter rupti massam sporarum nigram, pulveream, intermixtam cum cellulis sterilibus ostendentes. *Sporae* globosae, subglobosae usque late ellipsoidales,  $18\text{--}24(26) \times 20\text{--}28 \mu\text{m}$ , flavido- usque atro-subrufobrunneae; pariete  $2.5\text{--}3.5 \mu\text{m}$  crasso, verrucis irregularibus, obtusis vel subacutis,  $2\text{--}3 \mu\text{m}$  altis inclusis. *Cellulae steriles* globosae, ellipsoidales usque parum irregulares,  $15\text{--}40(55) \mu\text{m}$  longae, subhyalinae usque flavido-brunneo suffusae; pariete  $2\text{--}3 \mu\text{m}$  crasso, levi, nonnunquam leniter punctato.

*Sori* (Fig. 29) in some ovaries of an inflorescence, obovoid, with a narrow basal part,  $1.5\text{--}2 \times 2\text{--}5 \text{ mm}$ , first green, later brown, at maturity rupturing longitudinally disclosing the black, powdery mass of spores intermixed with sterile cells. *Spores* (Figs. 31, 32) globose, subglobose to broadly ellipsoidal,  $18\text{--}24(26) \times 20\text{--}28 \mu\text{m}$ , yellowish- to dark reddish-brown; wall  $2.5\text{--}3.5 \mu\text{m}$  thick, including the irregular, blunt or subacute,  $2\text{--}3 \mu\text{m}$  high verrucae. *Sterile cells* (Figs. 31, 32) globose, ellipsoidal to slightly irregular,  $15\text{--}40(55) \mu\text{m}$  long, subhyaline to tinted yellowish-brown; wall  $2\text{--}3 \mu\text{m}$  thick, smooth, sometimes finely punctate.

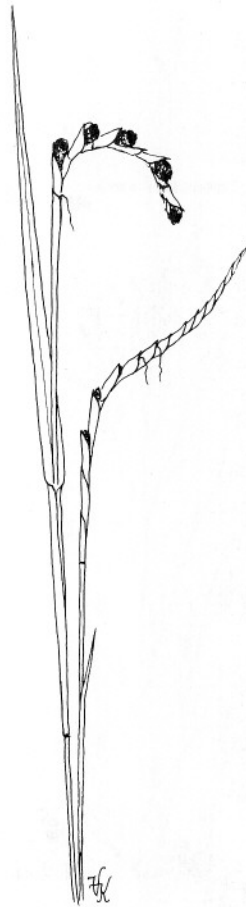




29

**Fig. 29.** Sori of *Tilletia whiteochloae* in some ovaries of the distal part an inflorescence of *Whiteochloa cymbiformis* (from holotype). Enlarged is a healthy spikelet and a mature, opened sorus. Bars = 1 cm and 2mm for enlargement.

On *Poaceae*: *Whiteochloa capillipes* (Benth.) Lazarides, *W. cymbiformis* (Hughes) B.K. Simon and *W. multiciliata* Lazarides, Australia. From the types and several additional collections, mainly by Andrew A. Mitchell, it seems that *Tilletia whiteochloae* is widespread in the Kimberley Region, Western



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**Fig. 30.** Sori of *Tilletia chionachnes* in the ovaries of *Chionache cyathopoda* (from holotype). Bar = 1 cm.

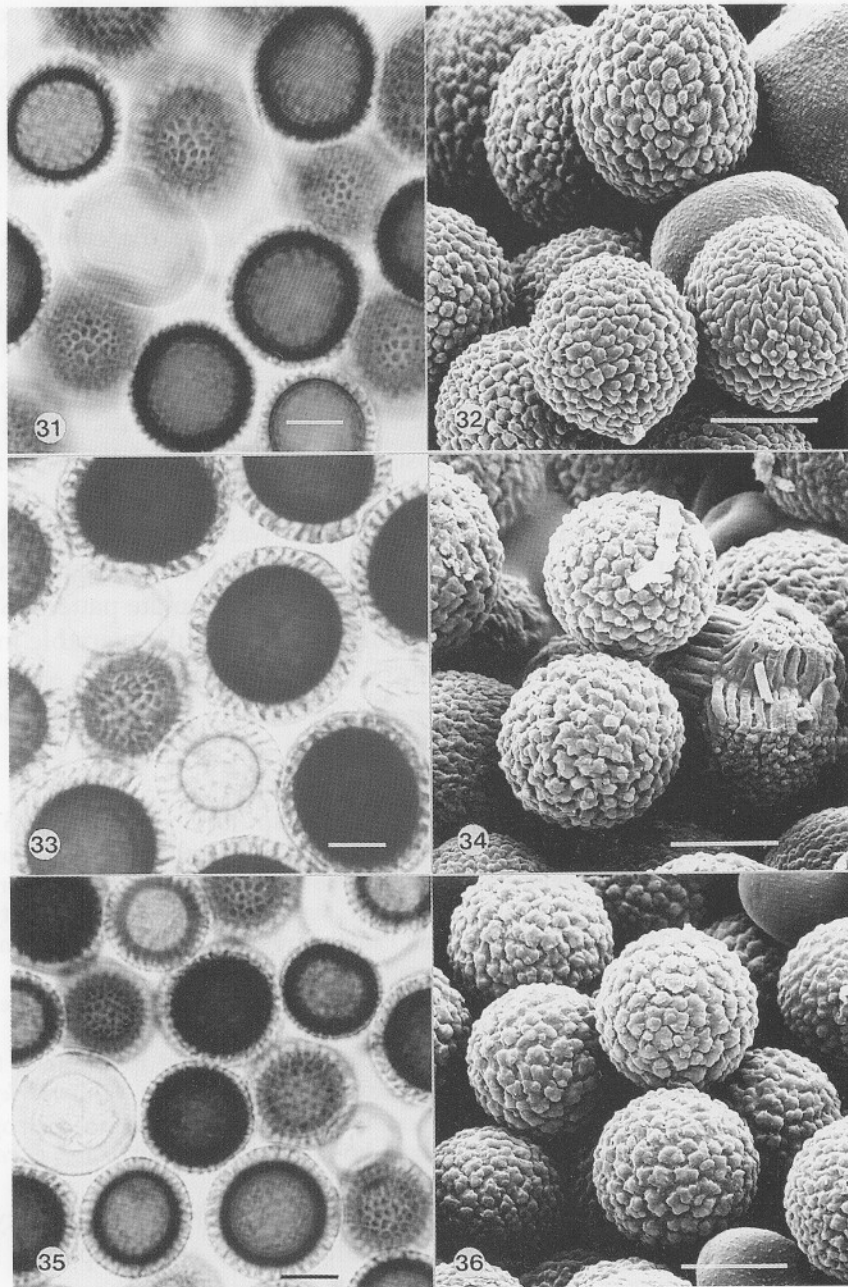
Australia, but locally uncommon, infecting only a few ovaries of an inflorescence.

***Tilletia chionachnes* K. and C. Vánky and R.G. Shivas, sp. nov.**

(Figs. 30, 33-34)

Typus in matrice *Chionachne cyathopoda* (F. Muell.) F. Muell. ex Benth., Australia, Queensland, Cape York Peninsula, 3 km N oppid. Bamaga, 10°51'15" S, 142°24'09" E, alt. cca. 50 m.s.m., 7.III.2000, leg. R.G. Shivas, P.J.L. Whittle, C. and K. Vánky [**Holotype** in BRIP 26898, **isotype** in Herbario Ustil. Vánky, HUV 19173, et in Vánky, Ust. exs. no. 1083].

*Sori* in ovariiis, tumefacti, obovoidei, apice rotundati, ad partem basalem tenuiescentes, 5–6 × 8–10 mm, primo virides, maturitate brunnei, cum orificio apicali vel subapicali, rotundo vel irregulari, propter membranam obtegentem tenuem partis huius sori. Massa sporarum nigra, semiagglutinata usque pulverea cum cellulis sterilibus intermixta per hoc orificium successive dispergens. Spicae infectae plerumque typice inclinatae propter soros tumefactos in eodem latere axix floralis dispositos. Maturitate inflorescentiae sori plus-minus evacuati perfecte simul cum spicula tota et segmento rachidis decidui. *Sporae* globosae, subglobosae usque late ellipsoidales, 22–30 × 23–36 μm, flavido- usque atro-badiae vel opacae; pariete 4.5–6 μm



**Figs. 31-36.** *Tilletia* species. **31, 32.** Spores and sterile cells of *Tilletia whitechloae* in LM and SEM (from holotype). **33, 34.** Spores and sterile cells of *Tilletia chionachnes* in LM and SEM (from holotype). Note the long, cylindrical warts of a partly broken spore in 34. **35, 36.** Spores and sterile cells of *Tilletia kimberleyensis* in LM and SEM (from holotype). Bars = 10  $\mu$ m.

crasso, inclusis verrucis 2.5–4  $\mu\text{m}$  altis et cca. 1  $\mu\text{m}$  latis ("projectionibus"), apice subacutis, rotundatis vel deplanatis. Verrucae obscuriores et spatia pallidiora inter eas visu superficiali imaginem subtilem irregulariter reticulatam formantes. *Cellulae steriles* subglobosae, ellipsoidales vel parum irregulares, magnitudine variae, 14–24(–35)  $\times$  14–28(–35)  $\mu\text{m}$ , subhyalinae; pariete 1.5–4(–6)  $\mu\text{m}$  crasso, levi.

*Sori* (Fig. 30) in the ovaries, swollen, obovoid with rounded tip and a narrowing basal part, 5–6  $\times$  8–10 mm, first green, brown at maturity with an apical or subapical, rounded or irregular opening due to the thin covering membrane on this part of the sori. The black, semiagglutinated to powdery mass of spores intermixed with sterile cells is successively scattered through this opening. Infected spikes are typically bent due to the swollen sori situated on one side of the floral axis. As the inflorescence matures, the more or less empty sori fall entirely together with the whole spikelet and a rachis segment. *Spores* (Figs. 33, 34) globose, subglobose to broadly ellipsoidal, 22–30  $\times$  23–36  $\mu\text{m}$ , yellowish- to dark chocolate-brown or opaque; wall 4.5–6  $\mu\text{m}$  thick including the 2.5–4  $\mu\text{m}$  high and c. 1  $\mu\text{m}$  wide warts ("projections") with subacute, rounded or flattened tip. In surface view, the darker warts and the lighter spaces between them form a finely, irregularly reticulate pattern. *Sterile cells* (Figs. 33, 34) subglobose, ellipsoidal or slightly irregular, variable in size, 14–24(–35)  $\times$  14–28(–35)  $\mu\text{m}$ , subhyaline; wall 1.5–4(–6)  $\mu\text{m}$  thick, smooth.

On *Poaceae*: *Chionachne cyathopoda* (F. Muell.) F. Muell. ex Benth., Australia. Known only from the type collection.

***Tilletia kimberleyensis* K. Vánky and R.G. Shivas, sp. nov.** (Figs. 35–36)

Typus in matrice *Chionachne cyathopoda* (F. Muell.) F. Muell. ex Benth., Australia, Western Australia, Kimberley Region, 5.5 km W urbe Kununurra, Junction of Ord and Dunham Rivers, 15°46'35" S, 128°41'12" E, 1.V.1999, leg. A.A. Mitchell 5779 [Holotype in BRIP 25642, isotype in HUV 19174, et in Plant Pathology Herb., Dept. of Primary Industry and Fisheries, Berrimah, Northern Territory, Australia].

*Etymology*: *kimberleyensis* from the Kimberley Region of Western Australia, where this fungus was collected.

*Tilletia kimberleyensis* a *T. chionachnes* K. and C. Vánky and R.G. Shivas forma, magnitudine, crassitudine parietis et colore sporarum distincta. *Sporae* *T. kimberleyensis* globosae vel subglobosae, 16–24  $\times$  16–24(–26)  $\mu\text{m}$ , flavido- usque atro-brunneae, non opacae; pariete 2.5–4.5  $\mu\text{m}$  crasso, verrucis (projectionibus) 1.5–3.5  $\mu\text{m}$  altis inclusis. *Sori* et *cellulae steriles* illis *T. chionachnes* similes.

*Tilletia kimberleyensis* differs from *T. chionachnes* K. and C. Vánky and R.G. Shivas in shape, size, wall-thickness and colour of the spores. In *T. kimberleyensis* the spores (Figs. 35, 36) are globose or subglobose, 16–24  $\times$  16–24(–26)  $\mu\text{m}$ , yellowish- to dark brown, not opaque; wall 2.5–4.5  $\mu\text{m}$  thick, including the 1.5–3.5  $\mu\text{m}$  high warts (projections). *Sori* and *sterile cells* similar to those in *T. chionachnes*.



On *Poaceae*: *Chionachne cyathopoda* (F. Muell.) F. Muell. ex Benth., Australia. Known only from the type collection.

*Tilletia chionachnes* and *T. kimberleyensis*, both on *Chionachne cyathopoda*, differ from *T. punensis* (S.D. Patil and Gandhe) K. Vánky (type on the closely related *Polytoca barbata* (Roxb.) Stapf (*Chionachne koenigii* (Spreng.) Thwaites and Hooker fil., India), i.a., in having smaller spores and lower ornamentation. The spores in *T. punensis* measure 28–50  $\mu\text{m}$ , the warts (projections) are 3–6.5  $\mu\text{m}$  high.

#### A new *Tilletia* on *Arundinella* (*Poaceae*)

Of the eight smut fungi described on *Arundinella*, there is one *Tilletia* species, *T. arundinellae* L. Ling (type on *A. anomala* Steud., China). A different *Tilletia* species was collected by the sharp-eyed Australian botanist, Andrew A. Mitchell, which is described as:

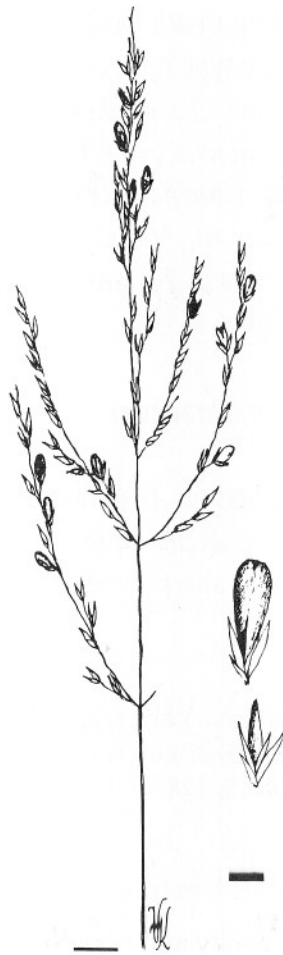
#### *Tilletia lineata* R.G. Shivas and K. Vánky, **sp. nov.** (Figs. 37, 39-40)

Typus in matrice *Arundinella nepalensis* Trin., Australia, Western Australia, Kimberley Region, ad lacum Kununurra, 15°46' S, 128°44' E, alt. cca. 20 m.s.m., 28.II.1995, leg. A.A. Mitchell [**Holotype** in PERTH 3801454, **isotype** in BRIP 26844, et in Herbario Ustil. Vánky, HUV 17450].

*Etymology*: *linea* (Latin) = line, from the grey stripes on the sorus.

*Sori* in nonnullis ovaris eiusdem inflorescentiae, satis conspicui, obovoidei, apice rotundati vel breviter acutati, cum pedicello longiusculo, tenui, (1–)1.5–2.5  $\times$  3–5 mm, a latere compressi (ca. 1 mm lati), pericarpio cooperti, primo virides, serius brunnei cum linea cinerea longitudinali in lateribus ambis. Sori maturis secundum unam linearum longitudinalium cinerearum vel in apice dehiscentes massam nigram, pulveream, intermixtam cum cellulis sterilibus sporarum ostendentes. *Sporae* globosae vel subglobosae, late ellipsoidales, ovoideae vel parum irregulares, 19–24(–27)  $\times$  20–27(–30)  $\mu\text{m}$ , pallide usque atro chocolatabrunnea; pariete 3–4  $\mu\text{m}$  crasso una cum endosporio tenui (ca. 0.6  $\mu\text{m}$ ), uniformi et exosporio verrucis 1.5–2.5  $\mu\text{m}$  altis instructo. Sub SEM verrucae illae isolatae vel coalescentes 2–3 sed non in seriabus ordinatae. *Cellulae steriles* plerumque maiores quam sporae, subglobosae, ovoideae usque parum irregulares, 20–40  $\mu\text{m}$  longae, subhyalinae usque pallide flavidobrunneae; pariete 1.5–6(–8)  $\mu\text{m}$  crasso, saepe multistratoso, levi.

*Sori* (Fig. 37) in some of the ovaries of an inflorescence, rather conspicuous, obovoid with rounded or shortly pointed tip and a longer, narrow pedicel, (1–)1.5–2.5  $\times$  3–5 mm, laterally compressed (c. 1 mm wide), covered by the pericarp, first green, later brown with a grey, longitudinal stripe on each side. At maturity the sori split along one of the grey, longitudinal stripes or from their apex exposing the black, pulverulent mass of spores intermixed with sterile cells. *Spores* (Figs. 39, 40) globose or subglobose, broadly ellipsoidal, ovoid or slightly irregular, 19–24(–27)  $\times$  20–27(–30)  $\mu\text{m}$ , pale to dark chocolate-brown; wall 3–4  $\mu\text{m}$  thick including the thin (c. 0.6  $\mu\text{m}$ ), uniform



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**Fig. 37.** Sori of *Tilletia lineata* on *Arundinella nepalensis* (from holotype). Enlarged is a sorus of *T. lineata* (above), and a sorus of *T. arundinellae* (below). Bars = 1 cm, and 2 mm for enlargement.

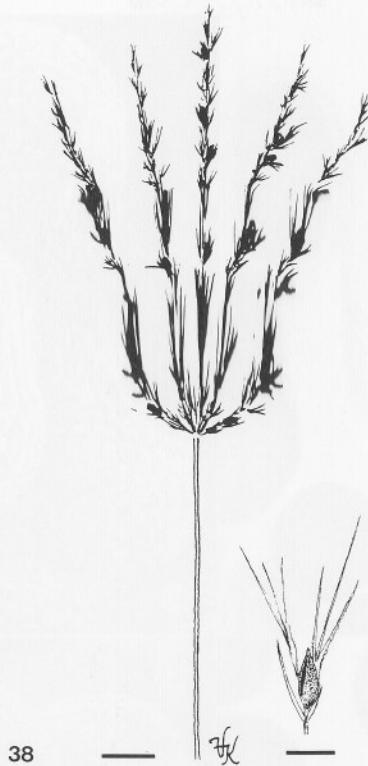
endospore and the exospore provided with 1.5–2.5  $\mu\text{m}$  high warts. In SEM the warts are isolated or 2–3 coalesce without forming rows. *Sterile cells* (Fig. 39) usually larger than the spores, subglobose, ovoid to slightly irregular, 20–40  $\mu\text{m}$  long, subhyaline to pale yellowish-brown; wall 1.5–6(–8)  $\mu\text{m}$  thick, often multilayered, smooth.

On *Poaceae*: *Arundinella nepalensis* Trin., Australia. Known only from the type collection.

*Tilletia lineata* differs from *T. arundinellae* L. Ling (Figs. 41–42; type on *Arundinella anomala* Steud, China) by smaller spores, by warts which are not fusing into rows as seen in SEM, and by larger sterile cells.

**Key to species of *Tilletia* on *Arundinella***

- 1. Spores 22–37  $\mu\text{m}$  long. In SEM warts often confluent in rows. Sterile cells 13–20  $\mu\text{m}$  long ..... *T. arundinellae*
- 1. Spores 20–30  $\mu\text{m}$  long. In SEM warts not confluent in rows. Sterile cells 20–40  $\mu\text{m}$  long ..... *T. lineata*



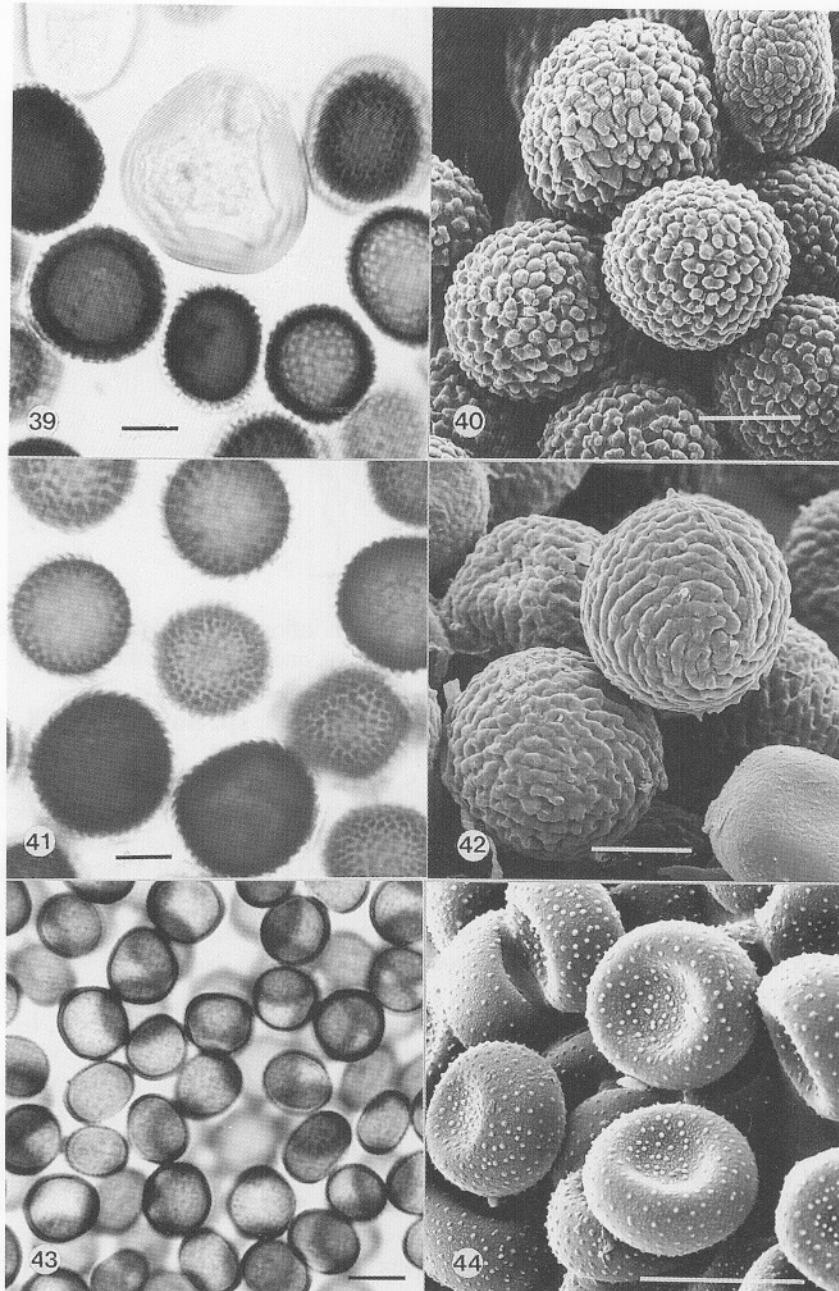
**Fig. 38.** Sori of *Ustilago chloridis* in some ovaries of an inflorescence of *Chloris lobata* (from holotype). Enlarged is a spikelet with a sorus. Bars = 1 cm, and 2 mm for enlargement.

***Ustilago chloridis* K. and C. Vánky and R.G. Shivas, sp. nov.** (Figs. 38, 43-44)

Typus in matrice *Chloris lobata* Lazarides (det. B.M. Waterhouse), Australia, Queensland, 51 km S oppid. Lakeland, 16°25' S, 144°45' E, alt. cca. 520 m.s.m., 5.III.2000, leg. C. and K. Vánky [**Holotype** in BRIP 27016, **isotype** in Herbario Ustil. Vánky, HUV 19177, et in Vánky, Ust. exs. no. 1084. **Paratypi** in matrice *C. lobata*, Australia, Northern Territory, 11 km NE pag. Mainoru, 24.V.1974, leg. S. Jacobs 1736, DAR 27620!; in matrice *C. divaricata* R. Br., Australia, Queensland, Ferndale, V.1949, leg. R.F.N. Langdon et T. Green (as *Ustilago induta*), IMI 43218!; Queensland, Boonah, 8.IV.1953, leg. R.F.N. Langdon, BRIP 8042!, DAR 52963!; et in matrice *C. truncata* R. Br., Australia, New South Wales, Mudgee, 21.III.1963, leg. ?, DAR 8033!].

*Sori* ovaria nonnulla inflorescentiae inficientes, citrifformes usque obovoidei, 1–1.5 × 2–3 mm, conspicui inter involucra floralia, membrana (pericarpio) primo viridi serius flavidobrunneae cooperti, qua irregulariter rupta massam nigrobrunneam, pulveream sporum ostendentes. *Sporae* subglobosae usque ellipsoidales, parum depressae (8–11 μm latae), magnitudine variae, 9.5–13 × (10–)11–13.5(–15) μm, mediocriter rubrobrunneae; pariete inaequaliter crasso, in lateribus depressis tenui (ca. 0.5 μm), ceterum cca. 1 μm crasso, raro, humiliter verrucoso; imago obliqua sporum levis vel valde leniter serrulata, imprimis ad latera depressa.

*Sori* (Fig. 38) infecting some ovaries in the inflorescence, lemon-shaped to obovoid, 1–1.5 × 2–3 mm, evident between the floral envelopes, covered by a first green later yellowish-brown membrane (pericarp), which ruptures irregularly disclosing the blackish-brown, powdery mass of spores. *Spores* (Figs. 43, 44) subglobose to ellipsoidal, slightly flattened (8–11 μm wide), variable in size, 9.5–13 × (10–)11–13.5(–15) μm, medium reddish-brown; wall



**Figs. 39-44.** *Tilletia* and *Ustilago* spp. **39, 40.** Spores of *Tilletia lineata* in LM and SEM (from holotype). **41, 42.** Spores of *Tilletia arundinellae* in LM and SEM (from holotype). **43, 44.** Spores of *Ustilago chloridis* in LM and SEM (from holotype). Bars = 10  $\mu$ m.



unevenly thick, on the flattened sides thin (c. 0.5  $\mu\text{m}$ ), elsewhere c. 1  $\mu\text{m}$  wide, sparsely, low verrucose; spore profile smooth or very finely serrulate, especially on the flattened sides.

On *Poaceae*: *Chloris divaricata* R. Br., *C. lobata* Lazarides, and *C. truncata* R. Br., Australia.

*Ustilago chloridis* differs from all 12 smut fungi reported on *Chloris*. It resembles *U. induta* Syd. (type on *Chloris breviseta* Benth., Africa, Sierra Leone), from which it differs in the shape and size of the spores. In *U. induta* the spores are globose, rarely subglobose, measuring 7–10  $\times$  8–11  $\mu\text{m}$ .

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