Four new species of smut fungi (*Ustilaginomycetes*) from Australia

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Abstract. Four new smut fungi are described from Australia, *Sporisorium incompletum* on *Cynodon incompletus, Tilletia lachnagrostidis* on *Lachnagrostis filiformis, Tranzscheliella austrostipae* on *Austrostipa verticillata,* and *Urocystis glabella* on *Hypoxis glabella.*

Key words: new species, smut fungi, *Sporisorium, Tilletia, Tranzscheliella, Urocystis, Ustilaginomycetes*

Introduction

Several smut fungi were found which were not able to be identified as earlier known species, while examining mycological collections in Australia (comp. also Zundel 1953). Below, four new species from Australia are described.

Materials and Methods

Sorus and spore characteristics were studied using dried herbarium specimens. For light microscopy (LM), spores were dispersed in a droplet of lactic acid on a microscope slide, covered with a cover glass, followed by gently heating to boiling point to rehydrate the spores, and examined at 1000× magnification. For scanning electron microscopy (SEM), dry spore balls (partly squashed), or dry spores were placed on double-sided adhesive tape, mounted on a specimen stub, sputter-coated with gold-palladium, c. 20 nm, and examined in a SEM at 10 kV.

Results

Seven smut fungi have been recognised on *Cynodon:* ***Ustilago paraguariensis*** Speg., ***U. cynodontis*** (Henn.) Henn., ***Tilletia montemartinii*** Canonaco, ***Ustilago hitchcockiana*** Zundel, ***Sporisorium cynodontis*** (L. Ling) R.G. Shivas & Vánky, ***S. normanense*** R.G. Shivas & Vánky, and ***Ustilago cynodonticola*** Vánky, R.G. Shivas & A. Witt. A further, unknown smut fungus was discovered amongst specimens in herbarium DAR. It is described as:

Sporisorium incompletum R.G. Shivas & Vánky, **sp. nov.**

Typus *in matrice Cynodon incompletus Nees, Australia, New South Wales, Muswellbrook, 32°17' S, 150°55' E, VI.1959, leg. incognitus.* ***Holotypus*** *in DAR 5698 (ut Ustilago sp.).* ***Isotypi*** *in BRIP 47 948 et in Herbario Ustil. Vánky, H.U.V. 21 355.*

Sori *in nonnullis spiculis eiusdem inflorescentiae, conspicui inter glumis distantibus, limoniiformes vel ellipsoidales cum apice acuto, 1-1,5 × 2-3 mm, primo peridio tenue, cinerescente cooperti, quo irregulariter rupto massam atrobrunneam, pulveream, culumellam brevem, crassam cingentem sporarum ostendentes.* ***Sporae*** *maturae singulae, ellipsoidales, ovoideae vel rotundato-irregulares, magis raro subglobosae, elongatae vel lacrimiformes cum apice subacuto, parum deplanatae, 6,5-8 µm latae, in visu superficiali 8-11,5 × 9-13 (–15) µm, pallide flavidobrunneae; pariete aequali, cca. 0,5 µm crasso, moderate dense, leniter verrucoso-echinulato, imago obliqua sporarum paene levis usque leniter serrulata.* ***Cellulae steriles*** *absentes.*

Sori (Fig. 1) in some spikelets of an inflorescence, showing between the spreading glumes, lemon-shaped or ellipsoidal with an acute tip, 1-1.5 × 2-3 mm, at first covered by a thin, greyish peridium which ruptures irregularly disclosing the dark

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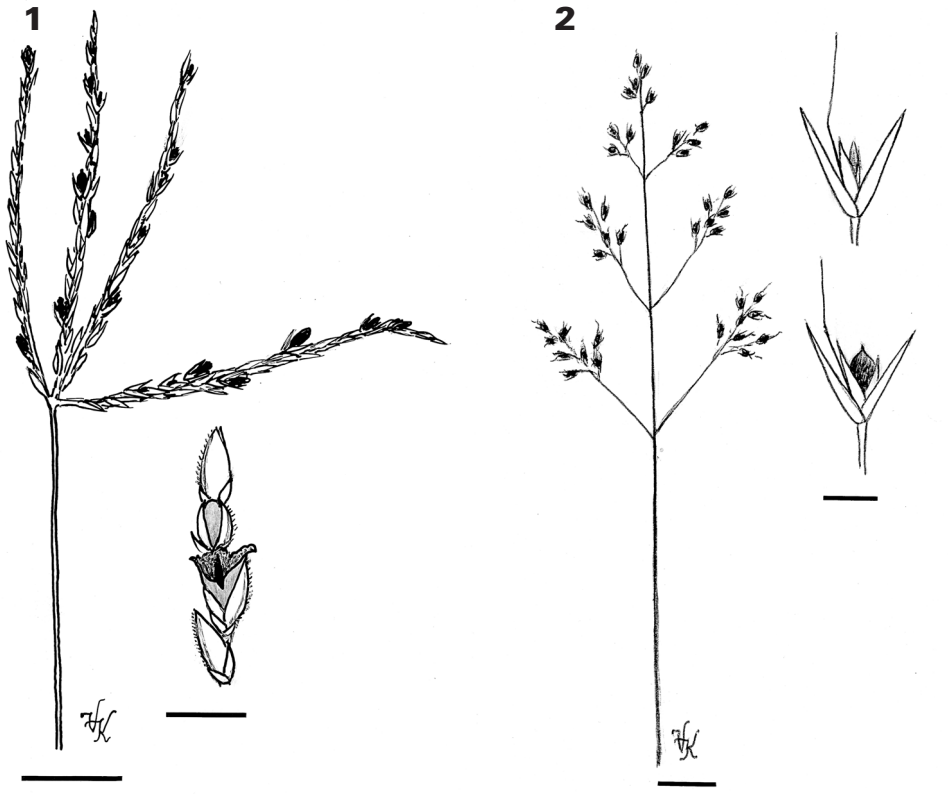
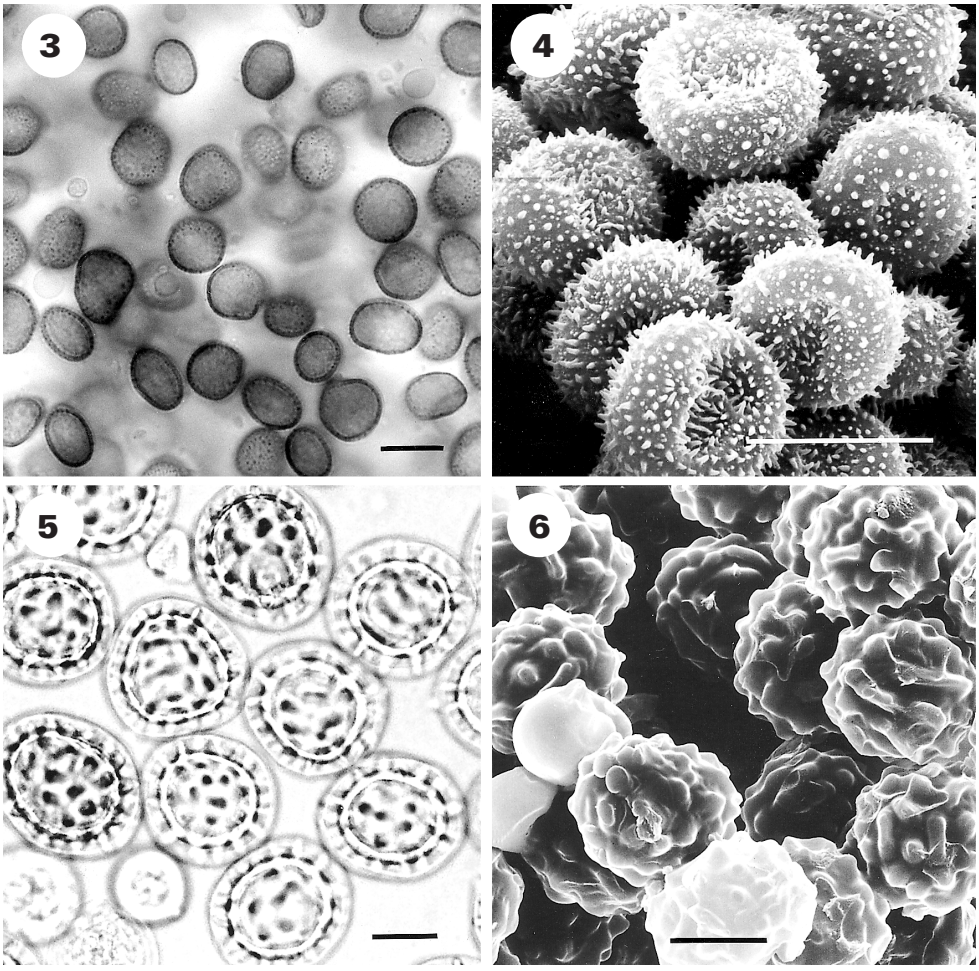


Fig. 1. Sori of *Sporisorium incompletum* in some spikelets of *Cynodon incompletus* (type). Habit and enlarged part of a spike with a young and a mature, opened sorus, and two healthy spikelets. Bars = 1 cm for habit, 3 mm for detail drawing **Fig. 2.** Sori of *Tilletia lachnagrostidis* in the ovaries of *Lachnagrostis filiformis* (type). Habit and enlarged a sorus and a healthy spikelet. Bars = 1 cm for habit, 2 mm for detail drawings



Figs 3-4. Spores of *Sporisorium incompletum* on *Cynodon incompletus,* in LM and in SEM (from holotype). Bars = 10 µm. **Figs 5-6.** Spores and sterile cells of *Tilletia lachnagrostidis* on *Lachnagrostis filiformis,* in LM and in SEM (from holotype). Bars = 10 µm

brown, powdery mass of spores surrounding a short, stout columella. **Spores** (Figs 3-4) when mature single, ellipsoidal, ovoid or rounded irregular, more rarely subglobose, elongated or tear-shaped with a subacute tip, slightly flattened, 6.5-8 µm wide, in face view 8-11.5 × 9-13 (–15) µm, pale yellowish brown; wall even, c. 0.5 µm thick, moderately densely, finely verrucose-echinulate, spore profile nearly smooth to finely serrulate. **Sterile cells** absent.

On *Poaceae: Cynodon incompletus* Nees.

Distribution: *Cynodon incompletus* is a grass native to South Africa, established in Australia and Argentina. This smut is known only from the type locality in Australia.

Key to the smut fungi of *Cynodon*

1	Sori in the ovaries; spores with coarse warts	***Tilletia montemartinii***
1*	Sori elsewhere, spores smooth, punctate or finely verrucose-echinulate	**2**
2	Sori in some spikelets; spores finely verrucose-echinulate	***Sporisorium incompletum***
2*	Sori elsewhere, not in the spikelets	**3**
3	Spore balls present	**4**
3*	Spore balls absent	**5**
4	Spores 10.5-17.5 µm long	***Sporisorium cynodontis***
4*	Spores 8-12 µm long	***Sporisorium normanense***
5	Sori on distal internodes; spores 7-11 µm long	***Ustilago paraguariensis***
5*	Sori on top of sterile shoots or in the inflorescence; spores smaller	**6**
6	Sori on top of sterile shoots; spores 6.5-9.5 µm long, punctate-verruculose	***Ustilago cynodonticola***
6*	Sori in the inflorescence or also in leaf sheaths; spores smaller, smooth	**7**
7	Sori in the inflorescence; spores 6-8 (–8.5) µm long	***Ustilago cynodontis***
7*	Sori in the inflorescence and distal leaf sheaths; spores 5-6.5 µm long	***Ustilago hitchcockiana***

A further smut fungus in herbarium DAR, identified as *Tilletia pallida,* turned out to be a new species:

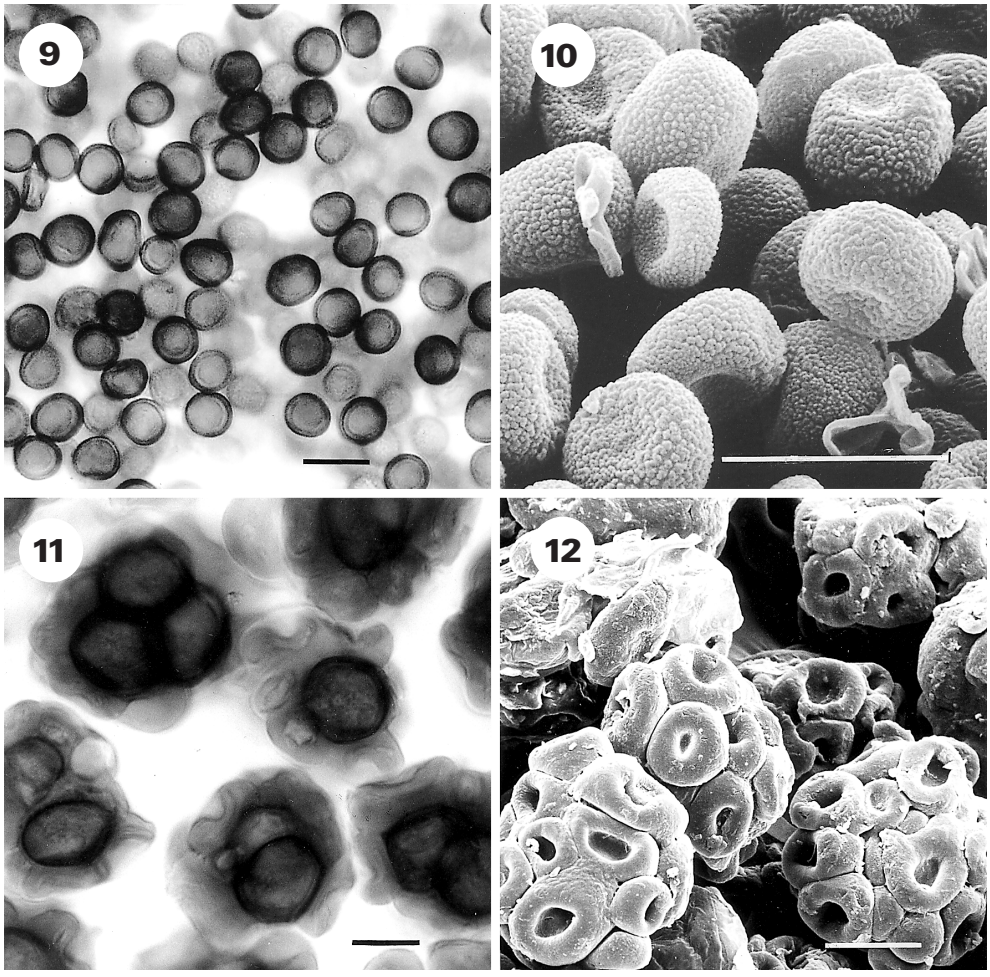
Tilletia lachnagrostidis Vánky & R.G. Shivas, **sp. nov.** ***Typus*** *in matrice Lachnagrostis filiformis (Forst.) Trin., Australia, New South Wales, 40 km SW of Mungindi, 28°59' S, 149°58' E, 21.XI.1990, leg. I.H. Parbery.* ***Holotypus*** *in DAR 67 135 (ut Tilletia pallida).* ***Isotypi*** *in BRIP 47 349 et in Herbario Ustil. Vánky, H.U.V. 21 220.* ***Paratypi*** *in matrice Lachnagrostis filiformis, Australia, New South Wales, Armidale, II.1963, leg. D. Cameron & J.W. Vickery, DAR 8499; Armidale, 25.II.1963, leg. J.W. Vickery, DAR 8498; Kangaroo Valley, 13.XI.1968, leg. D.H. Noble, DAR 17 669 (ut Tilletia pallida), H.U.V. 21 221; artificial inoculation from DAR 17 669, Rydalmere, 12.I.1970, leg. G.E. Stovold, DAR 29 604, DAR 29 606, BRIP 47 300; Kangaroo Valley, 13.II.1976, leg. G.E. Stovold, DAR 26 204; between Pilliga and Come-By-Chance, SW of Burren Junction, 18.XII.1990, leg. S.J. Allen, DAR 68 566.*

Tilletia lachnagrostidis a specie simili T. pallida G.W. Fischer (Mycologia 30: 393, 1938, typus in matrice Agrostis palustris Hudson, USA) distincta sporis minoribus (17,5-21 × 18,5-23 µm), verrucis 2,5-3,5 (–4) µm altis, subconicis, 3-5 in diametro sporae, lineis multis, tenuibus, atrioribus coniunctis, verrucis 16-20 in circumferentia aequatoriali. Sporae speciei T. pallida 17-24 × 19-27 µm, cum spinis tenuioribus nonnullis, 6-9 per diametrum sporae, 21-35 in circumferentia aequatoriali. Spinae lineis non connectae, secundum observationem in LM. Germinatio sporarum cum basidio aseptato, apice verticillum basidiosporarum cca. 30, acicularium, magnitudine cca. 1 × (30–) 50-65 µm producente.

Sori (Fig. 2) in all ovaries of an inflorescence, lemon-shaped or ellipsoidal with an acute tip, 0.5-0.8 × 1-1.5 mm, partly hidden by the floral envelopes, at first covered by the thin pericarp which ruptures irregularly disclosing the pale brown, semiagglutinated to powdery mass of spores and sterile cells. **Spores** (Figs 5-6) globose, subglobose to broadly ellipsoidal, 17.5-21 × 18.5-23 µm, pale yellowish brown, provided with 2.5-3.5 (–4) µm high subconical warts, in surface view appearing as darker, rounded or irregular spots, 3-5 per spore diam, connected by numerous, narrow, darker lines, sometimes two or three spots are fused, in optical median view there are 16-20 warts on the equatorial circumference, embedded in a hyaline sheath. **Spore germination** (J. Walker, a slide in Herb.) by means of an aseptate basidium with an apical whorl of about 30 acicular basidiospores measuring c. 1



Fig. 7. Sori of *Tranzscheliella austrostipae* on the stem of *Austrostipa verticillata* (type). Habit. Bar = 1 cm **Fig. 8.** Sori of *Urocystis glabella* on the leaves of *Hypoxis glabella* (type, reconstructed drawing). Habit. Bar = 1 cm



Figs 9-10. Spores of *Tranzscheliella austrostipae* on *Austrostipa verticillata,* in LM and in SEM (from holotype). Bars = 10 µm. **Figs 11-12.** Spore balls, spores and sterile cells of *Urocystis glabella* on *Hypoxis glabella,* in LM and in SEM (from holotype). Bars = 10 µm

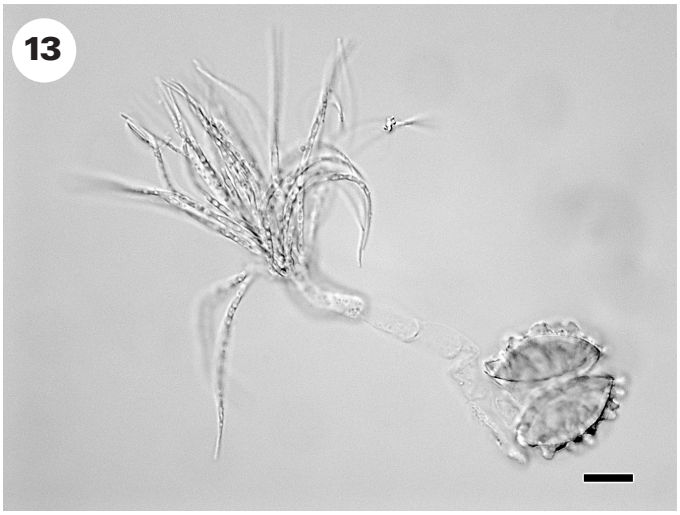


Fig. 13. Germinating spore of *Tilletia lachnagrostidis* with a holobasidium with retraction septa giving rise to an apical whorl of acicular basidiospores (from DAR 17669). Bar = 10 µm

× (30–) 50-65 µm (Fig. 13). **Sterile cells** (Figs 5-6) subglobose, ellipsoidal or irregular, 8-13.5 × 9-17 µm, hyaline; wall 0.5-1.5 µm thick, smooth. Subhyaline, larger, intermediate forms with trace of ornamentation are present.

On *Poaceae: Lachnagrostis filiformis* (Forst.) Trin.

Distribution: Australia.

Tilletia lachnagrostidis differs from the similar *T. pallida* G.W. Fisch. (type on *Agrostis palustris* Hudson, USA), in which the spores measure 17-24 × 19-27 µm, are provided with several, narrower spines, 6-9 per spores diam, 21-35 on the equatorial circumference. The spines of *T. pallida* are not connected by fine lines as seen in LM.

A collection of *Ustilago hypodytes* (Schltdl.) Fr. [= *Tranzscheliella hypodytes* (Schltdl.) Vánky & McKenzie] in BRIP on *Austrostipa verticillata* is markedly different from that species and is described as:

Tranzscheliella austrostipae R.G. Shivas & Vánky, **sp. nov.**

Typus *in matrice Austrostipa verticillata (Nees ex Sprengel) S.W.L. Jacobs & J. Everett, Australia, Queensland, Kumbia, 26°41' S, 151°39' E, 14.V.1971, leg. D.G. Hutton.* ***Holotypus*** *BRIP 3442,* ***isotypi*** *in Herbario Ustil. Vánky, H.U.V. 21 116 et in IMI 170 374.* ***Paratypus*** *in matrice Austrostipa verticillata, Australia, Queensland, Goodger, 8.II.1970, D.G. Hutton, BRIP 3441,* ***isoparatypus*** *IMI 170 373.*

Sori *in caulibus surculorum sterilium, internodia suprema circumdantes, vaginis foliorum partim absconditi, sine peridio, sicut involucra atrobrunnea, pulverea apparentes.* ***Sporae*** *subglobosae usque ellipsoidales, parum depressae, magnitudine variae, (6–) 6,5-8 (–9) × 7-10,5 µm, mediocriter atro-flavidobrunneae; pariete aequali, cca. 0,5 µm crasso, excepto in latere depresso sporarum nonnullarum, ubi pileus incrassatus, hyalinus, polaris fortasse praesens, surperficie leniter, dense, uniformiter verruculosa, imago obliqua sporae levis.*

Sori (Fig. 7) on the stems of sterile shoots, surrounding the uppermost internodes, partly concealed by leaf sheaths, peridium absent, appearing as a dark brown, powdery cover. **Spores** (Figs 9-10) subglobose to ellipsoidal, slightly flattened, variable in size, (6–) 6.5-8 (–9) × 7-10.5 µm, medium dark yellowish brown; wall even, c. 0.5 µm thick, excepting the flattened side of some spores where a thickened, hyaline polar cap may be present, surface finely, densely, uniformly verruculose, spore profile smooth.

On *Poaceae: Austrostipa verticillata* (Nees ex Sprengel) S.W.L. Jacobs & J. Everett (*Stipa verticillata* Nees ex Sprengel).

Distribution: Australia.

Tranzscheliella austrostipae differs from the polyphageous *T. hypodytes* (lectotype on *Leymus arenarius* (L.) Hochst.), in which the spores are much smaller, measuring 3.5-5.5 × 4-6 (–7) µm, and are more finely verruculose, in LM apparently smooth. *T. austrostipae* differs from all similar *Tranzscheliella* species in spore measurements and ornamentation, and partly in soral characters.

A fourth *Urocystis* on *Hypoxis* (*Amaryllidaceae*)

On *Hypoxis* three *Urocystis* species are known. **1. *U. hypoxis*** Thaxter (1893: 278), type on *H. erecta,* USA. It also occurs on *Hypoxis decumbens* L., *H. decumbens* var. *major* Seub., *H. domingensis* Urb., *H. erecta* L. [*H. hirsuta* (L.) Coville] in North America (Mexico, U.S.A.), Antilles (Dominican Rep.), and South America (Argentina, Brazil, Peru). **2. *U. thaxteri*** Vánky (2001: 270), type on *H. acuminata,* South Africa. It occurs on *H. acuminata* Baker, *H. angustifolia* Lam., *H. costata* Baker, *H. floccosa* Baker, *H. galpinii* Baker, *H. hemerocallidea* Fisch & Mey, *H. kraussiana* Buchinger, *H. rigidula* Baker, *Hypoxis* sp. from South Africa. **3. *U. aurea*** Vánky (2004: 81). It is known only from its type on *H. aurea* Lour., from southern Asia (India). Examination of the Australian "*U. hypoxis*" on *H. glabella* revealed that it was a different species:

Urocystis glabella Vánky & R.G. Shivas, **sp. nov.**

Typus *in matrice Hypoxis glabella R. Br., Australia, Victoria, County of Borung, Warracknabeal, 36°15' S, 142°28' E, 12.VII.1903, leg. F.M. Reader (ut Urocystis hypoxis), VPRI*

3226! (= VPRI 8910!). ***Paratypus*** *in matrice Hypoxis glabella, Australia, Victoria, Ardmona, 20.X.1897, leg. G.H. Robinson (ut U. hypoxis), VPRI 3227!*

Sori *in laminis et vaginis foliorum sicut pustulae lineares, cinereae, usque ad 3 cm longae, vel tumores irregulares, diam. 2 mm formati, primo epidermide obtecti, quo rupto massam nigram, semiagglutinatam usque pulveream glomerulorum sporarum ostendentes.* ***Glomeruli sporarum*** *globosi, ovoidei, ellipsoidales usque parum irregulares, 20-40 × 25-60 µm, modice obscure rubrobrunnei, e sporis (0–) 1-6 (–8) compositi et strato cellularum sterilium plerumque perfecte obtecti.* ***Sporae*** *subglobosae, ovoideae, ellipsoidales, plerumque irregulares, rotundato-subpolyedricae, saepe latere uno vel lateribus nonnullis complanatis, 9,5-14,5 × 13-16 (–18,5) µm, modice rubrobrunneae; pariete aequali, cca. 0,5 µm crasso, levi.* ***Cellulae steriles*** *forma et magnitudine variae, globosae, ellipsoidales, saepe irregulares, 8-25 µm longae, flavidobrunneae; pariete inaequali, 1,5-5 µm crasso, ad superficiem liberam tenuiore et hic forte impresso, levi.*

Sori (Fig. 8) in the leaves and leaf sheaths, as linear, grey blisters, up to 3 cm long, or as irregular swellings, 2 mm in diam, at first covered by the epidermis which ruptures exposing the black, semiagglutinated to powdery mass of spore balls. **Spore balls** (Figs 11-12) globose, ovoid, ellipsoidal to slightly irregular, 20-40 × 25-60 µm, medium dark reddish brown, composed of (0–) 1-6 (–8) spores and a usually completely investing layer of sterile cells. **Spores** (Figs 11-12) subglobose, ovoid, ellipsoidal, usually irregular, rounded subpolyhedral, often with one or several flattened sides, 9.5-14.5 × 13-16 (–18.5) µm, medium dark reddish brown; wall even, c. 0.5 µm thick, smooth. **Sterile cells** (Figs 11-12) variable in shape and size, globose, ellipsoidal, often irregular, 8-25 µm long, yellowish brown; wall uneven, 1.5-5 µm thick, thinner on the free surface which may be impressed, smooth. **Spore germination** not known.

On *Amaryllidaceae* (*Hypoxidaceae*): *Hypoxis glabella* R. Br.
Distribution: Australia.

Frequency of spores per spore ball of *Urocystis glabella:* 0 = 0.5 %, 1 = 14.5 %, 2 = 30.5 %, 3 = 26.5 %, 4 = 14 %, 5 = 9.5 %, 6 = 3 %, 7 = 0.5 %, 8 = 1 %. Very few (c. 1/1000) larger spore balls of 12 or 13 spores are most probably two balls closely stuck together.

Key to the *Urocystis* species of *Hypoxis*

1 Spore balls 35-70 (–80) µm long, composed of (3–) 5-25 (or more?) spores . . . . . ***U. thaxteri***

1* Spore balls smaller, composed of less spores **2**

2 Spore balls composed of (1–) 3-10 (–15) spores . . . . . ***U. hypoxis***

2* Spore balls composed of 1-6 (–8) spores **3**

3 Spore balls 25-60 µm long. Spores 13-16 (–18.5) µm long. Sterile cells 8-25 µm long, yellowish brown, wall 1.5-5 µm thick . . . . . ***U. glabella***

3* Spore balls 20-40 µm long. Spores 9.6-16 µm long. Sterile cells 6.5-16 µm long, pale yellowish brown, wall 0.5-1 µm thick . . . . . ***U. aurea***

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