SMUTS OF LILIALES IN AUSTRALIA

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Abstract

Seven smut species have been reported on Liliales in Australia. Four are accepted as genuine Australian records. *Urocystis cepulae* on *Allium cepa*, *U. destruens* on *Wurmbea dioica* and *U. hypoxis* on *Hypoxis glabella* are authenticated from specimens examined and are described in detail. The recently described *Yelsemia arthropodii* on *Arthropodium* spp. is mentioned briefly. Evidence is presented to show that *Urocystis colchici* and *U. gladiolicola* do not occur in Australia. *Ustilago allii* is excluded from the smuts, being based on onion bulbs infected by *Aspergillus niger*. A key to the accepted species is given.

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Introduction

During work on the smut of *Arthropodium* spp. described recently as *Yelsemia arthropodii* J. Walker (2001), all other reports of smuts on Liliales in Australia were examined. Names of six other species occur in the literature. In the light of the *Fungi of Australia* project, a detailed discussion of these reports is given to clarify the older literature and assist any future revision of the Australian smut fungi. In addition to *Y. arthropodii*, three species are authenticated as genuine Australian records and described below from local collections; evidence for rejection of the other three as authentic records of smuts for Australia is presented.

Materials and methods

Specimens studied are listed under each species. Spores for examination were mounted in clear lactophenol, warmed gently to expel air and to expand the dried spores and examined immediately. After scanning slides to determine the range of spore sizes present, 10 spores from each specimen were measured, with notes on abnormally large or small spores. The concept of Liliales adopted is that of the various authors of the included families in Vols 45 (1987) and 46 (1986) of the *Flora of Australia*. Any departures from this are noted in the text. Herbarium abbreviations are taken from Holmgren, Keuken & Schofield (1981) and author abbreviations for plant and fungus names from Brummitt & Powell (1992). For fungal binomials, at their first mention in the text, the year of publication is given after the author citation; where this is a reference listed in the reference list, the year is enclosed in brackets, otherwise no brackets are used (see suggestion by Hawksworth 2000).

Taxonomy

Species accepted as present in Australia

Urocystis cepulae Frost *in* Farlow, *Annual Report of the Secretary Massachusetts State Board of Agriculture* 24: 175, 1877

Sori in leaves and leaf sheaths of young plants (ADW 1692) and in outer scale leaves of bulbs (DAR 14614), more prominent towards the base of the bulb, at first covered by host tissue and dark leaden grey, later rupturing to expose the black powdery mass of spore balls, individual sori from minute (1–2 mm diam.) to long elongated streaks 1.5–3.0 cm long and up to 1 (–1.5) cm wide. Spore balls (Figs 1, 4) globose to subglobose, 15–22 (–24) µm diam., consisting of one, very rarely two, reddish brown spherical to broadly ovoid thin-walled (about 0.5 µm) ustilospores 11–15 µm diam., surrounded by an almost complete layer of yellowish sterile cells 4.5–7.0 µm diam., somewhat collapsed radially and with walls 1 (–1.5) µm thick. Less than 1% of spore balls with two ustilospores were seen.

Several early unconfirmed reports of onion (*Allium cepa* L.) smut occur in the Australian literature. Butler (1909) mentioned smut (as *Urocystis cepulae*), said to cause dark spots on leaves. In a later article on onion culture (Anon. 1914), smut (no organism named) was said to attack young plants causing dark leaf spots.

Neither article made specific reference to the presence of the fungus in Australia and, indeed, it was common practice at the time for some articles in the *Agricultural Gazette of New South Wales* to include discussions of overseas diseases not then known in Australia. No Australian specimens of *U. cepulae* from this period are known. McAlpine (1910) did not record it for Australia and a later article on onion diseases in New South Wales (Anon. 1939) stated that *U. cepulae* was not present.

Urocystis cepulae was first confirmed in the Australasian region in the South Island of New Zealand in January 1938. It was thought to have been introduced with imported onion bulbs (origin not mentioned) four to five years earlier (Gibbs 1938). The first confirmed Australian record was in South Australia in 1950 (ADW 1692, in DAR) in an Adelaide suburb. A further outbreak occurred in 1964 (Reddy 1976) and in January 1966 it was recorded for the first time in New South Wales on mature onion bulbs in a nursery at Blayney, on the Central Tablelands (Walker 1967, DAR 14614). In all these outbreaks, destruction of diseased plants, soil treatments and quarantining of infected sites were undertaken and it was considered that the disease had been eradicated from Australia (Reddy 1976). At least one subsequent outbreak, on young plants at Uraidla in the Adelaide Hills, South Australia, was reported in November 1985 (DAR 53135). At present, onion smut is not a problem in Australian onion culture but the possibilities of further local outbreaks, and future new introductions, exist.

The name *Urocystis cepulae* Frost *in* Farl. 1877 is used here for this smut, following Chupp (1960), Mordue & Ainsworth (1984), Mulder & Holliday (1971), Savile (1961) and Zundel (1939). By contrast, some other workers *e.g.* Durán 1987, Fischer 1953, Fischer & Shaw 1953, used the earlier name *Urocystis colchici* (Schltdl.) Rabenh. 1861, listing *U. cepulae* as a synonym. Their concept of *U. colchici* is a wide one, embracing distinct smuts occurring on various liliaceous genera (see below under 'Records not confirmed for Australia'). In the strict sense accepted here, *U. colchici* is a smut of *Colchicum* spp. in Europe, Asia and North America which differs from *U. cepulae* in having larger spore balls up to 50 × 35 µm (average 33 × 25 µm) with 1–3 (rarely 4 or 5) ustilospores per ball and thicker-walled sterile cells varying from 3–13 µm diam. (Chupp 1960, Mordue 1988, Savile 1961, Vánky 1985).

The name *Urocystis magica* Pass. *in* Thüm. 1875 also predates *U. cepulae*. The type host is *Allium magicum* L. from Parma, Italy (Lindeberg 1959). Zundel (1939) also identified as *U. magica* (which he distinguished from *U. cepulae*) an American collection from Utah on a host he listed as *A. palmeri* S. Wats. (neither this host nor any record of a smut on *Allium* spp. from Utah are listed in Farr *et al.* 1989). *Allium magicum* is identical to the plant commonly named *A. nigrum* L. (Seisums 1998a), which occurs throughout the Mediterranean region and in the Canary Islands (Seisums 1998b) and provides an earlier name for it. Seisums (1998b) has proposed conservation of the name *A. nigrum* L. to maintain current usage. Although *U. magica* was described on *A. magicum*, the name has been used for the smut on several *Allium* spp., including *A. cepa*, by Lindeberg (1959) and Vánky (1985), who both list *U. cepulae* as a synonym. Durán (1987), Fischer (1953) and Fischer & Shaw (1953) lump *U. magica* with *U. cepulae* as synonyms of *U. colchici*. Ciferri (1938), Liro (1938), Massenot (1953), Zundel (1939) and some other authors retain *U. cepulae* and *U. magica* as distinct species. According to Ciferri (1938) and Zundel (1939), *U. magica* has larger (to 35 µm diam. *fide* Zundel 1939) and darker spore balls than *U. cepulae*. Lindeberg (1959) commented that *U. magica s. lat.* is certainly divided into several physiologic races and that more work is needed to decide whether the alleged morphological differences between them are constant. Until such time as detailed studies have resolved problems surrounding the identity and host ranges of *Urocystis* spp. on *Allium* spp., the name *Urocystis cepulae* Frost, type host *Allium cepa*, is retained for onion smut. In Australia, *U. cepulae* has been recorded only on onions, even though other cultivated *Allium* spp. such as shallots, leeks, garlic and chives are widely grown. From the practical viewpoint, use of the name *U. cepulae* also clarifies the plant quarantine situation and makes it clear that only one of the complex of smuts recorded overseas on *Allium* spp., under the various names discussed above, occurs in Australia at present.

Specimens examined: all on *Allium cepa* L.: **Australia**: South Australia, Adelaide, Portrush Road, 4 Aug. 1950, B.W. Holloway, ADW 1692, in DAR (first confirmed record for Australia); Adelaide Hills, Uraidla, 7 Nov. 1985, T. Wicks, DAR 53135. New South Wales, Blayney, 7 Jan. 1966, W. Lee, DAR 14614; Blayney, 28 Apr. 1966, B.K. Smart, DAR 14849; Blayney, 2 June 1966, B.J. Ballantyne, DAR 17579.

Urocystis destruens McAlpine, *The Smuts of Australia* 196–197, 1910

Only the type collection has been seen. It consists of one flowering stem bearing two leaves and one leaf sheath from which the blade has been removed. On the leaves, there are two swollen blisters to 10 mm long, 1–2 mm wide, whose papery covering has torn. They now contain only a dusting of a granular spore powder (in contrast to the 'black, pulverulent spore masses' described by McAlpine 1910). Spore balls (Figs 2, 5) are globose to

subglobose to ovoid, 18–26 µm diam. They contain one, occasionally two (less than 5%), dark brown ustilospores, (10–) 12–16 (–17) µm diam. with a thin (1 µm) wall, surrounded by an almost complete layer of paler brown sterile cells. These are mostly collapsed, 3–7 µm thick, 10–12 µm wide in surface view and with wall slightly thickened to 1.5 (–2) µm.

This agrees well with McAlpine's (1910) original description. The type specimen was identified originally by McAlpine (1903) as *Urocystis colchici* but later recognised as distinct and described as *U. destruens*. Of the species discussed here, it is most similar to *U. cepulae* in having mainly one ustilospore per spore ball. It differs in having larger, slightly thicker-walled sterile cells and a slightly greater proportion of spore balls with two spores. In the *Flora of Australia*, the host genus *Wurmbea* Thunb. is grouped within Liliaceae *s. lat.* with genera more closely related to *Colchicum* than to *Allium* (Macfarlane 1987). In the familial classification used in the *Flora of New South Wales*, *Wurmbea* is placed in Colchicaceae (Harden 1993) whereas *Allium* is in Alliaceae (Godden 1993). *Urocystis destruens* is quite distinct from *U. colchici* which generally has larger (average 33 × 25 µm) spore balls, with 1–3 (rarely 4 or 5) larger ustilospores (11–20 µm) (Mordue & Ainsworth 1984, Vánky 1985).

Whilst its only known host, *Wurmbea dioica*, is widespread in temperate Australia (Macfarlane 1987), *Urocystis destruens* is known only from Victoria (Chambers 1982 host as *Anguillaria dioica*, McAlpine 1903, 1910, Zundel 1953, host in error as '*Wumbea*') and is rarely collected there. Nineteen native species of *Wurmbea* are known in Australia and about 20 others occur in southern and tropical Africa (Macfarlane 1987). No records of smuts on African species could be found. A more detailed search for this rare smut is needed on the Australian species.

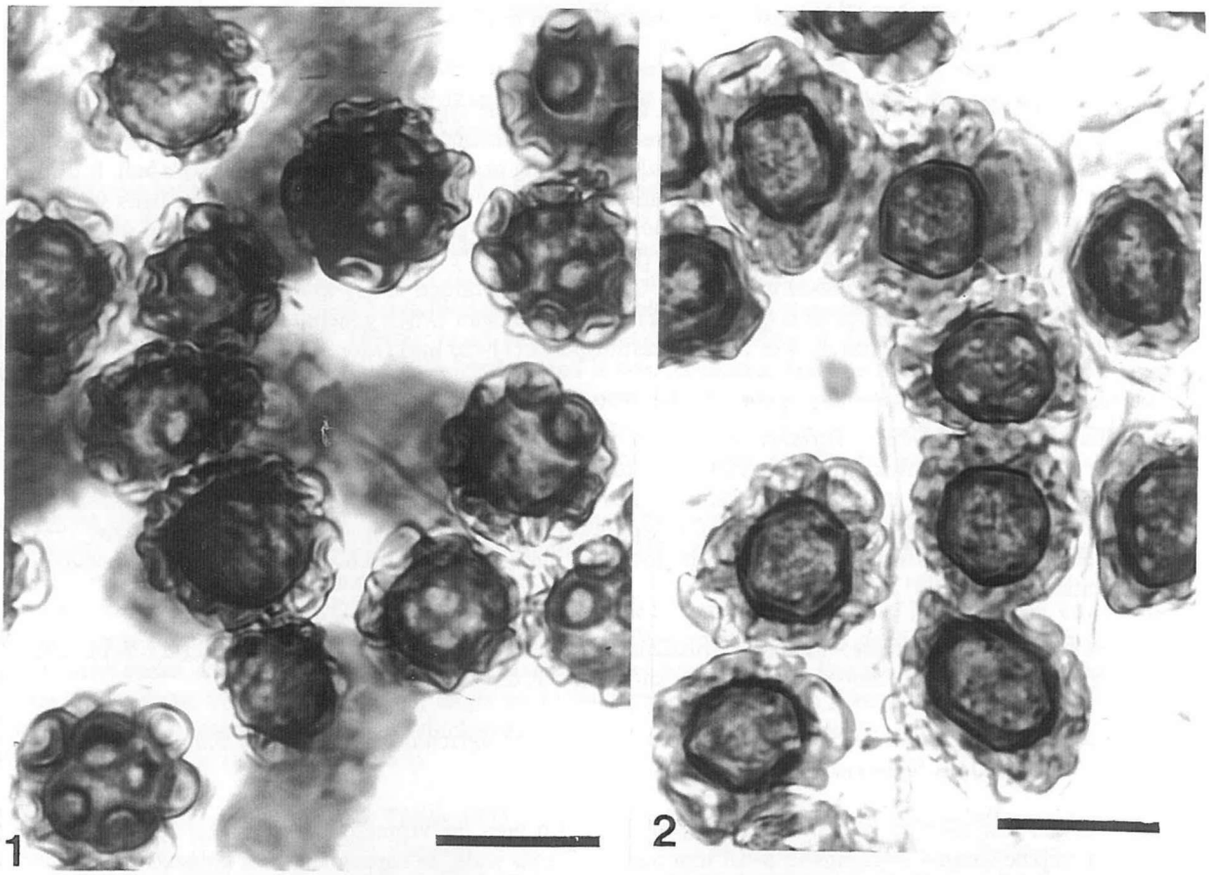
Specimen examined: **Australia**: Victoria, Armadale, on *Wurmbea dioica* (R. Br.) F. Muell., 27 Sept. 1902, D. McAlpine, VPRI 3224, Holotype (microscope slide as DAR 65740).

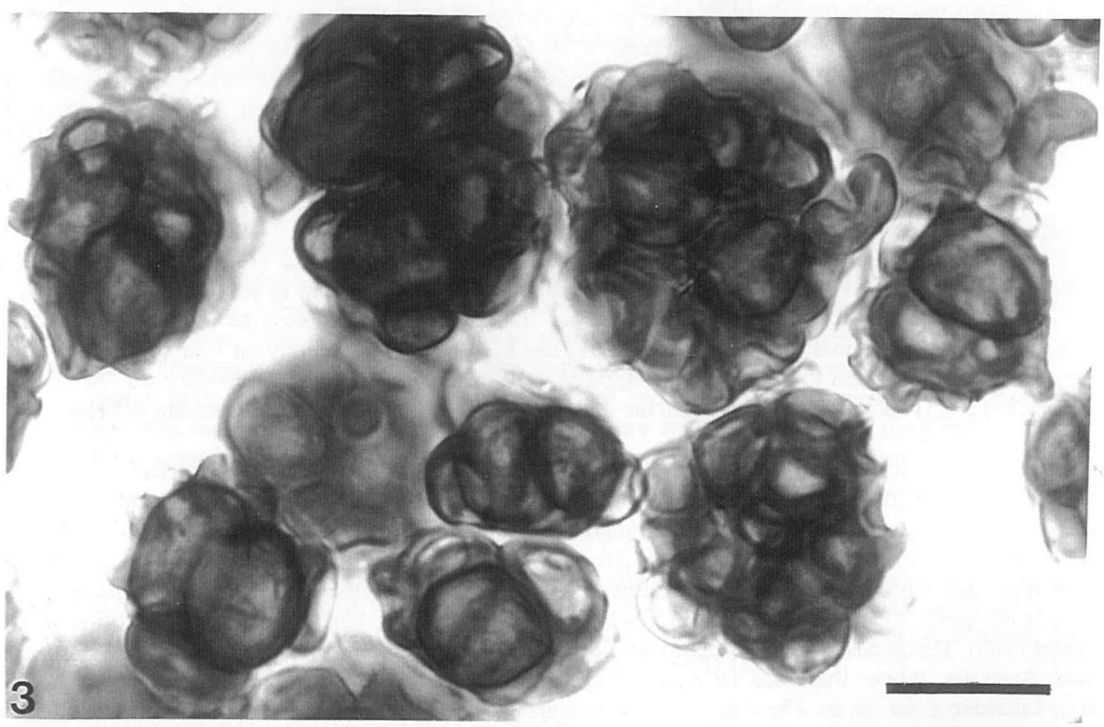
Urocystis hypoxis Thaxt., *Annual Report of the Connecticut Agricultural Experiment Station, New Haven* 1890: 153, 1890 (as '*hypoxys*')

Sori in leaves, leaf sheaths, peduncles and capsules, leaden grey, in vegetative parts blister-like or swollen elongated spindle-shaped swellings to 8–10 mm long, 1–2 mm wide, in capsules at first covered by a papery layer of host tissue, all rupturing to expose the black spore mass. Spore balls (Figs 3, 6) individually reddish brown, very variable in shape from subglobose to oval or obliquely triangular to almost rectangular, 22–55 × 22–53 µm (one to 62 × 44 µm seen), with from 1–10 (commonly 3–5) reddish brown subglobose to oval ustilospores 12–16 µm diam. or up to 22 × 13 µm. Ustilospores covered by an outer layer of sterile cells, often collapsed, subglobose to oval, (9–) 11–15 µm diam., wall 2 µm thick, yellowish brown. The layer of sterile cells is not complete in all spore balls; by contrast, in some balls, there are two layers of sterile cells over part of their surface.

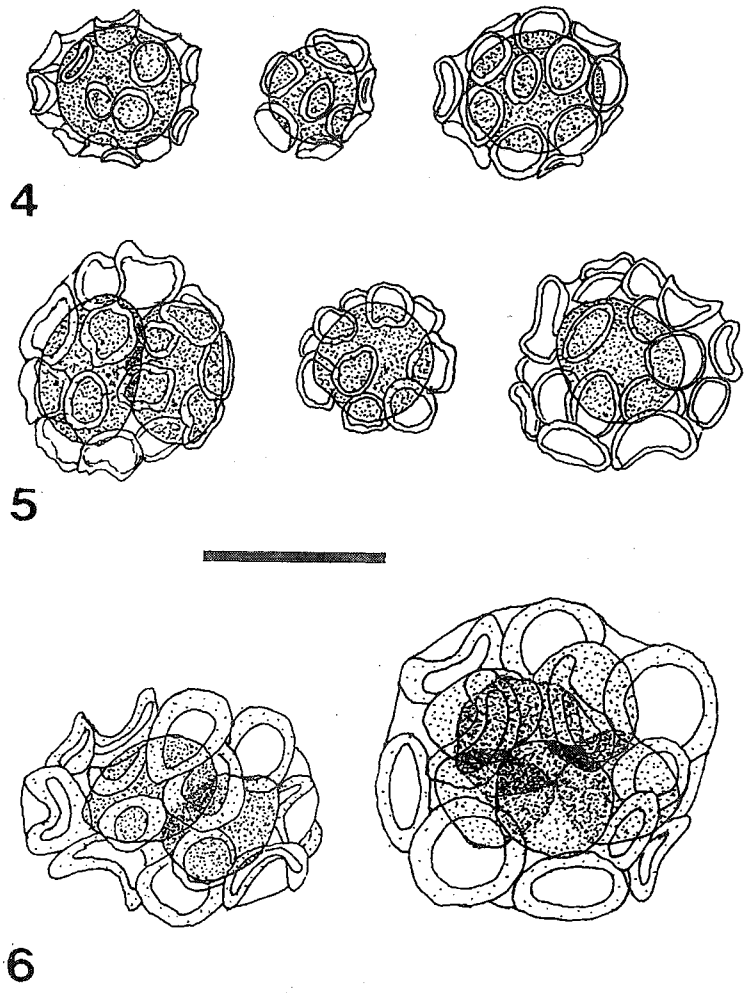
This description agrees closely with that given for North American collections of *U. hypoxis* by Clinton (1904, 1906), Durán (1987), Fischer (1953) and Thaxter (1893), and by McAlpine (1910) for three Victorian collections. As McAlpine (1910) noted, however, the smut in Australia occurs in leaves and leaf sheaths, as well as in flowers, pedicels and peduncles, which are the only organs reported as infected for the North American specimens. *Urocystis thaxteri* Vánky (2001) has been described recently on four species of *Hypoxis* from South Africa. It is stated to differ from *U. hypoxis* in having larger spore balls (30–50 × 35–70 (–80) µm) with more ((3–) 5–25) spores in the ball. From the description, it is distinct from the Australian collection.

Clinton (1904) reported this smut from North and South America, and Zundel (1939) included a record from Santo Domingo, West Indies. Ciferri (1963, as *Tuburcinia hypoxys* (Thaxt.) Liro) lists it from North America, Brazil, Hispaniola (presumably the Santo Domingo record of Zundel 1939) and Australia. In 1996, it was collected in Orange Free State Province, South Africa by Dr K. Vánky (Ingold 1999) on *Hypoxis acuminata* Baker. In Australia, it has been recorded three times from Victoria (McAlpine 1910) on *Hypoxis glabella* R. Br. and once from South Australia on the same host (Cook & Dubé 1989, host as *H. hookeri* Geerinck but see Henderson 1987). The genus *Hypoxis* contains about 150 species, widespread from the Americas to Africa, East Asia and Australia, where there are 10 endemic species, occurring mainly in temperate regions. Although placed in Liliaceae *s. lat.* in the *Flora of Australia* (Henderson 1987), it is segregated, together with *Curculigo* Gaertn., in Hypoxidaceae in the *Flora of New South Wales* (Richards 1993). *Urocystis hypoxis* differs from the two other species of *Urocystis* considered here in its larger spore balls with several ustilospores and larger thicker-walled sterile cells. Like the other smuts on native Liliales, it is rarely collected in Australia and further searches are needed to determine its distribution and host range.





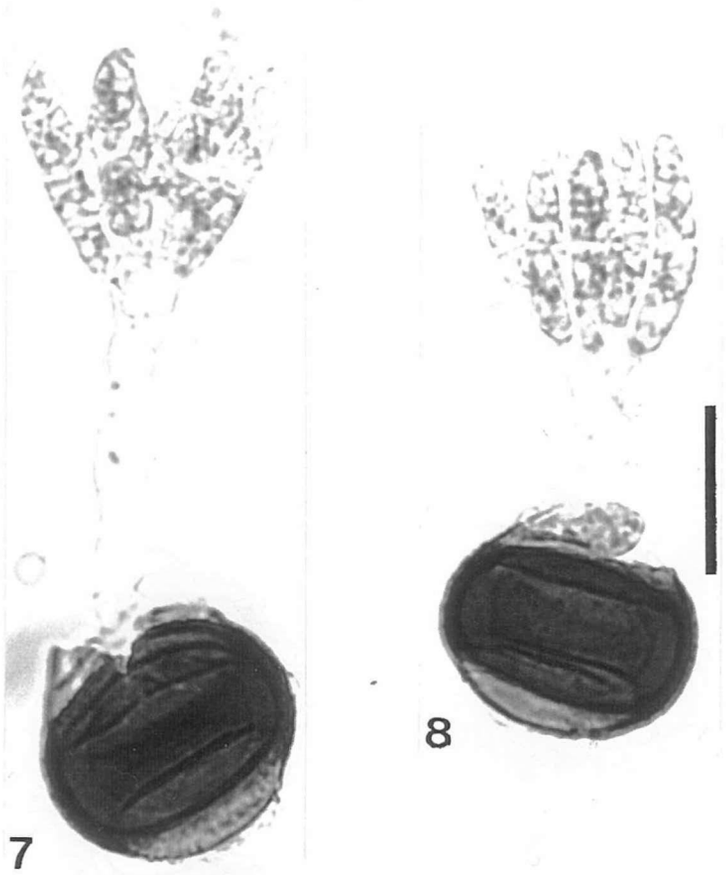
Figures 1–3. *Urocystis* spp., spore balls in lactophenol. Bars: 20 µm. **Fig. 1.** *Urocystis cepulae* DAR 14614, one ustilospore per spore ball and small sterile cells. **Fig. 2.** *Urocystis destruens* ex holotype VPRI 3224 (slide as DAR 65740), one ustilospore per spore ball and larger sterile cells. **Fig. 3.** *Urocystis hypoxis* ADW 1693 (in DAR), several ustilospores per spore ball and large sterile cells.



Figures 4–6. *Urocystis* spp., spore balls. Bar: 20 µm. **Fig. 4.** *Urocystis cepulae* DAR 14614, one ustilospore per spore ball and covering of small pale sterile cells. **Fig. 5.** *Urocystis destruens* ex holotype VPRI 3224 (slide as DAR 65740), one (rarely two) ustilospores per spore ball and covering of slightly larger sterile cells. **Fig. 6.** *Urocystis hypoxis* ADW 1693 (in DAR), two spore balls with two and six ustilospores and covering of large tinted thick-walled sterile cells.

A brief statement on use of the epithet '*hypoxis*' for this smut is needed but, whilst all variant spellings noted in the literature are mentioned, the arguments for and against them are not detailed here. As noted by Clinton (1904), there is considerable uncertainty in the literature about the spelling of the specific epithet. The original description gave '*hypoxys*' (see Thaxter 1893) and this was retained by Ciferri (1963, as *Tuburcinia hypoxys*). Saccardo (1891) altered this to a genitive form '*hypoxydis*' which was used in Australia by McAlpine (1910) and, more recently, by Cook & Dubé (1989). Thaxter (1893), after some linguistic advice, rejected Saccardo's change as an incorrect genitive and adopted '*hypoxyis*'; this has been retained by some later American authors (Clinton 1902, 1904, 1906, Pfister 1984, Zundel 1939, 1953). More recently, Durán (1987), Farr *et al.* (1989) and Fischer (1953) in America and Chambers (1982) in Australia have all used '*hypoxidis*', a genitive form derived from the current spelling '*Hypoxis*' of the host generic name (see Art. 60.12 of the ICBN, Greuter *et al.* 2000). Recently, Ingold (1999) has used the nominative epithet '*hypoxis*' based on this spelling, thus returning to Thaxter's original epithet, except for the change in spelling demanded by the modern spelling of the host genus name. This has been retained for the present in this paper, in accord with Art. 60.1 of the ICBN which states, in part, 'The original spelling of a name or epithet is to be retained, except for the correction of typographical or orthographical errors ...' (Greuter *et al.* 2000).

Specimen examined: **Australia**: South Australia, north of Grange, near Military Road, on *Hypoxis glabella* R. Br., 2 June 1917, T.G.B. Osborn, ADW 1693 (in DAR).



Figures 7–8. *Yelsemia arthropodii* DAR 63312, holotype. Two germinating ustilospores showing polar caps, with germination through one cap to produce a basidium, cluster of septate apical fusiform sporidia and conjugation between sporidia. Bar: 20 µm.

Yelsemia arthropodii J. Walker, *Mycological Research* 105: 227, 2001

This new genus and species of Tilletiales was described recently for a smut causing galls on *Arthropodium minus* R. Br. in New South Wales and *A. curvipes* S. Moore in Western Australia. It is known currently only from these two collections and is characterised by single dark finely roughened ustilospores with opposite paler polar caps, through which germination occurs, producing holobasidia bearing 2–5 apical septate fusiform sporidia (Figs 7, 8). It is fully described and illustrated, with specimen details, in Walker (2001).

Species not confirmed in Australia

Urocystis colchici (Schltdl.) Rabenh., *Rabenhorst Fungi Europaei* 396, 1861.

This name was used initially by McAlpine (1903) for the leaf smut of *Wurmbea dioica* he described eventually as *Urocystis destruens* McAlpine (1910). The features which distinguish *Urocystis colchici* and *U. destruens* are given above under the latter name. In this paper, the name *U. colchici* is used in the strict sense of Chupp (1960, who noted features which distinguish it from *U. cepulae*), Mordue (1988), Mordue & Ainsworth (1984) and Vánky (1985) for a smut confined to *Colchicum* spp. (including *Bulbocodium*), rather than in the wide sense of Durán (1987), Fischer (1953) and some other authors which includes smuts on several other liliaceous hosts such as *Allium*, *Polygonatum* and *Smilacina*. In this strict sense, *U. colchici* is not known in Australia and quarantine measures to prevent its entry are needed. It is widespread in counties of the Northern Hemisphere (Mordue 1988).

Urocystis gladiolicola Ainsw., *Transactions of the British Mycological Society* 32: 257, 1950

Langdon & Herbert (1944) recorded gladiolus smut (as *Urocystis gladioli* (Req.) W.G. Sm. 1876) in Queensland in April 1943, from Wooloowin, a suburb of Brisbane. They stated 'The corms from which the infected plants were raised were variety Picardy purchased in 1942, and were almost certainly (because of war conditions) grown in Australia. Gladiolus smut is therefore probably widely spread in Australia' (Langdon & Herbert 1944, p. 4). No precise description of the specimen(s) seen was given and the fungus was not described. The disease was said to have appeared on corms, stems and leaves. On corms, weals with a yellowish margin were produced, erupting to expose dark brown spore masses. On stems and leaves, dark streaks were produced. The record was not included in Simmonds' (1966) list of Queensland plant diseases and there are no subsequent reports of gladiolus smut from Australia.

Only one specimen agreeing with that mentioned by Langdon & Herbert (1944) could be located in BRIP, BRIU and DAR. It was examined through the courtesy of Dr J.L. Alcorn (BRIP). It consists of several broken corms and corm pieces with mechanical damage on their outer surface; no leaf or stem material was present. No sign of smut was found. Some insect damage was present, with many small pellets of insect excrement and frass mixed with abundant conidia of *Aspergillus niger* Tiegh. 1867 *s. lat.* Present with the specimen were copies of correspondence from September 1947 to March 1948 from the then Director of Plant Quarantine, Dr T.H. Harrison, indicating that re-examination of the specimen at that time by Dr Herbert and Mr J.H. Simmonds had found that the fungus present was not gladiolus smut but a 'moniliaceous deuteromycete'. The present finding confirms this report. *Urocystis gladiolicola* is not known in Australia at the time of writing and continuing quarantine action to prevent its entry is necessary. The taxonomic and nomenclatural problems surrounding the unsuitable name *Urocystis gladioli* (Req.) W.G. Sm. used by Langdon & Herbert (1944) have been dealt with by Ainsworth (1950).

Specimen examined: **Australia**: Queensland, Wooloowin, on *Gladiolus* × *hortulanus* L.H. Bailey cv. Picardy, Apr. 1943, D.A. Herbert, BRIP 15294 (as *Urocystis gladioli* (Req.) W.G. Sm., smut not found on specimen, *Aspergillus niger* Tiegh. *s. lat.* present).

Excluded species

Ustilago allii McAlpine, *Proceedings of the Royal Society of Victoria* 7: 220, 1895

McAlpine (1895a) described *Ustilago allii* on scale leaves of stored onion bulbs from Ardmona in the Goulburn Valley, Victoria. Sori were said to form minute pustules in parallel lines, at first covered by the epidermis, later rupturing to expose a black powdery mass of spores, which were dark brown individually, spherical, echinulate, 4.0–4.5 µm diam., embedded in a gelatinous mass, with accompanying hyphae 3 µm wide. One collection, Robinson 97, was mentioned.

McAlpine (1895b) included *Ustilago allii* in his list of fungi recorded from Australia but, in his smut monograph fifteen years later (McAlpine 1910), made no mention of it, either as recorded from Australia or as an excluded species. There are a few later reports in the literature. Stevenson (1926, p. 10) stated that it produced black spore masses in pustules on onion bulbs in Australia. Brittlebank (1937–1940, p. 302) listed it in brackets as a dubious record with the comment 'Non est. Probably one of the black spored fungi common on onions'. He did not include it in his Host Index (p. 326) of fungi on onion in Australia. Zundel (1953, p. 137) summarised McAlpine's (1895a) original description, noted the Australian type locality and mentioned that *U. allii* occurred also in 'Palestine'. Fischer & Holton (1957, p. 53) included it as an accepted species of *Ustilago* on a liliaceous host, quoting Zundel (1953) as their reference. Washington & Nancarrow (1983) did not include it in their list of onion diseases recorded in Victoria but they did list a black mould caused by *Aspergillus niger* with the first record from Ardmona (the type locality for *U. allii*) in 1893. Finally, Vánky (1988, pp. 371–372) summarised McAlpine's description and concluded '... I strongly doubt that it is a smut'. He mentioned two collections (from Russia and Lithuania) filed under this name which proved to be onion bulbs partially destroyed by *A. niger*. The Lithuanian collection was listed as *U. allii* in a compilation of Baltic smuts by Ignatavičiute (1975, p. 105, quoted by Vánky 1988).

The type specimen of *Ustilago allii* seems to be lost. No specimens under the name *U. allii* are present in the McAlpine Herbarium (VPRI) and, from Brittlebank's comments quoted above, it seems that he did not see any in 1940. Moreover, no collections of *Aspergillus niger* on onion from Ardmona could be found in VPRI to support the Washington & Nancarrow (1983) report from 1893; it was thought possible that such a collection

may have been the one on which McAlpine based his *Ustilago allii* and which was subsequently found to be *A. niger*. However, two collections on onion bulbs under the name *U. allii* in BPI have been studied. One was intercepted in quarantine from Australia on 27 Apr. 1948 at Seattle (No. 11970) and determined and verified as *Ustilago allii* by W.J.N. Brown and Lee Ling respectively. The other was collected in Jerusalem, Israel, in 1938 and is marked 'O.K.' by G. Zundel (this is presumably the evidence for the 'Palestine' record in Zundel 1953). No smut was detected on either of these specimens but both showed abundant black conidial masses and some conidial heads and conidiophores of *A. niger s. lat.* Conidia were dark brown, spherical, (3–) 4–5 µm diam. with walls roughened by short spines or ridges. Loose conidia were often in dried flakes of exudate between diseased scale leaves.

From the specimens examined here and by Vánky (1988), and from Brittlebank's (1937–1940) comments, there seems little doubt that *Ustilago allii* McAlpine (1895a) is not a smut but is based on the common ubiquitous onion bulb mould *Aspergillus niger* Tiegh. *s. lat.* Bulbs, especially in storage, are often infected, causing discolouration and sometimes rotting of the outer scale leaves. McAlpine's (1895a) original description is, as far as it goes, a precise account of both the symptoms caused by this fungus and its conidial morphology. *Ustilago allii* McAlpine is excluded from the Ustilaginales.

Specimens examined: both on *Allium cepa* L.: **Australia**: intercepted in quarantine at Seattle, Washington, U.S.A.. 27 Apr. 1948, L. Schoening, Seattle 11970, BPI. **Israel**: Jerusalem, 16 Jan. 1938, T. Rayss, BPI (both as '*Ustilago allii* McAlpine', now determined as *Aspergillus niger* Tiegh. *s. lat.*).

Key to smuts of Liliales in Australia

The localities in the key are the States where the smuts are known at present. They should, however, be sought wherever their hosts occur.

1 Ustilospores single, not in balls, with pale shallow polar caps. In capsules and vegetative organs of *Arthropodium* spp., New South Wales, Western Australia ..... *Yelsemia arthropodii*

1: Ustilospores in balls with a surrounding partial or complete layer of sterile cells, polar caps absent 2

1 Spore balls 22–55 µm diam.; ustilospores (1–) 3–5 (–10) per ball; sterile cells (9–) 11–15 µm diam. with wall 2 µm thick. In flowers, capsules and vegetative organs of *Hypoxis glabella*, South Australia, Victoria ..... *Urocystis hypoxis*

2: Spore balls less than 26 µm diam.; ustilospores 1 (or 2) per ball; sterile cells mostly less than 12 µm diam. 3

3 Sterile cells mostly 4–7 µm diam. with wall 1 (–1.5) µm thick. On *Allium cepa* leaves and bulbs. New South Wales, South Australia ..... *Urocystis cepulae*

3: Sterile cells mostly 10–12 µm diam. with wall 1.5 (–2) µm thick. On *Wurmbea dioica* leaves. Victoria ..... *Urocystis destruens*

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