

## Three species of Rhytismataceae from bromeliads

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Three species of Rhytismataceae, *Lophodermium vrieseae*, *Hypoderma tillandsiae*, and *Coccomyces parasiticus*, known only from members of the Bromeliaceae, are described and illustrated. *Coccomyces bromeliacearum*, originally described from a bromeliad, is discussed.

Keywords: Rhytismataceae, Bromeliaceae, *Lophodermium*, *Hypoderma*, *Coccomyces*.

Despite the leaves of bromeliads appearing to be physically suited for the development of Rhytismataceae, few species have been reported from this substrate. *Coccomyces bromeliacearum* Theissen and *Lophodermium vrieseae* Rehm are the only two species to have been originally described from bromeliads. Sherwood (1980), who considered that *C. bromeliacearum* may be conspecific with *C. dentatus* (Schmidt & Kunze) Saccardo, also reported *C. pampeanus* Spegazzini from a bromeliad.

Recent examination of the holotype of *L. vrieseae*, collected from Brazil, has shown that two species of Rhytismataceae are present on the piece of leaf making up the type specimen. One matches the description of *L. vrieseae*, the other is clearly a new species of *Hypoderma*. The two species are easily distinguished microscopically, and can be distinguished macroscopically by size and shape of the ascomata, and by the appearance of the pycnidial conidiomata. The new *Hypoderma* species is similar to two species described from New Zealand, *H. carinatum* Johnston and *H. cookianum* Johnston (Johnston, 1990).

Examination of collections of Rhytismataceae from bromeliads from Mexico has revealed another new species of *Coccomyces* associated with lesions on otherwise green leaves.

### Methods

Ascomata taken from herbarium material were rehydrated in 3% KOH, sectioned at about 10 µm using a freezing microtome, and mo-

unted in lactic acid. Asci, ascospores, and paraphyses were examined in squash mounts made in 3% KOH. The ascus measurements reported are from asci containing fully differentiated ascospores. Ascus length in species of Rhytismataceae is often variable, with asci in many species lengthening immediately prior to spore release. Paraphysis shape is described from apparently mature ascomata, the paraphysis apex often becoming differentiated only after ascomata open.

### Taxonomic treatment

*Lophodermium vrieseae* Rehm, Hedwigia 39: 212. 1900. – Figs. 1, 2.

**A s c o m a t a** and structures resembling anamorph pycnidia of Rhytismataceae develop on dead leaves within pale areas surrounded by incomplete narrow, black zone lines. – **A s c o m a t a** 0.3–0.5 x 0.2 mm, usually oblong-elliptic, rarely triangular in outline, walls dark grey to black, unopened ascomata with no preformed line of dehiscence, opened ascomata lacking macroscopically obvious lips along opening slit. Oblong-elliptic ascomata opening by a single slit, those triangular in outline with triradiate opening slits. In vertical section ascomata subepidermal, with epidermal cells becoming invaded as ascomata mature. Upper wall 25–30  $\mu\text{m}$  thick, more or less uniform in thickness, most of wall comprising very dark, very thick-walled, angular, 5–7  $\mu\text{m}$  diam. cells, with a few pale, thin-walled cells sometimes present along edge of opening slit, but lacking a well-differentiated layer of lip cells. Lower wall 10–12  $\mu\text{m}$  thick, of 2 or 3 rows of brown to dark brown, thick-walled, angular, 4–8  $\mu\text{m}$  diam. cells. In unopened ascomata epidermal cells only partially invaded, with upper wall mostly of very dark brown, very thick-walled, angular cells, a few hyaline, thin-walled, short-cylindric, periphysis-like cells lining inside of upper wall. A group of slightly paler, thinner-walled cells extend through wall near centre of unopened ascomata, along future line of opening. – **P a r a p h y s e s** 2  $\mu\text{m}$  diam., undifferentiated or slightly swollen to 2.5–4  $\mu\text{m}$  diam. at the more or less clavate apex, forming a regular palisade-like layer extending 10  $\mu\text{m}$  beyond the asci. – **A s c i** 95–120 x 14–16.5  $\mu\text{m}$ , subfusoid to subsaccate, tapering gradually to subtruncate apex, wall slightly thinner across apex, 8-spored, spores extending to base of ascus, development sequential. – **A s c o s p o r e s** not seen released, 70–85 x 3–4  $\mu\text{m}$ , filiform, tapering to narrow base, 0-septate, gelatinous sheath not seen.

Structures resembling pycnidia of Rhytismataceae associated with ascomata, round in outline, 0.1–0.2 mm diam., very pale brown with a dark brown margin, immersed in host leaf, lenticular. **C o n i d i a** and **c o n i d i o g e n o u s** cells not seen.

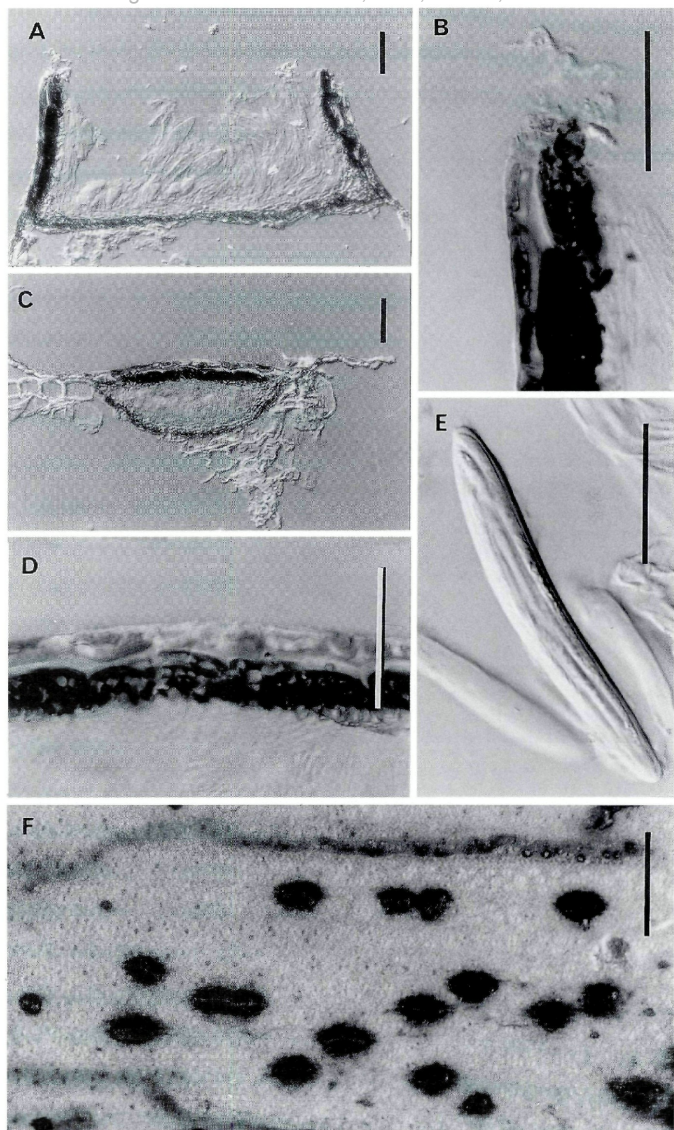


Fig. 1. - *Lophodermium vrieseae* (HBG - holotype). - A: Open ascoma in vertical section. - B: Open ascoma in vertical section, detail of upper wall along edge of opening. - C: Unopened ascoma in vertical section. - D: Unopened ascoma in vertical section, detail of central part of upper wall. - E: Ascus. - F: Macroscopic appearance of ascomata. - Scale bars: A-E = 50  $\mu$ m; F = 1 mm.

**Habitat.** – Dead leaves of *Tillandsia* sp. (Bromeliaceae). *Vriesea* is listed as a synonym of *Tillandsia* in Index Kewensis.

**Distribution.** – Brazil.

**Specimen examined.** – BRAZIL: Estado de Rio Janiero, Serra de Itatiaia, on *Tillandsia* sp. (as *Vriesea*), coll. E. Ule No.2139, i.1896 – in part (HBG – holotype).

*L. vrieseae* differs macroscopically from *Hypoderma tillandsiae* by the presence of zone lines around the bleached area within which the ascomata form, by its slightly smaller, oblong-elliptic rather than elliptic to ovate ascomata, and by the macroscopic appearance of the anamorph pycnidia.

Species of Rhytismataceae typically have ascospores surrounded by a gelatinous sheath. Although a sheath was not observed in this species, or in *H. tillandsiae*, it is often difficult to see, or apparently lacking, in slides made from old herbarium specimens. In some cases gelatinous sheaths are more easily seen in water rather than KOH. The *L. vrieseae* and *H. tillandsiae* specimens could not be adequately rehydrated in water.

Most *Lophodermium* species have differentiated layers of tissue associated with the ascomatal opening. For example, in unopened ascomata there may be a zone of pale cells along the future line of opening. In opened ascomata lip cells often line the exposed face of the broken upper wall, or persistent elongated periphysis-like cells line the inside of the upper wall near the ascomatal opening, or there may be differentiated marginal paraphyses forming an excipulum. Such features were used by Johnston (1989a) to help define a number of groups within the genus. In vertical section the upper wall of the ascomata of *L. vrieseae* is very simple in structure, with no differentiated cells associated with the opening slit, and no differentiated marginal paraphyses. In its simple ascomatal structure and subepidermal ascomata *L. vrieseae* resembles two other South American species, *L. subtropicale* Spegazzini (Argentina, Puerto Leon, Misiones, on *Psidium* sp., coll. C. Spegazzini, ix.1909, LPS. – holotype) and *L. platylacum* (Berkeley & Curtis) Saccardo (Johnston, 1989b). These last two species can be distinguished from *L. vrieseae* by ascus shape and size, ascospore size, and shape of the apex of the paraphyses.

*Hypoderma tillandsiae* Johnston, sp. nov. – Figs. 3, 4.

Ascomata elliptica vel ovata, atra; ascomatis ruptus paries superior sine cellulis cylindricis in superficie exposita. Asci (110–)120–140 x 17–19  $\mu$ m, subfusiformes vel subsaccati; ascosporae 35–50 x 6–8  $\mu$ m, bifusiformes.

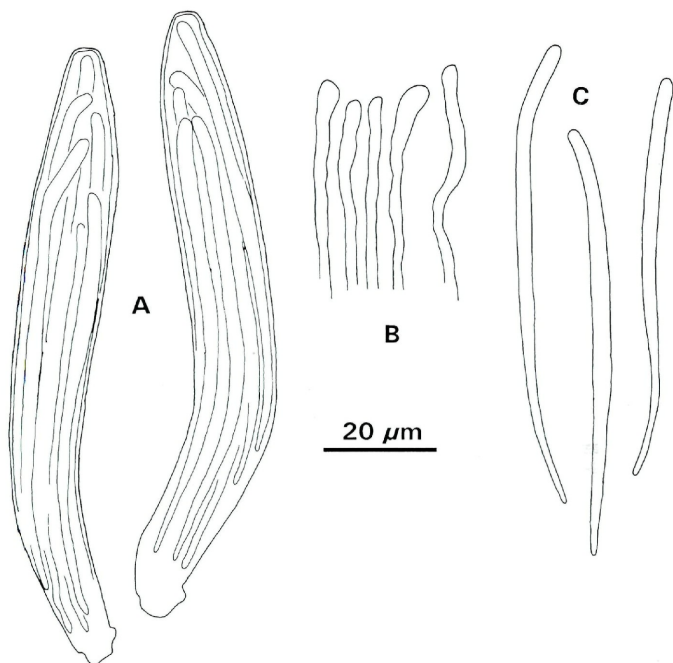


Fig. 2. - *Lophodermium vrieseae* (HBG - holotype). - A: Asci. - B: Apex of paraphyses. - C: Ascospores.

**Holotype.** - BRAZIL, Estado de Rio de Janeiro, Serra de Itatiaia, on *Tillandsia* sp. (as *Vriesea*), coll. E. Ule No.2139, i.1896 - in part (HBG).

**Etymology.** - *tillandsiae*; refers to host substrate.

**Ascomata** and anamorph pycnidia developing on dead leaves in discrete groups within pale areas, not associated with zone lines. - **Ascomata** 0.4-0.6 x 0.3-0.5 mm, broad-elliptic to subovate in outline, walls shiny black, unopened ascomata with no preformed line of dehiscence, opened ascomata lacking macroscopically obvious lip cells along single opening slit. In vertical section ascomata subcuticular. Upper wall up to 40 μm thick, slightly thinner towards edge of as-

coma and at edge of opening slit, comprising very dark, very thick-walled, angular cells, with a few hyaline, thin-walled, angular to short-cylindric cells present along edge of opening slit, but lacking a well-differentiated layer of lip cells, periphysis-like cells not present. Lower wall 6–10  $\mu\text{m}$  thick, of 2 or 3 rows of angular to short-cylindric, 3–4  $\mu\text{m}$  diam. cells, the outer 2 rows brown to dark brown and thick-walled, the inner row generally paler and thin-walled. In unopened ascomata, upper wall up to 40  $\mu\text{m}$  thick, slightly thinner towards outside and at centre of ascoma, comprising mostly very dark, very thick-walled, angular, 5–8  $\mu\text{m}$  diam. cells; inner 1 or 2 rows of cells slightly thinner-walled, paler, with a few short-cylindric, hyaline, thin-walled periphysis-like cells lining inside of wall; at centre of ascoma a more or less wedge-shaped group of hyaline, thin-walled cells extends through inner half of wall. – *Paraphyses* 1.5  $\mu\text{m}$  diam., undifferentiated or slightly and irregularly swollen to 2–2.5  $\mu\text{m}$  diam. at the apex. – *Asci* (110–)120–140  $\times$  17–19  $\mu\text{m}$ , subfusoid to subsaccate, tapering gradually to rounded apex, wall undifferentiated at apex, 8-spored, spores extending to base of ascus, development sequential. – *Ascospores* not seen released, 35–50  $\times$  6–8  $\mu\text{m}$ , bifusiform, 1–2  $\mu\text{m}$  diam. at centre constriction, with both ends more or less cylindric, often tapering slightly to lower end. Gelatinous sheath not seen.

*Pycnidia* 0.1–0.2 mm diam., more or less round, pustulate, pale brown. – *Conidiogenous* cells forming a palisade layer along base of pycnidium, 6–8  $\times$  2–2.5  $\mu\text{m}$ , more or less cylindric, proliferation percurrent. – *Conidia* 3–5  $\times$  1.5  $\mu\text{m}$ , oblong-elliptic with rounded ends, hyaline, 0-septate.

*Habitat*. – Dead leaves of *Tillandsia* sp. (Bromeliaceae).

*Distribution*. – Brazil.

*Specimen examined*. – Holotype only.

Bifusiform ascospores are known from only three non-coniferous species of Rhytismataceae distributed in the Northern Hemisphere: *Duplicaria empetri* (Persoon) Fuckel, *D. acuminata* Ellis & Everhart, and *Bifusepta tehonii* Darker. In contrast, and following relatively little exploration, in Southern Hemisphere regions there are 6 species recently described from New Zealand (Johnston, 1990, 1991) and several undescribed species in Tasmania (P.R. Johnston, unpublished data). Two of the bifusiform-spored species described from New Zealand, *Hypoderma carinatum* and *H. cookianum* (see descriptions in Johnston, 1990), are very similar to *H. tillandsiae* in ascomatal structure. *H. tillandsiae* differs in macroscopic appearance of both the ascomata and pycnidia, in ascus and ascospore size, and ascospore shape.

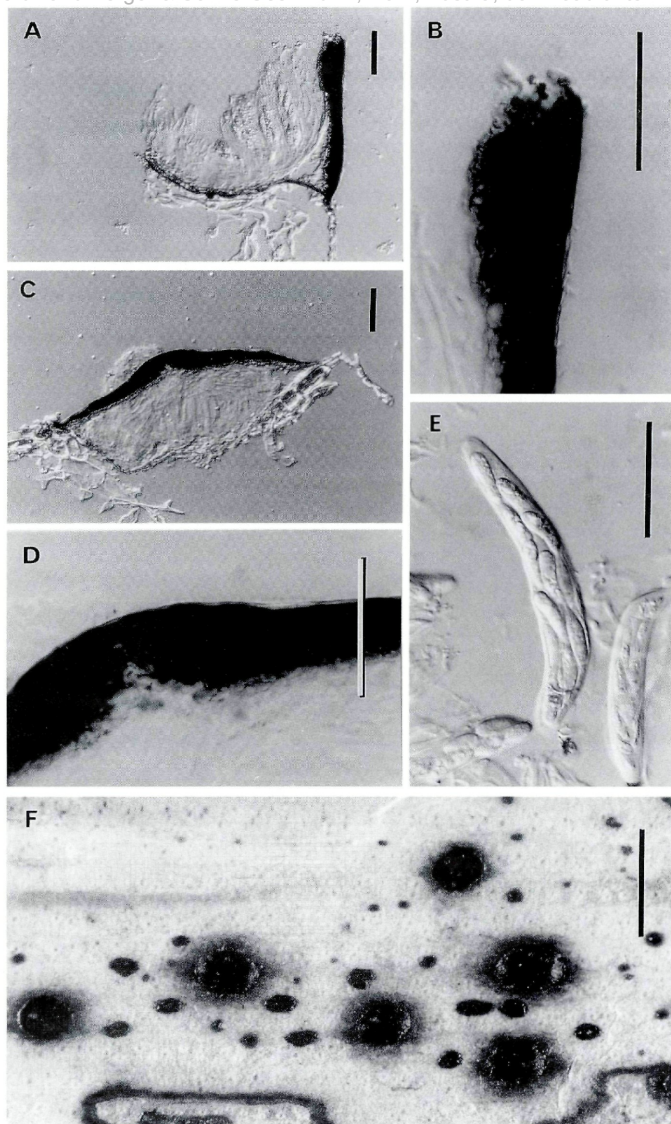


Fig. 3. - *Hypoderma tillandsiae* (HBG - holotype). - A: One side of open ascus in vertical section. - B: Open ascus in vertical section, detail of upper wall along edge of opening. - C: Unopened ascus in vertical section. - D: Unopened ascus in vertical section, detail of central part of upper wall. - E: Ascus. - F: Macroscopic appearance of ascus. - Scale bars: A-E = 50  $\mu$ m; F = 1 mm.

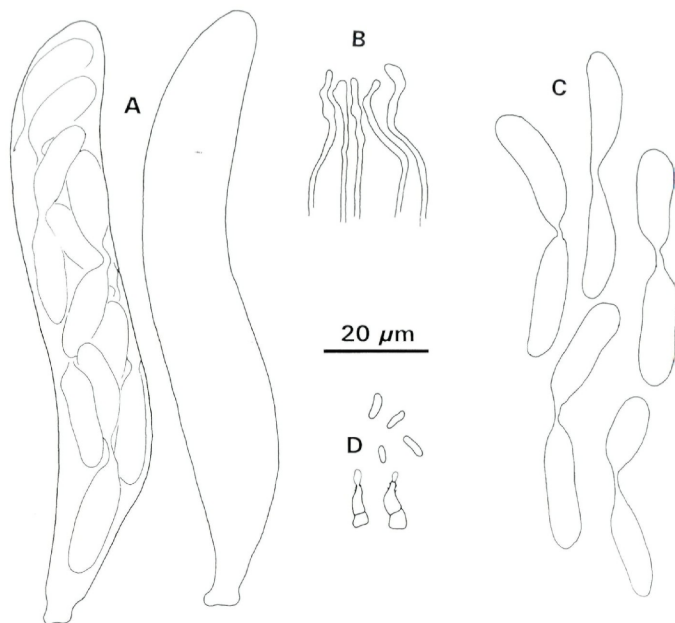


Fig. 4. – *Hypoderma tillandsiae* (HBG – holotype). – A: Asci. – B: Apex of paraphyses. – C: Ascospores. – D: Conidiogenous cells and conidia.

*Coccomyces parasiticus* Johnston, sp. nov. – Figs. 5, 6.

Ascomata in laesionibus brunneis margine purpureo, tetragona vel pentagona, 0.4–0.8 mm diam., atrobrunnea, evoluta intra hypodermata. Asci cylindrici vel subclavati, 155–180 x 10.5–12  $\mu$ m; ascosporae 110–145 x 2–2.5  $\mu$ m.

**Holotype.** – MEXICO: Veracruz (intercepted at Brownsville, Texas), on *Tillandsia imperialis*, coll. J. M. Van Valkenburgh, 21. xi. 1980 (BPI 1108406).

**Etymology.** – refers to the apparent parasitic habit of this species.



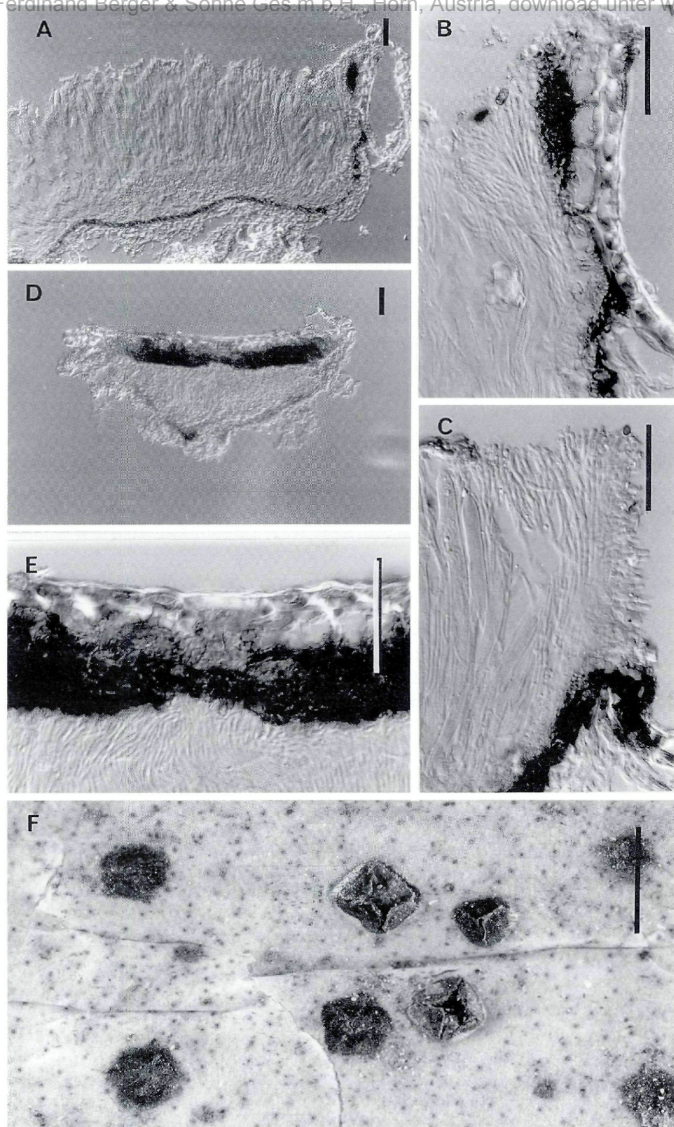


Fig. 5. – *Coccomyces parasiticus* (BPI 1108411). – A: One side of open ascus in vertical section. – B: Open ascus in vertical section, detail of upper wall. – C: Open ascus in vertical section, detail of excipulum in part of ascus between flaps of upper wall. – D: Unopened ascus in vertical section. – E: Unopened ascus in vertical section, detail of central part of upper wall. – F: Macroscopic appearance of ascomata. – Scale bars: A–E = 50  $\mu$ m; F = 1 mm.

**Ascomata** developing in groups within large, usually elliptic lesions, necrotic and pale brown in centre with a broad, purple-red margin, not associated with anamorph pycnidia. – **Ascomata** 0.4–0.8 mm diam., angular in outline, (3–)4 or 5-sided with radiate opening slits. Walls of unopened ascomata dark grey to black, sometimes with poorly differentiated paler zones along future lines of opening; in opened ascomata walls brown to dark brown, with translucent-yellow hymenium widely exposed at maturity when dry. In vertical section ascomata intrahypodermal, developing beneath thick-walled epidermal cells and 1 row of hypodermal cells, but with hypodermal cells becoming invaded as ascomata mature. Upper wall 50–60  $\mu\text{m}$  thick near ascomatal opening, slightly narrower toward edge of ascoma, comprising dark brown, thick-walled, angular, 3–5  $\mu\text{m}$  diam. cells, with a poorly developed layer of hyaline, thin-walled, cylindric, periphysis-like cells lining inside of upper wall near ascomatal opening. A layer comprising marginal paraphyses (termed an excipulum by Sherwood, 1980), differentiated by being more closely septate than the other paraphyses, develops between upper wall and hymenium, 40–60  $\mu\text{m}$  wide adjacent to top of hymenium, narrower to base, with apices of excipular elements often darkened. In parts of ascomata where upper wall is lost, excipulum 40–60  $\mu\text{m}$  wide to base of hymenium. Lower wall 10–12  $\mu\text{m}$  thick, of 3 or 4 rows of dark brown, thick-walled, angular cells. Unopened ascomata with upper wall up to 50  $\mu\text{m}$  thick, slightly narrower near centre of ascoma, comprising mostly dark brown, thick-walled, angular cells, with a group of paler, thinner-walled cells in outer half of wall near centre of ascoma, along future line of opening. – **Paraphyses** 2  $\mu\text{m}$  diam., slightly and irregularly swollen to 3–4  $\mu\text{m}$  at apex, branching several times in upper 40–50  $\mu\text{m}$ , becoming tangled to form a non-gelatinous epithecium, extending about 20  $\mu\text{m}$  beyond asci. – **Asci** 155–180 x 10.5–12  $\mu\text{m}$ , cylindric to subclavate, rounded at apex, wall thickened at apex with a broad central pore, 8-spored, development sequential. – **Ascospores** 110–145 x 2–2.5  $\mu\text{m}$ , filiform, tapering to base, 0-septate, with a prominent gelatinous cap.

**Habitat.** – Living leaves of *Tillandsia* spp.

**Distribution.** – Mexico.

**Specimens examined.** – MEXICO: Veracruz (intercepted at Brownsville, Texas), on *Tillandsia imperialis*, coll. J. M. Van Valkenburgh, 21. xi. 1980 (BPI 1108406 – holotype); *ibid.*, coll. J. M. Van Valkenburgh, 21. i. 1980 (BPI 1108409, as *Colpoma* sp.); *ibid.*, coll. J. M. Van Valkenburgh, 21. xi. 1978 (BPI 1108407, as *Clithris* sp.); (intercepted at Brownsville, Texas), on *Tillandsia imperialis*, coll. Fishman & J. M. Van Valkenburgh, 9. xii. 1977 (BPI 1108412, as *Colpoma* sp.); (intercepted at Brownsville, Texas), on *Tillandsia imperialis*, coll. J. M. Van Valkenburgh, 6. xii. 1978 (BPI 1108410, as *Colpoma* and *Clithris* sp.); Queteres, (intercepted

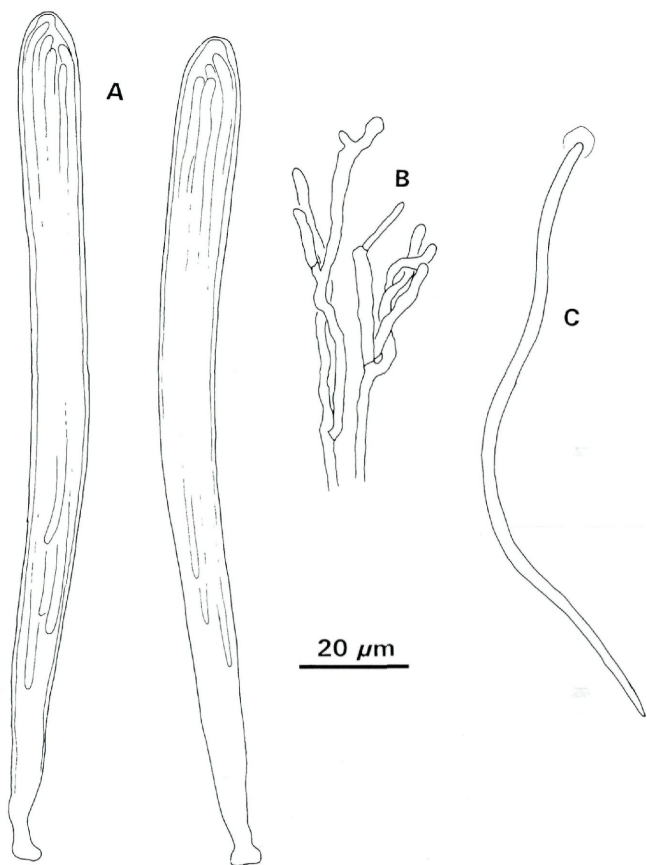


Fig. 6. – *Coccomyces parasiticus* (BPI 1108406). – A: Asci. – B: Apex of paraphyses. – C: Released ascospore.

at Brownsville, Texas), on *Tillandsia imperialis*, coll. J. M. Van Valkenburgh, 19. xi. 1977 (BPI 1108411, as *Colpoma* sp.); Chiapas (intercepted at Brownsville, Texas), on *Tillandsia guatemalensis*, coll. J. M. Van Valkenburgh, 27. ii. 1978 (BPI 1108413, as *Colpoma* sp.); Fortin (intercepted at Brownsville, Texas), on *Tillandsia* sp., coll. J. M. Van Valkenburgh, 2. xi. 1976 (BPI 1108414, as *Colpoma* sp.).

*C. parasiticus* is morphologically distinct from all described *Coccomyces* species. It is ecologically unusual for the genus, in being associated with a leaf-spotting disease. Most *Coccomyces* species are found on fallen dead leaves or dead twigs, although Sherwood (1980) and Cannon & Minter (1986) recorded a few pathogenic species. One of these, *C. vilis* Sydow & Butler, appears to be widespread in tropical Asia and America on a range of hosts. *C. parasiticus* differs from *C. vilis* in ascus and ascospore size, and in ascomatal structure. The ascomatal structure of *C. parasiticus* matches that described for the "*C. leptosporus* complex" by Sherwood (1980), but *C. parasiticus* differs from all species in this group in ascus and ascospore size and in its parasitic habit.

*Coccomyces bromeliacearum* Theissen in Theissen & Innsbruck, Botanischen Zentralblatt Beihefte 27: 407. 1910.

Specimens examined. - BRAZIL: S. Leopoldo, Rio Grande do Sul, on Bromeliaceae, coll. Rick, 1908, Theissen, Decades fungorum brasiliensium No.135 (S, BPI - isotypes).

Sherwood (1980) noted that *C. bromeliacearum* may be conspecific with *Coccomyces dentatus* (Kunze & Schmidt) Saccardo, but because the type material was overmature the synonymy could not be certain. My examination of isotype material from S and BPI confirmed that the material is overmature, but that macroscopically the specimens match *C. dentatus*. The original description of *C. bromeliacearum* closely matches *C. dentatus* and the two names are likely to represent the same species.

*C. dentatus* occurs on a wide range of plants, and it would not be surprising to find it on bromeliad leaves, a substrate apparently physically suited to the development of Rhytismataceae. However, *C. dentatus* is widely distributed in the Northern Hemisphere, and few leaf-inhabiting Rhytismataceae are found in both the Northern and Southern Hemisphere (Johnston, 1992). Sherwood (1980) reported several *C. dentatus* collections from tropical South America. It is likely that the presence of *C. dentatus* in South America represents a recent extension of the geographic range of this species from North to South America. Such a range extension has been postulated for other organisms, for example the phanerogams *Quercus* and *Alnus*, thought to have extended their range into South America in the late Miocene to Pliocene or later (Raven & Axelrod, 1974). Roy Halling (New York Botanical Garden, pers. comm.) has shown that some of the Agaricales associated with *Quercus* litter moved along with *Quercus* into tropical South America. It is quite likely that litter-inhabiting Ascomycetes did the same; *C. dentatus* is common on *Quercus* litter in the Northern

Hemisphere. Examination of numerous specimens of Rhytismataceae from tropical South America in NY show that although *C. dentatus* does occur in South America, it is not common (unpublished data).

### Acknowledgments

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