

***SPORISORIUM THEMEDAE*, NEW TO MAURITIUS, AND *TILLETIA MAURITIANA*, NEW TO MADAGASCAR**

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Abstract. Two smut fungi from Indian Ocean islands are described, illustrated and discussed. *Sporisorium themedae* (Duke) Vánky on *Themeda quadrivalvis* (L.) Kuntze is reported for the first time from Mauritius, and from the Madagascan subkingdom of the Paleotropics as a whole. *Tilletia mauritiana* Vánky on *Brachiaria umbellata* (Trin.) Clayton is new to Madagascar. This smut was hitherto known only from the type locality in Mauritius, and the present finding extends its geographic distribution ca 900 km westwards.

Key words: Indian Ocean islands, Mascarenes, Madagascan subkingdom, Paleotropics, smut fungi, *Sporisorium*, *Tilletia*

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INTRODUCTION

The islands of the western Indian Ocean belong entirely to the Madagascan subkingdom of the Paleotropics, characterized by great diversity of vascular plant flora including between 9000 and 12,000 species, with numerous endemic families, genera and species (e.g., Gautier & Goodman 2003). Such diverse and unique plants surely harbor many unusual species of phytopathogenic fungi. However, knowledge of the plant parasitic fungi of this area in general and of smut fungi in particular is very sparse. Records of smuts from Indian Ocean islands are very few (e.g., Viennot-Bourgin 1963; Piątek & Vánky 2007), and the smut fungi of this area await comprehensive studies. During analysis of various smut collections, two interesting species from this area were identified: *Sporisorium themedae* (Duke) Vánky, which is new to Mauritius, and *Tilletia mauritiana* Vánky, which is new to Madagascar. These new collections are described, illustrated and discussed here.

MATERIALS AND METHODS

Dried herbarium specimens were examined by light and scanning electron microscopy. For LM, small pieces of sori were mounted in lactic acid and examined under

a Nikon Eclipse 80i light microscope. At least 50 spores and 30 sterile cells were measured from the studied collections, using NIS-Elements BR 3.0 imaging software. LM micrographs were taken with a Nikon DS-Fi1 camera. For SEM, spores and sterile cells were dusted onto carbon tabs and fixed to an aluminum stub with double-sided transparent tape. The stubs were sputter-coated with carbon using a CRESSINGTON sputter-coater and viewed with a Hitachi S-4700 scanning electron microscope, at a working distance of 12–13 mm. SEM micrographs were taken in the Laboratory of Field Emission Scanning Electron Microscopy and Microanalysis at the Institute of Geological Sciences, Jagiellonian University, Kraków.

RESULTS AND DISCUSSION

Sporisorium themedae (Duke) Vánky

Figs 1 & 2

Mycotaxon 51: 163. 1994.

Sori in the racemes, cylindrical, up to 8 mm long and 1 mm wide, partly hidden by the spatheoles, first covered by a leathery, pale brown peridium which ruptures irregularly from the apex, exposing a dark brown, semi-agglutinated or powdery mass of spores intermixed with sterile cells surrounding a central narrowing columella; columella rarely

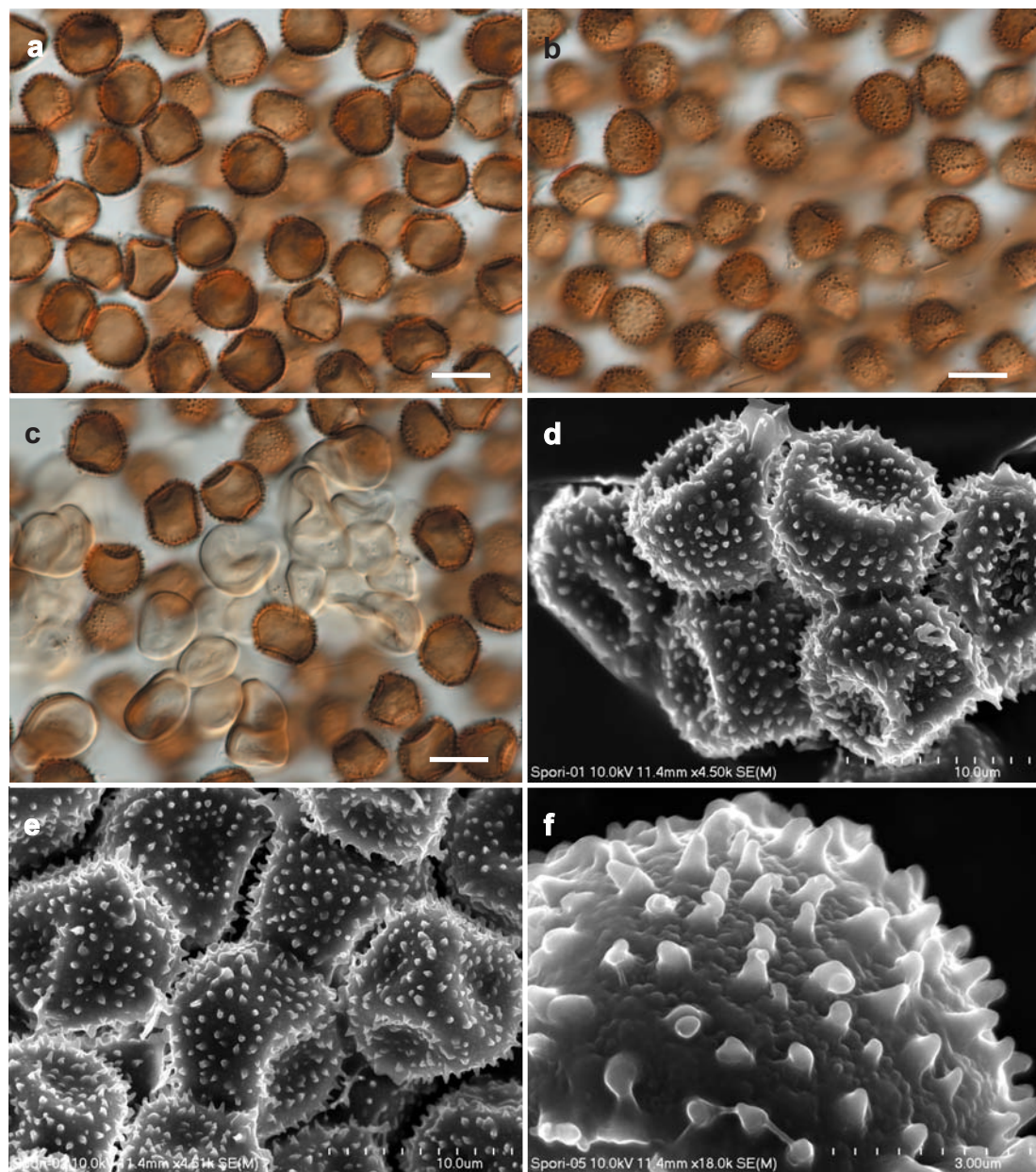


Fig. 1. *Sporisorium themedae* (Duke) Vánky on *Themeda quadrivalvis* (L.) Kuntze (from IMI 45968). a & b – spores seen by LM, median and superficial views respectively, c – spores and sterile cells seen by LM, d & e – spores from the outer and central parts of spore ball, respectively, seen by SEM, f – wall of spore seen by SEM. Scale bars: a–e = 10 µm, f = 3 µm.

bifurcate. Spore balls absent. Spores reddish brown, globose, subglobose, ovoid or subpolyhedrally irregular, $9.3\text{--}12.4 \times 8.3\text{--}11.5$ µm, mean $11.078 \pm 0.736 \times 10.037 \pm 0.690$ µm; wall even,

ca 0.5 µm thick, surface moderately densely verrucose in LM, verrucose-echinulate in SEM, spore profile serrulate. Sterile cells usually in irregular groups, single cells hyaline, subhyaline

or pale yellowish brown, subglobose, ovoid or irregular, often collapsed, (7.8–)10–13.7(–17.5) \times (5.8–)7.0–11.7(–14.0) μm , mean $11.850 \pm 1.954 \times 9.856 \pm 1.825 \mu\text{m}$; wall rather even, 0.7–1.5 μm thick, surface smooth as seen by LM and SEM.

SPECIMEN EXAMINED. On *Themeda quadrivalvis* (L.) Kuntze: MAURITIUS, without further details, IMI 45968 (ex RBG Kew).

COMMENTS. Twenty species of smut fungi are currently recognized on the grass genus *Themeda* Forssk. (Vánky 1994, 1995, 1997a; Shivas & Vánky 2002), several of which differ only slightly from each other. *Sporisorium themedae* is characterized by having sori destroying the racemes, single simple columella (only rarely bifurcate), spores 9.5–12.0 long and 8.0–10.5 μm wide, sterile cells 10–15 μm long, and by the absence of spore balls (Vánky 1994). Four other *Themeda* smuts are similar morphologically and probably constitute a natural group: *Sporisorium benguetense* (Zundel) L. Guo, *S. centrale* R. G. Shivas & Vánky, *S. lingii* Vánky and *S. punctatum* (L. Ling) Vánky. *Sporisorium benguetense* differs from *S. themedae* in having larger spores, 11.0–14.5 \times 10.5–13.0 μm , and sterile cells 11–18 μm long (Vánky 1994). *Sporisorium lingii* has a branched columella, slightly smaller spores, 8–12 \times 7.5–10.0 μm , and larger sterile cells, 12–25 μm long (Vánky 1994).

Sporisorium punctatum differs by having somewhat smaller, punctate-verruculose spores, 7–11 \times 7.0–9.5 μm , and larger sterile cells, 10–21 μm long (Vánky 1994; Shivas & Vánky 2002). Finally, *Sporisorium centrale* is distinguished by having slightly smaller punctate spores, 8–11(–15) \times 7.5–9.0 μm , and the absence of sterile cells (Shivas & Vánky 2002).

In general, the majority of the Mauritian collection agrees very well with the concept of *Sporisorium themedae*. One separate sori in the collection differs somewhat: an awn is present in the raceme, suggesting that the smut probably destroys only the ovary (not the whole raceme), while the spores are somewhat intermediate between *S. themedae* and *S. benguetense* (10.3–13.1 \times (8.2–)9.0–11.6(–12.1) μm , mean $11.780 \pm 0.733 \times 10.370 \pm 0.681 \mu\text{m}$). Thus, it was difficult to decide the species to which this part of the specimen belongs. It was included in *S. themedae* because most characters, including spore width, are closer to this species than to *S. benguetense*.

Sporisorium themedae was originally described under the name *Sphacelotheca themedae* Duke from infected *Themeda triandra* Forssk. collected in Nairobi, Kenya (Duke 1926), and reallocated to the genus *Sporisorium* Ehrenb. ex Link by Vánky (1994). Further locations of this smut are known in

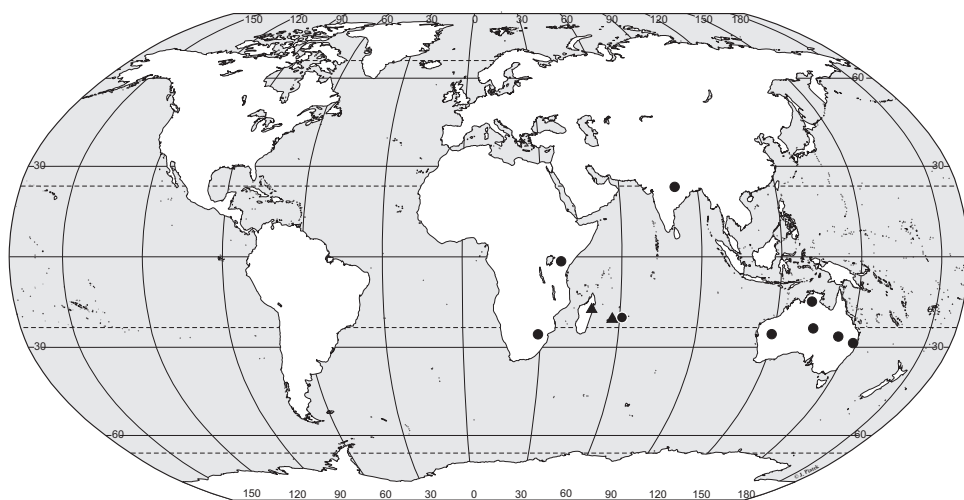


Fig. 2. Global distribution of *Sporisorium themedae* (Duke) Vánky (dots) and *Tilletia mauritiana* Vánky (triangles).

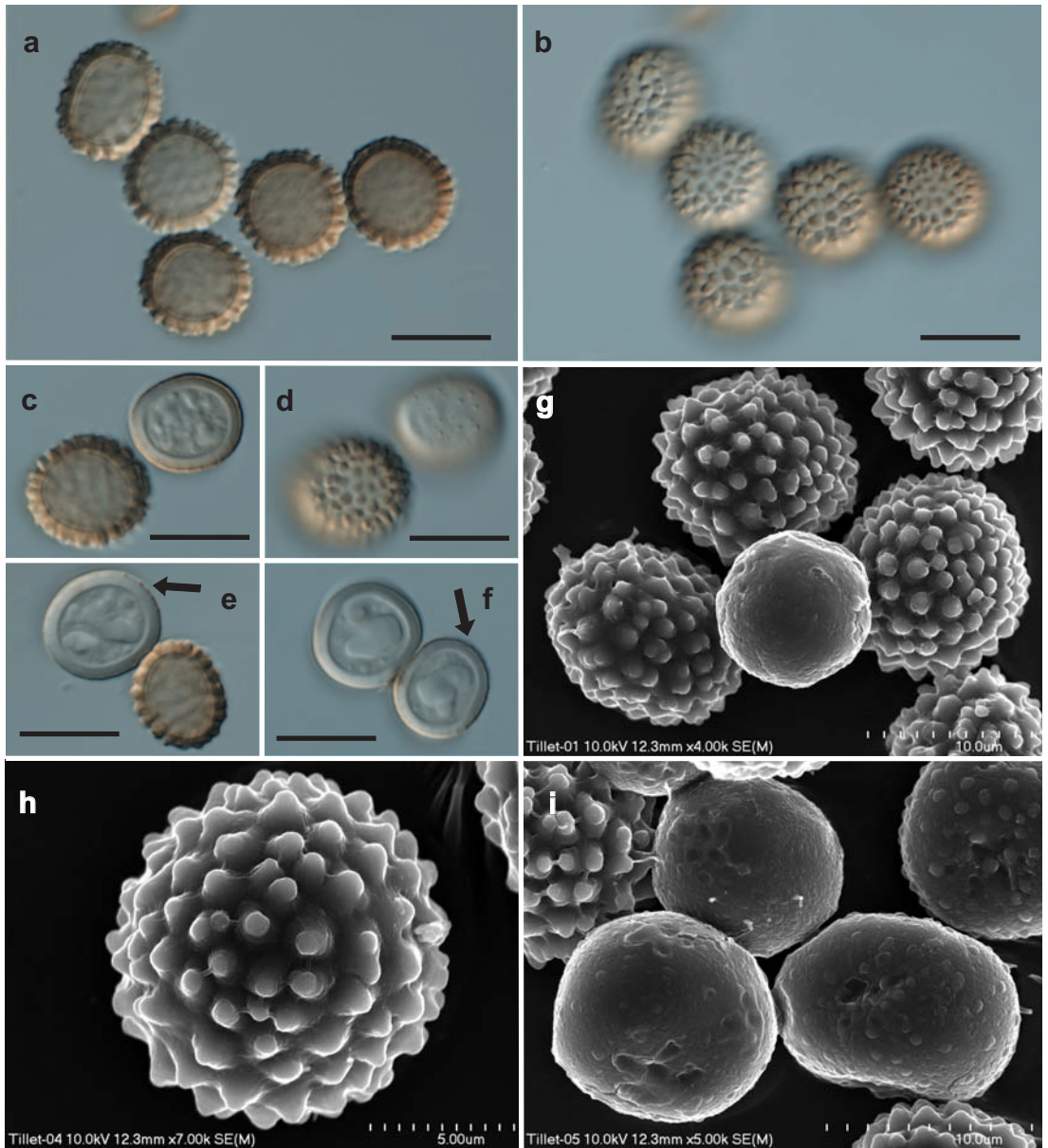


Fig. 3. *Tilletia mauritiana* Vánky on *Brachiaria umbellata* (Trin.) Clayton (from H). a & b – spores seen by LM, median and superficial views respectively, c & d – spore and sterile cell ('intermediate form') seen by LM, median and superficial views respectively, e – spore and sterile cell ('intermediate form'; note fine verrucae indicated by arrow) seen by LM, f – sterile cells (one smooth cell and one 'intermediate form'; note fine verrucae indicated by arrow) seen by LM, g – spores and sterile cell seen by SEM, h – spore seen by SEM, i – spores, sterile cells and punctate 'intermediate forms' seen by SEM. Scale bars: a–g and i = 10 µm, h = 5 µm.

South Africa on *Themeda triandra* (South Africa, Gauteng Province, ca 25 km W of Pretoria, elev. ca 1230 m, 25°43'14"S 28°01'13"E, 13 Jan. 1997,

leg. C. Roux et al., det. K. Vánky, distributed in K. Vánky – Ustilaginales no. 1029, not studied), India on *Themeda quadrivalvis* (Vánky 2007,

India, Madhya Pradesh, 12 km N of Jabalpur, near Sihora, 23°30'N 80°09'E, 9 Oct. 1992, *leg. N. D. Sharma et al.*, *det. K. Vánky*, distributed in K. Vánky – Ustilaginales no. 926, not studied), and Australia on *Themeda triandra* (Vánky & Shivas 2008). The present record of *Sporisorium themedae* in Mauritius is the first not only on the island but also in the whole Madagascan subkingdom of the Paleotropics (Fig. 2). The smut probably was introduced to the island, since its host plant *Themeda quadrivalvis* is not native to Mauritius.

***Tilletia mauritiana* Vánky** Figs 2 & 3

Mycotaxon 81: 377. 2002.

Sori in all ovaries of an inflorescence, ovoid, with a short, acute tip, 1.0–1.5 mm long, partly hidden by the glumes, covered by thin, first green and later brownish pericarp, which ruptures irregularly disclosing a brown, powdery mass of spores and sterile cells. Spores yellowish brown or pale brown, globose, subglobose to broadly ellipsoidal, (10.4–)13.3–16.8 × (9.7–)12.0–15.7 µm, mean 15.118 ± 1.242 × 13.779 ± 1.067 µm, provided with coarse, blunt subconical warts as seen by LM and SEM, verrucae 1.3–2.5 µm high, 7–10 per spore diameter, without external hyaline, gelatinous sheath. Sterile cells hyaline to subhyaline, globose to subglobose, 9.4–16.5 × 8.2–13.9(–15.8) µm, mean 13.166 ± 2.311 × 11.613 ± 2.012 µm, wall 0.6–1.8(–2.0) µm thick, smooth, but some cells have depressions caused by impressed warts from spores while others are evidently punctate ('intermediate forms').

SPECIMENS EXAMINED. On *Brachiaria umbellata* (Trin.) Clayton: MADAGASCAR. Soanierana Ivongo S, Manakinany, 17°19'S, 49°32'E, grassy seashore, 25 Oct. 1986, *leg. B. Pettersson & L. A. Nilsson* 38, H; MAURITIUS. sine loco et die, *leg. P. O. Wiehe* (D 145), comm. 22 Feb. 1939, IMI 42344 – holotype.

COMMENTS. *Tilletia mauritiana* is a poorly known species, only recently described as new to science from infected ovaries of *Brachiaria umbellata* collected in Mauritius (Vánky 2002) and so far known only from the type locality. The host plant, *Brachiaria umbellata*, is a perennial, mat-forming grass, distributed in tropical Eastern and

Southern Africa as well as on the western Indian Ocean islands (Clayton *et al.* 2006). Therefore it is highly probable that *Tilletia mauritiana* is more widely distributed and is not endemic to Mauritius. The present record of this smut in the Madagascar partly confirms this supposition.

The Malagasy specimen was originally identified as '*Sphacelotheca*' on '*Panicum* sp.' Its examination revealed that the host plant is actually *Brachiaria umbellata*, not *Panicum* sp., while the smut belongs to the genus *Tilletia* Tul. & C. Tul. and is very similar to *T. mauritiana*. The specimen has slightly smaller spores and smaller sterile cells with thinner walls than the original collection from Mauritius described by Vánky (2002 – spores 13.5–18.5 × 11–16 µm; sterile cells 12–20 µm long, wall 2.5–4 µm thick). Intermediate forms are only single in the specimen from Madagascar, while quite numerous in the type specimen from Mauritius. In general, however, in appearance the Malagasy specimen is hardly distinguishable from *T. mauritiana*, and the minor morphological differences are considered variation within the same species.

The only other species of *Tilletia* known on *Brachiaria* (Trin.) Griseb. is *Tilletia brachiariae* (Pavgi & Thirum.) Vánky, which has larger spores and sterile cells, 19–26 × 18–24 µm and 13–25 µm, respectively (Vánky 1997b). *Tilletia mauritiana* is reported here for the first time from Madagascar, and this record markedly extends the geographical range of the smut, being ca 900 km west of the type locality in Mauritius (Fig. 2).

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REFERENCES

- CLAYTON W. D., HARMAN K. T. & WILLIAMSON H. 2006 (onwards). GrassBase – The Online World Grass Flora. <http://www.kew.org/data/grasses-db.html>. [Accessed 20 November 2006].
- DUKE M. M. 1926. Fungi from Kenya colony. *Bull. Misc. Inform. Kew* 8: 305–320.

- GAUTIER L. & GOODMAN S. M. 2003. Introduction to the Flora of Madagascar. In: S. M. GOODMAN & J. P. BENSTEAD (eds), *The Natural History of Madagascar*, pp. 229–250. University of Chicago Press, Chicago.
- PIĄTEK M. & VÁNKY K. 2007. *Ustilago aldabrensis*, a new species from Seychelles, and two other smut fungi on *Dactyloctenium*. *Mycol. Progr.* **6**: 213–219.
- SHIVAS R. G. & VÁNKY K. 2002. A new smut fungus, *Sporisorium centrale* sp. nov., on *Themeda* from Australia. *Fung. Diversity* **11**: 141–144.
- VÁNKY K. 1994. Taxonomical studies on Ustilaginales. XI. *Mycotaxon* **51**: 153–174.
- VÁNKY K. 1995. Taxonomical studies on Ustilaginales. XIII. *Mycotaxon* **56**: 197–216.
- VÁNKY K. 1997a. Taxonomical studies on Ustilaginales. XV. *Mycotaxon* **62**: 127–150.
- VÁNKY K. 1997b. Taxonomical studies on Ustilaginales. XVI. *Mycotaxon* **65**: 133–158.
- VÁNKY K. 2002. Taxonomical studies on Ustilaginales. XXII. *Mycotaxon* **81**: 367–430.
- VÁNKY K. 2007. Smut fungi of the Indian Subcontinent. *Polish Bot. Stud.* **26**: 3–265.
- VÁNKY K. & SHIVAS R. G. 2008. Fungi of Australia: The Smut Fungi. ABRIS, Canberra; CSIRO Publishing, Melbourne.
- VIENNOT-BOURGIN G. 1963. Étude de micromycètes parasites récoltés à Madagascar. *Ann. Ins. Natl. Agron.* **47**: 3–28.

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