

# Two smut fungi on *Ischaemum*: *Sporisorium austroafricanum* sp. nova and *Tolyposporium bogoriense* revisited

Marcin Piątek

Department of Mycology, W. Szafer Institute of Botany, Polish Academy of Sciences, Lubicz 46, PL-31-512 Kraków, Poland (e-mail: mpiatek@ib-pan.krakow.pl)

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Two smut fungi on two different species of *Ischaemum* are taxonomically assessed based on newly studied collections. *Sporisorium austroafricanum* M. Piątek is described and illustrated as a new species infecting *Ischaemum fasciculatum* in South Africa. Among the smut fungi described on *Ischaemum*, it is similar only to *Sporisorium ischaemi-anthephoroides*, from which it differs by the macroscopic appearance of sori and by larger sterile cells with thicker walls. *Tolyposporium bogoriense* originally described as occurring on *Panicum* sp. in Indonesia (Java) appeared to be on *Ischaemum* cf. *timorensis* and identical with *Sporisorium flagellatum*, the latter having priority. The morphology of this species is described and illustrated based on the holotype of *T. bogoriense*.

Key words: new species, nomenclature, *Sporisorium*, taxonomy, Ustilaginaceae, Ustilaginales

## Introduction

During a survey of various smut collections, I studied two specimens on two different species of the grass genus *Ischaemum* (family Poaceae, subfamily Panicoideae, tribe Andropogoneae, subtribe Ischaeminae). The unidentified specimen from the herbarium in Pretoria (PREM) labelled as “*Sphacelotheca*” collected on *Ischaemum purpurascens* in South Africa clearly belonged to the genus *Sporisorium*, but could not be identified with any known species described on *Ischaemum*. The host plant, *I. purpurascens* is now accepted as a synonym of *I. fascicula-*

*tum*, a species occurring in South Africa right across tropical Africa, and eastwards through India to Indo-China (L. Fish pers. comm.). The smut fungus is described and illustrated here as a new species. The revised holotype specimen of *Tolyposporium bogoriense* from the herbarium in Kraków (KRA) originally described as occurring on *Panicum* sp. in Indonesia (Java) appeared to be on *Ischaemum* cf. *timorensis* and is inseparable from *Sporisorium flagellatum*, which has priority. The synonymy is proposed and the morphology of this species is described and illustrated based on the holotype of *T. bogoriense*.



**Fig. 1.** *Sporisorium austroafricanum* (from the holotype): to the left sori in all infected spikelets of inflorescence of *Ischaemum fasciculatum*, to the right enlarged sorus. Scale bars = 1 cm (left) and 0.5 cm (right).

## Material and methods

Sori and spore characteristics were studied using dried herbarium material. The specimens were examined by light microscopy (LM) and scanning electron microscopy (SEM). For LM, small pieces of sori were mounted either in 5% KOH or in heated lactophenol and examined under a NIKON Eclipse E600 light microscope. For SEM, spore balls, spores and sterile cells were dusted onto carbon tabs and fixed to an aluminium stub with double-sided transparent tape. The stubs were sputter-coated with carbon using a CRESSINGTON sputter-coater and viewed under a Hitachi S-4700 scanning electron microscope, with a working distance of ca. 12–13 mm. SEM micrographs were taken in the Laboratory of Field Emission Scanning Electron Microscopy and Microanalysis at the Institute of Geological Sciences of Jagiellonian University, Kraków (Poland). The description and the nomenclatural novelty are registered in MycoBank ([www.MycoBank.org](http://www.MycoBank.org), see Crous *et al.* 2004).

## Taxonomy

***Sporisorium austroafricanum*** M. Piątek, *sp. nova* (Figs. 1 and 2)

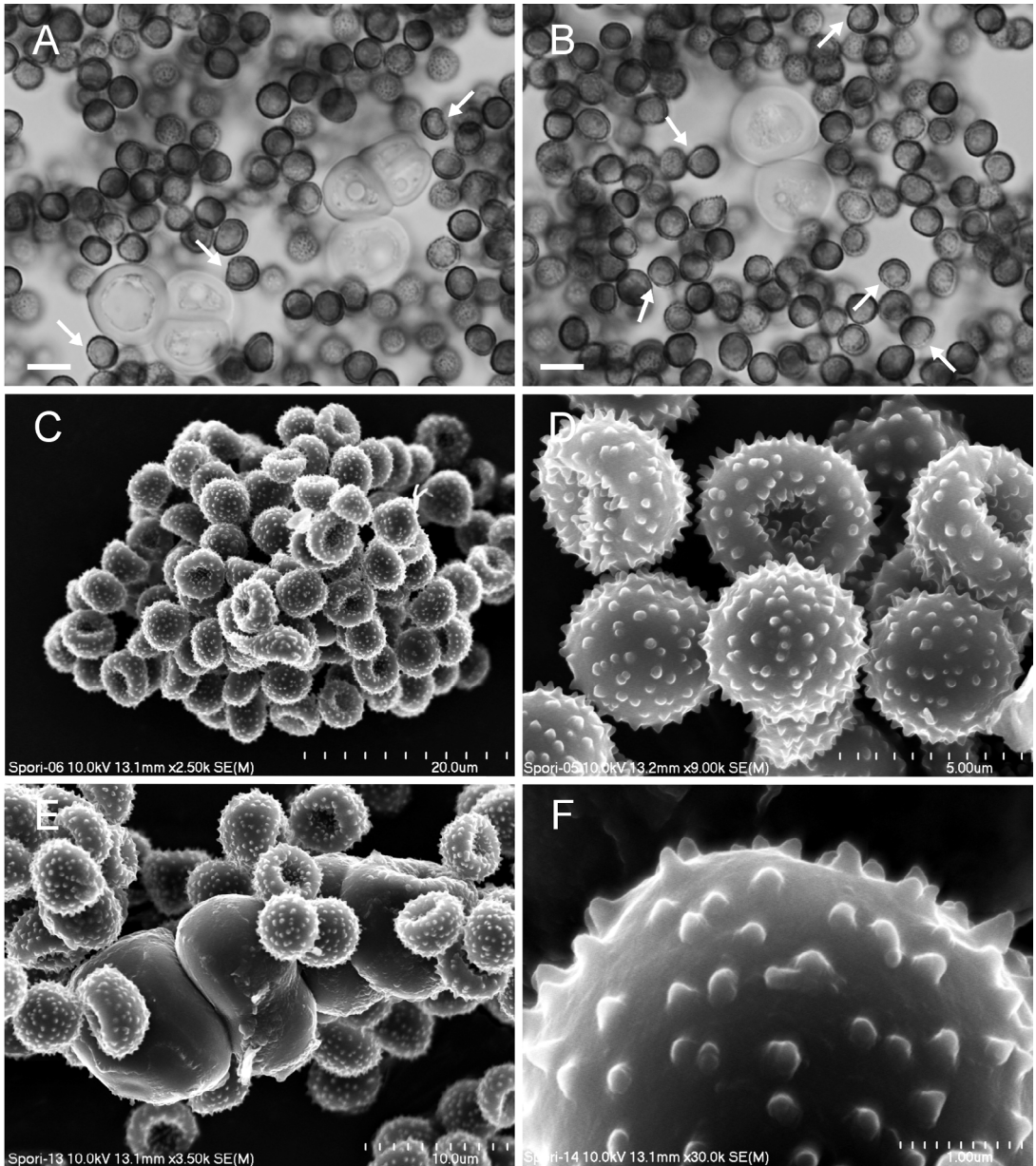
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*Sori in omnibus spiculis inflorescentiae, ellipsoidales, 1–2 × 2–5 mm, partim glumis occulti, primum contacti crasso, pallide fusco peridio irregulariter dehiscente et adaperiente semiagglutinatum vel pulveream massam glomerorum sporarum et cellularum sterilium columellam cingentium; occasionaliter duae columellae in soro. Glomeruli sporarum ephemerales et faciliter in simplices dissoluti. Sporae luteo-fuscae, aliquantulum appanatae et ex una parte clarius infuscaetae, globosae, subglobosae, rarius ovoideae vel ellipsoidales, (4.5–)5.0–7.5 × (4.0–)4.5–6.0(–6.5) μm; paries potius planus, ca 0.5(–1.0) μm crassus, sed paulo subtilior ex parte clarius infuscaeta, facies conspicua in LM leniter echinulata, obliqua imago sporae leniter serrulata, facies conspicua in SEM raro echinulata. Cellulae steriles plerumque in parvis irregularibus gregibus vel catenulis, rarius singulariter visibiles, cellulae solitariae magnae, hyalinae in subhyalinis transeuntes, globosae, subglobosae vel ellipsoidales, aliquando collapsae, 8–22 × 8–15 μm; paries potius planus vel rarius aliquantulum inaequalis, 1.5–3.0 μm crassus, facies levis conspicua in LM et SEM.*

TYPE: On *Ischaemum fasciculatum* Brongn. (= *Ischaemum purpurascens* Stapf), South Africa, Seringkop, Bronkhorstspuit Tul, 1944 *L. E. Codd* (holotype PREM 34354!).

ETYMOLOGY. Named after the country in which it was collected, South Africa.

Sori in all spikelets of inflorescence, destroying inner floral organs, ellipsoidal, 1–2 × 2–5 mm, partly hidden by glumes, first covered by a thick, pale brown peridium which ruptures irregularly disclosing dark brown, semi-agglutinated or powdery mass of spore balls, spores and sterile cells surrounding a stout, narrowing columella composed of some agglutinated branches; occasionally two columellae in sorus. Spore balls ephemeral and easily disintegrating into single spores. Spores yellowish-brown, somewhat flat-



**Fig. 2.** *Sporisorium austroafricanum* (from the holotype). — **A** and **B**: Spores and sterile cells seen by LM. Note the flattened spores with a thinner wall and lighter-coloured side (arrows). — **C**: SEM image of spore ball. — **D**: SEM image of spores. — **E**: SEM image of spores and sterile cells. — **F**: SEM image of spore wall. Scale bars = 1  $\mu\text{m}$  for **F**, 5  $\mu\text{m}$  for **D**, 10  $\mu\text{m}$  for **A**, **B** and **E**, 20  $\mu\text{m}$  for **C**.

tened and slightly lighter-coloured on one side, globose, subglobose, rarely ovoid or ellipsoidal, (4.5–)5.0–7.5  $\times$  (4.0–)4.5–6.0(–6.5)  $\mu\text{m}$ ; wall rather even, ca. 0.5(–1.0)  $\mu\text{m}$  thick, but somewhat thinner on lighter-coloured side, surface as seen by LM finely echinulate, spore profile

finely serrulate, surface as seen by SEM sparsely echinulate. Sterile cells usually in small irregular groups or chains, rarely single, single cells large, hyaline to subhyaline, globose, subglobose or ellipsoidal, sometimes collapsed, 8–22  $\times$  8–15  $\mu\text{m}$ ; wall rather even or rarely somewhat uneven,

1.5–3  $\mu\text{m}$  thick, surface smooth as seen by LM and SEM.

*Sporisorium austroafricanum* is the sixteenth smut fungus infecting grasses of the genus *Ischaemum* (Vánky 2004, 2006, 2007, Shivas *et al.* 2008). This grass genus comprises about 65 species distributed mainly, though not exclusively, in the Old World tropics, with the major concentration of species in tropical Asia. Therefore, it may not be surprising that of the 15 hitherto recognized smuts infecting *Ischaemum*, 11 are known only from SE Asia. Locations of two additional species are situated mainly in SE Asia, but their geographical range extends to Oceania: *S. ischaemicola* to Papua New Guinea and Micronesia, and *S. tonglinense* to New Caledonia. In addition, one species, *S. ischaemi-anthephoroides*, is known both from Asia (Japan) and South America (Colombia), and one species, *S. furcatum*, has been reported from Asia (India) and Africa (Sudan). *Sporisorium austroafricanum* is the second smut reported on *Ischaemum* in Africa, but the first to be known exclusively from this continent. Among the 16 smuts occurring on *Ischaemum*, two belong to the georgefischeriaceae genera *Jamesdicksonia* and *Phragmotenium*, one to the tilletiaceae *Tilletia* and 13 to the ustilaginaceae *Sporisorium*. It is noteworthy that no *Ischaemum* smut belongs to the genus *Ustilago*.

The new species has the essential features of the genus *Sporisorium*, such as presence of the peridium and columella as well as spore balls (ephemeral) and sterile cells. Among *Sporisorium* species known so far on *Ischaemum*, it is quite a distinct smut because of the small size of the spores, which are characteristically flattened and slightly lighter-coloured on one side. The wall on that side is slightly thinner and is collapsed in SEM micrographs. The spores with a lighter-coloured side are present in several species of *Sporisorium*. The lighter-coloured wall is sometimes weakly visible, as for instance in *S. clandestinum* (Vánky *et al.* 2006) and *S. sphacellatum* (Vánky 2003) and sometimes very evident, as in *S. panici-petrosi* (Piątek 2008). Such a structure of the spore wall is known not only in the genus *Sporisorium*, but is also observed in several species of other smut genera, for instance in *Antherospora*, *Pericladium*, *Ustilago*, and

*Tranzscheliella* (Vánky 1994, 2002, Bauer *et al.* 2008). A thinner wall and, consequently, a lighter-coloured side probably make germination of spores easier. *Sporisorium austroafricanum* is similar only to *S. ischaemi-anthephoroides*, which has spores that measure  $5\text{--}7 \times 4\text{--}6.5 \mu\text{m}$  and are also flattened and lighter-coloured on one side. However, *S. ischaemi-anthephoroides* differs from *S. austroafricanum* by the macroscopic appearance of sori, which replace entire inflorescences, and by smaller sterile cells ( $8\text{--}18 \times 6\text{--}13 \mu\text{m}$ ) with thinner walls ( $0.5\text{--}1 \mu\text{m}$ ) (Vánky 2004). All other species of *Sporisorium* described on *Ischaemum* differ from *S. austroafricanum* in having spores longer than  $7 \mu\text{m}$ .

In contrast to some relatively well-studied groups of fungi (Crous *et al.* 2006, Berndt 2008), the smut fungi of South Africa have not been investigated exhaustively by mycologists. This group has indeed attracted the attention of smut taxonomists in the past (*see* Zundel 1938, Doidge 1950, Vánky 1999, Crous *et al.* 2000), but altogether the number of reported species seems sparse given the extraordinarily rich flora of vascular plants with numerous endemic species known from South Africa.

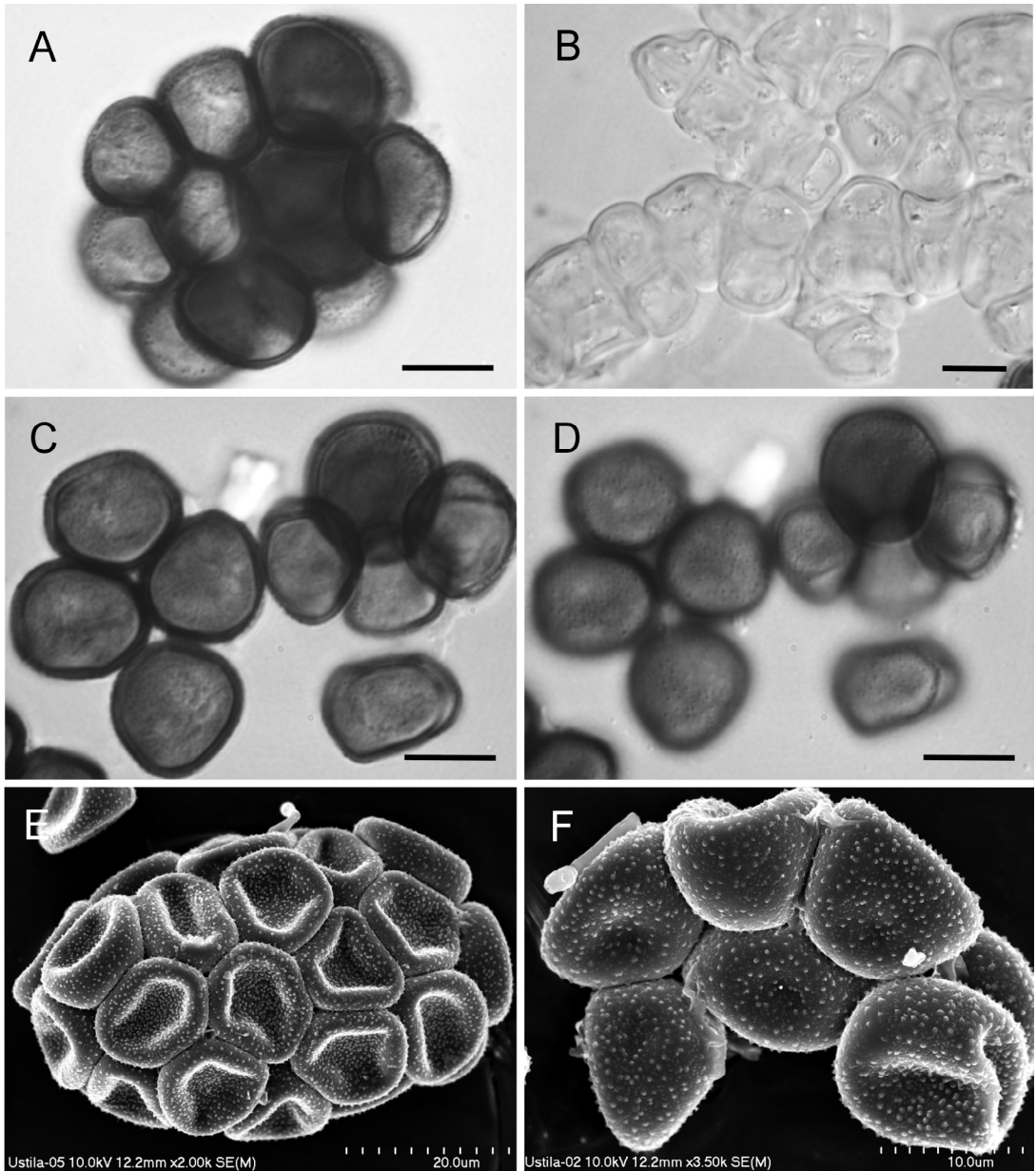
### ***Sporisorium flagellatum* (Syd., P. Syd. & E.J. Butler) Vánky (Fig. 3)**

Mycotaxon 62: 139. 1997. — *Sorosporium flagellatum* Syd., P. Syd. & E.J. Butler, Ann. Mycol. 5: 489. 1907. — TYPE: On *Ischaemum timorense* Kunth, India, Wynaad, Malabar, 30.IX.1904 E. J. Butler (holotype HClO 727; isotypes in Syd. Ust. No. 393, among others in H.U.V. 1667).

*Tolyposporium bogoriense* Racib., Bull. Int. Acad. Sci. Cracovie, Cl. Sci. Math. 3: 349. 1909, *syn. nov.* — TYPE: On *Panicum* sp. (= misidentified *Ischaemum* cf. *timorense* Kunth), Indonesia, Java, Bogor, Botanical Garden (holotype KRA 0–182!, as *Ustilago bogoriense* Rac.).

For further synonyms and types *see* Vánky (2004: 96).

Sori destroying whole inflorescence, cylindrical, 1–2 mm wide and 5–20 mm long, enclosed by uppermost leaf sheath, first covered by a thick, pale brown peridium, which dehisces at maturity from its distal part, disclosing dark brown, agglutinated to powdery mass of spore balls and sterile cells surrounding one central columella. Spore balls reddish-brown, globose, subglobose to elongated,  $35\text{--}55 \times 27\text{--}50 \mu\text{m}$ ,



**Fig. 3.** *Sporisorium flagellatum* (from the holotype of *Tolyposporium bogoriense*). — **A**: LM image of spore ball. — **B**: LM image of sterile cells. — **C** and **D**: LM image of spores; median and superficial view. — **E** and **F**: SEM image of spore ball and spores. Scale bars: 10  $\mu\text{m}$  for **A–D** and **F**, 20  $\mu\text{m}$  for **E**.

composed of numerous spores which separate fairly easily by pressure. Spores reddish-brown, globose, ovoid to irregular, (14–)15–18(–19)  $\times$  12–16  $\mu\text{m}$ ; wall ca. 0.5–1  $\mu\text{m}$  thick, surface as seen by LM finely verruculose, spore profile finely serrulate, surface as seen by SEM finely punctate-verruculose. Sterile cells numerous,

hyaline, in irregular groups, single cells globose, ellipsoidal or irregular, 10–17  $\times$  8–14  $\mu\text{m}$ ; wall smooth.

*Tolyposporium bogoriense* was described by Raciborski (1909) based on an infected specimen of *Panicum* sp. collected in the Botanical Garden at Bogor, Java, Indonesia. In his revision

of smut fungi infecting *Panicum* species, Vánky (2005) did not include the species, possibly by oversight because he had seen and annotated the type specimen. The re-examination of the type specimen preserved in herb. KRA (labelled as *Ustilago bogoriense* Rac.) revealed that the host plant is *Ischaemum* cf. *timorensis* not *Panicum* sp. The morphological characteristics of the sori, spore balls, spores and sterile cells of *T. bogoriense* correspond well with description of *Sporisorium flagellatum* by Vánky (2004). The latter was described from India only two years earlier than *T. bogoriense*, under the name *Sorosporium flagellatum* (Sydow *et al.* 1907), and moved to the genus *Sporisorium* by Vánky (1997). Therefore, *Tolyposporium bogoriense* is considered here as a synonym of *Sporisorium flagellatum*. This smut has been previously known on *Ischaemum indicum*, *I. timorensis*, and *Ischaemum* sp. in India, Japan, Myanmar, Sri Lanka (Vánky 2004) and Thailand (Shivas *et al.* 2007, as *Sporisorium* aff. *flagellatum*), and by the present synonymization its geographical distribution is extended to Indonesia.

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