The smut fungi (*Ustilaginomycetes*) of *Chrysopogon* (*Poaceae*)

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Description of the ten recognised species of smut fungi of *Chrysopogon* is given. A host-parasite list and a key facilitate the identification of these species. One new species is proposed: *Sporisorium tumiforme* Vánky & R.G. Shivas (type on *Chrysopogon pallidus*, Australia). Two new combinations are: *Sporisorium azmatii* (Mundk.) Vánky (based on *Sorosporium azmatii*, type on *Chrysopogon coeruleus*, India), and *Sporisorium chrysopogonis-grylli* (Thirum. & Pavgi) Vánky (based on *Sphacelotheca chrysopogonis-grylli*, type on *Chrysopogon gryllus*, India). A lectotype is designated for *Sorosporium tumefaciens* McAlpine (= *Sporisorium tumefaciens*).

**Key words:** lectotype, new combinations, new species, *Sporisorium tumiforme*, taxonomy.

**Introduction**

This paper is part of a series in which the smut fungi of various grass genera are revised, to pave the way towards a world monograph (comp. Vánky, 2000a,b, 2001, 2002, 2003a,b,c, 2004a,b,c,d; Vánky and Shivas, 2001; Shivas and Vánky, 2001).

*Chrysopogon* Trin., with 26 species in tropical and warm temperate regions of the Old World, principally in Asia and Australia, and one species in Florida and West Indies, belongs to the subfamily Panicoideae, tribe Andropogoneae, subtribe Sorghinae. It is closely related and intergrades with *Vetiveria* Bory, with 10 species in the Old World tropics (Clayton and Renvoize, 1986: 342). Therefore, it is expected, that some smut fungi may occur on members of both genera. On *Vetiveria* six smut fungi are recognised (Vánky, 1997b: 142-145), while on *Chrysopogon* at least 14 smut fungi have been described. Of these some are synonyms. Both *Sphacelotheca chrysopogonis* G.P. Clinton and *Tolyposporella chrysopogonis* Atkinson have been described on *Chrysopogon nutans* (L.) Benth., which is *Sorghastrum nutans* (L.) Nash. The host plant of *Sorosporium assamicum* A.K. Roy (= *Sporisorium assamicum* (A.K. Roy) Vánky) is not *Andropogon aciculatus*

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Retz. (= Chrysopogon aciculatus (Retz.) Trin.) as originally given but Imperata cylindrica (L.) Beauv. (teste A.K. Roy). The ten recognised smut fungi of Chrysopogon, including a new species, are:

**Macalpinomyces chrysopogonicola** (Mundk. & Thirum.) Vánky, 2001: 320.
≡ Sphacelotheca chrysopogonicola Mundk. & Thirum., in Thirumalachar & Mundkur, 1951: 2. — **Type** on Chrysopogon sp., India, Mysore, Bangalore, Uttarahalli, 2 September 1943, M.J. Thirumalachar, HCIO 10781!
≡ Ustilago chrysopogonis S. Ahmad, 1956: 2.
≡ Sorosporium capillipedii Mishra, 1957: 257.

Sori comprise the distal part of the stems transforming them into 3-16 cm long, *ca.* 1 mm wide, whitish, straight or whip-like, twisted, sometimes looped tubes filled with agglutinated spore masses intermixed with groups of sterile cells. At maturity, the sori split longitudinally liberating the blackish-brown, granular-powdery mass of groups of spores, spores and sterile cells. Usually all shoots of a plant are transformed into sori and infected plants do not flower. Peridium and columella lacking. **Spores** when mature single, subpolyhedrally globose, ovoid or irregular, 8-10.5 × 8-11 µm, medium reddish-brown; wall thin (0.5-0.8 µm), densely echinulate, spines short (0.3-0.4 µm) just affecting the spore profile which appears undulate or serrulate; in SEM the spore surface is provided with short, conical spines. **Sterile cells** variable in form and size, subglobose, ellipsoidal or subpolyhedrally irregular, 4-9(-13) × 5-11(-15) µm, hyaline, usually forming irregular groups; wall thin (c. 0.5 µm), smooth. **Spore germination** results in phragmobasidia, the cells of which may or may not conjugate, giving rise to basidiospores on long sterigmata, or to hyphae (Vánky, 1995a: 228-231, figs. 20 and 23).

**Hosts:** Capillipedium parviflorum (R. Br.) Stapf, Chrysopogon echinulatus (Nees) W. Wats, Ch. fulvus (Spreng.) Chiov., Ch. gryllus (L.) Trin.

**Known distribution:** S. Asia (India, Pakistan).

**Macalpinomyces effusus** (H. & P. Sydow) Vánky, 1997a: 129.
≡ Endosporisorium effusum (H. & P. Sydow) Vánky, 1995b: 212. — **Type** on Andropogon muricatus Retz. (= Vetiveria zizanioides (L.) Nash), India, Assam, Sylhet Distr., Kanaighat, 21 May 1905, E.J. Butler, HCIO 450!; isotypes BPI 160327, BPI 160328, BPI 188930, HUV 16416!
**Sori** in the interior of yellowish-white culms which split longitudinally disclosing the dark brown, semi-powdery mass of loose groups of spores intermixed with sterile cells. **Spores** globose, subglobose to broadly ellipsoidal, 3.5-5.5 × 4-6(-6.5) µm, reddish-brown; wall thin, verrucose. **Sterile cells** few, in groups or single, globose to ovoid, larger than the spores (5.5-8 µm long), collapsed in old specimens.


**Known distribution:** S. Asia (India).


**Type** on *Chrysopogon fallax* S.T. Blake, Australia, Queensland, ca. 20 km N of Gingin, alt. ca. 108 m., 25 April 2003, M.D.E. & R.G. Shivas, BRIP 39858; isotype HUV 20303!

**Sori** in some sessile and pedicelled spikelets of an inflorescence destroying the innermost floral organs, much hypertrophied, long tubiform, often bent or twisted, 2-3 × 25-50 mm, covered by a grey peridium of host and fungal origin which ruptures longitudinally disclosing the dark brown, powdery mass of spores intermixed with groups of sterile cells. **Spores** globose, subglobose, usually ellipsoidal, 8-11 × 9-13.5 µm, olivaceous-brown; wall even, 1.5-2.5 µm thick including the densely situated, acute, pyramidal warts. **Sterile cells** in irregular groups, single cells globose, subglobose, ellipsoidal, 5-8(-10) × 5-9.5(-12) µm, hyaline; wall thin, ca. 0.5 µm, smooth.

**Host:** *Chrysopogon fallax* S.T. Blake.

**Known distribution:** Australia. Known only from the type collection.


≡ *Ustilago andropogonis-aciculati* Petch, 1909: 303.

≡ *Sorosporium andropogonis-aciculati* (Petch) Petch, 1912: 227. — **Type** on *Andropogon aciculatus* Retz. (= *Chrysopogon aciculatus* (Retz.) Trin.), Ceylon (= Sri Lanka), Peradeniya.

**Sori** destroying the whole inflorescence, long cylindrical, 1-2 × 20-40(-50) mm, more or less hidden by the uppermost leaf-sheath, at first covered by a pale brown peridium which ruptures irregularly from its apex disclosing the blackish-brown, granular-powdery mass of spore balls and several long, filiform columellae. **Spore balls** subglobose, ellipsoidal to slightly irregular, 20-50 × 20-60 µm, dark reddish-brown to opaque, composed of tens or hundreds of spores which separate by pressure. **Spores** globose, subglobose, ellipsoidal to slightly irregular, 4.5 × 5-6.5 µm, yellowish-brown, somewhat lighter on one side; wall uneven, 0.5-1 µm thick, apparently smooth to very
finely punctate, in SEM finely, moderately densely verruculose. Sterile cells absent.

**Host:** Chrysopogon aciculatus (Retz.) Trin. (Andropogon aciculatus Retz.).

**Known distribution:** S. and E. Asia, Philippines, Indonesia, Papua New Guinea, Australia.

*Sporisorium azmatii* (Mundk.) Vánky, *comb. nov.*


**Type** on Chrysopogon caeruleus (Steudel) Watson, India, Mysore, Bilikere, 19 September 1903, C.A. Barber, HCIO 7734; isotypes IMI, HUV 17270!

Sori destroying the whole inflorescence, long cylindrical, 0.5-1 × 20-40 mm, completely hidden by the uppermost leaf sheaths, from which only the long, filiform columella is protruding. Sori covered also by a yellowish-brown peridium which later ruptures disclosing the blackish-brown, granular-powdery mass of spore balls surrounding a long, filiform columella. Spore balls semi-permanent, variable in shape and size, ovoid, ellipsoidal, elongated or irregular, 25-60(-70) × 30-100(-120) µm, reddish-brown to subopaque, composed of tens to hundred of spores which separate by pressure. Spores globose, subglobose, ellipsoidal to subpolyhedrally irregular, 6.5-9.5 × 7-10.5 µm, dimorphic; outer spores reddish-brown; wall uneven, 0.5-1.5 µm thick, finely verrucose-echinulate on the free surface, spore profile wavy to finely serrulate; inner spores pale yellowish-brown; wall even or nearly so, ca. 0.5 µm thick, smooth. Sterile cells between the spore balls not seen.

**Host:** Chrysopogon caeruleus (Steudel) Watson.

**Known distribution:** S. Asia (India). Known only from the type locality.

Herbert and Langdon (1941: 2) considered Sorosporium azmatii to be a synonym of *S*. tumefaciens McAlpine, which is a different species.

*Sporisorium chrysopogonis* Vánky, 1983: 327.

**Type** on Chrysopogon montanus Trin. (= C. fulvus (Sprengel) Choiv.), Sri Lanka (Ceylon), North Central Province, Polonnaruwa Distr., Habarane, alt. 250 m, 18 March 1974, K. Vánky, HUV 6685!; isotypes in Vánky, Ust. exs. no. 407.

Sori destroying the whole inflorescence, partially concealed by the leaf sheath, elongated, cylindrical, 1-2 mm wide, 1-4 cm long, sori exceptionally confined to the spikelets only, at first covered by a thick, yellowish-brown, fungal peridium, composed of long chains of hyaline, elongated cells, 4-9 × 4-22 µm. The peridium ruptures from its apex, disclosing the black, granular-powdery mass of spore balls and numerous filiform columellae of host origin. Spore balls globose, ovoid to slightly irregular, 32-56 × 36-80(-88) µm, reddish-brown, composed of (6-)10-75? spores which separate by hard
pressure. *Spores* 8-13 × 9-14(-16) µm, dimorphic; outer spores globose, subglobose, ovoid to slightly irregular, reddish-brown; wall uneven, 0.8-1.5 µm, verrucose-echinulate on the free surface, smooth on the contact sides, spore profile wavy to finely serrulate; inner spores subpolyhedrally irregular, subhyaline to pale yellowish-brown; wall even, *ca.* 0.5 µm, smooth.

*Hosts:* *Chrysopogon fulvus* (Sprengel) Choiv. (*C. montanus* Trin.), *Chrysopogon* sp.

*Known distribution:* S. Asia (Pakistan, Sri Lanka).

**Sporisorium chrysopogonis-grylli** (Thirum. & Pavgi) Vánky, *comb. nov.*


‘*Sori* in the inflorescence destroying it completely, long, cylindrical, 2 to 3 cm long and 1.5 to 2.5 mm broad, covered at first by a pinkish false membrane which soon ruptures exposing the dark spore mass and a long, simple columella. Mature *spores* reddish-brown, globose to subglobose, oval and measuring 10 to 15 µm in diameter with a mean of 11.5 µm. Epispore thick and minutely echinulate. *Sterile cells* of the membrane hyaline, irregularly globoid, thick walled, smooth and measuring 8.75 to 11.25 µm in diameter.’

*Host:* *Chrysopogon gryllus* (L.) Trin.

*Known distribution:* S. Asia (India). Known only from the type collection.

It is not known where the type specimen is deposited (Dr. M.S. Pavgi, pers. comm.). It is not in HClO or in IMI. The description above is taken from the original. The fungus belongs to the genus *Sporisorium*. It is different from all known *Sporisorium* species on *Chrysopogon*.


*Sori* destroying the entire inflorescence, elongated cylindrical, *ca.* 0.5 × 5 cm, partly concealed by leaf sheath, at first covered by a thick, greyish
peridium which ruptures and flakes away at maturity exposing the black, powdery mass of loose spore balls and several, long, filiform columellae. *Spore balls* globose, subglobose to ovoid, 30-65 × 30-85 µm, dark reddish-brown, semipermanent. *Spores* dimorphic; outer spores globose, subglobose to subpolyhedrally irregular, 6-8 × 6-10 µm, dark reddish-brown; wall 1-3 µm thick, densely verruculose on the free surface; inner spores globose, subglobose to subpolyhedrally irregular, often angular, 7-10 × 8-12 µm, pale yellowish-brown to medium reddish-brown; wall 0.5-1 µm thick, densely punctate- verruculose. *Sterile cells* not seen.

*Host:* *Chrysopogon fallax* S.T. Blake, *C. latifolius* S.T. Blake.

*Known distribution:* Australia.

*Sporisorium tumefaciens* (McAlpine) Vánky, 1983: 328

≡ *Sorosporium tumefaciens* McAlpine, 1910: 184. — *Lectotype (designated here)* on *Stipa pubescens* R. Br. (= misnamed *Chrysopogon* sp., S.T. Blake in Herbert & Langdon, 1941: 2, confirmed), Australia, Queensland, near Cloncurry, 10 May 1909, G.H. Robinson, VPRI 2978!

*Sori* destroying the whole inflorescence, swollen, elongated, narrow ovoid, broadly fusiform or long cylindrical, 0.2-0.8(-1) × 0.5-5 cm, partly hidden by the uppermost leaf sheath, at first covered by a whitish to yellowish-brown, tough peridium which ruptures irregularly, often in several places, to disclose the blackish-brown, granular-powdery mass of spore balls and numerous filiform columellae. *Spore balls* subglobose, ellipsoidal, irregular, 30-70 × 30-80(-100) µm, dark reddish-brown, composed of tens to hundreds of easily separating spores. *Spores* subellipsoidal, ovoid, oblong to slightly irregular, (6-)6.5-8 × 7-10.5(-11) µm, yellowish-brown; wall even to slightly uneven, 0.5-1 µm thick, from apparently smooth to finely, densely punctate or verruculose; spore profile smooth. *Sterile cells* in irregular groups, collapsed in old specimens, hyaline to yellowish tinted.


*Known distribution:* S. Asia (India, Sri Lanka), Australia.

McAlpine (1910: 184) when describing *Sporisorium tumefaciens*, mentioned two syntypes both collected by Robinson from the same place on the same date. One was on ‘*Stipa* sp.’ (no. 202/09), the other on ‘*Stipa pubescens*’ (no. 200/09). Later, both collections have been divided into two envelopes. No. 202/09 was filed as VPRI 2975 and VPRI 2976, no. 200/09 as VPRI 2977 and VPRI 2978.

R.F. Langdon studied these specimens and in 1976 noted inside the envelope that no. 202/09 on ‘*Stipa* sp.’ represents *Heteropogon contortus*
infected by *Sorosporium caledonicum* Pat. (= *Sporisorium caledonicum* (Pat.) Vánky, confirmed). The host plant of no. 200/09 is *Chrysopogon* sp., infected by *S. tumefaciens* (Herbert and Langdon, 1941: 2). Of the syntypes, the richer sample of *S. tumefaciens*, that of VPRI 2978 is designated as lectotype, VPRI 2977 being isolectotype.

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

*(Figs. 1-3)*


*Sori* inflorescentiam totam destruentes, tumefacti, elongatocylindrici, 0.5-0.8 × 5-10 cm, vagina folii supreme partim obtecti, primo peridio crasso, albido usque flavido brunneo coopterti, quo irregulariter rupto massam nigrobrunneam, granulosopulveream glomerulum spororum et colu mellarum multarum, filiformium ostendentes. *Glom eruli spororum* subglobosi usque late ellipsoidales, 30-60(-70) × 40-70(-80) µm, rubrobrunnei, e pluribus decem sporis, pressu faciliter separabilibus compositi. *Sporae* globosae, ellipsoidales usque subpolyedrice parum irregularaes, (7-)8-10.5 × 8-13 µm, flavido brunneae; pariete aequali, vel parum inaequali, 0.5-0.8 µm crasso, leniter, dense verruculoso usque verruculoso-echinulato, in SEM dense, uniformite verrucoso; imago obliqua sporarum undulata usque leniter serrulata. *Cellulae steriles* pauciae, in catervis irregularibus, cellulae singulares earum globosae, ellipsoidales usque parum irregularaes, magnitudine variae, 9-23 µm longae, hyalinae; pariete 0.5-1 µm crasso, levi.

*Sori* (Fig. 1) destroying the whole inflorescence, swollen, long cylindrical, 0.5-0.8 × 5-10 cm, partly hidden by the uppermost leaf sheath, at first covered by a whitish to yellowish-brown, thick peridium which ruptures irregularly disclosing the blackish-brown, granular-powdery mass of spore balls and numerous filiform colu mellae. *Spore balls* (Figs. 2, 3) subglobose to broadly ellipsoidial, 30-60(-70) × 40-70(-80) µm, reddish-brown, composed of tens of spores which separate easily by pressure. *Sporae* (Figs. 2, 3) globose, ellipsoidial to subpolyhedra ly slightly irregular, (7-)8-10.5 × 8-13 µm, yellowish-brown; wall even or slightly uneven, 0.5-0.8 µm thick, finely, densely verruculose to verruculose-echinulata, in SEM densely, uniformly verrucose; spore profile wavy to finely serrulate. *Sterile cells* few, in irregular groups, single cells globose, ellipsoidial to slightly irregular, variable in size, 9-23 µm long, hyaline; wall 0.5-1 µm thick, smooth.

**Hosts:** *Chrysopogon fallax* S.T. Blake, *C. latifolius* S.T. Blake, and *C. pallidus* (R. Br.) Trin. ex Steudel.

**Known distribution:** Australia.
Fig. 1. A sorus of *Sporisorium tumiforme* Vánky & R.G. Shivas on *Chrysopogon latifolius* S.T. Blake (from holotype). To the left a healthy inflorescence. Bar = 1 cm.
**Sporisorium tumiforme** differs from *S. tumefaciens* by the larger, more evidently ornamented spores and also in having more regular spore balls and spores.

Small variations in the spore measurements (± 1 µm) and in the spore wall thickness (± 0.2 µm) may occur between different collections of *S. tumiforme*.

**Key to the smut fungi of Chrysopogon**

*M* = *Macalpinomyces*; *S* = *Sporisorium*

1. Sori tubular, in the distal part of the stems .............................................................. 2
   1. Sori not tubular, not in the distal part of the stems ........................................... 3

2. Spores 8-11 µm long, densely echinulate ............................................. *M. chrysopogonicola*
   2. Spores 4-6(-6.5) µm long, verrucose ......................................................... *M. effusus*

3. Sori in hypertrophied spikelets. Spores with acute, pyramidal warts .......... *M. tubiformis*
   3. Sori in the whole inflorescence. Spores otherwise ornamented...................... 4

4. Spores dimorphic, i.e. outer and inner spores in a ball different ..................... 5
   4. Spores not dimorphic .................................................................................. 7

5. Spores 9-14(-16) µm long ................................................................. *S. chrysopogonis*
   5. Spores smaller .......................................................................................... 6

6. Spores 7-10.5 µm long. Columella one ......................................................... *S. azmatii*
   6. Spores 6-10 µm long. Columella several ................................................... *S. fallax*
7. Spores 5-6.5 µm long................................................................. *S. andropogonis-aciculati*

7. Spores larger ............................................................................................................... 8

8. Spores 10-15 µm long. Columella one ........................................... *S. chrysopogonis-grylli*

8. Spores smaller. Columella several...................................................................................... 9

9. Spores 7-10.5(-11) µm long. Spore profile smooth ...................................... *S. tumefaciens*

9. Spores 8-13 µm long. Spore profile wavy to finely serrulate .................... *S. tumiforme*

**HOST-PARASITE LIST**

*Ch. = Chrysopogon; M. = Macalpinomyces; S. = Sporisorium*

?Arundinella bengalensis – *M. effusus*
Capillipedium parviflorum – *M. chrysopogonicola*
*Ch. aciculatus – ?M. effusus, S. andropogonis-aciculati, S. tumefaciens*
*Ch. caeruleus – S. azmatii, S. tumefaciens*
*Ch. echinulatus – M. chrysopogonicola*
*Ch. fallax – M. tubiformis, S. fallax, S. tumefaciens, S. tumiforme*
*Ch. fulvus – M. chrysopogonicola, S. chrysopogonis*
*Ch. gryllus – M. chrysopogonicola, S. chrysopogonis-grylli*
*Ch. latifolius – S. fallax, S. tumefaciens, S. tumiforme*
*Ch. pallidus – S. tumefaciens, S. tumiforme*
*Ch. sp. – S. chrysopogonis, S. tumefaciens*
*Vetiveria zizanioides – M. effusus*

**References**

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