

***Erratomycetaceae*, fam. nov., and validation of some names of smut fungi recently described from India**

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Received 23 November 2012 / Accepted 9 January 2013 / Published 11 January 2013

Denchev, C.M. & Denchev, T.T. 2013. *Erratomycetaceae*, fam. nov., and validation of some names of smut fungi recently described from India. – Mycobiota 1: 63–70. doi: 10.12664/mycobiota.2013.01.07

Abstract. A new family, *Erratomycetaceae*, is described as distinct from *Tilletiaceae* based on host specialization, morphological features of the sori and spores, and results of published molecular phylogenetic analyses. Eight invalidly published names of Indian smut fungi are discussed. Four of these are considered to apply to distinct species and their names are validated as *Eballistra punensis*, *Anthracocystis kolhapurensis*, *Sporisorium mahabaleshwarsense*, and *Sporisorium lohagadense*. The remaining names are recognized as synonyms of validly published names. A new name, *Anthracocystis guoae*, is proposed to replace *Sporisorium apludae-muticae* L. Guo (non *Anthracocystis apludae-muticae* (A.R. Patil et al.) McTaggart & R.G. Shivas).

Key words: *Eballistra*, *Erratomyces*, *Erratomycetaceae*, India, *Melanotaenium*, smut fungi, *Sporisorium*, *Tilletia*

Introduction

As part of an ongoing revision of Asian smut fungi, we discuss the status of some Indian species.

The genus *Erratomyces* (*Tilletiaceae*) comprises five species restricted to hosts in *Fabaceae*: *E. patelii* (Pavgi & Thirum.) M. Piepenbr. & R. Bauer (distributed in Africa, Brazil, Central America, the Caribbean, and India), *E. ajmeriensis* (J.C.S. Gupta) M. Piepenbr. & R. Bauer (India), *E. crotalariae* (N.C. Joshi) M. Piepenbr. & R. Bauer (India), *E. smithiae* (Thirum. et al.) M. Piepenbr. & R. Bauer (India), and *E. thirumalacharii* (Pavgi) M. Piepenbr. & R. Bauer (India) (Piepenbring & Bauer 1997; Vánky 2011).

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Species of *Erratomyces* are characterized by (i) sori in leaves, forming dark spots or galls that do not rupture the epidermis; (ii) intercellular hyphae, septa with dolipores (with a pore traversed by two membranous plates; without caps); (iii) single, pigmented spores embedded in the host tissue, scattered in the intercellular spaces; and (iv) spore germination resulting in holobasidia of *Tilletia*-type (Piepenbring & Bauer 1997; Vánky 2011). They have *Entyloma*-like sori but differ in that *Entyloma* species have simple septal pores with two membrane caps. The genus *Erratomyces* was considered to be closely related to *Tilletia* on the basis of morphology characters (large, pigmented spores, spore germination of *Tilletia*-type, intercellular hyphae) and ultrastructure (dolipore without caps, traversed by two membranous plates) (Piepenbring & Bauer 1997; Vánky 2011) and was placed in the family *Tilletiaceae* (Piepenbring & Bauer 1997; Vánky 2002).

There are five other genera in the *Tilletiaceae*: *Tilletia*, *Conidiosporomyces*, *Ingoldiomyces*, *Neovossia*, and *Oberwinkleria*, which have species that are specialized pathogens restricted to ovaries of hosts in the *Poaceae*. Species of *Erratomyces* differ from the members of these genera by host specialization on *Fabaceae*, and by spores embedded in the leaf mesophyll without rupturing the epidermis. As an exception, a small group of *Tilletia* species also form sori in leaves, but their mature sori rupture the epidermis, exposing a powdery spore mass. The need for a new family to accommodate *Erratomyces*, was supported by results from molecular phylogenetic analyses (Castlebury et al. 2005).

We propose *Erratomyces* be removed from the *Tilletiaceae* and placed in a new family.

Recently, a new monograph of the smut fungi in India was published by Gandhe (2011). Eight names of new species, described in that book, were not validly published under the ICN. For those names, the necessary indication of the type was not given by the word 'typus' or an equivalent (Art. 40.6). Moreover, seven of these new species were described in an inappropriate genus. Four of the species in question are distinct and the names are validly published here (Art. 33.1) to facilitate their citation in forthcoming publication.

Material and methods

For examination of *Erratomyces patelii* under light microscope, spores from a dried specimen were mounted in lactophenol solution on glass slides, gently heated to boiling point to rehydrate the spores, and then cooled. Spore measurements are given in the form: min–max [mean \pm 1 standard deviation].

A new family for *Erratomyces*

A new family is proposed to accommodate *Erratomyces*, based on host specialization and morphology of sori and spores, as well as on results of published molecular phylogenetic analyses (Castlebury et al. 2005).

***Erratomycetaceae* Denchev & T. Denchev, fam. nov.**

IF 550107

Member of the order *Tilletiales* R. Bauer & Oberw.; having intercellular hyphae, septa with dolipores without caps, traversed by two membranous plates, and the characters of the genus *Erratomyces*. **Sori** in leaves of plants of *Fabaceae* forming dark spots or galls that do not burst or rupture the epidermis. **Spores** single, pigmented, embedded in the host tissue. **Spore germination** in holobasidia of *Tilletia*-type.

Type genus: *Erratomyces* M. Piepenbr. & R. Bauer, *Mycologia* 89: 930, 1997.

The type species of *Erratomyces* is characterised as follows:

Erratomyces patelii (Pavgi & Thirum.) M. Piepenbr. & R. Bauer, *Mycologia* 89: 933, 1997.

Figs 1–3

Sori in leaves, forming polyangular spots, limited by leaf veins, 1.5–6(–9) mm long, larger by fusion, dark reddish brown; not bursting or rupturing the epidermis. **Spores** single, embedded in the leaf mesophyll, globose, subglobose or broadly ellipsoidal, sometimes slightly irregular, (20–)21.5–31 × (17–)18.5–28 (26.2 ± 2.5 × 23.3 ± 2.1) µm (n = 100), medium to dark reddish brown; wall consisting of two layers, as seen in LM, inner layer evenly thickened, 0.8–1.8 µm thick, outer layer unevenly thickened, (1.8–)2.5–4.5(–6) µm thick, darker than the inner, ornamented with coarse warts, tuberculum-like and conical-like ornaments.

On *Fabaceae*: *Phaseolus vulgaris* L., *Vigna* spp.

Specimen examined— On *Vigna mungo* (L.) Hepper: INDIA, MADHYA PRADESH, Chhapara inter Seoni et Lakhnadon, 22°22' N, 79°35' E, 30 Aug 1998, leg. N.D. Sharma, det. K. Vánky (Vánky Ustilag. exsicc., no. 1052).

Validation of four names of smut fungi

1. *Melanotaenium punense* Gandhe (as '*punensis*'; 2011: 154, **nom. inval.**, Art. 40.6).

Melanotaenium proper is restricted to species on host plants in dicotyledonous families (Vánky 2002, 2011). All former species named in *Melanotaenium* on *Poaceae* were transferred to *Jamesdicksonia*, *Eballistra* or *Phragmotaenium* (Bauer et al. 2001; Vánky 2002).

On the legend of Fig. 8 of Plate 2.7 (where the spore germination of *Melanotaenium punense* was illustrated), Gandhe (2011) noted: 'terminal basidiospores with secondary blastospores'. Together with Fig. 132 of Plate 4.22 (Gandhe 2011), we can conclude that the spores of *M. punense* germinate in holobasidia with gastroid (rather than ballistic) basidiospores and apical budding of the basidiospores which is characteristic of *Eballistra*. The basidia, illustrated by Gandhe (2011), resemble those of *E. brachiariae* (Viégas) R. Bauer et al. The morphological features, as given in the original description, also seem similar with those of *E. brachiariae*, which is found on *Brachiaria distachya*, *B. piligera* (*Urochloa piligera*), *B. plantaginea*, *Ottochloa nodosa*, *Panicum coloratum*, *Urochloa panicoides*, *U. trichopus* (Vánky 2011). The genera *Ottochloa*, *Urochloa*, *Brachiaria*, and *Panicum* are

members of tribe *Panicaceae*. *Melanotaenium punense* was found on *Themeda triandra*, tribe *Sacchareae* (syn. *Andropogoneae*). As no species of *Eballistra* has previously been reported on *Themeda* (nor on a grass in the tribe *Sacchareae*), we consider that collection represents a new species.

Eballistra punensis Denchev & T. Denchev, **sp. nov.**

IF 550108

Type on *Themeda triandra* Forssk. (*Poaceae*): INDIA, MAHARASHTRA STATE, Pune, 15 September 1975, leg. R.V. Gandhe (**holotype**, AMH 9364).

Latin description by Gandhe in *Ustilaginales of India*: 154, 2011 (as *Melanotaenium punensis* Gandhe); illustrations by Gandhe (op. c., Plate 2.7, Fig. 8 on p. 35, and Plate 4.22, Figs 128–132 on p. 155).

2. *Sorosporium kolhapurense* Gandhe (as ‘*kolhapurensis*’; 2011: 197, **nom. inval.**, Art. 40.6), *Sorosporium mahabaleshwarsense* Gandhe (as ‘*mahabaleshwarsensis*’; 2011: 199, **nom. inval.**, Art. 40.6), *Sorosporium matheranense* Gandhe (as ‘*matheranensis*’; 2011: 200, **nom. inval.**, Art. 40.6).

Sorosporium was restricted to one species, *S. saponariae* F. Rudolphi, on caryophyllaceous plants (Vánky 1987, 1994). Later, *Sorosporium* was reduced to a synonym of *Thecaphora*, which has species restricted to dicotyledonous plants (Vánky 2002, 2011). The former *Sorosporium* species on *Poaceae* were transferred to *Sporisorium*. The proposal by Gandhe (2011) to establish three new species of *Sorosporium* on *Poaceae* is an error. A new taxonomic scheme of the *Ustilago-Sporisorium-Macalpinomyces* complex was recently proposed by McTaggart et al. (2012) and the circumscriptions of the genera *Sporisorium* and *Anthracoctysis* were emended.

Sorosporium kolhapurense has characteristics of *Anthracoctysis*: presence of filiform columellae (comp. Gandhe 2011: 198, Fig. 189) and spore balls (with darker outer spores), and absence of sterile cells.

Anthracoctysis kolhapurensis Denchev & T. Denchev, **sp. nov.**

IF 550109

Type on *Apluda mutica* L. (*Poaceae*): INDIA, MAHARASHTRA STATE, Kolhapur, 7 October 1975, leg. S.D. Patil (**holotype**, AMH 9369).

Latin description by Gandhe in *Ustilaginales of India*: 197, 2011 (as *Sorosporium kolhapurensis* Gandhe); illustrations by Gandhe (op. c., Plate 4.29, Figs 188–195 on p. 198).

Seven species of smut fungi are known on representatives of *Apluda* among which five species are members of *Sporisorium* s. lat. (Vánky 1997b, 2009, 2011), namely:

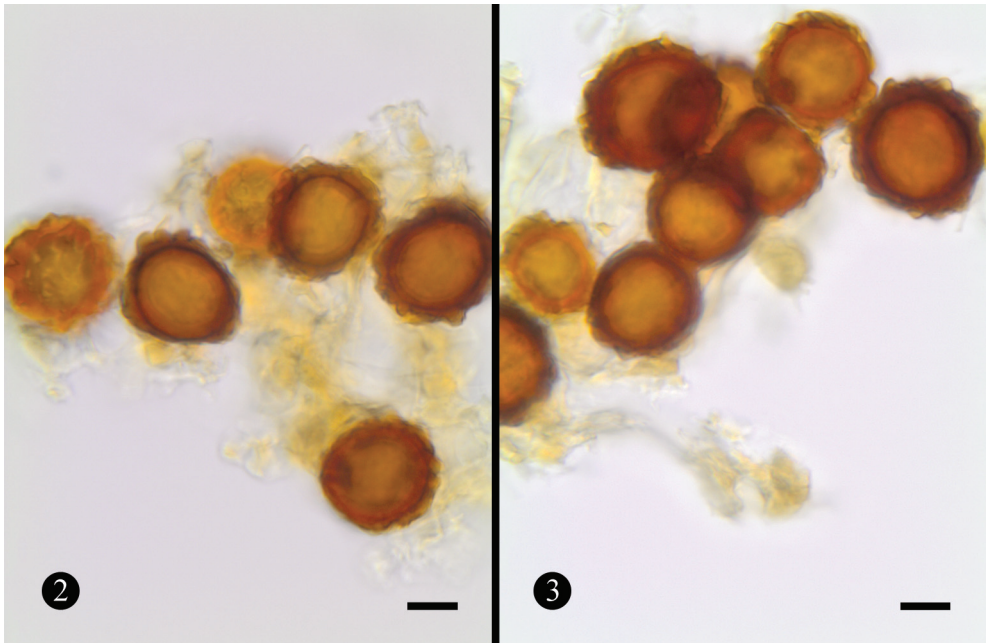
1) *Sporisorium apludae* (Syd. & P. Syd.) L. Guo, *Mycosystema* 3: 76, 1990.

2) *Anthracoctysis guoae* Denchev & T. Denchev, **nom. nov.**

IF 550110



Fig. 1. Sori of *Erratomyces patelii* forming polyangular spots on leaves of *Vigna mungo* (Vánky Ustilag. exsicc., no. 1052). Habit. Scale bar = 1 cm



Figs 2, 3. Spores of *Erratomyces patelii* on *Vigna mungo* (Vánky Ustilag. exsicc., no. 1052) in LM. Scale bars = 10 μ m

- Replacing *Sporisorium apludae-muticae* L. Guo, Mycotaxon 72: 390, 1999 (non *Anthracoystis apludae-muticae* (A.R. Patil, T.M. Patil & M.S. Patil) McTaggart & R.G. Shivas, Persoonia 29: 120, 2012). — Type on *Apluda mutica* L.: CHINA, GUANGXI, Pingxiang, 6 Jan 1998, Guo L. 1622 (**holotype**, HMAS 77 290).
- 3) *Anthracoystis apludae-muticae* (A.R. Patil, T.M. Patil & M.S. Patil) McTaggart & R.G. Shivas, Persoonia 29: 120, 2012 (Syn. *Sporisorium muticae* Vánky & A.R. Patil)
 - 4) *Anthracoystis apludae* (Mishra) McTaggart & R.G. Shivas, Persoonia 29: 119, 2012 (Syn. *Sporisorium mishrae* Vánky)
 - 5) *Anthracoystis apludae-aristatae* (B.V. Patil & Thirum.) McTaggart & R.G. Shivas, Persoonia 29: 120, 2012.

The sori of *Anthracoystis kolhapurensis* are localized in spikelets and differ from those of *A. guoae* and *A. apludae-muticae* which destroy the whole raceme. *Sporisorium apludae* differs from *A. kolhapurensis* by having smaller spores (5–7 μm long) while those of the latter are 8–9.5 μm long. *Anthracoystis apludae* differs from *A. kolhapurensis* by the presence of sori which are grouped in the spikelets into witches' brooms. *Anthracoystis apludae-aristatae* possesses spore balls in which the outer spores are larger (8–12(–13) μm long) than those of *A. kolhapurensis*, and are in addition prominently echinulate (with spines up to 1–1.5 μm high) compared to the verruculose ornamentation of *A. kolhapurensis*.

Sporisorium mahabaleshwarsense Denchev & T. Denchev, **sp. nov.**

IF 550111

Type on *Ischaemum impressum* Hack. (*Poaceae*): INDIA, MAHARASHTRA STATE, Mahabaleshwar, 12 October 1976, leg. R.V. Gandhe (**holotype**, AMH 9370).

Latin description by Gandhe in *Ustilaginales of India*: 199, 2011 (as *Sorosporium mahabaleshwarsense* Gandhe).

Based on the original description, *Sporisorium mahabaleshwarsense* destroys the whole inflorescence transforming it into a conspicuous, cylindrical, 2–4 cm long sorus, at first hidden inside in the leaf sheath, and covered by a peridium. The sori possess a central, conspicuous columella, as long as the sorus, with ridges and furrows. The spore balls are irregular, loosely arranged; the spores are 11–13.5 μm long (mean 12.4 μm), 'spinulose' at the free surface; the sterile cells are 14.5–20 μm long (Gandhe 2011). Thirteen known species of *Sporisorium* s. lat. infect *Ischaemum*. There are four species of *Sporisorium* s. lat. that destroy the whole inflorescence (Vánky 2009, 2011). *Sporisorium mahabaleshwarsense* can be distinguished from these species as follows. The spores of *S. ischaemi-anthephoroides* (S. Ito) Vánky & Kakish. are very short, 5–7 μm long. The sori of *Anthracoystis ischaemiana* (A.R. Patil et al.) McTaggart & R.G. Shivas (syn. *S. ischaemianum*) possess numerous filiform columellae. *Sporisorium flagellatum* (Syd., P. Syd. & E.J. Butler) Vánky differs by having larger spores (12–19 μm long). The sori of *S. ischaemi-rugosi* (Mishra) Vánky possess a stout, uniform columella, with a shortly bifurcate tip, that protrudes beyond the sorus, while *S. mahabaleshwarsense* has sori with a long, central, flagelliform columella with ridges and furrows.

Sorosporium matheranense Gandhe (as '*matheranensis*'), *Ustilaginales* of India: 200, 2011 (nom. inval.). — Type on *Spodiopogon rhizophorus* (Steud.) Pilg. (*Poaceae*), INDIA, MAHARASHTRA STATE, Matheran, 5 November 1976, leg. S.D. Patil (AMH 9371).

Sorosporium matheranense (invalidly published in the Gandhe's PhD thesis, 1978) was reduced to a synonym of *Sporisorium spodiopogonis* (M.S. Patil) Vánky (Vánky 1997a).

3. *Sphacelotheca lohagadensis* Gandhe (2011: 204, **nom. inval.**, Art. 40.6), *Sphacelotheca sinhagadensis* Gandhe (2011: 207, **nom. inval.**, Art. 40.6).

These smuts, found in inflorescences of members of the *Poaceae*, do not belong to the genus *Sphacelotheca*, species of which are restricted exclusively to *Polygonaceae* (see Langdon & Fullerton 1978; Vánky 2002, 2011). They should be treated as species of *Sporisorium* if required.

Sporisorium lohagadense Denchev & T. Denchev, **sp. nov.**

IF 550112

Type on *Ischaemum tumidum* Stapf (*Poaceae*): INDIA, MAHARASHTRA STATE, Lohagad, 5 January 1975, leg. R.V. Gandhe (**holotype**, AMH 9372).

Latin description by Gandhe in *Ustilaginales of India*: 204 & 206, 2011 (as *Sphacelotheca lohagadensis* Gandhe); illustrations by Gandhe (op. c., Plate 4.30, Figs 196–199 on p. 205).

Based on the original description, *Sporisorium lohagadense* destroys the whole inflorescence transforming it into a cylindrical, 3–5 cm long sorus, at first hidden inside in the leaf sheath, covered by a peridium, with a central, branched columella, as long as the sorus. Spores are single or 'in clumps'; the spores are 8–9.5 μm long (mean 8.8 μm), smooth to finely verruculose; sterile cells are 9.5–10.5 μm long (Gandhe 2011). There are four species of *Sporisorium* on *Ischaemum* that destroy the whole inflorescence (Vánky 2009, 2011). In soral and spore characters, *Sporisorium lohagadense* bears some resemblance to *S. ischaemi-anthephoroides* but possesses larger spores. *Anthracocystis ischaemiana* is distinguished by its sori with numerous, filiform columellae. *Sporisorium flagellatum* and *S. ischaemi-rugosi* differ by having larger spores. *Sporisorium mahabaleshwarensense* differs from *S. lohagadense* by having larger spores and larger sterile cells.

Sphacelotheca sinhagadensis Gandhe, *Ustilaginales* of India: 207, 2011 (nom. inval.). — Type on *Coix lachryma-jobi* L. (*Poaceae*), INDIA, MAHARASHTRA STATE, Pune, Sinhagad, leg. R.V. Gandhe (AMH 9373; a specimen with two gatherings, from 1 December 1975, and 5 November 1976).

Sphacelotheca sinhagadensis (invalidly published in the Gandhe's PhD thesis, 1978) was reduced to a synonym of *Sporisorium lacrymae-jobi* (Mundk.) Vánky (Vánky 1995).

4. *Tilletia fischeri* Gandhe (2011: 306, **nom. inval.**, Art. 40.6; and later homonym, non *Tilletia fischeri* P. Karst., 1884) on *Panicum psilopodium* Trin.

Based on the original description, *T. fischeri* infects only some ovaries of the inflorescence, and forms sori 0.5–2.0 mm long. The spores are 23–26 μm long (mean 24.6 μm), reticulate, with 'reticulations ... 1.6–3.2 μm broad', 'episore rim ... 1.6–3.2 μm in

thickness' (according to Gandhe 2011: 308). There are three species of *Tilletia* on *Panicum* with such soral characteristics and reticulate spores. The spores of *T. mexicana* Vánky are larger, 25–29 µm long. Whether *T. fischeri* is distinct from *T. courtetiana* Har. & Pat. or *T. narasimhanii* Thirum. & Safeulla needs further study.

5. *Ustilago tripogonis* Gandhe (2011: 365, **nom. inval.**, Art. 40.6) on *Tripogon lisboae* Stapf and *T. jacquemontii* Stapf.

This species requires re-examination; it is possibly a synonym of *Macalpinomyces tripogonis* (M.S. Patil) Vánky, although in the protologue sterile cells were not mentioned.

Acknowledgements. The authors thank Dr Paul Kirk and the reviewers of the manuscript for their helpful and constructive comments.

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