

## Ustilaginales of Commelinaceae\*

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The seven reported smut fungi on Commelinaceae are revised. Of these, five are recognised and described: *Ustilago aneilematis*, *U. burkillii*, *U. commelinae*, *U. nawaschirii* and *U. tinantiae*. *Entyloma commelinae* is considered to be a doubtful species and *U. rwandensis* is a synonym of *U. aneilematis*. A new species, *Ustilago combensis* (type on *Commelina benghalensis*) is proposed. A key to these species is presented.

Key Words—taxonomy; Ustilaginales of Commelinaceae; *Ustilago combensis*.

### Introduction

An unidentified smut on *Aneilema nudiflorum* R. Br., sent to me by Dr. N. D. Sharma (J. N. Agricultural University, Jabalpur, India), prompted me to revise the smut fungi of Commelinaceae.

The Commelinaceae is a rather large monocotyledonous family containing about 40 genera and 550–600 species (Engler, 1964). The smut fungi of Commelinaceae are unsatisfactorily studied and only seven species have been described. The first smut on a Commelinaceae was published by Komarov in 1899 as *Tilletia? commelinae* Komarov from the seeds of *Commelina communis* L. McLain (1960) demonstrated that the reticulated, *Tilletia*-like spores of this species germinate by a septate basidium and, consequently, this species must be transferred into the genus *Ustilago*. In 1909, Raciborski described *Ustilago nawaschirii* Racib. on *Polia* sp. from Java, giving spore measurements of 13–16  $\mu\text{m}$ . These measurements could not be confirmed by a study of the type specimen, when values of 7–11  $\times$  8–12(–13)  $\mu\text{m}$  were obtained. The incorrect measurements given by Raciborski led to subsequent confusion in describing new taxa. In 1912, H. & P. Sydow and Butler described *Ustilago burkillii* H. & P. Sydow & Butler in the flowers of *Aneilema nudiflorum* (L.) Wall ex C. B. Clarke from India, with smooth spores of 11–15  $\times$  12.5–15  $\mu\text{m}$ . In all specimens seen by me the young spores are smooth, but the mature ones are finely and densely verruculose. In 1935, Ito published *Ustilago aneilematis* S. Ito on *Aneilema keisak* Hassk. from Japan, characterised by a yellowish-brown spore mass and smooth spores of 7.2–9.6  $\mu\text{m}$  diameter. A study of the type specimen revealed that the spores are finely and densely verruculose. In 1953, Lindquist described *Ustilago tinantiae* Lindquist in the ovaries of *Tinantia fugax* Schweid. from Argentina. In 1963, Viennot-Bourgin described *En-*

*tyloma commelinae* Viennot-Bourgin in the leaves of *Commelina* sp. from Madagascar. The last smut fungus on a Commelinaceae was published in 1982 by Majewski and Nowak under the name of *Ustilago rwandensis* Majewski & Nowak, in the flowers of *Commelina diffusa* Burm. fil. from Rwanda. Except for *Entyloma commelinae*, a doubtful species, all Commelinaceae smuts have sori in the flowers or in the ovaries of the host plants. Of the six *Ustilago* species, two, *U. commelinae* and *U. tinantiae*, have reticulate spores while the remaining four species have finely verruculose spores and it is rather difficult to differentiate them. Moreover, *U. rwandensis* is so close to *U. aneilematis* that it is considered to be conspecific. A reticulate-spored *Ustilago* on *Commelina benghalensis* L. from Pakistan is distinct and is described in this paper under the name of *Ustilago combensis*. The main differentiating characters of these species are presented in a key.

### Materials and Methods

The present paper is based mainly upon study of herbarium material. Type specimens were checked (marked with “!”) when possible. For spore morphology and light microscopical (LM) measurements, dried spores were rehydrated in lactophenol by gently heating to boiling point and examined at 1100  $\times$  magnification using an oil immersion lens. For scanning electron microscopical (SEM) studies, dried spores were dusted on small pieces of double-sided adhesive tape and sputter coated with gold-palladium, ca. 20 nm. Germination experiments were carried out on water-agar in Petri-dishes.

\* Studies in Heterobasidiomycetes, part 102

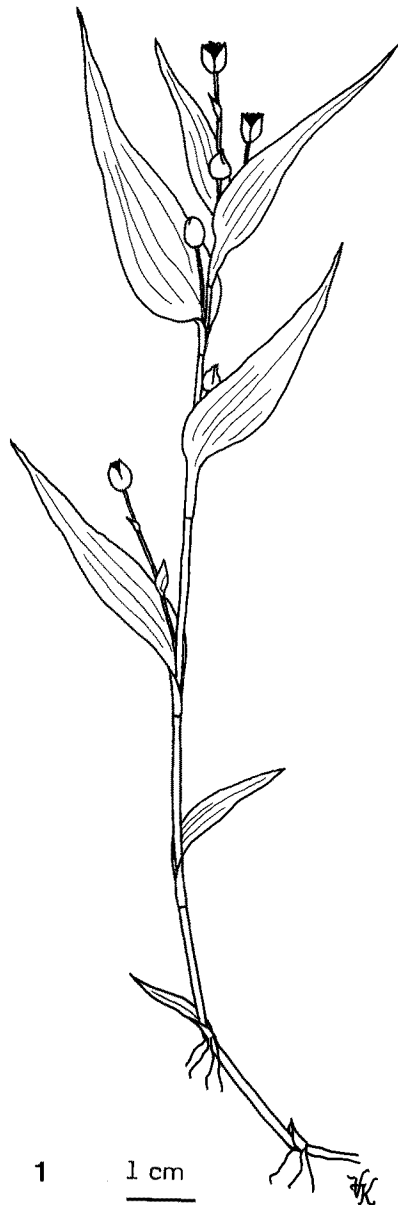


Fig. 1. Sori of *Ustilago aneilematis* on *Aneilema keisak* (Type).

#### Key to the Ustilaginales species on Commelinaceae

- |  |                            |
|--|----------------------------|
| 1. Sori in leaves as spots, spore mass not powdery                         | <i>Entyloma commelinae</i> |
| - Sori in flowers or ovaries, spore mass powdery                           | 2                          |
| 2. Spores reticulate   | 3                          |
| - Spores finely verruculose  | 5                          |
| 3. Spores 9.5–13 $\mu\text{m}$ long  | <i>Ustilago tinantiae</i>  |
| - Spores 14–22 $\mu\text{m}$ long  | 4                          |
| 4. Spores regular, mostly globose, muri 1.5–3 $\mu\text{m}$ high           | <i>Ustilago commelinae</i> |
| - Spores mostly irregular, muri 0.8–1.5 $\mu\text{m}$ high                 | <i>Ustilago combensis</i>  |
| 5. Spores 12.5–15 $\mu\text{m}$ long. Spore wall ca. 1 $\mu\text{m}$ thick | <i>Ustilago burkillii</i>  |

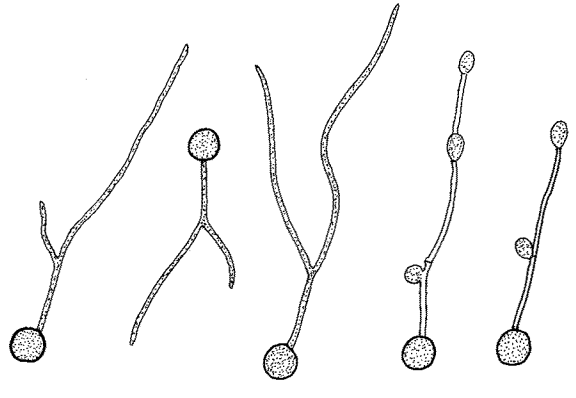


Fig. 4. Spore germination of *Ustilago aneilematis* (Type; Radrawn from pictures and drawings in Herb, SAPA).

- Spores smaller. Spore wall thinner

6

6. Spores 8–13  $\mu\text{m}$  long. Spore wall ca. 0.8  $\mu\text{m}$  thick  
*Ustilago nawaschinii*

- Spores 7–10  $\mu\text{m}$  long. Spore wall ca. 0.5  $\mu\text{m}$  thick  
*Ustilago aneilematis*

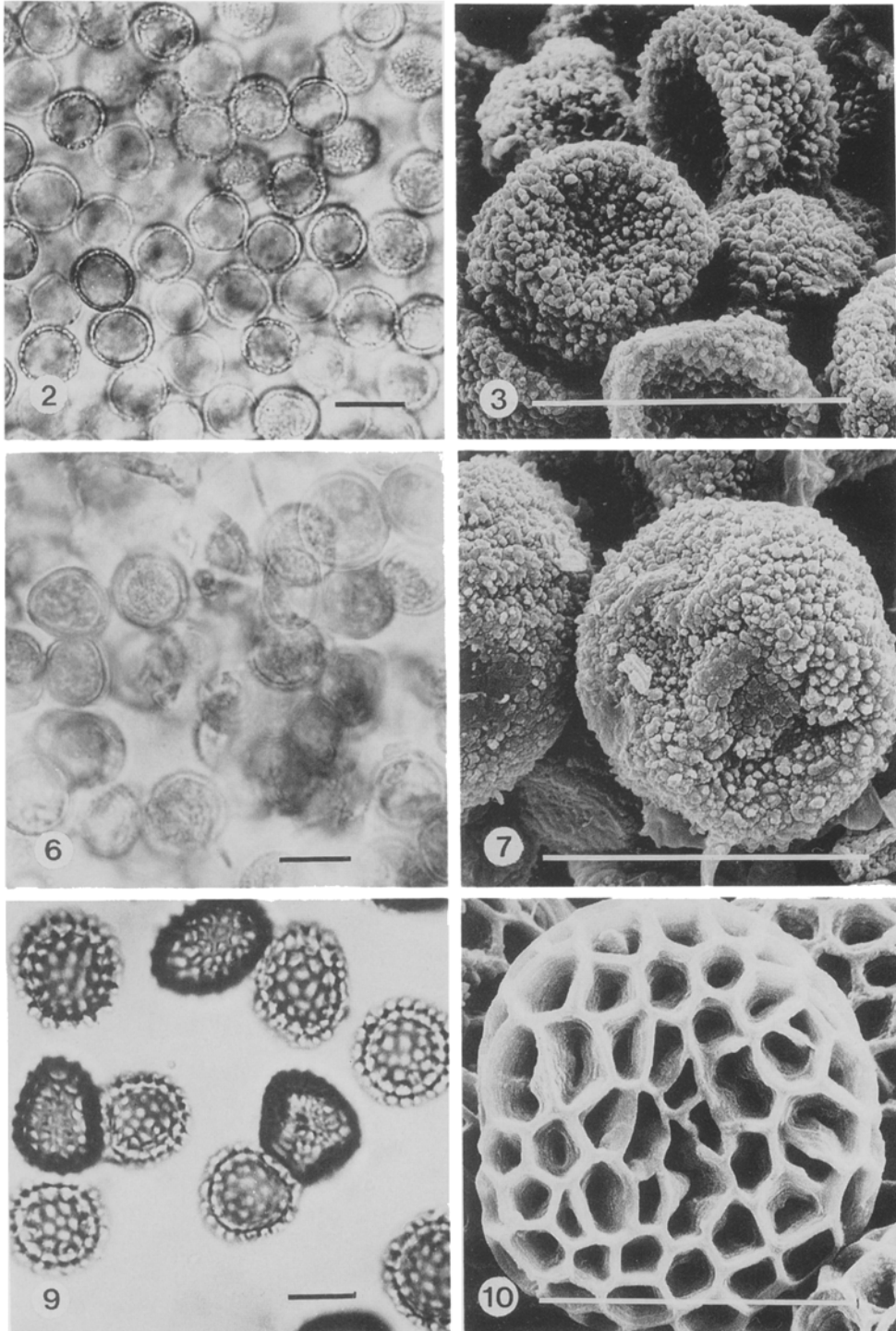
#### Description of the species

*Ustilago aneilematis* S. Ito, 1935. Figs. 1–4  
Holotype on *Aneilema keisak* Hassk. (*Murdannia keisak* (Hassk.) Hand.-Mazz.), Japan, Kozuke Prov. (=Tochigi Pref.), Kawachi-gun, Hongo-mura, Aza Isooka, 11.IX.1932, T. Watanabe & T. Yamada (SAPA; isotype in HUV 12340!).

*Ustilago rwandensis* Majewski & Nowak, 1982.—Holotype on *Commelia diffusa*, Rwanda, Kigali Pref., Masaka, 25.I.1980, K. A. Nowak (WA; isotype in HUV 11114!).

Sori (Fig. 1) in ovaries and anthers, protected by the perianth. Spore mass reddish-brown, powdery. Spores (Figs. 2, 3) globose to subglobose, 7–9  $\times$  7–10  $\mu\text{m}$ , when young hyaline, smooth, when mature pale yellowish-brown, finely and densely punctate-verruculose, warts easily detaching, spore content homogeneous; wall ca. 0.5  $\mu\text{m}$  thick, in median view very finely serulate. In SEM spore surface densely verruculose. Germination (Fig. 4) results in ramified mycelia or in 1–2-septate basidia with lateral and terminal, ovoid basidiospores (illustrated in the herbarium SAPA).

Other specimens examined: On *Aneilema nudiflorum* (L.) Wall. ex C. B. Clarke (*Commelina nudiflora* L., *Murdannia nudiflora* (L.) Brenan), India, Maharashtra State, Kolhapur Distr., Gaganbawad, 26.  $\times$ .1986, S. R. Yadav (HClO 30106); *Commelina* aff. *latifolia* Hochst ex A. Rich., Tanzania, Mt. Nguru ya Ndege, N. W. of Morogoro, alt. ca. 700–800 m, 4.VI.1972, A. Pócs & A. Björstad (HUV 11303); *Commelina spectabilis* B. C. Clarke, South Rhodesia, coll. W. E. Kerr (IMI 57218, as *Ustilago* sp.); *Commelina* sp., Tanzania, Geita Distr., 2 miles E. Harngongo, 3800 ft., 26.I.1971, D. L. Ebbels (IMI 163944, as *Ustilago* sp.).



Figs. 2-10. Spores of three species of *Ustilago*. 2, 3. Spores of *U. aneilematis* in LM and SEM (Type). 6, 7. Spores of *U. burkillii* in LM and SEM (Sydow, Fgi. exot. exs. 981). 9, 10. Spores of *U. combensis* in LM and SEM (Type). Bars = 10  $\mu\text{m}$ .

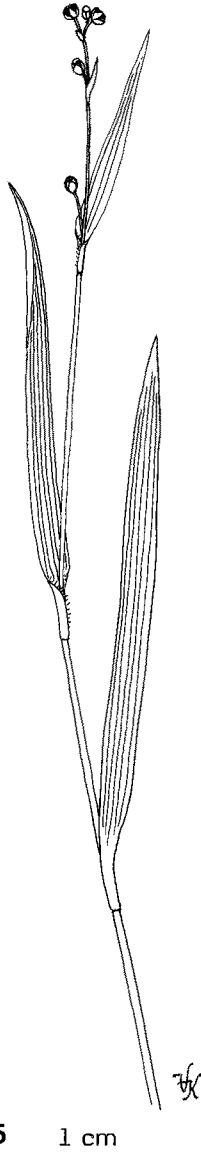
***Ustilago burkillii* H. & P. Sydow & Butler, 1912.**

Figs. 5-7  
Holotype on *Aneilema nudiflorum*, India, Mymensingh, Gauripur, 6.IX.1906, J. H. Burkill (E. J. Butler no. 1426).

Sori (Fig. 5) in ovaries, 4-6 mm long, ferruginous, covered by a greyish membrane. Spores (Figs. 6, 7) globose, subglobose to subpolyhedral, 9-13  $\times$  9-13(-

14)  $\mu\text{m}$  / 11-15  $\times$  12.5-15  $\mu\text{m}$  /, olivaceous yellow, contents granular; wall 1-1.5  $\mu\text{m}$  thick, apparently smooth but, in fact, very finely and densely punctate, in SEM densely verruculose. According to Mundkur (1939) surface minutely pitted giving the edges a serrate appearance.

Specimens examined: On *Aneilema nudiflorum* (L.) Wall ex C. B. Clarke (*Commelina nudiflora* L., *Murdannia*



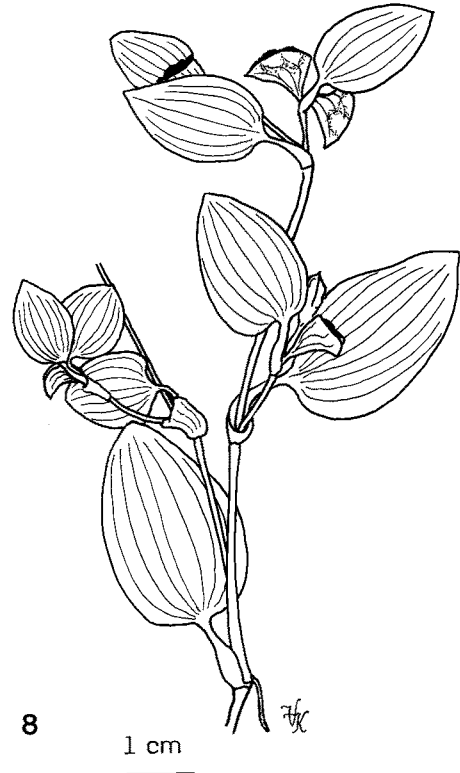
5 1 cm

Fig. 5. Sori of *Ustilago burkillii* on *Aneilema nudiflorum* (*A. malabaricum*; Sydow, Fgi. exot. exs. 981; HUV 3499).

*nudiflora* (L.) Brenan, *Aneilema malabaricum* (L.) Merrill, *Murdannia malabarica* (L.) Brueckner), Philippines, Pampanga Prov., Angeles, XI. 1921, S. Blanco, in Sydow, Fgi. exot. exs. 981 (HUV 3499); India, Madhya Pradesh, Jabalpur, comm. N. D. Sharma (HUV 14755!).

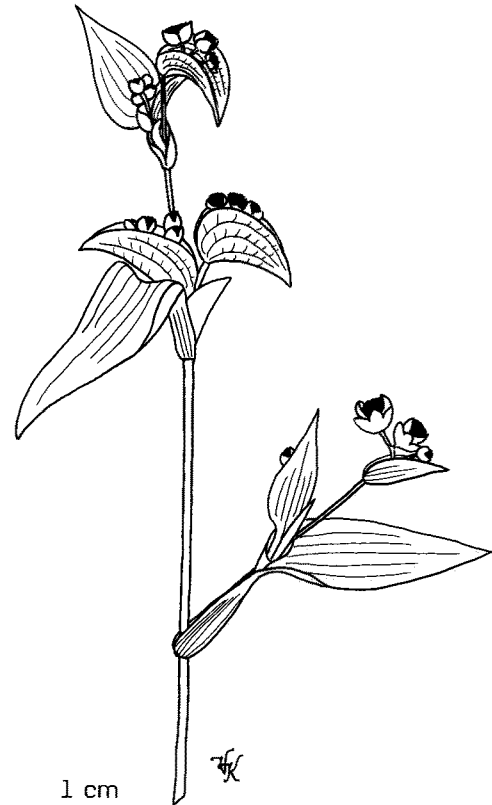
Type not seen. Description taken from the original, and supplemented from the specimens mentioned above. In the original description (Sydow et al., 1912) the spore measurements of *U. burkillii* are given as 11–15 × 12.5–15 μm. Only a study of the type specimen can reveal if *U. burkillii* is conspecific with, and thus a synonym to the earlier described *U. nawaschinii* Racib.

Thirumalachar and Mundkur (Thirumalachar, 1950) supposedly studied this fungus. They found that the spores developed on hyphae. By germination “one or more long, branched germ tubes” resulted. “Each cell of



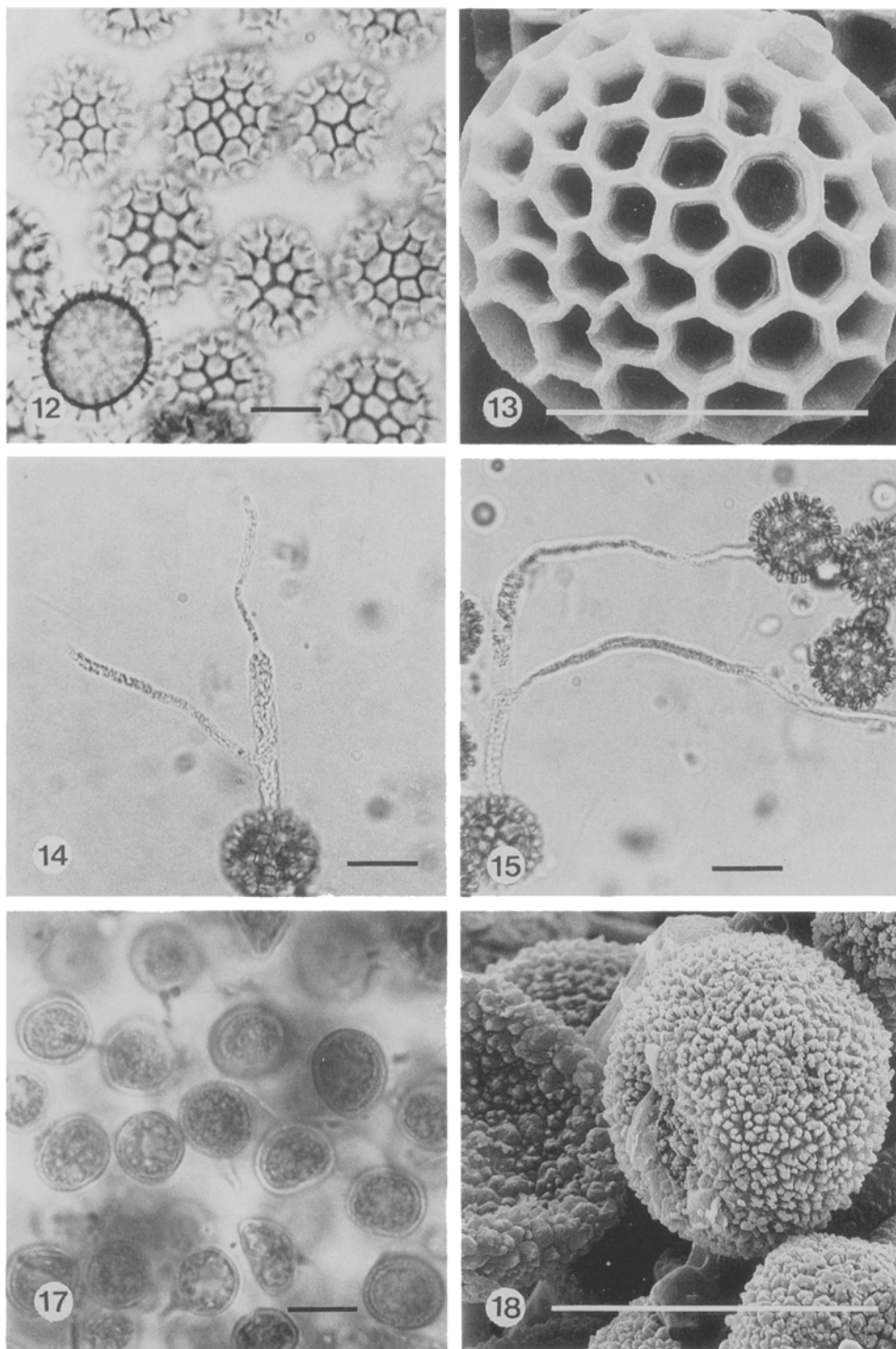
8 1 cm

Fig. 8. Sori of *Ustilago combensis* on *Commelina benghalensis* (Type).



11 1 cm

Fig. 11. Sori of *Ustilago commelinae* on *Commelina communis* (Type).



Figs. 12-18. Spores and spores in germination in two species of *Ustilago*. 12, 13. Spores of *U. commelinae* in LM and SEM (Type). 14, 15. Spore germination of *U. commelinae* (ex *Commelina communis*, Japan, Hirosaki, Univ. Campus, 18.IX.1986, Y. Harada, in Vánky, Ust. 635; HUV 13255). 17, 18. Spores of *U. nawaschii* in LM and SEM (Type). Bars = 10  $\mu$ m.

the separate germ tube shows a single nucleus and develops one to four conidia in clusters on short hyphae." On the basis of the spore formation and spore germination, Thirumalachar and Mundkur transferred *Ustilago burkillii* into *Ustilagoidea*, a phylomyceete parasitising

ovaries of Gramineae.

A specimen obtained from Dr. Sultan Ahmad, labelled as *Ustilago commelinae* on *Commelina benghalensis*, turned out to be an undescribed species:



Fig. 16. Sori of *Ustilago nawaschii* on *Pollia* sp. (Type).

***Ustilago combensis*** K. Vánky, sp. nov. Figs. 8-10  
 Holotypus in matrice *Commelina benghalensis* L., Pakistan, Murree, VIII.1952, S. Ahmad, in Herbario Ustil. Vánky (HUV 8966!), isotypus in Herb. S. Ahmad (Lahore, Pakistan).

Sori (Fig. 8) in floribus tumefactis deformatisque a perianthiis protecti, massa sporarum rufobrunnea, semiagglutinata usque pulverea conferti. Sporae (Figs. 9, 10) forma, magnitudine et ornamentatione variae, globosae, ovoideae usque submultiangulate irregulares, raro elongatae,  $13-16 \times 14-20(-22) \mu\text{m}$ , flavidobrunneae; pariete reticulato, maculis (3-)-4-8(-10) pro diametro, muri inter maculas  $0,8-1,5 \mu\text{m}$  alti in conspectu medio acuti, subacuti vel obtusi. Germinatio ignota.

Sori (Fig. 8) in swollen and deformed flowers, protected by the perianth, filled by a reddish brown, semiag-

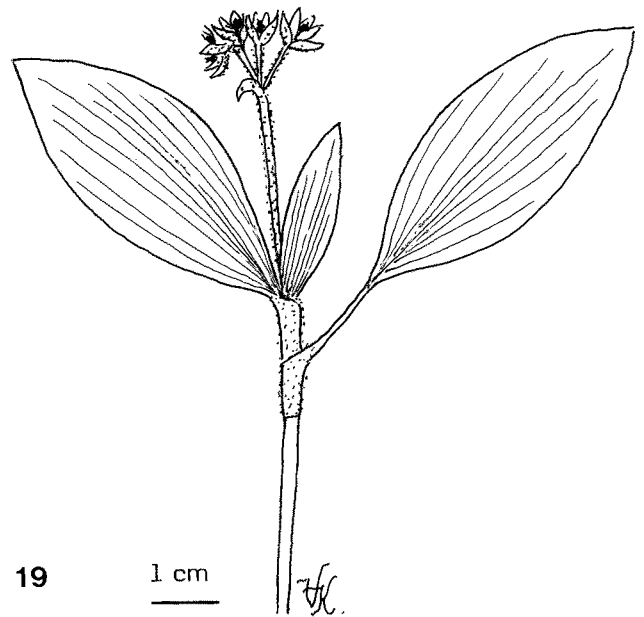


Fig. 19. Sori of *Ustilago tinantiae* on *Tinantia fugax* (Type).

glutinated to powdery mass of spores. Spores (Figs. 9, 10) variable in form, size and ornamentation, globose, ovoid to subpolyhedrally irregular, rarely elongated,  $13-16 \times 14-20(-22) \mu\text{m}$ , yellowish-brown; wall reticulate, (3-)-4-8(-10) meshes per spore diameter, muri  $0.8-1.5 \mu\text{m}$  high, in median view acute, subacute or blunt. Germination unknown.

Known from only the type collection.

Etymology: *combensis*, shortened from *commelinae-benghalensis*; both names *Ustilago commelinae* and *U. benghalensis* being occupied.

*U. combensis* differs from *U. commelinae* especially by the more irregular spores, smaller meshes and low muri; from *U. tinantiae* especially by its larger spores.

***Ustilago commelinae*** (Komarov) Zundel, 1953.

Figs. 11-15  
*Tilletia?* *commelinae* Komarov, in Jaczewski, Komarov, Tranzschel: Fungi Rossiae Exsiccati 210, 1899.—Holotype on *Commelina communis*, China, Heilongjiang Prov., near the town Mao-ell-shan, Jalu Valley, 3/14.IX.1897, V. L. Komarov; isotypes in Jacz., Kom., Tranz., Fgi. Ross. exs. 210 (HUV 2215!).

Sori (Fig. 11) in ovaries. Capsules swollen, deformed, filled with the dark reddish brown, powdery mass of spores. Infection systemic. Spores (figs. 12, 13) globose to subglobose, rarely ovoid,  $13.5-20 \times 15-21(-22) \mu\text{m}$  in diameter (including the reticulum), light to medium golden brown; wall reticulate, 4-7 meshes per spore diameter, muri  $1.5-3 \mu\text{m}$  high, in median view acute. Germination (Figs. 14, 15; on water agar, after 10 days, at room temp.) results in 2-celled basidia each cell giving rise to a dicaryotic infection hypha (comp. also McLain 1960; Ingold, 1989).

Other specimens examined: On *Commelina commu-*

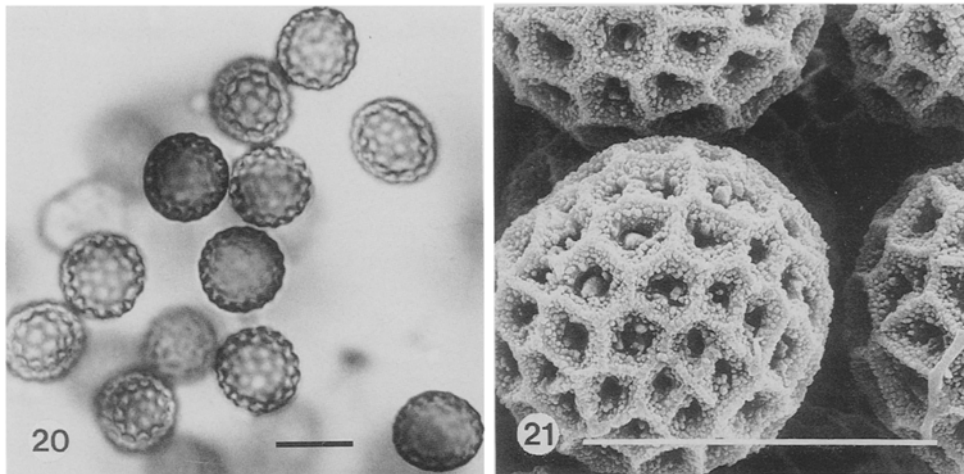


Fig. 20, 21. Spores of *Ustilago tinantiae* in LM and SEM (Type). Bars = 10 µm.

*nis* L., E. Asia: China (Vánky, Ustil. exs. 871, HUV 15658, HMAS 62199), Japan (HUV 11795; Vánky, Ustil. exs. 539, HUV 11796; Vánky, Ustil. exs. 635, HUV, 13255), Russia (HUV 5417), North America: USA (HUV 2216, 9925).

*Ustilago nawaschii* Raciborski, 1909. Figs. 16-18  
Holotype on *Pollia* sp., Java, Buitenzorg, S. Nawaschin (KRA!).

Sori (Fig. 16) in the swollen, deformed flowers, filled

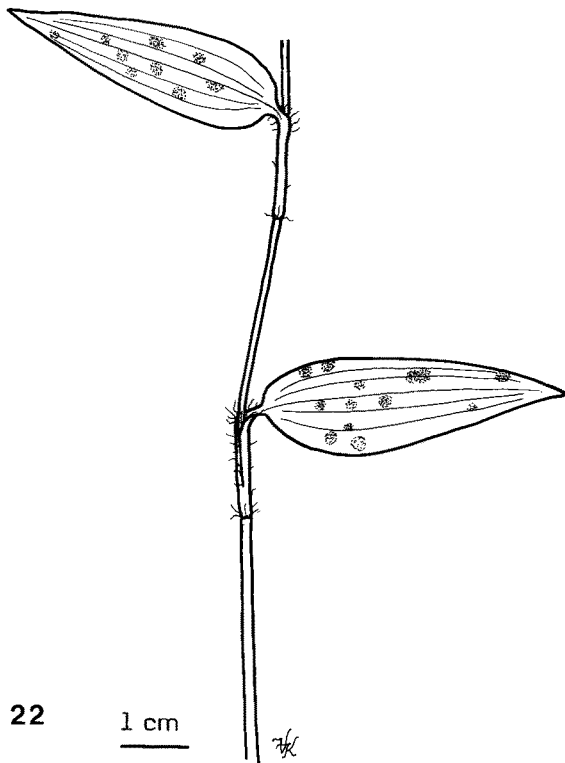


Fig. 22. Sori of "*Entyloma commelinae*" (Type).

with an orange-yellow, or reddish brown powdery spore mass, enveloped by the perianth. Infection systemic. Spores (Figs. 17, 18) globose, subglobose to ovoid, 7-11 × 8-12(-13) µm, when young hyaline, smooth, adhering in loose groups which disintegrate at maturity, when mature yellow or pale olivaceous brown; wall uniform, ca. 0.8 µm thick, minutely and densely punctate-verruculose, not or just affecting the spore profile which is very finely and densely wavy, in SEM finely and densely verruculose. Germination (Raciborski, 1909) results in septate basidia of 3 × 50-80 µm which separate into 2-4-celled units. On the tip of each basidial cell usually 4, small (2.5 µm diam), globose, hyaline basidiospores are produced. Rarely, the basidia may be ramified composed of a 3-celled and a 1-celled part with a total of 12 basidiospores.

Known from only the type collection.

The origin of the mycelia found between the spores of the type specimen is not clear. Some certainly belong to saprophytes but also a few germinated spores of *U. nawaschii* were observed with septate, up to 4-celled basidia.

*Ustilago tinantiae* Lindquist, 1953. Figs. 19-21  
Holotype on *Tinantita fugax* Schweid., Rep. Argentina, Salta, Capital, Quebrada de san Lorenzo, 1500 m, 19.III.1952, H. Sleumer (LPS 22062!).

Sori (Fig. 19) in ovaries. Spore mass chestnut-brown, powdery. Spores (Figs. 20, 21) globose, subglobose to ellipsoidal, 9.5-11 × 9.5-13 µm light brown; wall 1-1.5 µm thick, finely reticulate, 5-7 meshes per spore diameter, areolae 1-1.5 µm wide, muri ca. 0.8 µm high, blunt in optical median view. In SEM the reticulate pattern is combined with a verruculose one; the whole surface (muri and interspaces) being covered by densely situated, fine verrucae of variable sizes. Germination results in 4-celled basidia developing basidiospores both laterally and terminally (Lindquist, 1953).

Other specimen examined: On "*Tinantia concehinacea*", Rep. Argentina, Dto. Capital Yala, way to

Lagunas, 1600 m, 18.II.1959, F. Verworst (HUV 14776, ex Herb. E. Hirschhorn No. 4111).

*Entyloma commelinae* Viennot-Bourgin, 1963. Fig. 22 Holotype on *Commelina* sp., Madagascar, Tananarive, at the lake Itasy, 14.III.1962, G. Viennot-Bourgin (PCI; on the label host plant as *Commelina nudiflora*).

The original description was given as: Sori (Fig. 22) on leaves as small (0.4–5 mm), round or elliptic, first whitish, later brownish spots. Spores in the host tissue, loosely agglutinate, globose to ellipsoidal, 13–19  $\mu$ m in diameter; wall thin, minutely punctate-rough. Conidia of *Cylindrosporium kilimandscharicum* Allesch. are present.

Known from only the type collection.

Minutely punctate-rough spores are uncommon and not typical for *Entyloma*. Repeated attempts to find spores in the type specimen failed. Present and in abundance are mycelia and conidia of an imperfect fungus (*Cylindrosporium kilimandscharicum*, according to Viennot-Bourgin, 1963).

*Entyloma commelinae* is considered to be a doubtful species.

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labels of two unidentified specimens from IMI (Egham, England). This work was supported by the Deutsche Forschungsgemeinschaft.

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