

Restilago capensis gen. et sp. nov., an ascomycetous smut fungus

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Abstract. *Restilago capensis* gen. et sp. nov., a smut fungus found in flowers of *Ischyrolepis capensis* (*Restionaceae*) in South Africa, is described. The ultrastructure of the septal pores indicates that it belongs to the ascomycetes. In addition to the genus *Schroeteria*, this is the second genus of smut fungi of ascomycetous origin. The current definition of the term ‘smut fungus’ is briefly discussed in the introduction.

Key words: ascomycetous smut fungi, new genus, new species, *Restilago capensis*

Introduction

The results of molecular phylogenetical analyses (Blanz & Gottschalk 1984; Begerow *et al.* 1998; Swann *et al.* 1999; Hibbett *et al.* 2007) showed that the genus *Microbotryum* and some related genera are more closely related to the rust fungi than the smut fungi. This was a surprising result, because the smut fungi were almost universally considered to be a taxonomic unit belonging to the Order *Ustilaginales*. Bauer *et al.* (2000) and Vánky (2008) defined the term smut fungi as a phylogenetically heterogeneous group of microfungi having similar life strategy and organisation, specifically as plant parasites that develop teliospores as organs of dispersal and resistance. The germinating teliospores infect host plants, either directly or through the production of secondary spores. Vánky (2008) applied this definition to reinstate as a true smut fungus the ascomycetous genus *Schroeteria* G. Winter, with 6 known species, which had been excluded from the smut fungi (comp. Nagler *et al.* 1989; Vánky 2002).

In South Africa, a few samples of a curious ‘smut’ fungus were collected by Dr. Åsa Hagström on an unidentified species of *Restionaceae*. On request, she kindly sent me an infected plant and the data where she collected it. One year later, in 1996, in the same area, I was able to collect rich material suitable for detailed studies. Its ultrastructure, checked by Dr. R. Bauer (Fig. 6), revealed that it is an ascomycete. However, the material could not be identified by several specialists. As

the fungus corresponds with the definition of smut fungi, it is described as a new genus and species, representing the second ascomycetous genus of smut fungi.

Materials and Methods

Infected samples of *Ischyrolepis capensis* were collected in South Africa, and are preserved in Herbarium Ustilaginales Vánky (H.U.V. 18 033 and 18 036). Sorus and spore characteristics were studied using dried herbarium specimens. For study of sorus structure a sorus was boiled in distilled water and sectioned with a razor blade. For study of spore morphology, a mature sorus was softened in distilled water. For light microscopy (LM) a droplet of spore suspension from the surface of the sorus was placed on a microscope slide, a droplet of lactophenol was added, covered with a cover glass, gently heated to eliminate air bubbles, and examined by a light microscope at 1000× magnification. For scanning electron microscopy (SEM), a droplet of spore suspension was placed on double-sided adhesive tape, dried, mounted on a specimen stub, sputter-coated with gold-palladium, c. 20 nm, and examined in a SEM at 10 kV. For spore germination a suspension of freshly collected spores was placed on water agar (WA), kept at room temp. for 2–3 days. A square of WA with germinating spores was cut out, placed on a microscope slide, stained with a droplet of lactophenol cotton blue, covered with a cover glass and studied in LM.

Results and Discussion

Study of the infected *Ischyrolepis* specimens resulted in the description of a new genus and species as:

Restilago Vánky, gen. nov.

Mycobank # MB 511503

Sori ad fructos plantarum familiae Restionaceae, e stromate albo, basali, origine plantae nutrientis et fungi compositi. Ad stromam massae sporarum nigrae, durae, firme agglutinatae, non pulverebiles productae. Peridium, columella et cellulae steriles absentes. Sporae singulae, atro-pigmentiferae (brunneae), ornatae, strato maxime externo, gelatinoso parietis sporae agglutinatae. Hypharum septis simpliciter perforatis, corpusculae Woronini adsunt. Germinatio sporarum hyphis simplicibus vel ramulosis.

Typus generis: R. capensis.

Sori around the fruits of *Restionaceae*, composed of a white, basal stroma of host and fungus origin. On the stroma black, hard, firmly agglutinated, non-pulverulent spore masses are produced. Peridium, columella and sterile cells lacking. **Spores** single, dark pigmented (brown), ornamented, agglutinated by the outermost, gelatinous layer of the spore wall. **Septal pore** simple, associated with Woronin bodies (Figs 6-7). **Spore germination** results in simple or ramified hyphae.

Type of the genus:

Restilago capensis Vánky, sp. nov.

Mycobank # MB 511504

Typus in matrice Ischyrolepis capensis (det. H.P. Linder), South Africa, Western Cape Province, Cape Town, Table Mountain, supra hortum botanicum Kirstenbosch, in summum saltus 'Nursery Ravine', 33°58'55" S, 18°24'28" E, alt. cca. 700 m, 9.XII.1996, leg. C. & K. Vánky. Holotypus in Herbario Ustilaginales Vánky (H.U.V. 18 033), isotypus in PREM. Paratypus: Western Cape Province, Swartberg Pass, inter oppid. Oudtshoorn et Prince Albert, 33°21'54" S, 22°05'30" E, alt. cca. 1130 m.s.m., 17.XII.1996, leg. C. & K. Vánky; H.U.V. 18 036.

Sori ad capsulas nonnullas inflorescentiae corpora nigra, globoidea vel depressa, lobata, cordiformia, dura, non pulverebilia, cca. 2-3 mm alta, 2-3 × 3-4 mm lata formati. Superficies sororum e massa compacta sporarum agglutinatarum formata. Pars basalis sororum attenuata maturitate e stromate albo hypharum sporogenerum et telis hospitis cum massis sporarum marsupia formantes. Peridium, columella et cellulae steriles nullae. Sporae globosae, ellipsoideales, ovoideae usque elongatae, (9-) 9,5-14,5 × (10-) 11-20 (-22) μm, atro-rufobrunneae; pariete aequali, cca. 1 μm crasso, dense verrucoso, imago obliqua sporarum subtiliter serrulata. Sporae strato tenuiter, hyalino, gelatinoso obtegentes, in statu exsiccato sporas firme conglutinantes. Germinatio sporarum hyphas simplices vel ramulosas efficiens.

Sori (Fig. 1) around some of the capsules of an inflorescence forming black, globoid or flattened, 'heart-shaped', hard, non-pulverulent bodies, c. 2-3 mm high, 2-3 × 3-4 mm wide. Distal part of the sori 2- or 4-lobed according to the

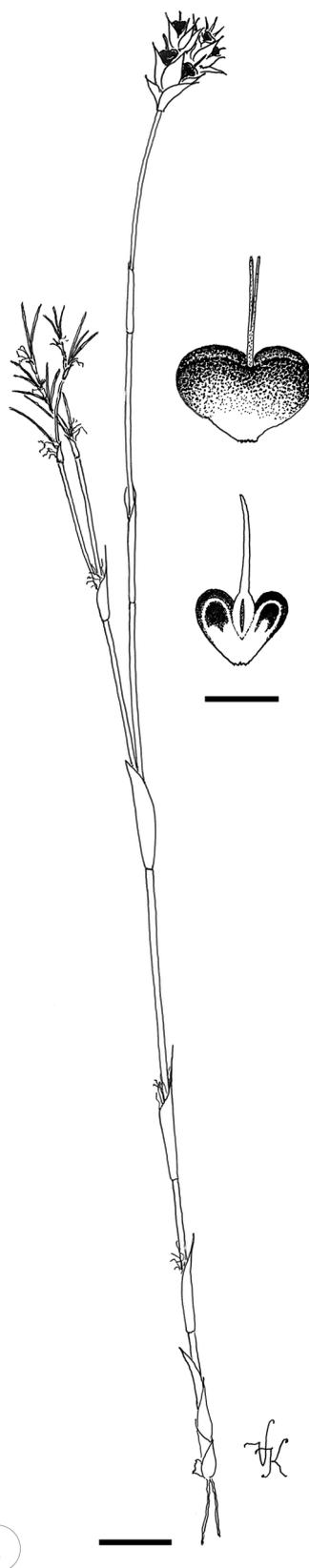
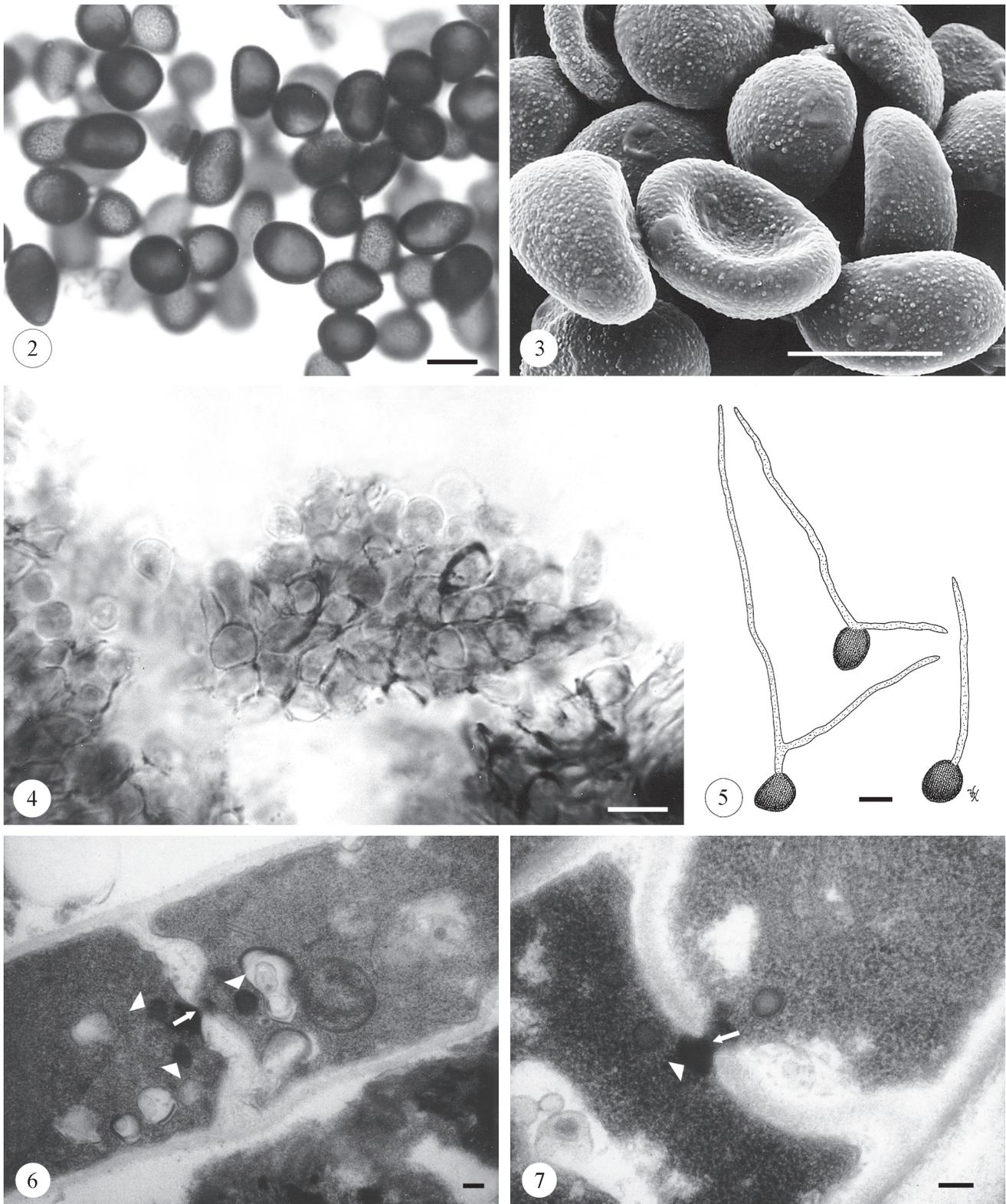


Fig. 1. Sori of *Restilago capensis* around the capsules of *Ischyrolepis capensis* (type). Habit and two sori at higher magnification, one longitudinally sectioned. Bars = 1 cm for habit, and 2 mm for the enlarged sori



Figs 2-3. Spores of *Restilago capensis* on *Ischyrolepis capensis* in LM and in SEM (type). Bars = 10 μ m. **Fig. 4.** Spore development on the basal part of a sorus with young, immature spores of *Restilago capensis* on *Ischyrolepis capensis* in LM (type). Bar = 10 μ m. **Fig. 5.** Germinating spores of *Restilago capensis* on *Ischyrolepis capensis* (type). Bar = 10 μ m. **Figs 6-7.** Septal pore apparatus in soral hyphae of *Restilago capensis* on *Ischyrolepis capensis* in TEM (type; photo R. Bauer). The simple septal pores (arrows) are associated with rounded, electron dense Woronin bodies (arrow heads). In Fig. 7, a Woronin body is blocking the septal pore to stop cytoplasmic flow between the two cells, or to prevent loss of cytoplasm. Bars = 0.1 μ m

apical part of the capsule, with the persistent, protruding style between the lobes. The surface of the sori is formed of a compact mass of agglutinated spores. Basal part of the sori narrowed, composed of a white stroma of sporogenous hyphae and host tissues forming pockets with spore masses at maturation (Fig. 1). Peridium, columella and sterile cells in the sori lacking. The sori become soft in water and release the blackish-brown, floating mass of spores. **Spores** (Figs 2-3) globose, ellipsoidal, ovoid to elongated, (9–) 9.5–14.5 × (10–) 11–20 (–22) µm, dark reddish brown; wall even, c. 1 µm thick, densely verrucose, spore profile finely serrulate. A thin, hyaline, gelatinous layer is covering the spores which when dry glues the spores firmly together or to the substrate. **Spore germination** (Fig. 4) results in simple or ramified hyphae.

On *Restionaceae*: *Ischyrolepis capensis* (L.) H.P. Linder.

Distribution: South Africa. Known only from the type collections.

Etymology: *Resti-*, from *Restionaceae*, the host plant family; *-lago*, alluding to *Ustilago*, to which in some respects it is similar.

Restilago capensis is an ascomycetous fungus of unknown affinity. Around its simple septal pores there are Woronin bodies (Fig. 6, arrowheads), typical for the ascomycetes. This fungus belongs to the smut fungi, because it has a similar plant parasitic life strategy and it produces thick-walled, pigmented spores (similar to the teliospores of basidiomycetous smut fungi), which germinate to infect new plants. *Restilago* resembles *Anthracoidea*, *Cintractia* and related smut genera (all on members of *Cyperaceae*) in that it has black sori around the host tissues with a basal stroma, and pigmented, solitary spores. However, *Restilago* differs from *Anthracoidea* and *Cintractia* (comp. also Vánky 2002), especially by the ascomycetous ultrastructure (Figs 6-7), by the sori with strongly agglutinated, non-pulverulent surface, by the type of spore germination and also by the different host plant families.

On members of the *Restionaceae* s. lat. two further smut fungus genera are known: the monotypic *Websdanea* Vánky, and *Restiosporium* Vánky, with 21 known species. Both genera belong to the *Websdaneaceae* Vánky (comp. Begerow *et al.* 2007), and are known only from Australia (comp. Vánky & Shivas 2008).

The biology and life cycle of *Restilago capensis* is unknown. Because only some (rarely all) fruits of an inflorescence are infected, it appears that infection is localised in the flowers, which is similar to *Anthracoidea* species. The hard, compact spore mass excludes a dispersal by wind. When sori are put in water, the dry, gelatinous outer layer of the spores absorbs water, swells up and after a short time spore masses are abundantly released into the water. It appears that rain-splash plays an important role in dispersal and the infection of new plants, by enabling spores to fall on the stigma of some flowers of healthy plants, where they germinate and infect them.

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