

The smut fungi (Ustilaginomycetes) of Restionaceae s. lat.

Kálmán Vánky

Herbarium Ustilaginales Vánky (H.U.V.), Gabriel-Biel-Str. 5, D-72076 Tübingen, Germany
(e-mail: vanky.k@cityinfonetz.de)

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Abstract. Smut fungi of Restionaceae s. lat. were studied. They are classified into two genera, *Restiosporium* and *Websdanea*. Problems of species delimitation in these smuts are discussed. In addition to the nine known smut fungi, thirteen new species are described and illustrated: *Restiosporium anarthriae*, *R. apodasmiae*, *R. chaetantheri*, *R. desmocladii*, *R. eurychordae*, *R. flexuosum*, *R. hypolaenae*, *R. lepyrodiae*, *R. pallentis*, *R. patei*, *R. proliferum*, *R. spathacei*, and *R. sphacelatum*.

Key words: new species, Restionaceae s. lat., *Restiosporium*, smut fungi, taxonomy, *Websdanea*

Introduction

The monocotyledonous Restionaceae is a remarkable family of Southern Hemisphere, evergreen, rush-like plants. They are concentrated mainly in SW Africa and in SW Australia. The c. 320 species of African Restionaceae, in 19 genera, were revised by Linder (1985, 1991). The 170 species of Australian Restionaceae s. lat. were published by Meney & Pate (1999) in a beautifully illustrated monograph. In it, two small families were separated from the Restionaceae, and further two families announced.

Only eight smut fungi have been described, all from Australia, on the nearly 500 species of Restionaceae s. lat., namely one species in the unispecific genus *Websdanea* and seven species in the genus *Restiosporium* (comp. also Vánky 2000, 2002, 2003; Vánky & McKenzie 2002; Vánky & Shivas 2003). Study of a number of smutted Restionaceae s. lat. revealed additional new *Restiosporium* species, which are described below, together with earlier known species.

Materials and Methods

For studies of the soral characters, fresh material was fixed with 2 % glutaraldehyde in 0.1 M Na-cacodylate buffer at pH 7.2 for several days. After six transfers in 0.1 M Na-cacodylate buffer, the material was postfixed in 1 % osmiumtetroxide in the same buffer for 1 h in the dark, washed in distilled water,

and stained in 1 % aqueous uranyl acetate for 1 h in the dark. After five washes in distilled water, the material was dehydrated in acetone series, embedded in Spurr's plastic, and sectioned with a diamond knife. Semi-thin sections were stained with new fuchsin and crystal violet, mounted in 'Entellan' and studied in a light microscope.

Spore ball and spore morphology was studied using a light microscope (LM) with an oil immersion lens at a magnification of 1000×. Dried spores were rehydrated in lactophenol by gently heating to boiling point under a cover glass. For measurements of spore wall thickness, freshly prepared specimens are recommended. In old specimens, the spore wall sometimes swells considerably in lactophenol solution. Spore- and spore ball formation, as well as germinated spores, were studied in lactophenol with cotton blue (lactic blue). For scanning electron microscopical (SEM) studies, dried spore balls were dusted on double-sided adhesive tape, mounted on a specimen stub, sputter-coated with gold-palladium, c. 20 nm, and examined in a SEM at 10 kV.

Results and Discussion

All known smut fungi of Restionaceae, except for *Websdanea lyginiae*, form their sori in the fruits (capsules, nuts), replacing the seeds by a black or blackish brown, first agglutinated, later granular powdery to powdery mass of spore balls. These are

produced within a hyaline mass of sporogenous hyphae and are composed of spores only (Vánky 2000: 347, 349, Figs 2-4). The spore balls are usually rather loose, more or less easily separating into single spores, more rarely they are persistent or exceptionally ephemeral. The spores are rounded or polyhedrally irregular. In the only successful spore germination of a *Restiosporium* species (*R. lepidoboli*, Vánky 2000: 350), the resulting basidia were four-celled. Compatible basidial cells fused pairwise by long copulation bridges. Infection is systemic; all ovaries of an inflorescence and all shoots of an infected plant are affected and infection persists throughout the life of their annual or perennial hosts. When male plants of dioecious restiads are infected by *Restiosporium*, the anthers remain undeveloped and the rudimentary gynoeceum becomes fully developed into capsules or nuts containing spore masses. Such male plants often look like infected female plants ('transvestism').

The species of *Restiosporium* are a difficult group to differentiate because the morphological characteristics are relatively few. Furthermore, there is often much variation in the shape and size of the spore balls and the spores, even within one specimen. Only rarely are excellent distinguishing characteristics available, such as the densely verruculose-echinulate spore surface of all spores in a ball of *Restiosporium dapsilanthi*. The spores of *Restiosporium* are usually smooth and finely or roughly verruculose only on the free surface.

Measurements of spores and spore balls are often an unreliable taxonomic characteristic in species of *Restiosporium* because of overlapping values. The situation can be compared to that of *Anthracoidea* species on Cyperaceae, in which most described species are morphologically only little but constantly different 'small' species, adapted to certain host plant species or groups of species (comp. Vánky 1979: 222). An essential difference is, however, the typical homothallism (absence of fusion between basidiospores or the basidial cells) of *Anthracoidea* species, a unique phenomenon within the smut fungi.

A question which arises is if there is a host specificity or is not in *Restiosporium*? If yes, to which level, to the genus, to the species, or perhaps once to the genus, once to the species level? Another question is how variable is a certain species? Because of the numerous 'small species', it is not easy to answer these questions, as long as no molecular support is available. The number of investigated specimens is also too small to give a definite answer. However, there are evidences that there is a host specificity to the species level. Some examples for this are the two *Restiosporium* species of *Anarthria*, those of *Apodasmia*, of *Balaskion*, *Dapsilanthus*, *Desmocladus*, and *Lepidobolus* (see the key below). On the other hand, there are species of *Restiosporium* which occurs on several host plant species within the same genus. Such species are *R. desmocladii* on *Desmocladus bififormis*, *D. elongatus*, *D. flexuosus*, and *D. lateriticus*; *R. hypolaenae* on *Hypolaena fastigiata* and *H. macrotrepala*; *R. lepidoboli* on *Lepidobolus chaetocephalus*, *L. drapetocoleus*, and *L. pressianus*; or *R. leptocarpi* on *Leptocarpus elegans* and *L. tenax*.

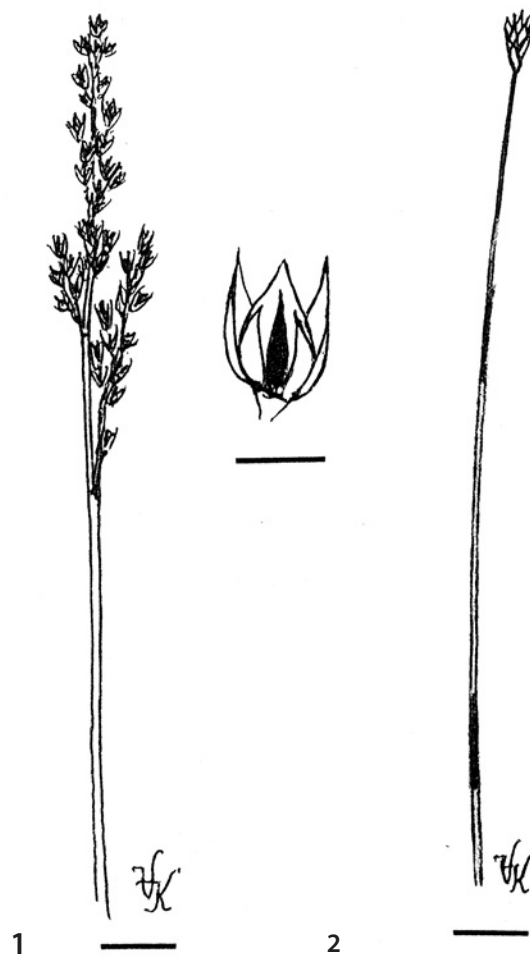


Fig. 1. *Restiosporium anarthriae* in the capsules of *Anarthria laevis* (type). Habit and enlarged an opened capsule filled with spore balls. Fig. 2. *Restiosporium apodasmiae* in the capsules of *Apodasmia ceramophila* (type). Habit. Bars = 1 cm for habit, and 3 mm for the enlargement

For species delimitation, character complexes were used, taking into consideration also host plant taxonomy. Deviation of a certain character (e.g. size of spore balls) alone did not exclude a collection from a certain species, if other characters were more or less similar to those of the type.

Curiously enough, despite intensive field and herbarium research, not a single smut fungus was found in South Africa which has twice as many Restionaceae species (c. 320) as there are in Australia (c. 170). Furthermore Dr. H.P. Linder, the world authority on South African Restionaceae, has never seen any smut on these plants (pers. comm.). Only an unknown ascomycete with spores very similar to a smut fungus (H.U.V. 18 043) was found in the capsules of *Ischyrolepis capensis* (L.) Linder on Table Mountain, Cape Town.

The smut fungi of the Restionaceae (*Restiosporium* and *Websdanea*) certainly represent a phylogenetically young group in speciation and radiation. This conclusion is based on the fact

that no smuts occur on African Restionaceae but there is a great number of often 'small species' on the Australian Restionaceae s. lat. These smuts often have only minor morphological differences, determined by a careful comparison with the type specimens (comp. also Vánky 1997: 189).

Restiosporium Vánky 2000: 346.

Sori in the fruits of plants in Restionaceae family, replacing the seeds with a black, granular powdery mass of spore balls differentiated within a mass of sporogenous hyphae. **Spore balls** composed of spores only. Peridium, columella, and sterile cells are lacking. **Spores** pigmented (brown, without violet or orange-yellow tint). **Spore germination** (where it is known) results in four-celled phragmobasidia in which basidial cells fuse in pairs. **Host-parasite interaction** by intracellular hyphae, coated by an electron-opaque matrix. Mature **septa** poreless. Attacked male plants develop gynoecea with sori.

Type: *R. meneyae*.

1. *Restiosporium anarthriae* Vánky, sp. nov.

Typus in matrice Anarthria laevis R. Br., Australia, Western Australia, Albany Distr., 50 km E urbe Albany, Betty's Beach, 34°56'18" S, 118°11'15" E, 6.III.1993, leg. K. Websdane. **Holotypus** in Herbario Ustil. Vánky, H.U.V. 17 159 (*hic designatus*)! **Isotypus** in UWA.

Sori in capsulis omnibus inflorescentiae eiusdem, tumefacti, involucris floralibus obtecti, massa atrobrunnea, semiagglutinata usque pulverea glomerulorum sporarum impleti. Glomeruli sporarum forma et magnitudine varii, subglobosi, ovoidei, ellipsoidales, elongati vel irregulares, 30-60 × 40-80 μm, olivaceobrunnei, e nonnullis decem sporarum facile separabilium compositi. Sporae forma et magnitudine variae, globoideae, ovoideae, ellipsoidales, elongatae usque plerumque subpolyedrice irregulares, (6,5-) 7-11 × (8-) 9-17 (-18,5) μm, pallide olivaceobrunneae; pariete aequali, 0,5-1 μm crasso, levi, in SEM superficie irregulariter depresso verrucoso.

Sori (Fig. 1) in all capsules of an inflorescence, swollen, hidden by the floral envelopes, filled with the dark brown, semi-agglutinated to powdery mass of spore balls. **Spore balls** (Figs 3, 5) varying in shape and size, subglobose, ovoid, ellipsoidal, elongated or irregular, 30-60 × 40-80 μm, olivaceous brown, composed of a few tens of easily separating spores. **Spores** (Figs 3-5) varying in shape and size, globose, ovoid, ellipsoidal, elongated to usually subpolyhedrally irregular, (6,5-) 7-11 × (8-) 9-17 (-18,5) μm, light olivaceous brown; wall even, 0,5-1 μm thick, smooth, in SEM free surface irregularly low verruculose.

On Anarthriaceae: *Anarthria laevis* R. Br. Known only from the type collection.

2. *Restiosporium apodasmiae* Vánky, sp. nov.

Typus in matrice Apodasmia ceramophila B.G. Briggs & L.A.S. Johnson, Australia, Western Australia, Plantagenet Distr., Kent River, 15 km E Rocky Gully on the Muir Hwy, 34°33'54"

S, 117°10'29" E, 5.I.1991, leg. J.S. Pate & K. Meney. **Holotypus** in Herbario Ustil. Vánky, H.U.V. 19 084 (*hic designatus*)! **Isotypus** in UWA sive KPBG.

Sori in nucibus omnibus inflorescentiae eiusdem, involucris floralibus obtecti, massa glomerulorum sporarum nigrobrunnea, semiagglutinata usque granulosopulverea impleti. Glomeruli sporarum forma et magnitudine varii, subglobosi, ovoidei, ellipsoidales, elongati vel irregulares, 30-80 (-100) × 30-120 μm, flavido- usque rubrobrunnei, aliquantum permanentes, e pluribus decem vel centum(?) sporis pressu separabilibus compositi. Sporae subglobosae, ovoideae, ellipsoidales usque parum irregulares, 8-13,5 × 9-16 (-17) μm, flavidobrunneae; pariete aequali, 1-3 μm crasso, in lateribus contactis levi, in lateribus liberis verrucis magnis, humilibus, rotundis; imago obliqua sporarum undulata.

Sori (Fig. 2) in all nuts of an inflorescence, hidden by the floral envelopes, filled with the blackish brown, semi-agglutinated to granular-powdery mass of spore balls. **Spore balls** (Figs 6-7) varying in shape and size, subglobose, ovoid, ellipsoidal, elongated or irregular, 30-80 (-100) × 30-120 μm, yellowish to reddish brown, rather permanent, composed of tens or hundred(?) of spores which separate by pressure. **Spores** (Figs 6-7) subglobose, ovoid, ellipsoidal to slightly irregular, 8-13,5 × 9-16 (-17) μm, yellowish brown; wall even, 1-3 μm thick, smooth on the contact sides, with large, low, rounded warts on the free surface, spore profile wavy.

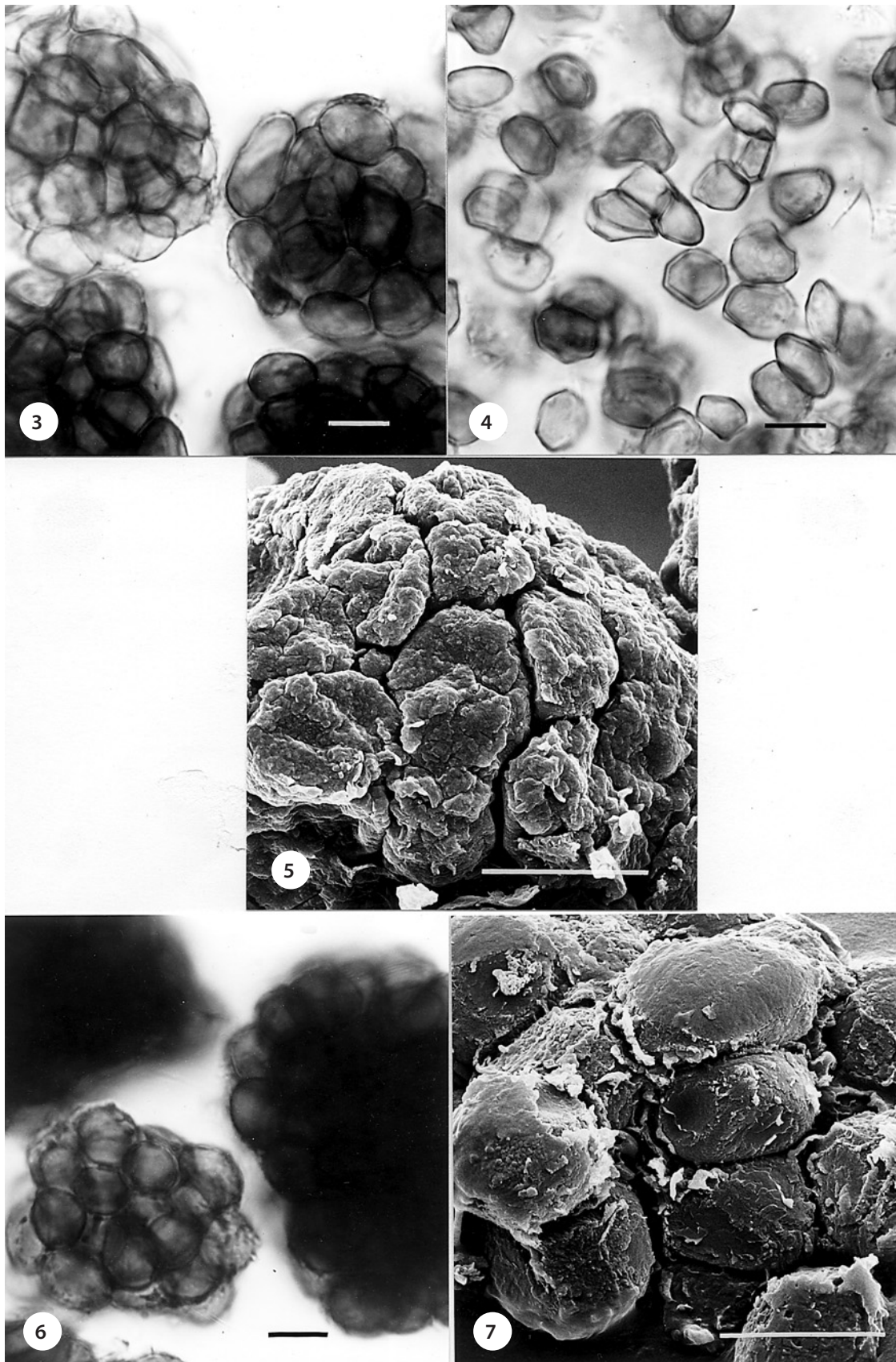
On Restionaceae: *Apodasmia ceramophila* B.G. Briggs & L.A.S. Johnson. Known only from the type collection.

Restiosporium apodasmiae differs from *R. dissimile* (type on *Apodasmia similis*, New Zealand) especially by smaller spores that are rounded, without acute tips and acute edges, and by larger warts on the free surface of the spores.

3. *Restiosporium baloskionis* Vánky & R.G. Shivas 2003: 251.

Type on *Baloskion tetraphyllum*, Australia, Victoria, c. 20 km NW of Halls Gap, Grampians National Park, Lake Wartook Reservoir, 37°05'38" S, 142°25'50" E, alt. c. 470 m, 9 Oct 2001, R.G. Shivas & K. Vánky. **Holotype** in BRIP 28 397. **Isotypes** in H.U.V. 19 748! and in Vánky, Ust. exs. no. 1141. **Topotype** ibidem, 6 Sep 2005, M.J. Ryley & R.G. Shivas, BRIP 47 088. **Paratype** c. 30 km WSW of Halls Gap, Glenelg River crossing Syphon Road, alt. c. 230 m, 9 Oct 2001, R.G. Shivas & K. Vánky, BRIP 28 981, H.U.V. 19 753!

Sori (Fig. 8) in the capsules filling them with a dark brown, semi-agglutinated to powdery mass of spore balls. **Spore balls** (Figs 11-12) varying in shape and size, subglobose, ovoid, ellipsoidal, elongated or irregular, 35-100 × 45-150 μm, olivaceous brown to subopaque, composed of a great number of easily separating spores. **Spores** (Figs 11-12) varying in shape and size, globose, ovoid, ellipsoidal, elongated or subpolyhedrally irregular, 8-13,5 × 9-17 (-20) μm, light olivaceous brown; wall even, thin, c. 0,5 μm, smooth.



Figs 3-5. Spore balls and spores of *Restiosporium anarthriae* on *Anarthria laevis*, in LM and in SEM (type). Figs 6-7. Spore balls and spores of *Restiosporium apodasmiae* on *Apodasmia ceramophila*, in LM and in SEM (type). Bars = 10 μ m

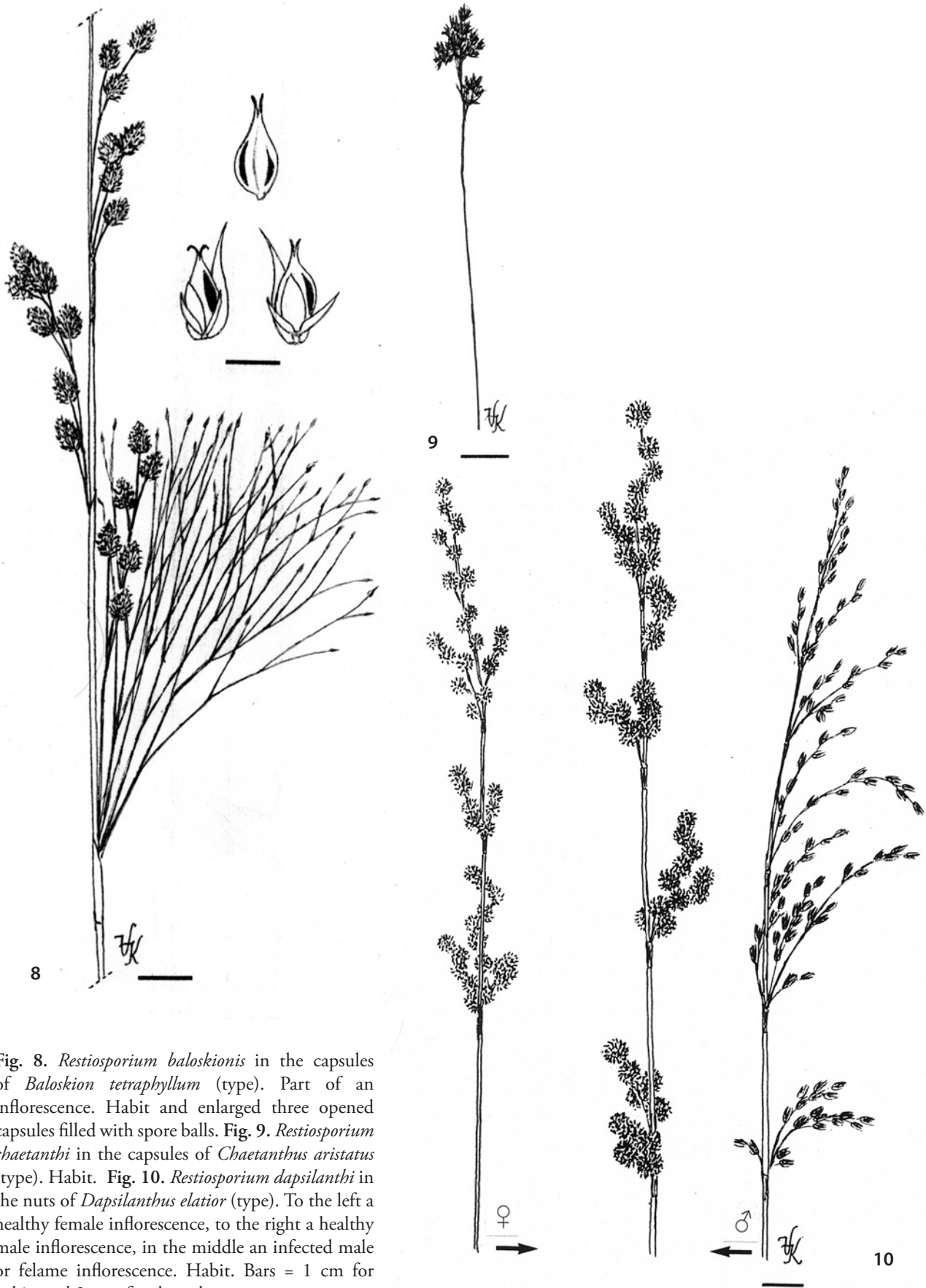
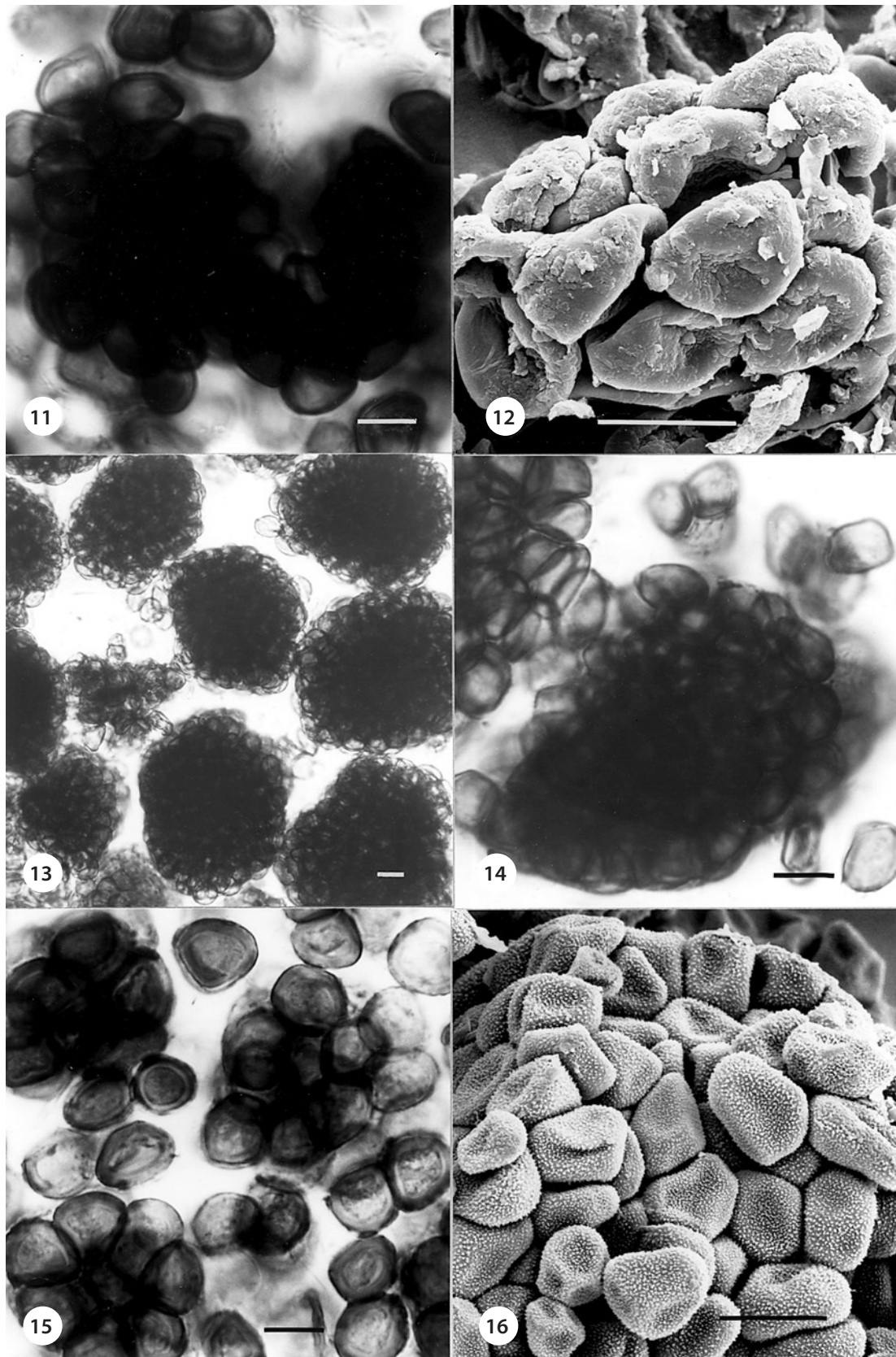


Fig. 8. *Restiosporium baloskionis* in the capsules of *Baloskion tetraphyllum* (type). Part of an inflorescence. Habit and enlarged three opened capsules filled with spore balls. Fig. 9. *Restiosporium chaetanthis* in the capsules of *Chaetanthus aristatus* (type). Habit. Fig. 10. *Restiosporium dapsilanthi* in the nuts of *Dapsilanthus elatior* (type). To the left a healthy female inflorescence, to the right a healthy male inflorescence, in the middle an infected male or felame inflorescence. Habit. Bars = 1 cm for habit, and 2 mm for the enlargements



Figs 11-12. Spore balls and spores of *Restiosporium baloskionis* on *Baloskion tetraphyllum*, in LM and in SEM (type). Figs 13-14. Spore balls and spores of *Restiosporium chaetantheri* on *Chaetanthus aristatus*, in LM (type). Figs 15-16. Spore balls and spores of *Restiosporium dapsilantheri* on *Dapsilanthus elatior*, in LM and in SEM (type). Bars = 10 μ m



Fig. 17. *Restiosporium desmocladii* in the capsules of *Desmocladus elongatus* (type). Part of an inflorescence. Habit. Fig. 18. *Restiosporium dissimile* in the capsules of *Apodasmia similis* (type). Habit and enlarged a spikelet with hidden, infected capsules, and an infected, broken capsule filled with spore balls. Bars = 1 cm for habit, and 3 mm for the enlargements

On Restionaceae: *Baloskion tetraphyllum* (Labill.) B.G. Briggs & L.A.S. Johnson (*Restio tetraphyllum* Labill.). Known only from the type collections.

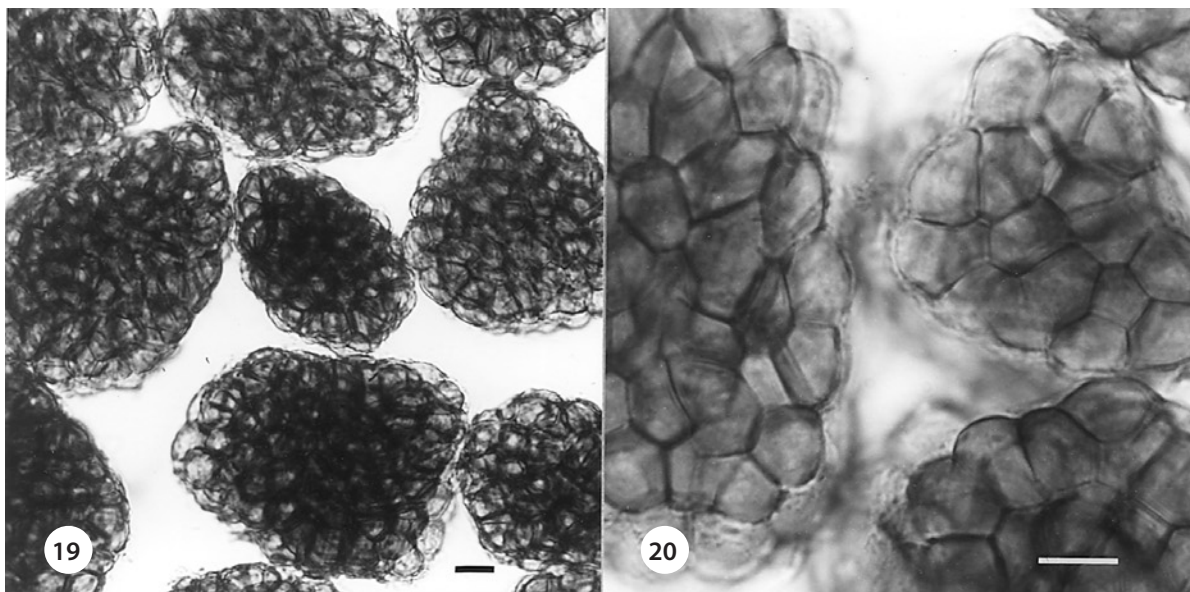
4. *Restiosporium chaetantheri* Vánky, sp. nov.

Typus in matrice *Chaetantherus aristatus* (R. Br.) B.G. Briggs & L.A.S. Johnson, Australia, Western Australia, urbs Perth, city of Gosnells, Kennwick, Brixton Road Swamp, 32°03'24" S, 115°59'36" E, 14.XI.1993, leg. I. Sieler. *Holotypus* in Herbario Ustil. Vánky, H.U.V. 19 083 (*hic designatus*)! *Isotypus* in UWA sive KPBG.

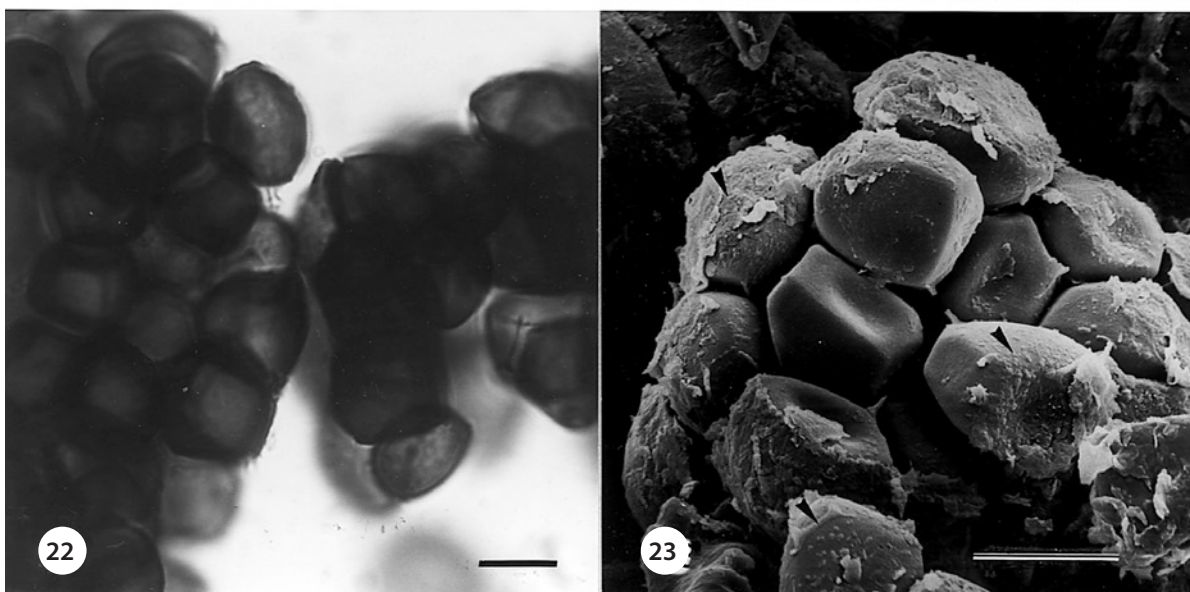
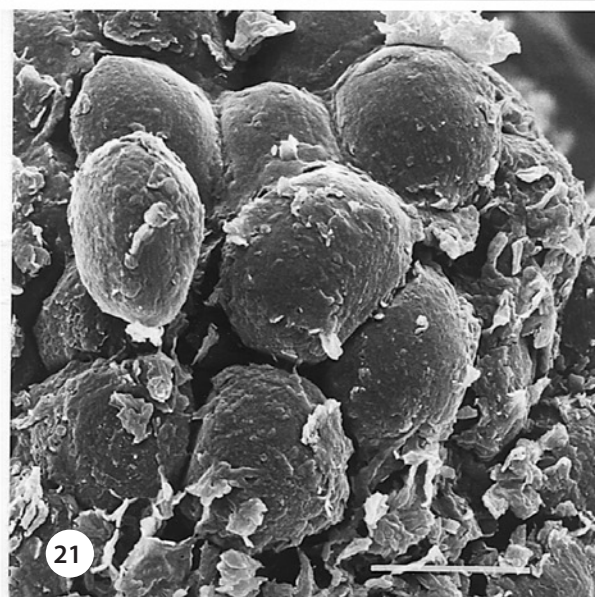
Sori in nucibus, eos massa nigra, primo agglutinata, serius granulosopulverea glomerulorum sporarum implentes, inconspicui, involucris floralibus aliquantum distantibus obtekti. Infectio systemica, capsulae omnes plantae eiusdem affectae. Glomeruli sporarum globosi, ovoidei, ellipsoidales, elongati, 35-

70 × 40-90 (-100) μm, flavido- usque atro-olivaceobrunnei, e sporis nonnullis decem, pressu separabilibus compositi. Sporae subpolyedricae vel polyedrice irregulares, inter latera duo saepe punctis subacutis vel acutis et item lineis, 7-11 × 9-13 (-14,5) μm, olivaceobrunneae; pariete parum inaequali, 0,5-1 μm crasso, ad angulos maxime crasso, in LM levi, in SEM superficie libera valde leniter, dense, humiliter verruculosa.

Sori (Fig. 9) in the nuts filling them with a black, first agglutinated, later granular-powdery mass of spore balls, inconspicuous, hidden by the somewhat spreading floral envelopes. Infection systemic, all capsules of a plant being enveloped. *Spore balls* (Figs 13-14) globose, ovoid, ellipsoidal, elongated, 35-70 × 40-90 (-100) μm, yellowish-to dark olivaceous brown, composed of tens of spores which separate by pressure. *Spores* (Figs 13-14) subpolyhedrally or polyhedrally irregular, often with subacute or acute points and also lines between two flattened sides, 7-11 × 9-13 (-14.5)



Figs 19-21. Spore balls and spores of *Restiosporium desmocladii* on *Desmocladius elongatus*, in LM and in SEM (type). Figs 22-23. Spore balls and spores of *Restiosporium dissimile* on *Apodasmia similis*, in LM and in SEM (type). SEM shows discrete, low warts (arrow heads) on the free surface of the outer spores. Bars = 10 μ m



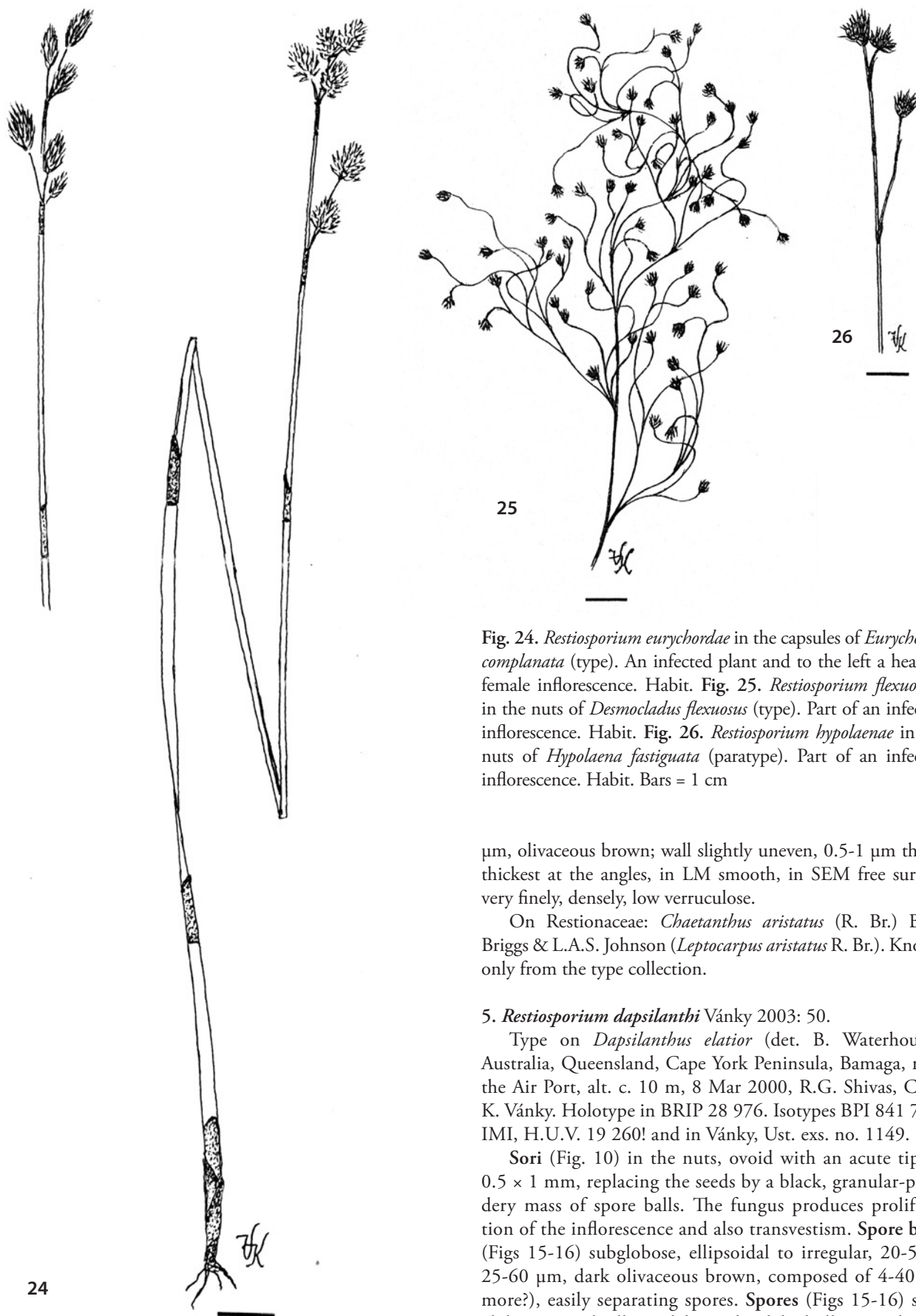


Fig. 24. *Restiosporium eurychordae* in the capsules of *Eurychorda complanata* (type). An infected plant and to the left a healthy female inflorescence. Habit. Fig. 25. *Restiosporium flexuosum* in the nuts of *Desmocladus flexuosus* (type). Part of an infected inflorescence. Habit. Fig. 26. *Restiosporium hypolaenae* in the nuts of *Hypolaena fastigata* (paratype). Part of an infected inflorescence. Habit. Bars = 1 cm

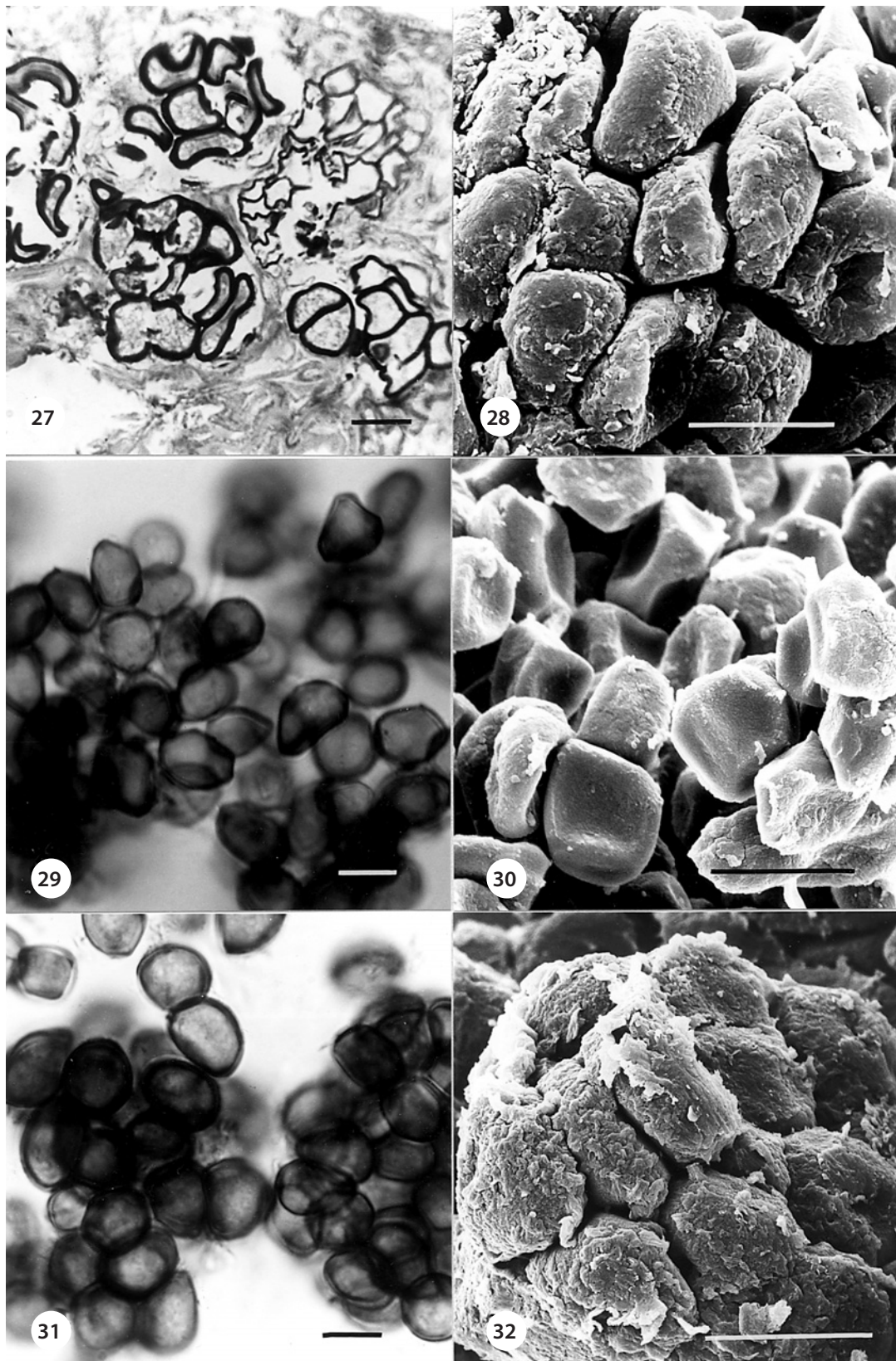
μm , olivaceous brown; wall slightly uneven, 0.5-1 μm thick, thickest at the angles, in LM smooth, in SEM free surface very finely, densely, low verruculose.

On Restionaceae: *Chaetanthus aristatus* (R. Br.) B.G. Briggs & L.A.S. Johnson (*Leptocarpus aristatus* R. Br.). Known only from the type collection.

5. *Restiosporium dapsilanthi* Vánky 2003: 50.

Type on *Dapsilanthus elatior* (det. B. Waterhouse), Australia, Queensland, Cape York Peninsula, Bamaga, near the Air Port, alt. c. 10 m, 8 Mar 2000, R.G. Shivas, C. & K. Vánky. Holotype in BRIP 28 976. Isotypes BPI 841 710, IMI, H.U.V. 19 260! and in Vánky, Ust. exs. no. 1149.

Sori (Fig. 10) in the nuts, ovoid with an acute tip, c. 0.5 \times 1 mm, replacing the seeds by a black, granular-powdery mass of spore balls. The fungus produces proliferation of the inflorescence and also transvestism. **Spore balls** (Figs 15-16) subglobose, ellipsoidal to irregular, 20-50 \times 25-60 μm , dark olivaceous brown, composed of 4-40 (or more?), easily separating spores. **Spores** (Figs 15-16) subglobose, ovoid, ellipsoidal to subpolyhedrally irregular, 9-



Figs 27-28. Spore balls and spores of *Restiosporium eurychordae* on *Eurychorda complanata*. Fig. 27. TS on a sorus with young spore balls in development, in LM. Fig. 28. Mature spore ball and spores in SEM (type). Figs 29-30. Spores in ephemeral spore balls of *Restiosporium flexuosum* on *Desmocladus flexuosus*, in LM and in SEM (type). Figs 31-32. Spore balls and spores of *Restiosporium hypolaenae* on *Hypolaena fastigata*, in LM and in SEM (type). Bars = 10 μ m



Fig. 33. *Restiosporium lepidoboli* in the nuts of *Lepidobolus chaetocephalus* (type). To the left a healthy and an infected female inflorescence, to the right a healthy and an infected male inflorescence. Habit. Bar = 1 cm

13 × 11-16 (-17) μm, olivaceous brown; wall evenly thick, 1-2 (-3) μm, apparently smooth to finely, densely punctate as seen in LM, and finely, densely verruculose-echinulate, as seen in SEM.

On Restionaceae: *Dapsilanthus elatior* (R. Br.) B.G. Briggs & L.A. Johnson (*Leptocarpus elatior* R. Br.). Known only from the type collection.

Typical for *Restiosporium dapsilanthi* is the finely, densely verruculose-echinulate spore surface of all spores in a ball, as seen in SEM.

6. *Restiosporium desmocladii* Vánky, sp. nov.

Typus in matrice Desmocladius elongatus B.G. Briggs & L.A.S. Johnson, Australia, Western Australia, Coorow, 12 km N of Jurien Bay turnoff, 30°07'22" S, 115°21'56" E, XI.1992, leg. K. Meney. *Holotypus* in Herbario Ustil. Vánky, H.U.V. 16 362 (*hic designatus*)! *Isotypus* in KPBG.

34



Fig. 34. *Restiosporium lepyrodiae* in the capsules of *Lepyrodia scariosa* (type). To the left a healthy female inflorescence. Habit. Bar = 1 cm

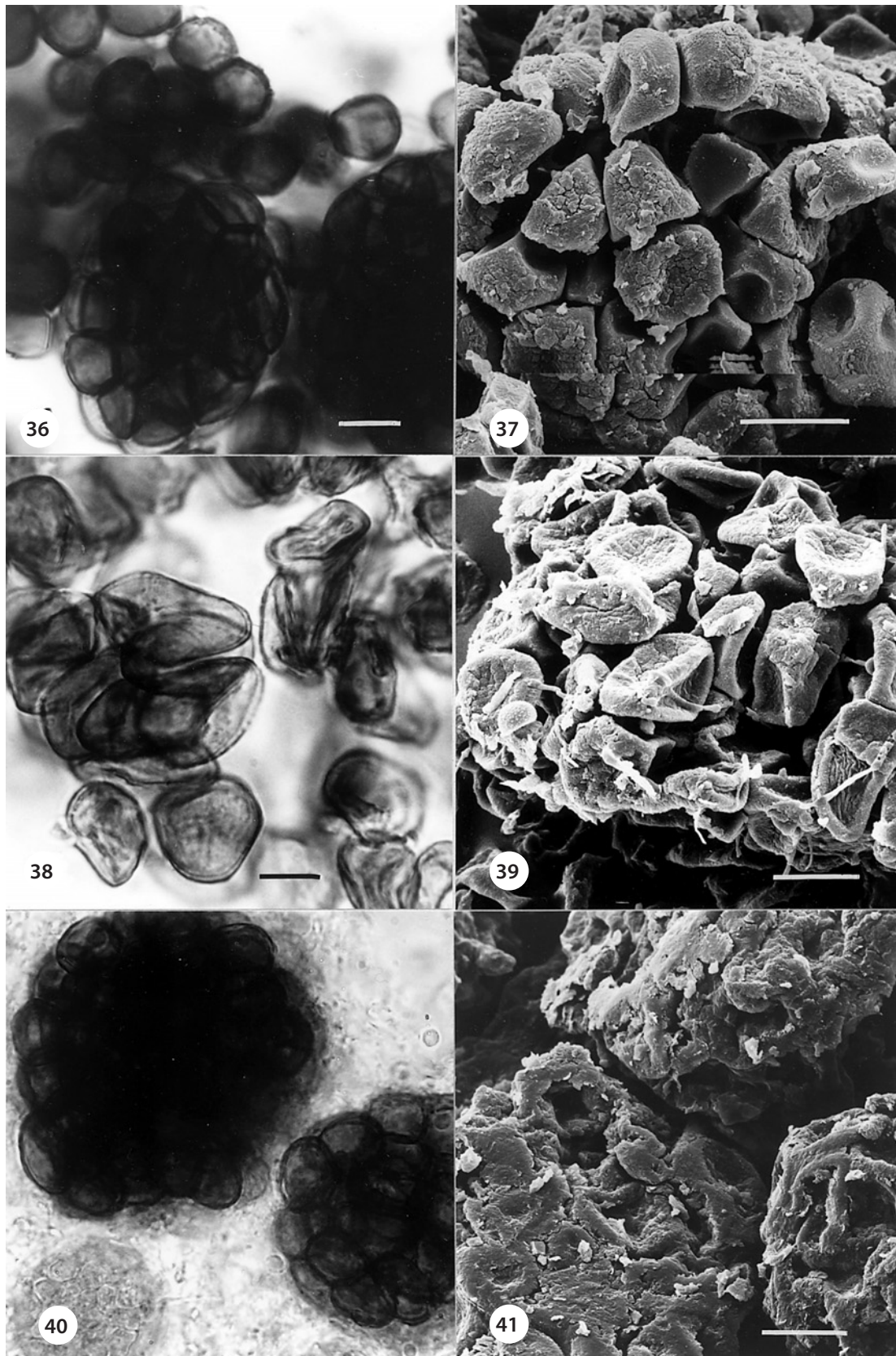


Fig. 35. *Restiosporium meneyae* in the capsules of *Lyginia barbata* (type). To the left a healthy female inflorescence, to the right a healthy male inflorescence, in the middle an infected female or male inflorescence. Habit. Bar = 1 cm

Sori in nucibus omnibus inflorescentiae eiusdem, elongati, trans involucra floralia protrudentes, cylindrici, parum flexi, 0,5-0,8 × 3-6 mm, apice acuto, massa nigra, granulosopulverea glomerulorum sporarum impleti. Fungus transvestismum producens. Glomeruli sporarum forma et magnitudine varii, globoidei, ovoidei, elongati vel irregulares, 40-80 × 40-130 (-140) μ m, flavido- usque rubro- vel atro-olivaceobrunnei, permanentes, e sporis pluribus decem usque centum, pressu valido in turmis separabilibus compositi. Sporae subpolyedrice vel polyedrice irregulares, cum latere uno vel lateribus nonnullis deplanatis, 8-11 (-12,5) × 9-16 (-19) μ m, pallide olivaceobrunneae; pariete

inaequali, 1-3 (-4) μ m crasso, ad angulos maxime crasso, saepe ad angulos cum apice breve, acuto et superficie lineis angustis, lateribus contactis levibus, superficie libera cum verrucis humilibus et residuis hypharum sporogenerarum.

Sori (Fig. 17) in all nuts of an inflorescence, elongate, protruding beyond the floral envelopes, cylindrical, slightly bent, 0.5-0.8 × 3-6 mm, with an acute tip, filled with a black, granular-powdery mass of spore balls. The fungus produces transvestism. **Spore balls** (Figs 19-21) variable in shape and size, globoid, ovoid, elongated or irregular, 40-80 × 40-130 (-140) μ m, yellowish- to reddish- or dark olivaceous brown,



Figs 36-37. Spore balls and spores of *Restiosporium lepidoboli* on *Lepidobolus chaetocephalus*, in LM and in SEM (type). Figs 38-39. Spore balls and spores of *Restiosporium leptocarpi* on *Leptocarpus tenax*, in LM and in SEM (type). Figs 40-41. Spore balls and spores of *Restiosporium lepyrodiae* on *Lepyrodia scariosa*, in LM and in SEM (type). Bars = 10 μ m

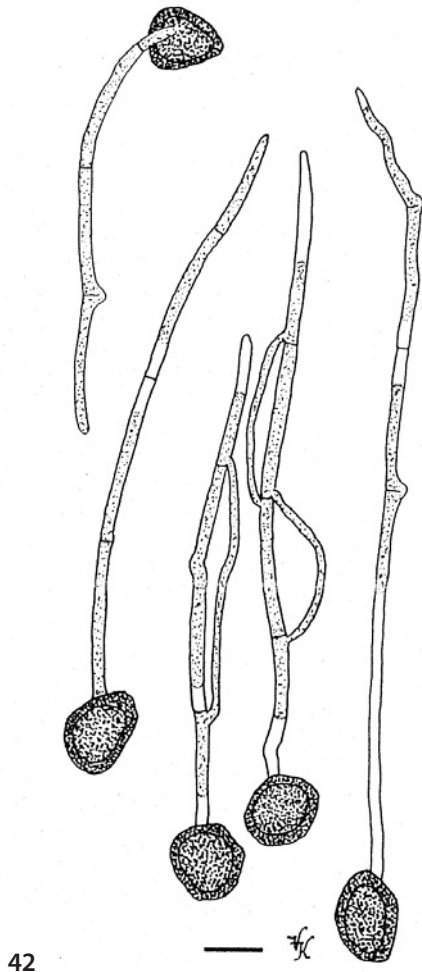


Fig. 42. Germinating spores of *Restiosporium lepidoboli* on *Lepidobolus chaetocephalus* (on WA, at room temp., in 3 weeks; Dr. R. Bauer, H.U.V. 17 979). Bar = 10 μ m

permanent, composed of tens to hundred of spores which separate into groups by hard pressure. **Spores** (Figs 20-21) subpolyhedrally or polyhedrally irregular with one or several flattened sides, 8-11 (-12.5) \times 9-16 (-19) μ m, pale olivaceous brown; wall uneven, 1-3 (-4) μ m thick, thickest at the angles, often with short acute tips at the angles and narrow lines on the surface, contact sides smooth, free surface with irregular, low warts and remnants of the sporogenous hyphae.

On Restionaceae: *Desmocladius biformis* B.G. Briggs & L.A.S. Johnson, *D. elongatus* B.G. Briggs & L.A.S. Johnson, *D. flexuosus* (R. Br.) B.G. Briggs & L.A.S. Johnson, *D. lateriticus* B.G. Briggs & L.A.S. Johnson; Australia (Western Australia).

The spore balls from *Desmocladius biformis* and *D. flexuosus* are smaller than those of the type. Other characters are similar, hence they are treated here as belonging to the same species.

7. *Restiosporium dissimile* Vánky & E.H.C. McKenzie 2002: 117.

Type on *Apodasmia similis* (*Leptocarpus similis*, det. B.H. Macmillian), New Zealand, Chatham Islands, near Pakauwera, alt. c. 10 m, 5 Apr 1993, E.H.C. McKenzie & P.R. Johnston. Holotype in PDD 68 681. Isotype in H.U.V. 18 548!

Sori (Fig. 18) in the nuts destroying the seeds and filling the capsules with a black, first agglutinated, later granular-powdery mass of spore balls, inconspicuous, lacrymiform, acute, c. 2 mm long and 1 mm wide at their base, hidden by the somewhat spreading floral envelopes. Infection systemic, all capsules of a plant being smutted. **Spore balls** (Figs 22-23) varying in shape and size, globose, ovoid, ellipsoidal, elongated or irregular, (30-) 40-80 \times 40-120 (-140) μ m, dark olivaceous brown, opaque, rather permanent, composed of tens to maybe more than 100 spores that separate by pressure. **Spores** (Figs 22-23) varying in shape and size, irregular, rounded or elongated, polyangular or subpolyangular, often with acute tips and also with an acute edge along the meeting line of two flattened sides, 10.5-14.5 \times 12-19 (-22) μ m, olivaceous brown; wall 1-4 μ m thick, uneven, thickest at the angles. Inner spores and contact sides smooth, free surface finely, sparsely verruculose and partly also covered by remnants of sporogeneous hyphae as irregular squamae.

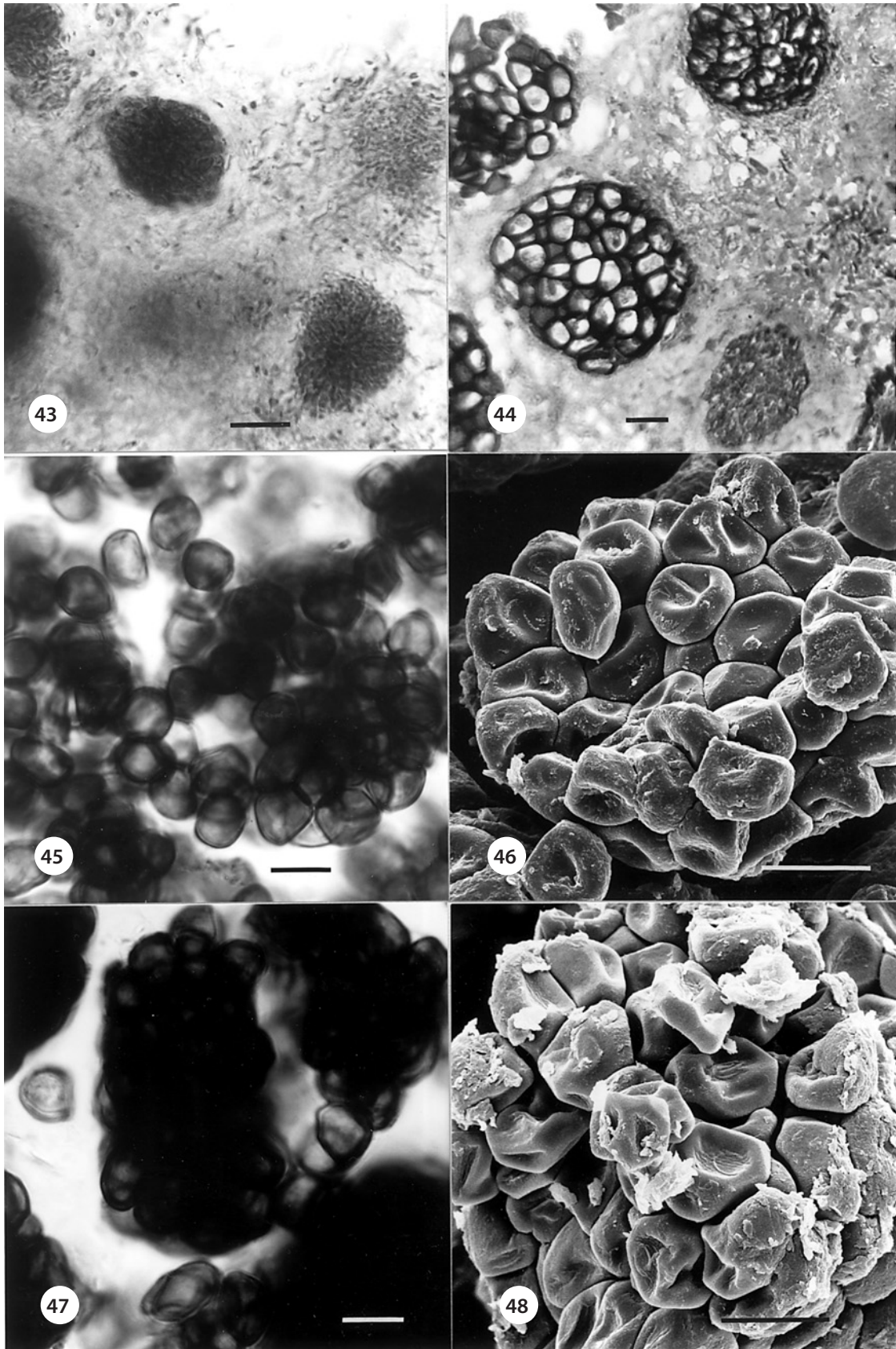
On Restionaceae: *Apodasmia similis* (Edgar) B.G. Briggs & L.A.S. Johnson (*Leptocarpus similis* Edgar); New Zealand. Known only from the type collection.

8. *Restiosporium eurychordae* Vánky, sp. nov.

Typus in matrice *Eurychorda complanata* (R. Br.) B.G. Briggs & L.A.S. Johnson, Australia, Queensland, cca. 220 km N urbe Brisbane, 57 km NE pag. Gympie, Carland Creek, 26°00'59" S, 153°01'01" E, alt. cca. 30 m.s.m., 11.IV.1998, leg. C. & K. Vánky. **Holotypus** in BRIP 46 596 (*hic designatus*)! **Isotypi** in H.U.V. 18 959! et in Vánky, Ust. exs. no. 1295. **Paratypus** in matrice *Eurychorda complanata* (det. D.I. Morris, HO), Australia, Tasmania, Tasman Peninsula, prope Tasman Arch, 43°02'30" S, 147°57' E, alt. cca. 40 m.s.m., 10.III.1996, leg. C. & K. Vánky, H.U.V. 18 056!

Sori in capsulis omnibus inflorescentiae eiusdem, rotundati, depressi, diametro 1-1,5 mm, involucris floralibus obtecti, massa atro-nigrobrunnea, semiagglutinata usque granulosopulverea glomerulorum sporarum atque sporarum impleti. Glomeruli sporarum globoidei, ovoidei, ellipsoidales usque irregulares, 30-80 \times 50-100 (-140) μ m, olivaceobrunnei usque subopaci, e pluribus decem sporis, laxe connectis, pressu facilliter separabilibus compositi. Sporae globoideae, ovoideae, ellipsoidales, elongatae, plerumque subpolyedrice irregulares, raro cum apicibus acutis ad angulos, 9-13,5 (-14,5) \times 11-20 (-24) μ m, mediocriter atro-olivaceobrunneae; pariete aequali vel parum inaequali, 1-2 (-2.5) μ m crasso, in LM levi, in SEM subtiliter, humiliter verruculoso, imprimis in superficie libera.

Sori (Fig. 24) in all capsules of an inflorescence, rounded, flattened, 1-1.5 mm in diameter, hidden by the floral envelopes, filled with a dark blackish brown, semiagglutinated to granular powdery mass of spore balls and spores. **Spore balls** (Figs 27-



Figs 43-44. Developing spore balls and spores of *Restiosporium meneyae* on *Lyginia barbata*, in LM. Figs 45-46. Spore balls and spores of *Restiosporium meneyae* on *Lyginia barbata*, in LM and in SEM (type). Figs 47-48. Spore balls and spores of *Restiosporium pallentis* on *Balaskion pallens*, in LM and in SEM (type). Bars = 10 μ m

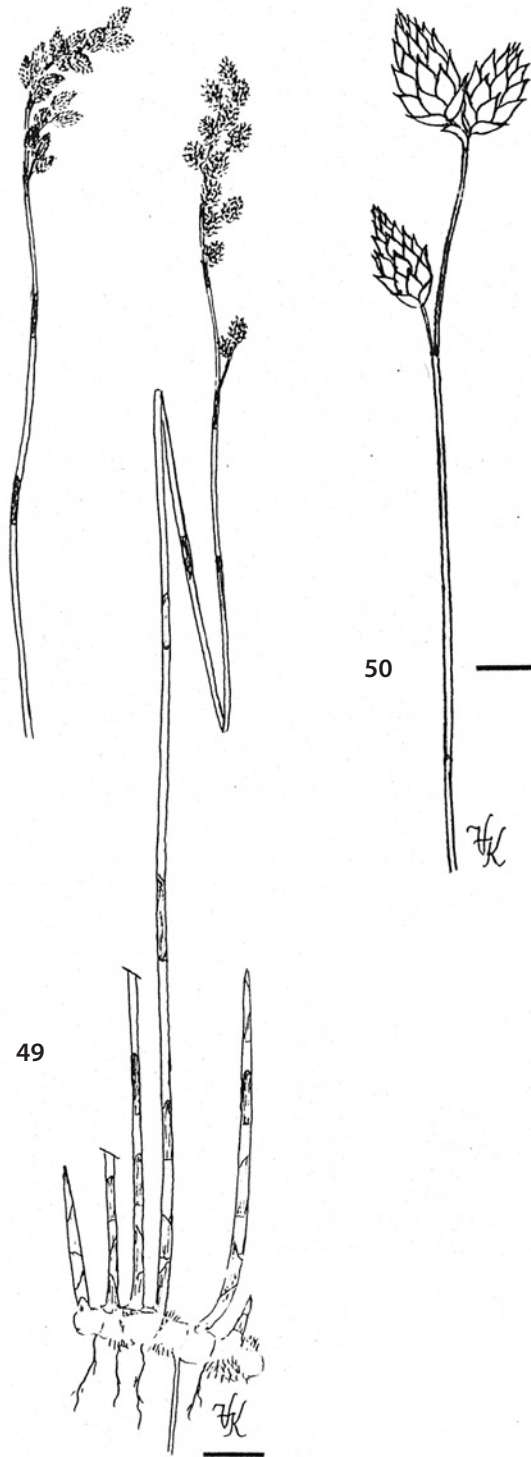


Fig. 49. *Restiosporium pallentis* in the capsules of *Baloskion pallens* (type). To the left a healthy female inflorescence. Habit. Fig. 50. *Restiosporium patei* in the nuts of *Lepidobolus densus* (type). Habit. Fig. 51. *Restiosporium proliferum* in the capsules of *Anarthria proliferata* (type). To the left a healthy female inflorescence. Habit. Bars = 1 cm

28) globose, ovoid, ellipsoidal to irregular, 30-80 × 50-100 (–140) μm, olivaceous brown to subopaque, composed of tens of loosely connected spores which separate easily by pressure. Spores (Figs 27-28) globose, ovoid, ellipsoidal, elongate, usually subpolyhedrally irregular, rarely with short acute tips at the angles, 9-13.5 (–14.5) × 11-20 (–24) μm, medium dark olivaceous brown; wall even or slightly uneven, 1-2 (–2.5) μm thick, in LM smooth, in SEM finely low verruculose, especially on the free surface.

On Restionaceae: *Eurychorda complanata* (R. Br.) B.G. Briggs & L.A.S. Johnson (*Restio complanatus* R. Br.); Australia (Queensland, Tasmania).

9. *Restiosporium flexuosum* Vánky, sp. nov.

Typus in matrice *Desmocladus flexuosus* (R. Br.) B.G. Briggs & L.A.S. Johnson, Australia, Western Australia, Albany Distr., Cape Riche, cca. 100 m W ab 'Camp grounds', 36°36'27" S, 118°45' E, alt. 15 m.s.m., 10.II.1996, leg. C. & K. Vánky. *Holotypus* in BRIP 47 199 (*hic designatus*)! *Isotypi* in H.U.V. 18 053, et in Vánky, Ust. exs. no. 1281.

Sori in nucibus omnibus inflorescentiae eiusdem, ovoidei, depressi, cum apice acuto, inter involucra floralia patentia conspicui, 0,5-1 × 1,5-2,5 mm, massa atrobrunnea, pulverea





Fig. 52. *Restiosporium restionum* in the capsules of *Alexgeorgia subterranea* (H.U.V. 17 890). To the left a healthy, to the right an infected male plant. Habit. Bar = 1 cm

glomerulorum sporarum ephemerorum atque sporarum impleti. Fungus transvestismum producens. Sporae maturae singulae, globoideae, ovoideae, ellipsoideales, elongatae vel subpolyedrice irregulares, raro apicibus acutis, brevibus ad angulos et in superficie lineis angustis, 7-12 × 9-16 μm, pallide olivaceobrunneae; pariete plus vel minus aequali, 0,5-1,5 μm crasso, in LM levi, in SEM sporae omnio subtiliter, dense verruculoso.

Sori (Fig. 25) in all nuts of an inflorescence, ovoid, flattened, with an acute tip, showing between the spreading floral envelopes, 0.5-1 × 1.5-2.5 mm, filled with a dark brown, powdery mass of ephemeral spore balls and spores. The fungus produces transvestism. **Spores** (Figs 29-30) when mature single, globoid, ovoid, ellipsoidal, elongate or subpolyhedrally irregular, rarely with short acute tips at the angles and narrow

lines on the surface, 7-12 × 9-16 μm, pale olivaceous brown; wall more or less even, 0.5-1.5 μm thick, in LM smooth, in SEM all spores finely, densely verruculose.

On Restionaceae: *Desmocladus flexuosus* (R. Br.) B.G. Briggs & L.A.S. Johnson. Known only from the type collection.

Restiosporium flexuosum differs from *R. desmocladii* (type on *Desmocladus elongatus*) especially by the ephemeral, not permanent spores balls, more rounded spores and thinner, finely, densely verruculose spore wall.

10. *Restiosporium hypolaenae* Vánky, sp. nov.

Typus in matrice Hypolaena macrotepala B.G. Briggs & L.A.S. Johnson, Australia, Western Australia, Jerramungup Distr., cca. 70 km W Bremer Bay, Bremer Bay and South Coast

Hwy junction, Boxwood Hill, 34°22'36" S, 118°44'35" E, 15.XI.1992, leg. K. Meney. Holotypus in Herbario Ustil. Vánky, H.U.V. 19 080 (hic designatus)! Isotypus in KPBG. Paratypus on Hypolaena fastigiata R. Br., Austarlia, Tasmania, N.E. Coast, V.1946, leg. J. de Bavay, DAR 76 747!

Sori in nucibus, eas massa nigra, primo agglutinata, serius granulosopulverea glomerulorum sporarum impleti, conspicui, involucris floralibus aliquantum patentibus obtecti. Infectio systemica, capsulae omnes plantae eiusdem affectae. Glomeruli sporarum subglobosi, ellipsoidales, elongati usque parum irregulares, 35-70 (–80) × 40-100 μm, flavido-usque rubrobrunnei vel subopaci, e sporis pluries decem (30-100 vel plus?), pressu faciliter separabilibus compositi. Sporae globosae, ovoideae, ellipsoidales, elongatae usque subpolyedrice irregulares, 8-12 (–13) × 9,5-17 (–20) μm, olivaceobrunneae cum areis parum atrioribus et pallidioribus; pariete parum inaequali, 1-3 μm crasso, ad angulos maxime crasso, in LM levi, in SEM superficie libera valde subtiliter, dense, humiliter verruculosa.

Sori (Fig. 26) in the nuts filling them with a black, first agglutinated, later granular-powdery mass of spore balls, inconspicuous, hidden by the somewhat spreading floral envelopes. Infection systemic, all capsules of a plant being smutted. **Spore balls** (Figs 31-32) subglobose, ellipsoidal, elongated to slightly irregular, 35-70 (–80) × 40-100 μm, yellowish- to reddish brown or subopaque, composed of tens (30-100 or more?) of spores which separate easily by pressure. **Spores** (Figs 31-32) globose, subglobose, ovoid, ellipsoidal, elongated to subpolyhedrally irregular, 8-12 (–13) × 9.5-17 (–20) μm, olivaceous brown with slightly darker and paler areas; wall slightly uneven, 1-3 μm thick, thickest at the angles, in LM smooth, in SEM free surface very finely, densely, low verruculose.

On Restionaceae: *Hypolaena fastigiata* R. Br., *H. macrotrepala* B.G. Briggs & L.A.S. Johnson; Australia (Tasmania, Western Australia).

11. *Restiosporium lepidoboli* (McAlpine) Vánky 2000: 350.

Tolyposporium lepidoboli McAlpine 1904: 127. — *Tolyposporidium lepidoboli* (McAlpine) Thirumalachar & Neergaard 1978[1977]: 181. — Type on *Lepidobolus drapetocoleus*, Australia, Victoria, Mallee Country, Dimboola, Jan 1903, F.M. Reader. Holotype in VPRI 3004! Isotype in BRIP 46143!

Sori (Fig. 33) in all nuts of an inflorescence, elongated, 1-1.5 × 3-7 mm, hidden by the floral envelopes, filled with the black, semiagglutinated to granular powdery mass of spore balls. **Spore balls** (Figs 36-37) subglobose, ovoid, ellipsoidal, elongated or irregular, 40-90 × 50-110 (–140) μm, dark reddish brown to subopaque, moderately permanent, composed of tens of spores which separate rather easily by pressure. **Spores** (Figs 36-37) subglobose, ovoid, ellipsoidal to usually subpolyhedrally or polyhedrally irregular, 9-13.5 (–15) × 10.5-20 (–24) μm, medium dark olivaceous brown; wall 2-4 (–5.5) μm thick, thickest at the angles, with one to several short, subacute or acute tips at the angles, and often

also narrow lines connecting two tips, lines between two contact sides with other spores. Spore surface finely punctate-verruculose, especially on the free surface which is rough also by remnants of sporogenous hyphae. **Spore germination** (Fig. 42; Vánky 2000: 346, 350) results in 4-celled basidia in which basidial cells fuse in pairs.

On Restionaceae: *Lepidobolus chaetocephalus* F. Muell. ex Benth., *L. drapetocoleus* F. Muell. ex Benth., *L. pressianus* Nees; Australia (Victoria, Western Australia).

Description above made on the type specimen. In some collections, the spore balls and spores may be somewhat smaller (30-70 (–90) × 40-90 (–120) μm, or 9-13 (–14) × 10.5-18 (–20) μm, respectively). However, other characters fit well with those of the type.

Typical for *Restiosporium lepidoboli* are the relatively large spores possessing a thick wall with one to several subacute or acute tips and the narrow lines between the tips.

12. *Restiosporium leptocarpi* (Berk.) Vánky 2000: 350.

Thecaphora leptocarpi Berkeley 1881: 388. — Type on *Leptocarpus tenax*, Australia, Victoria, Wilsons Promontory, May 1850, F. Mueller. Holotype in MEL 1 055 119!

Sori in all nuts of an inflorescence, hidden by the floral envelopes, filled by the black, first agglutinated, later granular powdery mass of spore balls. **Spore balls** (Figs 38-39) subglobose, ellipsoidal or slightly irregular, 35-70 × 40-90 μm, dark olivaceous brown to opaque, composed of tens of spores which separate easily by pressure. **Spores** (Figs 38-39) subglobose, ellipsoidal, elongated to subpolyhedrally irregular, 11-19 × 16-25 (–27) μm, medium dark olivaceous brown; wall even, 1-1.5 μm thick, finely, densely low verrucose, spore profile finely wavy.

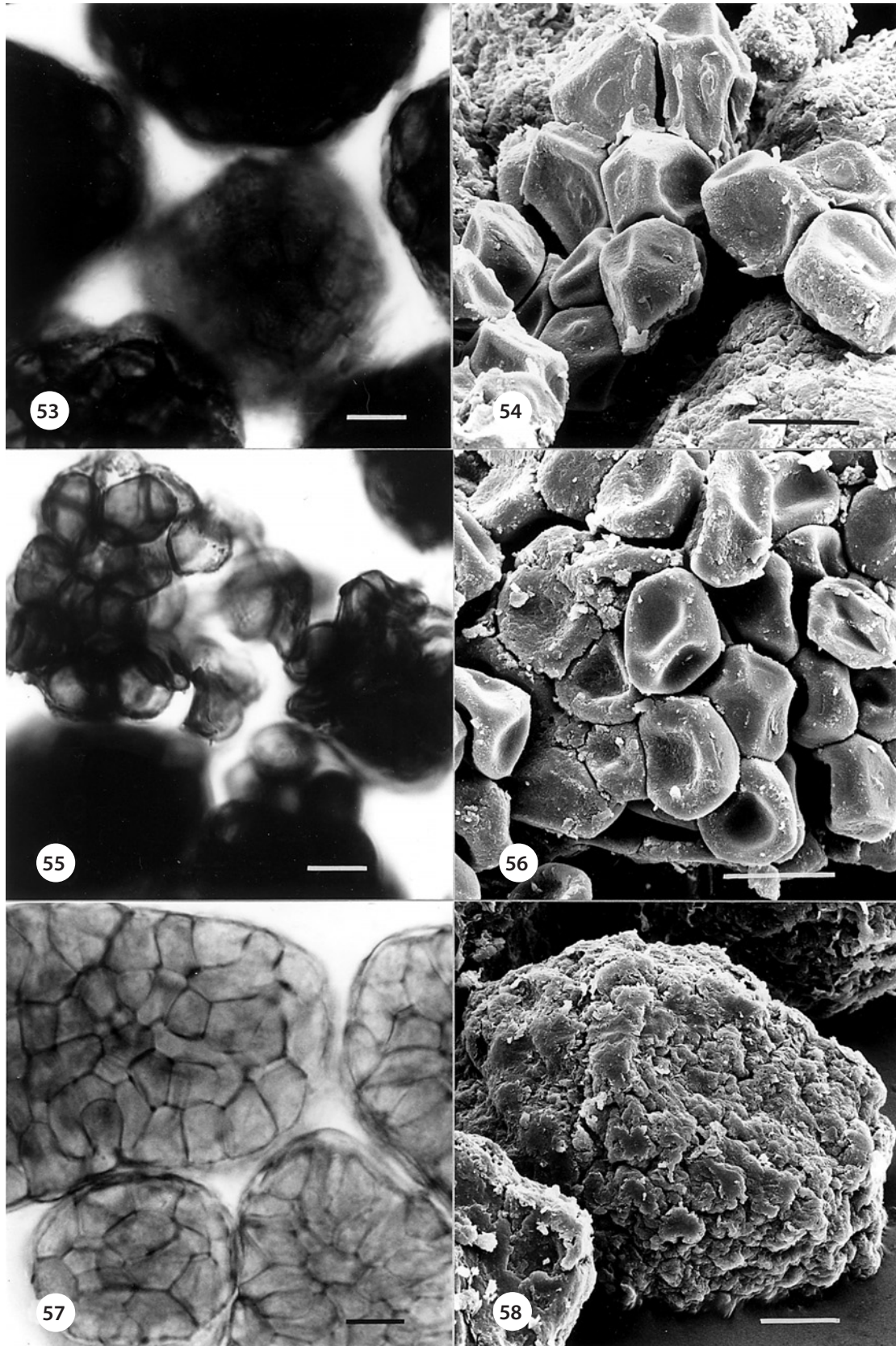
On Restionaceae: *Leptocarpus elegans* B.G. Briggs & L.A.S. Johnson, *L. tenax* (Labill.) R. Br.; Australia (New South Wales, Victoria, Western Australia).

Typical for *Restiosporium leptocarpi* are the large, verrucose spores. The description above is based on the type specimen. Some specimens may have somewhat smaller spores (13-24 μm long) but other characters are identical with those of the type.

13. *Restiosporium lepyrodiae* Vánky, sp. nov.

Typus in matrice Lepyrodia scariosa R. Br. s.lat. (det. B.G. Briggs, MEL), Australia, New South Wales, cca. 65 km NW urbe Sydney, Blue Mts., 'Wall lookout', alt. cca. 930 m, 23.III.1996, leg. C. & K. Vánky. **Holotypus** in BRIP 47 200 (hic designatus). **Isotypus** in H.U.V. 17 629!

Sori in capsulis locum seminum tenentes, capsulas massa nigra, primo agglutinata, serius granulosopulverea glomerulorum sporarum implentes, capsulis longitudinaliter ruptis sporae dispersae. Infectio systemica, flores omnes eiusdem surculi et surculi omnes eiusdem plantae affecti. Plantae infectae masculinae capsulas cum sporis evolventes. Glomeruli sporarum ovoidei, ellipsoidales vel elongati, plerumque parum irregulares, raro subglobosi, (30–) 40-65 (–70) × (30–) 45-100 μm, atro-rubrobrunnei, e sporis pluries decem aliquantum firme unitis.



Figs 53-54. Spore balls and spores of *Restiosporium patei* on *Lepidobolus densus*, in LM and in SEM (type). Figs 55-56. Spore balls and spores of *Restiosporium proliferum* on *Anarthria prolifera*, in LM and in SEM (type). Figs 57-58. Spore balls and spores of *Restiosporium restionum* on *Alexgeorgea nitens*, in LM and in SEM (type). Bars = 10 μ m



Fig. 59. *Restiosporium spathacei* in the nuts of *Dapsilanthus spathaceus* (type). Habit. Fig. 60. *Restiosporium sphacelatum* in the capsules of *Chordifex sphacelatus* (type). Habit. Bars = 1 cm

Sporae subglobosae, ellipsoideales usque irregulariter subpolyedricae, 8-13 × 11-20 μm, flavido- usque rubrobrunneae; pariete aequali, tenui (cca. 0.7 μm), apparenter levi, in SEM superficie libera subtiliter, humiliter verrucosa.

Sori (Fig. 34) in the capsules replacing the seeds, filling the capsules with a black, first agglutinated, later granular-powdery mass of spore balls which are dispersed when the capsules split longitudinally. Infection systemic, all flowers of a shoot and all shoots of a plant being affected. Infected male plants develop capsules with spores. **Spore balls** (Figs 40-41) ovoid, ellipsoidal or elongated, usually slightly irregular, rarely subglobose, (30-) 40-65 (-70) × (30-) 45-100 μm, dark reddish brown, composed of tens of rather firmly united spores. **Spores** (Figs 40-41) subglobose, ellipsoidal to irregularly subpolyhedral, 8-13 × 11-20 μm, yellowish- to reddish brown; wall uniform, thin (c. 0.7 μm), apparently smooth, in SEM free surface finely, low verrucose.

On Restionaceae: *Lepyrodia scariosa* R. Br. Known only from the type collection.

14. *Restiosporium meneyae* Vánky 2000: 347.

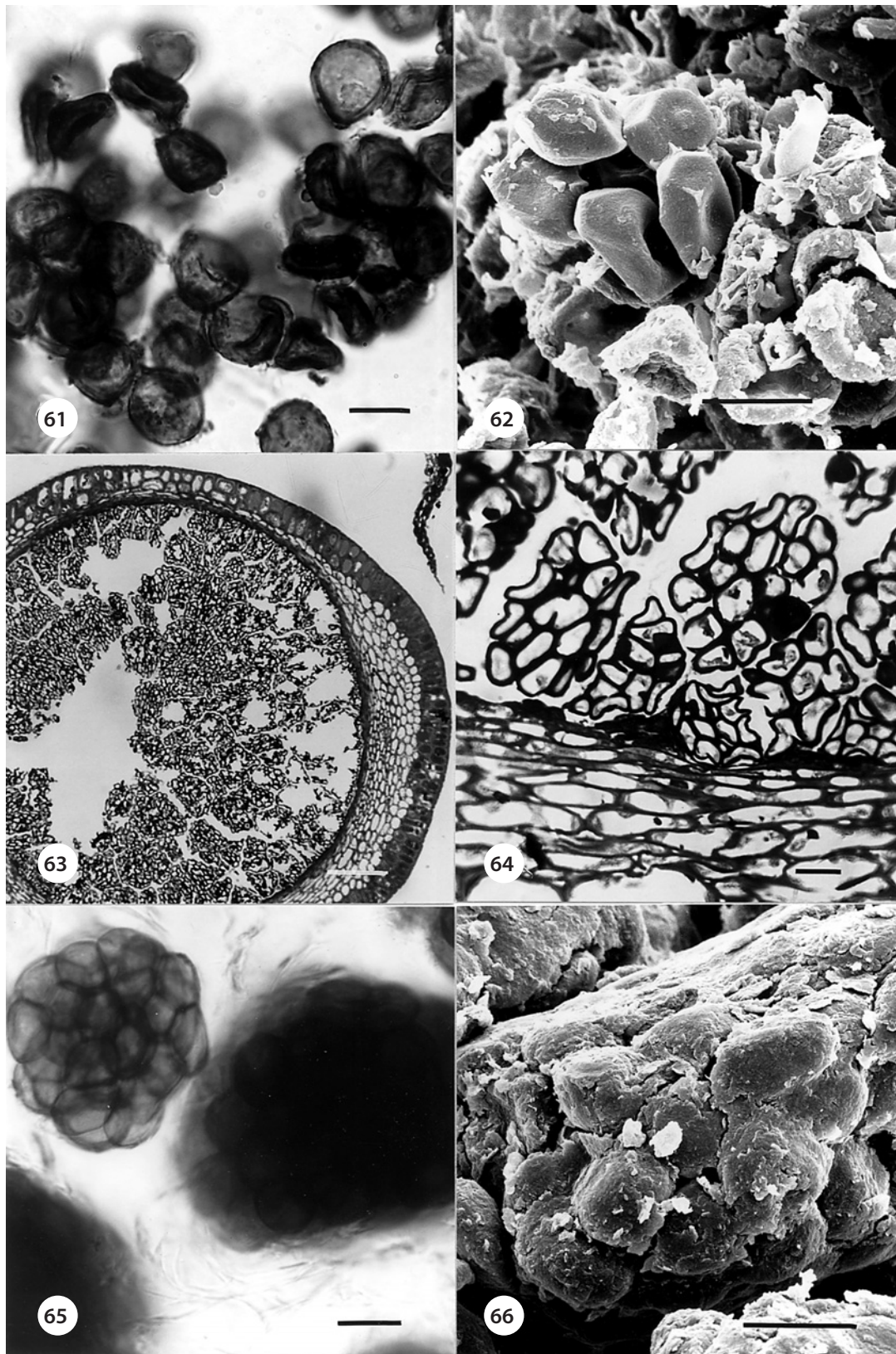
Type on *Lyginia barbata*, Australia, Western Australia, c. 200 km N of Perth, Dandaragan Distr., Brand Hwy, between Cataby Roadhouse and Badgingarra, alt. c. 200 m, 30 Jan 1996, K. Websdane, C. & K. Vánky. Holotype in Herbario Ustil. Vánky, H.U.V. 17 938! Isotypes PERTH and in Vánky, Ust. exs. no. 1075. Paratypes idem, 25 Feb 1992, K. Meney, KPBG, H.U.V. 17 161!; WA, 19 km SE of Perth, Nov 1992, K. Meney, UWA, H.U.V. 17162!; WA, Albany Distr., 15 km S of Albany, Torndirrup National Park, alt. c. 150 m, 11 Feb 1996, C. & K. Vánky, PERTH, H.U.V. 17 940!

Sori (Fig. 35) inconspicuous, in the capsules filled by black, granular-powdery mass of spore balls. Infected male plants develop capsules with spores. Infection systemic, all flowers of a plant being affected. Infected capsules smaller and in greater number per culm than those of healthy female plants. **Spore balls** (Figs 44-46) varying in shape and size, ovoid, elongated or irregular, 40-70 (-80) × 50-100 (-120) μm, dark olivaceous brown, composed of a great number (tens to hundreds) of easily separating spores. Spore balls develop from concentrated groups of sporogenous hyphae within a hyaline mass of hyphae (Figs 43-44). **Spores** (Figs 45-46) varying in shape and size, subglobose, ovoid, elongated, usually subpolyhedrally or polyhedrally irregular, in LM often with acute edges showing as lines on the spore surface when the spores are seen in surface view, spores 7-10 × 9-14 μm, olivaceous brown; wall even, thin, 0.5-1 μm, apparently smooth.

On Lyginiaceae: *Lyginia barbata* R. Br.; Australia (Western Australia).

15. *Restiosporium pallentis* Vánky & R.G. Shivas, sp. nov.

Typus in matrice Baloskion pallens (R. Br.) B.G. Briggs & L.A.S. Johnson, Australia, Queensland, cca. 70 km NNE urbe Brisbane, Bribie Island, White Patch, 27°01'38" S, 153°07'22" E, alt. cca. 5 m.s.m., 5.III.1998, leg. R.G. Shivas, C. & K. Vánky. **Holotypus** in BRIP 46 102 (*hic designatus*)! **Isotypi** in H.U.V. 19 771! et in Vánky, Ust. exs. no. 1279. **Topotypus** *ibidem*, 24.II.2005, leg. T.S. Marney & R.G. Shivas, BRIP 46 104, H.U.V. 20 969!



Figs 61-62. Spore balls and spores of *Restiosporium spathacei* on *Dapsilanthus spathaceus*, in LM and in SEM (type). Figs 63-64. TS on a capsule of *Chordifex sphacelatus* with young spore balls of *Restiosporium sphacelatum*, in LM (type). Figs 65-66. Spore balls and spores of *Restiosporium sphacelatum* on *Chordifex sphacelatus*, in LM and in SEM (type). Bars = 10 μ m, excepting for Fig. 63, in which it represents 100 μ m

Sori in capsulis omnibus inflorescentiae eiusdem, cca. 0,8 × 1-1,2 mm, involucris floralibus obtecti, massa nigra, semiagglutinata usque pulverea glomerulorum sporarum impleti. Glomeruli sporarum globosi, ovoidei, parum irregulares, raro elongati, 30-70 × 30-90 (–100) μm, atro-rubrobrunnei usque opaci, e sporis pluribus decem usque 100, faciliter separabilibus compositi. Sporae subpolyedrice usque polyedrice irregulares, raro ellipsoidales, saepe cum apice uno vel apicibus nonnullis subacutis, 7-11 × 9-16 (–17,5) μm, mediocriter atro-olivaceobrunneae; pariete inaequali, 0,5-1 μm crasso, ad angulos maxime crasso, in lateribus depressis saepe cum lineis 1-3 acutis longitudinaliter in lateribus depressis, levi, in SEM superficie libera aspero.

Sori (Fig. 49) in all capsules of an inflorescence, c. 0.8 × 1-1.2 mm, hidden by the floral envelopes, filled with a black, semi-agglutinated to powdery mass of spore balls. **Spore balls** (Figs 47-48) globose, ovoid, slightly irregular, rarely elongated, 30-70 × 30-90 (–100) μm, dark reddish brown to opaque, composed of tens to a hundred of easily separating spores. **Spores** (Figs 47-48) subpolyhedrally to polyhedrally irregular, rarely ellipsoidal, often with one or several subacute tips, 7-11 × 9-16 (–17.5) μm, medium dark olivaceous brown; wall uneven, 0.5-1 μm thick, thickest at the angles, often with 1-3 acute lines along the flattened sides, smooth, in SEM free surface rough.

On Restionaceae: *Baloskion pallens* (R. Br.) B.G. Briggs & L.A.S. Johnson (*Restio pallens* R. Br.). Known only from the type collections.

Restiosporium pallentis differs from *R. baloskionis* in possessing smaller spore balls and smaller, subpolyhedral or polyhedral spores with unevenly thickened wall.

16. *Restiosporium patei* Vánky, sp. nov.

Typus in matrice *Lepidobolus densus* B.G. Briggs & L.A.S. Johnson, Australia, Western Australia, Morawa Distr., 44 km E Mingenew, 29°12'39" S, 115°51'28" E, 15.II.1995, leg. S.J. Pate. **Holotypus** in Herbario Ustil. Vánky, H.U.V. 19 081 (*hic designatus*)! **Isotypus** in UWA sive KPBG.

Sori in nucibus omnibus plantae infectae eiusdem, cca. 1 × 3 mm, involucris floralibus obtecti, massa nigra, granulosopulverea glomerulorum sporarum impleti. Glomeruli sporarum forma et magnitudine varii, globosi, ovoidei, ellipsoidales, elongati vel irregulares, 30-60 (–70) × 40-80 (–90) μm, flavidobrunnei, e pluribus decem sporarum pressu valido separabilibus compositi. Sporae forma et magnitudine variae, plerumque subpolyedrice vel polyedrice irregulares, interdum rotundatae vel elongatae, vulgo ad angulos apicibus subacutis vel acutis, etiam lineis angustis inter 2 latera depressa, 7-11 (–12) × 10,5-16 (–18,5) μm, pallide olivaceobrunneae; pariete 0,5-1 μm crasso, in lateribus contactis levi, in superficie libera aspero et subtiliter verruculoso.

Sori (Fig. 50) in all nuts of an infected plant, c. 1 × 3 mm, hidden by the floral envelopes, filled by the black, granular-powdery mass of spore balls. **Spore balls** (Figs 53-54) varying in shape and size, globose, ovoid, ellipsoidal, elongated or irregular, 30-60 (–70) × 40-80 (–90) μm, yellowish brown, permanent, composed of tens of spores which separate by

hard pressure. **Spores** (Figs 53-54) varying in shape and size, usually subpolyhedrally or polyhedrally irregular, sometimes rounded or elongated, commonly with subacute or acute tips at the angles and also with narrow lines between two flattened sides, 7-11 (–12) × 10.5-16 (–18.5) μm, pale olivaceous brown; wall 0.5-1 μm thick, smooth on the contact sides, rough and finely verruculose on the free surface.

On Restionaceae: *Lepidobolus densus* B.G. Briggs & L.A.S. Johnson. Known only from the type collection.

Restiosporium patei differs from *R. lepidoboli* in smaller spore balls and spores, in the more permanent spore balls, in the thin spore wall and the light colour of the spores.

Etymology: This species is named in the honour of Dr. John S. Pate (Perth, Australia), outstanding phanerogamist, the co-author and co-editor of the beautiful monograph of Australian Rushes (Meney & Pate 1999), who also collected this smut.

17. *Restiosporium proliferum* Vánky, sp. nov.

Typus in matrice *Anarthria prolifera* R. Br., Australia, Western Australia, Manjimup Distr., 140 km W urbe Albany, 22 km NW Walpole, ad Inlet River, 34°55' S, 116°41' E, alt. cca. 40 m.s.m., 13.II.1996, leg. C. & K. Vánky. **Holotypus** in Herbario Ustil. Vánky, H.U.V. 17 981 (*hic designatus*)! **Isotypus** in UWA et in BRIP 47 201.

Sori in capsulis omnibus inflorescentiae eiusdem, involucris floralibus obtecti, massa nigra, semiagglutinata usque pulverea glomerulorum sporarum impleti. Glomeruli sporarum forma et magnitudine varii, subglobosi, ellipsoidales, elongati vel plerumque irregulares, 40-90 × 45-130 μm, atro-rubrobrunnei, subopaci usque opaci, e pluribus decem usque pluribus centum sporarum pressu separabilibus compositi. Sporae forma et magnitudine variae, rotundatae vel elongatae, plerumque subpolyedrice irregulares, aliquando apicibus subacutis vel acutis, 7-12 (–13,5) × 9-21,5 μm, olivaceobrunneae; pariete aequali, 0,5-1 μm crasso, levi, in SEM superficie libera verrucis paucis humilibus.

Sori (Fig. 51) in all capsules of an inflorescence, hidden by the floral envelopes, filling them with a black, semi-agglutinated to powdery mass of spore balls. **Spore balls** (Figs 55-56) varying in shape and size, subglobose, ellipsoidal, elongated or usually irregular, 40-90 × 45-130 μm, dark reddish brown, subopaque to opaque, composed of tens to hundreds of spores which separate by pressure. **Spores** (Figs 55-56) varying in shape and size, rounded or elongated, usually subpolyhedrally irregular, sometimes with subacute or acute tips, 7-12 (–13.5) × 9-21.5 μm, olivaceous brown; wall even, 0.5-1 μm thick, smooth, in SEM with a few low warts on the free surface.

On Anarthriaceae: *Anarthria prolifera* R. Br. Known only from the type collection.

Restiosporium proliferum differs from *R. anarthriae* in possessing larger, darker and more compact spore balls and somewhat larger spores.

18. *Restiosporium restionum* (Nees) Vánky 2000: 350, s. lat.

Uredo restionum Nees, in Lehmann 1846: 59. — *Tolyposporium restionum* (Nees) Websdane, Sivasithamparam, Dixon & Meney 1994: 473. — Type on *Restio nitens* (= *Alexgeorgea nitens*), Australia, Western Australia, Bassendeen near Perth, Nov 1839, L. Preiss 1696. Holotype in MEL 14 779!

Sori (Fig. 52) in all capsules of an infected plant, swollen, hidden by the floral envelopes, replacing the seeds by a black, semiagglutinated to granular-powdery mass of spore balls. Infected male plants are transformed into female plants with sori. **Spore balls** (Figs 57-58) subglobose, ellipsoidal, elongated, usually more or less irregular, 30-60 (-70) × 40-80 (-100) µm, dark olivaceous brown to subopaque, persistent, composed of tens of tightly compressed spores which separate by hard pressure. **Spores** (Figs 57-58) subpolyhedrally of polyhedrally irregular of variable shape and size, more rarely rounded, often with a short acute tip at the angles and narrow lines on the surface, 7-11 × 9.5-15 µm, olivaceous brown; wall slightly uneven, 1-2.5 µm thick, free surface slightly convex, in SEM with small warts.

On Restionaceae: *Alexgeorgea nitens* (Nees) L.A.S. Johnson & B.G. Briggs (*Restio nitens* Nees), *A. subterranea* Carlquist, *Chordifex isomorphus* (K.W. Dixon & K.A. Meney) B.G. Briggs & L.A.S. Johnson (*Restio isomorphus* K.W. Dixon & K.A. Meney), *Ch. microcodon* B.G. Briggs & L.A.S. Johnson, *Ch. stenandrus* B.G. Briggs & L.A.S. Johnson, *Cytogonidium leptocarpoides* (G. Bentham) B.G. Briggs & L.A.S. Johnson (*Restio leptocarpoides* G. Bentham).

Restiosporium restionum on the presented host plants is a rather heterogenous assemblage. Further studies, including molecular biological ones may show that they represent several taxa.

19. *Restiosporium spathacei* Vánky, R.G. Shivas & C. Vánky, sp. nov.

Typus in matrice Dapsilanthus spathaceus (R. Br.) B.G. Briggs & L.A. Johnson (det. R. Booth, BRI), Australia, Queensland, Cape York Peninsula, 18 km SSW oppid. Bamaga, 10°58'6.2" S, 142°20'1.7" E, alt. cca. 30 m.s.m., 8.III.2000, leg. R.G. Shivas, C. & K. Vánky. **Holotypus** in BRIP 26 965 (*hic designatus*)! **Isotypus** in H.U.V. 20 965!

Restiosporium spathacei Vánky, R.G. Shivas & C. Vánky a specie *R. dapsilanthi* Vánky (*Mycotaxon* 85: 50, 2003, *typus in Dapsilanthus elatior*, Australia) *distinctum imprimis pariete sporarum tenuiore* (0.5-0.8 µm, *adverse* 1-2 (-3) µm) in LM, *et sporis levibus in lateribus contactis, adverse in SEM subtiliter, dense verruculosus-echinulatis in R. dapsilanthi*.

Sori (Fig. 59) in the nuts, ovoid with an acute tip, c. 0.5 × 1 mm, replacing the seeds by a black, granular-powdery mass of spore balls. The fungus produces transvesitism. **Spore balls** (Figs 61-62) globose, subglobose to ellipsoidal or slightly irregular, 20-50 × 30-70 µm, dark olivaceous brown, composed of 10-30 (or more?), easily separating spores. **Spores** (Figs 61-62) subglobose, ellipsoidal or somewhat irregular, with one or two slightly flattened sides, 8-13 × 11-16 µm, yellowish- to olivaceous brown;

wall even, 0.5-0.8 µm thick, smooth, free surface very finely verruculose.

On Restionaceae: *Dapsilanthus spathaceus* (R. Br.) B.G. Briggs & L.A. Johnson). Known only from the type collection.

Restiosporium spathacei differs from *R. dapsilanthi* Vánky (type on *Dapsilanthus elatior*) in having thinner spore wall (0.5-0.8 µm against 1-2 (-3) µm) as seen in LM, and smooth spores on the contact sides against finely, densely verruculose-echinulate in *R. dapsilanthi* as seen in SEM.

20. *Restiosporium sphacelatum* Vánky, sp. nov.

Typus in matrice Chordifex sphacelatus (R. Br.) B.G. Briggs & L.A.S. Johnson, Australia, Western Australia, Jerramungup Distr., cca. 70 km W Bremer Bay, Bremer Bay and South Coast Hwy. junction, Boxwood Hill, 34°22'36" S, 118°44'35" E, 10.II.1996, leg. C. & K. Vánky. **Holotypus** in Herbario Ustil. Vánky, H.U.V. 18 054 (*hic designatus*)! **Isotypus** in UWA.

Sori in capsulis, eas massa nigra, primo agglutinata, serius granulosopulverea glomerulorum sporarum implentes, inconspicui, cca. 0,7-1 mm, involucris floralibus omnio obtecti. Infectio systemica, capsulae omnes plantae eiusdem affectae. Glomeruli sporarum subglobosi, ovoidei, ellipsoidales, elongati usque parum irregulares, 30-80 (-90) × 40-100 (-110) µm, atro-rufobrunnei, e sporis pluries decem usque centum(?), pressu valido separabilibus compositi. Sporae subglobosae, ovoideae, ellipsoidales usque subpolyedrice irregulares, 8-11 × 9-14,5 (-16) µm, uniformiter mediocriter atroolivacei; pariete aequali, cca. 0,5 µm crasso, in LM levi, in SEM superficie libera aspero, valde subtiliter, dense, humiliter verruculoso.

Sori (Figs 60, 63) in the capsules filling them with a black, first agglutinated, later granular-powdery mass of spore balls, inconspicuous, c. 0.7 × 1 mm, completely hidden by the floral envelopes. Infection systemic, all capsules of a plant being smutted. **Spore balls** (Figs 64-66) subglobose, ovoid, ellipsoidal, elongated to slightly irregular, 30-80 (-90) × 40-100 (-110) µm, dark reddish brown, composed of tens to a hundred(?) of spores which separate by hard pressure. **Spores** (Figs 65-66) subglobose, ovoid, ellipsoidal to subpolyhedrally irregular, 8-11 × 9-14.5 (-16) µm, uniformly medium dark olivaceous brown; wall even, c. 0.5 µm thick, in LM smooth, in SEM free surface rough, very finely, densely, low verruculose.

On Restionaceae: *Chordifex sphacelatus* (R. Br.) B.G. Briggs & L.A.S. Johnson (*Restio sphacelatus* R. Br.), ?*Ch. sinuosus* B.G. Briggs & L.A.S. Johnson; Australia (Western Australia).

Both *Restiosporium hypolaenae* and *R. sphacelatum* were collected from the same area. They differ in spore ball and spore morphology. The most evident difference is the spore wall thickness and colour of the spores, which are uniform in *R. sphacelatum* and varying in *R. hypolaenae*. There are also small differences in the size of spore balls and spores, as well as in the coherence of the spore balls. In addition, these two smuts parasitise different host plant genera.

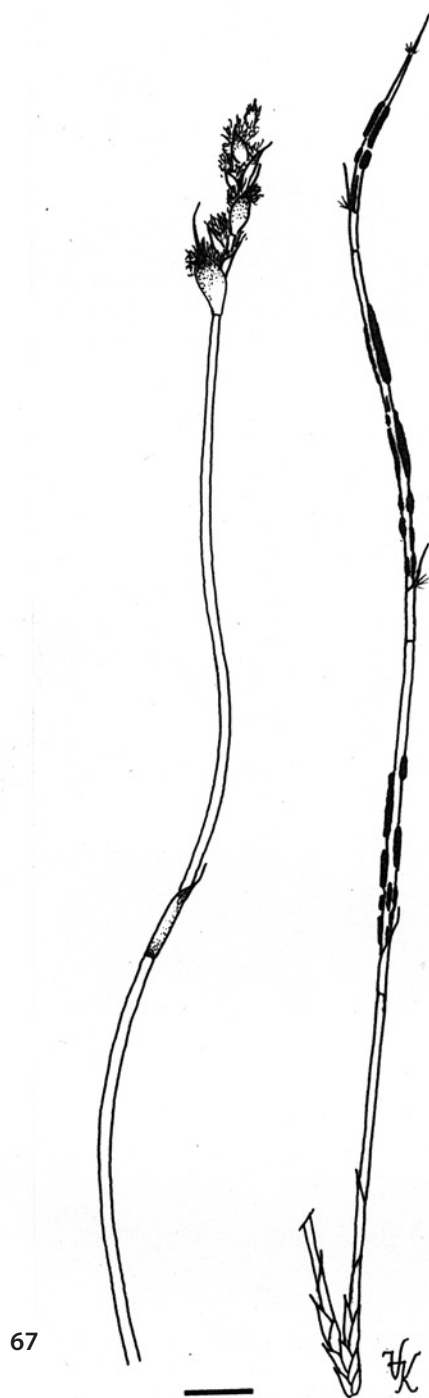


Fig. 67. Sori of *Websdanea lyginiae* on the stem of *Lyginia barbata* (type). To the left a healthy male inflorescence. Habit. Bar = 1 cm

Websdanea Vánky 1997: 184.

Sori in vegetative tissues of host plants belonging to the Restionaceae. Sori filled with spore balls, bursting at maturity. Spore balls composed only of spores which are differentiated within a sporogenous mass of hyphae. Peridium, columella, and sterile cells are lacking. Spores pigmented (brown, without

violet or orange-yellow tint). Spore germination results in septate basidia on which basidiospores on sterigmata or also hyphae are produced. Host-parasite interaction by intracellular hyphae, coated by an electron-opaque matrix. Mature septa poreless. Parasitic hyphae inter- and intracellular.

Type: *W. lyginiae*.

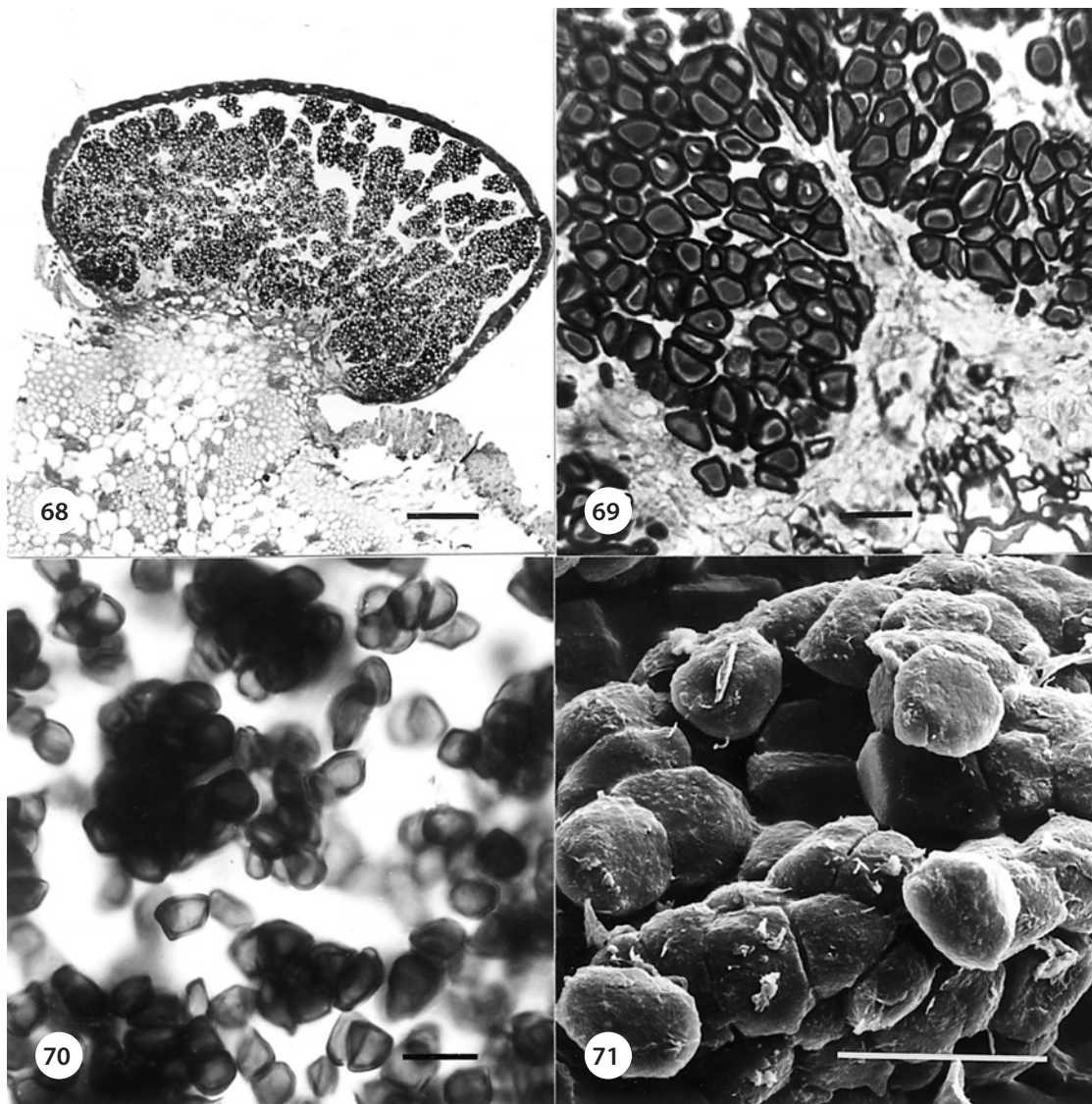
21. *Websdanea lyginiae* (Websdane, Sivasith., K.W. Dixon & Pate) Vánky 1997: 184.

Ustilago lyginiae Websdane, Sivasithamparam, K.W. Dixon & Pate 1993: 485. — Type on *Lyginia barbata*, Australia, Western Australia, Perth, Gosnells suburb, 16 Apr 1992, J.S. Pate. Holotype in PERTH. Isotype in Herb. Kings Park, Perth.

Sori (Figs 67-68) as bullate, dark reddish brown striae on the distal internodes of the culms, c. 1 × 1-50 mm, covered by the epidermis which ruptures at maturity disclosing the black, granular-powdery mass of irregular, loose spore balls. The swollen sori develop in longitudinal depressions of the culm, starting from a more or less narrow isthmus composed of sporogenous hyphae and host cells permeated by inter- and intracellular hyphae. In young sori, within the basal, sporogenous hyphae, groups of spore balls differentiate and during maturation are pushed toward the periphery (Fig. 68). When young, the groups of spore balls are separated into irregular lobes by fascicles of sporogenous hyphae which penetrate into the sori (Fig. 69). During maturation, these fascicles disappear towards the periphery. Infection systemic; usually all culms of a plant are affected. Smutted culms are sterile. Spore balls (Figs 68-71) varying in shape and size, subglobose, ovoid to usually irregularly elongated, 30-90 × 45-200 μm, dark olivaceous brown, opaque, composed of many, easily separating spores. Spores (Figs 69-71) extremely varying in shape and size, subglobose, ovoid, irregularly subpolyhedral or polyhedral, elongated, often prolonged into one or two shorter or longer, subacute or acute tips, (5-) 6-9 × (6-) 7-13 (-16) μm, olivaceous brown; wall unevenly thick, 0.5-1.5 μm, in LM smooth, in SEM outer spores inconspicuously low verruculose, inner spores smooth. Spore germination (Fig. 72; Vánky 1997: 189) results in (1-) 2-4-celled basidia measuring c. 1.5 × (6-) 20-40 μm. On the basidia, on well developed sterigmata, fusiform or ovoid basidiospores are produced successively, measuring 1-1.5 × 3.5-12 μm. The basidiospores bud giving rise to smaller, fusiform or ovoid cells or hyphae. In other cases, on the basidia abundantly ramifying hyphae are produced and only a few ovoid basidiospores are produced on the top of shorter or longer branches.

On Lyginiaceae: *Lyginia barbata* R. Br., Australia.

Unfortunately, since the description of *Websdanea* no further studies nor collections have been made. The following comments (Vánky 1997: 189) are still applicable. "The reason for the different types of germination obtained for *Websdanea lyginiae* is not known. It may depend on



Figs 68-69. TS on a sorus of *Websdanea lyginiae* with young spore balls in development, in LM. **Figs 70-71.** Spore ball and spores of *Websdanea lyginiae* on *Lyginia barbata*, in LM and in SEM (H.U.V. 17 819). Bars = 10 μ m, excepting for Fig. 68, in which it represents 100 μ m

varying external factors but also on the different collections which were used for germination. According to Websdane (1995: 77) all five morphotypes (R1, R2, R3, R4, and S) of *Lyginia barbata* R. Br. are hosts to the culm smut. Furthermore, she observed that spore morphology may vary between collections on different morphotypes. In some collections the spores are smaller, more round, in others they are larger, more irregular, elongate. Differences in spore germination may also be genetically fixed. Further studies are needed to elucidate if these differences are constantly connected with a certain morphotype and which taxonomic significance they have (different species?). It is interesting to mention that some Australian botanists consider these morphotypes, or at least some of them, to be separate taxa (partly unpublished data). Maybe these

groups of both the host plants and their parasites are in an early stage of speciation?

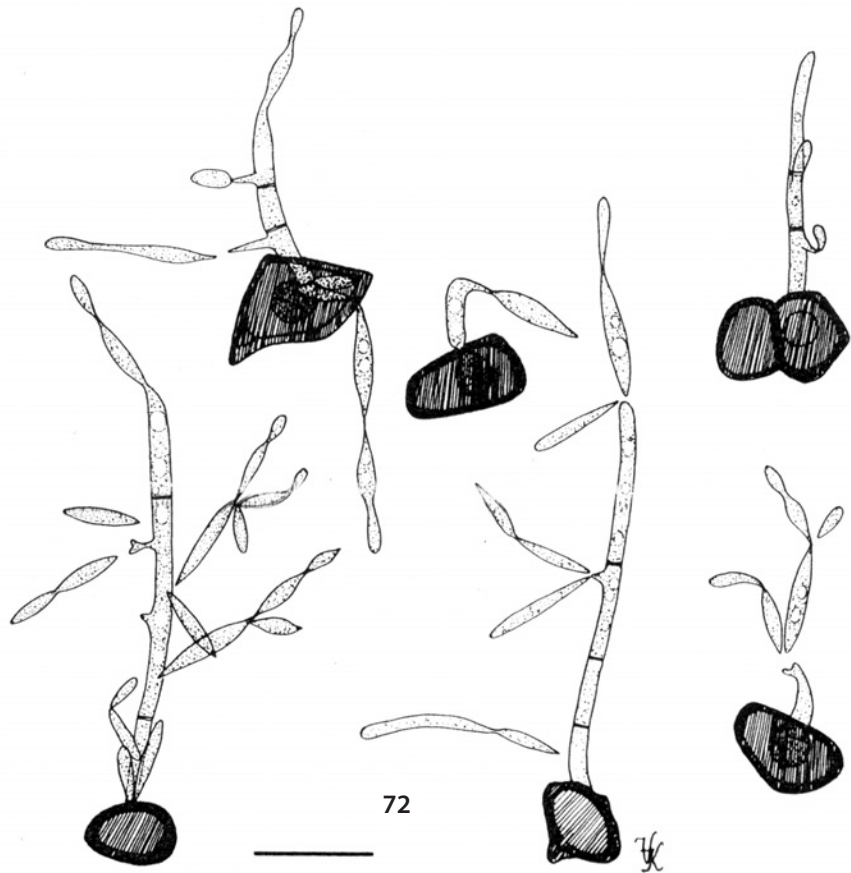
Since 1995, the classification of the Restionaceae has improved considerably (comp. Menezes & Pate 1999), and three species of *Lyginia* are recognised.

Fungus – host plant list

(*R.* = *Restiosporium*)

- R. anarthriae* – *Anarthria laevis*
- R. apodasmiae* – *Apodasmia ceramophila*
- R. baloskionis* – *Baloskion tetraphyllum*
- R. chaetantheri* – *Chaetantherus aristatus*
- R. dapsilantheri* – *Dapsilanthus elatior*

Fig. 72. Germinating spores of *Websdanea lyginiae* on *Lyginia barbata* (on WA, at room temp., in 2 days; H.U.V. 17 819). Bar = 10 μ m



- R. desmocladii* – *Desmocladus bififormis*, *D. elongatus*, *D. flexuosus*, *D. lateriticus*
R. dissimile – *Apodasmia similis*
R. eurychordae – *Eurychorda complanata*
R. flexuosum – *Desmocladus flexuosus*
R. hypolaenae – *Hypolaena fastigiata*, *H. macrotepala*
R. lepidoboli – *Lepidobolus chaetocephalus*, *L. drapetocoleus*, *L. pressianus*
R. leptocarpi – *Leptocarpus elegans*, *L. tenax*
R. lepyrodiae – *Lepyrodia scariosa*
R. meneyae – *Lyginia barbata*
R. pallentis – *Baloskion pallens*
R. patei – *Lepidobolus densus*
R. proliferum – *Anarthria prolifera*
R. restionum – *Alexgeorgea nitens*, *A. subterranea*, *Chordifex isomorphus*, *Ch. microcodon*, *Ch. stenandrus*, *Cytogonidium leptocarpoides*
R. spathacei – *Dapsilanthus spathaceus*
R. sphacelatum – *Chordifex sphacelatus*, ?*Ch. sinuosus*
Websdanea lyginiae – *Lyginia barbata*

Host plant – fungus list

(*R.* = *Restiosporium*)

- Alexgeorgea nitens* – *R. restionum*
Alexgeorgea subterranea – *R. restionum*

- Anarthria laevis* – *R. anarthriae*
Anarthria prolifera – *R. proliferum*
Apodasmia ceramophila – *R. apodasmiae*
Apodasmia similis – *R. dissimile*
Baloskion pallens – *R. pallentis*
Baloskion tetraphyllum – *R. baloskionis*
Chaetanthus aristatus – *R. chaetanthi*
Chordifex isomorphus – *R. restionum*
Chordifex microcodon – *R. restionum*
Chordifex sinuosus – *R. sphacelatum*
Chordifex sphacelatus – *R. sphacelatum*
Chordifex stenandrus – *R. restionum*
Cytogonidium leptocarpoides – *R. restionum*
Dapsilanthus elatior – *R. dapsilanthi*
Dapsilanthus spathaceus – *R. spathacei*
Desmocladus bififormis – *R. desmocladii*
Desmocladus elongatus – *R. desmocladii*
Desmocladus flexuosus – *R. desmocladii*, *R. flexuosum*
Desmocladus lateriticus – *R. desmocladii*
Eurychorda complanata – *R. eurychordae*
Hypolaena fastigiata – *R. hypolaenae*
Hypolaena macrotepala – *R. hypolaenae*
Lepidobolus chaetocephalus – *R. lepidoboli*
Lepidobolus densus – *R. patei*
Lepidobolus drapetocoleus – *R. lepidoboli*
Lepidobolus pressianus – *R. lepidoboli*

Key to the smut fungi of Restionaceae

- 1 Sori as bullate striae on the culms *Websdanea lyginiae*
 1* Sori in the fruits (capsules or nuts) *Restiosporium* spp.

Key to the *Restiosporium* species, based on host taxonomyOn *Anarthria*

- 1 Spore balls 40-80 µm long, olivaceous brown, easily disintegrating *R. anarthriae*
 1* Spore balls 45-130 µm long, dark to opaque, rather compact *R. proliferum*

On *Alexgeorgea* *R. restionum*

On *Apodasmia*

- 1 Spores 12-19 (-22) µm long, mostly angular, with acute tips and edges *R. dissimile*
 1* Spores 9-16 (-17) µm long, rounded, no acute tips or edges *R. apodasmiae*

On *Baloskion*

- 1 Spore balls 45-150 µm long; spores 9-17 (-20) µm long, mostly rounded, wall even, c. 0.5 µm thick *R. baloskionis*
 1* Spore balls 30-90 (-100) µm long; spores 9-16 (-17.5) µm long, mostly angular, wall uneven, 0.5-1 µm thick.
 *R. pallentis*

On *Chaetanthus* *R. chaetanthi*

On *Chordifex*

- 1 Spore balls persistent; spores subpolyhedrally or polyhedrally irregular, often with acute tips; wall slightly uneven, 1-2.5 µm thick *R. restionum*
 1* Spore balls separate by pressure; spores subglobose, ovoid, ellipsoidal to subpolyhedrally irregular, without acute tips; wall even, c. 0.5 µm thick *R. sphacelatum*

On *Cytogonidium* *R. restionum*

On *Dapsilanthus*

- 1 Spore wall 1-2 (-3) µm thick, verruculose-echinulate *R. dapsilanthi*
 1* Spore wall 0.5-0.8 µm thick, smooth *R. spathacei*

On *Desmocladius*

- 1 Spore balls persistent; spore wall uneven, 1-3 (-4) µm thick *R. desmocladii*
 1* Spore balls ephemeral; spore wall even, 0.5-1.5 µm thick *R. flexuosum*

On *Eurychorda* *R. eurychordae*

On *Hypolaena* *R. hypolaenae*

On *Lepidobolus*

- 1 Spore balls 40-80 (-90) µm long, permanent; spores 10.5-16 (-18.5) µm long, pale olivaceous brown, wall 0.5-1 µm thick *R. patei*
 1* Spore balls 50-110 (-140) µm long, less permanent; spores 10.5-20 (-24) µm long, medium dark olivaceous brown, wall 2-4 (-5.5) µm thick *R. lepidoboli*

On *Leptocarpus* *R. leptocarpi*

On *Lepyrodia* *R. lepyrodiae*

On *Lyginia* *R. meneyae*

Leptocarpus aristatus = *Chaetanthus aristatus*
Leptocarpus elatior = *Dapsilanthus elatior*
Leptocarpus elegans – *R. leptocarpi*
Leptocarpus similis = *Apodasmia similis*
Leptocarpus tenax – *R. leptocarpi*
Lepyrodia scariosa – *R. lepyrodiae*
Lyginia barbata – *R. meneyae*, *Websdanea lyginiae*
Restio complanatus = *Eurychorda complanata*
Restio isomorphus = *Chordifex isomorphus*
Restio leptocarpoides = *Cyrtogonidium leptocarpoides*
Restio nitens = *Alexgeorgea nitens*
Restio pallens = *Baloskion pallens*
Restio sphacelatus = *Chordifex sphacelatus*
Restio tetraphyllum = *Baloskion tetraphyllum*

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