The dark synnematous hyphomycete genus *Morrisographium:* described species transferred from *Sphaeronaema, Cornularia, Phragmographium,* and *Arthrobotryum*

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Five species congeneric with *Morrisographium persicae* (Schw.) Illman & G. P. White (=*M. pilosum* (Earle) Morelet) are transferred; viz., *Arthrobotryum fusisporium* A.L. Sm., *Sphaeronaema boudieri* Ch. Richon, *Sphaeronaema hispidulum* Ell. non Cda., *Cornularia ulmicola* Ell. & Ev., and *Phragmographium ulmi* Morris. Comparative studies of the accepted species are presented and a key to them is provided. Certain excluded taxa are discussed.

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Les auteurs transferent cinq espèces congénères du *Morrisographium persicae* (Schw.) Illman & G. P. White (=*M. pilosum* (Earle Morelet); ce sont *Arthrobotryum fusisporium* A.L. Sm., *Sphaeronaema boudieri* Ch. Richon, *Sphaeronaema hispidulum* Ell. non Cda., *Cornularia ulmicola* Ell. & Ev. et *Phragmographium ulmi* Morris. On présente une étude comparative des espèces acceptées et une clé pour ces espèces est présentée. Certains taxa exclus font l'objet d'une discussion.

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Introduction

Earle (1897) described *Isariopsis pilosa* as a new hyphomycete growing on peach twigs. Ferraris (1909) transferred it to *Phaeoisariopsis* (type species *P. griseola*), on the basis of the dark synnemata, but Jong and Morris (1968) excluded it from that genus because conidium ontogeny was quite different from that of *Phaeoisariopsis* spp. They recognized it as congeneric with that organism from elm bark which Morris (1966) had described 2 years earlier as *Phragmographium ulmi* gen. et sp. nov; the new combination *Phragmographium pilosum* (Earle) Morris was proposed (Jong and Morris 1968).

In the meantime, Morelet (1968) considered *Phragmographium* Morris a later homonym of *Phragmographum* P. Henn. His argument was much strengthened by Saccardo's etymological correction of Hennings's *Phragmographum* to *Phragmographium* (Saccardo 1911). Morelet proposed *Morrisographium* as a replacement with a single species, *M. pilosum* comb. nov. *Phragmographium ulmi* Morris was treated as a facultative synonym and *Isariopsis pilosa* designated as providing the basionym for the genus *Morrisographium*.

This organism, *Morrisographium pilosum*, had been earlier described as *Periconia persicae* Schweinitz (1822) and thereafter included in a variety of genera of hyphomycetes and coelomycetes (Illman and White 1984). It was Jaczewski (1900) who articulately expounded the most appropriate disposition of this genus under the name *Pseudographium* Jacz. (1898) as "nicht bei den Sphaeropsideae bleiben und müssten zu den Hyphomyceten . . . gestellt werden . . . da die einseitige innerliche Abschnürung der Conidien doch charakteristisch ist, und einem Übergang zu den echten Pycniden zeight." Recognition that congeneric fungi may have been placed in *Pseudographium* and in such coelomycete genera as *Sphaeronaema* and *Cornularia* has led to the discovery of a natural assemblage of species which is briefly documented with comparative photographs and drawings of salient features. Certain coelomycetes which have been grouped with some of these species in various genera by earlier workers are excluded from *Morrisographium* on the basis of morphology and conidiogeny.

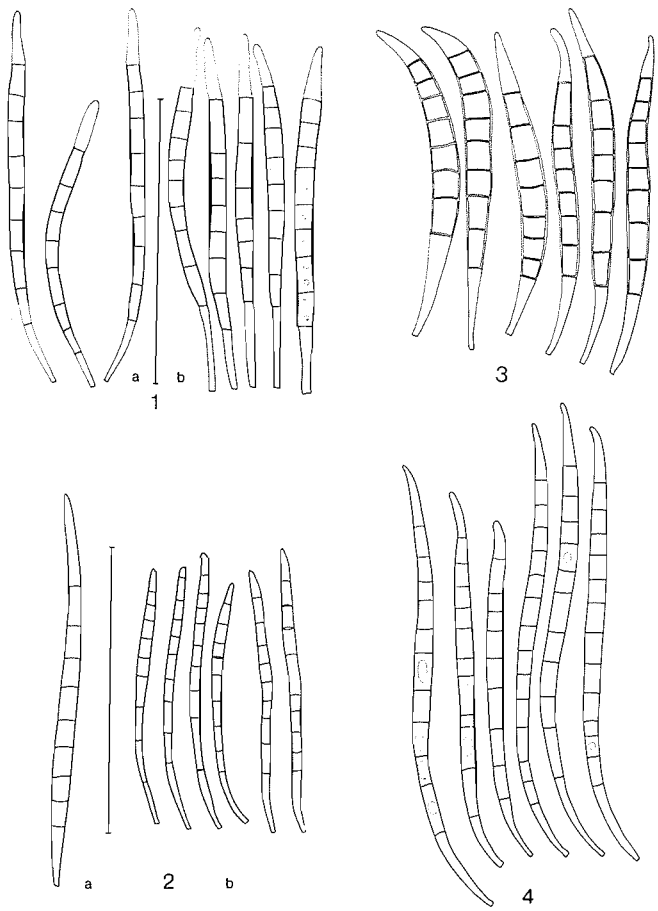
Results

Accepted species

1. *Morrisographium persicae* (Schw.) Illman and G. P. White (1984)
   (Basionym: *Periconia persicae* Schw., 1822)

The classic species of the genus, as *M. pilosum*, was designated type by Morelet (1968). It had, however, been much earlier described as *Periconia persicae* from twigs, branches, and trunk of the peach tree by Schweinitz (1822). He noted that it occurred on native species of the genus *Prunus* as well. Unfortunately the type material does not appear to be available, but Fries (1832) testified that he had seen it "(!)" and deposited in his herbarium an authentic specimen, named *Sporocybe persicae* (Schw.) Fr., sent to him from South Carolina, which we have examined. The hirsute synnemata are illustrated photographically in Fig. 5 and conidia delineated in camera lucida drawings in Fig. 1*a*. The same organism was distributed by J. B. Ellis as "*Sphaeronema persicae* (sub Sporocybe)" as his exsiccatus No. 946 of North American Fungi (N.A.F.). Since this collection, as represented in DAOM 186379, proved to have ample conidia (Fig. 1*b*), it has been selected neotype for the specific epithet, as *Morrisographium persicae*. Widely distributed in herbaria around the world, exsiccatus 946 of North American Fungi (Ellis) provides numerous isoneotypes.

Slides made by Dr. Frank Di Cosmo from type material of *Isariopsis pilosa* Earle (1897), deposited in BPI showed, as originally described, synnemata clothed along their lengths with divergent hyphal endings appearing yellowish gray to light yellowish olive in color under transmitted light. The conidia, borne apically, were subtended by reflexed sterile hyphae of like color. Conidia were mostly about 3 μm diam., possessed (8–)9 septa, and measured (58–)67(–71) μm in length. The obtusely rounded apical cell, 10–11 μm in length, was longer than other cells of the spore; it and the basal cell



FIGS. 1–4. Line drawings of conidia of *Morrisographium* spp. Scale bar, 60 μm. Figs. 1*a*, 1*b*, and 2*a*. *M. persicae* (Schw.) Illman & White. Fig. 1*a*. From authenticated material ex Herb. Fries of *Sporocybe persicae* (Schw.) Fr. Fig. 1*b*. From Ellis N.A.F. No. 946, as *Sphaeronaema persicae* (sub Sporocybe), NEOTYPE Fig. 2*a*. From TYPE of *Isariopsis pilosa* Earle. Fig. 2*b*. *M. ulmi* (Morris) Illman & White, ex TYPE from Herb. IA of *Phragmographium ulmi* Morris. Fig. 3. *M. hispidulum* (Ell.) Illman & White, from authentic material of *Sphaeronaema hispidulum* Ell. (non *S. hispidulum* Cda.) distributed by Ellis as N.A.F. 113. Fig. 4. *M. ulmicola* (Ell. & Ev.) Illman & White from ISOTYPE material in Herb. Dearness No. 1248.

were subhyaline, while the central cells were lightly colored. One of these conidia is outlined in Fig. 2*a*.

Once the identity of organisms called *persicae* (in several genera) and *pilosum* was established, review of specimens in DAOM (and in exsiccati held there) disclosed another score of collections, most of them under *Cornularia* Sacc., all unmistakably the same species. In addition, cotype material of Saccardo's (1915) *Harpographium magnum*, collected by H. D. House, July 1913 at Albany, NY, proves to be none other than the same fungus.

SELECTED MATERIAL EXAMINED: As "*Sporocybe persicae*, Fries" on *Persica*, South Carolina, com. Lenormand?, stamped Herb. E. Fries, DAOM 186376; as *Sporocybe persicae* Fr. on living branches of *Persica vulgaris* Mill., South Car., Aiken, summer 1876, dist. in Thum. M.U. No. 687, 1887, DAOM 186378; NEOTYPE as "*Sphaeronaema persicae* (sub Sporocybe)," dead limbs of cherry, Newfield, N.J., J. B. Ellis, Jan. 1880, distributed as N.A.F. No. 946, DAOM 186379; as *Sphaeronaema persicae* (Schw.) Ell., on branches of *Persica vulgaris*, near Amanda, Ohio, W. A. Kellerman, June 1883, ex Rabenh. 3198, DAOM 186384; *Cornularia persicae* (S) Sacc., ex Rel. Farl. No. 163, Charlotte, Vt., C. G. Pringle, 5 Mar. 1890, DAOM 186380; as *Cornularia persicae* (Schw.) Sacc., dead limbs of *Persica vulgaris*, Johnson, Vt., A. J. Grout, Apr. 1895, dist. as Fungi Columb. 1061, DAOM 186382; as *Isariopsis pilosa* Earle, TYPE, Bull. Torrey Bot. Club **24**: 30, 1897, on dead twigs of peach (=*Persica vulgaris*, =*Prunus persica*,) Auburn, Lee Co., Alabama, L. M. Underwood, 25 May 1896, ex BP1; as *Cornularia persicae* (Schw.) Sacc., on *Prunus hortula*, W. Raleigh, N.C., F.L. Stevens, 20 June, 1907, dist. as E. Barth. Fungi Columb. 2421, DAOM 186381; as *Harpographium magnum* Sacc. CO - TYPE: Ann. Mycol. **13**: 121, on *Prunus cuneata* Raf., Albany, N.Y., H. D. House No. 7, DAOM 186374.

2. ***Morrisographium ulmi*** (Morris) Illman and G. P. White, comb. nov.
(Basionym: *Phragmographium ulmi* Morris, 1966. Mycopathol. Mycol. Appl. **28**: 99.)

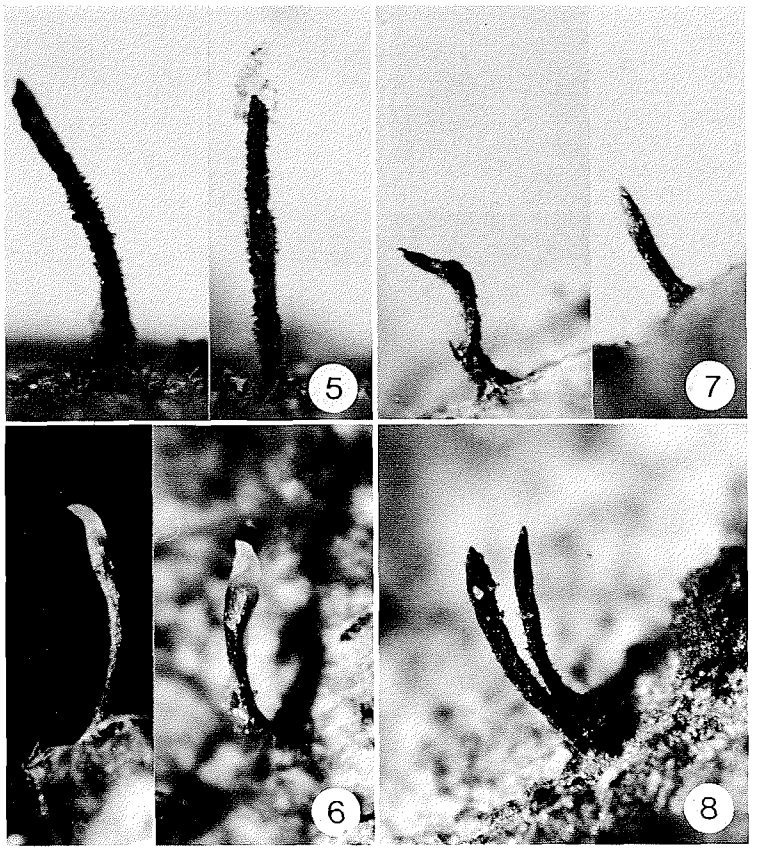
Jong and Morris (1968) affirmed that "*Phaeoisariopsis pilosa* is congeneric with *Phragmographium ulmi* which was proposed as the type of the genus *Phragmographium* by Morris in 1966." This indeed is true. They went on, however, to state "the new combination *Phragmographium pilosum* therefore becomes the type for the genus *Phragmographium*." In the mistaken belief that these two fungi were indeed identical, they placed *Phragmographium ulmi* Morris into synonymy under *Ph. pilosum* (Earle) Morris.

Morelet (1968) in proposing the substitute name *Morrisographium* for the genus *Phragmographium* accepted this error and listed *Phragmographium ulmi* as a synonym for *Morrisographium pilosum* (Earle) Morelet. Neither Jong and Morris nor Morelet made the formal combination *Morrisographium ulmi*. Morris's original description and illustration, as well as our own comparative studies, show *Ph. ulmi* to be distinctively different from *M. pilosum*.

The type specimen of *Phragmographium ulmi* Morris, from Herb. IA, has conidia with 8 or 9 septa, about 2 μm wide and (50–)53(–57) μm long; the basal cell was longest and distinctively bent (Fig. 2). The synnemata, as described and illustrated by Morris (1966), are smooth surfaced; the ends of sterile ensheathing hyphae appressed (not diverging at right angles as in *M. persicae*). The heads of conidia atop the synnemata are cylindrical bullet-shaped (Fig. 6), not expanded as in *M. persicae*; the investing melanized hyphae stand straight rather than splaying out into a broad cup so that the overall appearance of the synnemata is quite different.

We twice fortuitously recovered this organism from moist chamber cultures of elm bark set up to obtain the slime mould *Echinostelium* (as was probably the case also for Dr. Martin's type collection, Dec. 31, 1961). Subsequently the fungus was recovered directly from nature in late fall and in spring in crevices of inner bark of the rootstock trunk (*Ulmus americana*) of a Camperdown elm (*Ulmus glabra* Huds. var. *camperdownii* Rehd.). These collections conformed well to the characteristics of the type material, with conidia measuring (46–)51(–57) × 2 μm and having the basal cell longest and bent as in Fig. 2. Axenic cultures in agar media were obtained from the springtime collection; they were comparatively slow growing and displayed prominent fascicles of melanized hyphae.

MATERIAL EXAMINED IN ADDITION TO OUR OWN COLLECTIONS: TYPE: bark of fallen elm branch, developed in moist chamber, Iowa City, Iowa, 31 Dec. 1961, G. W. Martin No. 6462 (IA);



FIGS. 5–8. Habit photographs of synnemata of *Morrisographium* spp., all × *ca.* 38. Fig. 5. *M. persicae* ex Herb E. Fries. Fig. 6. *M. ulmi*. Fig. 7. *M. hispidulum*. Fig. 8. *M. ulmicola*.

bark of *Ulmus americana*, Mt. Burnet, Gatineau Co., Que. as *Podosporium*, M. I. Timonin, 16 Sept. 1934, DAOM 2270; bark of *Acer saccharum*, U. of Toronto Forest, Muskoka Dist., Ontario, as "? *Arthrobotryum*", D. Malloch, 13 Sept., 1968, DAOM 136794.

3. ***Morrisographium hispidulum*** (Ell.) Illman and G. P. White comb. nov.
(Basionym: *Sphaeronaema hispidulum* Ellis, 1867. Bull. Torrey Bot. Club, **6**: 106.)

Sphaeronaema hispidulum Ellis (1876) (non *Sphaeronaema hispidulum* Cda.) was one of seven species placed alongside *S. persicae* in *Pseudographium* by Jaczewski (1898) in his monograph of the fungi treated under *Sphaeronaema*. Examination of authentic material distributed by Ellis as N.A.F. 113 on dead twigs of black gum, *Nyssa multiflora*, reveals a fungus much like *Morrisographium persicae* but with synnemata clothed with a few divergent hyphal tips (Fig. 7). These contrast sharply with the glabrous conidiomata of *M. ulmi* and with the distinctly more densely clothed ones of *M. persicae*. The conidia, described by Ellis (1876) as "curved, 8–10 septate, of a pale yellowish tint except the acute hyaline extremities, .0025′ × .0002′ (63 × 5 μm)" are on average wider than those of *M. persicae* with the walls of the central cells thickened and, by flexing of the thinner walled ultimate subhyaline cells in like direction, becoming gondola shaped to falcate; i.e., "curved" (Fig. 3).

COLLECTION STUDIED: *Sphaeronaema hispidulum* Ell. ISOTYPE, distributed by Ellis, No. 113 in his N.A.F. exsiccati, on *Nyssa multiflora*, Newfield, N.J., October, 1875.

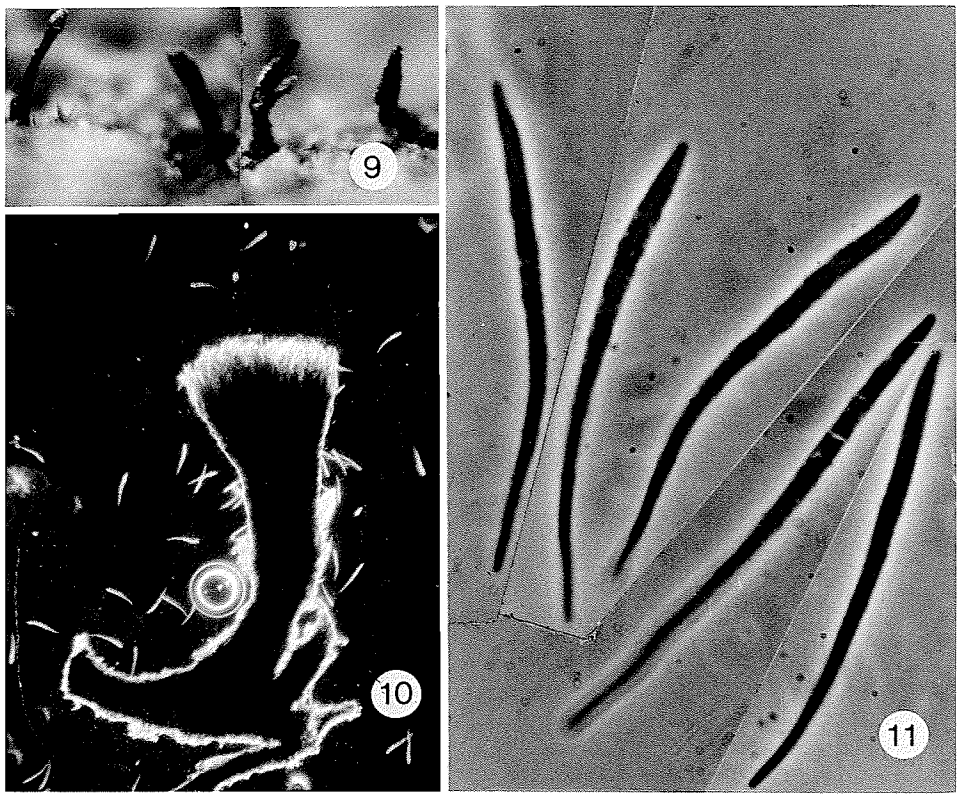
4. ***Morrisographium ulmicola*** (Ell. & Ev.) Illman and G. P. White comb. nov.
(Basionym: "*Cornularia ulmicola* Ellis & Everhart, 1891." Proc. Acad. Nat. Sci. Philadelphia **43**: 77.)

Following the expansion of Karsten's genus *Cornicullariella* (1884) by Saccardo (1884) as *Cornularia*, Ellis and Everhart (1891) described a fungus collected by J. Dearness on the bark of elm in a line fence at London, Ont. They placed it as "closely allied to *C. hispidula* Ell." and called it *Cornularia ulmicola* (Fig. 8), noting that it possessed "multiseptate sporules 70–80 × 3 μm, ends attenuated and mostly curved in opposite directions," an apt description for the conidia illustrated in Fig. 4. Characteristically the conidia have more than the 8 or 9 septa usual for *M. persicae*, an obviously allied species which, however, is restricted to bark of *Prunus* spp. in all specimens we have seen.

COLLECTION STUDIED: *Cornularia ulmicola* Ellis and Everhart ISOTYPE: on *Ulmus americana* bark in split rail fence, J. Dearness, London, Ont., 20 Dec. 1889, DAOM 186373 ex Herb. Dearness No. 1248.

5. ***Morrisographium boudieri*** (Richon) Illman and G. P. White comb. nov.
(Basionym: *Sphaeronaema boudieri* Richon, Vitry-le-François, 1879, in Rev. Mycol. **2**: 92.)

We examined a collection by Boudier from Herb. P of an organism described by Ch. Richon (1879) as *Sphaeronaema boudieri* Richon. While the type was reported on *Pinus*, the later collection from the type locality (Montmorency, France) was on bark of *Catalpa* (Figs. 9–11). The synnemata are



FIGS. 9–11. *Morrisographium boudieri* (Richon) Illman & White, from authenticated material ex Herb. Boudier. Fig. 9. Habit of synnemata on *Catalpa* twig. × *ca.* 38. Fig. 10. Dark field micrograph of mounted synnema. ×100. The clavate shape of dispersed conidia shows well. Fig. 11. Conidia ×2000, long clavate and faintly septate.

comparatively smooth, devoid of long divergent hairs. The distinctively long-clavate conidia are smaller (35–50 μm long), thinner walled, and much less distinctly septate than other species of the genus. Jaczewski (1900) clearly illustrated in his Fig. 32 that the conidia in this species arise singly, terminal on hyphal branches (an early demonstration of conidiogenesis characteristic of the genus).

COLLECTION STUDIED: "*Sphaeronaema boudieri* Richon" (scr. Boudier), ex. Herb. Boudier, held at Herb. P., authentic, on bark of *Catalpa*; garden, Montmorency, France; Boudier, Feb. 1894.

6. *Morrisographium fusisporium* (A.L. Sm.) Illman and G.P. White
(Basionym: *Arthrobotryum fusisporium* Annie L. Smith, 1901. J. Linn. Soc. London, Bot. **35**: 13.)

This species was pointed out to us by a reviewer as undoubtedly representing another *Morrisographium*. That assessment has been substantiated by examination of the type material which shows, as described and illustrated by Miss Smith, scattered, glistening, very dark brown synnemata about 7 mm high, expanded apically to bear elongate, fusiform conidia, yellowish in mass, 110–135(–140) × 5–7(–8) μm, 12–16 septate, subhyaline in transmitted light (Fig. 12).

SPECIMEN EXAMINED: TYPE: ex Herb. K. on wood, Castle Bruce River, Dominica, West Indies; W.R. Elliott, Feb. 1896.

Excluded species

1. *Corniculariella rhois* (Berk. & Curtis) Illman and G.P. White
(Basionym: *Sphaeronaema rhoidis* Berk. & Curtis, 1874. Grevillea, **2**: 178.)

In compiling Berkeley and Curtis's No. 404 *Sphaeronaema rhoidis*, on *Rhus copallina* from South Carolina, Saccardo (1884) corrected the specific epithet to the appropriate genitive form but abbreviated the attribution, to *Sphaeronaema rhois* Berk.

Karsten (1884) established his genus *Corniculariella* with *C. abietis* as type species. Later the same year Saccardo (1884) created a superfluous name *Cornularia* and compiled several species under the name, not all of them phialidic coelomycetes as was the type (Di Cosmo 1978).

Karsten (1890) recognized an Ohio collection of Lesquereux from *Rhus glabra* as a member of his genus but followed Saccardo in use of the superfluous *Cornularia*, the corrected specific epithet *rhois*, and the abbreviated attribution "Berk," *Cornularia rhois* (Berk.). We have examined this specimen from Herb. H and agree with Jaczewski (1900) that the species belongs in the same genus with *Corniculariella abietis* Karst., *Sphaerographium hystricinum* (Ellis) Sacc., and *Sphaeronaema fraxini* Pk. (=*Sphaeronaema spina* Berk. & Rav.), three species well documented by Di Cosmo (1978) in his assignment of them to *Corniculariella*.

2. *Subulariella macrospora* (Berk. & Curt.) Hoehn.

This species described by Berkeley and Curtis (1874) on *Robinia* as *Sphaeronaema macrosporum* was included by Saccardo (1884) under *Cornularia*. The species was noted by Overholts (1934) and described as a pycnidial form. Its pycnidia match neither the synnemata of *Morrisographium* nor the conidiomata of *Corniculariella* (Di Cosmo 1978). The demonstration of sympodial proliferations by Di Cosmo (1978) (corroborated by our own study) would indicate the logic of Hoehnel's (1915*a*) segregation of this fungus into a separate

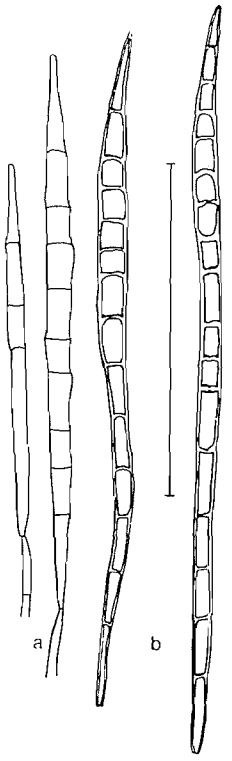


FIG. 12. *Morrisographium fusisporium* (A. L. Sm.) Illman & White. (*a*) Developing conidia on tips of conidiogenous hyphae; (*b*) liberated conidia. Scale bar, 60 μm.

genus, *Subulariella*. The chamber in the pseudoparenchymatous base is lined with the conidiophores and the rostrum above is constructed of parallel hyphae fused to produce a channel for conidial exit.

COLLECTION STUDIED: Ellis, 112, on living *Robinia pseudoacacia*.

3. *Sphaeronaema capillare* Ell. & Harkn.

The species described by Ellis & Harkness (1881) from bark of chestnut logs was compiled by Saccardo (1884) under *Sphaerographium* and placed in *Pseuodographium* by Jaczewski. Hoehnel (1915*b*), in amending and refining *Pseudographium* Jacz., removed this species to his new genus *Subulariella* as *S. capillaris* (Ell. & Harkn.) Hoehn. alongside *Subulariella macrospora*, where it is correctly disposed.

4. *Sphaerographium squarrosum* (Riess) Sacc. = *S. Ionicerae* (Fuckel) Sacc.

This fungus, placed by Jaczewski (1898) in his genus *Pseudographium*, being the type of the genus *Sphaerographium* Sacc. (1884), automatically makes *Pseudographium* Jacz. an obligate synnonym of *Sphaerographium* Sacc. (Sutton 1977). Unfortunately so, since Hoehnel (1915*a*) states "Er ist auch ganz anders gebaut, passt nicht in seine Gattung und wurde von Jaczewski völlig verkennt."

It does not form synnemata as those species of *Pseudographium* transferred to *Morrisographium* do. Hoehnel (1915*a*) removed all the other Saccardo species to various genera.

5. *Cornularia urticae* Ellis & Everhart (1898)

From the description, this fungus, on an herbaceous host, appears to fit neither with *Morrisographium* spp. (where the 3-septate, cylindric spores 12–15 μm long and lack of a proper synnema are anomalous) nor with the corticolous and lignicolous species of *Cornicularia*. Hoehnel (1916) placed it in *Topospora* Fr., the type species of which produces similar conidia in a pycnidial conidioma (Sutton 1980).

Summary

The genus *Morrisographium* is now envisaged as embracing those hyphomycetes with synnemata 0.5–7 mm in height, black to very dark brown, smooth or variously invested with diverging hyphal tips, composed of hyphae in *textura porrecta*; the exterior hyphae pigmented, becoming subhyaline towards the apex; interior hyphae hyaline, branching above to produce conidogenous cells each of which forms a holoblastic phragmoconidium with several to many septa. The apex is often somewhat expanded in containing the numerous conidia; the exterior hyphae covering the enlarging conidial mass during early development (giving the conidioma the appearance of a stalked pycnidium), but at maturity becoming deflexed to produce a fringe of hyphal endings (setae of authors), the cup so formed subtending the numerous conidia.

Following the recognition that the hyphomycete *Morrisographium pilosum* had been disposed in a variety of coelomycete genera as well as under a couple of invalid hyphomycete names (Illman and White 1984), investigations have led to a small assembly of species which are recognized as congeneric with that fungus.

Those species we have transferred to *Morrisographium* probably represent at best a reasonable sampling of total membership in this genus of dark synnematous hyphomycetes with hyaline to pale phragmoconidia. Nevertheless a key comparing these fungi may prove of worth.

Key to species of *Morrisographium*

Synnemata up to 7 mm high, lignicolous and tropical, conidia elongate fusiform, 110–135(–140) × 5–7(–8) μm, 12–15 septate ..... *M. fusisporium*
Synnemata mostly 0.5–2 mm high, conidia shorter, with fewer septa; corticolous

Conidia 35–50 μm, long clavate, often obscurely septate. ..... *M. boudieri*
Conidia longer than 50 μm, linear to lightly curved

Conidia to 60 μm long, 2 μm wide, the basal cell generally flexed; conidiomata smooth and glistening ..... *M. ulmi*
Conidia longer and (or) wider; conidiomata more or less invested by hairlike diverging hyphal tips

Conidia mostly 11–13 septate, 70–80 μm long, slightly sigmoid shaped ..... *M. ulmicola*
Conidia 7–9 septate; the central cells often lightly colored, basal and terminal cells hyaline

Conidia 2.5–3.5 μm wide, straight to flexuous, usually 70 μm or longer; synnemata often to 2 mm or more, densely hirsute; on *Prunus* spp. ..... *M. persicae*
Conidia to 5 μm wide, about 65 μm long, often falcately bent, on *Nyssa* ..... *M. hispidulum*

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——— 1915*b*. Fragmente zur Mykologie. 921. *Subulariella macrospora*. Mitt. Sber. Akad. Wiss. Wien, **124**: 118.

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