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Studies on Some Sooty Moulds on Guava in Malaysia

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ABSTRAK

Kulat jelaga membiak dengan banyak di atas daun jambu batu, mendapat makanan dari bahan manisan yang dikeluarkan oleh serangga teritip, kutu daun, lalat putih dan koya. Sembilan spesies, lima spesies dari Ascomyetes iaitu: Phragmocapnias betle, Scorias philippensis, Trichomerium grandisporum, Limacinula musicola *dan* Aithaloderma clavatisporum, *serta empat genus dari Deuteromycetes iaitu:* Tripospermum *sp.*, Polychaeton *sp.*, Leptoxyphium *sp. dan* Conidiocarpus *sp. adalah dihuraikan dan dilaporkan sebagai laporan terbaru di Semenanjung Malaysia.*

ABSTRACT

Sooty moulds proliferate in abundance on the foliage of guava, subsisting on the honeydew secreted by scale insects aphids, whiteflies, and mealy bugs. Nine species, five Ascomycetes species namely, Phragmocapnias betle, Scorias philippensis, Trichomerium grandisporum, Limacinula musicola *and* Aithaloderma clavatisporum; *and four Deuteromycetes genera viz.* Tripospermum *sp.*, Polychaeton *sp.*, Leptoxyphium *sp. and* Conidiocarpus *sp., are described and reported as new records on guava for Peninsular Malaysia.*

INTRODUCTION

Sooty moulds are a commonsight on the leaves, twigs and sometimes fruits of many tropical fruit crops (Lim and Khoo, 1985). They form thin, black, papery films; black, velutinous growth, black pellicles, or psuedoparenchymatous crusts. Such growths represent unit communities of an assemblage of several diverse species of fungi belonging to the Deuteromycetes and Ascomycetes with dark-coloured somatic and fruit-body cells, living together saprotrophically in apparent harmonious and mutualistic association. Their ubiquity and abundant proliferation on such micro-habitats can be attributed to their adaptability to grow and reproduce in the high stress environment of the crop foliage. In accordance with Grime's ecological terminology (1979), they can be termed as stress-selected or S-selected fungi. Such fungi have culminated in a stress-tolerant strategy for survival involving the development of adaptations which facilitate endurance of conditions of continuous environmental stress as are experienced on the foliage. They can also be deemed as true foliage residents.

Their diversity, temporal and spatial distribution on such niches depend on the supply of nutrients, availability of moisture, and thermal and radiation fluctuations. The sooty moulds obtain their water from free water films or water droplets on leaves from the rain or dew, atmospheric water vapour, and water exuded via guttation. They can obtain their nutrition from leaf diffusate or guttation fluid (Tukey, 1971); the cuticle which provide a rich and potential source (Baker, 1971, Holloway, 1971); honey dew secretions from insects such as scale insects, aphids, whiteflies and mealybugs; chemical contaminated rain; organic and inorganic dust particles; pollens; and spores of other microflora. Thus, they can be found on the plant foliage with or without the presence of the above-mentioned insects. However, on guava *(Psidium guajava* L.), sooty moulds are usually found in association with insects, subsisting on the rich, nutritive nabulum of the honey dew.

Despite their ubiquity and plenitude, their significance is usually overlooked. Many of the hyphae of the sooty moulds are mucilaginous, absorbing moisture readily and maintaining a moist surface for prolonged periods. This creates a very humid environment within the tree canopy, facilitating the establishment and spread of other fungal diseases. Extensive growth of the sooty mould on the leaves can reduce the photosynthethic activity of the leaves and adversely affects the normal flowering and fruiting of the tree. Besides, trees heavily colonized by these fungi exhibit a decrease in growth vigour and tend to fruit poorly. On fruits, sooty moulds spoil the cosmetic appearance of the fruits and reduce their marketable value (Lim and Khoo, 1985).

Information and studies on sooty mould of fruit trees in Malaysia are rather meagre and scanty, particularly on guava. In Peninsular Malaysia, only one sooty mould was listed on guava– *Trichopeltis pulchella* Speg. (Johnston, 1960). In Sarawak, four species namely : *Atichia glomerulosa* (Ach.) Flotow, *Capnodium moniliforme* Fraser, *Capnophaeum* sp. and *Phaeochaetia annonicola* (Hansf.) Bat. & Cif. were recorded by Turner (1971). In Sabah, Williams and Liu (1976) recorded three species viz. *Aithaloderma clavatisporum* Syd., *Caldariomyces fumago* Woron and a *Chaetothyrium* sp.

This paper reports and describes nine previously unrecorded species of sooty mould found on guava in Peninsular Malaysia. The specimens are kept at the Plant Pathology Herbarium, Department of Plant Protection, Universiti Pertanian Malaysia at Serdang, Selangor.

MATERIALS AND METHODS

Observations including morphometric measurements were made on all possible taxonomically significant characters. Tissues of sooty moulds were gently removed from guava leaf surfaces (Fig. la & b) and mounted in lactophenol clear on glass-slides and sealed with nail polish. Colloidin impressions of sooty mould *in-situ* on the leaves were made, mounted on glass slides and the colloidin materials were subsequently removed with acetone. Free-hand sections mounted in lactophenol clear or lactophenol cotton-blue were also prepared. The slides were studied and microphotographed using the Lietz Orthoplan fitted with a Nomarskii interference contrast attachment.

Identifications were based largely on the recent concepts proposed by Reynolds (1979, 1982) and also on some of the concepts of Hughes (1976). Descriptions in the literature especially of Hansford (1946), Hughes (1951, 1976) and Reynolds (1971, 1978, 1979, 1982) were utilized in aiding specimen identification and in understanding the taxonomical position of the species concerned. Isolation of non-sterilized sooty mould mycelia and spores was also attempted on potato dextrose agar (PDA) and malt extract agar (MEA).

No attempts were made to demonstrate holomorphic pleomorphy i.e. the relationship of any anamorphosis to a teleomorphosis.

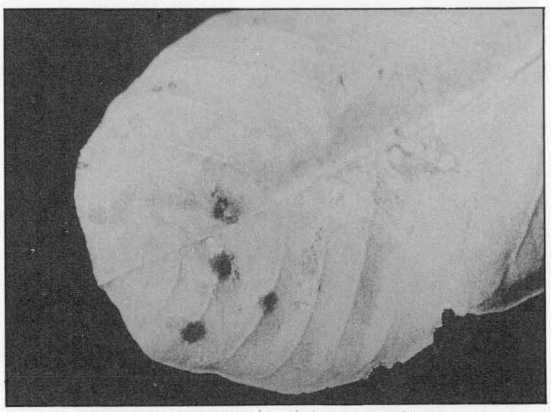

Fig. 1a: Sooty mould occurring as disrete, spongy, velvety, black spots on the guava leaf.

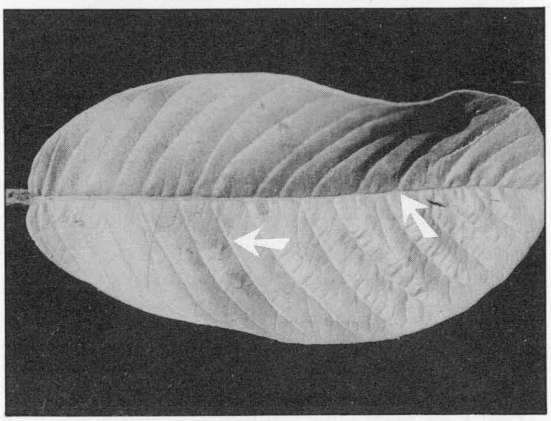

Fig. 1b: Sooty mould occurring as a thin papery, black film on guava leaves (arrowed).

RESULTS AND DISCUSSION

The following species of sooty mould listed and described below represent new records of sooty mould for *Psidium guajava* (guava) in Peninsular Malaysia.

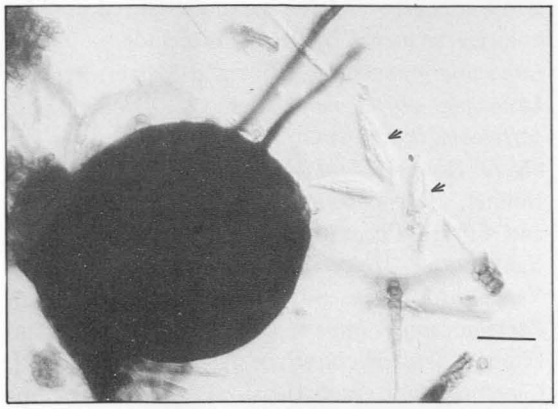

Fig. 2: Stalked, setose, subglobose ascocarp of Phragmocapnias betle. *Arrow denotes ascospores in ascus. Bar = 18 µm.*

***Phragmocapnias betle* (Sydow & Butler) Theissen & Sydow emend. Reynolds.**

This is a stalked capnodiaceous species with brown mycelia, epiphyllous and pelliculose on the leaf surfaces. Hyphae are dark brown, reticulate with cylindrical cells slightly constricted at the septa and somewhat mucilaginous. Mycelial setae are black, with a rounded, blunt tip and measure on the average 410 µm by 75.6 µm at its broad base. Ascocarp are subglobose, blackish-brown, setose, unilocular and are stalked (*Figure 2*). The setae are acuminate, 53.6–107.2 µm long, found usually on the upper half of the ascocarp. The ascocarps measure 75–165 x 70–125 µm (mean 107 x 112.6 µm). The asci bitunicate with eight hyaline ascospores. The ascospores are elliptical with blunt acute apices, 16–18.76 x 3.2–4.8 µm and have three transepta.

Phragmocapnias was established by Spegazinni in 1918 as a new genus on the basis of *Capnodium betle* Syd. & Butl. Reynolds (1979) emended the species to *P. betle* and listed the following species (teleomorphosis only) to be synonyms:– *Antennellopsis elegans* Bat. & Cif., *A. formosa* Bat. & Clif., *A. vulgaris* (Yamamoto) Bat. & Cif., *Antennella citri* Swada, *Capnodium tanakae* Shirae and Hara emend. Sawada, *Neocapnodium tanakae* (Shirae and Hara) Yamamoto, *Scorias communis* Yamamoto, *S. cylindrical* Yamamoto, *S. vulgare* Yamamoto, *Chaetoscorias vulgaris* Yamamoto, *Trichomerium jambosae* Bat. & Cif.

Phragmocapnias can be distinguished from species of *Scorias* on the absence of setae on the ascocarp in the latter (Reynolds, 1979). On guava, *Phragmocapnias* can be found together with *Leptoxyphium, Conidiocarpus* and *Polychaeton* in mixed colonies.

Scorias philippensis Mendoza emend. Reynolds

The fungus forms a black, epiphyllous, spongy subiculum on guava leaves. The hyphae are more or less cylindrical, 10.72 x 5.4 µm, brown to dark-brown, mucilaginous and they anastomise to form a much-branched network. The ascocarp is dark-brown, subglobose (39–41 x 41–43 µm) to ellipsoidal, nonsetose and subtended on a columnar stalk, 10–15 µm high (*Figure 3*). The ascocarp is uniloculate and ostiolate at maturity. Asci are bitunicate and eight-spored. The ascospores are hyaline, clavate, tapering more at one end, 22 x 4.82 µm, with three transepta.

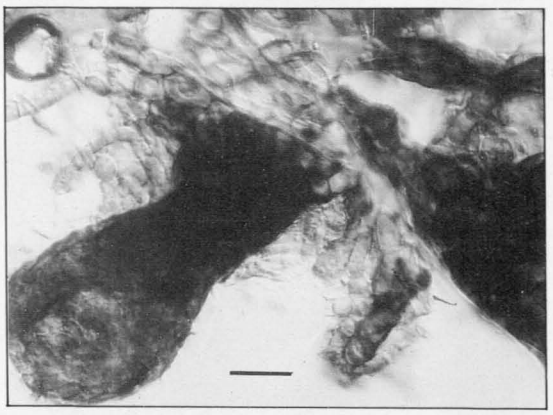

Fig. 3: Stalked, nonsetose ascocarp of Scorias philippenses. *Bar = 10.5 µm.*

On guava, *Scorias* can be found together with *Polychaeton* on the same mycelial network. Reynolds (1979) listed *Hyalocapnias psidii* Bat. & Cif. which was reported on guava to be synonymous.

***Trichomerium grandisporum* (Ellis and Martin in Ellis and Everhart) Bat. & Cif.**

This is a anon-stalked, capnodiaceous, foliicolous genus in the Ascomycetes, occurring as superficial, pelliculose, growths on the leaf surfaces. Mycelia are brown to olivaceous, much-branched with cylindrical hypae. Mycelia setae are blackish-

brown with acuminate apices and 85–320 μm long. The ascocarp are subglobose to ampuliform, 75–102 x 91 160 μm, olivaceous to dark brown, setose, apically ostiolate and unilocular (*Figure 4a*). The setae are 107–130 x 4–7 μm, dark-brown with rounded apices. The ascospores are hyaline, fusiform to elliptical with blunt acute apices, 18.6–24.12 μm in length and with three transepta (*Figure 4b*).

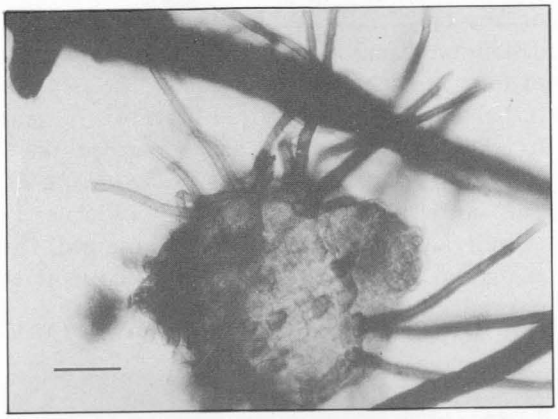

Fig. 4: Setose, ampulliform, sessile ascocarp of Trichomerium grandisporum. *Bar = 20 μm.*

Fig. 4b: Ascocarp of T. grandisporum *crushed to show the asci (arrowed). Bar = 18 μm.*

The genus *Trichomerium* was established in 1918 by Spegazzini with *T. coffeicola* as the type species (Reynolds, 1982). After examining over a hundred species specimens cited in the literature and scores of additional field collections, Reynolds (1982) reduced the many names to a monotypic genus *T. grandisporum* with the basionym as *Capnodium grandisporum* Ellis and Martin in Ellis and Everhart. This species comprises fungi having a capnodiaceous centrum with hyaline, trans–septate ascospores in a sessile, setose ascocarp and the synonyms listed in chronological sequence by Reynolds include :– *Limacinia grandispora* (Ellis and Martin) Arnaud, *Limacinia coffeicola* Puttemans, *Trichomerium coffeicola* (Puttemans) Spegazzini, *Limacinia spinigera* Hohnel, *Aithaloderma spinigera* (Hohnel) Hohnel, *Phaeochaetia spinigera* (Hohnel) Batista and Ciferri, *Chaetothyrium spinigerum* (Hohnel) Yamamoto, *Triposporiopsis spinigera* (Hohnel) Yamamoto, *Limacinia imperspicua* Saccardo, *Phragmocapnias impersicua* (Saccardo) Batista and Ciferri, *Trichomerium postericense* Spegazzini, *Chaetothyrium syzgii* Hansford, *Phaeochaetia ansyzigii* (Hansford), Batista and Ciferri, *Chaetothyrium annonicola* Hansford, *Phaeochaetia annonicola* (Hansford) Batista and Ciferri, *Trichomerium abhorrens* Batista, *Trichomerium psidii* Batista, *Trichomerium hirtellum* Batista, *Chaetopotius commistus* Batista, *Aithaloderma citri* (Sawada) Sawada, *Setella citricola* Batista and Peres, *Gilmania xylopia* Batista, Nascimento and Ciferri, *Vitalia averrhoae* Batista, *Vitalia cercropia* Batista, Vital and Ciferri, *Vitalia jaboatonensis* Batista, Nascimento and Ciferri, *Vitalia multiseptata* Nascimento and Ciferri, *Vitalia phormicola* Bastita, Nascimento and Ceferri, *Vitalia plumierae* Batista and da Matta, *Capnobatista serrulata* Cifferri and Leal, *Trichomerium abhorrens* Batista var. *coffea* Batista and da Matta, *Trichomerium crinosporum* Batista and Cifferri, *Trichomerium didymopanacis* Batista and Ciferri, *Trichomerium inconditum* Batista and Cifferi, *Trichomerium mangifericolum* Batista and Cifferi, *Trichomerium ornatum* Batista and Ciferri.

Although the ascospores of *T. grandisporum* are similar to those of *Phragmocapnias* and *Scorias* in septation and the absence of pigmentation at maturity and before germination, it can be differentiated from the latter two by the presence of the sessile ascocarp (Reynolds, 1982).

Tripospermum sp. Speganizzi.

A dematiaceous Hyphomycetes fungus that occurs together with other sooty mould as a superficial, pellicullose or crust–like black growth on leaf surfaces *(Figure 5)*. Hyphae are olivaceous to pale-brown, reticulate, consisting of long cylindrical cells 26 μm long by 7 μm wide. Conidia are brown, star-shaped (stauroconidia) with four divergent arms which are wide at the base and

tapering to a rounded apex. Each arm can have 4–8 cells i.e. 3–7 septa and are slightly constricted at the septa. Arms with 4–5 septa are the most common (*Figure 5*). Conidia can also be diradiate although triradiate or tetraradiate are the most common. Each conidium arises from a pyriform, stalked cell 5.5–8.8 μm long. Each arm measures 26–75 μm long by 7.65–10.5 μm at the base. The teleomorphosis is uncertain.

The genus *Tripospermum* was established by Spegazzini in 1918 as a segregate of *Triposporium* and *T. acerinum* was the type species (Hughes, 1951)(*Figure 5*).

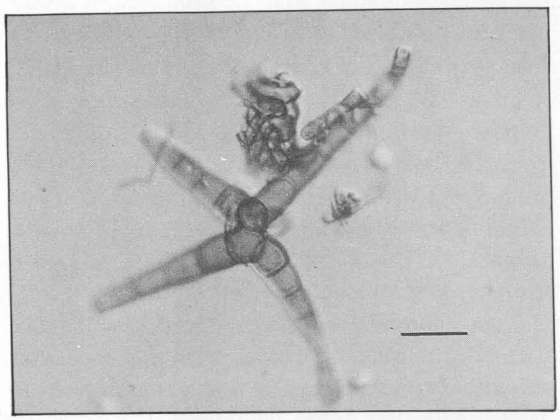

Fig. 5: Tetraradiate staurоconidium of Triposperium *sp. Bar = 15* μm.

Polychaeton sp. (Pers.) Lev.

The broad anastomising hyphae are made up of irregular, cylindrical (18.76 x 4.8 μm), dark brown cells immersed in a mucilaginous matrix. Pycnidia produced have broad, robust simple or branched stalks which can reach lengths of 109 to 345 μm and widths of 22 μm at the stalk base and 28 μm at the broadest portion of the pycnidia. The pycnidium is extended into a subulate or cylindrical neck and terminates in a fringe of hyaline, subulate extensions around the ostiole (*Figure 6*). The pycnidial cavity is ellipsoidal but there is no obvious swelling in the stalk to indicate its position. Conidia extruded through the ostiole and gather in a terminal droplet. They are minute (1.88 x 3.8 μm), hyaline and ellipsoidal.

Hughes (1976) designated *Fumago quercina* Pers. as the lectotype species of *Polychaeton*.

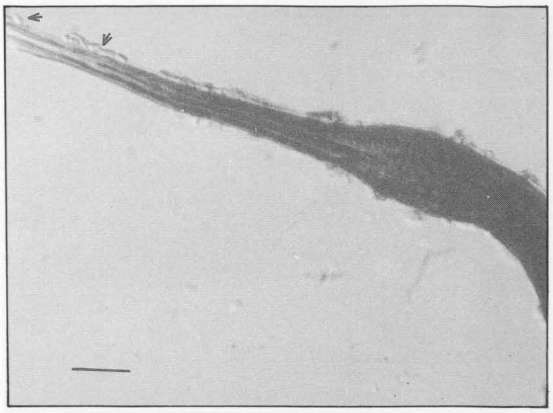

Fig. 6: Long-necked pycnidium of Polychaeton *sp. with hyaline, ellipsoidal conidia (arrowed). Bar = 12* μm.

He suggested that *Microxiphium aciculiforme* Cif., Bat. and Nasc., *M. coffeanum* Bat., & Matta, *M. pinicola* Bat., Nasc., & Cif. and *Astragoxyphium plumeriae* Bat., & Matta should be placed in *Polychaeton*.

On guava, *Polychaeton* usually occurs together with *Phragmocapnias betle* and *Scorias philippensis*. Yamamoto (1954) showed that *Polychaeton* was connected to *Neocapnodium tanakae* which is a synonym of *P-betle*. However, Reynolds (1979) regarded Yamamoto's taxonomical studies on the Taiwan Fungi to be intuitive and unsupported by systematic experimental work which he purported to have undertaken. Hence, the teleomorphosis of *Poly-chaeton* is still uncertain.

Conidiocarpus sp. Woronichin.

This fungus was found on the same type of hypae in a spongy subiculum as Scorias. The species on guava produces a long stalked 170–230 μm and short stalked, 48–110 μm pycnidia without a neck. The pycnidium can be seen as a terminal, oval to hemispherical (59 x 55 μm) swelling with an ostiole fringed with hyaline subulate extensions of the synematous hyphae. (*Figure 7*) The conidia are hyaline, ellipsoidal, minute, 5.36 x 1.6 μm.

This form genus was proposed in 1917 for the single species of *C. caucasicus* (Hughes, 1976). Yamamoto (1954) demonstrated that the pycnidia of the *Conidiocarpus* type were connected to

Fig. 7: Long stalked pycnidium of Conidiocarpus *sp. Bar = 20 μm*

Scorias commune Yamamoto which is a synonym of *Phragmocaphias betle* (Reynolds, 1979).

***Limacinula musicola* (Batista) Reynolds.**

This foliicolous species grows saprotrophically with other fungal species on leaf surfaces. The fungus mycelia consist of brown hyphae made up of short to elongate-rectangular cells forming a thin subiculum and a pale brown hyphae extending from the fruit body wall, collectively forming a loose, distinctive weft. The fruit body is a psuedothecium, brown, epipellicle, nonsetose, sessile, globose (150–320 μm in diameter) when immature becoming collabent and ostiolate at maturity. Asci are bitunicate, form in a basal hymenium in the locule of the psuedothecium. Ascospores are muriform, hyaline to olivaceous, large, 36–62.5 x 12.6–24 μm, with a polystichous longisepta and 7–12 transepta. (*Figure 8*)

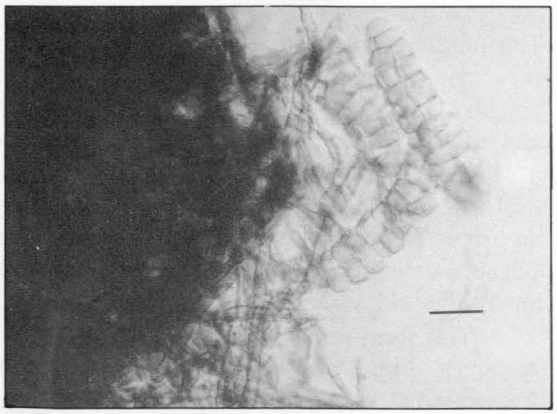

Fig. 8: Close-up of the large, muriform ascospores of L. musicola. *Bar = 12 μm.*

L musicola was emended by Reynolds (1971) as a new combination and he listed 5 synonyms viz.: *Phaeosaccardinula musicola* Batista., *Phaeosaccardinula guajavae* Bat. & Vital, *Phaeosaccardinula vera* Bat. & Cif., *Phaeosaccardinula guajavae* Bat. & Vital var. *citrina* Bat. and *Paracapnodium brevistipitatum* Bat., Cif. and Maia.

***Aithaloderma clavatisporum* H. & P. Sydow**

On guava, this sooty mould species produces brown, cylindrical-celled (8 x 4.02 um), mucilaginous hyphae which appear slightly constricted at the septa. No hyphal setae are produced. It produces brownish-black, subglobose to conical-globulose pycnidia which can measure up to 101–107.2 x 80.4–93.8 um. The latter pycnidia show some hyphae radiating from their base. Most of the pycnidia bear short, conical, dark-brown, thick-walled seta with tapering apices, measuring 8.04–22.95 μm; although some are devoid of setea (*Figure 9*). The pycnidia are usually produced in clusters. The conida are hyaline, minute, 3–4 x 2–2.5 μm, ellipsoidal and are produced in abundance. The teleomorphic ascigerous state was encountered with *Leptoxyphium* on some guava leaves infested with the spiral whiteflies. The ascocarps produced are subglobose (64 x 68 μm) to dome-shaped, brownish-black, ostiolate, uniloculate and have several (6) thick-walled, dark brown setae 11–27 μm long. The acid are bitunicate, and the ascospores are hyaline, clavate, 23 x 5 μm, with 3–5 septa.

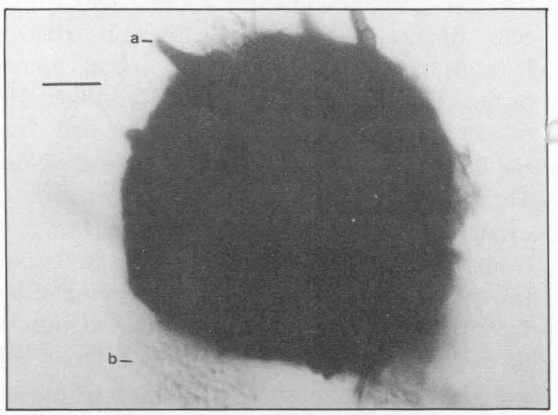

Fig. 9: Subglobose pycnidium of Aithaloderma clavatisporum *with distinct, short conical seta (a) and minute, hyaline conidia (b).; Bar = 12. 5 μm.*

Synonyms of *A. clavatisporum* are *Phaeochaetia clavatispora* (H. & P. Syd.) Hansf. Hughes (1976) listed the following as congeneric to *A. clavatisporum; A. ferruginea* Fraser, *A. viridis* Fraser, *A. capensis* Doidge *(Phaeochaetia capensis* Doidge) Bat. and *Aithaloderma* sp 1 (Herb. DAOM) which is the ascigerous state of *Ciferrioxyphium chaetomorphum* Speg.

***Leptoxyphium* sp. Speg.**

This fungus forms an epiphyllous, black, effuse, pelliculous crust on leaf surfaces. The hypae are more or less sylindrical, brown, mucilaginous, slightly constricted at the septa and form a tightly anastomising network. It produces synemata which are made up of closely adpressed erect hyphae with a helical twisting in its axis (*Figure 10*). The synema is covered with a mucilaginous layer and is cylindrical or subulate, reaching lengths of 200 μm with a wide base. The apex terminates in a fringe of sterile hairs enclosing the opening through which the conidia are extruded. The conidia are broadly ellipsoidal, and hyaline when immature, but larger (5.36 x 2.68 μm), may be one–septate and brown when mature.

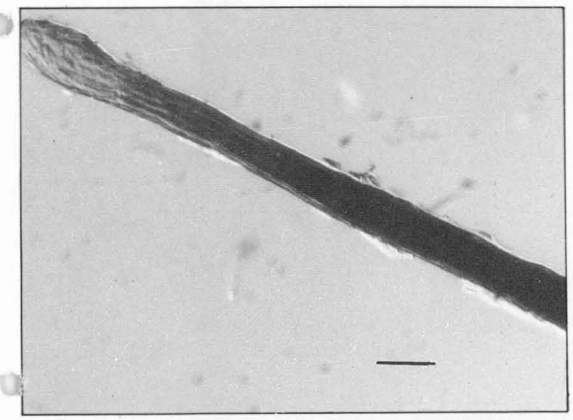

Fig. 10: Cylindrical synemata of Leptoxyphium *sp. Bar = 12.5 μm.*

Hughes (1976) listed *L. graminum* (Patouillard) Speg (= *Capnodium graminum* Pat) as the type species and the following genera as synonyms: *Caldariomyces* Woron., *Megaloxiphium* Cif., Bat. & Nasc. and *Astragoxyphium* Bat., Nasc. & Cif.

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