GLOECERCOSPORA AND RAMULISPORA
IN INDIA

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(With Plate 35 and 4 Text-figures)

The morphological characters of Gloecercospora sorghi and Ramulispora sorghi on leaves of Sorghum and in culture are described from Indian material. A redescription of Ramulispora alloteropsis is given, based on examination of the type specimen and a number of specimens in Herb. IMI on other genera of Gramineae-Paniceae. A new species, Ramulispora sacchari, is described in culture and on leaves of Saccharum officinarum. This species occurs in India and New Guinea. A note is given of some Ramulispora spp. on other graminaceous genera (not Paniceae) represented by specimens in Herb. IMI.


The following detailed description is based on Indian material on Sorghum vulgare Pers. and cultures.

Leaf spots elliptic, oblong or orbicular, up to 8 × 5 cm, zonate with alternate paler and darker brown zones; sometimes appearing as elongated reddish brown to purple stripes 15–50 × 2–3 mm. Young spots are not zonate and have a straw-coloured centre and a reddish brown margin. Mycelium internal: hyphae colourless or brown, inter- and intracellular, up to 6 μm wide, aggregated within the substomatal cavity to form a stromatic mass of prosenchymatous or pseudoparenchymatous cells which proliferates into a loose to compact mass of assurgent branched hyphae with moniliform cells which are thin-walled, colourless to slightly ochraceous, oblong and up to 13 × 3.5 μm: the terminal cells of the hyphae and branches are conidiogenous, each producing a single conidium (Fig. 1 A). Conidia colourless, broadest in the middle and narrowed towards each end, straight or curved, 1–7 (10) septate, up to 56 × 4.5 μm (Fig. 1 B). Sclerotia subepidermal, immersed in the mesophyll and not erumpent, ovoid, up to 270 μm diam, with an outer layer of thick-walled dark-brown cells (Fig. 1 C). Conidia germinate after 4 h in a drop of water in a moist chamber at 28 °C and produce germ-tubes from any cell.

Pinkish gelatinous spore masses have been recorded on natural substrata in wet conditions by Wernham & Kirby (1943), Ciccarone (1949), Sprague (1950) and Tarr (1962), but conidial production is not always in gelatinous masses under dry conditions.

Cultural characters. Single conidial isolations from infected leaves of Sorghum vulgare on potato-dextrose agar showed no morphological variation. Colonies on oatmeal agar after 10 days at 28° were circular, 6.5 cm diam,
Fig. 1. *Gloeocerospora sorghi*. A Stroma and conidiogenous cells bearing conidia; B, conidia; C, sclerotium; D, conidiogenous cells bearing conidia in culture from a part of sporodochium.
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with an entire margin. Aerial growth scanty, dull white. Sporodochia and sclerotia were formed independently of each other. Sporodochia pink, spherical to subspherical, raised, up to 0.5 mm diam, scattered or gregarious, often confluent and forming irregular patches, composed of radial hyphae with short conidiogenous cells (Fig. 1D). Conidiogenous cells colourless, broadly vesicular, aseptate, unbranched, determinate, solitary or in clusters, apical or lateral, 10–14 × 1–3 μm (Pl. 35, figs. 1, 2). Conidial scar terminal, minute, unthickened. Conidia colourless, filiform, often wider in the middle and attenuated towards each end, straight or curved, multisepitate (often more than 10 septate), smooth, slimy, 50–125 × 1–3 μm (Pl. 35, fig. 3). Sclerotia black, spherical to subspherical, raised, up to 0.5 mm diam, scattered or gregarious, often confluent and forming irregular patches.

Bain & Edgerton (1943) gave the length of the conidia as 20–195 μm and this figure was repeated by Deighton (1971) when providing a Latin description to validate the name *G. sorghi*. A re-examination of the slide mounts prepared from the type material and dried culture (BPI) show that the conidia, like those of the Indian specimens and cultures, do not exceed 125 μm in length and it seems probable that the maximum figure of 195 μm given by Bain & Edgerton is a typographic error.

*G. sorghi* occurs on *S. vulgare* in India and is often common on this host in many tropical and subtropical territories. Numerous specimens in Herb. IMI were examined, from Nigeria, Chad, Ghana, Zambia, Tanzania, Rep. Sudan, Ethiopia and Western Malaysia, on this host.

Sprague (1950) records *G. sorghi* on *Agrostis, Saccharum* and *Zea* in addition to *Sorghum*.

Two collections on *Pennisetum typhoides* are similar to the specimens of *G. sorghi* on *Sorghum* but the conidiogenous cells are somewhat wider (3.2–5.5 μm) and more ventricose.

**Specimens examined.** On *Sorghum vulgare*, Chandigarh, Sept. 1966, G. S. Rawla, IMI 153486; dried and living cultures, IMI 165194; *Pennisetum typhoides*, Guctula, Northern Cameroon, S. B. King 954 (IMI 136308); 100 miles south of Fort Lamy, Chad, S. B. King 958 (IMI 136309).


The following detailed description is based on Indian material on *Sorghum vulgare* Pers. and *S. halepense* (Linn.) Pers. The cultural details are from a study of Indian isolates.

Leaf spots circular (up to 2 mm diam), elliptical or oblong (up to 165 × 26 mm), purple-brown or reddish brown, in the centre straw-coloured or sooty (due to sclerotial development), with a yellow halo, often coalescing and covering the entire surface of the leaf blade: sometimes appearing as elongate stripes up to 50 × 2 mm, purple-brown or reddish brown, with or without a straw-coloured or sooty centre, often coalescing. *Mycelium* both internal and external (internal well-developed, external scanty), composed of inter- and intracellular hyphae, pale-brown to brown, septate, branched, up to 3.5 μm wide. Stroma absent or up to 60 μm wide.
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and 40 μm high, prosenchymatous or pseudoparenchymatous, substomatal or subepidermal. Conidiophores colourless or slightly ochraceous, simple or sometimes with a short lateral branch or bifurcate, cylindrical, straight or curved, sympodial, very slightly geniculate at the old conidial scars which are unthickened and inconspicuous, 0–2 septate, 10–55 × 1.5–2.5 (3.5) μm (Fig. 2 C). The conidiophores emerge through the stomata or are erumpent through the cuticle above or between epidermal cells, singly or more usually in loose or compact fascicles of parallel or slightly divergent conidiophores arising from the stromata (Fig. 2 A). Sometimes a sporodochium-like body is formed consisting of a compact hemispheroid to ovoid pseudoparenchymatous mass from the peripheral cells of which conidia may be produced when these cells are not sclerotized (Fig. 2 B). Sometimes short conidiophore-like hyphae in a fascicle emerging through a stoma become swollen and sclerotized at the apex, the walls becoming thick and brown, and sometimes an apical sclerotized cell is cut off by a septum: sometimes the whole cell mass above a stoma becomes gradually sclerotized from the periphery towards the centre to form a conspicuous external sclerotium. Sclerotia usually 75–182 μm (occasionally up to 240 μm) wide and up to 80 μm high, black, arranged concentrically or in lines. Conidia colourless, filiform, narrowly obclavate or cylindrical, straight or curved, 2–10 septate, 26–90 × 1.5–3.5 μm, unbranched or with 1–3 lateral branches which are 0–3 septate and 7–46 × 1.5–2.5 μm (Fig. 2 F). The conidia are produced in pink gelatinous masses under humid conditions. Germ-tubes are produced from apical and intercalary cells of the conidia after 5 h in a moist chamber in distilled water and in 2 % water agar. Sometimes some or all of the cells swell during germination. The germ-tubes may produce secondary conidia sympodially (Fig. 2 E): they were never seen originating from the lateral branches of a conidium.

IMI 153076 on S. halepense is a new host record for India.

Cultural characters. The colonies of several monosporic isolates on potato-dextrose agar did not show any morphological variation at 28°. After 15 days at 28° the colony was of an average diameter of 20 mm, almost circular, compact, crumpled with an entire narrow white margin and dark grey aerial growth producing irregular gelatinous spore masses, pink turning black with age. Reverse opaque. The hyphae were colourless to dark-brown, short to long-celled and up to 6 μm wide. The shape and size of the conidiophores and conidia were similar to those in nature. The conidiophores were produced singly or were connate in pseudoparenchymatous masses (Fig. 2 D). No sclerotia were produced in cultures up to 1 month old. In liquid culture, the fungus requires Fe, Zn, Mn and Mo for its growth. (The data on nutritional requirements of the fungus are taken from unpublished work of Rawla et al.)

R. sorghi is common on Sorghum spp. in many tropical and subtropical territories. Numerous specimens are deposited in Herb. IMI, from Nigeria,

Fig. 2. Ramulispora sorghi. A, Stroma, conidiophores and conidia; B, pseudoparenchymatous mass of cells of a sporodochium-like body bearing conidia on peripheral cells; C–D, conidiophores in culture; E, germ-tubes bearing secondary conidia sympodially; F, conidia in nature.


**OTHER RAMULISPORA SPECIES ON GRAMINEAE**

In addition to *R. sorghi* only two other species of *Ramulispora* have been described on grasses: *R. sorghicola* Harris (1960) on *Sorghum* and *R. alloteropsis* Thirum. & Naras. on *Alloteropsis*.

*R. sorghicola* is distinguished from *R. sorghi* in causing smaller suborbicular leaf spots and, in particular, in producing shortly setose sclerotia which are sparingly scattered over the spots and never as abundant and densely crowded as in *R. sorghi*: its conidia and sporogenous cells are indistinguishable from *R. sorghi*.

**RAMULISPORA ALLOTEROPSIS** Thirumalachar & Narasimhan, *Sydowia* 4: 72 (1950) (as ‘*alloteropsidis*’).

Leaf spots oval to oblong and sometimes appearing as stripes, up to 8 x 3 mm, ochraceous to brown. Stroma substomatal, consisting of a few pseudoparenchymatous cells. *Conidiophores* emerging in fascicles through the stomata, colourless, cylindrical, straight or curved, simple or sometimes with a short lateral branch or bifurcate, 0–1 septate, up to 16 x 2.2 μm, sympodial, very slightly geniculate at the conidial scars which are unthickened and inconspicuous (Fig. 3A). Conidiophores parallel or slightly divergent in the fascicle. No sclerotia observed. *Conidia* colourless, straight or curved, filiform, narrowly obclavate or cylindrical, unbranched, 3–5 septate, up to 52 x 1.5–2.2 μm.

Thirumalachar & Narasimhan say the conidia were mostly 25 x 1.25 μm,
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often with 1–2 lateral branches, but no branched conidia were seen in the part of the type examined.

The above description of *R. alloteropsis* is based on an examination of the portion of the type collection, IMI 48267, on *Alloteropsis cimicina* Stapf, India.

A number of collections of *Ramulispora* on various other grass genera belonging to the tribe Paniceae are deposited in Herb, IMI. No morphological characters could be found whereby they could be distinguished from *R. alloteropsis*, and unless future cultural studies indicate a difference it is considered best at present to include all in this species. The conidia seen in all specimens were unbranched and no sclerotia were present.


**Ramulispora sacchari** sp.nov.

Maculae ellipticae, usque 9 x 2 mm, vel lineares et usque 35 x 1 mm, rubrobrunneae centro stramineo. Stroma nullum vel parvum. Conidiophore incoloria, singularia vel laxe fasciculata, cylindrica, sympodialia, 8–28 x 0.5–1.5 μm. Conidia in gregibus gelatinosis subroseis producta, incoloria, anguste obclavata vel cylindrica, recta vel curvata, simplicia vel ramis lateralis 1–3 praedita, usque 5 septata, 11–48 x 1.5–2.2 μm. Sclerotia parva, usque 30 μm diam. In agaro cultura, conidiophora saepe in strato valliformi producta.

Habitat in foliis vivis *Sacchari officinar* Linn., Chandigarh, India, Nov. 1969, leg. G. S. Rawla, IMI 153075, holotypus.

A *Ramulispora sorghi* differt conidiophoris angustioribus, conidiis brevioribus, sclerotis minoribus, et characteribus in cultura.

Leaf spots oval, elliptic or fusiform, up to 9 x 2 mm, sometimes elongated and 7–35 x 0.5–1 mm, reddish brown usually with a straw-coloured centre and surrounded by a yellow halo which becomes wider in older spots, often coalescing. Mycelium internal: hyphae pale-brown to brown, septate, branched, up to 3.5 μm wide, inter- and intracellular. Stroma absent or consisting of a few substomatal layers of thick-walled brown cells. Conidiophores emerging through the stomata singly or in loose fascicles in which they are slightly divergent (Fig. 4A), colourless, cylindrical, straight or curved, simple or sometimes with a short lateral branch or bifurcate, 8–28 x 0.5–1.5 μm, sympodial, the old conidial scars unthickened and inconspicuous (Fig. 4D). Sometimes the conidiophore fascicle develops above the stoma into a pseudoparenchymatous mass the peripheral cells of which are often conidiogenous, and in the centre of this mass a small black sclerotium, up to 30 μm diam, may be formed (Fig. 4B). Sometimes short conidiophore-like hyphae emerging in a fascicle through a stoma become swollen and sclerotized as in *R. sorghi*. Conidia produced in gelatinous pink masses, colourless, narrowly obclavate or cylindrical, straight or curved, up to 5 septate, 11–48 x 1.5–2.5 μm (Fig. 4C). The conidia produce germ-tubes from their apical and intercalary cells.
Fig. 4. *R. sacchari*. A, Stroma, conidiophores and conidia; B, sclerotium above the conidiophores; C, conidia; D–F, conidiophores in culture; E, germ-tubes secondary conidia; G, conidial germination.
after 5 h in a moist chamber in distilled water or in 2% water agar. Sometimes some or all of the conidial cells swell during germination (Fig. 4G). The germ-tubes produce secondary conidia (Fig. 4E): they were never seen originating from a lateral branch.

Cultural characters. The colonies of several monoconidial isolates on potato-dextrose agar at 28° showed no morphological variation. After 15 days the colony was circular with total average diameter of 10 mm, and consisted of a pin-head sized centre with grey-black aerial growth, surrounded by a gelatinous or butyrous zone, subreticulate and resembling a bacterial growth. Reverse of colony opaque. Hyphae colourless to brown, short and long celled, up to 6 μm wide. Conidiophores produced singly or in a palisade-like layer (Fig. 4F), 20–38 × 1.5–4.5 μm. Conidia up to 5 septate, 8–38 × 1.5–2.5 μm, unbranched or with 1–3 lateral branches which are 0–3 septate and 5–15 × 1.5 μm. The conidiophores and conidia are otherwise similar to those produced in nature. No sclerotia were produced in cultures up to 1 month old. In liquid culture, the fungus requires for its growth Fe, Zn, Mn, Cu, Mo, Co, B, thiamine, biotin, pyridoxine and inositol.

R. sacchari differs from R. sorghi in its narrower conidiophores, shorter conidia and smaller sclerotia, and in culture in its butyrous or gelatinous growth, in the production of conidiophores in palisade-like layer and in its additional requirements of Cu, Co, B, thiamine, biotin, pyridoxine and inositol.

The herbarium specimen (IMI 93630) from New Guinea shows elongated stripes on the leaves, and the conidia are unbranched, 26–44 × 2.2 μm.

Specimens examined. On Saccharum officinarum, Chandigarh, India, Nov. 1969, G. S. Rawla, IMI 153075, holotype; also dried and living cultures; road to Frames, Goroka, New Guinea, 14. vi. 1962, D. Shaw 3554 (IMI 93630).

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Ramulispora species on other Gramineae

The following specimens in Herb. IMI were examined: on Imperata cylindrica (Linn.) P. Beauv., Nigeria (IMI 70058, 81792); on Polytoca macrophylla Benth., Papua (76742); and on Vetiveria nigritana (Benth.) Stapf, Ghana (70743). No sclerotia were seen on any of these specimens. Conidia on Imperata were up to 5 septate, 26–77 × 2.2 μm, unbranched or with 1–2 lateral 2–3 septate branches up to 16 × 1.5 μm. A very few small conidia, all unbranched, up to 24 × 2.2 μm, were seen on Vetiveria: the material is not sporulating well. On Polytoca the conidia were 1–7 septate, 55–120 × 2.2 μm, all unbranched.

Until further collections are available it seems inadvisable to identify these specimens further than to genus. Imperata and Vetiveria belong, like Sorghum, to the tribe Andropogoneae and Polytoca to the Maydeae.

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REFERENCES


EXPLANATION OF PLATE 35

*Gloeocercospora sorghi*

Fig. 1. Part of sporodochium in culture.

Fig. 2. Conidiogenous cells and the conidia.

Fig. 3. Conidia.

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