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NEW SPECIES OF TORRUBIELLA, HIRSU- TELLA AND GIBELLULA¹

H. B. MAINS

(WITH 2 FIGURES)

Torrubiella pulvinata sp. nov. (FIG. 1, A & B)

Mycelium album, corpus hospitis tegente et ad articulos floccos creante; perithecia partim immersa vel superficialia in pulvino mycelii, ovoidea, 450-600 \times 220-270 μ , brunnea, a tenui tunica flavi mycelii tecta; asci cylindrici, 450 \times 4.5-6 μ , deorsum attenuata, tenuibus membranis, ad apices membranis spissatis 2.5-3 μ ; ascosporae filiformes, 0.5-0.7 μ crassae, multiseptatae, cellis 4-8 μ longis; conidiophora e mycelio, sparsa vel caespitosa, 2-2.5 μ crassa, sursum capitulis phialidum; phialides anguste fusoides-ovoideae, sursum acuminatae, 8-12 \times 2 μ ; conidia hyalina, fusoides-ellipsoidea, 2-3 \times 1.5-2 μ , catenulata.

Ex Opilionioidis, Waianuka, Oahu, Hawaii. Dec. 9, 1945, D. P. Rogers (2090).

Mycelium white, covering the body of the host and developing tufts on the legs specially at the joints; perithecia partly embedded or superficial on a pulvinate mass of mycelium, ovoid, 450-600 \times 220-270 μ , brown, covered by a thin layer of yellow mycelium; asci cylindric up to 450 μ long, 4.5-6 μ wide, narrowing toward the base, the wall thin, thickened at the apex, 2.5-3 μ ; ascospores filiform, 0.5-0.7 μ thick, multiseptate, the cells 4-8 μ long; conidiophores arising from the mycelium, scattered or crowded, 2-2.5 μ wide, phialides grouped in whorls or heads in the upper part of the conidiophores or occasionally from short lateral hyphae, narrowly fusoid-ovoid, acuminate above, 8-12 \times 2 μ ; conidia hyaline, fusoid-ellipsoid, 2-3 \times 1.5-2 μ , catenulate.

On Opilionioides, south fork of Kaulaonahua, 1100 ft., Waianuka, Oahu, Hawaii, Dec. 9, 1945, D. P. Rogers, 2090, type. (Univ. of Mich. and N. Y. Bot. Gard.)

The hosts of this collection are so severely parasitized that accurate determination is difficult. They appear to be arachnids belonging to the Opilionioides. The conidial stage resembles *Spi-*

¹ Paper from the Herbarium and the Department of Botany of the University of Michigan.

caria longipes Petch. In the latter species the phialides generally develop from short hyphal branches. Petch (7) states that *S. longipes* is the conidial stage of *Torrubiella gonylepticida* (Möller) Petch. *T. gonylepticida* differs from *T. pulvinata* in having the

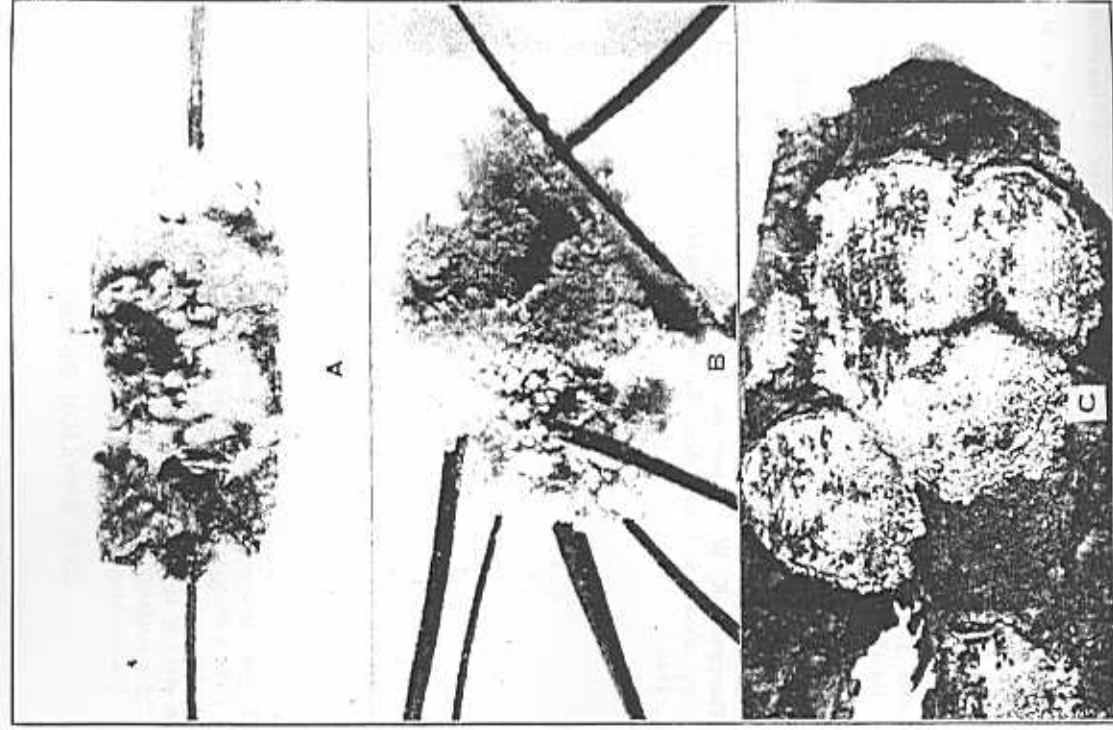


FIG. 1. *Torrubiella pulvinata* and *T. confragosa*.

perithecia scattered over the entire body and appendages of the host developing from a very scanty superficial mycelium. Möller (2) describes the perithecia of *T. gonylepticida* as orange red, flask-shaped, 300–400 μ long, and the asci as 170 \times 3 μ . Since it is desirable to have a name for the conidial stage, *Spicaria pulvinata* is proposed for that of *T. pulvinata*.

***Torrubiella confragosa* sp. nov. (Fig. 1, C)**

Mycelium tenue, album vel cremenum, hospitem tegente, floccosum, pulverulentum; perithecia irregulariter sparsa vel congesta, superficialia vel paululum immersa, ovoides, 350–650 \times 200–375 μ , rubro-brunnea vel castanea, muris 20–35 μ crassis ex duobus stratis constructis, interno strato rubro-brunneo, externo strato brunneo-flavo; asci cylindrici, 200–350 \times 3.5–4 μ , tenuibus membranis, ad apices membranis spissatis 2–2.5 μ ; ascospores filiformes, multiseptatae; synnemata summe brevia, 300–800 μ longa, 80 μ crassa, cylindrica, interdum furcata; phialides 14–20 μ longae, dorsum 1.5 μ latae, sursum attenuatae, acuminatis apicibus; conidia oblonga, 3–4 \times 1.5–1.7 μ , mucro tecta, 2–5 in giculis congregata.

In Cocciis, Novo Petropolis, Brazil, May 1923, Rick, specimen typicum; Baycaux, Haiti, J. R. Weir.

Mycelium thin, white to cream color, covering scale insects and extending slightly beyond on the substratum, slightly tufted, pulverulent; perithecia irregularly scattered to crowded over the scale, superficial or slightly embedded at the base in the mycelium, ovoid, 350–650 \times 200–375 μ , reddish brown to dark chestnut brown, the wall 20–35 μ thick and consisting of two layers, the inner reddish brown, the outer brownish yellow; asci cylindrical, 200–350 \times 3.5–4 μ , the wall thin, thickened at the apex, 2–2.5 μ ; ascospores filiform, 0.5 μ wide, almost as long as asci, multiseptate, part-spores not seen; synnemata very short, 300–800 μ long, 80 μ thick, cylindrical or furcate with short irregular branches, consisting of loosely interwoven hyphae; phialides arising from the outer hyphae or from short lateral hyphae, 14–20 μ long, 1.5 μ wide below, gradually narrowing to an acuminate apex; conidia oblong, 3–4 \times 1.5–1.7 μ , produced in a mucro, often in clumps of 2 to 5.

On large scale-insects, Novo Petropolis, Rio Grande do Sul, Brazil, May 1923, Rick, type (Univ. Mich. and Farlow Herb.); Baycaux, Haiti, J. R. Weir (Univ. Mich. and Mycol. Coll. Brit. Plant Ind. Washington, D.C.).

Both of these collections were received as *Torrubiella rubra*. *T. rubra* develops perithecia only at the margin of the mycelium cover-

ing the scale or on a hypothallus and the asci are much larger than those of *T. confragosa*. Petch (3) describes a conidial stage for *T. rubra* which differs considerably from that of *T. confragosa*. The latter can best be classified as a *Hirsutella*, although the synnemata are poorly developed. The scattered phialides and clumped spores in a surrounding mucus are characteristic of that genus. Since the conidial stage of fungi of this group frequently develop without the perithecial stage it is convenient to have a name applying to it and consequently *Hirsutella confragosa* is proposed.

Torrubiella liberiana sp. nov. (Fig. 2, A)

Perithecia albidobrunnea, ex myceliis in articulis hospitis erumpentia, partim immersa, ovoidea, 300–400 × 150–200 μ; asci cylindrici, tenues, 210 μ longa, 3–4 μ crassa, tenuibus membranis, ad apices membranis spissatis, 2 μ; ascospores filiformes, multiseptatae, fragentes, segmentis 3–4 × 0.5–0.7 μ.

Ex formica, Bonata, Liberia, Dec. 8, 1947, J. T. Baldwin, Jr.

Perithecia light brown, developing in small white patches of mycelium at the joints of the appendages and of the body, partly embedded, ovoid, 300–400 × 150–200 μ; asci cylindrical, slender, up to 210 μ long, 3–4 μ wide, wall thin, thickened at the apex, 2 μ; ascospores filiform, nearly as long as the asci, multiseptate, breaking into one-celled fragments, 3–4 × 0.5–0.7 μ.

On an ant, Bonata, Central Province, Liberia, Dec. 8, 1947, J. T. Baldwin, Jr. (Univ. Mich.), type.

As far as the writer is aware, this is the first report of a species of *Torrubiella* on ants. It occurs in close association with synnemata of a *Hirsutella* which may be the conidial stage. However, it was separated from a collection of ants which were mostly parasitized by *Cordyceps australis*. A *Gibellula* also occurs on a few specimens. The relationship of these fungi is therefore very uncertain and it seems best to describe them separately.

Hirsutella liberiana sp. nov. (Fig. 2, B)

Synnemata pauca, sparsa, ex exiguis albidis myceliis plerumque in articulis erumpentia, albida, tenuia, cylindrica, 3 mm. longa, dorsum 100 μ crassa, sorsum paululum attenuata, simplicia vel internum furcata; phialides sparsae vel congregatae, plerumque nonnullae ex brevibus lateralibus hyphis erumpentes, dorsum fusoido-ellipsoideae vel fusoido-oblongae, 8–12 × 3 μ.

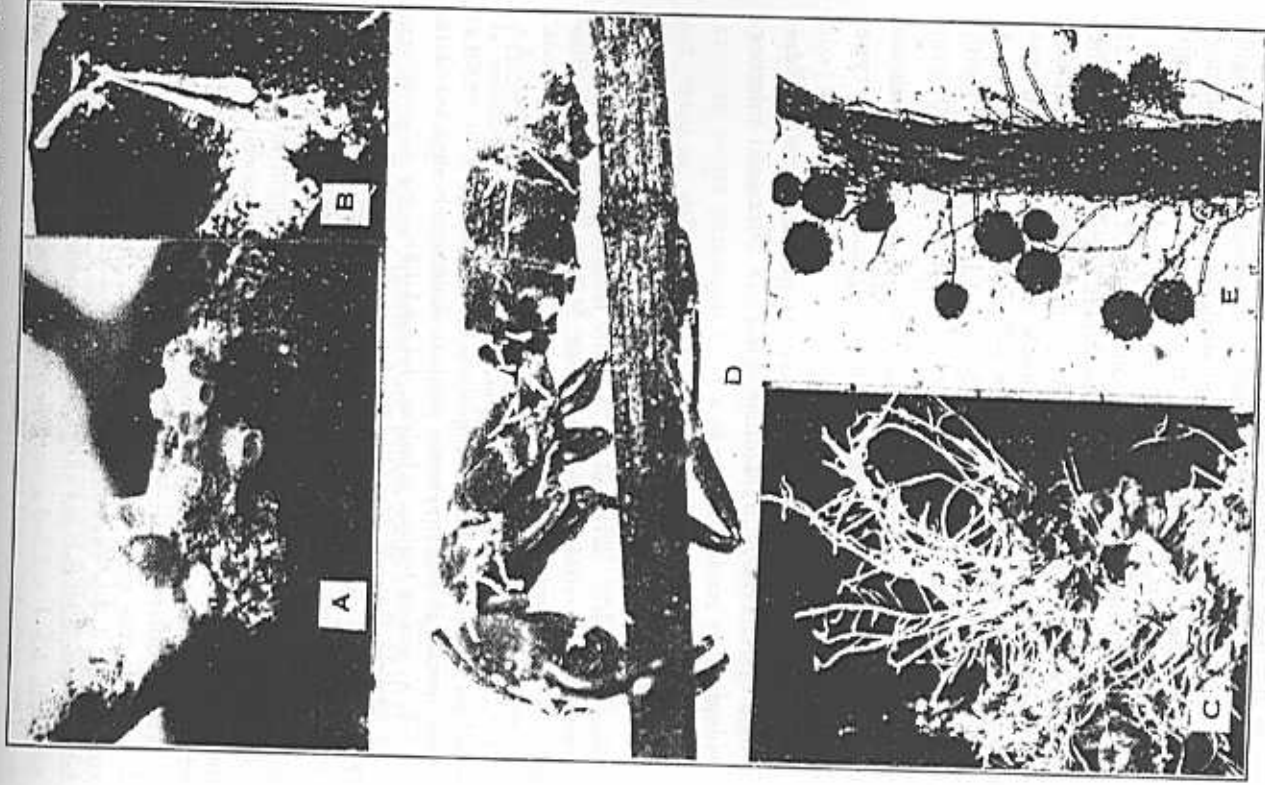


FIG. 2. *Torrubiella*, *Hirsutella* and *Gibellula*

sursum attenuatae quisque 10-14 μ longo sterigmata: conidia cylindrica, 3-4 \times 0.7-1.0 μ ; musco tecta, in glebulas congregata.

Ex formica, Bonata, Liberia, Dec. 8, 1947, J. T. Baldwin, Jr.

Synnemata few, scattered, arising from a slight whitish mycelium, usually from the joints of the body and the appendages, whitish, slender, cylindrical, slightly narrowing upward, up to 3 mm. long, 100 μ thick, simple or occasionally branched above; phialides scattered to crowded, usually several arising from short, one-celled lateral hyphal branches from the outer hyphae of the synnemata, the lower part fusoid-ellipsoid to fusoid-oblong, 8-12 \times 3 μ , the upper part prolonged into an attenuated, acuminate sterigma, 10-14 μ long, each producing several conidia which adhere together in a persistent mucus; conidia cylindrical, rounded at both ends, 3-4 \times 0.7-1.0 μ .

On an ant, Bonata, Central Province, Liberia, Dec. 8, 1947, J. T. Baldwin, Jr. (Univ. Mich.). type.

Petch (6) has described *Hirsutella formicarium* on ants from British Guiana and Ceylon and has stated that it is the conidial stage of *Cordyceps unilateralis*. He describes the conidia as narrowly cylindrical, 9-11 \times 2 μ . In an earlier publication (4) he described the conidia of the Ceylon specimens as oval, 3-5 \times 1 μ . Kobayasi (1) has identified Japanese collections on ants as *H. formicarium*, describing the conidia as ovoid, ellipsoid or fusiform, 3-4.2 \times 1.5-2 μ . It would seem probable that more than one species is concerned. *Hirsutella liberiana* is distinguished by its cylindrical narrow conidia. It was associated with perithecia of *Torrubiella liberiana* which is described herein.

Hirsutella ramosa sp. nov. (FIG. 2, C)

Synnemata multa, gregaria, tenuia, irregulariter ramosa, 8 mm. longa, dorsum 52-140 μ crassa, sursum attenuata, acuminatis apicibus, dorsum albedo-flava, sursum alba, multis albis rectis vel obliquis ramulis; phialides sparsae vel 1-3 caespitosae, hyalinae, subulatae, 19.3-36.4 μ longae, dorsum 2.1-3.2 μ crassae, sursum attenuatae, acuminatis apicibus; conidia oblonga, 3.2-5.5 \times 1.1-1.4 μ , tenui musco tecta, in parvas globositas 4.3-6.4 μ dia. congregate.

Ex larva lepidopterica, Salmon River, Nova Scotia, Sept. 7, 1931, L. E. Wehneyer (1474).

Synnemata numerous, arising from all parts of the host, slender, irregularly branched, the main stem up to 8 mm. long, 52-140 μ

thick at the base, gradually narrowing to acuminate apices, light yellow below, white above, the branches numerous, white, at right angles or slightly oblique to the main stem, occasionally producing secondary branches, the hyphae in the stem and branches longitudinal and parallel, multiseptate, 2 μ wide; phialides hyaline, minutely roughened, subulate, 19.3-36.4 μ long, 2.1-3.2 μ wide at the base, gradually narrowing to an acuminate apex, scattered on the upper part of the stem and branches giving a setose appearance, arising singly directly from a cell of the outer hypha of the synnema or 1-3 at the apex of short, 6.4-10.7 μ , laterally projecting cylindrical hyphae; conidia oblong, 3.2-5.5 \times 1.1-1.4 μ , covered with a slight mucus, adhering to form small, 4.3-6.4 μ , spherical clumps.

On fragments of a lepidopterous larva on a mossy log, Salmon River, Nova Scotia, Sept. 7, 1931, L. E. Wehneyer, 1474, type (Univ. Mich.).

The much branched synnemata and narrow subulate phialides distinguish *H. ramosa* from other species of *Hirsutella* infecting Lepidoptera.

Gibellula formicarium sp. nov. (FIG. 2, D & E)

Synnemata sparsa, plerumque ex articulis hirsutis erumpentia, albidobrunnea, anguste cylindrica, 1-2 mm. longa, 50-150 μ crassa, exterioribus hyphis laxis brunneis asperulatis; conidiophora 50-150 μ longa, 2-4-septata, inferioribus cellulis 3-5 μ latis, asperulatis, superiore cella obovoidea, 7-8 \times 4-8 μ , levi, hyalina, globosum vel cylindricum capitulum proprialitium et phialidium gerentis; prophialides ellipsoideae vel subglobosae, 3.5-4 \times 2.5-3 μ , quisque paucam phialidem gerentis; phialides ovoideae vel cylindricae, 4-14 \times 1.5-2.5 μ ; conidia hyalina, cylindrica, 3-4.5 \times 1-1.5 μ .

Ex formicis, Bellefleur-Kondessu-Zui, Liberia, Dec. 1947, J. T. Baldwin, Jr., specimen typicum: Bonata, Liberia, Dec. 8, 1947, J. T. Baldwin, Jr.

Synnemata scattered, arising from various parts of the body and appendages of the host, usually at the joints, very light brown, narrowly cylindrical, 1-2 mm. long, 50-150 μ thick, composed of longitudinal somewhat interwoven hyphae, the outer, loose, brown, asperulate; conidiophores arising from short lateral prolongations of cells of the outer hyphae, 50-150 μ long, 2-4-septate, the lower cells 3-5 μ wide, the walls brownish, asperulate, the terminal cell obovoid, 7-8 \times 4-8 μ , smooth, hyaline, bearing a globose to cylindrical head of prophialides and phialides; prophialides ellipsoid to sub-spherical, 3.5-4 \times 2.5-3 μ , each bearing several phialides; phialides ovoid to cylindrical, 4-14 \times 1.5-2.5 μ ; conidia hyaline, cylindrical, rounded at the ends, 3-4.5 \times 1-1.5 μ .

irregularly branched, the main stem up to 8 mm. long, 52-140 μ ovoid to cylindrical, 4-14 \times 1.5-2.5 μ ; conidia hyaline, cylindrical, rounded at the ends, 3-4.5 \times 1-1.5 μ .

On ants, along the route Bellefleur-Kondessu-Zui, Western Province, Liberia, Dec. 8, 1947, J. T. Baldwin, Jr. (Univ. Mich.).

The specimens were included in collections of *Cordyceps australis* (Speg.) Sacc. which were received from Dr. Baldwin. The collections were composites collected from several localities. The synnemata of *Gibellula formicarium* were not found associated with clavae of *C. australis* upon the same insect and therefore the ascogenous stage is uncertain. Petch (5) has reported that the conidial stage of *C. australis* is an *Hymenostilbe*.

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EXPLANATION OF FIGURES

FIG. 1. A & B. *Torrubiella pulvinata*. A. Pulvinate mass of mycelium bearing perithecia arising from a leg of the host. $\times 12$. B. Body of a host covered by a mass of mycelium and conidiophores. $\times 7$. C. *Torrubiella confusagosa*. Large scale-insects covered with a thin layer of mycelium-bearing synnemata and perithecia. $\times 4$.

FIG. 2. A. *Torrubiella liberiana* showing perithecia developing on a small mass of mycelia at the base of an antenna of an ant. $\times 25$. B. *Hirziella liberiana* showing synnemata arising from a small patch of mycelium on an ant. $\times 7$. C. *Hirziella ramosa* showing the branched synnemata. $\times 7$. D & E. *Gibellula formicarium*. D. An ant showing the scattered synnemata on various parts of the body. $\times 7$. E. A portion of a synnema showing capitate conidiophores (stained with nigrosin). $\times 200$.

PHASE-DETERMINING FACTORS IN BLASTOMYCES DERMATITIDIS

S. E. SALVIN

(WITH 2 FIGURES)

Blastomyces dermatitidis, the causative organism of North American blastomycosis, is characterized by the development (a) of aerial hyphae with numerous microconidia at room temperature, and (b) of large thick-walled predominantly single-budding cells at 37° C. The mycelial phase has been grown on a wide variety of complex media at room temperature, but the budding or yeastlike phase has been grown principally on beef-infusion or blood agars at 37° C.

The process of conversion from one growth phase to the other has been studied since the turn of this century, but is still not completely understood. Ricketts (8) and Hamburger (4) were among the first to examine the growth of the fungus "in vitro," and indicated that temperature was a most influential factor in determining the morphologic type. This fact has since been confirmed by others, such as Michelson (7), DeMonbreun (3), and Levine and Ordal (6). Levine and Ordal (6) also reported pH as being relatively unimportant in determining the type of growth.

Almost all this work, however, has been done in complex and not chemically defined media. Hence, little is known about the possible influence of nutrient factors on the conversion of the organism from one phase to the other. Investigations were therefore initiated on the nutritional requirements of the yeastlike and mycelial phases. This paper reports the effect of growth factors, amino acids and carbohydrates on the development of *B. dermatitidis* in the mycelial and yeastlike phases.

MATERIALS AND METHODS

The three strains of *B. dermatitidis* used in the present studies were from the collection maintained in this laboratory, and were