SCLEROTINIA CARUNCULOIDES, THE CAUSE OF A SERIOUS DISEASE OF THE MULBERRY (MORUS ALBA)[1]

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In 1903, Orton[2] described a disease of the mulberry characterized by the "peculiarly enlarged portions of the aggregated fruit." The disease was said to occur in Georgia, Alabama, and Mississippi. Dr. M. B. Waite, Pathologist in Charge, Office of Fruit Disease Investigations, Bureau of Plant Industry, states that specimens of mulberry fruits showing this condition have been received from various southern States by the United States Department of Agriculture a number of times during the past 20 years. Taubenhaus[3] reports the occurrence of this disease in Texas, where it is known under the name of "popcorn" disease of mulberry.

In July, 1920, specimens of diseased mulberry fruits (*Morus alba* L.) were received from Scranton, S. C. Specimens of this material show the greatly enlarged condition of the ovary (Pl. 1, A), and the calyx lobes are small and nonsucculent instead of being fleshy as in the normal fruits. Upon microscopical examination the ovaries are found to be entirely filled with mycelium and all traces of host tissue are lost. The hyphae are compact, producing a typical sclerotium, and preventing the formation or further development of drupelets. A layer of sporogenous hyphae completely envelops this sclerotium and produces small hyaline spores in a compact palisade within the ovary wall (Pl. 1, B). The spores, presumably microconidia, are often exuded in immense numbers and collect in what resembles a waxy mass on the outside of the ovary wall (Pl. 1, C, *a*). It is interesting to note the occurrence of microconidia on the diseased fruit, as no reference to microconidia of species of Sclerotinia occurring other than on culture media has been found in the literature. This disease undoubtedly is the same as that reported by Orton.[4]

The nature of the disease led us to suspect that we had either a species of Sphacelia, or, more probably, the microconidial stage of the genus Sclerotinia. It was thought that infection probably occurred at the blooming period of the host and resulted in the formation of such a sclerotium. Accordingly on March 18, 1921, an inspection was made of the planting in South Carolina from which diseased specimens had been received in 1920. At that time apothecia (Pl. 2, A) of a fungus belonging to the genus Sclerotinia were found in large numbers on the ground beneath the infected trees. The apothecia were attached to the infected

[1] Accepted for publication Oct. 28, 1921. The technical description from page 835 of this paper was printed in Science, vol. 55, no. 1422, p. 353, March 31, 1922.

[2] ORTON, W. A. ON A FUNGUS DISEASE OF THE MULBERRY FRUIT. (Abstract.) *In* Exp. Sta. Rec., v. 14, no. 6, p. 531–532. 1903.

[3] TAUBENHAUS, J. J. ON A PECULIAR DISEASE OF MULBERRY FRUIT. *In* Nature Study Rev., v. 17, no. 7, p. 282–285, 3 fig. 1921.

[4] ORTON, W. A. OP. CIT.

seeds (really ovaries) which were buried at an average depth of ½ inch in the soil. The ascospores were found to be mature on this date and capable of germinating in tap water. A microscopical examination of the blossoms showed practically 100 per cent infection at this time. An opportunity was not afforded to inoculate healthy blooms with ascospores.

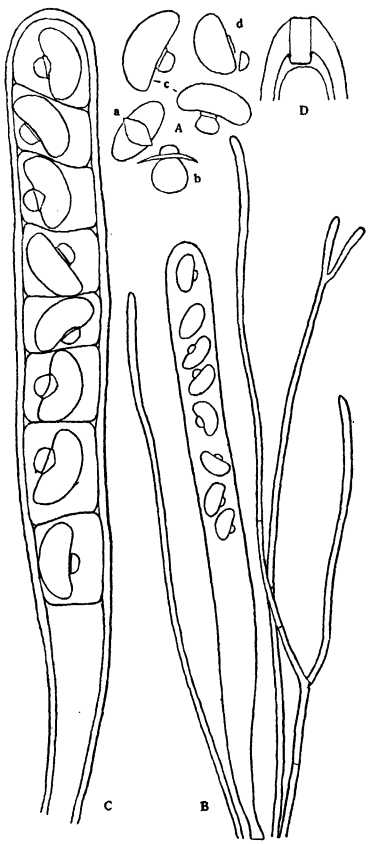

FIG. 1.—*Sclerotinia carunculoides:* Asci, ascospores, and paraphyses. A, Ascospores with bodies adjoining the concave surfaces; *a*, view from above showing rhombic shape of body adjacent to the spore; *b*, transverse section showing crescent shape of the body adjacent to spore; *c*, longitudinal section of spore, showing location of hemispherical body; *d*, spore with hemispherical body dislodged. ×1,600. B, Ascus, ascospores, and paraphyses. ×840. C. Ascus, showing ascospores surrounded by gelatinous membrane producing a cross-walled effect. ×1,600. D, tip of ascus. ×1,600.

Specimens of young blooms not less than 8 feet above the nearest group of apothecia were collected on March 18, placed in a killing solution, embedded in paraffin, and later sectioned. Upon microscopical examination of the prepared mounts typical ascospores (fig. 1, A) were readily found on the pistils. The foregoing observations constitute sufficient evidence to warrant belief in the pathogenicity of the fungus.

No record of a similar disease of mulberry in this country has been found. Two somewhat similar diseases due to *Sclerotinia shiraiana* P. Henn. and *Microglossum shiraianum* P. Henn. have been reported in Japan. In a letter of June 20, 1921, Dr. Shirai, of the Tokyo Imperial University, states that these fungi attack—

> mulberry fruits and form sclerotia just in the same manner ... and occur on the tree at the same time.

He also states that these two fungi can not be distinguished by the forms of the sclerotia but that the fruiting bodies are entirely different. Material of *S. shiraiana* was kindly sent by Dr. Shirai for comparison with the fungus collected in South Carolina. The latter differs in many respects from *S. shiraiana* and especially in its effect on the fruit and in the size and form of the ascospores. In *S. shiraiana* the entire aggregate fruit is transformed into a sclerotium (Pl. 2, B, *a*, *b*), while in our fungus the multiple fruit breaks up and the sclerotia are formed from individual druplets (Pl. 2, A, *b*). There is also greater variation in the size of the druplets in the American material as compared with the specimens from Japan (Pl. 2, B, *c*). A Botrytis stage develops in the fruits attacked by *S. shiraiana*, while in this country there is no record of a Botrytis on mulberry fruit. However, it is possible that a conidial form other than the microconidial may be found in this country.

In connection with the differences in the size and form of the ascospores, it should be noted that the spores of *Sclerotinia shiraiana* are elliptical and are, according to comparison with material received from

Dr. Shirai, slightly larger than the spores of our fungus. The spores of the latter are reniform, and attached to the concave surface of each spore are peculiar bodies (fig. 1, A) which are striking structures morphologically. Viewed under low magnification these bodies resemble a caruncle, (fig. 1, B). Under higher magnification they are seen to be composed of two parts, one a body adjacent to the spore and more or less rhombic in shape as seen from above (fig. 1, A, *a*) and crescent-shaped (fig. 1, A, *b*) in transverse section of the spore, the second a body adjoining the first and more or less hemispherical (fig. 1, A, *c*). No description of similar bodies has been found in the literature on Sclerotinia or on closely related genera. The presence of these caruncle-like bodies made possible the identification of the ascospores on the pistils. Further studies are being made on the nature of these structures. Stained preparations show the spores to be surrounded by a gelatinous-like substance which appears to be broken up into segments in the ascus, so that the ascus has somewhat the appearance of being marked by transverse septa (fig. 1, C). Somewhat similar appearances are shown by Woronin [5] on Plate 10, figures 21 to 23, of his drawings of *Sclerotinia megalospora* Wor. and by Boudier [6] on plate 318 of his drawings of *Peziza cucullata* Boud.

As stated above, this fungus differs morphologically from *Sclerotinia shiraiana*, which produces a somewhat similar but distinct disease in Japan; it also appears distinct from any other described species. The name, *Spermatomyces mori*, gen. nov., sp. nov., which was suggested by Orton (l. c.),[7] referred to the microconidial stage, and since no technical description was published, it must be considered a *nomen nudum*. The fungus is described as follows:

Sclerotinia carunculoides, n.sp.[8]

Apothecia one to several from a single sclerotium, disc cupulate to subcupulate, 4 to 12 mm. in diameter, inside snuff-brown,[9] outside Prout's brown; stalk cylindrical, flexuous, smooth, attenuated downward, 15 to 42 mm. in length, reaching a diameter of 1.5 mm., color Prout's brown; asci cylindrical to cylindro-clavate, 104 to 123μ by 6.4 to 8μ, average 117 by 7μ, 8-spored; ascospores uniseriate, reniform, hyaline, 6.4 to 9.6μ by 2.4 to 4μ, average 7.6 by 3.1 μ, with two bodies on the concave surface: namely, a body more or less rhombic in shape as seen from above, 2 by 4 μ, and adjoining it, a more or less hemispherical body 3 μ in its longest diameter; paraphyses filiform to cylindro-clavate, simple or branched, septate or nonseptate, 94 to 128 μ by 1.8 to 2 μ; microconidia hyaline, subglobose, 2 to 4 μ by 2 to 3.2 μ, average 2.8 by 2.5 μ; sclerotia black, fairly regular, subspherical with depressed surfaces.

On fruits of cultivated *Morus alba*. Type material collected at Scranton, S. C., U. S. A., March. 1921. Specimens have been deposited in the Office of Pathological Collections, Bureau of Plant Industry, United States Department of Agriculture, Washington, D. C.

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[5] WORONIN, Michael. ÜBER DIE SKLEROTIENKRANKHEIT DER VACCINIEEN-BEEREN. ENTWICKELUNGSGESCHICHTE DER DIESE KRANKHEIT VERURSACHENDEN SCLEROTINIEN. Mém. Acad. Imp. Sci. St. Pétersb. sér. 7, t. 36, no. 6, 49 p., 10 col. pl. St. Pétersbourg, 1888.

[6] BOUDIER, Émile. ICONES MYCOLOGICAE OU ICONOGRAPHIE DES CHAMPIGNONS DE FRANCE PRINCIPALEMENT DISCOMYCETES.....t. 2, pl. 318 (col.), t. 4, p. 177. Paris. 1905-1910.

[7] ORTON, W. A. OP. CIT.

[8] *Sclerotinia carunculoides*, sp. nov.

Ascomatibus ex uno sclerotio solitariis vel pluribus exorientibus, discis cupulatis vel subcupulatis, 4–12 mm. diam., intus sternutamento-brunneis, extus "Prout's"-brunneis; stipitibus cylindraceis, flexuosis, glabris, deorsum attenuatis, 15–42 mm. longis, usque 1.5 mm. diam., "Prout's"-brunneis; ascis, cylindraceis vel cylindro-clavatis, 104–123×6.4–8 μ, medio numero 117×7 μ, octosporis; ascosporis uniseriatis, reniformibus, hyalinis, 6.4–9.6×2.4–4 μ, medio numero 7.6×3.1 μ, faciebus superis duo corpusculis praeditis: videlicet corpusculo plano, nonnihil rhombio desuper viso 2×4 μ; et hoc attingente altero corpusculo plus minusve hemisphaerico, longissimo diametro 3 μ; paraphysibus filiformibus vel cylindro-clavatis, simplicibus vel ramosis, septatis vel non-septatis, 94–128×1.8–2 μ; microconidiis hyalinis, subglobosis, 2–4×2–3.2 μ, medio numero 2.8×2.5 μ; sclerotiis nigris, mediocriter regularibus, sphaeroideis, superficiebus depressis.

In fructibus cultis Mori albae, Scranton, South Carolina, U. S. A.

[9] RIDGWAY, Robert. COLOR STANDARDS AND COLOR NOMENCLATURE. IV, 43 p., 53 col. pl. Washington, D. C. 1912.

SUMMARY

Sclerotinia carunculoides, n. sp., is described as causing a disease of fruits of cultivated mulberry (*Morus alba*) completely destroying them as an edible fruit.

The disease is known to occur in South Carolina and has been reported from other southern States.

Ascospores of this fungus have been found on blooms which were collected not less than 8 feet above the nearest group of apothecia.

The occurrence of the microcondidial form of the fungus in the diseased fruit is noted.

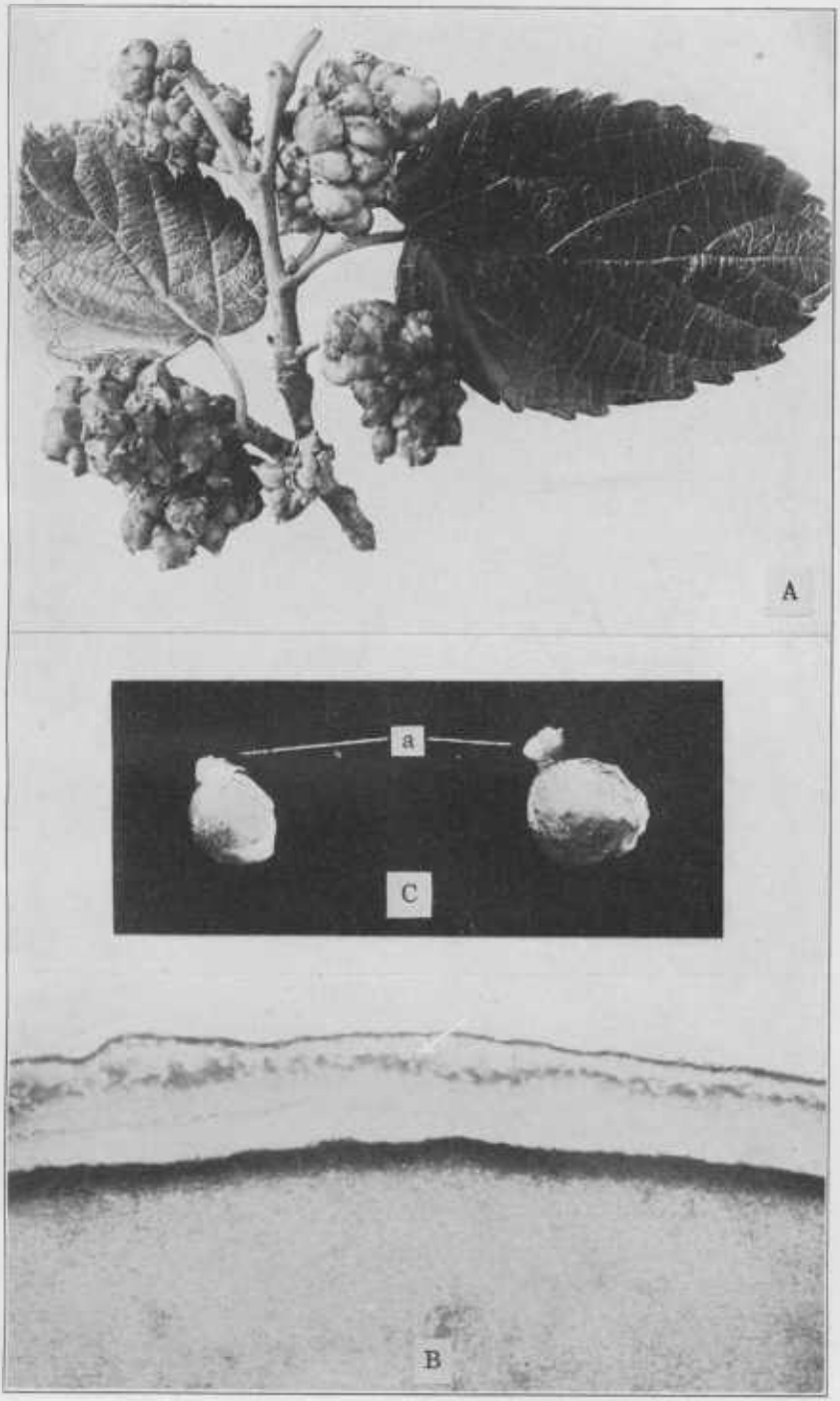
The most striking feature which distinguishes this fungus from others of the same group is the presence of a prominent caruncle-like body on the concave surface of the ascospore.

PLATE 1

A.—Diseased fruits of *Morus alba*, showing the greatly enlarged condition of the ovaries. × 1 1/3.

B.—Photomicrograph of section of infected ovary, showing the sclerotium and layer of microconidia, indicated by arrow. × 75.

C.—Infected ovaries (*a*), mass of microconidia on the outside. × 3.


A
a
C
B

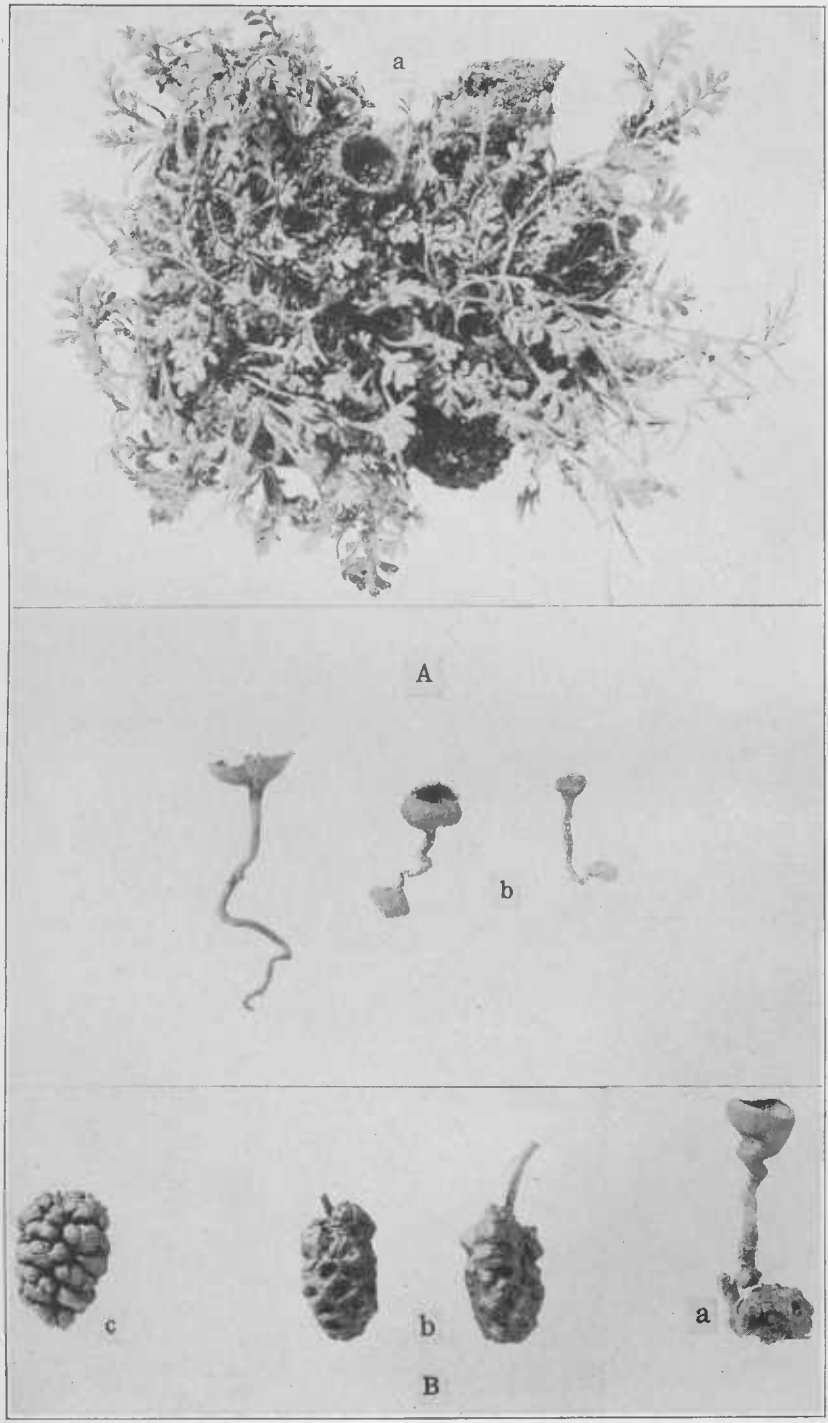

a
A
b
c
b
a
B

PLATE 2

A.—Apothecia of *Sclerotinia carunculoides*: (*a*) in situ, (*b*) attached to old seed (sclerotia). Natural size.

B.—*Sclerotinia shiraiana*: (*a*) apothecium arising from sclerotium composed of entire fruit, (*b*) sclerotia, (*c*) infected fruit, showing the comparative regularity in size of the druplets. × 1 1/4.

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