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CORDYCEPS SPECIES FROM MICHIGAN *

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NINE species of Cordyceps have been reported for Michigan: *C. clavulata* Schw. (9, 10, 18), *C. formicivora* Schroet. (17), *C. gracilis* (4 as *C. entomorrhiza*, 10), *C. Melolanthae* (Tul.) Sacc. (6 as *C. herculea*, 11), *C. michiganensis* Mains (10), *C. militaris* Link (10, 16, 17, 18), *C. ophioglossoides* Link (10), *C. stylophora* Berk. & Br. (2, 9), and *C. superficialis* (Peck) Sacc. (5). In this paper additional information and records of distribution are given for a number of them. Three species are added, one new, bringing the total for the state to twelve. In 1910 Seaver (20) reported thirteen species for the United States. Several of these have since been shown to be synonymous, and some new ones have been described. The number now recorded for the United States is twenty-one.

1) *Cordyceps ophioglossoides* Link

On *Elaphomyces sp.*, Kent Lake, Oakland Co., Aug. 26, 1937, A. H. Smith.

This is a fairly common species in Michigan. It has club-shaped clavae, short-cylindric part spores, and is attached to the subterranean tubers of Elaphomyces by rhizomorphs. In these characters it differs from the following species.

2) *Cordyceps capitata* (Holmsk.) Link

On *Elaphomyces sp.*, Kent Lake, Oakland Co., Sept. 19, 1937, A. H. Smith (7610).

This is apparently the first report of the species from Michigan. It doubtless is of more frequent occurrence than the one record would indicate. The clavae are capitate and are seated directly on the tubers; the part spores are slightly fusoid, 34–50 μ long and 4 μ wide.

* Papers from the Department of Botany and the Herbarium of the University of Michigan.

3) *Cordyceps stylophora* Berk. & Br.

On larvae of beetles, A. H. Smith, Oakland Co.: Kent Lake, Aug. 26, 1937, and Sept. 13, 1937 (7311, 7554); Horseshoe Lake, Sept. 24, 1937 (7733); Milford, Oct. 24, 1938 (11120).

This is a very interesting species. It has been rarely collected. It was first reported (2) for Michigan from a collection made by G. H. Hicks in 1892 near East Lansing. The type was obtained (1) by Ravenel in South Carolina about 1857. A. H. Smith recently found it in New York and in the Great Smoky Mountains National Park.

The collections listed above are immature, having either undifferentiated asci or asci without differentiated ascospores. This is puzzling because A. H. Smith first observed the clavae of collection 11120 on July 10 and did not collect them until October 24, when spores had not formed. The persistence of the clavae for so long a period is unusual in Cordyceps. Ample opportunity should have been afforded for maturation.

4) *Cordyceps unilateralis* (Tul.) Sacc.

Povah (17) reported a specimen of Cordyceps on an ant from Rock River, Alger Co., as *C. formicivora* Schroeter (Pl. I, Fig. 2). Apparently Schroeter's original record (19) of the species from Germany is the only other published report of its occurrence. Petch (15) has recently decided that *C. formicivora* is only a variation of *C. unilateralis*. The clavae of *C. formicivora* were described as capitate, with the perithecia in the terminal heads. *C. unilateralis* has the perithecia in pulvinate stromata located laterally at various places on the clavae (Pl. 1, Figs. 1–3). Petch reached his conclusion as a result of a study of collections from the Farlow Herbarium of Harvard University. An examination of these collections has resulted in the same conclusions. The stromata develop at various points on the clavae and occasionally terminally. The species has clavate asci and fusoid ascospores, and Petch (12) has placed it in Ophiocordyceps.

5) *Cordyceps Melolanthae* (Tul.) Sacc.

On "June beetle" larvae, Silver Lake, Washtenaw Co., Aug. 5, 1935, A. H. Smith (1718).

Two other collections have been reported (6, 11) from Washtenaw County. Specimens that appear to be of this species have also been received from S. A. Graham. They were collected in the Huron National Forest at the Mack Lake Tower, near Mio, Oscoda County. They are immature, and the clavae are sterile. The species has usually been reported as *C. herculea*, a name which is not tenable (7, 10, 14).

6) *Cordyceps gracilis* Mont. & Dur.

On larvae of beetles, Lakeland, Livingston Co., June 4, 1936, A. H. Smith (3966); Ann Arbor, Washtenaw Co., June 12, 1937, A. H. Smith (6375); Sharon Hollow, Washtenaw Co., June 26, 1937, A. H. Smith (6419).

Three other collections have been reported (4, 10) under this name from Wayne, Cheboygan, and Marquette counties. Of these, two are on larvae of beetles and one is on a larva of a lepidopterous insect. Only two other collections have been reported (8) from the United States, one from New York and the other from Indiana.

The Michigan collections (Pl. II, Figs. 1–3) have capitate clavae, which are 3–9 cm. long. The heads are cinnamon-buff to mahogany-red and are punctate from the ostioles. They are globoid to ovoid, 3–6 × 2–4 mm. The stalks are buff, chrome-yellow, or orange-yellow and are 1–2 mm. thick. The perithecia are entirely embedded and are narrow-ovoid or fusoid-ovoid, 720–840 × 240–360 μ. The asci are cylindric, 442–540 × 4–5 μ. The ascospores are filiform and are nearly as long as the asci. They break into part spores which are 6–9 × 1–1.5 μ. Only one of the Michigan specimens on beetle larvae develops from the middle of the larva. The others arise from an end. One specimen has a moderate amount of slender light-colored mycelial strands surrounding the lower part of the stalk. The specimen from lepidopterous larva (Pl. II, Fig. 1) arises from one end and lacks mycelial strands. It does not differ to any appreciable extent from the specimens on beetle larvae.

There has been considerable uncertainty regarding the name which should be applied to this fungus. Until fairly recently most of the specimens have been named *C. entomorrhiza* (Dicks.) Link. In 1913 Lloyd (7) pointed out that *C. entomorrhiza* is the fungus which had been known on the continent of Europe as *C. cinerea* and that the species to which the name had generally been given is *C. gracilis*. According to Lloyd and Petch, the collections of Ravenel, upon

which Ellis and Everhart's and Seaver's records (2, 20) of *C. entomorrhiza* are based, are *C. ophioglossoides*. Lloyd reported in 1920 that he had seen only two collections of *C. gracilis* from the United States. In 1934 the writer listed three collections from Michigan.

Recently Petch (13) has questioned the occurrence of *C. gracilis* in America and has concluded that the fungus reported as such is *C. Glaziovii* P. Henn. In his description of *C. Glaziovii* Hennings (3) gives the following information: Clava capitate; the stalk pallid, 6 cm. long, 2–3 mm. thick; the head rufous brown, ovoid-spheroid, 5–7 × 5 mm.; the perithecia immersed, subglobose; the asci cylindric, 120–180 × 4–5 μ; the spores filiform, multiseptate, breaking into numerous segments 0.5 μ thick. The host is doubtfully determined as a larva of a butterfly. Petch (13) states that the host is a larva of a beetle. The Michigan collections show several important points of difference, having narrow-ovoid to fusoid-ovoid perithecia (Pl. II, Fig. 3) and long asci, 442–540 μ.

Petch (13) places considerable emphasis on the following characters, by which he would distinguish *C. gracilis:* presence of free, abundant mycelial strands at the bases of the clavae; development of clavae from the ends of the larvae; and the hosts, lepidopterous larvae. The Michigan fungus occurs on larvae of beetles as well as of lepidopterous insects. The clava usually develops from one end of the larva, but may arise elsewhere. Although free mycelial strands are ordinarily lacking, a moderate development sometimes occurs. These differences hardly justify, however, the exclusion of the Michigan collections from *C. gracilis*.

7) Cordyceps macularis, comb. nov.

Ophiocordyceps macularis Mains, Proc. Am. Phil. Soc., 74: 269. 1934. — this is the original description of C. macularis

The species was described from a collection made at Harbor Springs, Emmet County. It has been collected in New York also (11). Petch established the genus Ophiocordyceps for the species of Cordyceps having clavate asci and fusoid ascospores which overlap in the asci. Species with these characters do not appear to form a natural group, but are more closely related to species of Cordyceps than to each other.

8) Cordyceps michiganensis Mains

On larvae of beetles, A. H. Smith: Bass Lake, Washtenaw Co., June 15, 1937 (6306); Milford, Oakland Co., July 29, 1937 (6684).

The species was described (10) in 1934 from collections from Alger and Livingston counties. It has also been collected (11) at Timagami, Ontario, and A. H. Smith recently obtained it in the Great Smoky Mountains National Park. It is a small species, with a number of slender orange clavae growing from the larvae. It is easily overlooked, especially when it is associated with sporophytes of mosses.

9) Cordyceps paludosa, sp. nov.

Clavis filiformibus, 5.5–13 cm. longis, 0.5–1.0 mm. crassis, grisco-brunneis, terminantibus in acuminatis sterilibus apicibus; perithe-ciis superficialibus, liberis, lateraliter compressis, ovoideis, 800–855 × 375–410 μ; ascis cylindricis, 480–550 × 8–10 μ; ascosporis filiformibus, 390–490 × 2.0–2.5 μ, multiseptatis, septis 12–18 μ distantibus. (Tab. III, Figg. 1–2.)

In larvis lepidopterarum, Kent Lake, Oakland County, A. H. Smith, Sept. 13, 1937 (7559, specimen typicum); July 28, 1938 (9640).

This species has long, slender filiform clavae, 5.5–13 cm. × 0.5–1.0 mm. They are grayish brown, especially in the lower part, and are covered with a matted felt. They terminate above in long, attenuated acuminate apices. The perithecia are flattened-ovoid and are large, 800–855 × 375–410 μ. The lower portion is grayish brown and the upper is deep brown. They are superficial, free, and often crowded. The asci are cylindric, 480–550 × 8–10 μ. The ascospores are filiform, 390–490 × 2.0–2.5 μ, and are multiseptate, the cells being 12–18 μ long and not readily separating.

This species is related to *C. superficialis* and *C. acicularis*. The former is much smaller, having clavae up to 4.5 cm. long. The perithecia are 360–660 × 300–564 μ, and the asci are 150–270 × 7–9 μ. The ascospores break into segments 14–30 × 1.5–2 μ. *C. superficialis* has been collected on larvae of beetles.

C. acicularis has clavae up to 10 cm. long and 1–2 mm. thick. The perithecia are 360–400 × 270–300 μ; the asci are clavate, 210–

200 × 7–10 μ. The ascospores are slightly fusoid, 160–240 × 2.5–3 μ. They are multiseptate and do not break into segments. *C. sciculatis* develops from larvae of beetles.

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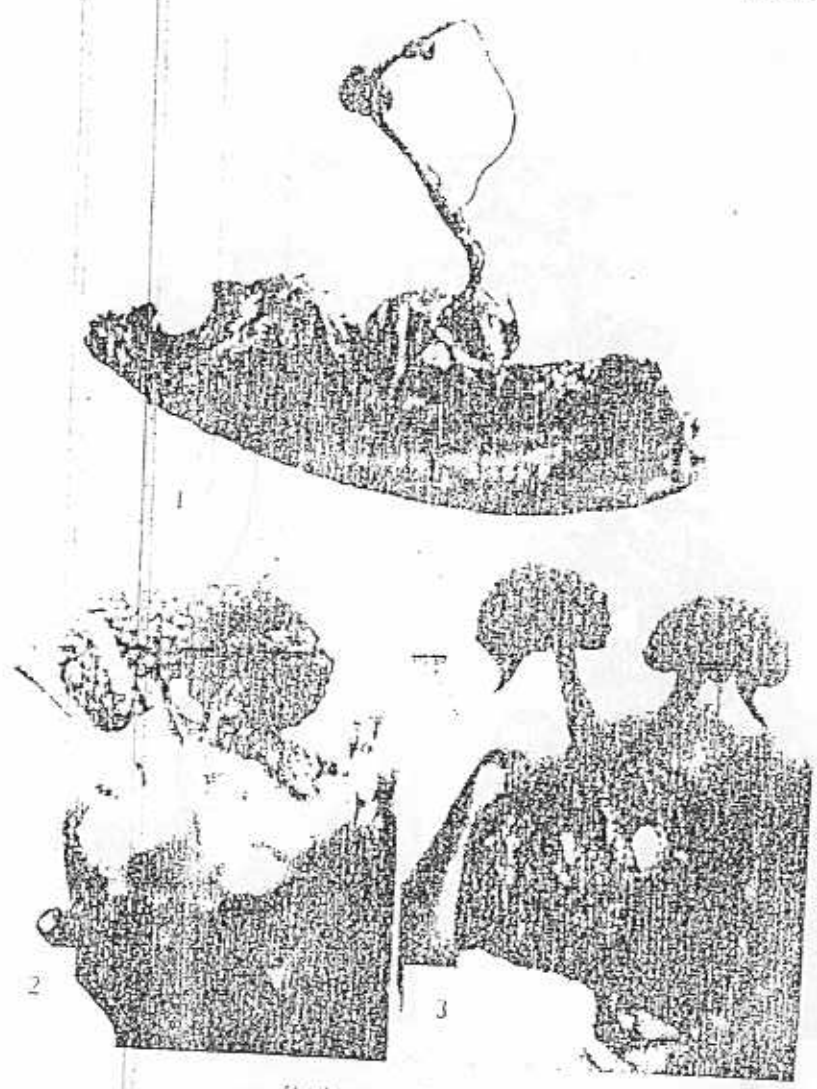


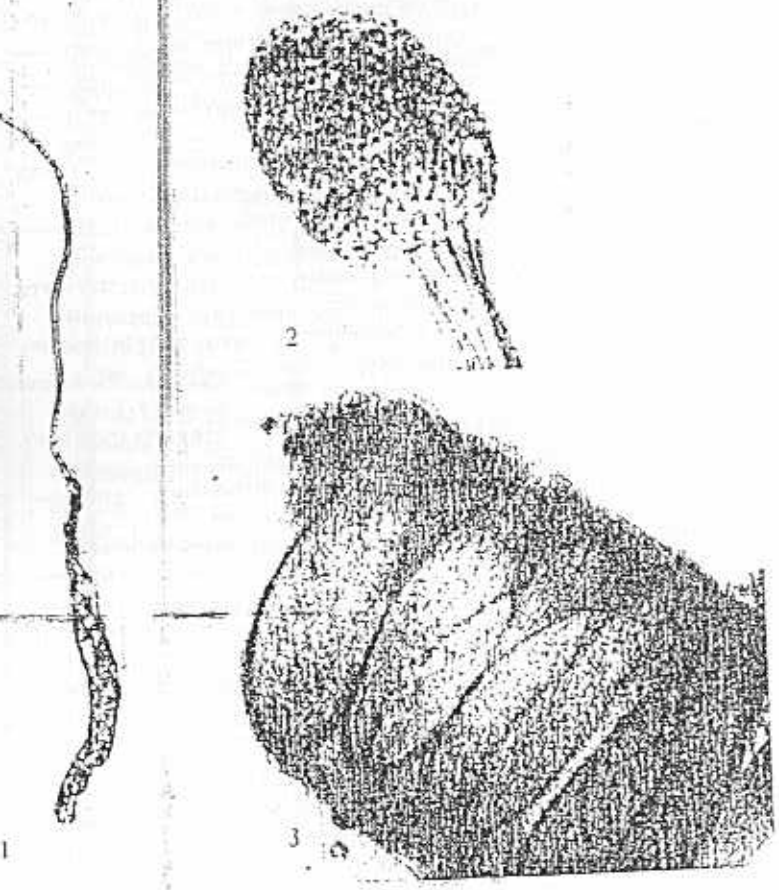
Cordyceps unilateralis

FIG. 1. Typical form with pulvinate stromata laterally placed on clava (Farlow Herb. No. 3057). × 5

FIG. 2. The form described as *C. paracuneata*, with the stromata terminal (Michigan collection). × 10

FIG. 3. An intermediate form (Farlow Herb. No. 3018). × 10

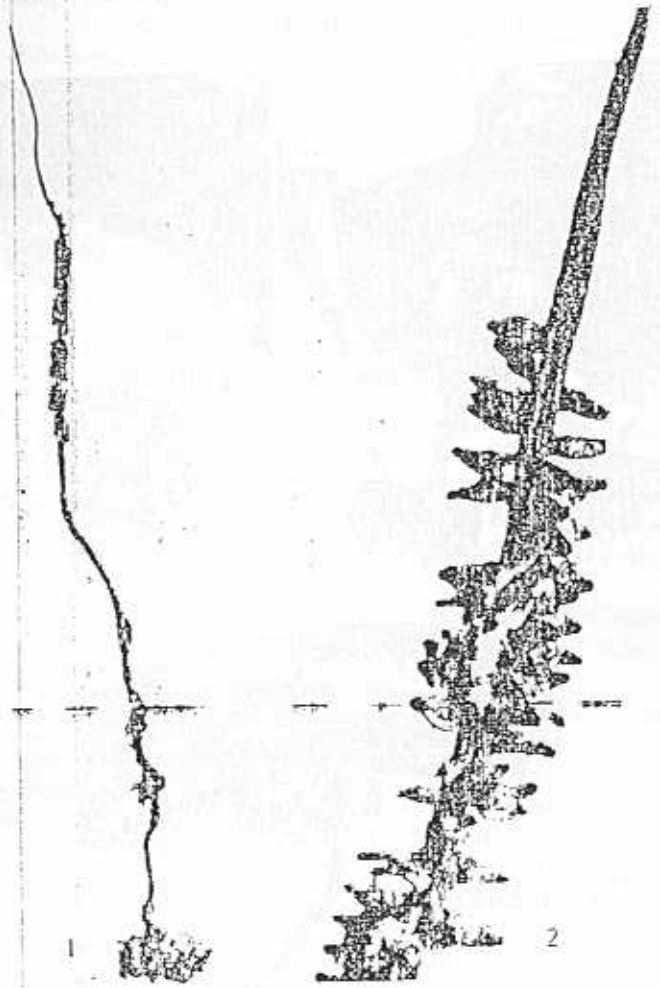
PLATE II



Cordyceps gracilis

FIG. 1. Capitate clava arising from a lepidopterous larva. × 1.5
FIG. 2. Head showing ostioles of the embedded perithecia. × 10
FIG. 3. Perithecia. × 70

PLATE III



Cordyceps paludosa

FIG. 1. Clava arising from a lepidopterous larva. × 1
FIG. 2. Portion of a clava showing the superficial free perithecia. × 10

290 × 7–10 μ. The ascospores are slightly fusoid, 160–240 × 2.5–4 μ. They are multiseptate and do not break into segments. *C. acicularis* develops from larvae of beetles.

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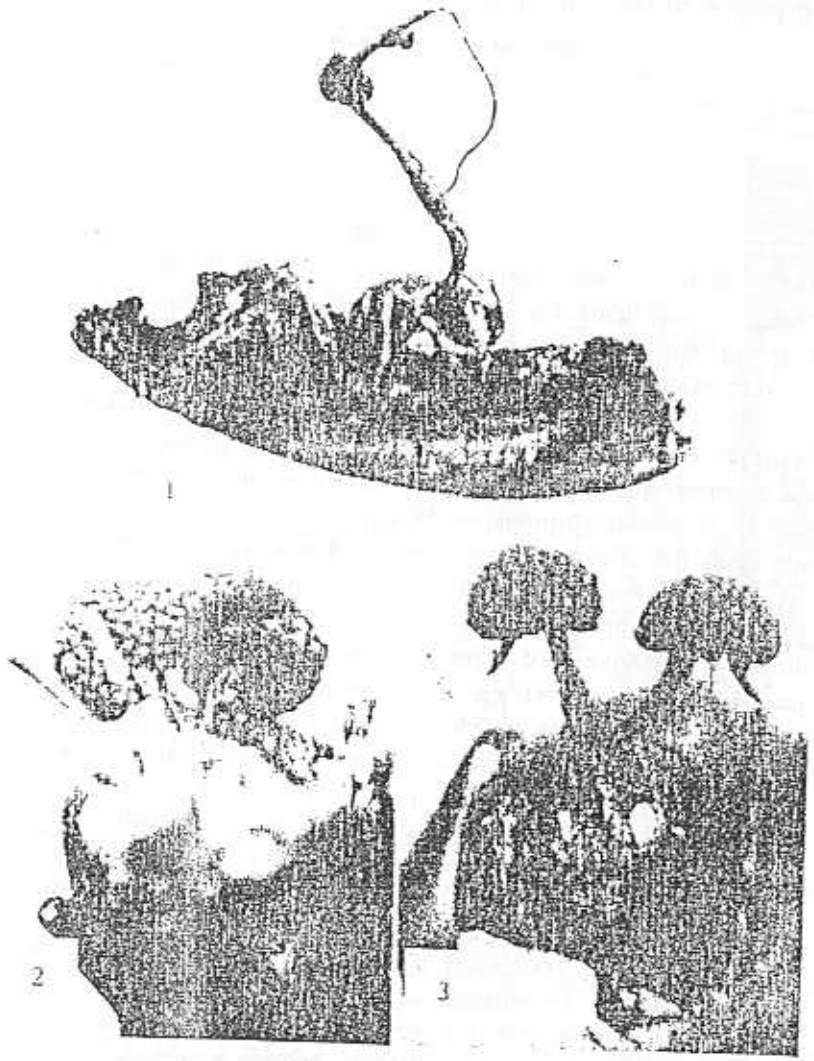

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