TYPIFICATION OF CORDYCEPS CANADENSIS AND C. CAPITATA, AND A NEW SPECIES, C. LONGISEGMENTIS

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ABSTRACT

The holotype collection for Cordyceps canadensis was found to be composed of two taxa, differing primarily in the length of the ascospore segments. A lectotype, corresponding to the original description, is designated. The name C. capitata has been applied to the same two taxa. A neotype is designated for C. capitata, and C. canadensis is placed in synonymy. The taxon with longer ascospore segments, often misidentified as C. canadensis, is named C. longisegmentis sp. nov.

Key Words: pyrenomycetes, taxonomy, Cordyceps capitata, Cordyceps canadensis, Cordyceps longisegmentis.

Fifteen species of Cordyceps Link are associated with subterranean Elaphomyces Nees (Kobayasi, 1982). Currently the names of two, C. capitata (Holmsk.: Fr.) Link and C. canadensis Ell. & Ev., are applied to distinct species but the species concepts have been confused.

Cordyceps species have ascospores which typically break into segments while still in the ascus. The size of these segments is a principal taxonomic character at the species level. The size of the segments in C. capitata has been reported as relatively short (ca. 7–30 µm) and as relatively long (ca. 25–60 µm). The earliest mention of the segment sizes in C. capitata was by Currey (1858) who recorded them to be 0.0006–0.0008 inch long (=15–20 µm). This is the size range prevalent in many recent publications, e.g., Breitenbach and Kranzlin (1981), Dennis (1978), Mains (1957), Maas Geesteranus (1963), and Moser (1963). On the other hand, several earlier works, e.g., Tulasne and Tulasne (1865), Saccardo (1883), Winter (1887), Ellis and Everhart (1892), and Seaver (1910) report the segments to be 2–3 times longer.

Ellis and Everhart (1898) described under the name C. canadensis a taxon which was similar to C. capitata but had ascospore segments “10–20” µm long. However, Mains (1957) concluded that the segments in C. canadensis were “24–48” µm and recent reports of C. canadensis associate the name with a taxon having relatively long ascospore segments. Kobayasi and Shimizu (1960) reported that C. canadensis was the more common taxon in Japan. Maas Geesteranus (1963) reviewed a number of European reports of C. capitata and assigned those containing ascospore segments measurements which were relatively long and broad to C. canadensis. He concluded that C. canadensis was more common in Europe than C. capitata.

The recognition of C. canadensis as distinct from C. capitata depends principally on ascospore segment sizes but the same two size ranges have been attributed to both C. capitata and C. canadensis. These problems are resolved by designating a neotype for C. capitata and a lectotype for C. canadensis, thus fixing each name to one taxon.

CORDYCEPS CAPITATA (Holmsk.: Fr.) Link, Handb. 3: 347. 1833. FIG. 1.

=Clavaria capitata Holmsk., Beata ruris otia fungis Danicos 1: 38, pl. 14. 1790. [Additional obligate synonymy is listed in Maas Geesteranus (1963)].


=Cordyceps capitata var. canadensis (Ellis & Ev.) Lloyd, Mycol. Writ. 5: 609. 1916.


Two species have been assigned to C. capitata. They differ in microscopic features, e.g., ascospore segment sizes and tissue structure of the stromal epidermis. Because the original description and other descriptions of C. capitata published before 1858 lack mention of microscopic features we cannot be certain which taxon the pre-1858 authors described.

Holmskjold (1797) did not designate a type specimen and his specimens have not been preserved. Thus there is no holotype and no specimen to serve as lectotype. The ICBN (Arts. 7.5, 8) states that an illustration or description can be designated as a lectotype, thus Holmskjold’s plate 14 is available to serve as lectotype, and he cited a “Flora Danica” plate. But neither refers to microscopic features and do not solve the problem.

The name C. capitata is a sanctioned name and Fries (1823) cited a specimen as “Moug. Crypt. exs. C. VIII. ined.,” presumably referring to Mougeot & Nestler, Stirpes Cryptogamae Vogeso-Rhenaneae 763, issued in 1823. Mains (1957) designated this number as “the lectotype of the species C. capitata” but his designation is not acceptable because he designated a number which represents several specimens. Mains cited two herbaria in stating “three specimens of this number at the New York Botanical Garden and the Farlow Herbarium have been available for study.” It is not possible to select the single specimen which Mains meant to be “lectotype.” I have studied no. 763 at NY and designate this packet as neotype. In this packet there were four Cordyceps stromata. The ascospore segments in each were 19–28 x 3–3.5 μm.

Cordyceps canadensis. — Ellis and Everhart (1898) segregated from C. capitata a similar taxon, which they named C. canadensis. They characterized it as follows: when fresh a light yellow color throughout and with ascospore segments 10–20 (mostly 15) x 2–2.5 μm, i.e., “only about half as long and wide as in C. capitata (Holmsk.) . . . .”
Their concept of *C. capitata* appeared in Ellis and Everhart (1892: 66) where the size of the spore segments was given as 25–40 × 5–6 μm. This agrees with the segment sizes in Winter (1887: 151) and Saccardo (1883: 574) which probably were the basis of Ellis and Everhart’s concept.

Mains (1957), in a monograph of the North American species of *Cordyceps* on *Elaphomyces*, also recognized *C. canadensis* as distinct from *C. capitata*. He described the spore segments of *C. capitata* as 8–25(–32) × 2.5–3 μm and those of *C. canadensis* as (18–)24–48 × 4–5 μm. Mains’ concept of *C. canadensis* is of a fungus with segments significantly longer than reported in the original description. He described two additional characters which distinguished it from *C. capitata*: 1) the palisade-like arrangement of the cells of the stroma epidermis; and 2) the thicker walls at the apices of the ascospore segments. Several European authors, e.g., Petch (1938) as *C. capitata*, had described the thickened wall but did not use the character to distinguish taxa.

The type specimen of *C. canadensis* was cited by Ellis and Everhart (1898) as “Growing on *Elaphomyces*, London, Canada (Dearness, no. 2641).” In the Dearness Herbarium the number refers to a species and not a collection. In the Dearness Herbarium at DAOM there are two packets with the species number 2641. They have similar collection data but are identified as “JWA Avon Nov 97” and “J.W.A. 4 Nov 1897.” I labelled these as A and B, respectively, to facilitate subsequent reference to each packet. According to notes with these packets parts of both collections were sent to Ellis. The fungus in packet A agrees with the original description, i.e., spore segment sizes are 10–20 × 2–2.5 μm, whereas the fungus in packet B is a distinct taxon and has segments two to three times longer and wider.

The holotype is the part in the Ellis Collection at NY because Dearness did not participate in publishing the original description. There is one packet in the Ellis Collection labelled *Cordyceps canadensis*. Data on the packet are primarily in Dearness’ writing and agree with the data in the original description and on packet A in the Dearness Herbarium. There are two pieces of stroma in the packet, as well as most of a stipe and bits of debris. One piece of stroma was about one-third of a stroma with a pallid core, on which there were many ascospore segments and asci. The segments were 20–27 × 3.5–4 μm with thin walls at the ends. This part agrees with the fungus in the Dearness Herbarium labelled A and I have annotated this piece at NY as A. The other piece, designated B, was about one-half a stroma with a black core. There were few asci and ascospore segments. The segments were 50–53 × 4–4.5 μm and had the end walls thickened and slightly refractive. Part B in NY seems to be part of the second collection in the Dearness Herbarium that Dearness labelled “spores on this not mature.”

When Mains (1957) studied the *C. canadensis* collection at NY he found “puzzling” the contradiction between the segment sizes as he measured them and the sizes published by Ellis and Everhart. Mains observed that the sizes recorded on the packet previously had been altered from 12–20 μm to 30–45 μm long. It appears that parts of two collections were in the packet before Mains saw it.

Clearly the holotype at NY is a mixed collection and presumably the two collections from Dearness have been combined. It is necessary to designate a lectotype and I have selected the part in the Ellis collection which has ascospore segments which agree with the sizes given in the original description, i.e., part A is designated as the lectotype. As a result of the lectotypification the name *C. canadensis* is placed in synonymy with *C. capitata*.

In searching for a name to be applied to the taxon with the long segments I examined the type (at NYS with data Maine, C. L. Fox: letters from Fox to Peck state “found at Saco, Maine—Nov. 5th/99”) of *C. nigriceps* and assigned that name to synonymy under *C. capitata*. The name *Sphaeria agariciformis* Bolt. was listed as a synonym of *C. capitata* by Fries (1823). Seaver (1910) resurrected the name, apparently because it was published in 1789 or a year earlier than *C. capitata*, and transferred the epithet to *Cordyceps*. He listed *C. capitata*, *C. canadensis* and *C. nigriceps* as synonyms. Watling (1966) knew of only one fungal specimen of Bolton’s that has survived. It is not a *Cordyceps* and it seems simplest to leave the name as a synonym of *C. capitata*. Thus a new name is proposed for the taxon with long segments.

*Cordyceps longisegmentis* Ginz, sp. nov.

**FIG. 2**

Differ a *C. capitatae* ascosporae segmentis longioribus, segmentis apicibus incrassatis, et stromatibus epidermidis vallatis. TYPUS DAOM 137162.
Ascocarp solitary, stipitate, with one, rarely two, apical, nearly spherical stroma. Stroma when fresh (DAOM 191349) broadly rounded, 13 mm diam just above the stipe apex, brown, dark brown to olive brown; when dried nearly obcor-diform, to 14 mm diam and 13 mm tall, glabrous, minutely punctate, abruptly enlarged where attached to the stipe, black or dark brown, the core solid or hollow, pallid. Stipe when fresh (DAOM 191349) 13 cm long and 7 mm diam, greyish yellow above and the lower one-third a deep yellow; when dried up to 11 cm long and 7 mm diam, essentially cylindrical, olive, some with the basal part dark olive or black, glabrous, hollow, the interior lining pallid.

Stroma epidermis about 20 μm thick, a distinct palisade of erect, cylindrical hyphal tips, 2–3 μm diam with small (2 μm diam), olive yellow in KOH, resinous deposits on the exterior of the hyphal walls. Tissue beneath the epidermis and surrounding the perithecia a textura epidermoidea with hyphae 2–10 μm diam, some short celled, thus the cells relatively broad, with resinous deposits in the zone 50–75 μm beneath the epidermis. Hyphae beneath the perithecia hyaline, thin-walled, 2–3 μm diam, parallel. Perithecia imbedded, ellipsoid, hyaline, about 500 × 300 μm. Ascii cylindrical to narrowly ellipsoid, up to 440 × 10–15 μm, nonamyloid, the walls fragile at spore maturity, the apex with a thick, non-refractive apical cap with a narrow pore. Ascospores filiform, smooth, hyaline, non-amyloid, when mature segmented into parts (12–)40–65 × (3–)4–5 μm which have truncated, thick-walled (~3 μm), slightly refractive apices. Stipe exterior a textura porrecta with hyaline, thin-walled hyphae 2–5 μm diam, rather frequently septate, i.e., cells mostly 20–50 μm long, with olive yellow, resinous deposits on the exterior of the hyphal walls. The interior tissue a textura intricata with hyphae hyaline, thin-walled, 2–3 μm diam, infrequently branched and septate.

Fig. 2. Cordyceps longisegmentis. A. Ascospore segments in ascus which has wall essentially dissolved. B. Ascus with characteristic tip and containing ascospores. C. Vertical section of epidermal palisade of stroma. D. Ascospore segment with thickened apices. E. Apical two segments of ascospore. Scales equal 20 μm. Scale in B applies to D and E. A, C and D from DAOM 191349, and B and E from DAOM 142203.
Habitat: On Elaphomyces species.

Distribution: In Asia, Europe, and North America; see under C. canadensis in Kobayasi and Shimizu (1960), Maas Geesteranus (1963), and Mains (1957).


Discussion

The name Cordyceps capitata is neotypified and will continue to be applied, as it has in recent European literature (Breitenbach and Kranzlin, 1981; Dennis, 1978, Moser, 1963), to the fungus with relatively short ascospore segments. However, reports which did not include data on the size of the spore segments will have to be reconfirmed or revised. Cordyceps canadensis is lectotypified and the name C. canadensis is now a synonym of C. capitata. Cordyceps longisegmentis is newly described. Recent references, e.g., Phillips (1981), to C. canadensis with relatively long segments should have the name corrected to C. longisegmentis.

Some variation existed in the length of the spore segments in C. capitata and C. longisegmentis. In C. longisegmentis most segments were 40–65 μm long and the few short segments (ca. 12–20 μm) were formed from the apices of the spores. In some C. capitata stromata most spore segments were 15–20 μm, in others they were 20–27 μm and in still others they were 17–24 μm. Although the segment lengths in two selected stromata may not overlap significantly, when a number of stromata are examined the segment lengths form an overlapping series and, to me, represent one species.

Cordyceps longisegmentis is allied to C. capitata but is readily recognized by its relatively long ascospore segments (greater than 30 μm) which have truncated, thick-walled, slightly refractive apices and a palisade-like structure of the stroma epidermis. No significant differences were found in the gross morphology of dried specimens of C. longisegmentis and C. capitata. However, Kobayasi and Shimizu (1960) observed that stromata of C. capitata lacked glossiness whereas the stromata of C. longisegmentis (C. canadensis in Kobayasi and Shimizu) were glossy. The specimens of C. longisegmentis I examined at 10× were glossy, whereas those of C. capitata were dull. Possibly there are differences in the colors of fresh ascocarps but insufficient data prevent me from commenting further.

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Literature Cited


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