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ON THE FUNGUS-INHABITING CORDYCEPS AND ELAPHOMYCES IN JAPAN

BY

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本邦産菌生コルディセプス並にエラフォミセスに就きて

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In the vicinity of Sapporo, the author has found two species of *Cordyceps* which are parasitic on the fruit bodies of *Elaphomyces*. Among them, one species of *Cordyceps* and two species of *Elaphomyces* seem to be new to science. The present paper was intended to report on these interesting fungi.

I. *Cordyceps* (FRIES) LINK, Handb. III, 347, 1833.

Sphaeria § *Cordyceps* FRIES, Syst. Myc. II, 323, 1823 (p. p.).

Torrubia LÉV. in TUL. Fung. Carp. III, 5, 1865.

1. *Cordyceps capitata* (HOLMSK.) LINK

Handb. III, 347, 1833—SACC. Syll. Fung. II, 574, 1883—WINTER, Die Pilze, II, 151, 1887—ELLIS & EVERH. North Amer. Pyrenom. 66, 1892—JACZEWSKI, Bull. Soc. Myc. Fr. XI, 190, 1895—LINDAU, in ENGL. Pr. Nat. Pflanzenf. I, 1, 369, 1897—KAWAMURA, Ill. Jap. Fungi, Pl. 13, fig. 11-12, 1915 (as FRIES).

Syn. *Sphaeria agariciformia* BOLT. Hist. Fung. III, 130, 1789.

Clavaria capitata HOLMSK. Topsv. 38, 1790.

Sphaeria (Cordyceps) capitata FRIES, Syst. Myc. II, 324, 1823.

Torrubia capitata TUL. Fung. Carp. III, 22, 1865.

Cordyceps canadensis ELLIS et EVERH. Bull. Torrey Bot. Club, XXV, 501, 1898.

Cordyceps nigriceps PECK, Bull. Torrey Bot. Club, XXVII, 21, 1900.

Cordyceps agariciformia SEAYER, North Amer. Fl. III, 53, 1910.

Hab. Parasitic on *Elaphomyces* sp. In woods. Hokkaido: Prov. Ishikari, Jôzankei (S. IMAI, Sept. 23, 1925). Honshu: Without locality (S. KAWAMURA, without date).

Distrib. Europe, North America and Japan.

Jap. name. *Tampo-take*.

Remarks. In our country, the present fungus was first recorded and illustrated by KAWAMURA in 1915. In the accompanying English text, it was stated that the fungus is parasitic on the fruit body of *Elaphomyces granulatus* which was found two or three inches below the surface of the ground.

Our specimen collected at Jôzankei unfortunately was lacking in the fruit bodies of the host fungus, but the hyphae found adhering to the base of the stalk of this fungus are undoubtedly those of *Elaphomyces*. The macroscopical feature of our fungus coincides very well with the descriptions and figures of both European and American forms of *C. capitata*. As to the size and form of the spore-segments, our fungus are similar to those of the American form described by SEAYER, but not so small as stated by LLOYD.

2. *Cordyceps Umemurai* S. IMAI, n. n.

Syn. *Cordyceps capitata* var. *canadensis* LLOYD, Myc. Notes, 44, p. 609, fig. 860, 1916.

Cordyceps japonica LLOYD, Myc. Writ. V, Index, p. 17, 1921; Myc. Notes, 62, p. 913, pl. 142, fig. 1621, 1921.

Stromata solitary or cespitose, simple or sometimes branched, 2.5–7 cm. high. Head clavate or oblong, obtuse at apex, subcompressed, generally with one or two longitudinal grooves, roughened by slightly protruded perithecia, nearly black in dried condition, subcarnose, yellowish within, 1.2–1.8 cm. long, 4–6 mm. wide. Stalk dark olivaceous or blackish in dried condition, cylindrical, equal, 2–3 mm. in width, growing directly from the upper portion of the carpophore of host fungus. Perithecia ovate, immersed with slightly protruding mouth. Asci cylindrical, oblong, attenuated at the base, 300–350 × 7.5–10 μ . Spores filiform, nearly as long as the ascus, multiseptate and breaking into segments,

yellowish; segments short cylindrical, $11.5-22 \times 2.5-3.5 \mu$.

Hab. Parasitic on *Elaphomyces japonica* LLOYD. Honshu: Prov. Mikawa, Okazaki (J. UMEMURA, June, 1915?).

Distrib. Endemic.

Jap. name. *Tampotake-modoki* (n. n.).

Remarks. When LLOYD received from J. UMEMURA the specimens of this *Cordyceps* growing directly from the upper portion of the fruit bodies of *Elaphomyces*, he considered it at first as the same fungus as *C. canadensis* of ELLIS & EVERHART and proposed the name *C. capitata* var. *canadensis*. After the examination of the type specimen of *C. canadensis*, he came to the conclusion that our fungus is not identical with *C. canadensis*, and he gave for it a new name *C. japonica*. In order to avoid a confusion with the preexisting name *Cordyceps japonensis* HARA which is parasitic on ant, we wish to propose a new name *C. Umemurai*. The above description was based on the co-type specimen which was kindly sent to the author from the collector of the fungus.

3. *Cordyceps jezoensis* S. IMAI, n. sp.

Stromata solitary or rarely cespitose, simple or rarely branched, 6-13 cm. high. Head clavate or oblong, rarely somewhat curved, subcompressed or with one or two longitudinal grooves, roughened by the slightly protruded and densely scattered perithecia, dark olive-gray or olivaceous black, becoming nearly black in drying, subcarnose, yellow within, $1.0-2.7 \times 0.3-0.8$ cm. Stalk dark olivaceous, becoming blackish in drying, lighter coloured at the base, longitudinally striated or wrinkled at the upper portion, cylindrical, nearly equal, narrowly hollow, 2-3 mm. thick, sending out numerous yellowish or whitish rhizoids which extend for some distance over the surface or into the surrounding mycelial mass of the host fungus. Perithecia ovate, slightly protruded or immersed. Asci very long, subcylindrical, conspicuously attenuated at the base, $350-560 \times 11-13.5 \mu$. Spores filiform, nearly as long as the ascus, multiseptate and breaking into segments, yellowish; segments fusoid-elongated or subbacillar, $16-50 \times 3.5-4.5 \mu$.

Hab. Parasitic on *Elaphomyces Miyabeanus* (n. sp.) and *E. nopporensis* (n. sp.). Hokkaido: Prov. Ishikari, Nopporo (S. IMAI, Oct. 8, 1923; Nov. 1,

1925; Nov. 15, 1925; Sept. 26, 1926; Oct. 7, 1926; Nov. 6, 1927).

Distrib. Endemic.

Jap. name. *Yezo-sanagitake-modoki* (n. n.).

Remarks. The present fungus belongs to the group of rooted stems, together with *C. ophioglossoides*, to which it closely resembles in the macroscopic feature, but it is quite different from the latter under the microscope, resembling rather to *C. capitata* in the dimension of the asci and ascospores.

II. *Elaphomyces* NEES v. ESENBECK, Syn. Gen. Pl. Mycet. 68, 1821.

The hypogaeous fungi have remained unstudied in our country on account of great difficulty in collecting them. The author was fortunate in finding out some species of *Elaphomyces* which he was collecting the fungus-inhabiting Cordyceps-fungi. It may be interesting to note here, that two species of *Elaphomyces*, collected in Hokkaido, usually form ectendotrophic mycorrhiza on the roots of *Ulmus japonica*.

1. *Elaphomyces japonica* LLOYD

Myc. Notes, 44, p. 609 fig. 860, 861. 1916.

Ascomata globose, subglobose or somewhat irregular in shape, cinnamon colour; surface entirely covered with minute poppy-seed-like warts, $1.3-2 \times 1.7-3 \times 1.7-2$ cm.; exoperidium dull yellowish or light yellowish brown, hard, rigid, 0.5 mm. thick, separable from the endoperidium when dried; endoperidium light yellowish-gray, punky, about 0.5 mm. thick when dried; gleba becoming at length brown to blackish brown with light yellowish-pink coloured sterile veins in radial or arachnoidal form; spores globose, $14-42.5 \mu$ in diam., mostly $18-20 \mu$ or $28-30 \mu$, reddish brown or blackish, finally echinulate; capillitium colourless, very fine, few in number.

Hab. Parasited by *Cordyceps Umemurai*. Honshu: Prov. Mikawa, Okazaki (J. UMEMURA, June 1915 ?).

Distrib. Endemic.

Jap. name. *Ki-tsuchidango* (n. n.).

Remarks. LLOYD, in his Mycological Notes, No. 44, made the following statement: "The exoperidium (cortex) has peeled away and separated from the

inner peridium, a feature I never noted on an *Elaphomyces* before. In nature of the warts, color of gleba, and spores, it seems the same as *Elaphomyces variegatus* of Europe, which, however, always has the cortex closely adnate to the inner peridium. The inner peridium, about 1 mm. thick, is only about half as thick as that of *Elaphomyces variegatus*, and of a different texture. The European species has a peridium as hard as a rock. This has much softer and thinner peridium, which cuts readily."

From the description of the fungus it is evident that it belongs to the *variegatus*-group, and is closely allied to *E. variegatus* VITT., *E. decipiens* VITT. and *E. reticulatus* VITT., but the present fungus is easily distinguished from *E. variegatus* by the thinner and separable peridium as LLOYD has stated, and also by the minute warts on the surface of its ascomatum. From *E. decipiens* by the larger ascomatum, and the thicker exoperidium, and from *E. reticulatus* by larger ascomatum and the presence of the light-yellowish-pink coloured sterile veins, the present fungus could easily be distinguished.

By the study of the co-type specimens received from Mr. J. UMEMURA, the writer was able to give a full description of the present species, which was left undescribed by LLOYD.

2. *Elaphomyces Miyabeanus* S. IMAI, n. sp.

Mycelia blakish brown, forming the loose or rigid mass around the ascomatum. Ascomata subglobose, depressed or subovate, $1.5-3 \times 1.5-2.5 \times 1.5-2$ cm.; surface more or less rough and provided on the apical or rarely on the basal part with warts; warts pyramidical with blunt apex, largest ones in the center, the size diminishing centrifugally, up to 1 mm. high; exoperidium blackish brown or black, rigid, hard, 0.5 mm. thick, not shrunken in drying, easily separable from the endoperidium when matured; endoperidium grayish-white with fine pinkish lines, more or less firm, 1.0-2 mm. thick, becoming thinner and dull pinkish in colour when matured or dried; gleba bluish gray at first, becoming blackish brown, with white cottony mass of hyaline hyphae in the center, from which white sterile veins radiate, and their side branches forming many compartments, finally these veins and cottony mass disappear; asci 8-spored; spores globose or subglobose, with a central gutta, $15-22 \mu$,

mostly 20μ in diam., wall thick, yellowish at first, and with radial fine striation, finally becoming blackish brown or black colour and densely echinulate; capillitium white, uneven wide, with many small guttae and provided with small hyaline crystals on the wall, at length becoming slender and hyaline.

Hab. Forming mycorrhiza on the roots of *Ulmus japonica*. Parasited by *Cordyceps jezoensis*. Hokkaido: Prov. Ishikari, Nopporo Forest (S. IMAI, July 4, 1926; Sept. 26, 1926; Oct. 7, 1927; Nov. 6, 1927).

Distrib. Endemic.

Jap. name. *Kuro-tsuchidango* (n. n.).

Remarks. The present fungus is closely related to *E. moretti* VITT., *E. aculeatus* VITT. and *E. echinatus* VITT. But it is easily distinguishable from *E. moretti* by the presence of the conspicuous sterile veins and of localized warts on the peridium, from *E. aculeatus* by the blackish brown mycelia and the localized warts on the peridium, as well as by the larger spores, and from *E. echinatus* by the blackish brown mycelia and the blackish brown spore-mass.

It is named in honour of Dr. KINGO MIYABE, Emeritus Professor of Hokkaido Imperial University.

3. *Elaphomyces nopporensis* S. IMAI, n. sp.

Mycelia blackish brown, forming loose mass around the ascomatum. Ascomata small, globose or subglobose, dark or blackish brown, nearly smooth, but rough under the lens, 3.5–10 mm. in diam.; exoperidium very thin, 0.25 mm. thick, blackish, rigid, not shrunk when dried; endoperidium very thin, papery, clove-brown, easily separable from the exoperidium when matured; gleba blackish, powdery when matured; sterile veins inconspicuous at maturity; spores globose or subglobose, 15–17.5 μ ; mostly 15 μ , thick walled, densely echinulate, dark brown to black; capillitium yellowish, granulate.

Hab. Forming mycorrhiza on the roots of *Ulmus japonica*. Parasited by *C. jezoensis*. Hokkaido: Prov. Ishikari, Nopporo Forest (S. IMAI, July 4, 1926; Sept. 26, 1926; Oct. 7, 1927; Nov. 6, 1927).

Distrib. Endemic.

Jap. name. *Ko-kurotsuchidango* (n. n.).

Remarks. The present fungus was found in association with *E. Miyabe-*

anus and not yet collected in its young ascomatum-stage. It resembles to *E. anthrocinus* VITT. and *E. septatus* VITT., but is easily distinguished from the former species by the smaller sized and not shrunken ascomatum, as well as by the smaller size of its spores, and from the latter species by the lighter colour of its endoperidium and the absence of sterile veins.

In conclusion, the author wishes to express his sincere thanks to Profs. K. MIYABE and S. ITO for their kind suggestions and also to Mr. J. UMEMURA for his kindness in supplying us with the valuable materials.

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摘 要

本邦産冬蟲夏草類中、菌類に寄生する種類三種と、其寄主たる土團子菌三種を報告せり。

1. タンボタケ *Cordyceps capitata* (HOLMSK.) LINK
2. タンボタケモドキ *C. Umemurai* S. IMAI

本種は *Elaphomyces japonica* に寄生するものにして、前に *Cordyceps capitata* var. *conadensis* LLOYD 及び *C. japonica* LLOYD と命名されたるものなり。

3. エゾサナキタケモドキ *C. jezoensis* S. IMAI

本種は *Elaphomyces Miyabeanus* 及び *El. nopporensis* に寄生する菌にして、新種と認めたるものなり。

4. キツチダンゴ *Elaphomyces japonica* LLOYD
5. クロツチダンゴ *Elaph. Miyabeanus* S. IMAI
6. コクロツチダンゴ *Elaph. nopporensis* S. IMAI

最後の二種は共に北海道、石狩國、野幌國有林内に於て採集し、新種と認めたるものにして、榆樹の根に菌根を形成す。