SYNOPSIS

OF THE

CORDYCEPS

OF

AUSTRALASIA

By

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CINCINNATI, OHIO, - MARCH, 1915.

PROF. P. MAGNUS.

We dedicate this pamphlet to the memory of our late friend, Dr. Magnus. We never visited Berlin without the pleasure of calling on him. He was an old bachelor, and like all old bachelors, was no doubt a little cross, but we have always found him most genial, and think he was not half as cross as would appear from the photograph.

The Cordyceps of Australasia.

Cordyceps are the most curious fungi that grow. They develop from insects either in the larval, pupal or perfect stage. Two species of Europe grow on hypogeal fungi.

In olden times these curious growths were thought to be a transmutation of an insect into a plant, but of course it has long been known that Cordyceps are parasitic plants that grow on the insect and subsist upon its animal tissue.

Like most mycology in Australia, Cordyceps are less known than from most other parts of the world. This is due to the fact that there are so few collectors. What little is known is mostly from specimens that were sent to Berkeley years ago and are preserved at Kew. We have worked over this material and this pamphlet is the result, but it is only a fragment.

Up to the present time about 160 species of Cordyceps have been named. They never have been critically monographed or studied, and probably about one-half of them are good. Most of these are small species from a few millimeters tall to five or six centimeters, and it is a curious fact that in Australia there are very large species with clubs six to eight inches, and all the large species are known from Australia.

In Brazil, where the subject has been well worked, there are about twenty species of Cordyceps listed, and in Australia only six, but the number could be increased several fold if they were observed and collected.

Cordyceps are usually club-shaped bodies. All the known Australian species are, and consist of the fertile club, borne on a stalk which is attached to the host. The large Australian species are all attached to buried larval, only the club and stem appearing above the ground, and they appear like simple Clavarias. In collecting them for the museum, the buried host should always be dug up and dried attached to the fungus.

Fig. 611.
Section of club enlarged.

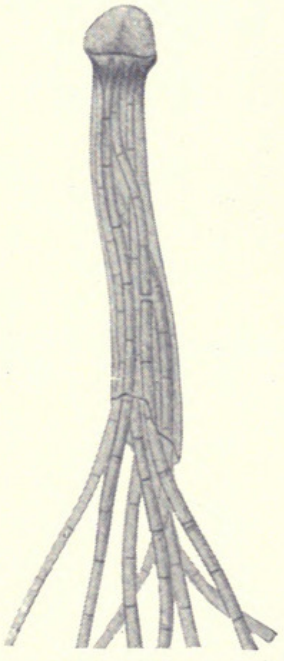

Fig. 612.
An ascus highly magnified.

The fertile portion when examined under the microscope is found to bear little sack-like bodies called perithecia. In most Cordyceps the perithecia are imbedded in the tissue (stroma), only the mouths reaching the surface. Some species, however, have the perithecia exserted, and they are borne on the surface of the stroma (free) in some species. Our figure 625 is an ideal drawing, though the head of a Cordyceps showing the perithecia as little sacks. Fig. 611, a section enlarged of a Cordyceps club, shows the perithecia as dark spots around the margin.

Each perithecium contains numerous long thread-like hyaline bodies. Under a low power they appear as simple threads, but under a high power are resolved into linear sacks (asci) each containing eight linear septate spores. The bundle of spores completely fill each ascus, and the walls of the ascus are so hyaline and thin they are difficult to see. The spores are septate in the ascus, and in water mount break up into their component cells, which are called secondary spores. Each spore breaks up into many, 120 or 160 secondaries. Some species have the spores tardily septate, and appear in the ascus as long threads, and it has been stated (erroneously) that there are species with non-septate spores. Other species have the spores at an early period, broken up into the little segments in the ascus. Fig. 612 is an ideal drawing of the top of an ascus highly magnified, showing the linear spores divided by septae.

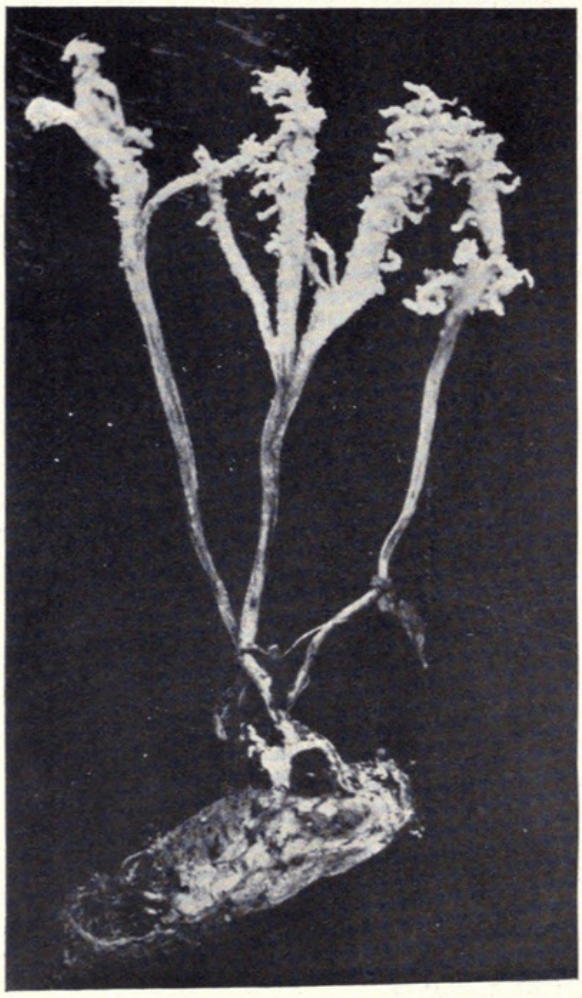

Fig. 613.
Isaria farinosa.

Fig. 614.
Cordyceps militaris.

Supposed to be the conidial and perfect form of the same species.

The life history of Cordyceps is not known, excepting as to the common species of Europe, Cordyceps militaris, which was first investigated by Tulasne, and afterwards by de Bary. It is probably, however, that the development of all the species is about the same. The spores become attached to the moist body of a caterpillar (or other insect) and germinate, sending out germ-tubes which penetrate the thin outer skin of the host. Here they enlarge and take the nature of fungal hyphae,

which branch and grow through the skin and into the flesh and tissue of the creature. In the blood these hyphae produce long cylindrical bodies called gonidia, that enlarge and divide into cells and develop to such an extent that they kill the insect. After the death these fungal hyphae continue to grow and absorb the tissue of the host until finally the skin of the host alone remains intact, the internal soft tissue of the host being replaced by the fungal hyphae, and in this condition is called a sclerotium. A section of a sclerotium is a uniform structure of interwoven hyaline, fungal hyphae showing no trace of the form of the internal organs of the host. It is said that traces of the intestines sometimes remain.

The sclerotia of most species of Cordyceps, perhaps all of them, produce in their life circle two different kinds of fruiting bodies which have little resemblance to each other. First, there is produced a conidial condition, when the spores are borne direct on the hyphae. This conidial development is either a loose, powdery (mildew-like) membrane over the host (Fig. 615) known as Botrytis, or it is a definite stipitate body (Fig. 613), called Isaria. Second, the sclerotium produces usually a club-shape body bearing perithecia (Fig. 614) and ascus spores, which is the true Cordyceps as previously described. The correlation of the Isaria and Cordyceps forms is known only as to a very few species. Isaria farinosa (Fig. 613), which is the only common Isaria we have in the United States, is known to be the conidial fruiting body of Cordyceps militaris (Fig. 614). In Brazil there are species which bear the Isaria and Cordyceps fruit concurrent, and in Ceylon is a species of Cordyceps where the upper part of the club bears conidial spores, and the lower part the perithecia. Usually, however, the Cordyceps form is supposed to be produced some months after the Isaria form. The Isaria form of none of the Australian species is known, excepting "Cordyceps Sinclairii" (Fig. 626), and that is only known from the Isaria fruit.

Fig. 615.

THE CORDYCEPS SPECIES OF AUSTRALASIA.

We present the usual formal description of the known Australasian species and a photograph of each made from authentic material. Specimens can be determined from the photographs much easier than from the descriptions, but it must be borne in mind that the specimens shrink in drying and the fresh specimens are thicker than the dried.

CORDYCEPS ROBERTSII (Fig. 616).—Fertile club slender, 2½ to 5 inches long, 3-4 mm., thick, acute, densely covered with the superficial perithecia, which reach the apex of the stem. Stem proceeding from near the thorax of the caterpillar, slender, 2 to 6 inches long, 2-3 mm. thick. Perithecia small, densely packed around the central axis, free, easily rubbed off from the axis.

Popular accounts were written of the fungus in the early days under the name of plant-caterpillar. It was eaten by the natives. It is the most slender of the large species, and from the accounts, is dark, almost black when fresh. The host, according to Gray, is the larva of Charagria virescens, a Lepiodoptera in the perfect state. These insects pass the first two states as larva and pupa, in the earth around the roots of tree ferns. The larva become infected with the spores of the Cordyceps and are killed before reaching the pupal state. Each sclerotium sends up but a single fruit.

Cordyceps Robertsii was named and figured by Hooker in Icones Plant, vol. 1 (1837), t. 11, and later by Berkeley (1840) in Hooker's Journal of Botany, Vol. 3, page 77, t. 1, fig. A. It has been known as Cordyceps Robertsii in all English (except one), French and general

literature. Corda included it in his Icones, Vol. 4, fig. 129 (1840) as Sphaeria Hügelii and Saccardo and Massee adopted Corda's specific name probably on the overworked principles of "priority," thinking that 1840 was an earlier date than 1837.

Cordyceps Robertsii seems frequent in New Zealand. There are five specimens at Paris, and over twenty at Kew and the British Museum, all from New Zealand. I believe it is unknown from Australia or Tasmania. The variety of Cordyceps Robertsii called var. neglecta can safely be nelgected, as it was based on a specimen that was mashed, which is all the difference as far as I could note.

CORDYCEPS GUNNII (Figs. 617 and 618).—Fertile club, solitary, rarely two from same host, 2-3 inches long, 5-10 mm. thick, obtuse, even, with the perithecia imbedded. Stem varying according to the depth of the larva in the ground, 5-7 mm. thick. Perithecia flask-shape, imbedded in the stroma, the mouths only showing as minute points on the surface. Ascus with a globose apex. Spores breaking usually into short sections in the ascus. Secondary spores very small, 2½ mic. long.

Cordyceps Gunnii was originally known from Tasmania, but was named from Australian collection of Gunn, who sent Berkeley a long letter on its habits. The host (teste Gray) is the larva of species of the genus Pielus, Lepiodopterous insects, the caterpillars of which live in burrows in the soil. Mr. Gunn wrote that the Cordyceps were found in great abundance in sandy soil. "They are from five to eighteen inches long (according to the depth of the burrow). The stem beneath the surface is white, but the club (2 to 4 inches long) is dark olive black. When fresh the club is from one-third to an inch thick, but one-half inch is the average. Usually one fungus springs from near the head of the larva, sometimes from the back, rarely two from the same larva."

The type specimen of Cordyceps Gunnii (Fig. 617) is short and thick and has no stipe, but the usual specimen at Kew is more slender (Fig. 618) and has a long stipe.

Cordyceps Gunnii is known from abundant specimens at Kew and British Museum, all from Australia and Tasmania. There are none from New Zealand. Also there is a single collection at Paris (called Cordyceps Lacroixii) from Japan, which appears to me to be the same species. I have specimens of Cordyceps Gunnii from F. M. Reader, Australia.

CORDYCEPS HAWKESII (Fig. 619) appears to me, from the account to be but a short-clubbed form of Cordyceps Gunnii. It was named from Tasmania, grew on the same host, and was distinguished by its short club and bearing two fruits near the back or other parts of the larva. Both of these features are recorded by Gunn as occurring exceptionally in his original account of Cordyceps Gunnii. I found no specimen of Cordyceps Hawkesii in either of the museums at London.

CORDYCEPS TAYLORI (Fig. 621).—Fertile club solitary from the host, but branching into several (usually three or four) branches which are again branched near the apex. Perithecia (unknown to me) stated to be superficial.

Fig. 616.

Fig. 617.

Fig. 618.

Fig. 616, Cordyceps Robertsii. Fig. 617, Cordyceps Gunnii (type). Fig. 618, same, the usual form.

The largest and most noteworthy Cordyceps known. Its method of growth is clearly shown on our photograph. The larva is supposed by Gray to be that of a species of Pielus, a large brown moth of Australia. The larva lives in burrows in the ground. When it is killed by the parasite, it remains in its tube in a vertical position. The fungus is developed in the same vertical plane in the head of larva. It branches near the base into three or four branches which grow to the surface of the ground (from two to four inches in all the specimens I have seen). At the surface of the ground each branch projects only about an inch, giving off short, compressed forks. The entire fungus when dug up resembles a stag's antlers, and it is a pity it was not named in accordance. The projecting portion, which no doubt becomes the fertile portion, forms on the surface "a circular bunch of branches of a brown, velvety appearance." The specimens I have are not in fruit, and I am unable to see any perithecia on any of the photographs I have. They are stated to be superficial, but I am not so sure.

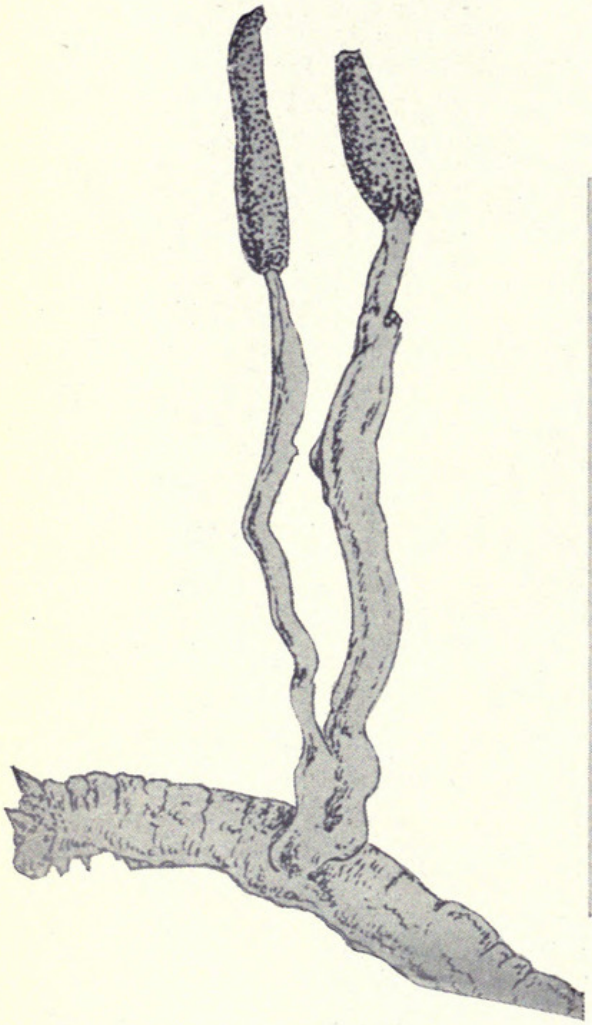

Fig. 619.
Cordyceps Hawkesii.

Fig. 620.
Cordyceps Dovei.

Cordyceps Taylori was first found in 1837 by "Rev. Mr. Taylor, of Waimati," and sent to Hooker. It was named by Berkeley and figured in Hook. Jour. Bot. 1843. I am not satisfied that it is the same plant as our photograph. The type is preserved at Kew, and

Fig. 621.
Cordyceps Taylori.

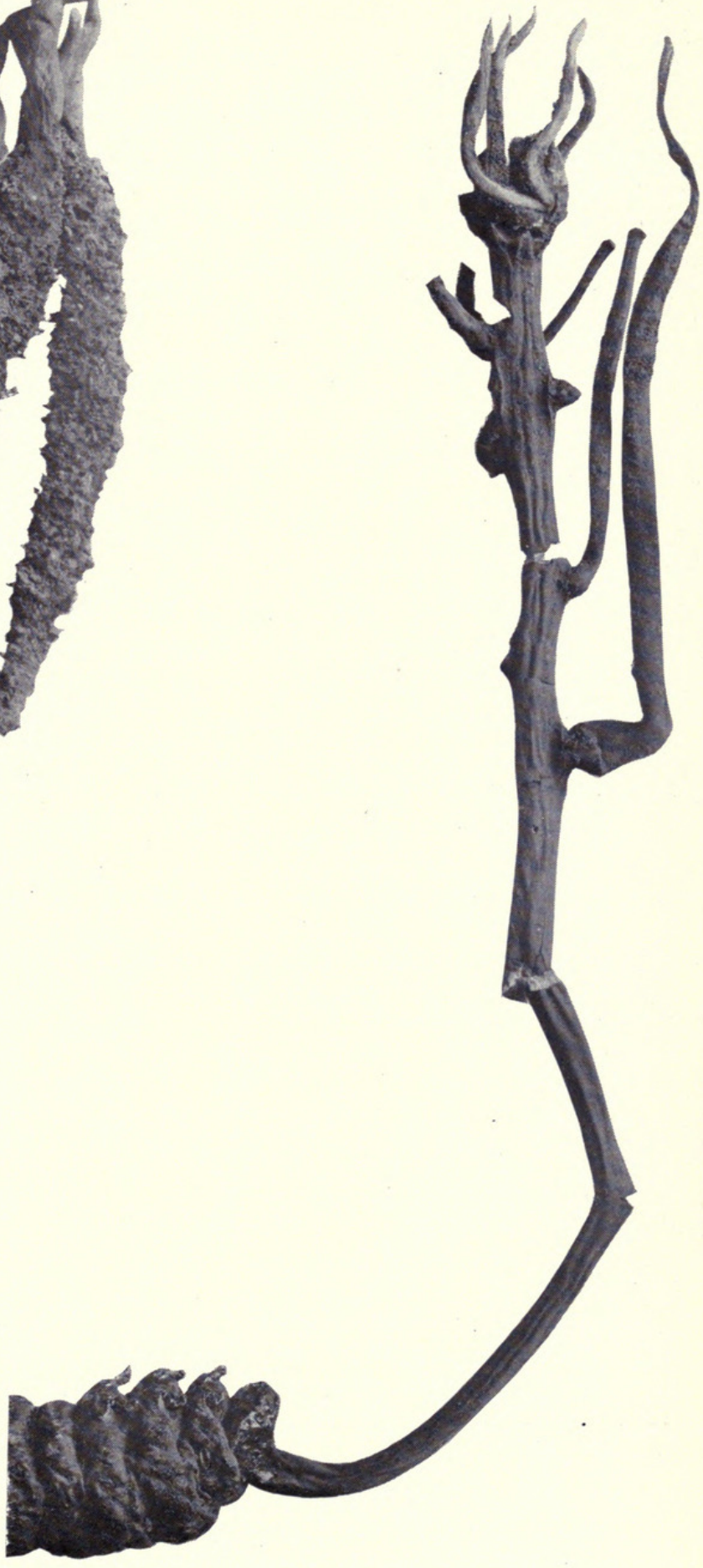

Fig. 622.
Cordyceps Henleyae.

it has numerous 15-20 immature branches, resembling the head of a Medusa. There are several collections (as our figure) received at a later date at Kew and the British Museum and referred to this species. Not one of them had more than four primary branches, and are quite different in appearance to me from the original specimen. I have a specimen received through the Botanical Garden, Warsaw, Russia.

CORDYCEPS HENLEYAE (Fig. 622).—Solitary, stem proceeding from the head of a large larva, seven inches high, five mm. thick, bearing above about a dozen fertile branches. Perithecia superficial. Spores separating in the ascus into numerous small secondary spores 2½ mic. long.

No other similar Cordyceps is known, and this is known from a single specimen at Kew. It was collected by Miss M. Henley in Victoria, Australia, and described and figured by Massee in 1895. Our photograph (fig. 622) of the type tells the whole story. The host is evidently the same, or a similar larva to the one that bears Cordyceps Taylori.

CORDYCEPS DOVEI (Fig. 620).—This is known to me only from the figures at Kew, evidently the original drawing by Rodway. It is a most curious species, the short sessile clubs forming a cluster at the apex of the host. There is no other similar species figured from any country. It was published in the Trans. R. S. Tasmania, Aug., 1898, and has entirely escaped Saccardo.

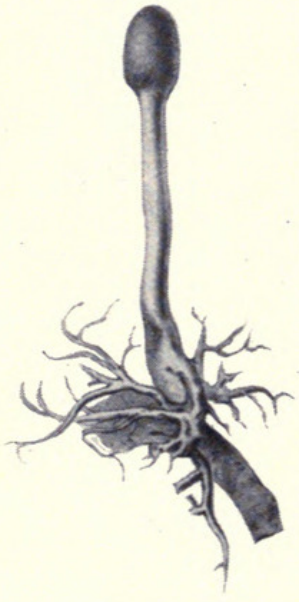

Fig. 623.
Cordyceps gracilis.

Fig. 624.
Australian form.

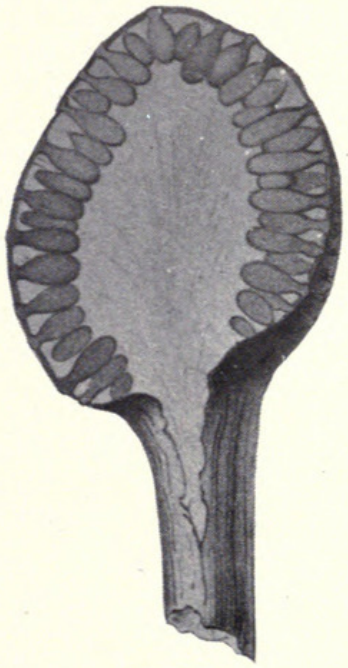

Fig. 625.
Section of head enlarged.

CORDYCEPS GRACILIS (Fig. 623).—Head globose or oval, 4-6 mm. in diameter, dark yellowish brown. Stem 2-3 cm. long, 2 mm. thick, yellowish, attached to the host by a rooting base. Perithecia imbedded, the mouths slightly protruding, so that the head is minutely rugulose.

Spores linear, moniliform, breaking into short secondary spores 4 x 6-8 mic. and rounded at the ends.

The only small Cordyceps that has been recorded from Australia is the most common species of England (Fig. 623). It is found also on the continent and in Algeria and has been rarely found in the United States. Mueller sent it to Berkeley under the name Cordyceps menesteridis from the host Menesteris laticollis. Cooke correctly referred it to Cordyceps gracilis under the mistake Cordyceps entomorrhiza, as Cordyceps gracilis is misnamed in most English museums and books. From Australia, it is only known in England from the one collection Mueller (Fig. 624).

SYNONYMS AND MISTAKES.

I have seen somewhere several additional synonyms for Australian species, based, it was claimed, on slight variations in the common species. I made no record of them.

Basili, New Zealand, Taylor (Sphaeria), said to be same as Sinclairii and caespitosa.

caespitosa, Tulasne. Mentioned incidentally only from New Zealand. No specimen in his herbarium or known to me. It is said to be same as Sinclairii (q. v.).

entomorrhiza. Usual English tradition (not original of Dickson) = gracilis.

Forbesii, New Zealand, Berkeley = Cordyceps Robertsii, apparently an inadvertence.

Fig. 626.

Hawkesii, Tasmania, Gray. See page 6. Appears to me a condition of Cordyceps Gunnii.

Hügelii, New Zealand, Corda = Cordyceps Robertsii, but used by Saccardo and Massee, who thus got "priority" hind end first.

innominata, Tasmania, Taylor (Sphaeria) = Cordyceps Taylori.

Lacroixii, Japan, Patouillard = Cordyceps Gunnii.

larvarum, New Zealand, Westwood (Sphaeria) = Cordyceps Robertsii, and a chance for a juggle.

menesteridis, Australia, Mueller = Cordyceps gracilis.

Sinclairii, New Zealand, Berkeley. No specimen known, only the figure (reproduced Fig. 626), which is evidently the conidial form of some unknown Cordyceps. It was described as a Cordyceps, but strictly speaking the specimen was an Isaria. It grew on Cicada, and may be the conidial form of Cordyceps sobolifera, a species common on Cicada in the West Indies and Japan. Cordyceps caespitosa as named by Tulasne is said to have been based on the same collection.

ILLUSTRATIONS.

Fig. 613 (Isaria farinosa) is from a photograph by G. D. Smith, the most skillful fungus photographer who has worked on the subject. Figs. 612, 623 and 625 are from Tulasne, the latter emended by cutting away the lines representing protruding spores, which in the original are misleading. Figs. 619 and 626 are copies from Cooke's copies. Fig. 620 is from the original drawing at Kew. The remainder of the figures are from photographs of authentic material by the writer.

The Collecting of Cordyceps.

This pamphlet will reach many persons, not only mycologists but entomologists, who are in position to secure material for a general knowledge of the Cordyceps. A few words in regard to their collection will not be amiss. Cordyceps have only to be picked up and dried, but as the host is usually buried, care should be taken to dig out the host and forward it, attached to the Cordyceps. Cordyceps change very little in drying, so it is not necessary to send them in alcohol. Simply lay them aside for a few days and dry them, wrap in tissue paper and place in a little box and mail to my address. If one is an entomologist and knows the name of the host it would add much to the interest, if the name of the host is stated on a piece of paper and enclosed with the specimen. All specimens will be named and acknowledged by private letter as soon as received, and published in my writings. Address

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INDEX AND ADVERTISEMENTS.

(According to our views, a binominal indicating the genus and species alone represents the name of a plant. According to custom, it is usual to append the name of individuals who are supposed to have named it, and their friends or the collector or some one who has compiled it or juggled it in some way. It seems to me the whole object of many "scientists" nowadays is to append their names to plant names, and so confusing and extensive has this abuse become that mycology has gotten to a very low state, and is liable any day to die of this form of appendicitis. We append the names for the benefit of those afflicted with this disease who wish to use them.)

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CORDYCEPS GRACILIS, GREVILLE, PAGE 10.
CORDYCEPS GUNNII, BERKELEY, PAGE 6.
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