NOTES ON ENTOMOGENOUS FUNGI

By T. PETCH

(With 4 Text-figures)

1. *Beauveria Peteloti* Vincens

Beauveria Peteloti Vincens was described by Vincens in *Bull. Soc. Bot. France*, Sér. 4, xv (1915), 132–144, from three collections from Brazil, one on the wasp, *Polybia chrysothorax*, another on the wasp, *Polystes canadensis*, and the third on bees, the fungus being so different in appearance in the three cases, that, as remarked by Vincens, one would consider them three different species, were it not that a study of their fructifications showed them to be the same. The following account is based on Vincens' descriptions and figures.

In the specimen on *Polybia*, the insect is attached to a leaf by thick brown strands of mycelium. From the insect arise numerous slender clavae, 2 to 10 mm. long, 0·2 to 0·5 mm. diameter, sometimes thickened upwards, straight or curved, pulverulent, white at first, becoming light brown and polished, and then resembling *Hirsutella Saussurei*. Vincens found that the clavae bore somewhat irregular phialides, varying from an elongated, slightly swollen base, 2–3 μ diameter, to one scarcely differentiated from a normal hypha. The conidia were oval or elliptic, 3–4 × 1–1·5 μ. He regarded the fungus as a form of *Spicaria*, because he sometimes found three phialides arising from a common basal cell. He remarked that the hymenial layer was less compact towards the base of the clava, where the phialides were borne on short tufts of mycelium.

Vincens' photograph of the specimen on *Polybia* shows a general resemblance to *Hirsutella Saussurei*, but the clavae are too white and fluffy in the upper part for that species. His drawings, however, show a much looser external layer than in that species, which has a closely packed palisade layer of hairs and phialides, quite different from the slightly inflated phialides illustrated by Vincens. Moreover, the phialides of *Hirsutella* bear a thin sterigma clearly differentiated from the swollen base, whereas those figured have no such sterigmata.

The second specimen, on *Polystes*, also has clavae arising from the thorax, but these are white, fluffy, and often branched above. The abdomen, however, bears small white cushions, arising from the sutures and forming bands across it, just as commonly occurs on beetles attacked by *Beauveria densa*. These cushions contained conidiophores similar to those borne on the tufts at the base of the clavae on the specimen on *Polybia*, but in addition Vincens found a few zigzag sterigmata which he considered similar to those of a *Beauveria*, and he

figured one arising from a phialide borne on the same hypha as other similar phialides, of the same shape as those of the specimen on *Polybia*. Similar sterigmata were found on the clavae on the thorax, but in that situation they did not arise from differentiated phialides, but were continuations of normal hyphae of equal diameter. The conidia of this specimen were the same as those of the specimen on *Polybia*.

Vincens' figures show that his supposed sterigma is not a *Beauveria* sterigma. It is a normal conidiiferous hypha of a *Sporotrichum*, undifferentiated in diameter from the hypha of which it is a continuation, and is quite different from the extremely fine sterigma of *Beauveria*. The sole point of resemblance is that growth in both is sympodial.

In the third collection, on bees, the insect is covered with a mycelium consisting of pale brown filaments. White clavae arise from the sutures of the insect, but these have collapsed, and hide the insect under a white mass of coarse cottony strands. The fertile hyphae of these strands are less regularly flexuose than those of the specimen on *Polystes*, but they are evidently of the same character.

In temperate climates one is apt to think of entomogenous fungi as species which grow from insects buried in the ground or in decaying wood, and that idea is strengthened by the accounts of the larger species of *Cordyceps* found in the tropics. But by far the greater number of entomogenous fungi in the tropics grow on insects attached to living leaves of trees and shrubs at some distance from the ground. Naturally, one would expect those which attack scale insects to occur on living leaves or stems, as the insects themselves occur normally in that situation, but fungi which attack spiders, flies, wasps, ants, cockroaches, etc., are also found, as a rule, on insects attached to the under side of living leaves. In collecting entomogenous fungi, one looks on the ground and examines decaying logs, for the larger *Cordyceps*, and other fungi which grow on insects in such habitats, but to make any representative collection of the species of a given district one must examine the under surfaces of leaves, which is most easily done by turning over, or cutting off, the branches of the jungle undergrowth.

From the beginning of the rainy season, one finds an increasing number of specimens in that situation. Infected insects settle on the under side of the leaves, are fixed to the leaf by the mycelium of the fungus, and die in that position. Subsequently, the fructifications are developed. But the specimens do not remain there indefinitely or until the leaf falls. Like other fungi, they decay, the decay being accelerated by the attacks of mites and insects, and especially by other fungi. Towards the close of the rains, very many of the specimens one finds have been attacked by secondary fungi.

This "superparasitism" is soon realised, if one makes periodic collections, in the same locality, of a well-defined species, such as *Cordyceps dipterigena* B. & Br. At first one gathers the typical specimens

of this species, with the two glabrous perithecial clavae arising from the thorax and the slender conidial clava from the tip of the abdomen. As the rainy season progresses, one meets with specimens which bear the various stages of *Byssostilbe tomentosa*, or *Sporotrichum album*, or other fungi, these being confined to the *Cordyceps* clavae, so that there is little doubt that they are parasitic on the *Cordyceps* and not on the insect. Later, specimens are found on which the *Cordyceps* has been almost obliterated by the secondary fungus, and only a careful examination, and a knowledge gained from previous specimens, will enable one to discover the remains of the *Cordyceps*, sometimes only the strigose brown mat which fastened the insect to the leaf.

Many of these secondary fungi have been recorded in previous papers. *Aegerita Webberi* is the host of several. *Cladosporium* spp. attack almost all entomogenous fungi, but especially *Hypocrella* and *Aschersonia*. Species of *Cephalosporium* are common. *Gibellula* may be so far obliterated by secondary fungi, that it can only be recognised by the remnants of the stalks of the conidiophores.

It may be queried whether it is correct to style these fungi superparasites. *Melanospora parasitica* is undoubtedly parasitic only on fungi, and *Byssostilbe tomentosa* and *Byssostilbe fusca* are probably parasitic on *Cordyceps* and *Torrubiella* respectively. But whether the various species of *Sporotrichum*, *Cephalosporium*, *Cladosporium*, etc., found on entomogenous fungi are restricted to that substratum, or to fungi in general, or are merely common saprophytes, cannot be stated in the light of our present knowledge of tropical fungi.

The foregoing remarks will illustrate the necessity of bearing in mind that entomogenous fungi can serve as hosts for other fungi, especially Hyphomycetes, and that it cannot be concluded that all the fungi found on an insect at the same time are stages of the same fungus, nor that the most obvious fungus on an insect is the one which killed it. Secondary fungi are to be expected on specimens gathered during prolonged wet weather.

With *Beauveria Peteloti* Vincens, there is little room for doubt that the conidiophores figured by Vincens are not those of a *Beauveria*, but of a *Sporotrichum*, which is growing on the clavae of *Hirsutella Saussurei*. According to Vincens' figures, the *Sporotrichum* is very near *S. album* Petch, but has smaller conidia. In the specimen on *Polybia* it is growing on the clavae only. In the specimen on *Polystes* it is growing on the clavae and on the body of the insect, the latter being permeated by the mycelium of the *Hirsutella*. In the third collection, on bees, it has overwhelmed all the clavae, and united them in a tangled mass. The three collections illustrate progressive stages of "mouldiness."

2. Sporotrichum

Sporotrichum album Petch, parasitic on *Cordyceps dipterigena* B. & Br., was described in *Trans. Brit. Myc. Soc.* xi (1926), 262. In culture on Quaker Oat agar, it gave a very scanty growth and coloured the agar chocolate-brown, but did not produce conidiophores. A figure of the conidiophore is given below (Fig. 1).

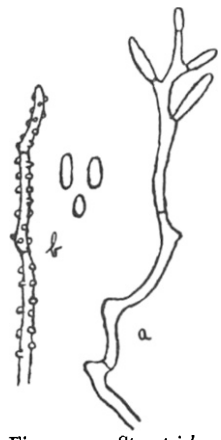

Fig. 1. *a*, *Sporotrichum album*; *b*, *Sp. isarioides*, conidiophore and conidia. × 1000.

Another *Sporotrichum* has been found on *Cordyceps dipterigena* at Nuwara Eliya, Ceylon. In addition to a covering of short erect conidiophores over the *Cordyceps* or the insect, it commonly produces "*Isaria*" forms, as many as twenty together in a single tuft. Sometimes the only indication of the presence of the *Cordyceps* is the brown strigose mat of mycelium which fastens the insect to the leaf, the clavae of the *Sporotrichum* then arising directly from the body of the insect. In culture on Quaker Oat agar it developed a continuous even pulverulent growth over the whole slant, with numerous short, erect, rather loose, cylindrical processes. It may be known as *Sporotrichum isarioides*.

Sporotrichum isarioides Petch, n.sp. White; forming a sparse pile of short erect conidiophores over the *Cordyceps* or its host insect, and also producing white cylindrical clavae, singly or in tufts. Clavae up to 1 cm. long, 0·6 mm. diameter, simple or branched, variously curved, peripherally somewhat floccose with flexuose interlaced conidiophores. Conidiophores branched, ends of the branches rough with the points of attachment of the conidia. Conidia oblong-oval, ends obtuse or subacute, hyaline, 3–4 × 1·5 μ.

On *Cordyceps dipterigena* on *Mydaea* (a fly), Nuwara Eliya, Ceylon, 1927–28.

3. Beauveria

Beauveria laxa Petch, n.sp. Forming white or cream-coloured pulverulent masses. Mycelium stout, up to 3 μ diameter. Prophialides lateral on the hyphae, or terminal on short lateral branches, often in whorls, oval, 4 × 2–3 μ, or globose, 3 μ diameter. Phialides numerous on each prophialide, flask-shaped or globose, with a conical or cylindric neck, 4–6 × 2–3 μ. Conidia hyaline, angularly globose, 1·5 μ diameter, or angularly oval, 1·5–2 × 1–1·5 μ, crowded on the sterigma and distorted by mutual pressure.

On larvae of a Lepidopteron, Kirimettia, Ceylon, January, 1927; also on *Tortrix* larvae, lepidopterous cocoons, tineid cases, and spiders, Nuwara Eliya, Ceylon, 1927–28.

This species differs from *Beauveria Bassiana* in its more regularly globose prophialides and its irregular conidia. The conidia are situated close together on the sterigma, which is not easily discerned, as it, with its attached spores, generally separates from the phialide as a whole, simulating a chain of conidia. In other species of *Beauveria*, the conidia are more widely separated and many of them fall off individually, so that for both reasons the sterigma is more easily seen. The prophialides usually stain more deeply with iodine than the conidia, and hence are visible as globose bodies in the middle of the spore cluster, which is more compact than in other species of *Beauveria*.

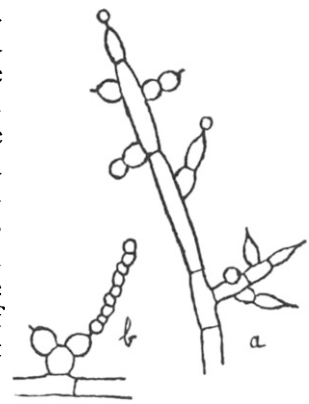

Fig. 2. *Beauveria laxa*. *a*, developing phialides; *b*, two phialides and a chain of conidia. × 1000.

When developed from cocoons embedded in moss, or under bark, the fungus penetrates the overlying substance in coarse strands and forms pulverulent cushions on the exterior. When dissected out, it has then the appearance of an *Isaria* with a subglobose head.

In culture on Quaker Oat agar slants, the fungus fills the tube with a white, loose, fluffy mass of mycelium and spreads over the glass in strands. Conidia are produced somewhat tardily, and in small scattered masses over the mycelium, not in a uniform stratum as in *Beauveria Bassiana*. In culture, the phialides first formed, may, as in other species of *Beauveria*, occur in a different manner and may differ in shape, *i.e.* they may be subcylindric, lateral on the hypha (lacking a prophialide), with a whorl of phialides below, or elongated flask-shaped, up to 10 μ high, 1·5–2·5 μ diameter at the base, lateral on the hypha, singly or in whorls.

Quaker Oat agar is not coloured by the growth of the fungus on it. On Dox agar, the growth is the same, and the agar is not coloured.

In old cultures, white globose parenchymatous bodies, sometimes in clusters up to 4 mm. in diameter, occur in the agar, and yellow conoid perithecioid bodies, up to 0·2 mm. diameter and 0·3 mm. high, in clusters on the glass. No spores have been found in these.

Beauveria Bassiana has been collected recently in Ceylon on caterpillars, beetles, *Astycus* sp., a pentatomid (*Cyclopeltella siccifolia*), tineid cases, a millipede, and a nest of centipedes. Specimens have been received from Dr C. F. Beeson, Dehra Dun, on the larva of *Haplocerambyx spinicornis* and on a longicorn larva.

Beauveria densa has been collected recently in Ceylon on a leafhopper, on various beetles, and on lepidopterous cocoons.

From Mr E. E. Green, I have received specimens of *Beauveria Bassiana*, on a Jassid, Camberley, Surrey, November, 1926, and on

Lecanium (? *persicae*) on *Cornus sanguinea*, Cheddar, Somerset, August, 1926. In the former, the fungus forms pale yellow, or ochraceous, rather loose pulvinate masses underneath and at the sides of the insect. On the *Lecanium*, the mycelium is abundant and forms a rather dense stroma, with a patch of conidia at one end.

It may be noted that, on young or poorly developed stromata of *Beauveria*, the phialides may bear only a single conidium on a short slender sterigma. Sometimes, when the majority have only a single conidium, a few may be found which bear two conidia on a short once-branched sterigma. Several specimens have been collected in this condition in Ceylon, and have been proved to be *Beauveria* by cultivation on agar. Often, the typical *Beauveria* sterigma is obtained if the specimen is merely left in a glass tube.

Except for a record of *Beauveria Bassiana* (as *Sporotrichum globuliferum* Speg.) on the flesh of dead birds recently received from America, by Miss A. L. Smith in *Trans. Brit. Myc. Soc.* 1 (1897), 70, no mention of *Beauveria* has appeared in British lists. There are, however, specimens in British herbaria.

In Herb. Kew., in the cover of *Isaria farinosa*, there is an unnamed specimen of a fungus on a Coccinellid, marked "Bishop's Wood." This is *Beauveria Bassiana*.

Also in Herb. Kew., in the cover of *Isaria crassa*, there is a specimen marked "*Isaria* E.C. Herb. Mycol. M.C. Cooke," on a pupa buried in vegetable debris. This again is *Beauveria Bassiana*. This may be the specimen referred to by Cooke in *Vegetable Wasps and Plant Worms*, p. 181, where he stated that "The only occasion on which we have met with this species [*Isaria crassa*] in Britain occurred on a much larger pupa than those on which we find *Isaria farinosa*."

In Herb. British Museum, in the cover of *Isaria arachnophila*, there is a specimen marked "*Isaria arachnifera*? Kent, Sept. 1837. Ch. Forest, C.B.," *ex* Herb. Bloxam. The insect is hidden in straw, and cannot be determined without dismembering the specimen. It bears several erect clavae, which resemble *Isaria farinosa*, but on microscopical examination it proved to be *Beauveria densa*.

I have recently collected in England, *Beauveria Bassiana* on pupae at Black Hills, North Wootton, March 23rd, 1930, and West Briggs, September 2nd, 1930, and on spiders at North Wootton Heath, May 14th, 1930, Holt House Wood, August 12th, 1930, and Bawsey, September 3rd, 1930; and *Beauveria densa* on a weevil and on a spider, Black Hills, March 30th, 1930, and on a beetle, Holt House Wood, April 3rd, 1930. All these localities are in Norfolk. Miss Brett collected *Beauveria Bassiana* on a Coccinellid near Barton Mills (Suffolk), on August 21st, 1930.

4. Rhinotrichum album Petch

This species was described in *Trans. Brit. Myc. Soc.* xi (1926), 258, from a specimen on *Lecanium*, on which it formed a loose white pile consisting of rigid erect conidiophores. Further collections of this species, and their culture on Quaker Oat agar, have shown that it is the same as *Gonatorrhodiella coccorum* Petch, *Trans. Brit. Myc. Soc.* x (1925), 181, which was originally obtained in culture from *Lecanium viride*, in company with *Cephalosporium Lecanii*. It has now been collected in Ceylon on *Lecanium*, *Aleyrodes*, aphides, and leaf-hoppers.

5. Volutella epicoccum Petch

In *Trans. Brit. Myc. Soc.* xii (1927), 44–52, I described *Peziotrichum Lachnella* Sacc., *Ophionectria coccorum* Petch, and *Volutella epicoccum* Petch, three fungi on scale insects, having similar circular brown byssoid stromata, from which arise erect fascicles of bristles. *Peziotrichum Lachnella* is a sterile stroma, which, however, bears globose pseudoconidia on the repent hyphae of the stroma. These pseudoconidia had been found on one occasion on the stromata of *Ophionectria coccorum*, but up to the time the above paper was written they had not been observed on the stromata of *Volutella epicoccum*.

The last-named fungus occurs in abundance on one tree of *Cinnamomum ovalifolium* at Hakgala, Ceylon. On revisiting this tree on May 7th, 1927, fallen leaves bearing effete stromata of the *Volutella* were collected, and the repent hyphae of these stromata were found to bear the globose pseudoconidia characteristic of *Peziotrichum*.

6. Hypocrella Schizostachyi P. Henn.

Hennings described the colour of this species as "cinereo-testaceus." As previously stated (*Ann. R.B.G. Peradeniya*, vii (1921), 223), the cotype specimens submitted to me were reddish purple, and they were figured that colour on Pl. II, fig. 7 (*op. cit.*). Recent, younger, specimens, from Sumatra, on *Lecanium bambusicola* Green (Mss.), kindly furnished by Mr E. E. Green, are ochraceous, or reddish ochraceous, sometimes with an ashy bloom, and blackening irregularly, the tubercles dotted with red-brown ostiola.

7. Isaria abietina v. Höhnel

Isaria abietina was described by von Höhnel in *Fragmente zur Mykologie*, No. 277 (*Sitzungsber. d. K. Akad. d. Wissenschaft. in Wien, Math. Nat. Kl.* cxviii (1909), 416). The specimen had been collected by Ouwens in Java, and was said to grow on a "Baumwanze."

The synnemata were awl-shaped, about 3 mm. high, 300 μ diameter below, 55 μ diameter above, scattered or in rows, sometimes fasciculate. In the lower half they bore short, cylindric, obtuse processes,

perpendicular to the clava, up to 160 μ long, 55 μ diameter. The lengths of the processes diminished from the base of the clava upwards, and von Höhnel stated that, when magnified, the whole fungus looked like a young fir tree—whence the specific name. The lateral processes, like the main clava, were composed of parallel hyphae, the ends of which formed, on the clava and the processes, a hymenium consisting of parallel, obtuse hyphae, perpendicular to the surface. The conidia were very small, globose, situated in clusters on the tips of the hyphae.

von Höhnel's specimen was one of those which had been collected some time before his visit to Java and handed over to him during his stay there. Several of these had been preserved in alcohol and then dried. As regards *Isaria abietina*, von Höhnel stated that the arrangement of the spores was obscure, and probably the description would require amendment.

From Mr T. Bainbrigge Fletcher, Imperial Entomologist, Pusa, India, I have received specimens which, macroscopically, agree exactly with von Höhnel's figures of *Isaria abietina*. These are on *Pyrilla pusana*, a hopper which attacks sugar cane. The clavae are up to 3 mm. high, 120 μ diameter below, tapering upwards, lavender in colour, and arise in clusters or rows from the sutures of the insect, united by mycelium at their bases but without any general covering of mycelium over the insect. The main clava is composed of parallel hyphae, and bears, in the lower half, lateral, subcylindric processes, up to 120 μ long and 40 μ diameter, perpendicular to the clava and composed of parallel hyphae with clavate tips which curve outwards but do not separate. In all these features the fungus agrees with *Isaria abietina*.

The upper part of the clava, however, bears *Hirsutella* conidiophores. These are up to 26 μ high, with an oval base, 8–10 × 5 μ, abruptly attenuated into an elongated sterigma, up to 16 μ long, 1·5 μ diameter below, tapering upwards. The cluster of four spores is lemon-shaped or oval, 5–6 × 3 μ. The separate conidia are oval or subcymbiform, ends usually obtuse, 4–6 × 2–2·5 μ. These conidiophores have not been found on the lateral processes.

The supposed conidia observed by von Höhnel may have been intrusive, or they may have been artefacts due to preservation in alcohol. The fungus is a *Hirsutella*, and must be known as *Hirsutella abietina*, comb. nov.

8. Naemosphaerella

Naemosphaerella epimyces Petch, n.sp. Pycnidia black, not carbonaceous, globose, 0·25 mm. diameter, superficial or partly immersed, with a long conical beak, up to 1 mm. high, 120 μ diameter below, 50 μ diameter above; base of the pycnidium clothed with a thin layer

of rusty tomentum which also covers, wholly or in part, the host stroma; mycelium brownish yellow, thick-walled, irregular, 4 μ diameter; spores blackish brown, cuboid, 11–14 × 9–11 μ, or globose, 9–11 μ, thick-walled, on stout pedicels from the pycnidium wall; chains of spores not seen.

On the stromata of *Aegerita Webberi* Fawcett on *Psychotria Thwaitesii*, Nuwara Eliya, Ceylon, June 26th, 1927; *ditto* on *Calophyllum* sp., Nuwara Eliya, March 11th, 1928.

9. Oospora

Oospora insectorum Petch, n.sp. White, covering the insect with a loose weft; hyphae slender, 1·25–1·75 μ diameter; conidiophores lateral and terminal, the former perpendicular to the hypha, but becoming oblique towards its extremity, so that the terminal group resembles a compound conidiophore with distant branches; conidiophores cylindric, attenuated above, 12–28 μ high, 1–1·5 μ diameter below, continuous or one-septate, usually simple, sometimes with a lateral branch; conidia in a terminal chain, narrow-oval or oblong-oval, hyaline, continuous, ends obtuse, 3–5 × 0·75–1 μ.

On a spider, Nuwara Eliya, Ceylon, September 11th, 1927; on pupae, Nuwara Eliya, October 10th, 1927, August 9th, 1928; on ? *Aleyrodes*, Nuwara Eliya, November 13th, 1927. In one specimen, on a pupa, the conidiophores form small, subglobose tufts on and round the cocoon.

On Quaker Oat agar, the growth is white and woolly, covering the whole slant and spreading over the glass. Conidia are tardily produced, and form best on the glass. When old, the stroma becomes pinkish in the centre. The agar is coloured pale ochraceous or yellow-brown.

Oospora subfasciculata Petch, n.sp. Mycelium white, scanty, closely investing the host, sometimes arising in short columnar tufts; conidiophores simple, elongated conoid, 16–24 μ high, 1·5 μ diameter at the base; conidia in a terminal chain, hyaline, continuous, narrow-oval, ends acute, 2–3 × 1·1–5 μ.

On a millipede, Nuwara Eliya, Ceylon, June 12th, 1927; on a pupa, Nuwara Eliya, August 15th, 1928.

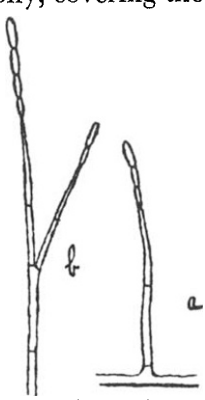

Fig. 3. *Oospora insectorum*. *a*, lateral conidiophore; *b*, terminal conidiophores. × 1000.

On Quaker Oat agar, the growth is white, strigose with numerous erect fascicles or columns, 2–3 mm. high; the agar is not coloured. The growth on Dox agar was similar, but no conidia were produced on this medium.

Of the species of *Oospora* previously recorded as parasitic on insects, *Oospora ovorum* Trabut, parasitic on the eggs of *Acridium peregrinum*,

was described as having globose spores, 0·7 μ diameter; *Oospora Aphidis* Cke. & Massee is a mixture of an *Oidium* and an *Entomophthora* (*Trans. Brit. Myc. Soc.* XI (1926), 265); *Oospora necans* Sacc. & Trott., on *Pemphigus bursarius* in galls on *Populus nigra*, apparently resembles *Oospora insectorum*, but differs in its conidiophore.

10. Tilachlidium

A species of this genus was collected at Nuwara Eliya, Ceylon, in January, 1928, on larvae of a microlepidopteron on a living leaf, each larva being covered by a web, the clavae of the fungus emerging through the web.

Tilachlidium larvarum Petch, n.sp. Mycelium white, covering the insect. Clavae numerous, white, up to 1 mm. high, 0·05 mm. diameter, cylindric, composed of parallel agglutinated hyphae, bearing conidiophores laterally, perpendicular to the clava, moderately crowded, but not forming a palisade layer. Conidiophores stout, conical or slightly flask-shaped, attenuated gradually upwards, 14–22 μ high, 2 μ diameter at the base, simple. Conidia persistent in mucilaginous heads, up to 14 μ diameter, on each conidiophore. Conidia narrow-oval, ends rounded, hyaline, 4–6 × 2–2·5 μ.

On larvae of a micro-lepidopteron, Nuwara Eliya, Ceylon.

This species is similar to *Tilachlidium subulatum* A. L. Smith. On this view *Tilachlidium* is a *Stilbum* which bears *Cephalosporium* conidiophores laterally.

11. Acremonium griseum Petch

This species was described in *Trans. Brit. Myc. Soc.* XI (1926), 262, from a specimen on a spider, collected at Hakgala, Ceylon, in March, 1922. During 1926–28, it was found in abundance at Nuwara Eliya, Ceylon, usually on spiders, but also on a cocoon (Lepidopteron) and on a fly (*Mydaea* sp.).

The fungus covers the body of the insect with a rather loose pulverulent stroma, and spreads out along the legs and over the leaf to which the insect is fixed. The stroma is usually nodular with small tufts of conidiophores, or protuberances of hyphae, and these are generally a well-marked feature along the legs of the insect. When old, the stroma becomes more floccose. Its colour may be yellowish-grey or lavender, fading with age to ashy or white.

The species was originally described as having simple conidiophores. These, elongated conoid and up to 16 μ high, occur on the looser parts of the stroma. The tufts, however, consist of loosely interwoven, more or less erect hyphae which bend outwards and branch repeatedly, the ultimate branches usually terminating in a single phialide, with two opposite phialides about 16 μ below the apex

(Fig. 4). Thus, on viewing a mounted tuft or protuberance, one sees a rather loose central core, fringed by interlacing pencils of conidiophores.

The protuberances may be so strongly developed that they may be classed as clavae. One specimen, on a spider, bears eighteen small erect clavae, up to 3 mm. high, bifurcating above and covered with minute nodular tufts. Another specimen, on *Mydaea*, bears numerous thin clavae, pale ochraceous to white, forming a large spreading tuft; these clavae are simple or branched, up to 1 cm. long, 0·1–0·2 mm. diameter, nodular with tufts of conidiophores. This latter specimen was thought to be a different species, but in culture it proved to be *Acremonium griseum*. It is an *Isaria* form of that species.

Fig. 4. *Acremonium griseum*. *a*, simple conidiophore; *b*, pencil of conidiophores from a tuft. × 1000.

In culture on Quaker Oat agar, the fungus forms a thin pulverulent stroma, which ultimately covers the whole slant. The stroma is at first white, then yellowish green or emerald-green with a broad white margin. A few tufts are formed in the centre of the stroma, but no elongated clavae have been obtained in culture. The agar is coloured pale reddish purple.

On Dox agar, growth was poor—a small, loose, grey tuft with a broad, thin, transparent, feathery margin. No conidia were produced on this medium, which becomes coloured deep purple.

In the type specimen of *Acremonium griseum*, the fungus occurred on a spider in company with *Gibellula* (not *Hirsutella*, as previously suggested), and it was thought that the *Acremonium* was parasitic on the *Gibellula*. Several other specimens have been collected in which this fungus occurs with *Gibellula*, on a spider, and others with *Beauveria* and *Spicaria* respectively, on cocoons and tineid cases. In the majority, however, the *Acremonium* occurs alone, and it is probable that the former specimens are merely instances of the occurrence of two entomogenous fungi simultaneously on the same insect.

The conidia are narrow-oval or sub-fusoid, hyaline, continuous, 3–5 × 1–1·5 μ, ends acute or obtuse, or one end subacute. Sometimes, especially in culture, they persist in short chains of three or four.

12. Botrytis necans Massee

Botrytis necans was described by Massee in *Kew Bulletin* (1914), p. 159. The fungus occurred at Singapore and in the Federated Malay States, on the larvae of *Brachartona catoxantha*, a pest of coconuts, killing them in large numbers. There is a type specimen in the Kew Herbarium, which I had apparently previously overlooked.

Massee described the conidia as very numerous, acrogenous, solitary, globose, 4 μ diameter. They are globose, 1·5–2 μ diameter, or broadly oval, 1·5 × 2 μ, in a typical *Beauveria* head. The fungus is *Beauveria Bassiana.*

13. Botrytis Eriophyes Massee

Botrytis Eriophyes was found on the mite *Eriophyes ribis* in "big bud" of black currant, and was described by Massee in Taylor, *Journ. Econ. Biol.* IV (1909), 5. It was said to form small white patches of repent, septate hyphae, from which arose erect conidiophores with subverticillate branches and branchlets. The branchlets (phialides) were slender, with a subacute apex, and bore conidia near the apex. The conidia were cylindric, hyaline, continuous, straight, 5–8 × 1·5–2 μ. In Saccardo, *Sylloge Fungorum*, XXII (1913), 1299, it was transferred to the genus *Verticillium*, as *Verticillium Eriophytis* (Massee) Sacc. & Trott.

The type in the Kew Herbarium consists of a single bud scale which bears a minute white patch of mycelium, covering the insect, at the base. This bears simple conidiophores, up to 20 μ high, 2 μ diameter below, attenuated upwards, arising singly or in groups from the mycelium. Each conidiophore bears a globose head, 4–8 μ diameter, of conidia united by mucilage. The conidia are cylindric, or narrow-oval and inequilateral, with rounded ends, 4–6 × 1·5–2·5 μ.

The fungus is a *Cephalosporium*, or, assuming that Massee saw branched conidiophores, an *Acrostalagmus*. It must stand as *Cephalosporium* (*Acrostalagmus*) *Eriophytis* (Massee), comb. nov. The small-scale figures in Taylor, *loc. cit.*, are good representations of a *Cephalosporium*, but in the large-scale figures the conidial heads are lacking, having probably been lost in manipulation.

14. Isaria Cicadae Miq.

Isaria Cicadae was described by Miquel in *Bull. d. Sci. Phys. et Natur. en Néerlande*, I (1838), 85–86, Pl. I, from a specimen from Brazil. It was recorded by Cooke for Australia in the *Handbook of Australian Fungi*. The specimen on which this record was based is now in the Kew Herbarium, and is labelled "Fungi growing on Cicadae (Locust), Port Phillip, C. French Jr., 6. 6. 90." The fungus does not bear any resemblance to the original figures of *Isaria Cicadae*, but forms small white or cream-coloured cushions. Examination shows that this Australian specimen is *Beauveria Bassiana.*

An *Isaria* on Cicada from New Zealand was described by Berkeley as *Cordyceps Sinclairii*. The same fungus occurs in the hill districts of Ceylon. It is a large species, very variable in form, usually divided into two or more stems from the base and branched into coarse lobes above, but sometimes forming a cluster of stout stalks from the head

of the insect, each with a compact subglobose head. It has large conidia, up to 8 μ long.

When von Höhnel visited Java, he was given an *Isaria* on a Cicada, which had been preserved for a long time in alcohol. This he described as *Isaria amorpha.* His description fits *Isaria Sinclairii,* though he gave the spores as 3–4 μ long. Under the conditions of preservation, however, it is probable that most of the conidia would be lost, and it seems certain that *Isaria amorpha* is *Isaria Sinclairii.*

Long-spored species of *Isaria* on Cicadae have been described as *Isaria Harioti* Arnaud, from Madagascar, *Isaria arbuscula* Hariot, from Mexico, and *Isaria Cosmopsaltriae* Yasuda, from Japan. From the figures and descriptions of these species, it is probable, as previously suggested by Lloyd (*Mycol. Notes,* No. 56, p. 806), that they are all *Isaria Sinclairii.*

The original specimen of *Isaria Cicadae* was in bad condition, but Miquel soaked it out in hot water and made the best he could of it. Thus his figure shows only the skeleton of the fungus, and it is what *Isaria Sinclairii* would be expected to look like after similar treatment. But until *Isaria Cicadae* has been re-found in Brazil, the question of its identity with the other species on Cicada must remain in abeyance.

15. Metarrhizium

Metarrhizium Anisopliae (Metsch.) Sor. is the fungus which causes the disease of insects known as the Green Muscardine, in both temperate and tropical countries. It was first recorded by Metschnikoff in 1879, as *Entomophthora Anisopliae,* on the cockchafer of wheat, *Anisoplia austriaca,* in Russia, and attempts were made to control the insect by means of the fungus. In the same year, Sorokin instituted for it a new genus, *Metarrhizium.* In 1880, Metschnikoff published another paper on the subject, and gave the fungus a new name, *Isaria destructor.* Subsequently it was found in France, and in 1893 Delacroix recorded it as *Oospora destructor* (Metsch.) Delacr. Hart found it on froghoppers in Trinidad, and twenty years later specimens from that country were re-described as *Septocylindrium suspectum* by Massee (*Kew Bulletin,* 1910, p. 4). There is an extensive literature relating to the attempts to control the froghopper of sugar-cane by means of this fungus in Trinidad (for bibliographies, see Rorer, J. B., "The Green Muscardine of froghoppers," *Proc. Agric. Soc. Trinidad and Tobago,* x, 467–482, *Society Paper,* No. 442 (1910), and Williams, C. B., "Report on the froghopper blight of sugar-cane in Trinidad," *Mem. Dept. Agric. Trinidad and Tobago,* No. 1 (1921)).

Pettit, who cultivated this, or a similar, fungus, stated that "the branched mycelium bears heads which are branched like *Penicillium* and bear long chains of conidia, cylindrical in form and rounded at the ends" "Studies in artificial cultures of entomogenous fungi,"

Cornell Univ. Agric. Expt. Sta. Bull. 97 (1895)). Vuillemin, in 1904 (*Bull. Soc. Myc. France*, XX, 214–221), transferred it to that genus as *Penicillium Anisopliae* (Metsch.) Vuill. This change has not met with universal acceptance. von Höhnel (*Fragmente zur Mykologie*, No. 269), though he adopted Vuillemin's transfer, stated that the branching of the conidiophore was not typically penicillioid. Rorer (*loc. cit.*) wrote: "It seems quite certain that the fungus is not an *Oospora* or a *Penicillium*, and probably not an *Isaria*, though in some culture media it takes on a more or less tree-like growth, characteristic of that genus. As it cannot be left in the genus *Entomophthora*, where it was first placed, perhaps it would be better to call it *Metarrhizium Anisopliae* (Metsch.) Sor., and consider it the type of the genus, which was created specially for this fungus and its characteristics are not those of any other described genus."

My opinion coincides with Rorer's. Though *Metarrhizium Anisopliae* may have resemblances to *Oospora* and to *Penicillium*, it is not characteristic of either, and the genus forms a convenient centre for a group of species which are decidedly abnormal in either of the other two.

Penicillium cicadinum v. H., described by von Höhnel from a specimen on a cicada from Java, is a "Green Muscardine," admittedly a *Metarrhizium*, and should stand as *Metarrhizium cicadinum* (v. H.). *Penicillium Briardi* Vuill. (*Isaria truncata* Briard *non* Pers., *Coremium Briardi* Sacc. & D. Sacc.) is, by Vuillemin's statement, an Isarioid *Metarrhizium*, and should stand as *Metarrhizium truncatum* (Briard). *Monilia penicillioides* Delacr., transferred to *Penicillium* by Picard, is, from Delacroix's figures and description, apparently not a *Metarrhizium*. *Penicillium Fieberi* Corda is again not a *Metarrhizium*, judging from Corda's figures and description; as books of reference sometimes omit the name of the host insect of this species, it may be noted that Corda stated that it grew on *Pentatoma prasina*.

From von Höhnel's account, it appears that he described his "Green Muscardine" on a cicada as a new species, because, owing to the differences in spore dimensions recorded for *Metarrhizium Anisopliae* by different mycologists, and to the fact that it had been recorded as occurring on so many different hosts, it was probable that the name covered several different, though similar, forms.

I have not been able to consult the papers on *Metarrhizium* by Sorokin and Metschnikoff respectively. Thaxter (*Mem. Boston Soc. Nat. Hist.* IV (1888), 190) stated that the [original] measurements of the spores of *Metarrhizium Anisopliae* were $4{\cdot}8 \times 1{\cdot}6\,\mu$, citing Metschnikoff in *Zeitschr. d. Kaiserl. Landwirth Gesell. f. Neurussland, Odessa* (1879), pp. 21–50, with plate.

Delacroix, who examined *Metarrhizium Anisopliae* found on the larva of *Melolontha* sp. in France, stated that the spores were cylindric,

rounded at the ends, 7–15 × 2·5–3·5 μ (*Bull. Soc. Myc. France*, IX (1893), 260–264). But Pettit (*loc. cit.*), who worked with a culture of *Isaria destructor* from France, supplied by Giard, found the spores cylindric with rounded ends, 6–7 × 3 μ, while in a form which he called var. *americana*, found on the larvae of *Agrotis mancus* near Ithaca, N.Y., they were 5–7 × 3 μ. Rorer (*loc. cit.*) found the spores of the "Green Muscardine" on froghoppers in Trinidad to be cylindric, rounded at the ends, 6–9 × 2–3 μ. Speare (Bull. 12, *Path. and Phys. Series, Expt. Sta. Hawaii Sugar Planters' Association*), recorded that the spores of *Metarrhizium Anisopliae* on the beetle, *Rhabdocnemis obscura*, measured 5–7·5 × 2·3–3·7 μ, and stated that although they had the same general appearance they varied somewhat in shape; he figured them as cylindric, or narrow-oval, attenuated towards one end, rather more irregular than in my specimens. Glaser (*Ann. Entom. Soc. Amer.* XIX (1926), 180–192), gave the spores of this fungus on silkworms as oblong, 5–7 × 3 μ.

Friederichs, who studied the Rhinoceros beetle of coconuts in Samoa and elsewhere, and visited several tropical countries in the course of his investigations, has dealt with this fungus at considerable length ("Studien über Nashornkafer als Schädlinge der Kokospalme," *Mon. zur angew. Entomologie*, No. 4; "Ueber die Pleophagie...Metarrhizium," *Centralb. f. Bakt.* Abt. 2, L (1920), 335–356).

Friederichs described the spores as cylindric, or elongated oval, varying in length from 6 to 14 μ, and in breadth from 2·5 to 3·3 μ. On the larvae of *Oryctes rhinoceros* in Samoa and the Philippines they were 9–14 μ long, and the same on the larva of another beetle in the Philippines, but on a cockchafer larva in the Philippines and on *Oryctes* in Madagascar, they were 6–8 μ long. On *Stenodontes insularis* Fairm., in Apia, the spores were 4–5 × 2 μ.

Friederichs recognised the existence of two forms of *Metarrhizium Anisopliae*, a short-spored form with spores 6–8 μ long, and a long-spored form with spores 9–14 μ long. He found the former in his strains from Madagascar, Hawaii, Southern France and Switzerland, the latter in Samoa, and both forms in the Philippines.

von Höhnel gave the spores of *Metarrhizium cicadinum* as oblong-ellipsoid, almost cylindric, 5–6 × 1·5–2 μ, rarely 7 μ long. Although his suggestion that the name *Metarrhizium Anisopliae* has been applied to more than one species is probably correct, it is evident that his measurements do not differ sufficiently from those of the common form, or from Metschnikoff's, to warrant the separation of the form on a cicada as a different species.

Obviously, the long-spored and the short-spored forms might be separated as subspecies or varieties, were it not for the measurements recorded by Delacroix, who apparently found spores covering practically the whole range in one strain.

The following are the dimensions of the spores of specimens collected in Ceylon and attributed to *Metarrhizium Anisopliae*:

On an earwig, Hakgala (5600 ft.); narrow-oval or cylindric, ends rounded, 5–7 × 2–2·5 μ.

On an earwig, Nuwara Eliya (6200 ft.); cylindric, ends rounded, 5–7 × 2 μ.

On a cricket, Hakgala; chiefly narrow-oval, 5–6·5 × 2·5–3·5 μ.

On a black ant, Peradeniya (1600 ft.); narrow-oval or cylindric, ends rounded, 5–7·5 × 2–3 μ.

On Red Weevil (*Rhyncophorus ferrugineus*), Peradeniya; narrow-oval or cylindric, ends rounded, 5–6·5 × 2·5–3 μ.

On larvae of firefly (*Lamprophorus*), Peradeniya; chiefly narrow-oval, 5–6·5 × 2·5–3 μ.

On larva of firefly (*Lamprophorus*), Peradeniya; chiefly cylindric, 5–7·5 × 2–3 μ.

On larva of firefly (*Lamprophorus*), Peradeniya; narrow-oval or cylindric, 5–7 × 2–2·5 μ.

On larva of firefly (*Lamprophorus*), Peradeniya; narrow-oval or cylindric, 5–7 × 2·5–3 μ.

On larva of firefly (*Lamprophorus*), Peradeniya; chiefly cylindric, 5–8 × 2·5–3 μ.

On full-grown larva of *Oryctes rhinoceros*, Peradeniya; cylindric, 10–14 × 3–4 μ, most about 12 μ.

On small larvae of *Oryctes rhinoceros*, Peradeniya; cylindric, 10–12 × 3–4 μ.

On small larvae of *Oryctes rhinoceros*, Peradeniya; cylindric, 10–13 × 3·5–4·5 μ.

The specimens on firefly larvae occurred as accidental infections in the Insectary of the Entomological Laboratory at Peradeniya at intervals over a period of nearly two years. Those on the larvae of the Rhinoceros beetle occurred in the same place, at intervals over a period of eight months, coincident with the beginning of the infection period of the firefly larvae. The long, cylindrical spores on *Oryctes* are sometimes slightly attenuated towards one end, and often gradually contracted from each end towards the centre.

A new species of *Metarrhizium* has been collected in Ceylon, on a leaf-hopper on rice. It differs from *Metarrhizium Anisopliae* in its colour, which is white, in the shape of the stroma, which is convoluted or cerebriform, resembling a flat *Cerebella*, and in the size of the conidia and the apex of the conidiophore. In culture on Quaker Oat agar, it forms circular, white, thick byssoid stromata, about 5 mm. diameter, which become pinkish buff from the centre outwards, and ultimately pinkish buff, pulverulent conidial stromata with a broad white margin. The reverse of the stroma is dark brown. In old cultures the

stromata are fawn-coloured, and the agar brownish yellow to greenish yellow. It may be named *Metarrhizium album.*

Metarrhizium album Petch, n.sp. Stroma cerebriform, covering the insect, white, fuscous internally towards the base; conidiophores arising from a basal stroma of interwoven hyphae, and forming a continuous palisade layer, simple or branched; ultimate branches cylindric, rounded at the apex, 8–10 μ high, 1·75 μ diameter; conidia oval or oblong-oval, hyaline, continuous, 3–4 × 1·75 μ, in chains which persist laterally adherent in columns.

On a leaf-hopper (*Tettigoniella spectra*) on rice, Southern Province, Ceylon, January 1928, *per* Dr J. C. Hutson.

16. Cephalosporium (Acrostalagmus) aphidicola n.sp.

In *Trans. Brit. Myc. Soc.* x (1925), 168, a species of *Cephalosporium* on an aphis, collected at Peradeniya, Ceylon, was referred to *Cephalosporium longisporum* Petch, a species found in Ceylon on *Icerya purchasi.* It differed from the latter in its slightly smaller conidia, and in the conidial heads coalescing into a yellow mass on the body of the insect.

This species has since been found common on aphides at Nuwara Eliya, Ceylon, and it appears to be sufficiently different from *Cephalosporium longisporum* to be regarded as distinct. The yellow colour is not evident unless the conidial heads are massed together, but the conidia are, as a rule, shorter than those of *Cephalosporium longisporum.* It may be known as *Cephalosporium aphidicola* n.sp.

In culture on Quaker Oat agar, the fungus forms a thin, white stroma, with a crystallised appearance due to the heads of conidia. The culture remains white, and the agar is not reddened.

The *Acrostalagmus* conidiophores may attain a height of 90 μ or more in culture, with whorls of lateral branches up to 30 μ long. The conidia in nature are 5–9 μ long, but in culture a few are 10–12 μ long.

Cephalosporium (*Acrostalagmus*) *aphidicola* Petch, n.sp. Mycelium white, sparse; conidiophores simple, up to 36 μ high, 1·5 μ diameter below, elongated conoid, or acrostalagmoid, up to 50 μ high; conidial heads up to 20 μ diameter; conidia oblong-oval, or cylindric, straight or slightly curved, ends obtuse, 5–9 × 1·5–2 μ.

On aphides, Nuwara Eliya, Ceylon, July 3rd, 1927, etc.

Acrostalagmus Aphidum Oud. was described from specimens on "skeletons" of an aphis on *Aristolochia gigas* in the Botanic Garden at Utrecht, presumably in a hothouse. It apparently differs from the present species in having trifurcate conidiophores and larger conidia, 7–14 × 2·5 μ. Nolla (*Journ. Dept. Agric. Porto Rico,* xiii (1929), 59–72), dealing with a species referred by him to *Acrostalagmus Aphidum,* states that its spores have a wider range of length and breadth than is given in the original description.

17. Cephalosporium crassum n.sp.

Dr G. O. Ocfemia has sent me from the Philippines specimens taken on Abaca (*Musa textilis*), of aphids, *Pentalonia nigronervosa* Coq., which are attacked by a fungus. The fungus is evident as coarse white tufts arising from the joints of the legs, and on closer inspection similar tufts are seen on the body. Repent hyphae extend from the tufts, both on the legs and on the body. The conidiophores occur in the tufts, and also scattered along the repent hyphae.

This species differs from the *Cephalosporium* found on aphids in Ceylon in its stout conidiophores and broad conidia. It may be known as *Cephalosporium crassum.*

Cephalosporium crassum Petch, n.sp. Conidiophores clustered in minute, white, pulvinate tufts, up to 0·3 mm. diameter, arising from the joints of the legs or on the body, with scattered conidiophores on repent hyphae round the tufts. Conidiophores simple, occasionally with a lateral branch, up to 50 μ high, stout, the smaller flask-shaped, the larger conoid, up to 4 μ diameter at the base, 1·5 μ diameter at the apex; conidia in a mucilaginous head up to 16 μ diameter; conidia oval or cymbiform, ends obtuse, hyaline, continuous, 8–12 × 3–5 μ. On an aphid, *Pentalonia nigronervosa* Coq., Los Banos, Philippine Islands, January, 1929.

18. Sterigmatocystis ferruginea Cke.

This species was described by Cooke in *Grevillea*, VIII (1879), 95. A further account of it was given in a paper, "Some Remarkable Moulds," *Journ. Quekett Microscopical Club*, II, Ser. 2 (1885), 139, and this was republished in all essential details in *Vegetable Wasps and Plant Worms* (1892), 184. It occurred on the pupa of the Eri Silk Moth (*Attacus ricini*) in Cachar. The type is now in the Kew Herbarium. Thom (*Aspergilli*) states that as it was not certain that the spores were produced in chains, the name should be dropped.

Cooke stated that the greater part of the exterior of the pupa was covered with a bright rust-coloured mould. The type specimen now bears effused, dark rufous brown patches which consist chiefly of a felted mass of conidia and crushed conidiophores. A few conidiophores, which have escaped crushing, stand more or less erect at the margin of a patch.

The stalk of the conidiophore is hyaline, smooth, about 12 μ diameter, and expands above into a globose receptacle, about 50 μ diameter. This receptacle bears close-packed, radial prophialides, which are clavate, 30 μ long, 5 μ diameter below, 12 μ above, facetted obliquely at the apex. Each prophialide bears several phialides, which are ovato-cylindric, or barrel-shaped, 14–18 × 7–9 μ, the apex rounded or truncate. The apex of the phialide is brown and verrucose,

and often bears a short cylindrical sterigma, either central or at one corner. One phialide was seen, which had an old sterigma at one corner and a developing conidium at the other, but phialides with three or four sterigmata, as described by Cooke, were not observed. In some cases, the phialide bears an arrested spore, oval, with its long axis perpendicular to the axis of the phialide; this spore may be cut off by a septum or not.

The conidia are yellow-brown, globose, 6–9 μ diameter, or oval, 9 × 5 μ, coarsely warted or with conical blunt spines up to 1 μ long. I was unable to find any spores in chains. Most of the conidia have germinated, and are bound together in a tangled mass of hyaline hyphae, 1 μ diameter.

The verrucose brown apex of the phialide, the arrested development of some of the conidia, and the large spinose spores on hyaline mycelium, suggested that the spores might be those of a *Sepedonium* which had overrun the *Sterigmatocystis*. I have, however, received *Aspergillus parasiticus* Speare from the United States in an exactly similar condition, most of the conidia having germinated in transit.

Cooke's account of this species is substantially correct, and there does not appear to be any doubt that it is a *Sterigmatocystis*.

Sterigmatocystis fulva (Mont.) Sacc. was described from a specimen on the silkworm, *Bombyx mori*, in France. The stalk of the conidiophore was said to be rough, the head golden then fulvous, and the conidia minute. Cooke's species apparently differs, *inter alia*, in its large conidia.

19. Penicillium brevicaule Sacc.

This species occurs on dead insects, probably as a saprophyte. I have had specimens on lepidopterous larvae in Ceylon, and on a larva of *Calandra glandium* from Dehra Dun, India, and cultures of it, obtained from a dead cotton stainer, *Dysdercus nigrofasciatus*, from Mr C. G. Hansford, Kampala, Uganda.

20. Ophiocordyceps gen. nov.

The majority of the species of *Cordyceps* which have been described have long cylindrical asci, with a hemispherical "solid" apex, the lower edge of which appears abruptly transverse to the ascus. The ascospores are filiform, almost as long as the ascus, in a parallel bundle, multiseptate, and divide, when mature, at each septum, into numerous short, continuous, cylindrical part-spores. These ascospores are all so much alike that they have little diagnostic value.

A few species, however, which have been described as *Cordyceps*, have asci and spores of a different type. The asci, instead of being uniformly cylindrical, are clavate, usually with a gradually thickened apex, and the spores are arranged more or less in two overlapping

bundles. The spores are elongated fusoid, multiseptate, and do not divide into part-spores at the septa. Both the ascus and the ascospore agree with *Ophionectria* or *Podonectria*, not with *Cordyceps*.

Cordyceps Blattae Petch, described and figured in *Trans. Brit. Myc. Soc.* x (1924), 35–6, Pl. I, figs. 8 and 14, belongs to this group. Its asci are cylindrico-clavate or narrow clavate, slightly thickened over the apex, but not capitate, and the ascospores are elongated fusoid, 50–80 × 3–4 μ, hyaline, multiseptate, with strong septa, 5–8 μ apart.

Cordyceps unilateralis (Tul.) Sacc. is another species with similar asci and spores. Mature ascospores in a specimen from British Guiana were about 90 μ long, 3 μ diameter in the middle, tapering to 1 μ diameter at the obtuse tips, multiseptate, with septa about 12 μ apart. In this species, the immature asci are capitate. von Höhnel, who obtained *Cordyceps unilateralis* in Java, described his specimen as a variety, var. *javanica* (*Fragmente zur Mykologie*, No. 210), but from his figure it does not appear to differ in any respect from South American examples of this species. von Höhnel stated that the asci were 220–250 × 8 μ, and the ascospores about 200 × 2·5–3 μ, but from his figure of the apex of the spore cluster, it is evident that the arrangement of the spores was not that of *Cordyceps*, and it would appear probable that an error was made in estimating the length of the spore in the unseparated cluster.

Cordyceps Ridleyi Massee is a form of *C. unilateralis*, in which the plate completely encircles the clava.

Cordyceps peltata Wakefield has fusiform ascospores, multiseptate, 72–91 × 3–3·5 μ, with acute tips. They are often bent in the middle and divide when mature into two halves, but they do not divide into part spores at every septum, as in *Cordyceps* proper.

Cordyceps rhizoidea v. H. has elongated clavate asci, 160–210 × 13–16 μ, which are thick-walled over the apex but have not the typical *Cordyceps* cap. The spores were described as cylindric, acute at the ends, about 80 × 5–7 μ, one-celled. In the last-named particular they do not agree with those of the other species considered here, but von Höhnel stated that his specimen was not quite mature, and it was therefore possible that the spores might develop septa later.

For the above four species, I propose a new genus, *Ophiocordyceps*, with the type species, *Ophiocordyceps Blattae*.

Ophiocordyceps gen. nov. Stroma carnosum, plerumque laeti-coloratum, stipitatum, erectum, supra clavatum vel subglobosum. Perithecia stromate immersa vel semi-immersa vel sublibera. Asci clavata, apice incrassata. Sporidia hyalina, fusoidea, multiseptata, asco breviora, non in articulos secedentia.

The species of this genus, known at present, are *Ophiocordyceps Blattae* Petch, *O. unilateralis* (Tul.) Petch, *O. peltata* (Wakef.) Petch, and *O. rhizoidea* (v. H.) Petch.

21. CORDYCEPS SHERRINGII Massee

This species, which was collected by R. V. Sherring in Grenada, was described by Massee in *Annals of Botany*, v (1891), 510, as *Cordyceps Sherringii*, not *Sheeringii*, as given in Cooke, *Vegetable Wasps*, etc., and Saccardo, *Sylloge Fungorum*, xi, 366. It grew on an ant.

Massee stated that the clavae sprang from all parts of the body. His figure shows two clavae only, the place of insertion of which is not evident. The type specimen bears two clavae only, and these are on the upper side of the insect, one between the head and the thorax, and the other between the thorax and the abdomen.

Massee figured perithecia with projecting ostiola, and described and figured asci with eight, comparatively short, septate spores, which did not divide into part-spores. Both the clavae on the specimen are immature and do not bear visible ostiola. One of them shows evidence of examination, and in this the perithecia are so immature that they do not contain spores or asci. There is nothing to support Massee's description of the ascospores.

The clavae occur exactly in the same positions as those of *Cordyceps Lloydii*, and their colour and texture are the same as in that species. There does not seem any doubt that the specimen is an immature *Cordyceps Lloydii*.