

NOTES ON ENTOMOGENOUS FUNGI

By T. PETCH

181. *CORDYCEPS SPHECOCEPHALA* (Klotzsch) Cooke

The only reputed British specimen of this species is in the Herbarium of the British Museum, and as it is not localized its British origin is doubtful. Mr E. A. Ellis collected another specimen at Wheatfen Broad, 20 September 1942, among dead leaves, free from any host but undoubtedly this species. The stalk is pale ochraceous, compressed, and the head is pale brown, ovoid, tuberculate with the apices of the oblique perithecia. The lower edge of the head is produced downwards as a collar round the apex of the stalk, thus resembling the specimens in Herb. Berlin recorded in *Trans. Brit. Myc. Soc.* xviii, 62 (1933). *Teste* Mr Ellis, the part-spores in his specimen are lanceolate, ends obtuse, $7.5 \times 1.5 \mu$.

In *Trans. Brit. Myc. Soc.* xxi, 55 (1937), I recorded that *Isaria sphecocephala* Ditm. is a *Hymenostilbe*, and that it is the conidial stage of *Cordyceps sphecocephala*. Conidial forms associated with *C. Ditmari* were described in *Trans. Brit. Myc. Soc.* xvi, 220 (1932), where it was stated that they belonged to *Hymenostilbe*. Kobayasi (*The Genus Cordyceps and its Allies*, p. 149, 1941) writes, under *Cordyceps Ditmari*, 'Quélet referred the conidial state of this species to *Isaria sphecocephala* Ditm., and Masee agreed with it. *Isaria sphecocephala* is, however, transferred into *Hymenostilbe* by Petch and at present is regarded as the conidial state of *Cordyceps sphecocephala*. Accordingly the Isarial fungus described and figured by Quélet awaits a further study to decide to what genus [it] should belong.' But now that *Isaria sphecocephala* is definitely known, it is evident that the conidial form associated with *Cordyceps Ditmari* is indistinguishable from it, Quélet's description of the conidia being an error. *Cordyceps armeniaca*, *C. Ditmari* and *C. Langloisii* are merely forms of *C. sphecocephala*. Massée quoted Quélet, and added: 'I have received a *Cordyceps* agreeing exactly with Quélet's description, and accompanied by *Isaria sphecocephala* Ditm. from Ireland, collected by Dr McWeeney. It was growing on the remains of a large bluebottle-like fly.' Obviously, Masee did not know *Cordyceps Ditmari* or *Isaria sphecocephala*. What he had were probably *Cordyceps Forquignonii* and *Hymenostilbe muscaria*, though these do not fit Quélet's figures and descriptions.

182. *CORDYCEPS TUBERCULATA* (Lebert) Maire

Records of this species for Britain, as *Cordyceps Sphingum*, are based on Berkeley and Broome's record of the conidial stage, *Isaria Sphingum*, in *Notices of British Fungi*, no. 1710 (1878), 'on pupae of Diptera, Kincardineshire, Mr Taylor'. That specimen is now in Herb. Kew. The pupae, if present, are hidden in debris. The specimen bears small, slender, terete clavate, clothed below with spicarioid conidiophores with flask-shaped phialides, $6 \times 2 \mu$, and oval, subacute conidia, $1.5-2.5 \times 1 \mu$. This is a linear



C.

form of *Spicaria (Isaria) farinosa*, and Berkeley and Broome's identification was incorrect. Moth scales are present on the specimen, and the host was probably misidentified.

I have received specimens of *Cordyceps tuberculata* from Mr E. A. Ellis, on pupae of Lepidoptera, Alderfen Broad, Norfolk, 15 August 1940, Osier Carr, Wheatfen Broad, 18 October 1942, and Low Common, Hellington, near Norwich, 9 May 1943. The clavae are at first narrow clavate, up to 9 mm. high, white, dotted with the yellow ostiola of the perithecia. Subsequently, the perithecia become superficial, pale yellow, crowded, making an ovoid or cylindrical head of closely packed perithecia.

The pupa from Hellington bears conidial clavae as well as perithecial clavae, and these are *Isaria Sphingum* Schwein. (1822), *Akanthomyces aculeata* Lebert (1858) and *Hymenostilbe Sphingum* (Schwein.) Petch (1932). *Akanthomyces* is distinct from *Hymenostilbe* (see later), and this species must now be known as *Akanthomyces Sphingum* (Schwein.) Petch, comb.nov.

183. *CORDYCEPS MILITARIS* var. *SPHAEROCEPHALA*

This was described as a species, *Sphaeria sphaerocephala*, by Kunze and Schmidt, and was placed as a variety of *Cordyceps militaris* by Fries. It is characterized by its long, thin stalk and globose head.

Forms of *C. militaris* with a short stalk and a globose head are not uncommon, but no one has considered them worthy of varietal rank. I have recently examined a specimen of *C. militaris* collected by Mr E. A. Ellis at Wheatfen Broad, 24 August 1939, which has a stalk, 3 cm. long, 0.75 mm. diameter, with a clavate head, 1 cm. long, 2 mm. diameter. Thus a long thin stalk is not necessarily associated with a globose head, nor a globose head with a long stalk. Consequently the variety *sphaerocephala* is not worthy of retention.

184. *AKANTHOMYCES* and *HYMENOSTILBE*

The genus *Akanthomyces* was established by Lebert in 1858 for a species, *A. aculeata* Lebert, found on a moth in Europe. An account of it with details of British specimens was published in *Trans. Brit. Myc. Soc.* xviii, 72 (1933). The genus was not included by Saccardo in *Sylloge Fungorum*, and for a long time Lebert's record was overlooked. Thaxter (*Mon. Laboulb.* 1, 359), when substituting *Rhachomyces* for *Acanthomyces* Thaxter because of the prior use of *Akanthomyces* by Lebert, stated that Lebert's fungus was 'probably identical with *Isaria Sphingum*'. That seemed to me doubtful, but examination of further specimens of both species has convinced me that Thaxter's view was correct. The conidial stage of *Cordyceps tuberculatum* (Lebert) Maire must be known as *Akanthomyces Sphingum* (Schwein.) Petch. Lebert described *A. aculeata* and *Cordyceps tuberculata* (as *Akrophyton tuberculatum*) in the same paper but without any suggestion of their possible relationship, and apparently his specimen of the former was European and that of the latter American. Details of *Cordyceps tuberculata* and its conidial stage were given in *Trans. Brit. Mycol. Soc.* xvi, 213 (1932).

In *The Naturalist* (1931), p. 101, I described a new genus *Hymenostilbe*, with the species *H. muscaria*, for a conidial fungus on Diptera which has

since been found to be the conidial stage of *Cordyceps Forquignoni* Quélet, and in the note on *Akanthomyces* cited above I stated that it appeared doubtful whether it would be possible to maintain *Hymenostilbe* Petch distinct from *Akanthomyces* Lebert. Nine species of *Hymenostilbe* are now known, several of them conidial forms of species of *Cordyceps*, and it is now clear that the two genera must be maintained, the most important distinction being that *Akanthomyces* has its conidia in chains, while those of *Hymenostilbe* are solitary on the phialide or basidium. Only one species of *Akanthomyces* is known at present.

Fries, in *Syst. Mycol.* iii, 274 (1832), described two species of '*Isaria*', *I. floccosa* and *I. strigosa*, which are still unknown. Both occurred on Lepidoptera. They were discussed in *Trans. Brit. Mycol. Soc.* xviii, 70 (1933). A specimen of *Akanthomyces Sphingum*, 'White Hill, Auchter House, Dundee, nov. subfin., 1847, G. Lawson', is included in the cover of *Isaria floccosa* in Herb. Kew., while a specimen from Sachsenwald near Hamburg, October 1907, coll. O. Jaap, is included in the cover of *Isaria strigosa* in Herb. Berlin. Thus *Akanthomyces Sphingum* has been taken by different mycologists as *Isaria floccosa* and as *I. strigosa*.

Isaria floccosa was said by Fries to have almost the appearance of a *Hydnum*, with spines, 2-4 mm. long. The spines (clavae) were subulate, simple, everywhere floccoso-tomentose. It differed from *Isaria arachnophila* Ditmar (*Hymenostilbe arachnophila* (Ditm.) Petch) in having acute clavae, but especially in its floccose appearance, for on old specimens the conidia were abundant, though under a low magnification the clava appeared only floccose. The comparison is not very enlightening, for Ditmar's figure shows the clava of his species dripping with masses of conidia.

Isaria strigosa was said by Fries to be altogether different from *I. floccosa*. The subulate clavae arose from a subdeterminate patch of mycelium, and were simple, or fasciculate and consequently branched, at first subdecumbent, slender, 4-6 mm. long. The surface of the clava was everywhere the same, almost naked, but when magnified pubescent and conidiiferous, becoming glabrous when old.

There is nothing in the two descriptions which would not agree with forms of *Akanthomyces Sphingum*, and in the absence of type specimens the best solution of the problem would be to regard *Isaria floccosa* and *I. strigosa* as synonyms of that name.

185. *TORRUBIELLA FLAVOVIRIDIS* (Möller) Kobayasi

Möller (*Phycomyceten und Ascomyceten*, p. 208) stated that this species belonged to *Torrubiella* Boud., but he described it as *Cordyceps* as he did not consider the genus *Torrubiella* necessary. Kobayasi appears to have been the first to make the combination. Some account of it was given in *Trans. Brit. Myc. Soc.* xix, 162 (1935), where it was suggested that it grew on a spider and might be a form of *Cordyceps Engleriana* P. Henn. Möller thought that his example had developed from two small insect pupae, but an examination of the type, through the glass of a museum jar, showed that it arose from a spider tent and was probably parasitic on a spider, the two pupae, apparently dipterous, being intrusive.

I have recently been able to examine a specimen of *Torrubiella flavoviridis* from British Guiana, collected by Mr N. Y. Sandwith, 12 August 1937. It is on a spider which is covered by white or pale yellow mycelium, forming a somewhat compact pulvinate stroma with a definite margin, and the perithecia are almost superficial, in small linear groups of two or three, usually near the margin of the stroma. The perithecia are large, up to 1 mm. high and 0.25 mm. broad, cylindrical, slightly contracted at the base, clothed nearly to the apex with a tomentum, now white, of variously curled hyphae, the apex being obtusely conical, naked and yellow. In this specimen the perithecia are laterally compressed, being oval in transverse section, measuring, for example, 0.25 × 0.12 mm. That may be due to a collapse in drying, but I have not previously observed such a regular collapse in any other species. The specimen had not been pressed. Möller did not mention the tomentum on the perithecium, but his description is deficient in details and his figure shows clearly the upper limit of the tomentum. The asci are linear-cylindrical, capitate, four- or eight-spored, 4–8 μ diameter, and the part-spores are lanceolate, 10–14 × 1.5 μ. The type of spore is that given by Kobayasi for his section *Neocordyceps*.

This particular specimen is overrun by an *Aspergillus*, and hyphae with inflated tips found among the tomentum are the old conidiophores of the *Aspergillus*. Entomogenous fungi from the tropics, if not dried rapidly, are soon overrun by *Aspergillus* or *Penicillium* during drying. That appears to be especially so with South American specimens, and the 'conidial stages' figured by Hennings for *Cordyceps Amazonica* and *C. juruensis* in *Fungi Amazonici*, II, *Hedwigia*, XLIII, 247, 248 (1904) are intrusive *Aspergillus* and *Penicillium*.

186. *Torrubiella albolanata* Petch, n.sp.

In *British Hypocreales*, one species of *Torrubiella*, *T. aranicida* Boud., which occurs on spiders, was recorded for this country from Hubberholme, Yorks. Recently Mr E. A. Ellis has made several collections of another species of *Torrubiella* on spiders, usually on *Gongylidium rufipes*, but in one instance on Thomisidae, in various localities on Wheatfen Broad, 21 June 1942, 9 and 13 August 1942, and 14 June 1943.

The fungus covers the body of the spider with a continuous, loose, white, tomentose stroma of intertwined hyphae. Usually the perithecia are almost completely immersed in the stroma, only the pallid or yellowish ostiola being visible, but sometimes they project and are clothed nearly to the apex with loose hyphae similar to those of the stroma. These hyphae are regular, 1.5–2 μ diameter, minutely rough, bifurcating or branching irregularly above. The perithecia are conoid, 0.5 mm. high, 0.25 mm. diameter, moderately crowded. The asci are linear-cylindrical, capitate, and when mature 4–5 μ diameter. The mature ascospores are wound in a very flat spiral, and the part-spores are cylindrical or lanceolate, ends obtuse, 5–7 × 1–1.5 μ. I name this species, *Torrubiella albolanata*.

Some of the stromata are conidial only. These resemble the perithecial stromata but lack perithecia. The branching hyphae terminate in conoid or slightly flask-shaped segments 12–18 μ long, 2–2.5 μ diameter, each

bearing an apical, cylindrical, hyaline conidium, 7–10 × 0.75–1 μ. Similar conidia occur on the hyphae between the perithecia, and the conidiiferous tips are sometimes clustered on the perithecial wall. This is a *Cylindrophora*, which may be known as *C. araneorum* n.sp.

Torrubiella aranicida differs from the present species in its longer, conoid or distinctly flask-shaped perithecia and in its perithecial wall, which is glabrous, evidently parenchymatous, of polygonal cells, 12–20 μ diameter, or transversely oval cells, 20 × 12 μ, with walls, 1–2 μ thick. Its perithecia are pellucid when fresh but dull orange when dry, and are scattered or clustered on a thin whitish or yellowish byssoid subiculum. Conidia have not been found on the available specimens.

On the other hand, the conidial hyphae of *T. albolanata* bear a remarkable resemblance to *Isaria cuneispora* Boud., the recorded conidial stage of *Torrubiella aranicida*. Boudier described the hyphae of his species as minutely rough, and the alleged conidia as elongated conoid, not or scarcely rough, attached by the thicker base, 12–14 × 2–2.5 μ. The terminal segments of the hyphae of *T. albolanata* resemble in size and shape Boudier's 'cuneiform conidia', and it would seem possible that *Isaria cuneispora* is a *Cylindrophora*, the real conidia of which were not observed. Boudier collected the *Isaria* two years later than the *Torrubiella*, though in the same locality, and he stated that the best time for the latter was summer or the beginning of autumn, but he found the *Isaria* in March. Consequently there is the possibility that he collected the perithecia of *Torrubiella aranicida* and the conidial stage of *T. albolanata*.

Torrubiella albolanata Petch, sp.nov. Mycelio albo, laxo, limitato, tomentoso, hyphis regularibus, 1.5–2 μ diam., ramosis, minute verrucosis, intertextis; peritheciis immersis v. exsertis et albo-lanatis, pallidis, gregariis, conoideis, 0.5 mm. alt., 0.25 mm. diam.; ascis cylindraccis, capitatis, praelongis, maturitate 4–5 μ diam.; ascosporis maturitate in spiram subplanum convolutis; articulis ascosporarum cylindraccis v. lanceolatis, obtusis, 5–7 × 1–1.5 μ.

On spiders, Britain.

Cylindrophora araneorum Petch, sp.nov. Mycelio albo, laxo, limitato, tomentoso, hyphis regularibus, 1.5–2 μ diam., ramosis, minute verrucosis, intertextis; segmentis terminalibus hypharum conoideis v. angustampullaceis, 12–18 × 2–2.5 μ; conidiis hyalinis, apicalibus, solitariis (? semper), bacillaribus, 7–10 × 0.75–1 μ.

On spiders; the conidial stage of *Torrubiella albolanata* Petch.

187. *Torrubiella albotomentosa* Petch, n.sp.

This, the third British species of *Torrubiella*, was found by Mr E. A. Ellis on a small dipterous pupa lodged in a dead stem of *Glyceria maxima* at Parish Marsh, Wheatfen Broad, 30 May 1943. The perithecia are clustered, divergent, without evident stroma or subiculum, flask-shaped, 0.5 mm. high, 0.25 mm. diameter, white or pallid, minutely white tomentose with short, contorted and variously inflated hyphae. The immature asci are linear, cylindrical, capitate, 200–220 μ long, 3–4 μ diameter, with linear

ascospores, 0.75μ diameter. The spores were not sufficiently mature to show septa or part-spores.

Torrubiella albotomentosa Petch, sp.nov. Peritheciis caespitosis divergentibus, ampullaceis, 0.5 mm. alt., 0.25 mm. diam., albis v. pallidis, minute albo-tomentosis, hyphis brevibus contortis et varie inflatis vestitis; asci cylindraccis, capitatis, $200-220\mu$ long., $3-4\mu$ diam.; ascosporis linearibus, 0.75μ diam. (immaturis).

On a dipterous pupa, Britain.

A similar pupa, found by Mr Ellis in the stem base of *Glyceria maxima* at Home Marsh, Wheatfen Broad, 19 June 1943, bears minute pulvinate cushions, elongated oval in plan, up to 0.75 mm. long, 0.25 mm. broad, minutely tomentose, white or yellowish white, brownish yellow at the base, composed of interlacing, curved, hyaline hyphae, 2.5μ diameter. These hyphae bear scattered lateral branches, similar to the terminal segments of the hyphae, which are conoid or narrow flask-shaped, $7-12 \times 1.5-2\mu$, with a long, thin neck. This would appear to be another species of *Cylindrophora*. Numerous conidia were present, but I was unable to find one attached; they were hyaline, cylindrical with rounded ends, usually attenuated slightly but uniformly towards the middle, $6-10 \times 2.5-3\mu$. Whether these are actually the conidia of the fungus which forms the cushions must remain undecided until further specimens are available, as numerous conidia of other fungi, e.g. *Mastigosporium*, collect round entomogenous fungi found in such situations.

188. *EMPUSA TENTHREDINIS* (Fres.) Thaxter

This species, which occurs on the larvae of sawflies (Hymenoptera), was described by Fresenius as *Entomophthora* and was transferred to *Empusa* by Thaxter. It is apparently a rare species, and Fresenius's record in 1858, on *Tenthredo* larvae on alder in September, appears to have been the only one until Thaxter found a single specimen on a *Tenthredo* larva on *Scutellaria* in September in a swampy situation among woods in Maine and recorded it in 1888. The conidia are ovoid, with a prominent papilla, and according to Thaxter vary from $35 \times 25\mu$ to $55 \times 35\mu$. Fresenius, *teste* Thaxter, gave the maximum length as 62.5μ .

On 14 June 1943, Mr E. A. Ellis found two examples of this species on sawfly larvae on *Spiraea ulmaria* at Parish Marsh, Wheatfen Broad, Norfolk. The conidia measured $32-44 \times 30-32\mu$, but I did not obtain a good spore print. Another example was found by Mr Ellis on the same plant in the same locality on 27 June 1943. In the latter specimen, the conidia had been abjected, and some were collected in a yellowish mass on the leaf. These conidia measured $33-45 \times 22-30\mu$; it is possible that some of these were secondary conidia, which are the same shape as the primary. Several of these conidia had germinated and had produced resting spores (azygospores), oval, $30-33 \times 25-27\mu$, or globose, $27-36\mu$, hyaline, smooth, with a wall up to 4μ thick. The conidiophores are simple, and at first form a short velvety pile over the larva, ultimately coalescing in a pale brown mass.

In *Ann. Mycol.* iv, 105 (1906), Bubák described *Entomophthora Cimbicis*,

which occurred in the chrysalides of *Cimbex* sp. (sawflies) in Bohemia. Only resting spores were found, and consequently Lakon changed the name to *Tarichium Cimbicis* in *Zeitschr. f. Pflanzenkr.* xxv, 257 (1915). The resting spores were described as globose or slightly ellipsoid, yellowish, $26-48 \times 24-32\mu$, with a thin wall, $1-1.5\mu$ thick. It would seem possible that this is the resting spore form of *Empusa Tenthredinis*.

189. *Empusa acaridis* Petch, n.sp.

A single example of this species was collected by Mr E. A. Ellis, on a mite, *Pergamasus crassipes* L., at Wheatfen Broad, Norfolk, 9 August 1942. The conidiophores emerged along the edge of the body, forming a narrow swollen cushion, especially round the hinder end; they appeared to arise from an external stroma, but that could not be determined with certainty from the material available. The conidia were broadly oval, $16-22 \times 11-13\mu$, with a broad, convex, slightly elevated papilla. There were no rhizoids and no sign of any attachment.

Empusa acaridis Petch, sp.nov. Conidiophoris circum corpus praecipue postice emergentibus; conidiis late ovalibus, $16-22 \times 11-13\mu$, papilla lata convexa parum elevata; hyphis rhizoideis nullis.

On a mite (Acarid), England.

190. *ENTOMOPHTHORA FORFICULAE* Giard

According to Giard, this species, which was found on earwigs adhering to plants near Boulogne, has oblong or long elliptical conidia with rounded ends, the base scarcely different from the apex, without oil globules, strongly but uniformly refringent, $20-25 \times 6-8\mu$. The conidiophores are short and sparingly branched, and emerge from all the junctions of the chitinous plates of the host. The insects were attached to the plants by the thorax, the feet and the antennae, but Giard was unable to find rhizoids.

Rostrup, who recorded this species in *Mædd. naturh. Foren.* [Copenhagen], 1893, p. 87, from three localities in Denmark, gave the conidia as $18-21 \times 8-10\mu$, with a vacuole at each end. Guégen, in *Champignons parasites*, p. 63, 1904, queried its reference to *Entomophthora*, and on the available data that appears justified. It must be placed in *Empusa*, as *Empusa Forficulae* (Giard) Petch, comb.nov.

Mr E. A. Ellis, on 10 August 1942, obtained two specimens of an *Empusa* on earwigs at Old Lakenham, Norfolk, which agree macroscopically with Giard's description. The conidiophores emerge from all sutures and ultimately coalesce in part over the body; as far as I could determine they are unbranched. The insects were detached when received, but had apparently been attached by their feet, rhizoids being absent. The conidia were ellipsoid, scarcely papillate, or with a broad, flattened convex papilla occupying the whole breadth of the base, but they measured $20-30 \times 15-18\mu$. The resemblance to Giard's species is too close to permit the proposal of a new species, and this form may be known as *Empusa Forficulae* var. *major* Petch, var.nov.

191. *ENTOMOPHTHORA OCCIDENTALIS* Thaxter

This species was collected by Mr E. A. Ellis on aphides on *Ranunculus repens*, Old Lakenham marshes, 26 July 1942. This is the second recorded occurrence in England.

192. *ENTOMOPHTHORA VIRESCENS* Thaxter

During a plague of caterpillars on *Brassica* at North Wootton in September 1942, a single example of *Entomophthora virescens* Thaxter was found. The fungus was pale green and completely covered the larva, the mass of conidiophores and rhizoids descending to the leaf on both sides of it and forming a roof-like structure with sloping sides and a central longitudinal ridge. The free conidia on the adjacent parts of the leaf were greenish yellow in mass, oval, $18-27 \times 8-13 \mu$, but the specimen was over-mature, and it could not be determined whether these were primary or secondary conidia.

It may be noted that large numbers of caterpillars died from a 'wilt' disease, but I was not able to find in them the polyhedra which occur in the wilt diseases of caterpillars in the United States of America and in Ceylon.

193. *ENTOMOPHTHORA COLEOPTERORUM* Petch

This species was described in *Trans. Brit. Myc. Soc.* xvii, 172 (1932) from a specimen containing resting spores only. It had the peculiarity of being attached to the substratum by definite fascicles of rhizoids which emerged from two points on the lower surface of the body of the insect and spread out in a more or less conical bundle. The distal ends of the rhizoids were stout, but not expanded into plates. The resting spores were dark brown, thick-walled (up to 6μ), densely verrucose, globose, $35-50 \mu$ diameter, or broadly oval, $48-52 \times 44-46 \mu$, or sometimes pyriform, $56 \times 44 \mu$. Since that publication other examples have been collected which are probably the same species, as they have the same peculiar attachment, though the number of fascicles of rhizoids may be more than two. These specimens, however, are conidial only. One is on coleopterous larvae on a living leaf, collected at Lartington, Yorks, 16 September 1933, another on weevils, *Sitones flavescens*, Wick, 10 October 1937 (Miss D. J. Jackson). The conidiophores appear in minute tufts, ultimately coalescing over the body of the insect. The conidia are narrow oval, $32-44 \times 8-14 \mu$. Cystidia, 10μ diameter, tapering upwards, are present.

It is probable that this is the same as *Entomophthora Carpentieri* Giard, a name proposed by Giard in *Bull. Sci. Fr. et Belg.* 1888, p. 296, without description, for a species found on *Agriotes spectator* and *Elater* sp. Giard stated that the insects were attached to plants by a small tuft of very stout rhizoids which emerged at definite points on the ventral surface, especially at the junction of the prothorax and the mesothorax, while a second tuft was often present behind the pair of metathoracic legs. Because of this mode of attachment, Giard proposed a new subgenus, *Lophorhiza*.

194. *Entomophthora anglica* Petch, n.sp.

This species has occurred on beetles on several occasions, and, as no description has been found to fit it, it is necessary to describe it as new. The mode of attachment to the plant varies according to the degree of development of the fungus. At first the beetle is attached by rhizoids from the head, and it sometimes grasps the plant by its mandibles. As the fungus develops, rhizoids are produced from the ventral surface and the sides, while there is often a strong growth of coarse strands spreading from the head and thorax. The conidiophores in fully developed examples extend in a continuous sheet from the sides of the body to the substratum, but in general they do not spread over the elytra or only partially along their outer edges. The primary conidia from a spore print were oval, narrow oval or subfusoid, sometimes slightly bent, with a broad, truncate papilla, $22-27 \times 11-13 \mu$, while the secondary conidia were the same shape but shorter, $18-21 \times 10-11 \mu$. Measurements of conidia taken directly from the insect on various occasions gave a total variation of $18-27 \times 8-13 \mu$.

I have had this species on a beetle (? *Plateumeris*) on meadowsweet, Hornsea, E. Yorks, 14 July 1931; on *Agriotes sputator*, Coton, Cambs, 3 May 1931 and June 1933 (E. W. Jones); type, on ? *Plateumeris*, Pickering, 6 June 1938 (W. G. Bramley); on a heather beetle, *Lochnoea suturalis*, Edinburgh, June 1939 (R. W. G. Dennis); on *Cantharis* sp., Old Lakenham, 25 June 1942 (E. A. Ellis); on a Staphylinid, Wheatfen Broad, 9 August 1942 (E. A. Ellis). The specimens on *Agriotes* were recorded in *Trans. Brit. Myc. Soc.* xvii, 171, as *Entomophthora Lamphyridarum* Thaxt., because of the mode of attachment, but the latter has larger conidia ($30-37 \mu \times 14-20 \mu$) and its secondary conidia are a different shape; the name must be deleted from the British list.

Entomophthora Nebriae Raunkiaer, found on *Nebria brevicollis* in Denmark, would appear from the description to have conidia similar to those of *E. anglica*, but larger, $28-37 \times 10-13 \mu$, and it has pale brown, smooth, globose, resting spores, $35-50 \mu$ diameter, produced outside the body of the host.

Entomophthora anglica Petch, n.sp. Insectum primum hyphis rhizoideis antice adfixum, dein conidiophoris et hyphis rhizoideis omnino circumdatum; conidiis primariis ovalibus, angustioribus vel subfusoidibus, interdum leniter curvatis, $22-27 \times 11-13 \mu$, papilla lata truncata, conidiis secundariis similibus sed brevioribus, $18-21 \times 10-11 \mu$.

On Coleoptera, Britain.

195. *Spicaria stricta* Petch, n.sp.

Mr E. A. Ellis collected this species on a spider at Poor's Marsh, Wheatfen Broad, 13 August 1942. The fungus covered the body and legs of the host with a greyish white, farinose web. The repent hyphae are hyaline, 4μ diameter, and bear stout scattered conidiophores, up to 150μ high, $3-4 \mu$ diameter below, 2μ diameter towards the apex, sometimes widely branched below, the main stem and branches bearing in their upper part rather closely set, short lateral branches terminated by a cluster of

phialides producing chains of conidia, those on each stem forming a sub-cylindrical head. The phialides are oval, $5-6 \times 2-3 \mu$, and the conidia narrow oval or oblong oval, hyaline, catenulate, ends truncate in the chain but becoming rounded, $4-5 \times 1.5-2 \mu$.

Spicaria stricta Petch, sp. nov. Mycelio cinereo-albo, farinaceo, insectum obducente; hyphis repentibus hyalinis, 4μ diam.; conidiophoris ad 150μ alt., infra $3-4 \mu$ diam., supra 2μ diam., simplicibus vel infra late furcatis, prope apicem ramos laterales breves approximatos phialidibus coronatos ferentibus; phialidibus ovalibus, $5-6 \times 2-3 \mu$; conidiis angusto-ovalibus vel oblongo-ovalibus, hyalinis, catenulatis, in catena truncatis, dein rotundatis, $4-5 \times 1.5-2 \mu$.

On a spider, England.

196. *SPICARIA (ISARIA) FUMOSO-ROSEA* (Wize) Vassil.

Wize described this species, as *Isaria*, in *Bull. Acad. Cracovie* (1905), 354, fig. 7, Pl. X, fig. 4, from specimens on the larva of a beetle, *Leonus punctiventris*. It was transferred to *Spicaria* in *Morbi Plantarum, Leningrad*, xviii, 113-48, 9 figs. (1929) by Vassilievsky, who found it on pupae of cabbage flies, *Hylemyia floralis* and *H. brassicae*, and stated that it was indistinguishable morphologically from *Spicaria Aphodii* Vuill. Vuillemin had described the latter in *Bull. Soc. Sci. Nancy*, xi, 147-52, figs. 1-12, from specimens on the beetle, *Aphodius fimetarius*. Further information about *Spicaria fumoso-rosea* was given in *Archiv. Biol. Soc. Sc. Lett. Varsovie*, vi, fasc. 1, 57, Pl. I, fig. 14, Pl. III, fig. 8 (1937) by Siemaszko, who recorded it on several species of lepidoptera as well as on beetles.

Mr E. A. Ellis has submitted to me numerous specimens from Wheatfen Broad, September 1937 and August-October 1942, which appear to be referable to this species, generally on glow-worms, the larvae of *Lampyrus noctiluca*, but once on a pupa which may be lepidopterous. The clavae arise from continuous stromata along the sutures, and are of two forms, though both forms sometimes occur together on the same larva. In the one form, thin, feathery, simple clavae, up to 15 mm. long arise together in a tuft. The central stem of a clava is 0.2 mm. diameter at the base, diminishing above to 0.1 mm., pinkish ochraceous, and is covered with scattered conidiophores, up to 150μ long, perpendicular to the clava, farinose with white masses of conidia. The conidiophore is spicarioid, with lateral and terminal clusters of phialides which are flask-shaped, $8-9 \times 2-3 \mu$, and bear chains of oval, oblong oval or subfusoid, hyaline conidia, usually obtuse, $4-7 \times 1.5-2.5 \mu$. In the other form, the clavae are short and stout, up to 5 mm. long, 0.3 mm. diameter, terete or flattened, simple, or forked above, and in the flattened clavae the conidiophores tend to be concentrated along the edges, while at the apex they are crowded, more or less parallel, and constitute a palisade layer.

I refer this species to *Spicaria fumoso-rosea* with some doubt. It appears to agree in morphological characters, but the conidia are white in mass. Wize described the colour of the conidia as smoky rose, and Vuillemin as rose, and the disease caused by the fungus is known as the pink muscardine. But, until Russian specimens are available for comparison, it seems ad-

visible to place it under Wize's name rather than to describe it as a new species. The phialides resemble those of *Spicaria (Isaria) farinosa*, but the conidia are much larger than those of the latter, and of a different shape.

197. *Cylindrodendrum suffultum* Petch, n.sp.

Numerous examples of this species on dipterous pupae, chiefly Psychodidae were collected by Mr E. A. Ellis in August 1942 in several localities near Norwich—Trowse marshes, and Home Marsh and Poor's Marsh, Wheatfen Broad. On these small pupae it forms minute, white, tomentose tufts, which afterwards become confluent, along the sutures. But in a collection on larger Tipulid pupae, Wheatfen Broad, 19 June 1943, some of the tufts grow on into loose isarioid clavae, up to 2 mm. long, usually decumbent or prostrate. The hyphae are hyaline, lax, intertwined, branched, septate, $3-4 \mu$ diameter, and bear whorls of prophialides and phialides, with an apical cluster of phialides. The prophialides are inflated, ovoid, inequilateral, about $6 \times 5 \mu$, each bearing one or more phialides, which are flask-shaped, $7-12 \times 4 \mu$, with a truncate base. The apical cluster sometimes consists of two phialides only, arising from the obtuse apex of the terminal segment of the hypha. On the smaller pupae, the conidia are hyaline, oblong or oblong-oval, $6-9 \times 4 \mu$, or globose, 5μ diameter, not catenulate; on the larger pupae they are $8-12 \times 3-4 \mu$.

Cylindrodendrum suffultum Petch, sp. nov. Caespitibus minutis, albis, tomentosis, discretis dein confluentibus, interdum in clavas laxas, ad 2 mm. long., decumbentes v. procumbentes, productis; hyphis hyalinis, laxis, intertextis, ramosis, septatis, $3-4 \mu$ diam., prophialides et phialides verticillatim ferentibus; prophialidibus inflatis, ovoideis, inaequilateralibus, circa $6 \times 5 \mu$; phialidibus ampullaceis, basi truncatis, $7-12 \times 4 \mu$; conidiis hyalinis, oblongis v. oblongo-ovalibus, $6-12 \times 3-4 \mu$, v. globosis, 5μ diam.

On pupae of Diptera, Britain.

198. *Verticillium larvarum* Petch, n.sp.

This species occurred on a lepidopterous larva (Nettle Grub) at Nuwara Eliya, Ceylon, 11 September 1927, and a second specimen was collected in the same district on a different lepidopterous larva, 9 September 1928.

The larva is sparsely covered with yellow or ochraceous mycelium, which here and there forms short, loose, clavate tufts or processes. The conidiophores are erect, rigid, up to 120μ high, 2.5μ diameter, with opposite or ternate simple branches near the apex, the branches being narrow flask-shaped, up to 18μ long, 1.5μ diameter, tapering to the apex and bearing the conidia in a small head. The conidia are broadly oval, ends rounded, or oblong-oval, hyaline, continuous, $2-5 \times 1.5-2 \mu$. In the second specimen some of the longer conidia are up to 7μ long and one-septate. When mounted, the head of conidia sometimes collapses into a band, with the conidia parallel.

Verticillium larvarum Petch, n.sp. Mycelio flavo v. ochraceo, larvam sparse obducente, hic illic caespites laxis breves clavatos formante; conidiophoris erectis rigidis, ad 120μ alt., 2.5μ diam., supra ramosis, ramis oppositis v. ternatis, anguste ampullaceis, ad 18μ long., 1.5μ diam., ad

apicem attenuatis, conidia in capite parvo ferentibus; conidiis hyalinis, continuis, late ovalibus, utrinque obtusis, v. oblongo-ovalibus, $2-5 \times 1.5-2 \mu$, interdum 7μ longis et uniseptatis.

On lepidopterous larvae, Ceylon.

199. *UREDINELLA SPINULOSA* Couch & Petch

In *Trans. Brit. Myc. Soc.* XIX, 193 (1935), I described and figured, under the title 'A sterile stroma', a fungus found on *Aspidiotus* sp. on *Psychotria* at Nuwara Eliya, Ceylon. Subsequently, Dr J. N. Couch published a paper in *Mycologia*, XXIX, 665-73 (1937), entitled 'A new fungus intermediate between the rusts and *Septobasidium*', in which he instituted a new genus, *Uredinella*, with the species, *Uredinella coccidiophaga*. As the Ceylon fungus appeared to fall in this new genus, specimens were sent to Dr Couch who has described them as *Uredinella spinulosa* Couch & Petch in *Mycologia*, XXXIII, 405 (1941). Two collections were made from the same bush, on 28 August 1926 and 16 January 1927, respectively. The figure referred to above was drawn from a stroma of the first collection which was sterile, but Dr Couch found fertile stromata in the material sent him. He describes the cells figured by me as 'teleutospore-like cells'. The teleutospore is spherical or pyriform, with an apical germ pore, and produces a cylindrical four-celled basidium, $63-72 \times 6.3-7.5 \mu$, with sterigmata about 7μ long which bear bent-elliptic, hyaline, smooth basidiospores, $21-23 \times 4.6-5.4 \mu$. There are also elongated-oval, teleutospore-like cells, with an apical germ pore, each of which produces an allantoid hyaline spore, $45-58 \times 3.8-5 \mu$, directly. Similar allantoid spores were considered homologous with uredospores in the generic type species, *Uredinella coccidiophaga*.

200. *LABOULBENIALES*

No one has yet systematically collected *Laboulbeniales* in this country, and the British list still consists chiefly of chance discoveries on museum specimens, any of which are welcome in the present state of our knowledge. Two more occurrences on fresh specimens have come to my notice, viz. *Laboulbenia vulgaris* Peyr. on *Bembidium assimile*, found by Mr J. C. F. Fryer at Woodwalton, 4-6 July 1931, and *Rhachomyces Philonthinus* Thaxter on *Philonthus varians* Payk., found by Mr H. Britten at Cotterill Clough, Cheshire, 16 November 1943. These are not 'new to Britain', both names being included in Bisby and Mason's *List of Pyrenomycetes recorded for Britain*. With regard to the latter list, the following may be noted.

The genus *Rhadinomyces* was merged by Thaxter in *Corethromyces*, and the British species, *Rh. pallidus* now stands as *Corethromyces pallidus* Thaxter, *Proc. Amer. Acad.* XLVIII, 180 (1912).

Bisby and Mason include *Monoicomyces Homalotae* Thaxter in the British list, but the evidence is somewhat confusing. In *Mon.* v, 43, Thaxter referred to 'The British types of this species from *Homalota putrescens*'. In *Mon.* II, 269, he wrote, 'the form occurring on *H. putrescens* in Britain'. But in *Mon.* II, 268, *M. Homalotae* was described from *H. putrescens*, B.M. No. 412, Azores. Unless there is further evidence, it would seem that the types are only British in the sense that they were found in the British Museum.

Under *Corethromyces Lathrobii*, Thaxter wrote, in *Mon.* II, 323, 'specimens corresponding in all respects to the type of this species were found in the Hope collection at Oxford on the European *L. quadratum*, labelled "Payk. Gyll." [sic]. Whether this is a locality and if so where it is I am unable to say. The host is a European species.' Again, in *Mon.* v, 202, in connection with the same specimen he referred to 'the cryptic label "Payk. Gyll."' On mentioning this problem to Mr H. Britten, he informed me that the beetle was named by Paykull in 1789, and the addition of Gyll. presumably conveys the idea that the specimen is Gyllenhal's conception of Paykull's species. Mr Britten considers that we are justified in assuming that it was a British specimen.

(Accepted for publication 18 January 1944)

STUDIES ON BRITISH CHYTRIDS

II. A NEW CHYTRID ON *CERATIUM* AND *PERIDINIUM*

By C. T. INGOLD

(With Plate IX and 3 Text-figures)

Apart from two species of *Rhizophyidium* described by Dangeard (1888) as parasites of *Glenodinium cinctum*, chytrids have not been reported on members of the Dinophyceae. In July 1943, however, a chytrid was found in abundance on *Ceratium hirundinella* and, to a lesser extent, on a species of *Peridinium*, in a sample of plankton from Windermere. Unfortunately only material preserved in 4% formalin was available for study.

Ceratium hirundinella was abundant in this plankton and about half the individuals bore the chytrid. The contents of the infested cells appeared to be completely disorganized and, although the point could not be settled definitely from pickled material, it seemed that the fungus was saprophytic. The *Peridinium* was much less common in the plankton and only a few specimens were attacked.

The structure of the thallus is shown in Text-figs. 1-3 and in Pl. IX. It is monocentric, extramatrical and consists of a spherical sporangium (developed from the encysted zoospore) resting on a smaller spherical apophysis from which the three or four main axes of the rhizoidal system arise laterally. For a short distance these are unbranched and often act like the legs of a tripod raising the apophysis above the surface of the host cell. Distally the rhizoids taper and branch repeatedly on the surface of the *Ceratium* to produce an extensive rhizoidal system which seems to be entirely superficial, although some of the finer rhizoids may perhaps penetrate the wall of the host. Frequently, fine rhizoids trail out into the water and a heavily infected cell may have a regular fringe of these around it.

Text-figs. 1-3 illustrate examples in which only one or two chytrids were present on the host cell; these were chosen because it was easier to