

NOTES ON ENTOMOGENOUS FUNGI

BY T. PETCH

161. *EMPUSA ACARICIDA* Petch

THE red-legged earth mite (*Halotydeus destructor*), a serious pest of certain forage crops in Western Australia, was found by Mr K. R. Norris to be attacked by a fungus which he identified as an *Empusa*, and subsequently Mr Norris sent me specimens from which it was possible to confirm his identification. No *Empusa* has been recorded on mites before, and this is a new species. Mites attacked by this fungus may be picked out in the field because of their change of colour. Normally the mite has a black body and red legs, but when attacked by the *Empusa*, the whole of the dorsal surface and the sides of the body become yellowish brown, and this area is sharply demarcated from the black ventral surface. An account of the fungus, including a formal description under the name *Empusa acaricida*, has been published in Australia in *Proc. Linn. Soc. N.S.W.* LXV, 259-60, 16 September 1940.

The mites killed by this *Empusa* are attached to the host plant by their mouthparts or are entangled in the tomentum of the leaf. There are no rhizoids. The conidiophores are short, stout and unbranched. The primary conidia are oval, $9-12 \times 5-7 \mu$, or subglobose, $8 \times 6 \mu$, always with a broad, truncato-convex papilla. The secondary conidia are similar, and are borne on a stout germ tube from any part of the primary conidium, but usually laterally, as in *Entomophthora Aphidis*.

162. *CORDYCEPS MILITARIS* (L.) Link

Cordyceps militaris is a well-known parasite of lepidopterous larvae and pupae, to which hosts it is supposed to be confined, though there are records of its occurrence on Coleoptera, one by Roumeguère in *Revue Mycologique*, vi, 150 (1884), on a cockchafer, Dept. Aude, France, and another by Briard, in *Florule Cryptogamique de l'Aube*, p. 339 (1888), on the remains of a cockchafer buried in the soil in the wood of Bailly, Dept. Aube, France, while in Farlow and Seymour, *Provisional Host Index of the Fungi of the United States*, the entomogenous fungi of which were revised by Thaxter, *Lachnosterna quercina* is given as a host.

It has been surmised that either these records were erroneous, or that they really referred to *Isaria farinosa*, which was then believed to

be the conidial stage of *Cordyceps militaris*. It was a common practice at that time to record the perfect stage of a fungus, when only the imperfect stage had been collected, e.g. *Tubercularia vulgaris* would be recorded as *Nectria cinnabarina*. In 1939, however, I was able to examine a specimen which, up to a point, supports the records quoted.

The specimen was collected on 16 September 1938 at Gönnebeck, East Holstein, by Dr Meyer who was engaged on an investigation of the cockchafer pest, and was forwarded to me by Dr H. Blunck, Director of the Institute for Plant Diseases, Bonn. It was said to have occurred on a second year cockchafer larva, buried at a depth of about half a centimetre. I have not seen the larva, but in the circumstances there should be no doubt about the identification. The larva was covered, except for the head, with an irregular, dirty white mycelial layer, with rhizomorphic strands spreading through the soil. From the neck arose a group of four clavae, 15-20 mm. high and about 2 mm. diameter, sealing-wax red in colour when fresh. The lower part, or stalk, of the clava was almost smooth, while the upper third, or head, was rough with projecting ostiola. The clavae resembled exactly in appearance and structure rather stout clavae of *Cordyceps militaris*. Unfortunately they were quite immature, and I was unable to find asci. It is possible that the fungus may have ascospores different from those of *C. militaris*; and at present it cannot be decided whether *C. militaris* can attack Coleoptera, or whether there is another *Cordyceps*, indistinguishable from *C. militaris* on macroscopic characters, on those hosts.

163. *CORDYCEPS TYPHULAEFORMIS* Berk. & Cooke

This species was discussed in *Trans. Brit. Mycol. Soc.* xviii, 49 (1933), where it was stated that although Cooke described the colour as red, there was no trace of red on the type specimen now, the colour being brownish yellow or dark amber and subtranslucent, and brownish yellow internally. I have since been able to examine further specimens of this species, and it appears to be certainly red when fresh.

Specimens on cocoons of nettle grub (Lepidoptera) from the Tea Experimental Station, Nilgiris, South India, were submitted to me in September 1934 by the Imperial Mycological Institute. The collector's note described it as orange-red, club-shaped. Numerous clavae arose from a single cocoon. The clavae were straight or curved, 1-2 cm. high, with a cylindrical or clavate, terete or more usually laterally flattened head, 4-10 mm. high, 1.5-2 mm. diameter, and a stalk 1.5-2 mm. diameter or broad. The stalk sometimes branched above, but only in one instance was a lateral branch fertile. The perithecia were usually lacking on a longitudinal band down one

side, but on the smaller specimens they were continuous; they appeared free, but evidently they were at first embedded in loose tissue up to two-thirds their height. The immature perithecia were flask-shaped, with a subcylindrical obtuse apex, up to 0.6 mm. high, 0.25 mm. diameter. The specimens had been preserved in formalin, and asci and spores could not be found.

Another specimen was included in a collection of entomogenous fungi from the Herbarium of the Missouri Botanic Garden, 'Clemens 7793 F, New Guinea, Morobe, Sambanga. Orange red fungus on caterpillar, November 26, 1937'. Fourteen clavæ, up to 1 cm. high, grew from a hairy caterpillar. They were red and subtranslucent, with an ovoid or subglobose head, and strongly projecting free perithecia with yellow mycelium between them, sometimes lacking down one side of the head. The perithecia were conoid, obtuse, 0.6 mm. high, 0.5 mm. diameter. This specimen was mature, the asci being capitata, 4μ diameter, and the part-spores rod-shaped, $4 \times 1\mu$.

I have also seen a specimen on a pupa from Behungi, Uganda, 4 April 1927, Linder no. 2526 in the Farlow Herbarium, in which the pupa bore two clavæ only.

As the result of these examinations, the synonymy given in the previous note must be revised. *Cordyceps mitrata* Pat., *C. flavobrunnescens* P. Henn., and *C. coccinea* var. *subochracea* Penz. & Sacc., all from Java, are I think the same as *C. typhulaeformis*, but *C. deflectens* Penz. & Sacc. is most probably different.

164. *ISARIA CICADAÆ* Miq. and *CORDYCEPS SOBOLIFERA* (Hill) Sacc.

In *Trans. Brit. Myc. Soc.* x, 39 (1924), *Isaria Sinclairii* (Berk.) Lloyd was redescribed from Ceylon specimens, with a photograph, and it was stated that it did not appear to differ from *I. arbuscula* Hariot from Mexico. That was followed in the same journal, xvi, 66 (1931), by a note on *I. Cicadae* Miq., the type of which came from Brazil, and later, in xviii, 64 (1933), after examination of specimens from Mexico in Herb. British Museum, the latter name was adopted for *I. Sinclairii* and a number of other species which had been recorded on cicadas. Most of the synonyms there given are cited for *I. Sinclairii* by Kobayasi in 'The genus *Cordyceps* and its allies' (*Science Reports Tokyo Bunrika Daigaku*, B. No. 84, v, 53-260, 1941), though he apparently dissents from its reference to *Isaria Cicadae* Miq. The same writer remarks (p. 245): 'Some authors think that this (*I. Sinclairii*) is the conidial stage of *Cordyceps sobolifera*, but against such a speculation we may mention the fact that the latter fungus is provided with the pycnidial lateral branches with conidia as already mentioned.'

In 1938, through the kindness of Professor C. W. Dodge, I was able

to examine a large number of specimens of *Cordyceps sobolifera* and *Isaria Cicadae* from the herbarium of the Missouri Botanic Garden, collected at San Sebastiad, Jalisco, Mexico (date not stated). Some isarial specimens had a large subglobose head, up to 1.5 cm. diameter, on a comparatively thin stalk, the individual branches of the head being more visible than is usual in fresh specimens of *I. Sinclairii*, though that may have been due to loss of conidia after collection. Others had clusters of branches arising directly from the insect, without a main stem. Clusters of conidial branches also arose from the stem of the perithecial clavæ, or even from the head in immature specimens; and conclusive evidence of the relationship of *Cordyceps sobolifera* and *Isaria Cicadae* was provided by specimens in which the main stem divided into two or three stems, of which one terminated in the *Isaria* and the others in the *Cordyceps*.

In these specimens, the processes on the perithecial clavæ were branches, often short and scattered, terminating in a conidial head, though in one instance the processes, arising just below the head, were long and branched, forming an isarial cluster which extended to half the height of the immature head. In a previous account I stated that these branches (soboles) were apparently easily detached; that was not so in the present specimens, in which the processes were stout branches, not separable without fracture. Some perithecial clavæ showed no trace of soboles; others bore minute white points which might indicate where branches had been broken off, or more probably where they were beginning to develop.

The conidia in these specimens were cylindrical with rounded ends, or very narrow oval, $7-11 \times 2.5-3\mu$. The total height of the perithecial clavæ was up to 8.5 cm., with a cylindrical head, rounded at the apex when mature, 2 cm. high, 3 mm. diameter, rough with slightly projecting ostiola when dry. The asci were $5-7\mu$ diameter, according to the degree of maturity of the spores, and the part-spores cylindrical, ends truncate, $7-12 \times 1-1.5\mu$.

It is to be noted that Berkeley described the head of *C. sobolifera* as globose. In a West Indian specimen in Herb. British Museum, illustrated in *Trans. Brit. Myc. Soc.* xix, 175, Fig. 2, the head is elongated oval. In a photograph of a specimen from the Bahamas, reproduced by Lloyd, *Mycol. Notes*, v, 584, the head is clavate. The latter specimen shows conidial processes on the stem, bearing, according to Lloyd, narrowly elliptical conidia, about $8 \times 4\mu$. It is evident that the shape of the head of *C. sobolifera* is variable, as indeed it frequently is in *Cordyceps*, e.g. *C. militaris*.

The specimens described above leave no room for doubt that *Isaria Cicadae* is the conidial stage of *Cordyceps sobolifera*. The latter species, however, has recently been redescribed by Kobayasi from Japanese specimens. His description agrees in the main with the Mexican

specimens as regards the perithecial stage, but he states, with figures, that the processes or soboles are pycnidial. Nothing resembling these pycnidia has been observed on the Mexican specimens. It may be that *C. sobolifera* produces both pycnidia and conidial synnemata on the perithecial clavae, but that is a matter for further enquiry. No *Isaria* stage has been reported for *Cordyceps sobolifera* from Japan, though *Isaria Cicadae* (*I. Sinclairii*) occurs in that country.

165. *CORDYCEPS* on mole crickets

In *Mycol. Notes*, vi, Fig. 1622, C. G. Lloyd published a photograph of an immature *Cordyceps* on a mole cricket under the name, *C. Gryllotalpae*; and on p. 913 he wrote: 'There are several specimens of this [at the New York Botanical Garden] on "ground puppies" or "sand moles", as Curtis calls them. They were sent to the Garden by E. C. Wurzlow, Houma, La. All are immature, but I have no doubt are young *Cordyceps*. Curtis lists the name but nothing further, and I did not find at Kew that he had sent any specimen to Berkeley.' The name does not appear to have been known to Cooke or Masee.

Lloyd's reference to Curtis is somewhat tantalizing, as he did not indicate where the list referred to was to be found or whether there was any specimen in the Curtis herbarium. As the name does not appear in any previous account of the genus *Cordyceps*, it would seem that it was a manuscript list. Moreover, there is no indication whether Curtis's specimen was a North American one or a Wright specimen from Cuba. The specimens at the New York Botanic Garden, of course, have no connexion with Curtis, and the assignment of his name to them rests on a series of assumptions which would only be justifiable if only one species of *Cordyceps* occurred on mole crickets. The photograph shows several (? nine) narrow clavae directed backwards more or less parallel to the insect, and suggests that the latter was upside down in its burrow, or that the clavae had been bent over in packing. Until more specimens have been collected in Louisiana, it is uncertain whether the mature clavae are linear or develop a head.

In his 'Genus *Cordyceps* and its allies' (1941) Kobayasi gives the name, *Cordyceps Gryllotalpae* Ellis & Seaver, for a Japanese *Cordyceps* on *Gryllotalpa*. His figure shows narrow cylindrical clavae, with an intercalary region bearing crowded, superficial perithecia. The ascospores are cylindrical, attenuated towards the ends, $40-63 \times 2-2.5 \mu$, 7-8-septate, not dividing into part-spores. His ascription of the name to Ellis and Seaver is probably due to Lloyd's statement on p. 912: 'We recently looked over the *Cordyceps* material at the New York Botanical Garden, where are preserved the specimens on which Ellis and Seaver, for the most part, based their work.' But Seaver did not mention *Cordyceps Gryllotalpae* in his *Hypocreales of North America*,

from which it may be deduced that the Louisiana specimens were not then in the herbarium.

Whether *Cordyceps Gryllotalpae* is to be attributed to Curtis or Lloyd must be left to experts in nomenclature. But the Japanese fungus is an *Ophiocordyceps*, and should stand as *Ophiocordyceps Gryllotalpae* (Kobayasi) Petch n.comb.

In *Trans. Brit. Myc. Soc.* xix, 173 (1935) I recorded *Cordyceps amazonica* P. Henn. on a mole cricket from Trinidad, collected by Mr Stell in January 1925. In this specimen the clavae are fasciculate, two mature and one initial arising together from the insect, the height of the largest being about 2 cm. The stalk is pale brown, rough, terete, up to 2 mm. diameter below, 1.5 mm. above, and each mature clava has a short sterile branch a little distance below the head. The head is globose or ovoid, regular, sharply defined from the stalk, about 2.5 mm. diameter, red-brown, with dark brown, scarcely projecting ostiola. The head has a definite cortex, and the perithecia are immersed, perpendicular to the surface, narrow flask-shaped to elongated oval, 0.6 mm. high, 0.15 mm. diameter, crowded in a peripheral layer. The part-spores are cylindrical, ends rounded, $4.5-6 \times 2-2.5 \mu$.

166. *CORDYCEPS CITREA* Penz. & Sacc.

This species was described by Penzig and Saccardo from a specimen collected at the hill station, Tjibodas, in Java on the larva of a beetle. I have a specimen, kindly sent to me by Dr W. McRae, collected at Shembagunur, Pulnis (6000 ft.), Madras Presidency, May 1922, on a larva which appears to be that of a beetle.

The larva is about 8 cm. long and 1 cm. diameter, and is enclosed for the greater part of its length in a smooth white coat of mycelium, which suggests that it was situated in a boring in wood. Towards the head, numerous branching strands of mycelium arise from the external coat, and some of these terminate in perithecial clavae. The largest clava arises from a flattened strand about 2 mm. broad, which expands into a flattened palmate clava, 1.2 cm. broad, dividing above into four conoid heads, up to 1 cm. long, the total height of the clava being about 2 cm. Another strand terminates in a clavate head, 1.5 cm. long, 4 mm. diameter, and another in a cylindrical head, 4 mm. long, 2 mm. diameter. The mycelium is white, but the heads are lemon-yellow, closely dotted with brown ostiola. The perithecia are immersed, but the head has no definite cortex, and the apices of the perithecia become prominent on the older parts. The apex of the head is rounded. The perithecia are oval, attenuated above, with a truncate apex, 0.55-0.7 mm. high, 0.25-0.28 mm. diameter, crowded; and the asci are cylindrical, capitate, with cylindrical, truncate part-spores, $4-8 \times 1 \mu$.

Penzig and Saccardo described and figured a clava with an erect, compressed stalk, 4-4.5 cm. high, branching at the apex, with short, erect, cylindrical or compressed branches, terminating in elliptic, obtuse heads, 5-10 mm. long. In the present specimen the mycelium divides below ground and does not produce a single main stem. A more important difference is in the size of the perithecia, which Penzig and Saccardo stated were very small, 250 μ high, 90 μ diameter. Their specimen was apparently not quite mature, as they did not give the dimensions of the part-spores, but that would scarcely account for the smaller dimensions of the perithecia. It would seem possible that there may have been some error in measurement.

167. *CALONECTRIA COCCIDOPHAGA* Petch

This species was described with coloured figures and line drawings in *Trans. Brit. Myc. Soc.* VII, 141-3, Pl. IV, figs. 1-4 and Pl. V, figs. 7 and 13, together with its conidial stage, *Discofusarium tasmaniense* (McAlp.) Petch, syn. *Microcera tasmaniensis* McAlp. In 1935, Dr O. Reinking asked me to send him a specimen for examination, and I accordingly sent him the specimen figured on Pl. IV, fig. 3. In his reply Dr Reinking wrote: 'After having made a study and drawings of the ascospores as well as accompanying *Fusaria*, Dr Wollenweber came to the conclusion that the fungus was identical with *Gibberella pulicaris* (*Fusarium sambucinum*). The lighter coloured base of the perithecia turned bluish black upon addition of an alkali which would indicate that this colour modification is merely dependent upon the reaction.' This synonymy was published by Wollenweber & Reinking in their book, *Die Fusarien*.

The dried perithecia of *Calonectria coccidophaga*, when detached from the yellow stroma, appear black above, but pinkish yellow below. From the colour of the perithecium when soaked in water, it is probably very dark red when fresh. The wall is minutely pruinose, except round the ostiolum, probably from adhering rubbish, as it is otherwise smooth and has a horny appearance; it is rigid, not collapsing, and does not become wrinkled or warted in drying. Internally the wall is entirely rose-red, but in section the outer layers are vinous or purple-red, while the inner layers are yellowish white. It is composed of small cells, obscurely parenchymatous, with an external amorphous film. The cells round the ostiolum are thick-walled, oval, 4-5 \times 3-4 μ , arranged concentrically. The wall is quite different from the coarsely parenchymatous, large-celled wall of *Gibberella pulicaris*. The ascospores are larger than those of the latter (22-34 \times 8-9 μ), not the same shape, and distinctly thick-walled.

The *Fusarium* stage has a thick, white, marginal wall of parallel hyphae surrounding a disk of conidiophores, the latter salmon-pink

when fresh, but yellowish when dry. It looks like a *Peziza*. No doubt the presence of the marginal wall caused McAlpine to place the fungus in *Microcera*, but it is not similar to the sheath of *Microcera*. The conidia are three to five septate, 44-58 \times 5-6 μ . Its only resemblance to *Fusarium sambucinum* is in its conidiophore, which is of the same type as that of the latter.

I did not trouble to contradict Wollenweber and Reinking's identification, being confident that no one who collected the fungus again in Australia would regard it as *Gibberella pulicaris*. It has, however, been pointed out to me recently, in connexion with my paper, *British Hypocreales*, that it is not sufficient merely to ignore erroneous records or determinations, and that if not contradicted they are regarded as correct and continue to be cited. (Incidentally, that was the reason for the publication of several sections of my recent paper, *Further Notes on British Hypocreales*.) Consequently I must express my complete disagreement with the statement that *Calonectria coccidophaga* is *Gibberella pulicaris*.

168. *Calonectria truncata* Petch, n.sp.

This species was collected by Mr R. G. Fennah in St Lucia, B. W. I., 20 November 1939, on a leaf-hopper, and was kindly submitted to me by the Imperial Mycological Institute. The insect is covered by a thin layer of white mycelium, in which the perithecia are partly immersed. The perithecia are pale yellow, broadly flask-shaped or conoid, 0.1 mm. diameter, 0.25 mm. high, tomentose at the apex with short, erect or spreading, rigid hairs, which make the apex appear truncate. The asci are clavate, 85-95 \times 14-15 μ , the apex being truncate when immature, but not thickened, and becoming rounded or subacute when mature. The ascospores are fusoid, sometimes attenuated below, seven to fourteen septate, hyaline, 40-50 \times 7-9 μ . This species differs from *Calonectria hirsutellae* in the shape and colour of the perithecia, the shape of the asci and the dimensions of the ascospores.

The mycelium bears elongated conoid *Hirsutella* phialides, 14-18 \times 3-4 μ , with a short sterigma. This is *H. floccosa* Speare. In describing *Calonectria hirsutellae*, its conidial stage was said to be *H. floccosa*, but a re-examination of that specimen shows that the identification was incorrect; its phialides have a flask-shaped base, 9-18 \times 4-5 μ , with a stout sterigma, 1 μ thick, but complete sterigmata have not been observed and its identification is uncertain.

Calonectria truncata Petch, n.sp. Mycelio albo insectum obtegente; peritheciis in mycelio semi-immersis, pallide flavis, late ampullaceis vel conoideis, 0.1 mm. diam., 0.25 mm. alt., truncatis, apice crinibus brevibus rigidis rectis vel patentibus vestitis; ascis clavatis, octo-

sporis, $85-95 \times 14-15 \mu$; ascosporis fusoides, interdum infra attenuatis, hyalinis, $7-14$ -septatis, $40-50 \times 7-9 \mu$. On leaf-hoppers, St Lucia, B.W.I.

169. *TORRUBIELLA BLATTAE* Petch

This species, which occurred on the ootheca of a blattid, was collected by M. J. Vinson at Macabé, Mauritius, and was forwarded to me by M. Raymond Mamet.

The subiculum forms a somewhat definite, rather compact, white or cream-coloured patch, in which the perithecia are partly embedded. The perithecia are crowded, narrow flask-shaped or conoid, amber (when dry), darker at the apex, white tomentose below, glabrous above, 0.5 mm. high, 0.25 mm. diameter below. The wall is hyaline by transmitted light. The asci are long cylindrical, 3μ diameter, and the ascospores linear, 0.75μ diameter, multiseptate, with septa $4-6 \mu$ apart. Part-spores were not observed.

A description of this species has been published in the *Mauritius Institute Bulletin*, II, 17 January 1941.

The type species of the genus *Torrubiella*, *T. aranicida* Boud., has no paraphyses. Those described by Boudier were immature asci, which have the usual capitate apex.

170. PYCNIDIA ON CICADAЕ, ETC.

When an entomogenous fungus attacks an adult insect, it may spread from the body to the wings and produce its fructifications on the latter. That occurs commonly in *Cordyceps tuberculata* (Lebert) Maire, *Hirsutella entomophila* Pat., and in most Entomophthoraceae. It is, however, rather surprising to find that the wings of certain insects are specifically mentioned as the habitat of several fungi. Spegazzini described *Phoma alicola* Speg. on the decaying wings of *Fidicina bonariensis* (Cicadae) in Argentina, Tassi described *Phoma Acridii* Tassi on the decaying wings of *Acridium peregrinum* in Italy, and Saccardo added *Phyllosticta Berlesiana* Sacc. on the wings of a dead *Cicada plebeja*, again in Italy. There is very little difference between the three descriptions. The pycnidia are described as lenticular or globoso-lenticular, and the structure of the pycnidium wall loosely parenchymatous, coarsely parenchymatous, and distinctly parenchymatous respectively, while the shape and dimensions of the pycnospores agree. *Phoma Acridii* was said to be near *Ph. alicola*. It would appear that all these three are the same species.

Septoria pterophila Sacc. was found on the decaying wings of *Cicada orni* in Italy, and *Vermicularia cicadina* Ell. & Kell. on the wings of a dead Cicada at Manhattan, North America. From the descriptions it would appear that these two are distinct species.

All these fungi were found on dead insects, and in three the wings were described as putrescent or putrid. It is probable, therefore, that they are not pathogenic, and it may be that they are merely common saprophytes on decaying animal matter.

171. *Hymenostilbe Aphidis* Petch, n.sp.

A *Hymenostilbe* on aphids was collected by Mr R. G. Fennah in Dominica, B.W.I., in January 1940, and was kindly forwarded to me by the Imperial Mycological Institute. The clavae are usually solitary, rufous brown, up to 2 mm. high, 0.1 mm. diameter, erect or suberect, straight or flexuose, equal or slightly thickened upwards, terete, minutely pruinose. They are clothed with a palisade layer of basidia, which are conoid, narrow flask-shaped, or subcylindrical, $12-18 \times 4-6 \mu$, pale brown, with an abrupt, hyaline, stout, cylindrical sterigma, $3-6 \times 1 \mu$. The conidia are narrow oval or fusoid, hyaline, smooth, $9-15 \times 4-5 \mu$, with a short, truncate apiculus.

Hymenostilbe Aphidis Petch, n.sp. Clavis rufobrunneis, ad 2 mm. alt., 0.1 mm. diam., rectis vel flexuosis, aequalibus vel supra leniter incrassatis, teretibus, minute pruinosis; basidiis conoideis, vel anguste ampullaceis, vel subcylindraceis, pallide brunneis, $12-18 \times 4-6 \mu$, sterigmate cylindraco, hyalino, $3-6 \times 1 \mu$; conidiis anguste ovalibus vel fusoides, hyalinis, levibus, breviter apiculatis, $9-15 \times 4-5 \mu$. On aphids, Dominica, B.W.I.

On the same specimen as the foregoing fungus is a *Hirsutella*, sometimes on the same aphid as a *Hymenostilbe* clava, sometimes alone on an aphid. The insects are overrun by hyphae, at first hyaline, becoming fuscous, varying in diameter from 2 to 6μ , which extend from them to the leaf. These hyphae bear *Hirsutella* phialides, hyaline, elongated conoid, sometimes attenuated regularly from the base, sometimes passing into a thin sterigma for one-half or one-third of their length, with a total length of $30-65 \mu$, and a diameter of $4-5 \mu$ at the base. They usually occur laterally on the hyphae, but are very variable. Sometimes a phialide forks equally, so that two appear to arise at the apex of a cylindrical base, $13-16 \times 5 \mu$. Others may bear slender lateral sterigmata at varying heights. The mycelium and phialides form minute greyish tufts scattered over the insect, and in these it may simulate an irregularly branched conidiophore, up to 100μ high, with a main stem 6μ diameter at the base. The mycelium may also run over a *Hymenostilbe* clava and produce clusters of phialides on it. The spore cluster is oval, $10 \times 8 \mu$, and the conidia are hyaline, cymbiform, $9 \times 1.5-2.5 \mu$. This species is *Hirsutella Aphidis* Petch, *Naturalist*, 1936, p. 60, originally described from a specimen collected in England.

Several of the details of *Hymenostilbe Aphidis* suggest a comparison

with *Isaria acaricida* Pat. It appears possible that the latter may be a combination of the two species found in the present specimen, but that can only be decided by an examination of the type.

172. *Isaria (Beauveria) sphaerocephala* Petch, n.sp.

This species was collected at Peradeniya, Ceylon, in November 1912, on cocoons of *Thosea recta* Hmps. (Lepidoptera), one of the nettle grubs. The larva within the cocoon is covered with white mycelium, but only the clavae emerge. The latter when full grown have a stout simple stalk and a well-defined subglobose head. The stalk is up to 2.5 mm. high, 0.5 mm. diameter, expanding upwards, pruinose, cream-coloured or brownish, and the head is up to 2 mm. diameter, cream-coloured, farinose, appearing compact, but somewhat loose internally and composed of radial conidiophores. The conidiophores are 2.5 μ diameter, and bear lateral and terminal clusters of phialides, oval, 3-4 \times 2 μ , or subglobose, 3 μ diameter, with conidia on thin, *Beauveria*-like sterigmata. The conidia are hyaline, oval, 2-2.5 \times 1-1.5 μ , or globose, 1 μ diameter, not readily separating from the sterigma.

Isaria Orthopterorum Petch has a slender, zigzag or branching sterigma, not catenulate spores as stated in the original description, but differs from the present species in the size and shape of its conidia.

Isaria sphaerocephala Petch, n.sp. Clavis pistilliformibus, pallide flavidis; stipitibus ad 2.5 mm. alt., 0.5 mm. diam., supra incrassatis, pruinosis, brunnescentibus; capitibus ad 2 mm. diam., subglobois, farinaceis, ex conidiophoris radiatim compositis; conidiophoris 2.5 μ diam., phialides in acervis lateralibus et terminalibus ferentibus; phialidibus ovalibus; 3-4 \times 2 μ , vel subglobois, 3 μ diam., in sterigmate tenui terminatis; conidiis lateralibus et terminalibus, hyalinis, ovalibus, 2-2.5 \times 1-1.5 μ , vel globois, 1 μ diam. On larvae of Lepidoptera, Ceylon.

173. *ISARIA TENUIPES* Peck

A redescription of this species, from American specimens, was published in *Trans. Brit. Myc. Soc.* xxi, 58 (1937). It occurs on lepidopterous pupae, and is similar in general appearance to *Spicaria (Isaria) farinosa*, but as a rule it is more feathery, and the arrangement of the phialides in spheres at the ends of simple hyphae makes the head more granular. The conidia are cylindrical or oblong-oval, 4-6 \times 1.5-2 μ . I have recently received specimens of this from Mr E. A. Ellis, collected on two occasions, 15 October 1938 and 8 August 1940, at Wheatfen Broad, Norfolk. This is the first record of this species for Britain, though I have always been looking for some other

species among the scores of *Isaria farinosa* from all parts of England which I have examined during the last ten years. I find, however, that I have European examples of *I. tenuipes* from M. N. Taymans, Turnhout, Belgium, which I misidentified at the time as *I. dubia* Delacr. M. Taymans informed me that this long-spored *Isaria* was the common form in his district, and that he had not found *I. farinosa*. He had found *I. tenuipes* in 1939 at Westerloo, twenty miles from Turnhout, and at Schooten, six miles from Antwerp. The arrangement of the phialides in *I. tenuipes* is similar to that in *I. ochracea* Boud., but the latter has larger conidia.

174. *SPICARIA PRASINA* (Maubl.) Saw.

A specimen of this species, on a caterpillar attached to a leaf of a grass, was found by Mr E. A. Ellis at Wheatfen Broad, Norfolk, in August 1939. As far as I am aware, this is the first European record of this fungus.

In *Trans. Brit. Myc. Soc.* xi, 264 (1926), I pointed out that, with certain additional punctuation, the description of *Botrytis Rileyi* Farlow might be taken as that of a *Spicaria*, and that the type should be compared with *Spicaria prasina*. The transfer has since been made by Miss V. K. Charles in *Mycologia*, xxviii, 398 (1938), but I have not seen any statement that the essential comparison has been made.

175. *SPICARIA GRACILIS* Petch

This species was described as *Coremium gracile* in *Trans. Brit. Myc. Soc.* xi, 260 (1926), and was transferred to *Spicaria* in *Notes on Entomogenous Fungi*, No. 45, *Trans. Brit. Myc. Soc.* xvi, 241 (1932). On further consideration, and a better knowledge of *Spicaria (Isaria) farinosa* as it occurs in Britain, I am of opinion that *S. gracilis* cannot be separated from the latter species. Like the latter it attacks insects of all kinds, but in general it does not occur in the isarioid form.

176. *CEPHALOSPORIUM COCCORUM* Petch

This species was described as *Cephalosporium (Acrostalagmus) coccorum* in *Trans. Brit. Myc. Soc.* x, 171 (1925). Many of the species of *Cephalosporium* on insects produce *Acrostalagmus* conidiophores, often sparingly in nature but usually abundantly in culture. In the list of cultures issued by the Centraalbureau voor Schimmelcultures, Baarn, in 1936, this species is listed as *Verticillium coccorum*, and as reported in *Rev. App. Myc.* xvi, 677 (1937), P. Kotthoff in *Angew. Bot.* xix, 127-30, stated that Miss Westerdijk had transferred it to *Verticillium* because of its profuse verticillate branching in old cultures. But that branching was recognized in the original naming, and the transference, if any were needed, should have been to *Acrostalagmus*.

177. *CEPHALOSPORIUM APHIDICOLA* Petch

Dr C. E. Foister sent me this species in February 1939, on the aphid, *Capitophorus fragariae*, on strawberry, presumably grown under cover, from Auchincruive, Scotland. It was originally described in *Trans. Brit. Myc. Soc.* xvi, 71 (1931), from Ceylon specimens. The conidia in the Scottish examples are oblong or oblong-oval, sometimes slightly curved, $4-8 \times 1.5 \mu$, as against $5-9 \times 1.5-2 \mu$ in the type. In *Trans. Brit. Myc. Soc.* x, 175 (1925), reference was made to *C. Lefroyi* Horne, described in *Gard. Chron.* LVII, 139 (1915), on *Aleyrodes vaporariorum* on *Centropogon*, a greenhouse plant, at Wisley. Its conidia were given as ellipsoid, ovoid, or oblong, straight or slightly curved, $\pm 7 \times 1-1.7 \mu$. No specimens were preserved, and it has not been reported again. There would appear to be some probability that the two species are the same, notwithstanding the host difference, but the question must be left in abeyance until the re-discovery of specimens on *Aleyrodes*.

178. *Cephalosporium subclavatum* Petch, n.sp.

A diseased caradrinid larva (Lepidoptera), kindly forwarded by Mr J. C. F. Fryer, was found to be attacked by an undescribed species of *Cephalosporium*. When received, the larva was sparsely covered by loose greyish white mycelium bearing scattered lateral conidiophores, but on keeping it in a damp chamber it developed a dense white covering, tomentose with conidiophores, and ultimately in places a luxuriant fluffy growth. The conidiophores on the original sparse mycelium were lateral, simple, subulate, $12-18 \mu$ high, 1.5μ diameter at the base, tapering uniformly to the apex, with conidia $4-7 \times 1.5-1.75 \mu$. In the more developed growth, *Acrostalagmus* conidiophores were produced, up to 400μ high, $2-3 \mu$ diameter at the base, septate, with whorls of three to six branches in the upper part, the branches being 2μ diameter below, $20-25 \mu$ long, subulate, tapering uniformly, with heads of conidia about 10μ diameter. The conidia were irregularly placed in the head, not parallel, and were oblong-oval or narrow-oval, the longer subclavate, ends obtuse, $4-8 \times 1.5-2 \mu$.

Cephalosporium (Acrostalagmus) subclavatum Petch, n.sp. Mycelio albo insectum obducente; conidiophoris simplicibus, lateralibus, subulatis, $12-18 \mu$ alt., basi 1.5μ diam., vel ramosis, ad 400μ alt., basi $2-3 \mu$ crass., supra verticillis 3-6 ramorum, $20-25 \mu$ long., basi 2μ crass.; conidiis oblongo-ovalibus, angusto-ovalibus, vel subclavatis, obtusis, $4-8 \times 1.5-2 \mu$. On larvae of lepidoptera, Britain.

179. *Sorospora* and *Syngliocladium*

Among a collection of diseased wireworms (*Agriotes* sp.) recently sent me by Mr H. C. Gough, Rothamsted, were several attacked by what I believe to be *Sorospora uella* (Krass.) Giard. The larvae were

completely filled with a solid, white or pale brown mass of cells, either globose, 9μ diameter, or ovoid, $11-12 \times 7-8 \mu$, hyaline, sometimes with short projecting remnants of adjacent cells, but otherwise smooth. This is *Sorospora*. On keeping the specimens moist, they produced short clavae, sometimes in a continuous fringe along the sutures. These clavae bear short *Gliocladium* conidiophores, with subulate phialides about 18μ long and 3μ diameter at the base, each conidiophore bearing a globule of hyaline ellipsoid conidia, $5-7 \times 3-3.5 \mu$. This is a *Syngliocladium*, and it is evidently the same as *Acremonium Cleoni* Wize; which was described from a juvenile condition and must now stand as *Syngliocladium Cleoni* (Wize) Petch. Both *Sorospora uella* (as *Tarichium*) and *Acremonium Cleoni* were originally described from specimens in and on the larvae of *Cleonus punctiventris*, a weevil which attacks sugar beet in Russia.

Tarichium uella was described by Krassilstchik in 1886. Two years later, Sorokin described a similar fungus in lepidopterous larvae as *Sorospora Agrotidis*. Giard noted the similarity of the two species, and united them under the name *Sorospora uella* (Krass.) Giard. But both names referred to a sclerotial or resting spore state, and now that another stage of each is known, it seems clear that the two fungi are different. Speare published a preliminary note on *Sorospora uella* in *J. Agric. Research*, viii, no. 8, 189-94 (1917), and followed that with a fuller article in the same journal, xviii, no. 8, 399-439 (1920), but his account deals with *Sorospora Agrotidis*, not *S. uella*. Speare was able to infect lepidopterous larvae with his fungus, but not coleopterous larvae. A full bibliography is given by Speare in his second paper.

Syngliocladium Cleoni has elongated conoid or subulate phialides about 18μ long, 3μ diameter below, and ellipsoid conidia, $5-7 \times 3-3.5 \mu$. Speare's figure of the conidial stage of *Sorospora Agrotidis* is of a *Syngliocladium*, though he did not show the conidia united in heads; he gave the conidia as $9-11 \times 4-6 \mu$ and the phialides as bottle-shaped or almost subulate. It should, however, be recorded that on a very young example of *S. Cleoni*, in which usually only one conidium was present on each phialide, the conidia were cylindrical or narrow-oval, with rounded ends, $6-13 \times 1.5-3 \mu$.

Both in *Sorospora uella* and *S. Agrotidis* the internal cells are said to occur in loose masses, like bunches of grapes. In the English specimens, the internal cells form a continuous solid mass, white when fresh, pale brownish when dry. It is possible that the mass may disintegrate when old, but that condition has not yet been observed.

In *Trans. Brit. Myc. Soc.* xxxiii, 133 (1939), I described, but did not name, a *Syngliocladium* on the larva of a beetle, *Phyllophaga anxia* Lec., which occurred at Apple Hill, Ontario, in a cell underground. On re-examining that specimen, it was found that the larva was com-

pletely filled by a hard, solid sclerotial mass, chocolate-brown when dry, rather pale brown when soaked, composed of globose smooth cells, 9–11 μ diameter, budding like *Sorosporrella* cells, and stout irregular hyphae, all hyaline by transmitted light. This is a *Sorosporrella*, and, as in *S. uvella* and *S. Agrotidis*, it has a *Syngliocladium* conidial stage. As previously recorded, the *Syngliocladium* produces clavae or strands of mycelium from all parts of the larva, lax, white, minutely pruinose, about 0.25 mm. diameter, terete or flattened, the branches and main stems of the clavae apparently extending indefinitely, but generally broken in this specimen and entangled with one another. The conidiophores are about 20 μ high, and variable in structure; some bear phialides on prophialides, while in others the prophialides are absent, and all combinations of the two conditions occur. The phialides are narrowly flask-shaped or conoid, attenuated above, 7–12 \times 1.5 μ , and the prophialides oblong, up to 6 \times 2 μ . The conidia are oval, oblong-oval, or oblong with rounded ends, 2–3.5 \times 1 μ , with a few globose, 1.5 μ diameter. In the account cited, I associated this species with an immature *Cordyceps* found on the same insect. That was apparently a mistake, as there is no evidence of a *Sorosporrella* in the larvae which bear the *Cordyceps*. I name the *Syngliocladium*, *Syng. intricatum*.

Syngliocladium intricatum Petch, n.sp. Cellulae internae (alias *Sorosporrella*) globosae, hyalinae, leves, sclerotium durum fusco-brunneum formantes; synnemata circa 0.25 mm. diam., laxa, alba, ramosa, intricata; conidiophorae breves, circa 20 μ alt., prophialides (praesentibus) oblongae, ad 6 \times 2 μ , phialides angustae ampullaceae vel conoideae, supra attenuatae, 7–12 \times 1.5 μ ; sporae ovaes, vel oblongo-ovales, utrinque rotundatae, 2–3.5 \times 1 μ , interdum globosae, 1.5 μ diam.

A re-examination of the type of *Syng. araneorum* Petch, the type species of the genus, did not reveal any *Sorosporrella*. The body of the spider, however, was broken before it was collected, and it is possible that any sclerotial mass may have fallen out.

180. ACREMONIUM

Wize described three species of *Acremonium* on the larvae and chrysalides of a weevil, *Cleonus punctiventris* in Russia, viz. *Acremonium Cleoni*, *A. Danyszii*, and *A. soropsis*, with figures. In dealing with fungi parasitic on insects it has to be borne in mind that most stilboid species, e.g. *Hirsutella*, *Gibellula*, *Tilachlidium*, etc., produce conidiophores and conidia on repent hyphae as well as on clavae, or prior to the formation of the latter. Consequently it is necessary to be certain that one has the full-grown fungus, not merely a juvenile form.

Acremonium Cleoni is evidently a juvenile form. The figure shows a single immature conidiophore growing from a cluster of *Sorosporrella* cells. As already stated, the full-grown form is a *Syngliocladium*, which must stand as *Syngliocladium Cleoni* (Wize) Petch.

Acremonium Danyszii, from the figure, is evidently an early stage of a *Hirsutella*, probably *H. Eleutheratorum* (Nees) Petch, which is not uncommon on larvae of coleoptera.

Acremonium soropsis, represented and described as producing brown masses of cells on the exterior of the insect, is probably a *Synnematium*.

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