

## Note on the Sugar-cane Disease of the West Indies.

BY

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THE cultivation of the Sugar-cane is still, and—withstanding the competition of the Beet in temperate countries—is likely to remain a very important part of the tropical agriculture of the Empire. But of late years it has been hampered, as is sooner or later the fate of all cultural industries, by the ravages of disease.

The problem presented to the botanist in such a case is one of no ordinary difficulty. He has to engage in a conflict with a singularly elusive enemy, and he has to discover the conditions, often by no means obvious, in which that enemy is most open to attack. And the form in which the disease, or the Fungus which produces it, finally presents itself is rarely one which admits of remedial treatment. It is necessary, therefore, to trace back the Fungus through its often multiform life-history, and so to discover the stage at which its mischievous course can be most readily intercepted.

The task is difficult enough when one is face to face with the problem on the spot where it presents itself. It is still more so when the material to be studied only reaches the investigator after a long voyage, more or less decayed and infested with all the Fungi that attend decay.

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Nothing is more common than for a Fungus which has long possessed merely a scientific interest and has been preserved in herbaria in scanty specimens, suddenly to exhibit an overpowering fecundity and develop into a scourge.

Something like this seems to have happened in the West Indian cane-fields some ten years ago. A disease made its appearance which caused considerable immediate loss and apprehension of greater.

The disease in Barbados exists in two forms which, though apparently distinct, there is reason to think have a common cause. These are called respectively the 'Rind disease' and the 'Root disease.'

#### RIND DISEASE.

The following account is condensed from the Kew Bulletin, 1895, p. 81 :—Canes infected with the Rind Fungus are first noticed by dark red or brown marks in one or two joints towards the middle or base of the cane. This red patch having made its appearance, rapidly spreads upwards and downwards; the infected area darkens in appearance, and is evidently rotten. Little black specks make their appearance on the cane between the joints, breaking from the inside to the surface; finally the cane shrivels and dries up.

The bursting through of the epidermis is followed by the emission of a black filament, sometimes an inch and a half long or even more. The resulting appearance of the cane is figured by Masee (*Ann. of Bot.*, vol. VII, pl. 27, figs. 1 and 2) and by Prillieux and Delacroix (*Bull. Soc. Myc.*, vol. XI, pl. 10, fig. A). The filaments are composed of agglutinated spores (*Melanconium-stylospores*) which are discharged from a conceptacle or pycnidium buried in the tissues of the internode. This phase of the Fungus was first described by Cooke (*Grevillea*, vol. XIX, p. 45) from a Queensland specimen as *Strumella Sacchari*.

Masee, regarding it as the conidial stage of a Sphaeriaceous Fungus, named it *Trichosphaeria Sacchari* (*Ann. of Bot.*, vol.

VII, p. 516). The technical diagnosis is given in the Kew Bulletin, 1894, p. 84. Prillieux and Delacroix (l. c., p. 80) identified it with *Coniothyrium melasporum*, Sacc., which is founded upon a specimen from Porto Rico (not Australia), named in manuscript by Berkeley *Darluca melaspora* and described by Cooke. According to Masee (Kew Bulletin, 1895, p. 86), Berkeley's type specimen is a *Diplodia*, and the identification of Prillieux and Delacroix therefore falls to the ground.

All analogy would lead to the conclusion that the life-history of the Rind Fungus comprises more than one reproductive phase. And this proves to be the case. Masee has described the formation of *macroconidia* 'in the interior of a cane, when the tissue is disorganized,' and of *microconidia* on a wounded surface exposed to the air. Both these were obtained in a flask-culture inoculated with *Melanconium-stylospores*, the *microconidia* being borne on conidiophores growing into the air, the *macroconidia* being immersed. (Ann. Bot., vol. VII, p. 518.)

Prillieux and Delacroix (l. c., pp. 81, 82) confirm Masee's descriptions of the macro- and microconidia. And generally 'à part quelques points de détail, sans grande importance pratique, ils confirment l'opinion de M. Masee' (l. c., p. 75).

They add still another reproductive stage, that of chlamydo-spores (l. c., p. 81). These have also been observed by Howard.

Went has criticized Masee's results (Ann. of Bot., vol. X, pp. 583-600). His paper was written in Java, where the *Trichosphaeria*, if it exists at all, is 'only to be found on dead canes' (l. c., p. 595). But as Professor Harrison points out (British Guiana Daily Chronicle, Jan. 15, 1897), the work of the Java experts 'appeared to be done chiefly with the white and purple transparent varieties which were relatively immune to some of the diseases affecting the Bourbon,' and Went apparently had not seen the research of Prillieux and Delacroix.

Went thinks that Masee's macro- and microconidia belong to *Thielaviopsis ethacetica*, which produces the 'Pine-apple

Disease.' It is to be noticed that this is not, as might be supposed, a disease of pine-apples, but a disease of the sugar-cane accompanied by a pine-apple odour. He has overlooked the fact that Massee had already called attention to its probable identity with *Trichosphaeria* (Kew Bulletin, 1894, p. 84). Prillieux and Delacroix had done this the following year (l. c., p. 82).

Massee obtained macro- and microconidia in a flask-culture inoculated with stylospores. Went suggests: 'The most probable explanation of this would have been that these macro- and microconidia were an impurity having by chance entered into the flask' (l. c., 594). This seems a purely hypothetical supposition. The experiment has been frequently repeated at Kew with the same result. On the other hand, Went in Java and Howard in Barbados have failed to obtain macro- and microconidia from flask-cultures of stylospores. This, however, does not prove more than that tropical conditions may be unfavourable to their production by this method. Howard, on the other hand, obtained them without difficulty when he inoculated the interior of healthy canes with stylospores, and Prillieux and Delacroix appear to have been equally successful (l. c., p. 81).

It is to be observed that while the stylospores are produced on the external surface of the cane, the macroconidia are only produced in the interior. It is not easy to see how a flask-culture of the former could be accidentally infected with the latter, as suggested by Went.

In any case there can be little doubt that the macro- and microconidia met with in Barbados are actually identical with *Thielaviopsis* (Went, l. c., p. 593). And as Went sought for 'other organs of reproduction' (p. 591), it may be inferred that he regarded this only as a form-genus. A comparison of the figure in Krüger's 'Das Zuckerrohr,' p. 415, of the effect of *Thielaviopsis* on the interior of a sugar-cane with that given by Massee (Ann. of Bot., VII, t. 28, f. 6), showing the growth of the macroconidia of *Trichosphaeria*, will leave little doubt as to their identity.

It may be remarked that Went has ignored the striking resemblance indicated by Masee (l. c., 524) between the macro- and microconidia and their mode of production in *Thielaviopsis* and in *Ceratocystis fimbriata*, Ellis and Halsted (Journ. of Myc., vol. VII, pp. 1-11), which produces the 'Sweet Potato Black Rot.' It is interesting to observe that this has also a pycnidial form, and that as in *Trichosphaeria* the stylospores are extruded in an agglutinated mass.

Ellis and Everhart have briefly described (Journ. Inst. Jam., vol. I, 1892, p. 159) a sugar-cane Fungus under the name of *Trullula Sacchari*. This has been definitely ascertained at Kew to be identical with *Trichosphaeria*. As the diagnosis mentions the 'erumpent' stylospores and the 'catenulate' conidia, it is evident that these authors observed the macroconidia.

According to Went (l. c., p. 595), the *Melanconium* in Java 'is only a saprophyte, and not a wound-parasite, as the form in the West Indies seems to be.' The latter conclusion is, however, abundantly established not merely by the Kew experiments but by Prillieux and Delacroix in Paris (l. c., p. 81) and Howard in Barbados.

It is to be observed that the *Melanconium*-stage of *Trichosphaeria* seems altogether unknown in Java. Its sugar-planters are much to be congratulated. Krüger, who gives (op. cit.) a very full account of all the diseases of the sugar-cane known in Java, indicates nothing in the least resembling the 'Rind Fungus' of the West Indies. What is quite certain is that Went's '*Melanconium (Sacchari?)*' has nothing to do with it. Fig. 31 in the Annals (l. c.) would rather suggest that it may be a stage of some Basidiomycetous Fungus. The fourth section of Went's paper (l. c., pp. 595-598) is wholly irrelevant, because it is clear that he has identified under the name of *Melanconium Sacchari* two perfectly distinct things. His experimental results were made with a Javanese Fungus which has nothing to do with *Trichosphaeria*. His results have therefore no bearing on its life-history. He concludes by observing: 'I regret that I am not able to experiment with

*Melanconium* from the West Indies, because I do not wish to introduce this Fungus in the living state into Java (l. c., p. 598).

From a practical point of view the only reproductive form of *Trichosphaeria* of importance is the *Melanconium*-stage producing stylospores. These appear to be ubiquitous in the cane-fields of some of the West Indian Islands, and no attempt seems to be made to destroy canes infested with them. In Antigua Barber says (Kew Bulletin, 1894, p. 176), 'the whole atmosphere is saturated with the spores.' The other reproductive forms of the Fungus appear to be of secondary, at any rate merely of scientific interest. As Masee has pointed out (Kew Bulletin, 1894, p. 83): 'The *Melanconium*-stage can reproduce itself continuously, without the intervention of any other form.' It is 'the conidial form destined for the rapid reproduction and dissemination of the species. . . . The disease is caused by this phase of the Fungus.' The fact is in no way remarkable. In Australia rust in wheat is propagated entirely by the reproduction of uredospores: the æcidial stage is unknown. The 'Leaf Disease' in Ceylon was continued and the cultivation of coffee practically exterminated by the continual reproduction of the uredospores of *Hemileia*.

#### ROOT DISEASE.

About the same time as the 'Rind Disease' a second malady of the sugar-cane, the 'Root Disease,' also attracted attention in Barbados. The following account is taken from the Kew Bulletin (1895, p. 83): 'The canes appear to receive a check in their growth; the plant dwindles down, fresh basal shoots are formed to supply the place of the dying ones, but notwithstanding this it is ultimately found that growth has been arrested and no cane formed: and if the plant be dug up the roots are nearly all dead; and those that are still living are dotted over by little red spots.'

The resemblance of the disease above described to the

'Sereh' of Java has been generally noticed (Kew Bulletin, 1895, p. 83). Went (l. c., p. 588) says it 'looks very much like the "Sereh" in Java.'

It is again to be noticed that 'it was only the Bourbon cane affected. The Caledonian Queen and Transparent are healthy and vigorous.' (Kew Bulletin, 1893, p. 346.)

Diseased stools of sugar-cane were sent to Kew from Barbados for examination. Massee reported that this 'demonstrates conclusively that the disease is due to a parasite fungus known as *Colletotrichum falcatum*, Went' (Kew Bulletin, 1893, p. 347). Went thinks this 'extremely improbable' (l. c., p. 588). He further says that Massee 'gives no evidence for his opinion.' It appears to me, on the contrary, that the description of the Barbados Fungus given by Massee exactly tallies with Went's own description. I do not see what other evidence could be required. And Went (l. c., p. 588) admits having 'received the Fungus from the West Indies.' I may now quote some remarks of my own in the Kew Bulletin (1894, p. 176): 'It is evident that canes infected with "rind fungus" are used for propagation. It further appears that when this was the case the resulting plants are attacked by root disease. This fact points to the conclusion that the root disease and the rind disease are really due to one and the same organism, and that the *Colletotrichum* is only another phase of the polymorphic *Trichosphaeria*. This was indeed suggested by Mr. C. A. Barber, the Superintendent of Agriculture in the Leeward Islands, in a private letter, December 1, 1893, as the result of his observations. But the evidence was not deemed at the time conclusive. The possible identity of the two diseases is still a matter under investigation at Kew.' The Barbados Commission in their Report state: 'It has been finally decided at Kew that *Colletotrichum falcatum*, Went, is simply one phase in the life-history of *Trichosphaeria Sacchari*.' (Kew Bulletin, 1895, p. 83.) This statement was based on information furnished to the Barbados Government but not published. A healthy seedling sugar-cane was inoculated with the spores of *Colletotrichum falcatum*, and at

the end of twenty days developed the *Melanconium*-stage of *Trichosphaeria*. This and the result of other experiments is still open to independent confirmation. But the practical result was of considerable importance. The sugar-cane is propagated by planting 'tops.' It cannot be doubted that these were often infested with the mycelium of the 'rind fungus.' Under these circumstances they failed to develop a healthy cane but, as is believed, exhibited the symptoms of 'root disease.' According to Masee's view (Kew Bulletin, 1894, p. 177): 'The new canes and their rootlets are attacked by the *Colletotrichum*, which, from the evidence at hand, appears to be nothing more than a condition of the *Trichosphaeria*, modified by being more or less buried in the ground.'

Using this as a working theory, the advice was given to take great precautions to avoid planting 'tops' which were possibly infected by rind disease. When followed, the result was 'a marked improvement.' (Kew Bulletin, 1895, p. 88.)

Went (l. c., p. 581) gives the disease produced by *Colletotrichum falcatum*, the name 'Red Smut,' apparently having regard to the red discolouration exhibited by the interior of the affected canes. But the development of a red colour, especially in the neighbourhood of the fibro-vascular bundles, is probably not characteristic of the *Colletotrichum* but may be found in any diseased cane, whatever the cause of the disease.



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