THE POTATO DISEASE[1]

II.

THE Peronosporeæ are usually divided into two genera, viz.—Cystopus and Peronospora: with the former the potato disease has no connection.

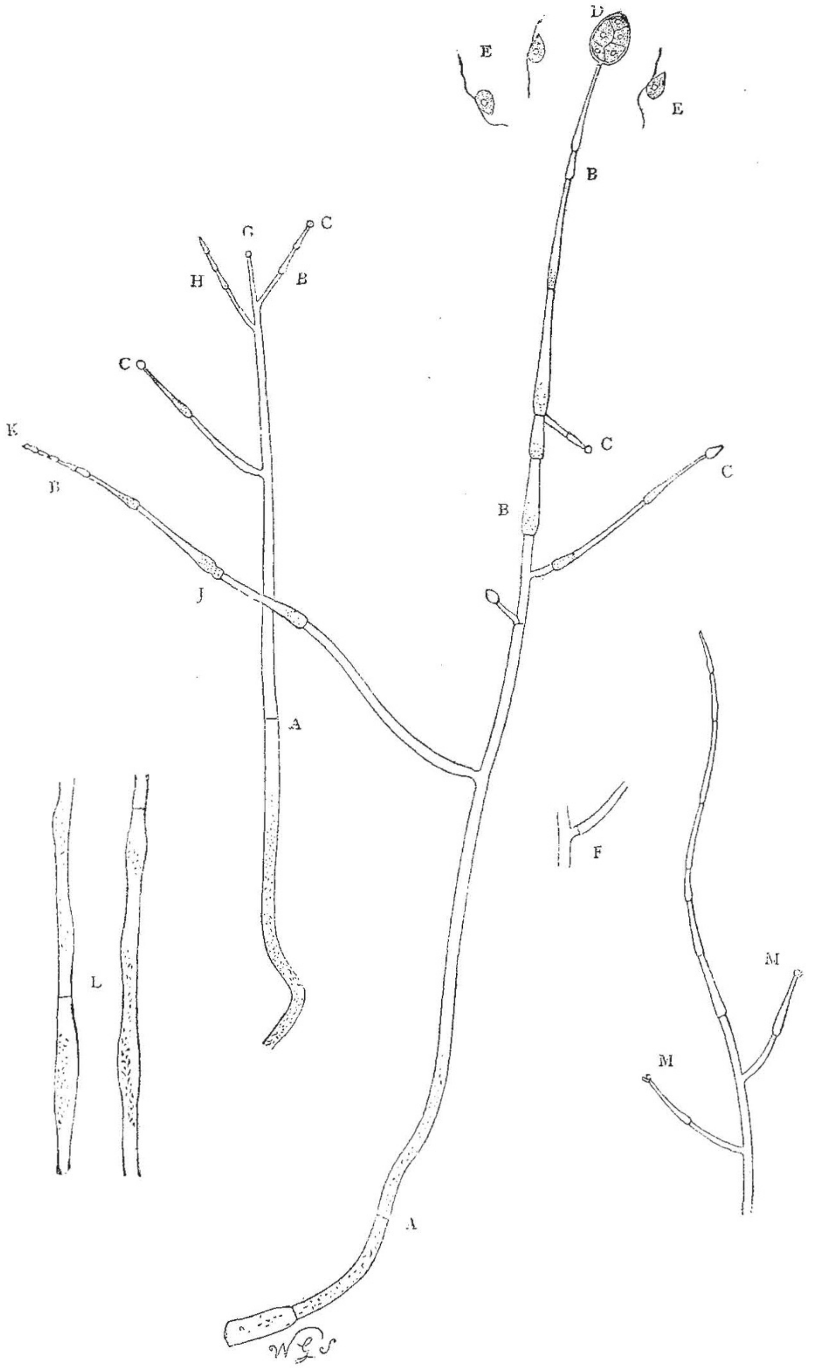

FIG. 7.—*Peronospora infestans*, Mont., × 250 dia. From De Bary's slide, No. III. A, A, septate conidiophores; B, B, vesicular swellings; C, C, immature conidia; D, conidium, showing differentiation of its contents; E, E, free zoospores; F, frequent mode of attachment of branch.

II.—PERONOSPORA, *Corda*.

The fungus of the potato disease was first placed under the genus Botrytis Mich., but Corda established Peronospora to receive the species with non-septate threads. Unfortunately for the genus, and for *P. infestans* in particular, the threads of the latter are always more or less septate, and this character effectually separates the potato-fungus from the *Saprolegnieæ* (as at present defined) where septa are unknown. De Bary now proposes the establishment of another new genus (under the name of Phytophthora) to receive the potato-fungus, the chief character of the proposed new genus resting on the development of, not one, but several spores (conidia) successively at the end of each branch of the aerial threads of the fungus (conidiophores). This character has been known to fungologists since the potato-fungus was first described, although it has generally been esteemed of specific rather than of generic value. The Rev. M. J. Berkeley in illustrating the potato-fungus for the Royal Horticultural Society, figures the conidia as being pushed off the branches (Pl. 13. Fig. 12*, 14). The same phenomenon is illustrated in the Micrographic Dictionary (Pl. 20, Fig. 6). I have also recorded the habit in the secondary condition of the fungus where the oogonia are successively pushed off the supporting threads.

As so much attention has of late been directed towards the Peronosporeæ it is more than ever necessary that the characters of the family should be correctly known, and this is especially important as regards the nature of the secondary state of these fungi: a brief statement of the sexual condition may therefore be useful. The female cells (oogonia) are borne sometimes on the tips of mycelial threads, sometimes as sessile bodies on different parts of the threads and sometimes intercalated within the threads themselves, after the manner of the illustrations on Figs. 1, 3, and 4. The male organs (antheridia) are usually smaller and carried on finer threads, not as a rule anatomatically distinct from the oogonium-bearing threads. The contact of the antheridium with the oogonium, gives rise to the oospore or resting-spore.

Peronospora infestans, Mont., in its aerial state has been so often and so accurately described by Berkeley, De Bary, and others, that any further illustration or description is almost unnecessary. It must be confessed, however, that the figures first published by Messrs. Berkeley and Broome (in connection with Dr. Montagne) and latterly by De Bary, have only too many times been copied and recopied without reference to the fungus itself. There is therefore no apology required for publishing the present illustration (Fig. 7) which is new, and I trust exact. It is a camera lucida reproduction enlarged 250 diameters of a group of conidiophores as supplied by Prof. A. De Bary

[1] Continued from vol. xiii., p. 527.

to the Royal Agricultural Society, on their Slide No. III. (The three free zoospores are from a drawing by De Bary.) The septate aerial branches of the fungus, named conidiophores are seen at A A. The characteristic vesicular swellings peculiar to the potato-fungus at B B. Immature conidia at C C, and mature conidia at D, the latter showing the contents differentiating into zoospores. The zoospores are shown free at E E. The mycelium and conidiophores of *Peronospora infestans* are generally furnished with septa (A A) but this character is liable to great variation. The conidia are at first terminal (G) with no swelling on the thread below, but as the threads grow they push off the old conidia and continue to produce new ones on each newly formed apex. De Bary explains this phenomenon by saying, "When the first conidium is ripe, it is pushed to the side by an unequal swelling of the point to which it is attached. The top of this swollen portion then begins to grow in the original direction of the branch into a new conical point; and when this has reached a length equal to that of a conidium, or a conidium and a half, a new conidium is produced at the apex." I take this to be only partially correct, for the more reasonable explanation of the vesicular swellings on the threads is that the thread is constantly making an effort to produce new conidia, and each swelling is really an *abortive conidium*: each of these pieces will grow in water if free, as will the immature dust-like conidia (C C) the latter are being pushed off at M M. On looking at point B, it will be seen that the swellings there illustrated have never produced terminal conidia at all, but that each successive swelling is in itself an *attempt* to become one. Instead of these bodies *when terminal* growing to the length of "a conidium or a conidium and a half" they commonly remain the mere fourth or sixth part of a conidium in length, and often less, and never produce conidia. At J will be seen a double swelling: the first effort of the thread fell short, and the attempt to produce the conidium was renewed: such double swellings are common; a terminal one occurs at K. Vesicular swellings occur on all parts of the conidiophore; they are frequent at the base, commonly irregular as at L and always (to me) represent an attempt at fruit production.

It may just be well to remark that the suggestion as to the possibility of the oospores of *P. infestans* being ultimately found on some plant different from *Solanum tuberosum* is very old, and that Mr. Berkeley has recently found the potato-fungus growing upon the garden Petunia, this plant, we believe, has not been given in any previous list, and its importance must not be overlooked, for the Petunias come from the native country of the potato, one garden species even coming from Chili.

Prof. De Bary is not right in his surmise that he was "perhaps" the first to call attention to the perennial mycelium of the potato-fungus in 1863; Mr. Berkeley did this in 1846 and the fact has been confirmed by many observers since. The subject is thoroughly old and is discussed in our popular books; for instance—see vol. xiv. of the "International Series" Fungi (p. 156), where Dr. M. C. Cooke says, "The Peronospora of the potato is thus perennial by means of its mycelium." Most fungi depends for their existence upon "perennial mycelium." The "spawn" of the common mushroom is a good and well known example. A mycelium may however be perennial and yet produce oospores.

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THE OCCULTATION OF SATURN, AUGUST 7, A.M.—Perhaps some observers who are provided with good telescopes may be induced to look for the occultation of the planet Saturn, on the morning of August 7, although (in the south of England) the immersion does not take place until half an hour after sunrise, and at emersion Saturn is only some five degrees above the south-western horizon.

Reference is made to the phenomenon here with the view to illustrate the use of the method of distributing predictions over a given geographical area, explained by Mr. W. S. B. Woolhouse in the *Companion to the Almanac* for 1871, as applicable to the phases of a solar eclipse, to the approximate prediction of the times of immersion and emersion of a star or planet in a lunar occultation, and the angles on the moon's limb at which they occur, at any place within the given area or very near to it. It is founded upon the assumption that the value to be determined is a linear algebraic function of the latitude and longitude of the place, for which the calculation is to be made. On this assumption the time (t), of any phase, &c., may be expressed thus:—

$$t = c + p.\ L + q.\ M.$$

where c, p, and q are three constants to be found.

If now direct calculations of the particulars of any phenomenon be made for three places moderately distant as Greenwich, Dublin, and Edinburgh, the constants will be determined by the substitution of the results, which supply the three equations of condition necessary. If the difference Greenwich—Dublin be called h, and Greenwich—Edinburgh k, then, as calculated by Mr. Woolhouse:—

$$p = 0{\cdot}1425\,h - 0{\cdot}2840\,k$$
$$q = 0{\cdot}05014\,h - 0{\cdot}02137\,k$$
$$c = G - 1{\cdot}4772\,k.$$

G being the result of the computation for Greenwich.
Also L is latitude — 50°, expressed in degrees and decimals.
And M is longitude from Greenwich, + if east, − if west, in minutes of *time* and decimals.

Applying this method to the occultation of Saturn we have, by direct computation for Greenwich, Dublin, and Edinburgh (astronomical times at Greenwich, Aug. 6):—

	Immersion.	Emersion.	Angle N.Pt. Immersion.	Angle N.Pt. Emersion.
	h. m.	h. m.	°	°
Greenwich ...	17 7·53 ...	18 3·10 ...	94·6 ...	331,1
Dublin ...	17 0·25 ...	18 2·35 ...	107·6 ...	319,0
Edinburgh ...	17 0·25 ...	18 2·38 ...	111·2 ...	313,8

The necessary data being taken from the *Nautical Almanac*, and the angles expressed as usual in that work.

Thus we find for Greenwich time of immersion and emersion at any place in this country, and for the angles on the moon's limb from north point:—

		h. m.
Immersion ...	Aug. 6	17 9·05 − 1·03 L + 0·21 M.
Emersion ...	,,	18 3·24 − 0·10 L + 0·02 M.
		°
Angle Imm.		90·3 + 2·9 L − 0·3 M.
Angle Em.		336·3 − 3·5 L + 0·2 M.

The differences between the results of these equations and direct calculations for Exeter and Liverpool are:—

	Exeter.	Liverpool.
	m.	m.
Immersion	− 0·2	+ 0·2
Emersion	+ 0·1	− 0·3
	°	°
Angle Imm.	+ 0·3	− 0·2
Angle Em.	+ 0·1	+ 0·1

In this manner have been derived the following particulars, as regards the occultation in question, which will illustrate the applicability of Mr. Woolhouse's method to such phenomena:—

	G.M.T. of Immersion.	G.M.T. of Emersion.	Angles from N. point. Imm.	Em.
	h. m.	h. m.	°	°
Aberdeen ...	16 59·9 ...	18 2·4 ...	113 ...	310
Cambridge ...	17 6·9 ...	18 3·0 ...	90 ...	329
Exeter	17 5·6 ...	18 2·7 ...	96 ...	331
Glasgow ...	16 59·4 ...	18 2·3 ...	112 ...	312
Liverpool ...	17 2·8 ...	18 3·0 ...	104 ...	322
Manchester ...	17 3·6 ...	18 2·7 ...	103 ...	322
Nottingham ...	17 5·9 ...	18 2·9 ...	99 ...	326
Oxford	17 6·1 ...	18 3 0 ...	97 ...	329
Portsmouth ...	17 7·3 ...	18 3·1 ...	94 ...	332
York	17 4·9 ...	18 2·8 ...	102 ...	322