Warty Disease of Potato.

BY

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With Plate XXIII.

The recognition of this disease is of comparatively recent date. It was first described by Schilbersky[1]. The infected tubers were sent to him from Upper Hungary. A few years later, Professor Potter[2] discovered the same disease in England, an outbreak having occurred in Cheshire. Dr. R. Stewart Macdougall[3] has also recorded the occurrence of the disease in the same county. The Board of Agriculture has also issued a leaflet dealing with it. Further, several articles have appeared in the "Gardeners' Chronicle." In one of these, Dr. M. C. Cook[4] mentions the disease as occurring in Cheshire, North Wales, and other localities, and according to information which I have recently received from Professor Potter, the disease is not unknown in the South of Scotland. The disease, therefore, is spreading, and it has undoubtedly reached the Midlands of Scotland, the illustrations accompanying this article being all taken from material sent from Stirlingshire. The disease is clearly rapidly spreading, and although it is not yet known to be doing an alarming amount of damage, still its continued increase is sufficiently ominous, and potato growers would do well to take warning in time and to exercise strict supervision of their crops.

Attention was drawn to the outbreak in Scotland, to which I am about to refer, by Mr. Robert Forbes, Overseer of Kennet Estate, Alloa, who sent the diseased material to the Royal Botanic Garden along with the following description of its occurrence :—

[Notes, R.B.G., Edin., No. XVIII., August 1907.]

"The diseased potatoes were grown in 1906, on a piece of large "garden ground at Kennet Village, the property of Lord Balfour "of Burleigh, in the County of Clackmannan, the area of the "ground being about 24 poles in extent. The kinds of potatoes "grown were British Queen, Up-to-Dates, Scottish Triumph, "Herd Laddie, and Princess May Kidney. The whole crop was "damaged to the extent that they could not be used. They were "quite useless, the early varieties being, if anything, worse than "the late—especially the early Kidneys. The disease was first "noticed when the new potatoes began to form. It first appeared "on the stems as a greenish-looking canker, which attacked the "tubers as they grew and soon made them into a mass of "corruption. The ground on which the diseased potatoes grew "is the ordinary black garden soil about 15 inches deep, resting on "clayey till. The surface soil seems to be a good deal mixed "with furnace ashes, and does not appear to be very pure black "soil. The same ground was planted with potatoes in 1905, and "there was no disease then, or at least, if there was, it had been "so slight that it had not been taken notice of. It is said that "the disease was noticed in a few of the neighbouring gardens "in 1906, but if it did exist it was only very slightly. The "dwelling-house in connection with this piece of ground was "partly rebuilt in 1905–06, and some of the lime rubbish from "the building was spread on part of this ground. The part on "which the rubbish was put was the worst part with the "disease."

Examination of the tuber showed that sometimes only a few localised warty excrescences, or again the whole potato, was converted into a coral-like mass. Figs. 12 to 18 show the general appearance of the malady. The excrescences are the result of the irritation caused by a parasitic fungus which inhabits the parenchyma-cells near the surface.

On examining the tissues microscopically, numerous resting spores were to be seen in the infested parts. They occurred most abundantly in the outer layers—see Fig. 8, which is a photo-micrograph of a median longitudinal section, also Fig. 11, which is a small portion photographed under a higher magnification while Figs. 7 and 10 are low and high-power photomicrographs of surface sections. In this condition of spores the fungus passes

the winter, and experiment[5] has proved that they are able to propagate the disease from year to year.

The extent of damage done varies. Fig. 3 shows the diseased tubers in various stages of attack. On the upper offset to the left, the oldest or first-formed tubers have been totally destroyed. It is interesting to note, as may be seen in this figure and also in Fig. 6, that the deeper-lying tubers have escaped, which would suggest that the fungus confines itself to the upper layers of soil.

Tubers which have been badly attacked rot away in the ground or dry and shrivel up when kept. Figs. 1 and 2 are photographs of specimens which had lain in a box for a few weeks.

On the tubers themselves the first symptoms of attack appear at the "eyes," where warty excrescences of various sizes may be seen (see Fig. 18). As regards the nature of these excrescences, Professor Potter says :—"Judging from some sections in an early "stage, the attack appears to commence at the 'eyes,' the parasite "easily gaining an entrance into the outer cells of the young and "tender structures which normally would develop into leaves. In "these the cells are readily stimulated to divide, and, as a result of "the injury caused by the parasitic invasion, irregular cell-division "is set up. The destruction of any one cell causes those in "contact with it to divide in the attempt to heal the wound; "when these latter cells are attacked in their turn, a further cell-"division is induced, and by a repetition of the process the leaf-"protuberances become converted into an irregular cell-mass "which in the initial stages may be seen as finger-like out-"growths. From these points the irritation spreads along the "cork-cambium, so that the cells over a large portion of the "surface of the potato gradually undergo this irregular division "and multiplication, which is extended also into the internal "tissues."

I entirely agree with the statements of the author just quoted, and in support of the view of the foliar origin of these protuberances I may point out that they are to be found in the foliage leaves themselves—a fact which, so far as I know, has not been recorded previously. In Fig. 4 one or two groups of excrescences may be seen on the separate lobes which on close examination appeared as branches from the leaf. The nature of these branches is shown in Fig. 5; and Fig. 9, which is also a photo-

micrograph of one of these swellings, shows the presence of the resting sporangia of the fungus to the left. Again, in Fig. 3, where the haulm forks at the surface of the soil, malformed and warty leaves are quite evident. The same thing may also be seen at the apex of the stolon to the left of the same figure.

The parasite, it would seem, is able to obtain a lodgement in others parts of the plant than the tubers, and as the resting sporangia found in all these tissues are capable of propagating the disease, this would suggest the destruction of the whole plant by burning as a preventive to the further spread and infection. Diseased tubers should upon no account be used as "seed," because the sporangia contained in the infected tubers are as much the "seed" of the parasite as the tuber is the "seed" of the host, and such material will as surely reproduce the fungus as the potato plant.

The appearance of this disease in Scotland is as unfortunate as it is unwelcome, and no doubt new centres of infection will be reported from time to time as the disease spreads and becomes better known. Preventive measures, to be effective, must be adopted by all growers of potatoes; individual or isolated action although productive of some good, may be of no avail in a case of this kind, nor in the case of any other threatened epidemic. Infectious diseases among animals must be reported in order that prompt action may be taken in isolating and stamping out the malady before it has had time to spread, and no one will question the foresight and wisdom which lead to such regulations; but in regard to plants it is to be regretted that there is as yet no properly organised system of dealing with an outbreak or a threatened outbreak of diseases, although the loss occasioned in their case may be as serious as that caused in animals. The health of the potato crop in Scotland is of extreme importance not only to the country itself, but to other countries to which "seed" potatoes are sent; hence no effort should be spared in order to stamp out this new and recently introduced enemy to such an important food crop.

LITERATURE.

1. K. SCHILBERSKY. Ein neuer Schrofparasit der Kartoffel-knollen, in Berichte der Deutsch. Bot. Gesellsch., XIV (1896).
2. M. C. POTTER. A new potato disease (*Chrysophlyctis endobiotica*, Schilb.), in Journal of the Board of Agriculture, IX, p. 320.
3. R. S. MACDOUGALL. New fungus disease of potatoes (*Chrysophlyctis endobiotica*, Schilb.), in Trans. Highland and Agric. Soc. of Scotland, 1903.
4. M. C. COOK in Gardeners' Chronicle, 3rd Series, XXXIII (1903), p. 187.

DESCRIPTION OF FIGURES IN PLATE XXIII.

Illustrating Dr. Borthwick's paper on "Warty Disease of Potato."

FIGS. 1–2. Diseased tubers shrivelled and dried up.
FIG. 3. Haulm and offset with diseased leaves and tubers.
FIG. 4. Portion of foliage leaf with excrescences caused by the parasite.
FIG. 5. Leaf in transverse section at an excrescence.
FIG. 6. Diseased tubers preserved in weak alcohol as contrast to Figs. 1 and 2.
FIG. 7. Diseased tuber in surface section showing numerous sporangia.
FIG. 8. Papilla with sporangia aggregated in the surface layers in median longitudinal section.
FIG. 9. Attacked foliage leaf in section, with fungus-sporangia to the left.
FIG. 10. Portion of Fig. 7 more highly magnified.
FIG. 11. Portion of Fig. 8 more highly magnified.
FIGS. 12–18. Tubers in various stages of attack.

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BORTHWICK – CHRYSOPHLYCTIS ENDOBIOTICA, SCHILBERSKY.