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ROTHAMSTED RESEARCH

# Report for 1931

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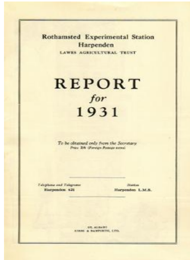
Rothamsted Experimental Station
Harpenden

REPORT
for
1931

# Virus Diseases

## Rothamsted Research

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more fertile plots. There was no evidence of seasonal fluctuations in numbers, such as have been recorded for bacteria and for protozoa. Barnfield (continuous mangolds, the leaves always ploughed in) contained more fungi but less actinomycetes than Broadbalk (continuous wheat) ; there was also some difference in the proportions of the fungal population. Barnfield contained more *Penicillia* and *Dematia* but less *Fusaria* and *Verticillia* than Broadbalk.

## VIRUS DISEASES OF PLANTS

This work is carried out by J. Henderson Smith, with the assistance of J. Caldwell, M. A. Hamilton and F. M. L. Sheffield. It falls into three sections :

1. *The Nature of Virus.* Juices extracted from diseased plants are usually themselves infective and remain so after passage through most porcelain filters. By using graded collodion membranes it has been found possible to determine a limiting porosity (varying with different viruses), above which the filtrate remains infective but below which the virus is held back and the filtrate does not cause disease. Again, when infective material is rubbed on the leaves of certain plants, virus enters through the broken hairs and produces a local lesion at the point of entry. If the material is suitably diluted before rubbing on the leaves, infection occurs in only a few of the many broken hairs and only a few local lesions result. Such experiments show that in infective material virus exists in a particulate state and not generally diffused. The size of these particles has been estimated approximately ; but it is still uncertain whether the virus is itself particulate or merely attached to other particles. Work is in progress to determine which is the true explanation. Nothing has yet been found incompatible with the view that virus is a living organism.

It is frequently asserted that viruses are invisible stages in the life-cycle of visible bacteria, largely because there is a regular association of specific bacteria with certain virus diseases. We have investigated one such case, and find that when the plants are grown aseptically throughout from sterile seed, inoculation with bacterium-free virus produces the typical disease, and the bacteria usually associated with it do not appear. It is also said that intracellular inclusions which are characteristic of virus disease are either colonies of the virus or visible stages of a usually invisible parasite. The development of such inclusions has been watched in individual living cells from their first beginnings to their complete formation, and in the cases investigated they are essentially aggregates, made up by the coalescence of small particles of cytoplasm which has been locally coagulated or precipitated under the influence of the virus.

A cinematograph film has been prepared showing the whole process. The final form of the inclusion varies with the host plant and with the virus.

2. *The behaviour of Virus in, and its effects on, the host plant.* Within the infected plant the virus does not travel in the transpiration or water stream, nor, indeed, does it normally enter the stream. If deliberately introduced into the xylem vessels, it cannot normally escape ; it therefore does not produce the disease, unless and until

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it is artificially liberated. In none of the experiments devised to test the point did virus enter an unbroken cell. Large quantities of virulent juice can be injected into the leaf of a plant through the stomata, but symptoms will not develop unless some of the cells are ruptured. The development of virus in the leaves of an infected plant is followed by considerable alteration in the enzyme content. The mechanism of respiration is also greatly affected. This is being investigated in detail, and the work is still incomplete, but it seems clear that one of the first effects of the entry of virus into the cell is a greatly enhanced respiration rate and a state of general excitation.

3. *The relation of Virus to Insect-vectors.* By the development of a technique for maintaining insects upon solutions apart from the plant, considerable control has been obtained over the conditions determining the infection of the insect. Data have been obtained as to the time required for dyes and other substances taken in by the alimentary canal to reach the salivary glands, information which is necessary for the correct evaluation of the incubation or non-infective period after the insect has fed upon diseased material. By use of this technique it has become possible to investigate such problems as the filterability of viruses which are not transmissible by juice, e.g. leaf-roll of potatoes, and to approach the question why one insect carries and another does not.

A new virus disease has been discovered in *Hyoscyamus*, which is readily transmitted both by needle and by aphis, and has an incubation period in the insect. At the same time, at least two other unrecorded virus diseases were distinguished in commercial crops of this plant. These may prove to be due to viruses already better known in other crops, e.g. potato; and there is reason to believe that one at least of these new diseases is a composite disease caused by the simultaneous action of two different viruses.

## BACTERIAL DISEASES OF PLANTS

The angular leaf-spot or " black-arm " disease of cotton is being investigated by R. H. Stoughton in considerable detail, because of its importance in many of the tropical cotton-growing countries of the Empire. The results have proved to be unusually interesting.

The responsible organism, *Bacterium malvacearum*, is of great bacteriological interest, as it possesses a nucleus and forms accessary reproductive bodies never previously described in this group of bacteria. It appears also to pass through a conjugation stage in which two cells join together to form a fusion-body or zygospore, of possibly different potentialities. It also " dissociates " or breaks down into a number of strains, quite unlike in pure culture and having different degrees of virulence. Strongly virulent strains may give rise to almost non-virulent ones, and these again revert to the culturally-unlike virulent form. The possible relation of this production of variants to the life history is now being studied.

The geographical and climatic distribution of the disease indicate that meteorological factors play a large part in determining its severity. Careful study has therefore been made of the separate effects of air temperature, soil temperature and air humidity.

Cotton plants were grown in special chambers in which these three factors are controlled automatically over a wide range so that

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