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## Rothamsted Report for 1938

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### The Plant in Disease : Control of Disease

#### Rothamsted Research

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MICROBIOLOGY

(Departments of Fermentation and General Microbiology)

- xxxv. E. H. RICHARDS. "Note on the Effect of Temperature on a Mixed Culture of Two Organisms in Symbiotic Relation." *Journal of Agricultural Science*, 1939, Vol. XXIX, pp. 302-305.

A study was made of nitrogen-fixation by *Azotobacter chroococcum* alone in a medium containing dextrose (which it can utilize) and in mixture with a coliform organism on a medium containing no carbohydrate except starch, which *Azotobacter* cannot utilize unless it be hydrolysed by the coliform organism or some other agency.

The amount of nitrogen fixed in the mixed cultures was found to be maximal at two temperatures, and a discussion is given of the causes thought to be operative in producing the double maximum.

- xxxvi. A. DIXON. "The Protozoa of some East Greenland Soils." *Journal of Animal Ecology*, 1939, Vol. VIII, pp. 162-167.

Soil samples from Kangerdlugssuak in East Greenland were examined. A large protozoan population was present even in those which were frozen for nine months of the year, the greatest number of species being found in the soils producing the richest vegetation. The testaceous Rhizopods in these soils were unusually numerous in some of the non-peaty samples.

THE PLANT IN DISEASE: CONTROL OF DISEASE

(Departments of Entomology, Insecticides and Fungicides,  
and Plant Pathology)

(a) INSECTS AND THEIR CONTROL

- xxxvii. C. B. WILLIAMS. "The Migration of Butterflies in India." *Journal of the Bombay Natural History Society*, 1938, Vol. XL, pp. 439-457.

This account of the known migrations of butterflies of India was written at the request of the Bombay Natural History Society to stimulate interest in the subject in India. About eighty records relating to 52 species are discussed and tabulated. A map shows the localities where flights have been seen. The species migrating on the slopes of the Himalayas in North India are different from those migrating further south on the plains. The species migrating in South India are, however, very similar to those in Ceylon. There is some evidence of the flight seasons being related to the seasonal temperature changes in the north, and to the monsoon changes in the south.

- xxxviii. C. B. WILLIAMS. "Recent Progress in the Study of Some North American Migrant Butterflies." *Annals of the Entomological Society of America*, 1938, Vol. XXXI, pp. 211-239.

This is a summary and discussion of a number of new records of migration of butterflies in North America and particularly of the Monarch (*Danaus plexippus*), the Painted Lady (*Vanessa cardui*), and the Migratory Sulphur (*Phoebis eubule*). In the former southward autumn flights are found in the Eastern States down to Florida and in the Central Plains from the Great Lakes down to Texas. In the mountain areas there are no flights, but they are again found on the Pacific coast. In the Painted Lady invasions occur in the spring from the south apparently only from the arid portions of Western Mexico. Great immigrations occurred in 1924, 1926, 1931 and 1935 but none in the intervening years. For *Phoebis eubule* there is given a remarkable series of observations by Mr. P. Smyth lasting over eighteen consecutive years. Other species are also discussed.

- xxxix. K. J. FISHER (K. J. GRANT). "Migrations of the Silver-Y Moth (*Plusia gamma*) in Great Britain." *Journal of Animal Ecology*, 1938, Vol. VII, pp. 230-247.

An account of immigrations of the Silver-Y moth from 1932-1936. The flights in the last of these years was on a very extended scale and considerable



damage was done by the larvae. The moth was seen as far north as the Shetland Islands. The first immigrants were seen on May 6th, but the main immigration was in June. The data are analysed and show considerable evidence to support a return flight to the south in the autumn. The wind has no apparent influence on the direction of flight.

- XL. D. C. THOMAS. "Report on the Hemiptera-Heteroptera taken in the Light Trap at Rothamsted Experimental Station, During the Four Years 1933-1936." Proceedings of the Royal Entomological Society of London, A, 1938. Vol. XIII, pp. 19-24.

Seventy-four species of Heteroptera were identified of which 57 were of the family Capsidae. This latter number is about one-third of the known British species of Capsidae. Several species captured were new to the district. The Capsidae were predominantly males, and the Corixidae chiefly females.

- XLI. B. LOVIBOND. "The Fever Fly *Dilophus febrilis* L." Journal of the Board of Greenkeeping Research, 1938, Vol. V, pp. 271-273.

Fever fly grubs are frequently found in clusters on golf greens and are often confused with leather jackets. The damage consists of thin patches round the nests and loosening of the soil. The life history has been thoroughly investigated by other workers and is quite straightforward, there being two generations in the year. Lead arsenate has given good control.

- XLII. B. LOVIBOND. "*Meloe proscarabaeus* L." Journal of the Board of Greenkeeping Research, 1939, Vol. VI, pp. 42-45.

Specimens of the oil beetle *Meloe proscarabaeus* L. were troublesome on a Lancashire golf course but did not cause any actual damage to the turf. It was found that they mated and laid eggs readily under laboratory conditions. An excellent hatch was obtained but as the triungulins could not be persuaded to feed, it was impossible to carry them on to the adult stage.

- XLIII. K. N. TREHAN. "Two New Species of Aleurodidae Found on Ferns in Greenhouses in Britain." Proceedings of the Royal Entomological Society of London, B, 1938 Vol. VII, pp. 182-189.

Two new Whiteflies were found on ferns in the Fernhouse at the Royal Botanic Gardens at Kew. They are described as *Aleuroplatus kewensis* and *Trialeurodes williamsi*.

- XLIV. A. C. EVANS. "Studies on the Distribution of Nitrogen in Insects." I. In the Castes of the Wasp, *Vespula germanica* (Fab.)." Proceedings of the Royal Entomological Society of London, A, 1938, Vol. XIII, pp. 25-29.

In the adult wasp most of the nitrogen is present in the cuticle and soluble protein fractions, in prepupae little is found in the cuticle, but over 60 per cent. is in the form of soluble protein. Just emerged wasps probably contain a reserve protein, insoluble in water, which is utilised to complete the hardening of the cuticle. The fat-body of queens preparing for hibernation weighs about 25 per cent. of the body-weight and contains about 1.3 per cent. of nitrogen.

- XLV. A. C. EVANS. "Studies on the Distribution of Nitrogen in Insects. II. A Note on the Estimation and Some Properties of Insect Cuticle." Proceedings of the Royal Entomological Society of London, A, 1938, Vol. XIII, pp. 107-110.

The cuticle of *Tenebrio molitor* L. contains about 60 per cent. protein which is soluble in dilute acids and alkalis. The hypothesis is put forward that part of the material absorbed from the cuticle at the last larval moult may eventually be utilised to form the major part of the adult cuticle.

- XLVI. A. C. EVANS. "Physiological Relationships between Insects and their Host Plants. I. The Effect of the Chemical Composition of the Plant on Reproduction and Production of Winged Forms in *Brevicoryne brassicae* L. (Aphididae)." Annals of Applied Biology, 1938, Vol. XXV, pp. 558-572.

Under late summer conditions of light the rate of reproduction of the aphid *Brevicoryne brassicae* is positively correlated with the nitrogen content



of the host plant and, in particular, with the protein content. The formation of winged forms is negatively correlated with the same factors.

- XLVII. W. R. S. LADELL. "Field Experiments on the Control of Wireworms." with an Appendix by W. G. Cochran. *Annals of Applied Biology*, 1938, Vol. XXV, pp. 341-389.

An account is given of three field experiments planned to show the effect of soil insecticides on wireworms. One was in the form of a 5 x 5 latin square; the other two 3 x 10 and 6 x 8 randomised blocks. The mean density of wireworms before control was 65, 335 and 277 per square yard respectively. Distribution was uneven and thus introduced high sampling errors. Several fumigants showed significant reductions in the population, one of the best being crude naphthalene.

- XLVIII. F. TATTERSFIELD and J. T. MARTIN. "The Problem of the Evaluation of Rotenone-containing Plants. IV. The Toxicity to *Aphis rumicis* of Certain Products Isolated from *Derris* Root," with an Appendix by W. G. COCHRAN. *Annals of Applied Biology*, 1938, Vol. XXV, pp. 411-429.

An account is given of the preparation and a few of the properties of a compound isolated from the extracts of Sumatra-type derris root.

This compound yields optically inactive toxicarol in high yield, and is characterised by the switch-over from laevo- to dextro-rotation on the addition of caustic potash in methyl alcohol to its benzene solution, and is mainly responsible for this feature of the Sumatra-type resins under similar treatment. The change-over in rotation was followed by a gradual fall in rotation of a unimolecular type. The compound is laevo-rotatory in benzene and dextro-rotatory in alcohol.

The toxicities to *Aphis rumicis* of rotenone, toxicarol precursor, sumatrol, toxicarol and the residual resins from the Sumatra-type and *Derris elliptica* roots have been determined. In our experiments the toxicity in descending order was Rotenone > *D. elliptica* resin > Sumatra-type resin > sumatrol = toxicarol precursor > inactive toxicarol.

In the Appendix, the computations necessary to estimate the relative potencies of two insecticides from controlled experiments on insects are illustrated by a numerical example. A brief discussion is given of the appropriate tests of significance.

- XLIX. J. T. MARTIN. "The Chemical Evaluation of *Pyrethrum* Flowers (*Chrysanthemum cinerariaefolium*)." *Journal of Agricultural Science*, 1938, Vol. XXVIII, pp. 456-471.

Comparative analyses of pyrethrum flowers have been carried out by the methods of Tattersfield, Seil, Ripert, Haller and Acree and Wilcoxon.

The methods were of value in indicating the relative richness in pyrethrins of the samples tested, but discrepancies were seen in the absolute values of the pyrethrins I and II recorded. Under present conditions and until a standard method of analysis is agreed upon, it would appear requisite to state the method employed in the evaluation of the flowers.

The Wilcoxon method has given higher figures for the pyrethrin I content than the Seil method. The degree of divergence between the results depended upon the richness of the flowers, and upon the excess of acid used in distilling the volatile acid in the Seil method. The relationship between the amount of the pyrethrin I acid present and the titration recorded in the Wilcoxon method was not a linear one.

The question of the solvent to be used for the initial extraction of the flowers has been briefly discussed.

- L. S. H. HARPER. "A New Compound from *Derris elliptica* Resin." *Chemistry and Industry*, 1938, Vol. LVII, p. 1059.

By chromatographic absorption on alumina of a rotenone-free *D. elliptica* resin Buckley's compound is obtained. It has the formula  $C_{20}H_{16}O_6$ . A structure is assigned based on its similarity to *iso*-rotenone.



(b) FUNGUS DISEASES

- LI. S. D. GARRETT. "Soil Conditions and the Root-Infecting Fungi." *Biological Reviews*, 1938, Vol. XIII, pp. 159-185.

An examination is made of papers published during the last fifteen years on soil-borne fungus diseases of plants, with special reference to the influence of soil conditions on infection.

In reviewing the ecology of the root-infecting fungi, a distinction is drawn following Reinking, between *soil inhabitants* and *soil invaders*.

The *soil inhabitants* are considered to be primitive or unspecialised parasites with a wide host range; these fungi are distributed throughout the soil, and their parasitism appears to be incidental to their saprophytic existence as members of the general soil microflora.

The *soil invaders*, to which class the majority of the root-infecting fungi seem to belong, are more highly specialised parasites; the presence of such fungi in the soil is generally closely associated with that of their host plants. In the continued absence of host plant, such fungi die out in the soil, owing to their inability to compete with the soil saprophytes for an existence on non-living organic matter. This close association between the *soil invaders* and their host plants thus seems to be enforced by the competition of the general soil microflora.

The influence of soil conditions upon a number of soil-borne fungus diseases is tabulated and discussed under the headings of soil moisture content, texture, organic matter, reaction and chemical composition.

- LII. S. D. GARRETT. "Soil Conditions and the Take-all Disease of Wheat. III. Decomposition of the Resting Mycelium of *Ophiobolus graminis* in Infected Wheat Stubble Buried in the Soil." *Annals of Applied Biology*, 1938, Vol. XXV, pp. 742-766.

Decline in viability of the resting mycelium of *Ophiobolus graminis* in artificially infected wheat straw was followed under experimentally controlled soil conditions in glass tumblers. The results suggested that the disappearance of *Ophiobolus* from the straws was due to its natural decomposition by the other soil organisms, since, in its resting phase, the fungus tolerated adverse physical conditions of the soil better than those optimum for microbiological activity. The decline of *Ophiobolus* was hastened by the addition to the soil of energy materials poor or lacking in nitrogen, such as glucose, starch and rye-grass meal, whilst it was postponed by the addition of organic nitrogen in the form of dried blood, or of inorganic nitrogen, as ammonium carbonate. These results led to the hypothesis that the *Ophiobolus* mycelium is decomposed as a source of nitrogen by the micro-organisms engaged in breaking down the straw residues.

- LIII. S. D. GARRETT. "Soil Conditions and the Take-all Disease of Wheat IV. Factors Limiting Infection by Ascospores of *Ophiobolus graminis*." *Annals of Applied Biology*, 1939, Vol. XXVI, pp. 47-55.

No infection of wheat seedlings by the ascospores of *Ophiobolus graminis* could be obtained except under strictly pure culture conditions in bacteriologically sterile soil or sand. Yet such ascospores germinated well on nutrient agar, and the resulting mycelial cultures would produce infection of wheat seedlings growing under natural soil conditions. Failure of the ascospores to cause infection under ordinary soil conditions was attributed to competitive assimilation by the other soil micro-organisms of the root excretions, which in sterile soils are wholly available to the germinating ascospores.

(c) VIRUS DISEASES

- LIV. F. C. BAWDEN and N. W. PIRIE. "Liquid Crystalline Preparations of Potato Virus 'X'." *British Journal of Experimental Pathology*, 1938, Vol. XIX, pp. 66-82.

Methods are described for the isolation of nucleoproteins from *N. tabacum*, *N. glutinosa* and *Lycopersicum esculentum*, infected with the S and G strains of potato virus "X." These have not been isolated from healthy plants, and



the available evidence suggests that they are the viruses themselves. Infections were obtained with  $10^{-9}$  gm., and specific serological reactions with  $\frac{1}{6 \times 10^6}$  gm. Concentrated solutions are spontaneously bi-refringent and dilute solutions show anisotropy of flow; when sedimented by high-speed centrifugation the nucleoproteins form birefringent jellies, but when precipitated with acid or ammonium sulphate the material appears amorphous under the microscope.

The filterability of the virus after purification is less than that of the virus in untreated sap, and purification appears to cause the virus particles to aggregate into rods.

Two types of inactivation are described: one leads to a loss of infectivity without changing the optical properties or serological reactions, whereas the other denatures the protein and destroys all three. The effects of heating, drying, acid, alcohol, sodium dodecyl sulphate, irradiation with X-rays and ultra-violet light, and hydrogen peroxide are described. The properties of virus "X" are compared with those of tobacco mosaic virus, and the results discussed.

- LV. F. C. BAWDEN and N. W. PIRIE. "*Crystalline Preparations of Tomato Bushy Stunt Virus.*" British Journal of Experimental Pathology, 1938, Vol. XIX, pp. 251-263.

The isolation of a protein, probably the virus itself, is described from plants infected with tomato Bushy stunt virus. This protein not only differs from the normal plant proteins, but it also differs more from the other purified plant viruses than these differ from one another. It is fully crystalline instead of liquid crystalline. It has a higher nucleic acid content than tobacco mosaic virus or potato virus "X," and is more stable towards pH changes, but less stable towards dehydrating agents. Its particles are not elongated, and liquid and solid preparations are isotropic. 1 c.c. of solution containing  $10^{-7}$  gm. produces infection when rubbed on to *N. glutinosa*, and 1 c.c. containing  $10^{-6}$  gm. gives a specific precipitate with antiserum. Precipitates of the rod-shaped viruses with their antisera resemble those obtained with bacterial flagellar ("H") antigens, but those of Bushy stunt virus resemble those with somatic ("O") antigens. When irradiated with ultra-violet light or treated with nitrous acid the virus loses its infectivity, but it can still be crystallised and still retains its serological activity.

- LVI. F. C. BAWDEN and N. W. PIRIE. "*A Note on Some Protein Constituents of Normal Tobacco and Tomato Leaves.*" British Journal of Experimental Pathology, 1938, Vol. XIX, pp. 264-267.

Proteins with high molecular weights have been isolated from healthy tobacco and tomato plants. Except for their large size, these proteins have little in common with the plant viruses that have been purified. They contain 14-16 per cent. N., but less than 0.2 per cent. P and less than 1 per cent. carbohydrate, whereas the viruses are nucleoproteins.

- LVII. F. C. BAWDEN and F. M. L. SHEFFIELD. "*The Intracellular Inclusions of Some Plant Virus Diseases.*" Annals of Applied Biology, 1939, Vol. XXVI, pp. 102-115.

The contents of healthy cells and those infected with a number of different plant viruses are described. Some of these viruses apparently do not cause the production of intracellular inclusions; others cause the production of amorphous bodies only and the remainder produce both amorphous and crystalline inclusions. The properties of the inclusions are compared with those of purified preparations of the viruses. It is shown that insoluble complexes of the viruses with protamines, histones and proteins which in many ways resemble the intracellular inclusions can be produced *in vitro*. Possible explanations for the formation and disappearance of the inclusions in infected plants are suggested.



- LVIII. F. M. L. SHEFFIELD. "Vein Clearing and Vein Banding Induced by *Hyoscyamus III* Disease." *Annals of Applied Biology*, 1938, Vol. XXV, pp. 781-789.

The first symptom of Hy. III disease in tobacco is a clearing of the veins. This is followed later by vein banding. During clearing no anatomical or cytological abnormalities occur. The yellow colour is due to a retardation of chlorophyll formation.

When vein banding becomes apparent considerable hypertrophy is seen in the tissues near the veins and hypoplasia is apparent in the interveinal areas. Intracellular inclusions are abundant in all tissues except the xylem.

Cleared tissue contains 6-11 times as much virus per unit volume as does the banded tissue. The latter also contains less than do the yellower parts of banded leaves.

- LIX. M. A. WATSON. "Further Studies on the Relationship Between *Hyoscyamus Virus 3* and the *Aphis Myzus persicae*, with Special Reference to the Effects of Fasting." *Proceedings of the Royal Society of London, B*, 1938, Vol. CXXV, pp. 144-170.

The efficiency of *Myzus persicae* in transmitting Hy. 3 virus increases with increasing time of fasting before feeding on the infected plants. Their efficiency decreases with increasing feeding time on the infected plants up to one hour, at which time a constant low level is reached. Infectivity is lost by the aphides when fasting after infection feeding, but the loss is less rapid if the feeding time on the infected plants was very short. The rate of loss of infectivity appears to be more rapid than the rate at which the virus is inactivated *in vitro* in expressed plant sap. Individual aphides vary in their efficiency as vectors, but the relative efficiency of individuals can be altered if the preliminary fasting treatments are varied. The most probable explanation of these results is that the virus is inactivated by some substance secreted by the aphides when feeding.

- LX. F. M. L. SHEFFIELD. "Microsurgical Studies on Virus-Infected Plants." *Proceedings of the Royal Society of London, B*, 1939, Vol. CXXVI, pp. 529-538.

Cells of virus-infected plants were examined by micro-manipulative methods.

The pH of the cell contents was found to be the same in diseased and in healthy plants.

The non-crystalline intracellular inclusions of aucuba mosaic disease of tomato disintegrate immediately on slight mechanical pressure or on pricking. They are almost unaffected by acids from pH 7 to 2.2. They break down if the osmotic pressure is reduced below 0.07 M, but can be isolated into solutions of 0.1 M. These inclusions contain virus, but virus may also be dispersed through the cell.

The striate material of tobacco and enation mosaics cannot be isolated, as immediately it is touched with a micro-needle it breaks down into needle-like fibres.

#### APICULTURAL PROBLEMS (Section for Bee Investigations)

- LXI. H. L. A. TARR. "Studies on American Foul Brood of Bees." II. *The Germination of the Endospores of Bacillus larvae in Media containing Embryonic Tissues*," with an Appendix by W. G. COCHRAN. *Annals of Applied Biology*, 1938, Vol. XXV, pp. 633-643.

The difficulty of producing vegetative growth from the spores of *Bacillus larvae*, the organism responsible for American foul brood of bees, even on rich media such as a complex egg yolk carrot extract suggested the possibility of using media containing the tissues of the developing chick embryo. Experiments comparing four different media showed that chick embryo "brei" and the chorioallantoic membrane of the developing chick are by far the most favourable media yet found for the growth of this organism. Added available nitrogen in the form of beef digest broth to the embryo brei tended to inhibit