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Report for 1937

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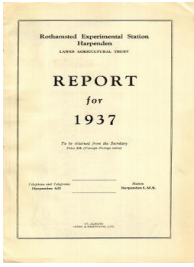

The Plant in Disease : Control of Disease

Rothamsted Research

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Marsh Spot disease of peas in the Romney Marsh area is more closely related to soil reaction than to soil series or soil texture. It was not found on any acid soil but on most of the alkaline ones in a representative set of 35 samples. Most of the soils contained appreciable amounts of free oxides of manganese and of salt-soluble manganese. The soils with Marsh Spot contained less salt-soluble manganese than the soils on which peas were healthy, but this relationship depended essentially on the contrast between acid and alkaline soils. Peas grown in pot cultures in manganese-deficient soils and in a sand-bentonite mixture developed Marsh Spot. Addition of manganese sulphate increased the manganese content of the seeds and controlled the disease.

Soils on which oats suffered from Grey Speck disease and sugar beet from "Speckled Yellow" contained little or no salt-soluble manganese.

THE PLANT IN DISEASE: CONTROL OF DISEASE

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

(*a*) Insects and Their Control

XXXII. C. B. Williams. "*The Migration of Day-flying Moths of the Genus* Urania *in Tropical America.*" Proceedings of the Royal Entomological Society of London, 1937, Vol. XII, pp. 141-147.

A number of new records of migration of *Urania leilus* and *Urania fulgeus* is given, and it is shown that the latter species is known in nearly all the central American countries from Mexico to Panama, and also in Columbia, Ecuador and Peru in western South America. There appear to be two flight seasons, and there is some evidence that the flights are more or less to the north in March and April and more or less to the east or south-east in June to September.

XXXIII. K. J. Grant. "*Some Recent Migrations of the Silver-Y. Moth.*" Transactions of the South Eastern Union of Scientific Societies, 1937, pp. 1-8.

An account is given of the evidence available on the migrations of *Plusia gamma* in 1932 to 1936. In 1936 there was a remarkable immigration and the species was seen as far north as the Shetland Islands. Immigrant swarms arrived in May and June and extensive damage was done to the sugar beet fields of Norfolk and Lincolnshire by the resulting larvae. During August and September migrations on a large scale were noted to both south and west.

The effect of wind on the flights is discussed and also the evidence that the Silver-Y. moth may survive the winter.

XXXIV. K. J. Grant. "*An Historical Study of the Migration of* Celerio lineata lineata *Fab. and* Celerio lineata livornica *Esp.* (*Lepidoptera*)." Transactions of the Royal Entomological Society of London, 1937, Vol. LXXXVI, pp. 345-357.

The distribution and outbreaks of the sub-species *Celerio lineata lineata* in America and *Celerio lineata livornica* in the Old World are described. It is suggested that both sub-species originate in semi-desert areas, and this idea is supported in the case of the American sub-species by the fact that a correlation exists between outbreaks of moths and a certain sequence of direct rainfall.

The main occurrences and outbreaks of both races in the past century are listed, and it is shown that a correlation exists between years of unusual abundance and unusual absence in the two continents. Outbreaks tend to occur simultaneously, and therefore their causes must be sought in some factor common to the two continents.

XXXV. C. B. Williams. "*The Use of Logarithms in the Interpretation of Certain Entomological Problems.*" Annals of Applied Biology, 1937, Vol. XXIV, pp. 404-414.

It is found that where catches of insects in a light trap are being examined statistically more consistent results are obtained if the logarithm of the catch

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number is used instead of the number itself. This also has the effect of reducing the swamping of a series of values by a single exceptionally large catch. The transformation appears to be made necessary by the fact that unit changes in the factors of the environment, such as temperatures, produce similar geometric or percentage changes in the catch.

XXXVI. H. F. BARNES. "*Methods of Investigating the Bionomics of the Common Crane Fly,* Tipula Paludosa, *together with some Results.*" Annals of Applied Biology, 1937, Vol. XXIV, pp. 356-368.

Full grown larvae were obtained by the O.D.B.C. method and reared to the adult stage on young wheat. The crane flies were mated and oviposition took place in glass tubes. The eggs were kept in solid watch glasses. The young larvae were reared on wheat rootlets, clover or chickweed leaves, pieces of cabbage leaf, slices of potato and bran in petri dishes. The breeding potential was as follows: 51 per cent. of the larvae emerged as adults, 75 per cent. of the available eggs were laid, 46 per cent. of the eggs hatched and 46 per cent. of the larvae survived the two first instars.

XXXVII. H. F. BARNES. "*The Asparagus Miner* (Melanagromyza Simplex H. *Loew*) (*Agromyzidae ; Diptera*)." Annals of Applied Biology, 1937, Vol. XXIV, pp. 574-588.

The asparagus miner has two generations a year at Harpenden. The flies are on the wing from early June to the end of July and again from the beginning of August to mid-September. The larvae mine the stems of asparagus, but the damage is not serious except when it occurs in seedling beds or when it is followed by an attack of the larvae of *Lonchaea flavidipennis* Zett. Three parasites, a braconid *Dacnusa ?bathyzona* Marsh, a pteromalid *Sphegigaster* sp. and a eulophid *Pleurotropis epigonus* Walk were found. The fly is generally distributed in asparagus growing areas in England, U.S.A. and Europe.

XXXVIII. H. F. BARNES. "*The Hollyhock Seed Moth* (Platyedra malvella) *together with Notes on the Distribution of* Apion radiolus *Kirby and an Associated* Clinodiplosis *Species.*" Annals of Applied Biology, 1937, Vol. XXIV, pp. 589-599.

The life cycle of the moth is described. There is one generation a year, the moths being on the wing late in June until the beginning of August. The larvae feed on the seeds of hollyhock perforating them characteristically. The winter is spent in the soil, in May they become active again pupating towards the end of May and in June. An ichneumonid parasite *Angitia rufipes* Grav. was recorded. The moth is only found in the south-eastern counties of England. The *Apion* beetle and *Clinodiplosis* midge are found all over England, the latter also occurring in Wales and Ireland.

XXXIX. A. M. LYSAGHT. "*An Ecological Study of a Thrips* (Aptino Thrips Rufus) *and its Nematode Parasite* (Anguillulina Aptini)." Journal of Animal Ecology, 1937, Vol. VI, pp. 169-192.

Aptino Thrips rufus is abundant on the grass plots of the classical Park Grass at Rothamsted. Sampling has been carried out for two years on a number of plots and population counts made. *A. rufus* is parasitised by an eelworm *Anguillulina aptini*, on which some experimental work is described.

The nematode was rarely found on two of the plots and this difference was found to be constant in two years. There is a rank growth of *Holcus lanatus* on these plots and this seems to have an unfavourable influence on the eelworm. Infected insects have, however, been found on *H. lanatus* under greenhouse conditions. Other factors, and particularly liming, that might affect the distribution are discussed.

XL. B. LOVIBOND. "*Investigation on the Control of Leather Jackets. II. Notes on Crane flies and their Larvae.*" Journal of the Board Greenkeeping Research, 1937, Vol. V, pp. 12-17.

Several species of crane flies have been reported as injurious in the larval stages in this country. An attempt is being made, by the rearing of samples of grubs, to determine the species which are injurious to golf greens—it being

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impossible at present to distinguish the species from an examination of the larvae. Suggestions have been put forward that the trapping of adults by light traps would serve to reduce the larval population. Examination of light trap material shows that in the case of *T. paludosa* the females had laid approximately 95 per cent. of their eggs before trapping. Hence this control measure is valueless for this species. Experiments with the St. Ives exterminator show that there is a tendency for the efficiency of the exterminator to vary with the age of the grubs. Thus the time of application is important from the point of view of efficient control.

XLI. B. LOVIBOND. "*Investigations on the Control of Leather Jackets. III. Some Results of Breeding and Sampling Experiments during the Current Season.*" Journal of the Board of Greenkeeping Research, 1937, Vol. V, pp. 107-112.

The rearing of samples of leather jackets from various golf courses confirms the view that *T. paludosa* is the most prevalent species, although other species do occur. In many cases there is a considerable amount of parasitism, but it is not sufficient to effect any appreciable decrease in the population. It is easy to distinguish between the eggs of *T. paludosa*, *T. oleracca* and *T. vernalis*. These species also differ in such details as number of eggs and incubation period, etc.

Repeated sampling of shows that there is a tendency for grubs to move to free areas from adjacent populated areas.

XLII. F. TATTERSFIELD. "*Modern Developments in Research on Insecticides. Part I. General Survey.*" Journal of the Society of Chemical Industry, 1937, Vol. LVI, pp. 79T-85T.

A critical survey of recent work on insecticides. It covers many of the more important researches carried out here and in America.

Means of assessing toxicity of contact and stomach insecticides, the recently developed statistical technique, field trials, chemical developments, soil fumigation and mode of action of insecticides are dealt with.

XLIII. J. T. MARTIN. "*Modern Developments in Research on Insecticides. Part II. Insecticidal Plant Products.*" Journal of the Society of Chemical Industry, 1937, Vol. LVI, pp. 85T-91T.

An account of recent research work on these insecticides. The chemistry and proposals for the chemical evaluation of fish-poison plants and pyrethrum are surveyed.

XLIV. S. G. JARY, J. T. MARTIN and F. TATTERSFIELD. "*The Artificial Drying of Pyrethrum Flowers.*" Journal of the South-Eastern Agricultural College, Wye, Kent, 1937, pp. 108-114.

An account of a joint experiment between the South-Eastern Agricultural College, Wye, Kent, and Rothamsted Experimental Station upon the drying of pyrethrum flowers at different temperatures in an experimental hop kiln.

The apparatus used is described and the pyrethrin content of the kiln-dried flowers given for a comparison with their air-dried controls.

There is a loss of pyrethrins in the sample dried at 45°C. (113°F.) for 21 hours and in those dried at 68°C. (154°F.) and 75°C. (167°F.) for 5¾ and 3½ hours respectively. There is little or no loss of pyrethrins in samples dried at temperatures of 52°C. (126°F.) and 60°C. (140°F.), when comparisons are made with their air-dried controls.

XLV. J. T. MARTIN and C. POTTER. "*A Colourless Active Extract of Pyrethrum Flowers.*" Journal of the Society of Chemical Industry, 1937, Vol. LVI, pp. 119-120.

A brief account of the preparation of a colourless extract of pyrethrum by extracting the powdered flowers in the presence of absorbent charcoal with light petroleum. The colourless extract was highly toxic to larvae of *Plodia interpunctella*.

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XLVI. F. TATTERSFIELD and J. T. MARTIN. "*An Optically Active Constituent of* Derris *Resin related to Toxicarol.*" Journal of the Society of Chemical Industry, 1937, Vol. LVI, p. 77T.

A brief account of the isolation and some of the properties of the crystalline precursor of toxicarol.

(*b*) FUNGUS DISEASES

XLVII. G. SAMUEL and F. J. GREANEY. "*Some Observations on the Occurrence of* Fusarium Culmorum *on Wheat.*" Transactions of the British Mycological Society, 1937, Vol. XXI, pp. 114-117.

This fungus, which is known to be significantly pathogenic on oats and wheat under certain conditions, was found present on healthy wheat plants at the time of flowering, and increased in amount as the season advanced, as many as 70 per cent. of the plants examined being found infected before harvest. Although the fungus must have been present in the soil from the start, and was shown to be potentially parasitic, it had invaded the plants parasitically, only as the roots began to lose viability after flowering. Yet in other districts, e.g., the North of England, it causes appreciable injury. The cause of the difference, perhaps a soil condition, is not known.

XLVIII. S. D. GARRETT. "*Soil Conditions and the Take-all Disease of Wheat. II. The Relation between Soil Reaction and Soil Aeration.*" Annals of Applied Biology, 1937, Vol. XXIV, pp. 747-751.

By forced aeration acid soils can be rendered quite as favourable for the growth of *Ophiobolus graminis* along the roots of wheat seedlings as alkaline soils. This agrees with the hypothesis that such growth along the wheat roots in acid soils is retarded by the accumulation of respiratory carbon dioxide.

XLIX. S. D. GARRETT. "*Brom-thymol Blue in Aqueous Sodium Hydroxide as a Clearing and Staining Agent for Fungus-infected Roots.*" Annals of Botany, 1937, Vol. I, p. 563.

A note on a useful method.

L. J. SINGH. "*Soil Fungi and Actinomycetes in Relation to Manurial Treatment, Season and Crop.*" Annals of Applied Biology, 1937, Vol. XXIV, pp. 154-168.

A direct correlation was found between soil fertility as measured by crop growth (mangolds, wheat) and the number of fungi and actinomycetes in the soil ; but evidence as to periodicity in these numbers was inconclusive. There is no support for the view that particular manurial treatments produce specific fungus flora.

(*c*) VIRUS DISEASES

LI. J. HENDERSON SMITH and F. C. BAWDEN. "*Discussion on Recent Work on Heavy Proteins in Virus Infection and its Bearing on the Nature of Viruses.*" Proceedings of the Royal Society of Medicine, 1938, Vol. XXXI, pp. 199-210.

Our knowledge of the nature of viruses has been greatly deepened in the last few years. The virus of tobacco mosaic has now been shown to be a nucleo protein, which when sufficiently purified exists in a liquid crystalline state, showing permanent birefringence if in relatively high concentration and anisotropy of flow when the concentration is reduced. This indicates that the constituent particles are rod-shaped, and X-ray analysis has given the measurements of their width. From solutions of the protein needle-shaped paracrystals or fibres are readily obtained, which are visible under the microscope, and in certain conditions mesomorphic fibrils are produced which are visible to the naked eye. In the process of purification the protein undergoes a linear aggregation, but in the plant there is good reason to believe that it exists in a less aggregated state. When fully purified it appears to be homogeneous, and there is no valid reason to doubt that the protein is actually the virus. It has all the properties of tobacco mosaic virus, except for a loss of filterability due to the aggregation, and reproduces the disease in indefinitely extensible series. It does not occur in normal plants, but in

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the infected plant it is found in quantities as large as 2g. per litre of sap, and has a molecular weight of the order of 20 millions. Similar proteins have been isolated from three strains of tobacco mosaic and two strains of cucumber mosaic, the individual proteins exhibiting characteristic differences just as the diseases they produce are characteristically distinct.

LII. F. C. BAWDEN and N. W. PIRIE. "*The Isolation and Some Properties of Liquid Crystalline Substances from Solanaceous Plants Infected with Three Strains of Tobacco Mosaic Virus.*" Proceedings of the Royal Society of London, 1937, Vol. CXXIII, pp. 274-320.

Nucleo-proteins with characteristic optical properties were isolated from solanaceous plants infected with three strains of tobacco mosaic virus, but not from healthy plants. They are infective at a dilution of $1/10^{10}$, and give specific precipitates with antisera at a dilution of $1/10^{7}$. Solutions of the purified proteins separate into two layers if the protein content is raised above about 2 per cent. The lower layer is the more concentrated and is birefringent, while the upper shows anisotropy of flow. There is no essential difference in the virus activity, expressed in solid content, of the two layers. The anisotropy of flow can be easily recognised in solutions containing only 0.02 per cent. of protein. When centrifuged at high speed these solutions deposit the protein in the form of a birefringent jelly.

No enzyme preparation has yet been found which attacks these proteins at an appreciable rate, but the activity can be affected by a number of chemical agents. The stability towards heat and drying has been studied, and the conditions under which the nucleic acid-protein complex breaks down.

The physical properties of virus preparations and the X-ray measurements on them are interpreted on the theory that in purified preparations the constituent particles are rod-shaped, and it is suggested that these rods are built up by the linear aggregation of smaller units. There is evidence that, in the plant, part at least of the virus is not aggregated, for filters which pass an infectious filtrate with untreated plant sap do not do so with purified preparations

LIII. F. C. BAWDEN and N. W. PIRIE. "*The Relationships between Liquid Crystalline Preparations of Cucumber Viruses 3 and 4 and Strains of Tobacco Mosaic Virus.*" British Journal of Experimental Pathology, 1937, Vol. XVIII, pp. 275-290.

Methods are described for the isolation of nucleo-proteins from cucumber plants infected with cucumber viruses 3 and 4. These have not been isolated from uninfected plants, and the evidence available indicates that they are the viruses themselves. Infections were obtained with 10^{-10}g., and specific precipitates with antiserum with $1/8 \times 10^{-6}$g. Concentrated solutions are spontaneously birefringent and dilute solutions show anisotropy of flow; when sedimented by high-speed centrifugation they form birefringent jellies, and when precipitated with acid or ammonium sulphate they form needle-shaped para-crystals. Although these viruses have a distinct host range from tobacco mosaic virus, the purified preparations have similar chemical compositions and many properties in common with purified preparations of strains of tobacco mosaic virus; they differ from tobacco mosaic virus, however, more widely than the recognised strains of tobacco mosaic virus differ from each other. The cucumber viruses and the tobacco mosaic viruses have certain antigens in common; the results of cross-absorption experiments between the various viruses and their antisera are described and provisional antigenic formulae suggested. Possible methods of relating and distinguishing between viruses and the relationship between the cucumber and tobacco viruses are discussed.

LIV. F. C. BAWDEN and N. W. PIRIE. "*A Note on Anaphylaxis with Tobacco Mosaic Virus Preparations.*" British Journal of Experimental Pathology, 1937, Vol. XVIII, pp. 290-291.

Normal tobacco protein is anaphylactogenic but tobacco mosaic virus is not. That virus purified by ammonium sulphate precipitation may still retain a normal protein impurity which is removable by tryptic digestion can be demonstrated by the anaphylactic reaction.

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LV. M. A. WATSON. "*Field Experiments on the Control of Aphis-transmitted Virus Diseases of* Hyoscyamus Niger." Annals of Applied Biology, 1937, Vol. XXIV, pp. 557-573.

Aphis-infestation of the first year's growth of *Hyoscyamus* (grown as a biennial crop) was reduced by spraying with nicotine and soft soap for the first eight or nine weeks. The greatest effect was obtained by spraying at weekly intervals. The percentage of infection was lower on the sprayed than on the unsprayed plots. The first cropping in the first year showed no effect on yield as the result of the treatment; but in the second year a 30 per cent. increase of yield was obtained.

APICULTURAL PROBLEMS

(Sections for Bee Investigations and Biochemistry, and Bacteriology Department)

LVI. H. L. A. TARR. "*Studies on European Foul Brood of Bees. III. Further Experiments on the Production of the Disease.*" Annals of Applied Biology, 1937, Vol. XXIV, pp. 614-626.

Evidence is submitted which supports the theory that European Foul Brood is a single disease caused by *Bacillus pluton* White. The course of the disease can be modified by introducing cultures of certain secondary invading bacteria into colonies of bees infected with *B. pluton*. A certain "mass inoculum" of *B. pluton* organisms is required to induce the disease in healthy colonies. The causal organism is present in a virulent form in the rectal ampullae of young bees in affected colonies; but does not appear to exist elsewhere in the bee, or to multiply in its intestinal tract. It appears as if *B. pluton* is a strict parasite which will only multiply in the intestines of young larvae.

LVII. H. L. A. TARR. "*Studies on American Foul Brood of Bees. I. The Relative Pathogenicity of Vegetative Cells and Endospores of* Bacillus Larvae *for the Brood of the Bee.*" Annals of Applied Biology, 1937, Vol. XXIV, pp. 377-384.

Vegetative cells of *Bacillus larvae* have not produced American Foul Brood in healthy nuclei of bees even when a dose almost three thousand times greater than an inoculum of spores of the organism capable of causing the disease has been sprayed over the developing brood. A very much smaller inoculum of spores of *Bacillus larvae* is effective in producing American Foul Brood when the developing larvae of healthy nuclei are sprayed directly with them, than when the spores are fed in syrup to the bees.

LVIII. H. L. A. TARR. "*Addled Brood of Bees.*" Annals of Applied Biology, 1937, Vol. XXIV, pp. 369-376.

It is shown that "Addled Brood" of bees is not of an infectious nature but is produced by a defective queen and can be cured by re-queening.

LIX. C. R. MARSHALL and A. G. NORMAN. "*The Analysis of Mixtures of Glucose and Fructose with Special Reference to Honey.*" The Analyst, 1938, Vol. LXIII, pp. 315-323.

A procedure for the direct determination of glucose and fructose in mixtures is described, involving hypoiodite oxidation for glucose followed by a micro-copper reduction method for fructose. The behaviour of these sugars in a mixture is not precisely that of the sum of the individual components taken separately. No constant correction can be applied for fructose oxidised by the hypoiodite. From the analysis of known mixtures equations have been derived for amounts of glucose and fructose within the limits of 0.08-0.04 g. of each. The presence of small amounts of sucrose is without effect. Examples of the application of this method to some typical honeys are given.

LX. HUGH NICOL. "*A Test of Gas Tightness of Honey Jars.*" The Bee World, 1937, Vol. XVIII, pp. 103-105.

Some standard metal-capped glass containers for honey were tested by putting the closed containers in an atmosphere containing ammonia and watching for change of colour of a faintly acid indicator solution inside the honey-jars. No jar was found to be gas-tight. Hence, when fermentation occurs in storage the cause may possibly be due to absorption of atmospheric moisture through imperfect closures.