ROTHAMSTED RESEARCH

# Rothamsted Report for 1951

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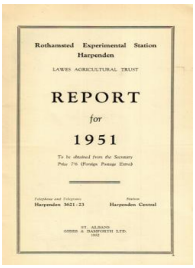


## Entomology Department

### C. B. Williams

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# ENTOMOLOGY DEPARTMENT

By C. B. WILLIAMS

The work of this department continued during 1951 on the lines of previous years with little change except that Mr. Banks resumed his work on Aphid predators and Mr. Murphy replaced Dr. Evans in the work on Forest Soil Arthropods.

## EFFECT OF WEATHER CONDITIONS ON INSECTS

(C. B. Williams, R. A. French, B. P. Singh and M. M. Hosni)

Trapping during 1951 has been carried on by two light traps and two suction traps. The light traps were of a new mercury-vapour type rich in ultra-violet light, which had been shown by experiments last year to be considerably more efficient than the type that we had previously used. One of the new traps placed in the garden of the Manor House caught 26,000 Macro-lepidoptera between March and November 1951, as compared with an average of about 4,000 per year in previous years with the older type of trap.

The use of one light trap inside a wood and the other outside has enabled us to measure the effect of trees in damping down the micro-climatic changes as compared with outside.

One suction trap has been working near each light trap so that we have a comparison of the two environments with two types of traps. The suction traps have also been working for two hours each day—from 12-2 p.m.—so that we have for the first time a measure of day-time activity for study in relation to day weather.

A preliminary experiment in 1950 had shown evidence that about four times as many insects were captured in a suction trap at night at the period of new moon as at full moon. Results obtained from the suction traps in 1951 confirmed this result in the case of the trap inside the woodland, but the trap outside showed no significant periodicity.

Mr. B. P. Singh is writing up the results of his two years' work with suction traps as a thesis for a London Ph.D. degree. His quantitative estimates of the effect of various weather conditions on insect activity agree closely with those previously obtained by the use of light traps. This considerably increases the reliance that can be placed on both sets of calculations.

## RELATIVE ABUNDANCE OF DIFFERENT SPECIES OF INSECTS

(C. B. Williams)

An analysis of very large catches of insects—such as has been obtained from our new mercury-vapour traps in 1951—shows that the relative abundance of different species corresponds more to the log-normal distribution than to the logarithmic series. A paper on this problem is almost ready for publication. The mathematical problems involved have been studied by Dr. P. Grundy of the Statistical Department (q.v.).



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## Insect Migration

(C. B. Williams and R. A French)

Records continue to come in from all parts of the world—and Rothamsted also receives each year for study and storage several thousand records collected by the Insect Immigration Committee of the British Isles.

Attention has been focussed in recent years on the problem of the return flight to the south in autumn in species which are known to move north in the spring. An examination of more than a thousand records in our files show that there is definite evidence of a southerly autumn movement in at least four of our British butterflies : the *Vanessa atalanta*, *Vanessa urticae*, *Colias edusa* and *Colias hyale*. The discovery of evidence for the movement of *V. urticae* is particularly interesting as although there were a few records suggesting the possibility of migration in the Continent, we had not previously considered the insect to be an immigrant into Britain.

G. F. Cockbill—who worked at Rothamsted about 10 years ago —has just published an account of the migrations of *Catopsilia florella* in Southern Rhodesia, and there also he finds evidence of a reversal of direction at different seasons.

## The Effect of the Population Density on Lepidopterous Larvae

(D. B. Long)

Last year it was shown that the larvae of the Silver-Y Moth (*Plusia gamma*) reacted to the larval population density. When they were bred under solitary conditions the larvae were typically light green but when bred under crowded conditions much darker forms were produced as well.

Due to the late spring it was possible to investigate the larval response of only a few additional species. Whereas the migrant Silver-Y Moth had shown a definite response, no obvious results were obtained with the larvae of the migrant Cabbage White Butterfly. On the other hand, definite colour variants were produced in the larvae of the non-migrant Emperor Moth (*Saturnia pavonia*) and in certain non-migrant species of the genus *Orthosia* (Family Noctuidae).

In the case of the Silver-Y Moth further work has been done on the relative rates of development of larvae bred under solitary and crowded conditions. " Crowded " larvae grow at a more uniform rate and complete their development much more rapidly than do solitary larvae. This appears, in part, to be related to the number of moults which the respective larvae undergo. There has been some evidence to suggest that the relative frequencies of the dark and light forms in the crowds is dependent on a genetic factor. In order to investigate this, a heated greenhouse has been erected and selected breeding lines are being set up.

## The Distribution of Aphids by Wind

(C. G Johnson and L. R. Taylor)

The work at Cardington on aerial dispersal of insects continues. It is found that, on the average, there is an approximately linear relation of log. aphid density to log. altitude ; this enables curves

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of density on height to be integrated. Thus it is possible to estimate not only the density at different heights but the total number of insects in a zone of air. This shows that, in general, by far the greater proportion of aphids flying during the day are at altitudes above 100 feet and thus subject to dispersal by air currents. The consequences of this in the ecology of the insect are being studied together with work on rates of elevation and deposition.

*Factors influencing changes in aerial numbers of aphids at crop levels*

The first stage of an intensive study of changing aerial densities of bean aphis (*A. fabae*) at crop level has now been completed, with an analysis of the roles of population change and flight activity as influenced by current meteorological conditions.

In the past great stress has been placed on the importance of wind, temperature, humidity, etc., as factors regulating aphid flight. It is now clear, however, that changes in the level of alate populations which take place with a rapidity not hitherto appreciated can outweigh in importance the changes in current meteorological factors, and that factors of population rather than of flight behaviour are of primary significance in regulating numbers of aphids in the air even from one half day to another.

*Statistical techniques and estimation of aphid numbers*

For some time now work has been in progress in producing a suitable method for counting large numbers of aphids by sampling aliquot parts of a bulk suspension.

The statistical side has been in the hands of Mr. J. A. Nelder of the Vegetable Research Station, Wellesbourne.

An apparatus has now been devised and perfected on which by counting a small fixed number of aphids it is possible to estimate numbers from 1,000 to 20,000 within $\pm$ 7 per cent fiducial limits in about five minutes.

*Design and refinements of suction traps*

In using suction traps it has been assumed that, with aphids, the numbers caught varies directly with the volumetric flow of the trap. There are, however, errors in this, particularly those associated with the increased momentum of insects as they traverse the trap in winds of different velocities. Attempts to assess these errors are being made in conjunction with the Aerodynamic Section of Blackburn and General Aircraft Co. Ltd.

*Infestation patterns*

The pattern of infestation of bean fields infested with *Aphis fabae* has been shown to follow, in some cases, the direction of the wind during primary migration. Work on this problem has continued in collaboration with Mr. C. E. Taylor of Sutton Bonington.

## The Natural Enemies of Aphids

(C. J. Banks)

Not much is known about the effects of an enemy population on an aphid population, or of its ability to control or prevent outbreaks of aphids. Work was started on this problem in the summer

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of 1951. Enemies of the Black Bean aphid, *Aphis fabae* Scop. were studied, for not only is this insect of economic importance but its ecology is being studied in this department.

There were two initial problems: first, to record the various species of enemies and second, to estimate their numbers in relation to the varying numbers of aphids present. Special sampling techniques will have to be developed for estimating degrees of parasitisation, and therefore, for the time being, quantitative methods have been concerned mainly with the predators, which include lady-bird beetles, hover-fly larvae, lacewings, Anthocoridae and mites.

A detailed study of a bean crop was carried out, using three methods of sampling: (1) The suction trap method has given information on the abundance of flying predators such as lady-birds, hover-flies and lacewings. (2) The removal from the crop of 40-50 infested stems each week during the infestation has provided information on the numbers of aphids present on stems and the numbers of predators associated with them. This method has, so far, proved satisfactory only for hover-fly larvae (Syrphidae). (3) Weekly field-counts of predators and their eggs on a large number of stems have provided data which could not have been obtained by any of the other methods. Errors of sampling have been estimated and the reliability of the methods assessed. No single method is of general application and future work will have to include all three with improved techniques.

Two of the main problems encountered in the investigations are that the natural enemies are few in total numbers, especially when compared with the numbers of their prey, and that many of them tend to aggregate on the infested stems. The pronounced aggregation of hover-fly eggs on infested stems suggests that the female flies are attracted to the aphids, and this is a problem which will be investigated in the coming year.

## Population Studies

(H. F. Barnes)

The expected fifth peak of the two wheat blossom midges in 1951 was masked on Broadbalk owing to the failure locally of the appearance of the wheat ears to coincide exactly with the emergence of the midges. But serious outbreaks did occur in S. Ireland and Yugo-Slavia (on rye) while news has been received of serious damage occurring in China.

*S. mosellana* larvae collected each year (except 1947) since 1939 inclusive have been successfully rear during 1951 thus demonstrating the probability of fully grown larvae of this species surviving twelve winters in the soil. Mr. G. H. Golightly of the National Agricultural Advisory Service, Northern Province, has this year obtained figures showing that *S. mosellana* does survive in the soil under field conditions for at least seven winters.

The twenty-fifth successive year of sampling Broadbalk for wheat blossom midge has now been completed.

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## Gall Midges of Economic Importance

(H. F. Barnes and Miss B. M. Stokes)

Vol. 5 of Dr. Barnes' monograph on gall midges of economic importance was published during February. This volume which deals with the gall midges of trees thus appeared after Vol. 6, which was published in 1949. The final preparation of Vol. 7 which will deal with the gall midges of cereals has been delayed so that it may contain a full account of the wheat blossom midges as they have occurred on Broadbalk during the last quarter of a century (1927-51).

Enquiries concerning the identification and control of gall midges have continued to come in from all over the world. Noteworthy among these has been a serious outbreak of *Contarinia chrysanthemi* Kieffer attacking Shasta Daisy in the north of England. This is an instance of a change of host plant from a weed (Ox-eye Daisy) to a cultivated plant and emphasizes, if necessary, the importance of the studies on host plant range of gall midges that are being undertaken. Other gall midges attacking willow, mushrooms, rose, apple, peas, wheat and oats have been sent in. An interesting discovery of *Camptodiplosis* sp. living on Jew's Ear Fungus (*Auricularia auricula-judae*) has been made by Professor P. A. Buxton. Other notable consignments of gall midges have been received from Madagascar, India and Yugo-Slavia.

Miss Stokes' investigations into the host plant range of the swede midge is nearing completion. Considerable advance has been made in an investigation of the biology of a gall midge whose larvae feed in the overwintering flower buds of elm and form part of the winter and spring food of tits. Comparison with newly acquired larval specimens of a somewhat similar American species has shown that the two species are distinct. During the year two families of the Hessian Fly were successfully reared and demonstrated that unisexual families in this species occur in this country as had been previously shown to exist in the United States. Dr. Barnes has now personally reared all the species of gall midges in which this phenomenon is known to occur.

## Slugs

(H. F. Barnes and Miss B. M. Stokes)

The garden studies of slugs have been largely in abeyance during 1951. Miss Stokes has continued her laboratory study of the biology of *Testacella* and should be writing up her results in the near future.

## Wireworms

(F. Raw and J. W. Stephenson)

The wireworm population studies on the Ley and Arable Experiment on Highfield and Fosters have been continued. Samples were taken in March and September, 1951, and now that the experiment is fully established the full complement of plots from both fields was sampled. The examination of the samples and the material extracted from them has formed a major part of the year's work. At least one further year's sampling will be necessary before a detailed analysis of results will be possible but already there are clear indications of consistent differences in the wireworm

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populations of the various leys. As the movements and oviposition preferences of the adults are likely to cause these differences it is hoped to study these factors in the coming spring and summer.

The wireworm experiment on Little Hoos has now been ended. A final sampling made in September, 1950, showed that the differences in wireworm population between the plots were consistent with the assessment of the immediate and residual effect of the treatments as measured by crop yield. Gammexane 3·5 per cent dust broadcast at 2 cwt. per acre and combine-drilled at $\frac{3}{4}$ cwt. per acre, and 41 per cent ethylene dibromide injected at 15 gall. per acre had given good immediate and residual effects. The wireworm population of these plots was greatly reduced. It was also greatly reduced on the plots in which 5 per cent D.D.T. dust had been combine-drilled. This treatment, though not having such good immediate effect as the previous three, had had a good residual effect. The populations of the plots injected with D.D. at 400 lb. per acre, and those in which the seed was treated with gammexane seed dressing showed little or no difference from the controls. These treatments, though having an immediate effect, had shown no residual effect.

*Park Grass*

The sampling of selected plots on Park Grass to study the distribution of the soil fauna has been continued. One of the most interesting results so far concerns the abundance and distribution of Protura. These primitive insects generally considered rare have been found in great numbers in some of the plots (as many as 400 individuals have been found in a single soil sample 2 in. diameter and 9 in. deep). Their abundance is strongly correlated with pH, being greatest on the more alkaline plots. From the data so far collected it is not possible to decide whether pH is itself the causative factor or whether other factors correlated with pH are responsible.

## Earthworms

(J. E. Satchell)

Progress has been made in developing the electrical sampling method for quantitative work. A water cooled electrode has been developed whereby the fall in current due to heating and consequent drying out of the soil has been reduced. Using this electrode and by stepping up the current at intervals the sampling area can be increased and the errors due to surface species, e.g. *A. chlorotica*, coming up much nearer the electrode than deeper living species, e.g. *L. terrestris*, have been reduced.

In April 1951 selected plots on Park Grass were sampled. Four sampling points were taken in each plot and the worms which surfaced in 40 minutes were collected. Of the eight species present *A. caliginosa*, *L. castaneus*, and *E. rosea* were dominant. The greatest numbers were found on the limed halves of plots 7 and 13. Only occasional worms were found on the very acid plots $4_2$ and $11_1$. Below pH 4·5 abundance was strongly correlated with pH but above pH 4.5 no clear relationship was evident. *L. castaneus* showed the greatest tolerance of acidity. The work of seeking to relate the

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distribution of the various species to other physical and biotic factors is being continued.

### Staff

Dr. G. O. Evans resigned from his work for the Forestry Commission on Soil Arthropods, and Mr. P. Murphy was appointed in his place.

Mr. M. M. Hosni of Egypt came as a voluntary worker in January 1951 for two years.

Mr. B. R. Laurence resigned from the Agricultural Research Council scholarship which he had held at Rothamsted for nearly two years.

Dr. Williams, Dr. Barnes, Dr. Johnson and Dr. Raw officially attended the 9th International Congress of Entomology at Amsterdam, and in addition Mr. French, Mr. Long and Mr. Hosni attended privately.

Dr. Williams was invited to give an address to the full Congress on "The International Aspects of Insect Migration and Insect Drift" and also to provide a paper at the Symposium on Insect Phenology.

Dr. Barnes was invited to be Chairman of the Symposium of Insect Phenology and to contribute the opening paper.

Dr. Johnson also read a paper on the Distribution of Aphids.

During the Congress the Netherlands Entomological Society elected Dr. Williams as an honorary member.

Dr. Barnes has been invited to serve on the Editorial board of "Marcellia"—the International Journal for the study of Plant-Galls.

### Visiting Scientists

Mr. W. S. Volkers of the University of Utrecht, Holland, spent two weeks in June and July studying problems of population statistics with Dr. Williams.

Mr. W. C. Nijveldt, also from Holland, spent a few weeks in the department in October to study problems of Gall Midges with Dr. Barnes and Miss Stokes.

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