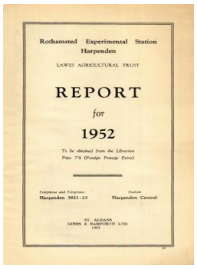
ROTHAMSTED RESEARCH

Report for 1952

Full Table of Content



Entomology Department

C. B. Williams

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ENTOMOLOGY DEPARTMENT

C. B. WILLIAMS

The work of the department continued during the year without any major change.

STAFF

C. B. Williams was elected President of the British Ecological Society.

H. F. Barnes was invited to visit Eire during July 1952 to report on an exceptionally heavy outbreak of wheat blossom midge, and to discuss future work and control measures with the Department of Agriculture of Eire.

Miss Stokes obtained her degree of M.Sc. at Reading for work on gall midges at Rothamsted. She also visited Holland for two months (June and July, 1952) to study gall midge problems in that country, working chiefly at the Institute for Phytopathological Research at Amsterdam. This visit was arranged as an exchange with Mr. Nijveldt who came to Rothamsted in 1952.

B. Singh completed his work on the problems of insects caught in suction traps near the ground, and was awarded the Ph.D. degree of London University for his thesis. He returned to India in July, 1952.

J. E. Satchell's Agricultural Research Council Scholarship was extended for a third year to enable him to continue work on earthworms.

Miss S. El Ziady came as a post-graduate worker from Egypt for about two years in the department.

POPULATION CONFERENCE

In September, 1952, a four-day conference was held in Harpenden on problems of Insect Populations under the auspices of the "Comité Européen d'Etudes de Zoologie Agricole" for which the Entomology Department of Rothamsted acted as hosts. Delegates from abroad came from France (2), Holland (2), Belgium (2), Switzerland (2) and Eire (1), with about 25 British visitors from outside Harpenden and about 25 from Rothamsted and the Ministry of Agriculture Plant Pathology Laboratory. I. Thomas of the Ministry of Agriculture was Secretary, and C. B. Williams was Chairman. Meetings were held on three days and visits were paid to Rothamsted laboratories and to Cambridge.

EFFECT OF WEATHER CONDITIONS ON INSECTS

(C. B. Williams, B. P. Singh, M. M. Hosni, Samira El-Ziady)

This work continued with ultra-violet light traps working in the Manor Wood and in the Manor garden, and suction traps in these same two localities for comparison, and also at two levels, 5 feet and 30 feet, in the Rothamsted Lodge garden. The ultra-violet traps caught about the same number of insects as the previous

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year. An analysis of these results by M. M. Hosni shows a closer relation between insect activity and mean night temperature than between activity and minimum temperature as previously used.

The analysis of the moon's effect on suction traps was continued with conflicting results, as some traps showed a lunar periodicity and others none.

Insect Migration

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

Work has consisted chiefly in completion and re-arranging our files of records, which now include over 50,000 cards. A book on the subject is in preparation by C. B. Williams and the manuscript of this is nearly completed.

The Effect of Population Density on Insects

(D. B. Long)

Certain fundamental differences which were found to exist between larvae of Lepidoptera bred in solitary and crowded conditions have been studied in greater detail. Several species examined showed differences in colouration, darker forms being generally found amongst the crowded larvae. The basis of these colour differences has been studied in three species. It was found that the hypodermis carried the colour pattern whilst the pigmentation of the cuticle which appeared to be of a melanin type was superimposed. The pigments of the hypodermis are unstable and a method of reducing the rate of their decomposition has been developed. The pigmentation of the hypodermis and the cuticle appeared to be inter-related and was governed by the condition of culture. In the case of larvae of *Plusia gamma* L., although the colour differences do not begin to appear until the fourth instar, it could be shown that the condition of culture in the early instars did influence the final colour. Variations in the degree of the colour response occurring within crowded cultures of *P. gamma* were shown by the breeding of selected lines to involve a genetic factor.

Crowded larvae had been observed to have a shorter larval duration than their solitary counterparts, taking about 80 per cent of the time of the latter to complete their larval development. It was found in *P. gamma* and *Diataraxia oleracea* L. that about a quarter of this time difference was due to the tendency of crowded larvae to pass through fewer instars. The actual number of instars is most probably directly associated with a rapid rate of development. The lower mortality in the crowded cultures also appears to be associated with the faster rate of development.

These effects coupled with the better mating opportunities afforded by large simultaneous emergences of the imagos in crowded cultures indicate the possible importance of localized population densities in the subsequent population build-up of a multi-voltine species.

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Gall Midges of Economic Importance

(H. F. Barnes, Barbara M. Stokes)

The occurrence of the wheat blossom midges on Broadbalk was studied for the twenty-sixth successive year and, as was expected, the infestation was less than in 1951. The percentage grain infestation for 1951 and 1952 was 14·2 and 7·7 respectively.

At the invitation of the Eire Department of Agriculture, a visit was paid during July to inspect the occurrence of the wheat blossom midges in Co. Cork, Co. Waterford and Co. Wexford and to assess the effectiveness of D.D.T. spraying. A report embodying recommendations was submitted to the Department.

The investigations of the swede midge was continued during the summer in the Netherlands by Miss Stokes. Possible discrepancies between the behaviour of the midge there and in England were especially studied. A report of this work has been sent to the Netherlands Institute for Phyto-pathological Research (I.P.O.) for publication.

A survey of the distribution of the new Shasta Daisy flower pest, *Contarinia chrysanthemi*, on wild Ox-eye Daisy was initiated with the co-operation of the entomologists of the National Agricultural Advisory Service and others. As a result it has already been established that this midge occurs in fourteen English counties, south of a line from the Wash to the mouth of the Severn and in Anglesey, Caernarvonshire and Cardiganshire as well as Co. Meath and Co. Wexford. Two other gall midges that may attack cultivated chrysanthemums were found to occur in wild Ox-eye Daisy flowers. The biology of these midges is being studied and preliminary experiments to test their host plant range have been started.

Among the more interesting gall midges sent in for identification have been *Asphondylia sarothamni* on ornamental broom being forced for display purposes; *Dasyneura mali*, the Apple Leaf midge, that seems to be on the increase in the eastern counties; *Thomasiniana theobaldi*, the Raspberry Cane midge, from Finland; *Dasyneura brassicae*, the Brassica Bladder Pod midge, from France; *Profeltiella soya*, the Soy Bean Stem Gall midge, from Japan; and *Contarinia sorghicola*, the Sorghum midge, from Uganda.

The gall midge collection, which now contains nearly 8,500 slides has been enriched by named material received from Canada, the United States and Germany.

Aphid Problems

Factors influencing aphid numbers at crop level, and the infestation of crops

(C. G. Johnson, Elsa Haine, L. R. Taylor, B. Johnson)

For the last twenty years weather-induced flight behaviour has been regarded as the most important factor contributing to numbers of aphids in the air. It has been shown, however, that this view may be misleading and that it is the extremely rapid changes in the size of the alate population on the crop, which occur even during the course of a few hours, which are the basic features determining the intensity of the migration over short periods during the day. The

https://doi.org/10.23637/ERADOC-1-74

effects of this population change may overwhelm changes in proportion taking flight due to weather. Most dispersal occurs at relatively high winds. What appear to be important now are the weather factors and conditions of crop layout which encourage aphids to alight. Calm weather and shelter is not the prerequisite of migration, as formerly thought, but it is important for the maintenance of those high concentrations in the neighbourhood of plants which is so significant in virus transmission.

B. Johnson is studying the flight of aphids with reference to the factors which determine the frequency, duration and cessation of flight. This links with the work mentioned above and also with the deposition of aerial populations being studied, in collaboration, at Cardington and at Sutton Bonington.

A detailed study was made in 1952 of the three most important phases which, as the above work has shown, lead up to migration. In this work Dr. E. Haine has collaborated actively. These three phases are the moulting periodicity underlying the rhythmical production of alatae, the duration of the pre-flight period before migration during which the aphids mature but will not fly, and the actual departure by flight. The first two appear to have more influence on the timing and intensity of migration than the last.

Dr. Haine is investigationg factors which determine the rhythmical sequence of alate production.

The investigation of infestation patterns on bean fields in relation to wind direction continues in collaboration with Mr. C. E. Taylor of Sutton Bonington.

In the problem of wind dispersal of aphids our suction traps for use on barrage balloons at Cardington have been redesigned and remade. One of the greatest difficulties in investigating aphids occurring at high altitudes is to sample enough air to obtain a sufficient number of aphids for statistical analysis. The larger the suction traps the fewer can be carried by the balloon to a desirable height. To overcome these difficulties two very large light-weight traps are being constructed. The Royal Society has given a grant of £100 towards this.

Data from Cardington from the four past years is being analysed.

The natural enemies of aphids (C. J. Banks)

The preliminary observations on the predators of the Black Bean aphid, *Aphis fabae* Scop., carried out in 1951 have formed the basis of further studies in 1952. Special attention was paid to the population changes of Coccinellidae which were particularly abundant.

Populations of these in their overwintering quarters, on stinging nettles and on three experimental bean plots, were investigated.

There were large fluctuations of numbers on the bean plots and it was possible to associate these with the parallel changes on the nettles; information obtained from the numbers caught in two suction traps was of especial value in this connection.

Populations on the three plots varied considerably during the 8–9 weeks of the infestation by the aphid, both within and between

https://doi.org/10.23637/ERADOC-1-74

plots, but showed a close correspondence of egg numbers with the populations arriving from overwintering quarters and from the nettles. Larval populations of the plots also showed marked differences between plots but they could be reduced to a common type, the variations from week to week being largely caused by fluctuations in the numbers of eggs laid the week before.

The female beetles usually lay their eggs at random and the adults themselves may be distributed at random on the bean stems. The emerging larvae are, therefore, frequently in unfavourable positions for food and, when their population density is high, resort to cannibalism. Destruction of the eggs by the larvae was a common phenomenon on one of the plots which was conspicuous for its high density of all stages of Coccinellidae.

Work on Syrphidae was also continued. The non-random distribution of eggs and larvae of these Diptera, noticed last year, was confirmed by the field work of 1952. Unlike the Coccinellidae, female Syrphidae tend to lay their eggs on the most heavily infested stems and often among the aphid colonies, with the result that the emerging larvae are well supplied with immediate food. The abundance of various species of adult Syrphidae flying over bean plots during the spring and summer was estimated by the use of the suction traps and an attempt has been made to associate these numbers of adult flies and of eggs and larvae with the populations of aphids.

In confirmation of similar work of 1951, it was observed that the aphis infestations were well established at a time when adult Syrphidae were scarce in the traps and by the time that the flies had once more become adundant, the infestations by *A. fabae* were almost over. It is probably significant that in the three plots, high aphid numbers were associated with low larval populations.

Soil Arthropod Problems

Agriculture (F. Raw, 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 1952 and their examination has again formed a major part of the year's work. The results to date reveal two important features of the build-up of wireworm populations in leys.

1. Starting from the low population resulting from three years' arable cropping wireworm numbers can rise during three years under grass to a level at which damage to crops would follow ploughing up.

2. Under similar circumstances there appears to be relatively little build-up of population during three years under lucerne. Unfortunately because of the use of D.D.T. to control weevils on some of the lucerne plots, all the plots could not be included in these observations.

The rapid build-up under grass is of interest because it was generally supposed that build-up from old arable conditions would be slow and farmers using short leys might thereby avoid wireworm attacks. We still know very little about the behaviour and move-

https://doi.org/10.23637/ERADOC-1-74

ments of adults in the field and the extent to which build-up of population depends on oviposition by adults emerging within the field or by adults migrating from surrounding fields. In the ley and arable experiment with small contiguous plots migration may be considerable.

The small build-up under lucerne is of particular interest as it substantiates farming experience which has tended to show that wireworm attacks following lucerne leys are unusual. Where farmers wish to take potatoes as their first crop after a ley, and where chemical control is precluded, lucerne leys may be valuable.

In collaboration with the Insecticides Department a follow-up of the 1947–50 experiments on chemical control of wireworms has been started. The new experiment is designed to test the direct and residual effects of aldrin, chlordane, B.H.C. and D.D.T. in winter wheat. There was some difficulty in finding a suitable site and five fields on the farm were sampled before a site in Geescroft was selected. The initial wireworm population of the field while still under grass was approximately $2\frac{1}{2}$ millions per acre. During 1952, the first year out of old grass, the wireworm attack was slight and at harvest no significant difference in yield between treated and control plots was recorded.

Park grass

The study of the distribution of arthropods in selected Park Grass plots representing varying environmental conditions has been continued and progress has been made in the difficult task of identifying certain groups.

Of the various factors with which it has been sought to correlate insect abundance, pH has attracted most attention. It is felt, however, that other physical or biotic factors correlated with pH rather than pH itself are the operative factors in determining insect abundance. For example mycetophylid larvae (*Sciara* sp.) are very abundant on the extremely acid plots but their abundance is presumably linked with the increased fungal activity under such acid conditions rather than with acidity itself. Other insects, e.g. Protura, are more abundant on the alkaline plots but the reason for this is still obscure. Our work to date has emphasized the need for further work on the biology, and in particular the feeding habits, of many of the insects and also for further surveys of insect distribution in relation to soil types and conditions for comparison with the Park Grass plots.

Earthworms (J. E. Satchell)

In April 1952 selected plots on Park Grass were again sampled by the electrical method. The population estimates obtained agreed closely with those of 1951 and an account of this work is in the course of preparation for publication.

The relationship between the six most abundant species and various physical and biotic characteristics of the plots was studied. The percentage in the total flora of *Agrostis vulgaris*, *Dactylis glomerata* and Leguminosae gave significant simple regressions on most of these species but this was largely an indirect effect of soil pH. No connection between earthworm populations and the mois-

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ture content of the plots was found. The most densely populated plots are those receiving organic manure but owing to the lack of an appropriate method of chemical analysis, the effect of soil organic matter on earthworm populations could not be demonstrated.

The regressions of pH on *Allolobophora caliginosa*, *Eisenia rosea*, *Lumbricus castaneus* and *Lumbricus terrestris* were highly significant but on *Allolobophora nocturna* and *Octolasium cyaneum* they were not significant.

Earthworms kept in the laboratory would not enter soil from the most acid plots and over a critical range, six species, including *A. nocturna* and *O. cyaneum*, were sensitive to changes of pH 0·2 in acidity of aqueous solutions.

The soil acidity complex, in relation to its effect on earthworm populations, is being further investigated.

Forestry (P. W. Murphy)

Considerable progress has been made in the examination and analysis of samples obtained in previous years. It is now possible to give a broad outline of the faunal population occurring in natural and cultivated heathland. The table contrasts the total population of arthropod organisms in natural heathland with that occurring in cultivated heathland planted with Sitka Spruce (trees 20 years old and forming canopy). These populations represent 570,000 and 835,000 individuals per square metre respectively, or 2,300 and 3,380 million per acre. The population in the natural heathland is concentrated in the surface layers, 96 per cent of the total being present in the first 2¼ inches of the profile. The cultivated heathland with trees shows two zones: the litter layer on the surface where 40 per cent of the population occurs and the raw humus "sandwich" formed in the "ploughing" process which contains 54 per cent of the population.

Qualitative structure of the arthropod fauna occurring in heathland

Sample type	Total population per sample (500 cc.)	Acari	Collembola	Other arthropods
		%	%	%
Natural Heathland ..	998	95·2	3·8	1·0
Cultivated Heathland plus Sitka Spruce ..	1462	90·5	8·1	1·4

The qualitative structure of the population is indicated in the table, the most striking feature being the preponderance of Acari in both habitats. However, owing to the great variations from sample to sample, these figures should be regarded merely as broad indications. The Collembola figures are particularly subject to violent fluctuations from sample to sample and it is probable that they are here represented by minimal values.

In the 1950–51 report attention was drawn to the occurrence of a species of the Acaridiae in natural heathland. This mite (*Schwiebia* sp.) is of interest because although forming only 5 per cent of the total population, its distribution shows a marked zoning in the profile. There tend to be two peaks, one in the lower part of the raw humus horizon (just below the main faunal concentration)

https://doi.org/10.23637/ERADOC-1-74

and the other in the organic material above the pan. At the second level this mite is virtually the only arthropod representative.

The main laboratory work in connection with an experiment designed to test the effect of various methods of sample preparation for extraction in modified Berlese funnels has been completed. The principal methods tested were (1) undisturbed samples of various depths, (2) disturbed samples, (3) sample orientation, and (4) effect of sample storage.

At the same time an effort was made to relate population movement to moisture content of sample. At the time of writing the experimental data have not been analysed, but the following more obvious preliminary findings may be mentioned:—

1. The tendency for the arthropod fauna (except some predatory species) to remain in the sample until a certain critical moisture content is reached.
2. Larger populations were recovered from undisturbed samples ½ in. deep, than from those of greater depth.
3. Much larger populations were obtained from undisturbed than disturbed samples, though it is interesting to note that one or two species recovered from the latter samples were rarely present in the undisturbed samples.
4. Sample storage (at room temperature) had a somewhat deleterious effect on the populations recovered though the effect was not as marked as one would expect.
5. Extraction with the funnel air temperature 30–35°C was more efficient than at room temperature.

It should be stressed that these results were obtained with *Calluna* heathland samples, and do not necessarily apply to other habitats.

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