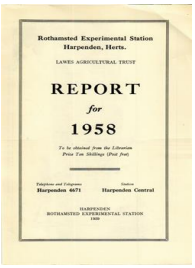
ROTHAMSTED RESEARCH

Report for 1958

Full Table of Content



Entomology Department

K. Mellanby

K. Mellanby (1959) *Entomology Department ;* Report For 1958, pp 133 - 145 **- DOI: https://doi.org/10.23637/ERADOC-1-91**

ENTOMOLOGY DEPARTMENT

K. MELLANBY

P. W. Murphy, who had been working on the biology of forest soils since 1951, left in September 1958 on appointment as lecturer in Agricultural Zoology in the University of Nottingham. D. S. Madge, Agricultural Research Council Scholar, and B. S. Miller, Professor in the Department of Flour & Feed Milling Industries, Kansas State College, holding a National Science Foundation Senior Post-doctoral Research Fellowship, joined the department. C. G. Johnson continued his secondment to the West African Cocoa Research Institute in Ghana for the whole of the year.

H. F. Barnes obtained special promotion to the Grade of Senior Principal Scientific Officer; all his colleagues greatly appreciated this deserved recognition of his contribution to research.

During July the Station, and the Entomology Department in particular, were hosts to the Colloquium on Research Methods in Soil Zoology, organized on behalf of the Soil Zoology Committee (Biology Commission) of the International Society of Soil Science. The full brunt of the work fell on P. W. Murphy, the organizing secretary and editor, but most members of the department assisted and presented communications or demonstrations.

K. Mellanby was elected President of the Association for the Study of Animal Behaviour. J. W. Stephenson was awarded the degree of M.Sc. London University.

R. M. Dobson gave a course on " Life in the Soil " at Flatford Mill (Field Studies Council) in August. K. Mellanby gave a paper on " Acclimatization of Insects to Low Temperatures " in the symposium on " Life at Low Temperatures " at the British Association meeting in Glasgow, and a course on " Recent Advances in Biological Science " to the school for junior clergy of the Church in Wales at St. David's College, Lampeter, in September.

The new glasshouses and insectaries were built, and work is in progress to complete the installation and regulation of the heating and ventilating system. The building planned as a " potting-shed " has been adapted as a soil zoology laboratory and houses three workers. These additional facilities should increase the scope of the department considerably.

INSECT PHYSIOLOGY AND BEHAVIOUR

Work on fundamental problems relating to insect physiology and behaviour, particularly as these are affected by climatic conditions, has continued. This work is closely related to many of the investigations described in later sections of the report, and the intention is that this relationship should become closer, but at present certain lines of study are still distinct.

Further results have been obtained showing the rapidity and

https://doi.org/10.23637/ERADOC-1-91

importance of acclimatization to many species of insect. Acclimatization, complete in under 24 hours, affects not only the position of the cold and heat death points, but also may have a profound effect on behaviour. The importance of these effects on behaviour, rather than on survival, is receiving increasing attention, for the majority of species of insects seldom experience lethal exposures to extreme temperatures.

Effects of moisture have been studied further. Drinking by insect larvae has been shown to be important in several more species, including the European corn borer (*Pyrausta nubilalis* (Hbn.)), a serious pest of maize in North America. Water gained by drinking is important in enabling insects to survive unfavourable conditions of temperature and humidity. Work on fat metabolism also continues. (Mellanby and French.)

Insect Pests at Rothamsted

Periodic inspections of the crops at Rothamsted for insect damage have continued, and advice has been given when requested by other departments. On the whole, little serious damage from insects has been seen in 1958. The spring migration of the bean aphid was small, attacks on experimental or commercial crops of beans were light. Damage by bean weevils (*Sitona* sp.), though it occurred in most areas, was slight. Patchiness in spring wheat in one section of Delharding was thought to be due to leather-jackets (*Tipula* sp.), although no larvae could be found to confirm this diagnosis from the typical damage observed.

The oats planted on 25 March showed little frit-fly attack, though later experimental crops were heavily infested (see p. 135 below). Wheat-bulb-fly attack was insufficient to cause material losses in any of the wheat crops. (French.)

Frit-fly Investigation

Work was begun in this department in the autumn of 1957. During the winter preliminary observations on the distribution of larvae were made. In April a comparison was started on the infestation of two adjacent areas of the oat varieties Eagle and Sun II; this was done as part of a National Agricultural Advisory Service co-operative experiment, but we were able to make some additional observations. A number of small patches of oats were also planted on different parts of the farm, and the frit population was studied in them also. A comparison was made of the efficiency of different methods used for trapping adult frit flies. Grain samples from these experiments are still being examined, and the results are being analysed.

It was confirmed that frit-fly attack can stimulate tiller production in oats. An area of Sun II, sown 25 April 1958, was partly covered by terylene cages from 15 May to 16 June (while most frit flies were egg-laying); this completely protected the oats from tiller attack. Another part of the crop was sprayed with DDT twice (12 May and 22 May); this reduced the infestation to one-third. The table shows that, from 80 plants in each sample, the uninfested

https://doi.org/10.23637/ERADOC-1-91

plants had on an average 2 tillers, and the heavily infested sample had 4·9 per plant.

	Control	DDT sprayed	Caged
Tillers	356	292	165
Tillers attacked	139	39	0
% attack	39·1	13·4	0

(Riches, Mellanby and French.)

Insect Migration

The most notable migration reported this year was that of the Diamond-Back moth, *Plutella maculipennis*, an insect which may be a serious pest of cruciferous plants. This did not occur at Rothamsted, but many reports from the north-east coast of England and the east coast of Scotland were received, showing that thousands of millions of moths appeared about 28 June. Although some damage to crops was reported, even where no spraying of insecticides was possible this was of little importance, as the cold wet weather seemed to reduce the number of caterpillars produced by the migrants to quite small numbers. So far the exact source of this migration has not been fixed; Scandinavia was also subject to it, so Russia seems the probable place of origin of the moths.

Most regular migrants were recorded in 1958, as in 1957, in low numbers. There was a very early immigration of many species in the latter half of February, but further immigration was halted by a spell of cold and wet weather, and these species did not appear again until the beginning of May. These immigrants did not increase in numbers greatly by breeding in Britain, because of the cold weather, and it was not until a further late immigration in August and September that the Painted Lady (*Vanessa cardui*), the Red Admiral (*Vanessa atalanta*) and the Silver Y moth (*Plusia gamma*) became at all common. In the earliest migrations some of the less-common species (e.g., *Laphygma exigua*, *Heliothis peltigera*, *Plusia ni* and *Nycterosea obstipata*) were present in relatively greater numbers than usual. The migrant hawk moths, in particular the Humming-bird hawk moth (*Macroglossa stellatarum*), were to be found in only small numbers throughout the year. (French.)

Experimental Ecology of Mites Inhabiting Moss and Lichen

The mite population of various habitats is being studied, and the behaviour and physiology of the different species investigated. (Madge and Mellanby.)

Gall Midges of Economic Importance

Gall midges, either of known or of potential economic importance, show great population fluctuations. Investigations are primarily aimed at explaining these fluctuations, and in establishing more accurately the relationship between various gall midges and their host plants. This latter work has been extended during 1958 to include a biochemical examination of susceptible and resistant

https://doi.org/10.23637/ERADOC-1-91

varieties of wheat in relation to hessian-fly (*Mayetiola destructor*) attack. In the first instance, qualitative identifications of the amino acids, organic acids, sugars and phenolic compounds present in the tissues of various wheat varieties which range from very susceptible to totally resistant are being made. Another new line of work concerns the nature of the damage done by the midge *Contarinia tritici* to wheat grains; the effect on milling and baking quality is being studied.

The long-term study of the wheat-blossom midges, *Contarinia tritici* and *Sitodiplosis mosellana* on Broadbalk reached its 32nd consecutive year. As expected, the infestation by both species increased markedly in 1958 over the 1957 level. (*C. tritici* from 4,596 larvae per 500 ears to 14,550; *S. mosellana* from 602 to 1,969. Grain infestation increased also.) In the insectary a new record was established; one *S. mosellana* adult emerged 17 years after the larva fed and entered diapause.

Studies are being made to determine the actual field resistance of different wheat varieties to *C. tritici* and *S. mosellana*. It has been found, for instance, that though the variety Atle has been described as resistant, it is in fact quite susceptible if ear emergence coincides with midge emergence. Dates of ear emergence of winter wheats (Hybrid 46, Square Heads Master) and spring wheats (Svenno, Atle, Fylgia II) on experimental plots are being related to emergence and oviposition of midges on the open and in the insectary.

Larval descent from the wheat to the soil has been studied at Rothamsted and at Cockle Park, Durham. The date of descent varies considerably, not only from widely separated areas, but even from field to field on the farm. Thus in 1958 the descent of *C. tritici* larvae, started about 9 July on Capelle wheat on Pennell's Piece, about 20 July on Plot 8 of Broadbalk and even later on other fields at Rothamsted.

Last year *Stenodiplosis geniculati*, one of the Meadow Foxtail seed midges, was shown to be breeding on Timothy grass at Rothamsted. In 1958 National Agricultural Advisory Service entomologists have shown that it also breeds on Timothy grass in Cardigan, Merioneth, Derbyshire, Oxfordshire and Buckinghamshire.

Data are being accumulated regarding the speed at which the life cycle is completed by the hessian fly, in the open glasshouse and in the laboratory. In the open glasshouse the quickest cycle (31–33 days) was found in June and July; later the period increased (45–51 days) and no adults emerged the same year from eggs laid after the end of August, as the larvae overwinter in puparia. Transfer of these to warm conditions shows that some adults may emerge quite soon, but the response to heated-room conditions has been very variable. To try to elucidate this point, and also to provide adult material for other experiments at all times of year, the effects of controlled temperature and humidity conditions on emergence are being investigated.

The importance of the genus *Mayetiola*, in addition to the hessian fly, indicates that further study is required. A species of *Mayetiola* damaged *Poa pratensis*, and another species destroyed a field of cocksfoot. Both these grasses are grown for seed crops. A new

https://doi.org/10.23637/ERADOC-1-91

species, *Mayetiola schoberi*, has been described from *Poa pratensis* in Germany.

Preliminary studies of gall midges in the stubble of oats, wheat and several species of grass have shown that several species are concerned; they may be of importance in the breakdown of stubble, but their biology has not yet been worked out.

Advisory and taxonomic work has continued, and inquiries have been received from Germany, Sweden, Turkey, the U.S.A. and, through the Commonwealth Institute of Entomology, from Aden, Cyprus, India and South Africa. Close touch has been maintained with the National Agricultural Advisory Service. Several specialist workers have visited the department and consulted the Barnes collection; mention may be made of the visit from 13 to 27 March of Dr. E. Möhn of the Staatliches Museum für Naturkunde in Stuttgart. (Barnes, Arnold and Miller.)

Studies on Slugs

Weekly collections of slugs have been continued throughout the year in a Harpenden garden. The numbers and weights of those collected correspond to those in collections made by H. F. Barnes from 1941 to 1945. Particular attention has been given to the study of *Arion hortensis*, *Arion subfuscus*, *Agriolimax reticulatus*, *Milax budapestensis* and *Milax sowerbyi*. Study of the gonads of these slugs has given information about the breeding and feeding habits. (Cochrane and Barnes.)

Wheat-bulb-fly Investigations

(*Leptohylemyia Coarctata*)

Field studies

The two field experiments, begun in 1957 in commercial farms, Herkstead Hall and Fowes Farm, in Essex (*Rep. Rothamst. exp. Sta. for 1957*) have been completed. Each was planned to obtain information about the effect of different tilths on oviposition, the effect of plant and shoot density on larval survival and the effect of infestation on yield.

Egg counts made at the end of the oviposition period showed that the fallow treatments had induced different levels of infestation (*Rep. Rothamst. exp. Sta. for 1957*) and confirmed the results of an earlier experiment done at Rothamsted (*Rep. Rothamst. exp. Sta. for 1954*) which showed that a rough tilth and cultivation during the oviposition period both resulted in heavier infestations than did a smooth tilth or no cultivation.

To study the effect of plant and shoot density on larval survival each experiment was drilled at two seed rates on split plots to obtain contrasted plant and shoot densities. Estimates of plant infestation in spring showed that more larvae per unit area were found in the split plots drilled at 3 bushels/acre than in those drilled at a lower seed rate for each of the four levels of infestation studied. Soil samples taken after pupation showed corresponding differences in the numbers of pupae in the split plots.

The yield of each split plot was taken at harvest. At Herkstead

https://doi.org/10.23637/ERADOC-1-91

Hall a long delay in applying a spring dressing of nitrogen seriously retarded growth on some plots and vitiated the results. At Fowes Farm no effect of infestation on yield was detected, although the infestations ranged from 150,000 to 900,000 larvae/acre on the split plots sown at 3 bushels/acre and from 45,000 to 450,000/acre on the split plots sown at $\frac{2}{3}$ bushel/acre.

Effect of plant and shoot density on survival of wheat-bulb-fly larvae

1 April 1958

	Herkstead Hall		Fowes Farm	
Seed rate	3 bushels/ acre	1 bushel/ acre	3 bushels/ acre	$\frac{2}{3}$ bushel/ acre
Plants (thousands/acre)	900	360	930	314
Shoots (thousands/acre)	3,220	1,475	4,440	1,950
Infestation ratio:				
Larvae	1·6	1·0	2·8	1·0
Pupae	1·4	1·0	2·7	1·0

In practice, early sowing is recommended so that growth and tillering is well advanced by the time the wheat-bulb-fly larvae hatch. The experimental results showed that an early sown crop can withstand heavy attack without a reduction in yield. They also indicate that an early sown crop favours survival of the pest better than a late-sown one because it will have tillered more. This may mean that culture methods which reduce damage in the current year may increase the fly population and the possibility of damage in succeeding years. (Raw and Lofty.)

Field studies on emergence, survival and activity

A marking experiment was again made in a field cage on Pennell's Piece during the summer. A cage twice as large as before was used (i.e., 24 × 24 × 6 feet), and by dividing the enclosed crop into small plots, and thinning and weeding when necessary, observations were made without touching the plants or disturbing the flies. The observations gave much information on emergence, longevity, movement and individual behaviour, but the full results have yet to be analysed. (Dobson.)

The results of two experiments using marked flies to investigate movement in the field are also still being analysed. (Dobson and Long.)

Larval studies

The spring survey of larval infestation in winter wheat after fallow showed a slight rise over 1957 (428,000 larvae/acre as against 370,000 larvae/acre) on Broadbalk. On the Alternate Wheat and Fallow, however, the level fell again, to 168,000 larvae/acre. These two areas had very similar populations in 1954–56, but this experiment has reduced the area of bare land available in summer in the alternate wheat and fallow, and this reduction has coincided with a halving of the larval population. This may indicate that the width of these long, narrow plots has reached a critical value, and further work on the effects of this on the behaviour of the fly is being planned.

The experiment on the alternate wheat and fallow using seed

https://doi.org/10.23637/ERADOC-1-91

rates of $\frac{1}{3}$ and 3 bushels/acre has continued. This season one striking result of a non-entomological nature was the demonstration that, on this very poor soil, the young wheat sown at $\frac{1}{3}$ bushel/acre looked very much better nourished (colour, size of plant) than did that sown at the more normal rate of 3 bushels/acre. It was confirmed that the rate of larval infestation was higher in the denser sowing, but there is some evidence that the flies developed better in the thinly sown wheat. The thinly sown wheat was no more attractive to the egg-laying female than the denser areas.

Larvae are known to locate plants by chemotaxis, as they move up the increasing gradient of exudate from the growing plants. An attempt was made to " confuse " larvae by destroying this gradient. An aqueous solution of exudate was prepared from some 2,500 plants each week. This was sprayed at weekly intervals on 25 plots each of 4 sq. ft. of wheat following fallow from 3 January to 12 March. 1,700 plants were growing on the sprayed areas. Samples taken on 18 March showed 14·8 per cent more larvae in these samples than in samples from control (unsprayed) plots. This suggests that the sprayed exudate attracted larvae from outside, and that this more than offset any confusion caused by the spray. Preliminary analyses suggest that the active ingredient in the exudate is a protein or protein-like substance.

A detailed analysis of data on larvae infestation covering the last 5 years has been undertaken in collaboration with Marjory M. Morris of the Statistics Department. The incidence and distribution of some 8,900 larvae in 42,000 plants is being studied, and the results may increase our understanding of the interaction between the larva and the host plant. The results suggest that differences in " quality " between individual stems may influence the distribution and success of the infestation. This " quality " may be associated with the age of the stem. (Long.)

Aphid Ecology and Insect Dispersal

The distribution of insects in the air

Much information has been accumulated about the number of insects present at various heights in the air. Those records at high levels, from 50 to 20,000 feet, have already been treated collectively, by Johnson (*Rep. Rothamst. exp. Sta. for 1956*), and shown to produce a definite pattern of insect density in relation to height. This suggests a dependence of some insects upon physical factors for their upward, and consequent horizontal, dispersal.

At lower levels, up to 50 feet, there is also much information, collected over the last 30 years, but it is difficult to analyse because of the method of collection, which usually measures, not insect density, but the flow of insects past a point. This quantity depends as much on wind speed as on insect numbers. An attempt has now been made to collect the material together and make allowance for this error of measurement. The results suggest strongly that previous conclusions based on these records, which maintained that many species of small insect fly at specific heights, are probably due to an artifact of the sampling methods used. It also appears that, with these small insects, thrips, aphids, psocids, frit fly and even

https://doi.org/10.23637/ERADOC-1-91

coccinellids, the density diminishes in a fairly regular way with increase in height. This is understandable if the majority of flight occurs when the wind speed exceeds the insect's flight speed, as is probably true with such day-flying insects. The information about larger insects is more limited, and has not yet produced any conclusive results. (Taylor.)

Temperature and development

The work of relating growth in *Aphis fabae* to temperature has been started in the laboratory in order that population growth in the field may be related to temperature and hence to time (*Rep. Rothamst. exp. Sta. for 1957*). The time taken by *A. fabae* nymphs, feeding on broad beans, to develop from birth to the final moult has been measured at constant temperatures in the laboratory. It varies from more than 40 days below 8° C. to a minimum of 4·7 days at 29–30° C., and above this temperature it increases again. Humidities varying from 15 to 85 per cent (relative humidity) do not greatly affect these times, although mortality is apparently influenced by humidity.

The duration of development was also measured in a glasshouse, where the temperature fluctuated daily and reached a maximum of 31° C. and a minimum of 7° C., and where humidity also varied over a wide range. The expected time for the final moult, calculated from the results at constant temperatures, was within 5 per cent of the measured time in this preliminary trial. These measurements will be repeated with more critical temperature records to see how accurately the effect of constant and fluctuating temperatures coincide, i.e., to find out if temperature is the sole external factor affecting the rate of development of an aphid on a given host. (Taylor.)

Reproduction in Aphis fabae

The reproductive capacity of various forms of *A. fabae* has been examined under constant conditions. It seems that all spring and summer virginoparae, apterous and alate, have the capacity to generate, on the average, about ninety-five nymphs. This is independent of the host they are reared on and whether they come from the field or from a culture of many generations of virginoparae. But the ability to produce these nymphs alive depends primarily on the longevity of the parent. This in turn depends on two major factors: the reserves present in the newly matured adult and the food available during reproductive life.

The biggest factor affecting reserves is the absolute size of the aphid. In order to live to its full term of about 30 days at 20° C. an aphid must exceed a certain minimum size. This creates a strong bias against the chances of an alate completing its reproductive function even if it finds a suitable host, for the average size of field alates is well below this critical value. Aptera, on the other hand, are usually large enough to live for 30 days provided they have enough food to continue reproducing. Shortage of food does not stop the aphid reproducing, so that it might continue to live on the material available, but the aphid starves to death while reproduction continues in full spate. Autumn winged forms may not behave

https://doi.org/10.23637/ERADOC-1-91

in the same way, but the evidence is so far very limited. The basic reproductive potential of sexual forms has not yet been established. (Taylor and Cockbain.)

Flight studies in Aphis fabae

The nature of the reserves used during flight by *Aphis fabae*, their distribution in the body and their depletion during flight were studied in aphids flown tethered to pins in a wind tunnel under controlled conditions. Both glycogen and fat were used, the main reserves of which are in the fat body cells of the abdomen and thorax, and in the flight muscles themselves. During the initial period of flight, glycogen is used, but within a short time this reserve shows signs of depletion and the fat is then mobilized. From the first hour of flight, the total fat content decreases uniformly. After a flight lasting 6 hours the decrease in fat represents about 90 per cent of the total energy transformed.

The factors affecting the duration of tethered flights were also studied. Aphids flown in this manner can fly for several hours, the actual duration before fatigue sets in depending on temperature and the amount of initial reserves. The temperature at which cultured aphids flew longest was just above the flight threshold, i.e., 16–17° C. Presumably an increase in the rate of metabolism and a greater water loss shortened flights at higher temperatures. The duration of flight at a constant temperature is closely related to the initial fat content. During flight, water is lost by evaporation, and the total decrease in water content depends on the temperature and humidity of the air. The importance of evaporation of water from the insect's body in stopping flight is difficult to assess, however, for some fluid is directly lost by excretion during flight.

Work has also proceeded on the effect of flight fatigue on the subsequent reproduction of the flight-exhausted parent. Results indicate that large aphids, even when flown to exhaustion, can still settle on a suitable host plant, feed, reproduce and establish a colony. Mortality of the nymphs produced by flight-exhausted alates appears to be no higher than in nymphs born of parents which have flown for several minutes only as opposed to several hours.

Field studies of alighting and growth of populations were planned for this season, as well as a second experimental investigation of the effect of planting date on aphid colonization. However, there was a very poor primary migration, and an equally poor growth of populations during the summer due to climatic conditions, mainly low temperature. The complete failure of this aspect of the work was finally ensured by the drift of insecticidal spray into the experimental plot. (Cockbain.)

Earthworm Studies

Rehabilitation of marginal grassland

Observations have continued on the field experiment at Lancaster begun in 1954 to investigate the influence of earthworms on the rehabilitation of marginal grassland. Soil samples were taken in April and November to estimate numbers of earthworms and cocoons. These confirmed the result obtained in 1957 that the

https://doi.org/10.23637/ERADOC-1-91

plots initially treated with lime and phosphate now have much higher populations than the other plots. So far no effects of dung or artificial fertilizers applied after this initial treatment have been detected. The population of plots initially treated with lead arsenate to eliminate all worms is still very low, though the November samples showed some evidence that one species, *Eiseniella tetraedra*, was increasing in numbers on some of these plots.

In November the samples were divided and the mat and mineral soil examined separately. Few worms were found in the mineral soil, and pH determinations showed that there is still a steep gradient of pH in the soil profile. This suggests that pH may be limiting burrowing, though waterlogging and aeration may also be involved. Another dressing of lime and phosphate will be given soon, and thereafter an annual maintenance dressing of lime will be given.

Tests made on the November samples showed that about half of the worms in the mat samples were missed by hand sorting but were recovered by a washing method. Most of these worms were small, and more were missed in wet samples than in dry. To avoid this selective loss the washing method will be used in future.

Material has been collected for laboratory work on some problems of earthworm biology relating to the field experiment. (Raw and Dobson in conjunction with Mr. E. Crompton of Durham University.)

Earthworm populations in orchards

In four orchards near Wisbech which have received different manurial and fungicide treatments, J. M. Hirst estimated the survival of apple leaves between leaf fall and spring and we estimated the earthworm population. In one orchard, where 85 per cent of the leaves survived, we found few worms, in the other three, where only 2–15 per cent of the leaves survived, we estimated there were 300,000–500,000 worms/acre (*Rep. Rothamst. exp. Sta. for 1957*). Six species of worms were found and, of these, *Lumbricus terrestris* removed most leaves from the soil surface in pot experiments.

An experiment has now been started to estimate the rate at which earthworms in orchards bury leaves. Ten wire cages each 2 feet square, contained 100 apple leaves of known fresh weight and estimated dry weight, have been placed in each of seven orchards, five grass and two arable. Ten *L. terrestris* were added to two cages in each orchard. The number of leaves pulled into the soil and the decrease in dry weight of the remainder will be recorded, and the earthworm population under the cages will be estimated. (Raw and Stephenson.)

Biological studies

Effects of environmental factors, particularly temperature and soil moisture, are being investigated in the laboratory, using several species of earthworm. Changes in body-weight, cocoon production and the onset of aestivation are among the reactions being noted. These experiments are planned so that the results may show what environmental conditions are optimal, and which are, in varying degrees, unsuitable for the different types of worm. Field observations are being made to supplement the laboratory experiments.

https://doi.org/10.23637/ERADOC-1-91

For instance, records are being kept of surface activity of worms at night, in relation to changes of air and soil temperature.

Field experiments on worm biology have made it necessary to sample the population in the areas under consideration, so that we may know what worms are being investigated. The reliability of existing sampling techniques has therefore been reassessed. Digging and washing the soil seems to be the only reasonably accurate method. Electrical and poisoning methods bring only a small proportion, perhaps less than 10 per cent, of the worms to the surface. Some poisons (e.g., Mowrah meal, permanganate) bring these worms up in a few minutes; others (e.g., rotenone) take several days to act.

Knowledge concerning the food of earthworms is still scanty. Several species appear to feed on dung, though we do not know what part of the dung they assimilate. Preliminary experiments on cellulose digestion and the effect of earthworms on soil organic matter have been made in collaboration with N. Walker of the Soil Microbiology Department. (Gerard, Raw and Mellanby.)

Ecological Studies on the Natural Enemies of Aphids

The study of the association of the garden ant (*Lasius niger*) with the bean aphid (*Aphis fabae*), started in 1956, was continued in 1958. Experiments were made to assess the degree of protection given to *A. fabae* by the ant against attacks from the aphid's insect enemies; the effects of various predator species in reducing known populations of the aphids on bean plants were also assessed.

The results confirmed the earlier finding that the protection given by the ants against Coccinellid larvae, whether large or small species, was almost complete, so that the aphids were able to feed and reproduce unhindered; but these predators were able to destroy many of the aphids when they were not ant-attended.

The aphids were also protected from the attacks of Anthocorid bugs which, probably because of their small size, were not very effective in killing many aphids.

Syrphid larvae were able to eat very few aphids attended by ants, but quickly destroyed many aphids in the absence of ants; despite their large size, they were able to find and destroy aphids hidden in crevices on the plants which small predators like Anthocorids can also do. Chrysopid larvae were also attacked by the ants, which, however, protected aphids less completely against these predators; Chrysopid larvae can also destroy many aphids in the absence of ants.

The parasitoid wasp, *Aphidius* sp., was not attacked by ants and did in fact destroy more ant-attended aphids than aphids which were not so attended.

Field experiments confirmed the effectiveness of Syrphid larvae in killing many aphids on bean plants. These predators appear to be very efficient individually, and their importance, unlike that of Coccinellids, appears to have been underestimated, no doubt because they are not so conspicuous.

The study of the ecology of *Aphis fabae* and its control by natural enemies, started in 1956, continued in collaboration with M. J. Way

https://doi.org/10.23637/ERADOC-1-91

of the Insecticides Department. Many aphid eggs had overwintered on some of the spindle trees selected for special study, but many of the nymphs which emerged in February did not survive the cold weather throughout that month. Predation by Coccinellids and Anthocorids, which were very abundant, further reduced the aphid populations on spindle in the early spring. Consequently, relatively few aphids migrated and colonized spring beans in May and June, and Coccinellids and Anthocorids again took their toll. Later, in July, Syrphid larvae were especially abundant and were responsible for eliminating many colonies of the aphids on beans.

Small aphid populations continued on beans in August and September, and sufficient winged forms were produced in September and October on sugar beet and weeds like *Chenopodium* to provide a substantial build-up of aphid populations on spindle in the autumn. A detailed study of the mortality of the overwintering eggs of the aphid is in progress. (Banks.)

Biology of *Aphis Fabae*

Work on the feeding and excretion of *Aphis fabae* was resumed. By allowing the aphid nymphs to feed on bean plants made radioactive in water culture containing ^{32}P and measuring the radioactivity of the insects and their excreted honeydew, the amount of food ingested and material excreted during various times of feeding was estimated. (Banks with H. L. Nixon of Plant Pathology Department.)

Studies are in progress to determine whether there are biochemical differences in the juices of bean (*Vicia faba*) varieties, which may explain the known differences in the degree of attack of different varieties by *Aphis fabae*. Amino-acids, organic acids, sugars and phenolic compounds present in the juice extracted from both young- and old-leaf samples from resistant ("Rastatter") and susceptible ("Schlanstedter") bean plants are being investigated. (Banks, Miller and Arnold.)

The Effect of Synthetic Oestrogens on the Soil Fauna

The synthetic oestrogens hexoestrol and stilboestrol when used to fatten stock may reach the soil in the excreta of treated animals. Little is known about their breakdown in the soil or their effect on the soil fauna. At the request of the Agricultural Research Council some observations on the latter problem are being made.

At present, the results of pot experiments and field observations suggest that hexoestrol only affects the soil fauna when present in amounts which are many times greater than any likely to occur in practice. (Raw.)

Soil Fauna Associated with Raspberry Ringspot Virus

There is a strong evidence that soil organisms are concerned in the transmission of soil-borne viruses of the ringspot type. At three sites the soil fauna near infected plants was compared with that near healthy plants. At each site many more Collembola, and at one

https://doi.org/10.23637/ERADOC-1-91

site more Tyroglyphid mites, were found near the infected plants. The preponderance of these groups suggests a saprophytic association with the diseased plants and need not imply a direct association with the virus. (Raw, in conjunction with B. Harrison, Plant Pathology Department.)

Studies on Beetles

No biological investigations of beetles have been made during the present year, but routine identification of *Carpophilus* spp. (Nitidulidae) have continued. Specimens have been received from many parts of the world, including the Soviet Union, and in all, about 120 packages have been dealt with. Of exceptional interest was a single specimen of *Carpophilus fumatus* Boheman found in cocoa in Ghana. This species has previously been recorded only once or twice from stored produce. (Dobson.)

Population Density Studies on Insects

Earlier experiments showed that the larval population density of several species of lepidoptera strongly influenced the rate of subsequent development of the individual, and pilot experiments have been set up under constant-temperature conditions to study its mode of action. These experiments, so far, have shown that the environmental conditions, in terms of population density, during the larval state of the parents can influence the developmental pattern of the F_1 larvae. These experiments await confirmation in a second series planned for 1959.

Studies have also been started on " weight economy " during the pupal stages to explain differences observed between larval and adult stages in both solitary and crowded cultures.

A study has been completed on the morphology of the adults from both solitary and crowded larval culture, taking into consideration changes in weight during adult life. (Long.)

https://doi.org/10.23637/ERADOC-1-91 *pp 14*