ROTHAMSTED RESEARCH

Report for 1959

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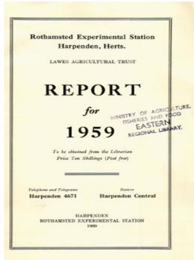
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Entomology Department

K. Mellanby

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ENTOMOLOGY DEPARTMENT

K. MELLANBY

R. M. Dobson left in December to become lecturer in Agricultural Zoology in Glasgow University; C. A. Edwards was appointed to succeed him, and is expected early in 1960. B. S. Miller left on completing his year's visit, and Jane A. Cochrane moved to Cambridge to continue her work on slugs there in the School of Agriculture. C. J. Banks was seconded for two years to the Central Treaty Organisation Nuclear Centre, Teheran.

C. G. Johnson returned after 2½ years' secondment to the West African Cocoa Research Institute in Ghana. G. W. Heath joined the department in July to work on problems relating to forest soils. D. Calnaido from the Tea Research Institute, Ceylon, a Colombo Plan Scholar, arrived in May, and two Agricultural Research Council scholars, W. S. Tallack and Frances Bull, in the autumn.

THE FAUNA OF THE SOIL

Work on soil fauna was expanded, and during 1959 several new investigations were started. The name of the department—"Entomology"—has always been interpreted liberally, for not only soil insects but also earthworms, slugs, millipedes, mites and even, at times, moles have been studied. It is more logical to study all the animals living in the soil, for their activities are closely interrelated, than to be restricted by taxonomic exactitude.

Long-term bare fallow plots

Cultivation affects, and usually decreases, the soil fauna. It is sometimes difficult to interpret changes in the fauna, and for that reason studies were begun on what happens when the soil is kept free from plant growth for a long period in the hope of understanding better the changes in fauna with different crops, different forms of cultivation and different manurial regimes.

Two areas at Rothamsted, one of old grassland in Highfield, one of old arable in Fosters, and two at Woburn, one arable plot in Stackyard and one part of the neglected garden near the laboratory, were selected. Three areas are just under ½ acre, and the Woburn garden is ⅛ acre. Soil samples were taken; all areas will be ploughed and cultivated frequently to prevent weed growth. This experiment is planned to continue for 10 years, but progress will be reviewed after 5 years.

Other departments at Rothamsted will co-operate. Chemistry will study changes in organic matter, nitrogen and available nutrients. Physics and Pedology will follow physical changes in soil structure. Microbiology will estimate changes in the microflora. Botany will study the survival of weed seeds, Plant Pathology the changes in the organisms causing crop diseases and Nematology the nematode population. At Woburn fluorine deposition will be measured. It is intended to try to correlate the changes in fauna with the findings of all these other departments. (Mellanby.)

Rehabilitation of marginal grassland

The experiment at Winder in Lancashire, started in 1954 to study the effect of earthworms in the process of improving hill pasture, continued. The areas which received different manurial treatments, and those to which lead arsenate was applied in 1955 to exclude earthworms, were sampled in the spring and autumn, and earthworms and their egg capsules were counted and identified. No clear-cut effects relating the soil fauna to the herbage have yet been demonstrated.

Various difficulties, inseparable from an experiment several hundred miles from Rothamsted, arise in spite of the valuable co-operation of the farmer on whose land the experiment is situated. It was often difficult to arrange for some treatments to take place on the most desirable date, and to take full advantage of weather conditions. The very dry summer affected growth on all plots, and the " hard grazing " which was intended to play a part in the experiment was impossible before October. There was also an excessive growth of rushes; " spot " spraying with 2–4 D in April was repeated in July with moderate success. (Raw, Dobson and Lofty.)

Rehabilitation of farmland after open-cast coal-mining

Open-cast coal-mining has gone on for some years in Northumberland, near the Cockle Park Experimental Farm of the University of Durham. The top-soil from mined areas was stored separately in heaps for several years while the coal was removed; this affected its structure and fauna. The university Faculty of Agriculture began an experiment comparing various manurial treatments of the restored land with control, undisturbed areas on an adjacent field. At the request of Professor M. M. Cooper the fauna of the restored and control soils were examined before manures, etc., were applied. The control area contained a fairly high (normal) population of earthworms, mites and collembola. The soil of the restored area contained very few animals. These initial observations, and others to be made in the spring of 1960, are meant to serve as a basis for a thorough investigation of the faunal changes, to be made by a worker stationed at Cockle Park but collaborating with Rothamsted. (Mellanby.)

Fauna of Barnfield

Proper sampling to study the soil fauna requires removing large quantities of soil and applying chemicals to expel certain animals, e.g., *Lumbricus terrestris*. For these reasons none of the classical fields has previously been surveyed comprehensively. The decision to stop in 1960 the experiment on Barnfield, where root crops have been grown continuously since 1843, made it possible to sample the fauna in 1959. The mangold sections of the dung, complete fertiliser and no manure plots of series O (no nitrogen), series N (sulphate of ammonia), series A (nitrate of soda) and series AC (nitrate of soda + rape cake) were studied. In August 20 soil samples each $2\frac{1}{2}$ inches diameter and 8 inches deep were taken from each plot to

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estimate the arthropod fauna. In October the earthworm population of each plot was estimated by taking 8 soil samples each 8½ inches diameter and 8 inches deep for worms in the top-soil and by treating 10 quadrats each 22 inches square with dilute formalin for worms such as *L. terrestris*, which burrow deeply and cannot be sampled satisfactorily by removing soil samples.

The animals from the samples have not yet all been identified. (Raw and Lofty.)

Earthworm populations in orchards

The amount of leaf litter buried by worms was measured in 5 grass and 2 arable orchards near Wisbech by placing a known number of weighed leaves on the ground beneath wire cages at leaf fall and recording the number and weight of leaves remaining in spring (*Rep. Rothamst. exp. Sta.* for 1958). The leaves which disappeared from the cages were drawn into worm burrows by *Lumbricus terrestris*.

To estimate the earthworm population beneath the cages, potassium permanganate solution was first used, but it underestimated the population greatly. Dilute formalin expelled the worms much more effectively and seemed to give a reliable estimate of *L. terrestris*.

In the grass orchards the number and weight of leaves removed from the cages was closely correlated with the estimated fresh weight of *L. terrestris*. Some orchards had about 20 cwt. of *L. terrestris* per acre, which buried 8–9 cwt (dry wt.) of leaves during the winter. In the arable orchards the removal was more rapid, possibly because the worms had no alternative source of leaf material and the apple leaves were easier to find and pull into burrows when there was no surface vegetation. Evidence to support this was obtained in one grass orchard, where the number of leaves removed from each cage was inversely proportional to the amount of surface vegetation.

Leaves which remained on the soil surface lost about 25% in dry weight between leaf fall and spring.

Adding 10 *L. terrestris* to 2 cages in each orchard increased the leaves removed. This increase was greatest in orchards which already had a high population; this may reflect differences in the survival of the worms added.

Cultivation did not appear to affect the abundance of *L. terrestris* greatly (previous workers showed that the other large earthworms, *Allolobophora longa* and *A. nocturna*, almost disappear when grassland is ploughed); nor did regular applications of farmyard manure or compost. The highest population was recorded in a grass orchard which received an annual dressing of 1 cwt./acre of sulphate of ammonia. The arable orchards contained few *Lumbricus castaneus* or *Allolobophora caliginosa* and no *A. longa* or *A. nocturna*. *L. castaneus* and *A. caliginosa* were most abundant in the two grass orchards where organic manures are applied regularly; *L. castaneus* was particularly abundant in the one getting farmyard manure.

In two grass orchards with a long history of heavy spraying with copper fungicides the only earthworms found were a few *L. castaneus* in the surface litter. In these orchards the leaf litter decomposes slowly on the soil surface and the soil profile has typical

" mor " characteristics. The yield and nutrient status of the trees seems unaffected. (Raw and Lofty.)

Earthworm biology

Four species of worm from Winder (see p. 133 above)—*Lumbricus rubellus*, *Dendrobaena rubida*, *Dendrobaena subrubicunda* and *Eiseniella tetaedra*—were bred in the laboratory, to obtain information on life span and fecundity. (Dobson.)

At Rothamsted a grass field (Pastures) was sampled by digging out a square yard (in four replicates, each 18 inches square) each month. The soil was taken in separate layers, each 3 inches deep, for the first foot from the surface, and lower layers of soil were examined. The results give information on the vertical movements of the different species, the existence of quiescent periods in some and on population dynamics.

Effects of irrigation, to keep the moisture content of the soil at " field capacity ", and of preventing rain falling on the soil, to give dry soil, were studied by sampling as in the grass field.

Nocturnal activity was studied on the surface of a lawn; effects of temperature, water and light were particularly noted. Surface casting on a lawn and a closely-cut area of meadow were followed, and it was attempted to relate the results to temperature and water. Water appears to act in two ways—as soil moisture (measued as pF) and by affecting the humidity in the growing grass. (Gerard, Raw and Mellanby.)

Studies on slugs

Slugs are being increasingly recognised as agricultural pests, which cannot yet be chemically controlled on a field scale. Studies made by Barnes between 1940 and 1949 were revived and extended. Attempts are being made to establish slug cultures in the laboratory, to work out the biology of pest species and to obtain many in a uniform stage of development, which is necessary to evaluate slug poisons. Factors studied include a comparison of containers, of coil cover and the effects of different constant and fluctuating temperatures.

Slug damage to potatoes was studied in a garden where *Arion hortensis* and *Milax budapestensis* occur. The considerable damage to the tubers during the very dry summer of 1959 was surprising, particularly as frequent searches 2 hours after sunset revealed little activity at the soil surface. This showed that underground activity can sometimes contrast sharply with surface activity. The distribution of slugs in the plot and its relation to soil organic matter is being studied. (Stephenson and Barnes.)

Studies relating to forest soil

To obtain information on the rate leaves disappear from the litter layer, small disk samples were taken regularly from labelled leaves lying in Knott Wood (oak and beech) and Geescroft Wilderness (oak only). The samples are weighed and ashed; parallel samples of oak leaf are used in feeding experiments with mites.

Cultures of the mite *Steganacarus magnus* were established to study feeding and respiration. Respiration is being studied in two types of apparatus, one large enough to hold undisturbed cores of litter and soil up to 7 × 7 mm., the other smaller and suitable for cultures of mites. (Heath.)

Insect Pests of Economic Importance

The department cannot study all pests of agricultural crops, and the programme changes often. Some pests, e.g., gall midges, have been studied intensively and continuously over many years, and work in this group continues. Much attention was paid to aphids in the 1920s, and since the Second World War study of this group has again been an important part of the department's programme. Work on the wheat-bulb fly was intensified in 1953 after severe damage to crops in many parts of Britain. It is now ending, and the results are summarised below (pp. 216–229). Experiments on the farm and in the laboratory with the frit fly, begun in 1957, are being expanded.

Most of the work on pest insects has a double purpose. First, we are concerned with the problems of control, but by biological rather than by chemical methods. Secondly, much of our work concerns principles (e.g., the distribution and spread of insects), and for this economically unimportant insects might equally be used, except that a pest insect is numerous and easily reared and so a good "experimental animal". We think that work on basic principles may, perhaps unexpectedly, sometimes give information helpful in controlling pests.

Insect pests at Rothamsted

Routine inspections throughout the year were not possible, but whenever suspected pest damage was reported it was investigated. There appeared to be little serious insect damage during 1959, except for that done by bean aphids on an unsprayed field of beans; routine spraying controlled the aphid. Heavy frit-fly attack occurred on late-sown oats (as was intended), but despite this yields of over 30 cwt./acre were obtained. Wheat-bulb fly and bean weevil attack caused little damage. (French.)

Gall midges

The long-term study of the Wheat Blossom Midges on Broadbalk reached its 33rd consecutive year. A new record for longevity of *S. mosellana* larvae was established; one midge emerged on 23 June 1959 from a larva collected in late July 1941.

Last year's study of the field susceptibility of Atle, Svenno and Fylgia to Wheat Blossom Midges' attack was extended to certain American varieties of known resistance or susceptibility to Hessian Fly in America. Only one of the varieties was resistant to *Sitodiplosis mosellana* and none to *Contarinia tritici*. When tested with Hessian Fly of mixed foreign parentage, the susceptible variety Tenmarq was attacked and the resistant varieties were not.

Advantage was taken of the dry harvest this year to repeat last year's investigation with Dr. P. Halton at the Cereals Research Station, St. Albans, into the damage done by *Sitodiplosis mosellana* into 2 randomised blocks of 2 plots, and 2 replicates were sown on each of 3 dates, i.e., 13 March, 10 April and 22 May. Frit fly were caught by nets and traps throughout the season, and the eggs laid, tillers attacked and grains attacked were measured. The results are being compared with those of similar experiments in other parts of England.

On Little Knott I an area of about 4 acres was sown with oats on 11 April, half with the variety Eagle and half with Sun II. The migration of frit fly into the different parts of the field was estimated by "sticky traps" which were examined every day from the beginning of May (when the flies first emerged) until the flies disappeared several weeks after harvest. Part of the field received two sprays of DDT, part was caged during the early weeks of growth to prevent tiller attack, and part was sprayed with the weed-killer CMPP. Egg laying, tiller and grain attack were measured for different parts of the field. The rate of infestation in 1959 was rather low, though up to a third of the plants eventually suffered tiller attack, and the dry weather enabled a crop, unusually heavy for such late sowing, of over 30 cwt/acre, to be harvested. (Mellanby, French and Riches.)

Experiments on small plots of oats on various parts of the farm were compared with the field-scale tests. R. Hull arranged for a small area of oats to be sown at Dunholme Field Station, and for tiller and grain samples from this plot and from a commercial field of oats nearby to be sent to Rothamsted for examination. On the Garden Plots detailed studies on the infestation of the grain and of the date of panicle burst were made. Unfortunately birds damaged many marked panicles, but enough material for several months' work was obtained. Bulking samples of panicles which burst between 22 June and 14 July, with the variety Eagle 57% of main grain and 29% of bosom grains were attacked. The comparable figures for Sun II were 46 and 24%. (Riches, French and Mellanby.)

An intensive trapping programme was begun in June to study the behaviour of the frit fly and the effects of climatic and microclimatic changes. This included placing traps in a tower up to 60 feet above the ground, in clearings of different sizes in the oat crop and in different crops in various parts of the farm. Other insects are being included in this work, particularly during the winter, when threshold temperatures for the appearance of several species are being studied. (Calnaido and Mellanby.)

A suitable method of breeding frit flies during the winter months was found, based on the work of Mr. A. Ibbotson of Durham University, and modifications which may increase the size of the culture population are being tested. An olfactometer, designed to offer to frit fly and other insects repeated choices between air and odour streams, is being made; it is hoped to use this to study the rôle of olfactory stimuli in the selection of oviposition sites. (Bull and Mellanby.)

Mite Ecology and Physiology

Although mites form an important part of the soil fauna, particularly in forest soils, they have received little attention. The

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ecology of a sphagnum bog near Woburn was selected for their study because conditions are thought to be less complicated than in soil, but similar principles may apply. Eighteen random samples of cores of 9 cm. diameter were taken each month from each of two apparently homogeneous areas of two species of sphagnum in a transitional valley bog. The animals in these samples were extracted by a modified Tullgren funnel, and changes in population throughout the year estimated. These population changes are being correlated with climatic changes. Temperature, humidity and evaporation were recorded at regular intervals within the sphagnum, at different levels above ground and in other types of vegetation over continuous periods of 24 hours; this should make it possible to interpret the effects within the vegetation of conditions recorded by the traditional meteorological techniques.

Laboratory experiments were done on the effects of temperature and humidity on various species of mites, some from the sphagnum and others from drier environments. Apparatus was made to study the behaviour of mites in gradients of temperature and humidity and their survival under different climatic conditions. Great differences of behaviour between hygrophyl, mesophyl and xerophyl species were observed. (Madge and Mellanby.)

Migration of Lepidoptera

Records of migrating butterflies and moths are regularly received from some eighty observers throughout the British Isles, who fill up a form and return it twice a year. Records are abstracted from entomological publications, and many other reports of insect movements of special interest are also received. This provides a picture covering the whole country.

In spite of the hot, dry summer of 1959, migrants were not abundant. The only apparent effect of the weather was to increase their number in September, a time when the number usually begins to fall. The species which showed this most were the Red Admiral (*Vanessa atalanta*), the Silver Y Moth (*Plusia gamma*), the Rush Veneer Moth (*Nomophila noctuella*) and the Humming-bird Hawk Moth (*Macroglossa stellatarum*). The Clouded Yellow (*Colias crocea*) was also common in August and September in the south of England and Ireland, and isolated individuals were captured as far north as southern Scotland. Other regular migrants were rare, particularly the Painted Lady (*Vanessa cardui*).

The Cabbage White Butterfly (*Pieris brassicae*) was abundant in some places during the spring, almost certainly because pupae overwintered, for there was no evidence of an immigration at this, or any other, time. During the summer it was rare and the caterpillar caused little damage. (French.)

Biology of Sciomyzidae

Professor C. O. Berg of Cornell University visited the department during a European tour to study Sciomyzidae (Diptera) parasitic upon land snails. Sciomyzid flies (often called "Marsh Flies") were found on the dry chalk slopes of Ivinghoe beacon and (not *Contarinia tritici* as erroneously stated in last year's report) to wheat grains, as this effects milling and baking quality. Three hard red winter wheats differing in their resistance to attack by Hessian Fly (*Mayetiola destructor* Say) were compared at the fourth leaf stage for their content of constituents soluble in 80% ethanol as a preliminary attempt to find any biochemical basis for resistance. This work was done with the co-operation of Dr. T. Swain at the Low Temperature Research Station, Cambridge. The main difference was that the susceptible variety (Tenmarq) contained allulose, or allulose combined with some other component, whereas the resistant variety C.I. 12855 did not, and the semi-resistant Ponca contained less than did Tenmarq. Tenmarq but not the other varieties also contain Sorbitol. It is, of course, not known whether these differences are connected with differences in susceptibility.

Further data were collected on the speed at which the life cycle of the Hessian Fly is completed in an open unheated glasshouse, and the work on how humidity and temperature affect the speed and percentage of emergence of the Hessian Fly's overwintering larvae was published.

Evidence of delayed emergence was obtained in preliminary studies of the phenology of the Pea Midge, *Contarinia pisi*. More midges that had completed their larval feeding in the field during 1957 emerged in the Rothamsted Lodge insectary in 1959 than in 1958. There was evidence that the Pea Midge produces unisexual families.

The species of grass-inhabiting *Mayetiola* reported in last year's Report as damaging cocksfoot was identified as *M. dactylidis*. Mr. R. Gair of the National Agricultural Advisory Service reported an outbreak of a *Mayetiola* species on *Poa* near Newark, Notts, in the late autumn of 1958. This midge was reared and identified as *M. schoberi*, discovered in Germany in 1957. Midges were reared for the first time from *Mayetiola* larvae damaging *Agrostis*. An undescribed *Mayetiola* species on *Festuca* and already known to occur in England was received from Denmark.

Mr. K. M. Harris, while on a visit from Nigeria, prepared for publication a description of a new sorghum stem midge. (Barnes, Arnold and Miller.)

Aphids

Work on aphids and their distribution has, for some years, included a wide range of subjects difficult to classify briefly. A detailed study of the many insects accumulated over the past years continues and is making it possible to formulate general principles of insect dispersal. Work on aphid physiology and control continued.

The collections of insects, and of biological and meteorological data obtained during several years at Cardington (where traps were operated at different altitudes) are being sorted and arranged for a general study of the vertical profile of insect density, applying to many orders, in relation to time of day, time of year and atmospheric conditions. The factors operating in the mass migration of aphids were found to apply to migrant insects of other orders, and a

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general system of insect mass migration is being developed. (Johnson.)

The distribution of small insects, once they have " taken off ", is primarily determined by wind, for the wind speed, except very close to vegetation, is usually greater than their flight speed (e.g., under 2 miles per hour for aphids). Suction-trap experiments show that larger insects, including some species of moths, are distributed differently. These larger insects fly at speeds above the average wind speeds and so determine their own distribution to a considerable extent. (Taylor.)

Aphids may take a series of short flights, and they may probe plants on which they land after each of these flights, but they do not readily settle down to reproduce until they have been airborne for some time. Mass flights of aphids at low levels were observed; the insects frequently alight and take off again, but only when the air is stable, mainly in the evening and in autumn. This behaviour, possible only under these atmospheric conditions, may well favour virus transmission. Usually the wind speed is greater than the flight speed of aphids, so the insects may be carried high into the air and may remain there, flying, for long periods. Laboratory experiments suggest that insects flown to exhaustion do not take off again when they land, but settle down and form colonies, a conclusion supported by the fact that small colonies examined on beans usually still contain winged parents. It is suggested that high-level dispersion spreads populations efficiently, because when after a long flight an alate aphid finds a plant it is likely to stay on it and reproduce. (Taylor and Cockbain.)

A major factor on the infestation of crops by aphids seems to be the filtering effect of the crop on the wind; and aphids probably can alight only when wind eddies carry them into the crop shelter. (Taylor and Cockbain.)

The anomalous behaviour of an aphid, closely allied to *A. fabae*, in selecting a host was studied. This aphid, which breeds in summer on Tropaeolum, will readily fly to and settle down to feed and reproduce on broad beans. In a few days the parent, and any nymphs that may have been produced, die. Yet neither walks off the plant. The aphids received no sap from the plants; how their pattern of behaviour has become so maladjusted to their ability to feed is not known. (Taylor.)

Some workers have considered that many of the insects found in summer at high altitudes are unimportant because they are likely to be dead or so damaged that they cannot reproduce when they land. In joint work with Mr. W. G. Harper of the Meteorological Office on the cause of radar " angels ", insects were caught in nets at Cardington between 1,000 and 5,000 feet above the ground. They were nearly all alive and active. Many of the insects, mainly aphids, but also including frit flies and a fly indistinguishable from the Hessian Fly, were viable, fertile and produced live eggs or young when placed on suitable host plants. This confirms that many small day-flying insects can easily and safely circulate up to several thousand feet before being deposited, unharmed, on a plant. (Taylor.)

The flight physiology of *Aphis fabae* and the effects of prolonged flight on vitality were studied. The aphids use most of their carbohydrate reserve in the first hour of flight, but then use fat, sometimes for flights lasting as long as 12 hours. Flight fatigue seems to result mainly or entirely from exhaustion of fuel, and not from dehydration, neural fatigue or the accumulation of waste metabolites. Provided they found food, aphids flown to exhaustion lived as long and reproduced as successfully as those that flew for only 15 minutes. Aphids flown to exhaustion, however, could seldom be induced to fly on the following day (though they had fed amply), whereas aphids that had flown for only 15 minutes flew again readily. (Cockbain.)

Work on natural control in relation to chemical control was continued by Banks in collaboration with M. J. Way of the Insecticides Department (pp. 126–127).

Eggs of certain predators of aphids, particularly Coccinellidae and Syrphidae, were attacked by ants, but the stalked eggs of Chrysopidae seemed to escape. (Banks.)

Effects of the nature of the food on the biology of *Aphis fabae* were studied. Many alatae were produced on mature bean leaves for three generations after the first, but few alatae occurred on young bean growth. The results suggest that the quality of the sap ingested by the aphids is more important in wing-determination than its quantity and that some results previously attributed to ant attendance require to be reassessed. The results also show that form determination in *Aphis fabae* can occur after birth instead of before birth, as happens in some other aphid species. An attempt to study reproduction and the rate of development on different varieties of beans, " resistant " and " susceptible " to aphids, failed because many aphids died from the heat in the summer of 1959. (Banks.)

Wheat-bulb fly

The predators and parasites of wheat-bulb fly were studied briefly. Pupae obtained from Broadbalk in 1958 were kept in soil pots in the insectary and examined periodically. Many individuals of the cynipoid parasite *Trybliographa* sp. were obtained. A few of these emerged during the autumn of 1958, but most during a few days in March 1959. The insects were sent to Mr. G. J. Kerrich of the Commonwealth Institute of Entomology for further study and specific identification.

Some 4,000 pupae obtained from Whittlesea and Peterborough (Fenland) were kept (mostly) individually and examined daily. 3,431 wheat-bulb flies emerged and 257 specimens of *Aleochara bipustulata*, 105 specimens of *A. inconspicua* Auhe (Staphylinidae—parasitic forms) and 2 specimens of the Ichneumonoid *Phrygadeuon trichops* Thoms. were obtained. Ninety-eight other pupae had evidently been parasitised—possibly by *Aleochora* sp. The two species of *Aleochora* differ biologically—*A. bipustulata* pupates inside the host puparium while the smaller *A. inconspicua* pupates in a small cell in the soil. Various soil arthropods were also found to attack the eggs and puparia. (Dobson.)

Of another 3,275 pupae obtained from the field, 2,045 emerged successfully; 533 of the failures (16·3% of all pupae) appeared to be parasitised. The mean weight of pupae was 11·4 mg., with a range of 5–17 mg. The mean weight of the sexes did not differ, and under constant temperature flies emerged earlier from smaller pupae. (Long.)

The very wet autumn of 1958 delayed sowing of winter wheat, which was not completed on Broadbalk until January 1959. Large areas of Section V (first year after fallow) were water-logged for much of the winter, germination was poor and the plant density was about half that expected. Wheat-bulb-fly eggs had already started to hatch when the wheat germinated, so there were no plants for the larvae to parasitise and they died. The infestation by wheat-bulb fly was therefore small; the estimated mean population of 55,000 larvae/acre was little more than one-tenth of that in 1958. On the Alternate Wheat and Fallow experiment, where sowing was completed earlier, germination was also not good, but plants were in the single leaf stage (i.e., they could be attacked) at the time of hatching, and the infestation (184,000 larvae/acre) was comparable with that of 1958. In wheat sown at normal density in this experiment 75% of the larvae died for in the first two of its three instars. (Long.)

The interaction between larva and plant is being analysed in collaboration with M. G. Morris of the Statistics Department. An improved sampling technique was devised, and 630 samples, each equivalent to a 1-foot row of wheat sown at normal density, were examined from the Alternate Wheat and Fallow on Hoosfield. (Long.)

Previous observations showed that in different years, and on different sites, the size of mature larvae varied considerably. A study of the effect of size on fecundity showed that smaller flies lay fewer eggs. Thus, factors governing larval size may influence the size of the next generation, and the possibility is being tested of forecasting from observations on larval infestation and associated factors both the immediate effect on the crop and the trend of the population.

Numerous flies were dissected and examined for fungal parasitism, but very few flies were infected; possibly because of the dry summer, only one contained a cystic fungus, which did not grow in culture. (Long.)

Frit fly

Several experiments with frit fly in oat crops were done at Rothamsted. Results in 1958 showed that this insect may behave differently in small plots and in fields uniformly planted with the same crop, so for most of the experiments areas of ½ acre or more were used.

On Long Hoos V an experiment—planned to provide information that may help in forecasting frit-fly attack, so that advice on spraying with insecticides can be given as early as possible—was made in collaboration with Mr. A. H. Strickland and Mr. K. S. George of the Ministry of Agriculture, Fisheries and Food Plant Pathology Laboratory. An area of about 3 acres was divided into 6 blocks and sown with the oat variety Blenda. The area was split in swamps by the River Ver. In the Nature Conservancy reserve at Wood Walton, Hunts, eggs of the Sciomyzid *Pherbellia schoenherri* were found on the shells of Succineid snails. Most of the life cycle of the fly has been worked out from material brought back to Rothamsted. (Stephenson with Professor C. O. Berg, Cornell University.)

SPIDER ECOLOGY

The importance of predation by spiders in various habitats is being studied. In the laboratory, physiological experiments on food consumption by spiders began. (Tallack and Mellanby.)