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Report for 1957

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Departmental Publications / Abstracts of Papers

Rothamsted Research

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PUBLICATIONS

Physics Department

- 1.1. EMERSON, W. W. (1957). Organo-clay complexes. *Nature, Lond.* **180**, 48-49.
- 1.2. LONG, I. F. (1958). Some observations on dew. *Met. Mag.* (In the press.)

The difference between dew, fog precipitation and guttation on a grass cover is described along with a short review of the measurement of dew. The source of dew, whether from distillation of water vapour from the ground or "dewfall" from the nocturnal inversion of the atmospheric vapour pressure gradient, is shown to be influenced by the type of crop cover, its height and density. Evidence is given that dew may occur but not persist until 0900 hours when routine weather observations are taken, so leading to underestimates in reports of the frequency of its occurrence.

- 1.3. MONTEITH, J. L. (1957). Dew. *Quart. J. R. met. Soc.* **83**, 322-341.

Dew formation on short grass has been studied with a balance, recording weight of condensation, and with filter-papers to absorb moisture. Three regimes are distinguished: in the first, daytime evaporation continues and the grass remains dry; in the second, the surface continues to lose weight, but the grass becomes wet owing to the partial condensation of water vapour evaporating from the soil; in the third, this loss of weight ceases or there is an increase in weight attributed to condensation of atmospheric water vapour. A distinction is therefore made between "distillation" of water vapour from soil to grass ($1-2 \text{ mg. cm.}^{-2} \text{ hour}^{-1}$) occurring on very calm nights through a laminar layer with a transfer coefficient approaching the molecular value; and "dewfall", the turbulent transfer of water vapour from the atmosphere, negligible when the wind at 2 m. falls below 0.5 m./second, but reaching $3-4 \text{ mg. cm.}^{-2} \text{ hour}^{-1}$ with stronger winds. This distinction is supported by analysis of the surface heat-budget. On windless nights, since heat flux from the soil and net radiative loss were almost equal, the transfers of sensible and latent heat from the atmosphere were negligible, and distillation was of much greater importance than dewfall. Implications for taller crops and warmer climates are briefly considered.

- 1.4. MONTEITH, J. L. (1957). Climatology in arid zone research. *Weather*, **12**, 203-210.

A review of a United Nations Educational Scientific and Cultural Organization symposium held in Australia is given. Subject headings are: water relations of plants; water relations of animals; measurement of evaporation; estimation of evaporation from climatic data; measurement of rainfall and dew; modifying the water balance; temperature relations of plants and animals; heat balance; modifying the heat balance; light; and the scope of climatology.

- 1.5. PENMAN, H. L. (1957). Hill climate. *Nature, Lond.* **180**, 574-576.

- 1.6. PENMAN, H. L. (1958). Water control for increased crop production. In *The Biological Productivity of Britain* (Inst. of Biology, London).

Drainage. There is need for more research on the responses of different types of crop to different depths of water-table. Surface drainage systems on the clay lands of south-east England need renewal over about half the area. On the hill land of the north and west, about half needs a drainage system, and half of this has been done.

Irrigation. It is possible to specify which areas of Britain might benefit from supplementary irrigation, and experimental work within these areas is

showing that grass and potato yields are increased in most summers, sugar-beet yields in some and cereal yields occasionally.

- 1.7. RUSSELL, E. W. (1957). The effects of very deep ploughing and of subsoiling on crop yields. *J. agric. Sci.* **48**, 129-144.

1. Deep tillage, namely, ploughing to a depth exceeding 12 inches, or subsoiling to a depth of about 18 inches, increased crop yields on about half the fields in which an experiment was made. Unfortunately, it was not possible to recognize what was the difference in soil properties between the 50 per cent of fields that responded appreciably to deep tillage and the remainder, whose yields were either unaffected or sometimes reduced by deep tillage, though, as one would expect, sands were normally less responsive to deep tillage than the heavier soils.

2. On the clay soils deep ploughing in autumn tended to give a surface soil that dried out up to several weeks earlier in the spring than land that was shallow ploughed. Subsoiling did not cause the surface soil to dry out in the same way. Only rarely did the subsoil brought up by deep ploughing give difficulty in working down to a seedbed, and probably in as high a proportion of fields the subsoil worked easier than the surface soil.

3. On the clays and loams the response of potatoes to deep tillage was more marked on fields that were heavily manured than on those lightly manured.

4. Sugar beet normally gave a higher yield if its potash and phosphate was spread on the land before ploughing, even if this was in the autumn, than if it was applied in the seedbed. The exceptions to this result were for soils heavier than sandy loams if ploughing depths exceeding 12 inches were used, for the yield of beet was, on the average, depressed on these soils if the potash and phosphate was ploughed in compared with it being worked into the seedbed.

5. Deep ploughing tended to give better control of many perennial weeds, and often of annual weeds than shallow ploughing. It is suggested that much of this benefit could be obtained when ploughing to 9-10 inches deep if ploughs were used that cut a furrow considerably wider than the conventional 10½-11-inch furrow, so allowing more complete inversion of the furrow slice.

Chemistry Department

GENERAL PAPERS

- 2.1. COOKE, G. W. (1956). Soils and fertilizers. *J. R. agric. Soc.* **117**, 113-129.

- 2.2. COOKE, G. W. (1957). Soils and fertilizers. *J. R. agric. Soc.* **118**, 131-146.

- 2.3. COOKE, G. W. (1957). The value of fertilizer placement. *J. R. agric. Soc.* **118**, 37-49.

A summary of recent fertilizer placement research carried out in this country. The value of placement for common crops is stated, and the factors affecting the use of the method are discussed.

- 2.4. HAINES, W. B. (1958). On the cyclic recurrence of peak yields in the individual palm. *Oléagineux*. (In the press.)

- 2.5. MATTINGLY, G. E. G. (1957). The use of the isotope ³²P in recent work on soil and fertilizer phosphorus. *Soils & Fert.* **20**, 59-68.

A detailed review of some of the uses of ³²P-labelled orthophosphate in laboratory and greenhouse experiments during the past few years. The following problems are discussed:

Properties of calcium, iron and aluminium phosphates.

Adsorption and exchange of phosphate on resins, clays and CaCO₃.

Isotopic exchange of phosphates in soil.

Uptake of phosphorus from ³²P-labelled fertilizers.

Diffusion and movement of phosphate in soil.

Phosphate residues in soil.

- 2.6. MATTINGLY, G. E. G. (1957). The agricultural value of sewage sludge and town refuse. *Proc. Instn Civ. Engrs*, **8**, 414-420.

The paper gives a brief description of sewage sludges and town wastes, their chemical compositions and estimates of their values as organic manures from field experiments.

- 2.7. TALIBUDEEN, O. (1957). Nutrient availability. *Soils & Fert.* **20**, 189-190.

RESEARCH PAPERS

- 2.8. BREMNER, J. M. & SHAW, K. (1958). Denitrification in soil. I. Methods of investigation. *J. agric. Sci.* (In the press.)

Methods of investigating denitrification in soil are critically discussed with special reference to methods based on total-N analysis. A modified Kjeldahl method of determining nitrogen which includes nitrate and nitrite and is applicable to waterlogged soil is described, and the use of this method in studies on denitrification in soil is illustrated and discussed. Rapid denitrification of nitrate in soil can be induced by incubating the soil under waterlogged conditions with organic materials such as glucose, and denitrification can be followed by total-N analyses if the organic material used to induce denitrification is not added in such excess that it also promotes significant fixation of atmospheric nitrogen. The percentage of added nitrate-N lost by denitrification on incubation of waterlogged soils with different amounts of nitrate and sufficient glucose for denitrification was the same whatever the level of application of nitrate. Denitrification of nitrate in waterlogged soil containing glucose was accompanied by a rapid but temporary accumulation of large quantities of nitrite and by the formation of smaller amounts of ammonia. Hydroxylamine could not be detected during denitrification, but this compound was rapidly decomposed in the soils examined by a process which appeared to be purely chemical. Denitrification of nitrate in soil is a microbiological process, and the viability of the micro-organisms responsible for denitrification is not affected by air-drying and storage of the soil.

- 2.9. BREMNER, J. M. & SHAW, K. (1958). Denitrification in soil. II. Factors affecting denitrification. *J. agric. Sci.* (In the press.)

The factors affecting denitrification in soil were studied by determining loss of nitrogen from soil under various conditions by total-N analysis. The rate of denitrification of nitrate in soil was dependent upon various factors such as pH, temperature and water content of the soil. Under conditions conducive to denitrification 80-86 per cent of nitrate-N added to Rothamsted soils was lost by denitrification in 5 days. Rate of denitrification was greatly affected by soil pH. It was very slow at low pH (below 4.8), increased with rise in soil pH and was very rapid at pH 8.0-8.6. The rate of denitrification increased rapidly with rise in temperature from 2° to 25°; the optimum temperature being about 60°. The degree of water saturation of the soil affected the rate of denitrification profoundly. Below a certain moisture level practically no denitrification occurred; above this level denitrification increased rapidly with increase in moisture content. The critical moisture level was about 60 per cent of the water-holding capacity of the soil. No loss of nitrogen by denitrification could be detected when moist soils were incubated with or without nitrate and glucose and were aerated continuously during incubation. The rate of denitrification in soil depended upon the amount and type of organic material present. The results obtained support the view that denitrification occurs only when the supply of oxygen required by the soil micro-organisms is restricted.

- 2.10. COOKE, G. W. & CUNNINGHAM, R. K. (1958). Investigations on soil nitrogen. Part III. Mineralisable nitrogen determined by an incubation technique. *J. Sci. Fd Agric.* (In the press.)

"Mineralisable-N" values were determined by incubating a series of 27 soils of medium and heavy textures at 50 per cent of their moisture-holding capacity and at 18° for 30 days. Increases in nitrate levels following incubation of soils which had been air-dried beforehand were, on average, three

times as great as increases given by incubating corresponding freshly-sampled soils. In all soils the levels of nitrate and total mineral nitrogen increased appreciably on incubation; corresponding changes in ammonium levels were smaller, they were also irregular and were not related to other soil characteristics. Increases in nitrate and in total inorganic nitrogen on incubating air-dried soils were approximately related to the initial levels of nitrate present in the soils when they were sampled, and to their percentages of total nitrogen.

- 2.11. CUNNINGHAM, R. K. & COOKE, G. W. (1958). Investigations on soil nitrogen. Part II. Changes in levels of inorganic nitrogen in a clay-loam soil caused by fertilizer additions, by leaching, and uptake by grass. *J. Sci. Fd Agric.* (In the press.)

Concentrations of nitrate and ammonium in both the surface (0-9 inches) and the subsoil (9-18 inches) of a heavy clay-loam were determined at intervals both on uncropped soil and under ryegrass. On uncropped land high levels of nitrate were maintained through wet periods, which caused percolation through 20 inches of bare soil. Only persistent and heavy rainfall in late summer reduced surface-soil nitrate to low levels. Ammonium provided by ammonium sulphate or by decomposition of urea was converted to nitrate quite slowly, and the soil contained equal amounts of ammonium and nitrate in July. No ammonium was transported into the subsoil. Little total mineral nitrogen was lost from the top-soil of uncropped land during June and July, but during August and September nitrate concentrations in the subsoil increased rapidly. Total inorganic nitrogen in the top 18 inches of soil remained roughly constant until the end of July, afterwards there was a loss of nitrogen from the profile as a whole. On unmanured plots fluctuations in ammonium levels were much smaller than corresponding changes in nitrate.

Under grass soil nitrate levels fell quickly in warm wet weather when growth was rapid. In the same period on plots receiving ammonium sulphate or urea, grass removed ammonium quickly, and there was no increase in soil nitrate. When a first cut of grass was taken in July four-fifths of the total supply of nitrate or ammonium present in the soil at the beginning of the experiment had been removed. While the second crop was growing there was little nitrate (or ammonium) in the surface soil, but the harvested grass "recovered" as much of the applied nitrogen as the first crop. It is suggested that nitrogen used in growth by the second crop was either taken up earlier and stored in the plant or that it was taken from the subsoil.

- 2.12. COOKE, G. W., MATTINGLY, G. E. G. & WIDDOWSON, F. V. (1958). The value of nitrophosphate fertilizers. *J. agric. Sci.* (In the press.)

The phosphorus effects of several nitrophosphates were compared with those of superphosphate and dicalcium phosphate in field experiments in 1954 and 1955. In both years immediate effects were measured on radishes, and in 1954 residual effects were measured on a crop of ryegrass which was cut twice.

None of the nitrophosphates tested was more than one-third as efficient as superphosphate for radishes. The residual effects of nitrophosphates (relative to superphosphate) for grass were much larger than their corresponding immediate effects on radish; several materials were as good as superphosphate for increasing the yields of the second cut of grass. The immediate effects of nitrophosphates were much increased by preparing finely ground powders from commercial granulated products.

In both years dicalcium phosphate was equivalent to superphosphate and gave significantly higher yields of radish than any of the granulated nitrophosphates. At the second cutting of grass in the 1954 experiment there were no significant differences between yields given by dicalcium phosphate and the nitrophosphates.

The solubilities of the phosphorus of nitrophosphates in solutions of citric acid, neutral ammonium citrate and alkaline ammonium citrate were of little value in estimating immediate effects of granulated products. It is suggested that physical properties of the granules affect the rate at which phosphate ions can diffuse and so complicate the interpretation of solubility tests.

- 2.13. COOKE, G. W., MATTINGLY, G. E. G. & WILLIAMS, R. J. B. (1958). Changes in the soil of a long-continued field experiment at Saxmundham in Suffolk. *J. Soil Sci.* (In the press.)

A four-course rotation experiment was carried out at Saxmundham on wheat, mangolds, barley and legumes. Yields of all crops were much increased by phosphate fertilizers; nitrogen fertilizers increased yields of non-legumes; extra yields from potash fertilizers were smaller. Fifty-six years of continuous manuring caused the following changes in the calcareous boulder clay soil: plots receiving farmyard manure contained half as much again organic carbon as plots receiving fertilizers, plots receiving N and P fertilizers contained slightly more organic matter than plots without these fertilizers. Total soil nitrogen was considerably increased by farmyard manure and was slightly higher on plots receiving sodium nitrate than on plots without nitrogen fertilizer. Total soil phosphorus was built up by farmyard manure and by bone meal, and to a smaller extent by light annual dressings of superphosphate. "Soluble phosphorus" determined by three methods differentiated clearly between plots which had received phosphate fertilizers and those which had received none. An accumulation of bone-meal residues was demonstrated by dilute hydrochloric acid extraction, but not by methods involving extraction with 0.5M-sodium bicarbonate or equilibrium with 0.01M-calcium chloride. Soluble-phosphorus values by all three methods indicated the presence of fertilizer residues more clearly than did values for total soil phosphorus. The soil contained a large quantity of total potassium, and the values were not materially affected by manuring. Dilute HCl soluble-K and exchangeable-K values differentiated between plots which had received potash fertilizers and those which had received none. They also reflected changes in soluble potassium caused by the different amounts of potassium removed in the crops grown.

- 2.14. HAINES, W. B. (1958). On the significance of cyclic peak yields in Nigerian oil palms. *Emp. J. exp. Agric.* (In the press.)

Examination of the yields of individual oil palms in Nigeria (provided from the records of manuring experiments) has established the existence of a very interesting and important rhythmic behaviour. Peak yields occur with very considerable regularity every third or fourth year in almost all palms. In between these good years the yield is often very poor, or may fail altogether. The peak year is shown to be expected from considerations of the sexual cycles in the flowers and the rate of their appearance with emerging fronds. The difference between good and bad years must therefore be regarded as losses, and it is of such magnitude that a restoration of the bad years to normal would increase average crops by 74 per cent. Arguments are adduced for considering that the yield reductions are not due to inevitable physiological reaction to the strain of the good years.

The explanation advanced is that the natural palm rhythm is of a shorter period than the annual weather cycle. The female or fruiting cycle recurs on the average every 9 months. The peak year is supposed to be the result of a propitious conjunction between weather and the phases of development of the fruit, so avoiding abortions. Then in the next year the relationship moves and must have some adverse conjunction which reduces the crop. The propitious year would recur every third year as a "beat" between a 9-month palm cycle and a 12-month weather cycle. The particular nature of the sensitive phases in the palm upon which such a mechanism depends (such as certain weather conditions needed during pollination) have still to be defined. It is clear that there is great possibility of rewards if the sensitive phases prove capable of recognition and correction by established field treatments (such as spraying).

- 2.15. MATTINGLY, G. E. G. & WIDDOWSON, F. V. (1958). Uptake of phosphorus from ^{32}P -labelled superphosphate by field crops. Part I. Effects of simultaneous application of non-radioactive phosphate fertilizers. *Plant & Soil.* (In the press.)

Results from nine field experiments carried out in 1952, 1953 and 1954 on contrasting sites at Rothamsted are described. The effects of the simultaneous application of non-radioactive fertilizers (superphosphate, dicalcium

phosphate and Gafsa rock phosphate) on yield, total phosphorus uptake and uptake of radioactive superphosphate drilled with the seed for barley, and near the seed for fodder beet, are discussed, with reference to the influence of soil conditions and the weather.

The amounts of phosphorus taken up from superphosphate drilled near the seed of barley or root crops were almost independent of the simultaneous application of normal agricultural dressings of other phosphate fertilizers applied broadcast. Uptake increased with time from sowing (with one exception), and the total amount of labelled fertilizer recovered in the crops at harvest varied both with the season and with the site of the experiment. In general, less fertilizer was utilized on soils of high phosphate status, particularly in years when crops grew slowly.

"Superphosphate equivalents" of the broadcast non-radioactive phosphate fertilizers were estimated in terms of placed radioactive superphosphate as a standard by measuring the increase in labile or isotopically-exchangeable phosphorus in the soil from single dressings of broadcast phosphate fertilizers. Results obtained by this method confirmed that drilled applications of superphosphate were more effective than broadcasting for barley and that the two methods of application were equivalent for fodder beet.

- 2.16. TALIBUDEEN, O. (1958). Isotopically exchangeable phosphorus in soils. III. The fractionation of soil phosphorus. *J. Soil Sci.* **9**, 131-140.

Phosphate residues in the soil were subdivided into three fractions on the basis of isotopic exchange of orthophosphate ions between the soil and the soil solution. It was observed that the total labile phosphorus was a smaller fraction of the total phosphorus in the heavier soils (ca. 20 per cent clay) than in the lighter soils (1-10 per cent clay). This could be partly attributed to a higher organic-phosphorus content in the heavier soils. In comparable soils, recent manuring with superphosphate increased the ratio of the rapidly labile phosphate to the total labile phosphate; in the soils of lower clay content this ratio was higher than the corresponding ratios in the heavier soils. The recovery of phosphorus added at a moderately heavy rate was estimated by this method of fractionation in soils incubated for periods up to 3 months after treatment. Recovery of added phosphorus in the total labile fraction was incomplete for the calcareous soils, as compared to a 100 per cent recovery in a neutral soil of similar clay content. Moreover, a redistribution of phosphorus with time was observed in the calcareous soils *within* the total labile fraction, no such effect being observed with the neutral soil. This was attributed to the presence of internal surfaces on the calcium carbonate present.

- 2.17. WARREN, R. G., COOKE, E. H. & COOKE, G. W. (1958). Field experiments on concentrated organic nitrogen fertilizers. *J. agric. Sci.* (In the press.)

Hoof, formalized hoof, formalized casein, leather wastes and dried blood were compared with ammonium sulphate for vegetables in several field experiments which were continued for a number of years. Residual effects were measured on grass in one experiment at Rothamsted.

For crops which had a high requirement for nitrogen, hoof and formalized casein tended to give somewhat lower yields than equivalent ammonium sulphate. Organic nitrogen fertilizers tended to be slightly superior to ammonium sulphate for less responsive crops and also in experiments where the high rate of ammonium sulphate gave lower yields than the medium rate.

Crushed hoof and a formalized casein product gave similar yields of most crops. There were no marked gains from treating hoof with formalin; a coarse (5-7-mm.) sample of formalized casein did not give materially different yields from the ordinary fine (2-mm.) product.

One leather product made by simple roasting was inferior to ammonium sulphate and to hoof. Other leather wastes processed by alkalis did not behave very differently from crushed hoof or from ammonium sulphate. Dried blood was tested in a few experiments; there were no significant differences between yields given by blood and by ammonium sulphate.

In experiments on light soil spring cabbages planted in autumn were very sensitive to the time of applying nitrogen fertilizer; there were much larger

gains in yield from ammonium sulphate applied half at planting and half in spring than from either ammonium sulphate or organic nitrogen fertilizers applied wholly at planting.

Plots which had received either organic nitrogen fertilizers or ammonium sulphate continued to give significantly larger yields of grass than untreated plots for several years after manuring was stopped. The apparent "residual effects" of organic nitrogen fertilizers were similar to those of ammonium sulphate. Residues of formalized hoof gave slightly larger yields than residues of untreated hoof. Coarse formalized casein did not have appreciably larger residual effects than the fine material.

There were only small changes in the nitrogen contents of the soils of the plots at Rothamsted during the 10 years when fertilizers were applied. Soil nitrogen decreased on plots receiving no nitrogen fertilizer; hoof, formalized casein and ammonium sulphate dressings maintained soil nitrogen at its original level, and there was a slight increase where formalized hoof had been applied for a number of years.

2.18. WIDDOWSON, F. V. & COOKE, G. W. (1958). Nitrogen fertilizers for spring barley and wheat. *J. agric. Sci.* (In the press.)

Ten experiments on spring barley (mainly Proctor) and four on spring wheat (mainly Atle) in 1954-56 compared 0.25 and 0.5 cwt. N/acre (as ammonium sulphate) when drilled with the seed with dressings broadcast before sowing. Tests were also made of "Nitro-Chalk" dressings given in mid-May. In heavier split applications seedbed dressings were supplemented by top-dressings of 0.5 cwt. N/acre.

Barley gave much larger average responses than wheat. For barley combine-drilling 0.25 or 0.5 cwt. N/acre gave consistently larger yields than broadcasting the same nitrogen dressing on the seedbed; for wheat combine-drilling gave slightly higher yields at the high rate of dressing only.

For both crops 0.5 cwt./acre of N drilled with the seed was almost sufficient for maximum yields, but where only 0.25 cwt. N was applied at sowing a mid-May top-dressing of 0.5 cwt. N/acre gave higher yields.

At most centres May top-dressings of "Nitro-Chalk" gave lower yields than equivalent ammonium sulphate drilled with the seed. Yields were often reduced by lodging on plots which received seedbed-dressings plus top-dressing or the heavier rates of top-dressing alone; these treatments also reduced the quality of the grain. Combine-drilled or broadcast seedbed dressings did not cause serious lodging or reduce grain quality.

0.25 cwt. or 0.5 cwt. N/acre broadcast on the seedbed or combine-drilled had little effect on the percentage of nitrogen in the grain; equivalent top-dressings in mid-May consistently increased nitrogen content. Seedbed dressings plus top-dressings supplying heavier total quantities of nitrogen continued to increase nitrogen percentage in grain without giving any increase in yield.

On average about one-third of dressings supplying 0.5 cwt. N/acre was recovered in barley grain; wheat grain recovered only about one-eighth of the nitrogen applied. Percentage recoveries of nitrogen from heavy dressings applied partly on the seedbed and partly as top-dressings were rather smaller.

2.19. WIDDOWSON, F. V. & COOKE, G. W. (1958). Comparisons between placing and broadcasting of nitrogen, phosphorus and potassium fertilizers for potatoes, peas, beans, kale and maize. *J. agric. Sci.* (In the press.)

In eight experiments on main-crop potatoes in 1953-54 placing 0.5 cwt. N/acre in a band beside the seed tended to give higher yields than broadcasting the dressing; when 1.0 cwt. N/acre was applied, broadcasting tended to be superior to placement. There were no consistent gains from placing 1.5 cwt. K₂O/acre.

Four other potato experiments in 1954-56 tested all combinations of placing and broadcasting two levels of nitrogen and potassium. There was no clear relationship between the effects of broadcasting or placing one nutrient and the way in which the other nutrient was applied. When 0.5 cwt. of N was applied, placing gave higher yields in seven out of ten possible comparisons (one effect was significant). With 1.0 cwt. N/acre there were also seven of ten comparisons in favour of placement (three significant effects), but in two

other comparisons broadcasting gave significantly higher yields. Placing potassium gave higher yields than broadcasting in sixteen out of twenty comparisons (six significant effects), in one of the remaining comparisons broadcasting potassium was significantly superior. Placing of the potassium and, to a lesser extent, the nitrogen components of a complete potato fertilizer is likely to be beneficial.

In two experiments, each on green peas and broad beans, placing of phosphorus and potassium separately and together gave consistently higher yields than broadcasting these nutrients. When nitrogen was used in addition to phosphorus and potassium there were small gains in yield of broad beans provided the mixture was placed. There were no gains in yields of green peas from nitrogen, however the mixture was applied.

In one kale experiment in 1955 there were no significant effects on yield. In a 1956 experiment placing P, PK and NPK fertilizers beside the seed gave higher yields of kale than broadcasting these fertilizers.

In one maize experiment in 1956 the crop did not ripen properly. All nitrogen dressings delayed maturity, and where nitrogen was placed (with or without potassium) it gave significantly less crop than broadcasting.

BOOK

- 2.20. COOKE, G. W. (1958). Contribution to: *The Agricultural Notebook*, originally compiled by Primrose McConnell. 13th Edition.

Pedology Department

- 3.1. BLOOMFIELD, C. (1957). The possible significance of polyphenols in soil formation. *J. Sci. Fd Agric.* **7**, 389.

The translocation of iron compounds down the profile of soils of the podzol group is considered to be caused by the action of soluble organic compounds leached from the overlying unhumified tree litter. The solution and reduction of ferric oxide is apparently caused by the joint action of carboxylic acids and polyphenols. As aqueous leaf extracts will disperse clay suspensions, it is apparent that the development of textural profiles could be promoted by the action of these extracts. In the dispersion of clays, polyphenolic compounds constitute one of the chief groups of active compounds.

- 3.2. GREENE-KELLY, R. (1957). The montmorillonite minerals. In: *The Differential Thermal Investigation of Clays*, edited by R. C. Mackenzie; pp. 140-164. London: The Mineralogical Society.

- 3.3. GREENE-KELLY, R. & GALLAVAN, R. C. (1957). A Micro-calorimeter for clay mineral studies. *Clay Min. Bull.* **3**, 167-174.

The features required in a calorimeter for studying clay mineral systems are discussed, and a suitable calorimeter of high sensitivity is described in detail.

- 3.4. GREENE-KELLY, R. & WEIR, A. H. (1956). A silica spiral thermo-balance for studies on the dehydration of clay minerals. *Clay Min. Bull.* **3**, 68-78.

Constructional details of the balance and methods to give maximum sensitivity in obtaining and presenting results are described. Examples of work on clay minerals include comparison of results from the balance with d.t.a. traces of kaolinite and halloysite, low-temperature dehydration of various montmorillonites and a series at different rates of heating showing the relation between the d.t.a. trace and the equilibrium isobaric dehydration curve of Li⁺-Wyoming bentonite.

- 3.5. MUIR, A. (1954). The soils of the Shire Valley. In: *A Report on the Control and Development of Lake Nyasa and the Shire River*. Vol. 2, pp. 129-178. London: Sir Wm. Halcrow and Partners.

An account of the distribution, morphology and properties of the soils in relation to geology, relief and agricultural potential.

- 3.6. MUIR, A., ANDERSON, B. & STEPHEN, I. (1957). Characteristics of some Tanganyika soils. *J. Soil Sci.* **8**, 1-18.

A mineralogical study of soils, derived mainly from amphibolite, show that only small amounts of the more resistant aluminosilicate minerals survive. The clays of the red loams are characterized by a dominance of kaolinite, whereas the more poorly drained grey soils have a disordered kaolin (fire-clay mineral). Other components are iron oxides and small amounts of illite. The pallid soils contain moderate amounts of montmorillonite in the weathering zone, some of which persists into the soil. The mbuga and black valley soils contain montmorillonite or illite, with subordinate kaolin.

- 3.7. MUIR, A. & STEPHEN, I. (1957). The superficial deposits of the Lower Shire Valley, Nyasaland. *Colon. geol. miner. Res.* **6**, 391-406.

Field observations on the physical features and superficial deposits, together with mineralogical examinations of the sand and clay fractions of the deposits, suggest that the bulk of the material forming the valley slopes is of a localized nature, and that its origin can be ascribed to a kind of pedisidimentation brought about in part by the various earth movements associated with the Rift Valley.

- 3.8. OSMOND, D. A. & STEPHEN, I. (1957). The micropedology of some red soils from Cyprus. *J. Soil Sci.* **8**, 19-26.

For abstract see below 16.3.

Soil Microbiology Department

RESEARCH PAPERS

- 4.1. BROWN, MARGARET E. & METCALFE, G. (1957). Nitrogen fixation by a species of *Pullularia*. *Nature, Lond.* **180**, 282.

A species of *Pullularia* was isolated from clay-loam soil, chalk soil, heath soil and woodland mull soil and also from the thallus of the lichen *Cladonia uncialis*. Tests made with the fungus isolated from the clay-loam soil showed that the organism could fix 4-5 mg. of atmospheric nitrogen per g. of glucose supplied in the cultural medium. An estimation of the numbers of *Pullularia* in the soil gave an approximate count of 8×10^3 cells per g. of soil.

On nitrogen-rich media the fungus very rapidly loses its ability to fix atmospheric nitrogen.

- 4.2. BROWN, MARGARET E. (1958). Preliminary studies on the inoculation of partially sterilized soils with selected microorganisms. *J. gen. Microbiol.* **18**, 239-247.

For abstract see p. 80.

- 4.3. JACKSON, R. M. (1957). Fungistasis as a factor in the rhizosphere phenomenon. *Nature, Lond.* **180**, 96-97.

The spores of certain fungi which are unable to germinate on glass slides buried in fresh soil, owing to the presence in the soil of a fungistatic factor, may do so readily when seedling roots grow in their immediate vicinity. This observation has been made with five fungi and three different plants.

Conidia of *Fusarium solani* and an unidentified species of *Fusarium* both normally produce chlamydospores in the soil and cease further development, but in the presence of seedling roots the chlamydospores germinate. With *Gliocladium roseum* and the *Fusaria* studied the germ tubes show a marked tropic growth towards the stimulating roots. *Paecilomyces marquandii*, although stimulated to germinate, shows no tropic response.

It is suggested that the rhizosphere effect is likely to be due as much to the indirect influence of root exudates in stimulating germination of inhibited fungal spores as to the subsequent direct nutritional effect of exudates and sloughed-off root tissue.

- 4.4. JACKSON, R. M. (1958). An investigation of fungistasis in Nigerian soils. *J. gen. Microbiol.* **18**, 248-258.

The presence of a fungistatic factor in Nigerian soils was demonstrated by the use of a technique in which discs of agar are placed in contact with moist fresh soil and inoculated with fungal spores. After incubation the discs are examined and the percentage of germinated spores recorded.

Inhibition of germination was not caused by autoclaved soil nor when 0.5 per cent (w/v) glucose is present in the agar. The presence or absence and the type of vegetation had little effect on the fungistatic power of the soil. In two profiles examined the property of fungistasis was confined to approximately the upper 40 cm. of the soil. Of nineteen species of fungi tested by the agar-disc method, the germination of eleven was significantly inhibited, of seven unaffected and of one stimulated.

The data obtained suggest that the phenomenon described in Nigerian soils is similar to that reported from other parts of the world.

- 4.5. (METCALFE, G.) & BROWN, MARGARET E. (1957). Nitrogen fixation by a new species of *Nocardia*. *J. gen. Microbiol.* **17**, 567-572.

Two new species of the genus *Nocardia* (Trev.) have been isolated from the soil of chalk grassland. One of these, *Nocardia calcarea* n.sp., fixes atmospheric nitrogen in culture in amounts of 2-4.5 mg. N/g. glucose, sucrose or mannitol present in the medium. The second species, *N. cellulans* n.sp., decomposes cellulose in culture and fixes atmospheric nitrogen in culture using glucose, sucrose, mannitol and cellulose as carbon source; amounts of 12 mg. N fixed/g. cellulose decomposed were recorded. The properties of nitrogen fixation and cellulose decomposition have not previously been recorded for this genus.

- 4.6. WALKER, N. (1957). The persistence in soil of bacteria adapted to the decomposition of hormone herbicides. *Turf for Sport*, **3**, No. 2.

After repeated sprayings of turf with commercial preparations of either 2:4-D or MCPA, the soil micro-flora became adapted to decompose these herbicides. It was shown that these adapted organisms persisted in the soil for 12 months after the sprayings were discontinued.

REVIEW ARTICLES

- 4.7. MEIKLEJOHN, JANE (1957). Nitrification in soil. *N.A.A.S. Quart. Rev.* (In the press.)
- 4.8. THORNTON, H. G. & MEIKLEJOHN, JANE (1957). Soil Microbiology. *Ann. Rev. Microbiol.* **11**, 125-148.

BOOK

- 4.9. *Magnesium, the fifth major plant nutrient*. By A. Jacob. English translation by N. Walker. London: Staples Press Ltd., 1957.

Botany Department

GENERAL PAPERS

- 5.1. WATSON, D. J. (1957). The physiological basis of the effect of potassium on crop yield. In: *Potassium Symposium 1956*. Bern: International Potash Institute, pp. 109-119.

RESEARCH PAPERS

- 5.2. HUMPHRIES, E. C. (1958). Effect of removal of a part of the root system on the subsequent growth of the root and the shoot. *Ann. Bot. Lond.*, N.S. (In the press.)

Removal of up to 50 per cent of the roots of barley or rye had no effect on the growth rate of the root, but the growth rate of the shoot decreased as more roots were removed. When more than 50 per cent of the roots were removed, root growth declined, but not so rapidly as that of the shoot. Removal of lateral roots of tomato gave similar results, but root growth began to decline when more than 40 per cent of the lateral roots were removed.

- 5.3. OWEN, P. C. (1957). The effect of ultra-violet radiation on the respiration rate of tobacco leaves, and its reversal by visible light. *Nature, Lond.* **180**, 610.

The respiration rate of tobacco leaves exposed to radiation of wave-length 2,537 Å. for 5 minutes was increased by 20 per cent, but if the leaves were exposed to natural visible light for 2 hours after irradiation this effect disappeared.

- 5.4. OWEN, P. C. (1957). Rapid estimation of the areas of the leaves of crop plants. *Nature, Lond.* **180**, 610-611.

A method of leaf-area measurement described by other workers has been modified for use with leaves whose shapes are not regular ellipses.

- 5.5. OWEN, P. C. (1957). The effects of infection with tobacco mosaic virus on the photosynthesis of tobacco leaves. *Ann. appl. Biol.* **45**, 456-461.

The rate of photosynthesis of tobacco leaves infected with tobacco mosaic virus was lower than that of comparable healthy leaves from within 1 hour of inoculation. It was not caused by an effect of the virus on the stomata, and inactivated virus did not affect the rates. These results indicate either a more rapid movement of virus from the epidermis into the chlorenchyma than has previously been recorded or an effect of virus infection at a site distant from the cells containing virus.

- 5.6. OWEN, P. C. (1958). Photosynthesis and respiration rates of leaves of *Nicotiana glutinosa* infected with tobacco mosaic virus and of *Nicotiana tabacum* infected with potato virus X. *Ann. appl. Biol.* (In the press.)

The rates of respiration and of photosynthesis of tobacco leaves infected with potato virus X were not affected until the leaves showed symptoms; the respiration rate was then increased by more than 30 per cent, and the photosynthesis rate decreased by 20 per cent. When local lesions appeared on the leaves of *N. glutinosa* infected with tobacco mosaic virus, but not before, the respiration rate was increased by an amount, up to 30 per cent, that varied with the number of lesions. The photosynthesis rate was decreased by 20 per cent, but there was no effect on either respiration or photosynthesis until symptoms appeared. These results differed from those previously reported for tobacco leaves infected with tobacco mosaic virus, in which both respiration and photosynthesis were affected within 1 hour of inoculation. The validity of extrapolating arguments based on the results obtained with other combinations to this commonly used combination and vice-versa is questioned.

- 5.7. OWEN, P. C. (1958). Some effects of virus infection on leaf water contents of *Nicotiana* species. *Ann. appl. Biol.* (In the press.)

Infection with tobacco mosaic virus decreases the water content attained by detached tobacco leaves when kept under conditions of minimum water stress, and does so more with plants kept in light than in darkness before inoculation. No such effects of infection during the first day after inoculation were obtained with tobacco leaves infected with either tobacco etch virus or potato virus X or with *Nicotiana glutinosa* leaves infected with tobacco mosaic

virus. These results suggest that inoculation with tobacco mosaic virus affects tissues deeper than the epidermis in tobacco leaves earlier than in other leaves, and earlier than other viruses affect tobacco leaves.

- 5.8. THORNE, G. N. (1957). The effect of applying a nutrient in leaf sprays on the absorption of the same nutrient by the roots. *J. exp. Bot.* **8**, 401-412.

Ammonium nitrate solution applied to the leaves of sugar beet increased plant dry weight and uptake of nitrogen by the roots. Uptake of phosphorus by the roots of swedes, but not sugar beet, grown with high phosphorus supply to the roots, was decreased by applying sodium phosphate solution to the leaves; uptake from a lower phosphorus supply to the roots was unaffected. Phosphorus applied to the leaves had no effect on dry weight. Potassium uptake by the roots of sugar-beet plants grown with high potassium supply to the roots was unaffected by painting the leaves with a potassium chloride solution, that of plants with an intermediate potassium supply was slightly increased, and plants grown with a low supply to the roots absorbed almost all the available potassium, so painting could not much increase uptake by the roots. Application of potassium to the leaves increased dry weight of plants with low or medium potassium supply to the roots and did not affect that of plants with a high potassium supply.

The top : root ratio for phosphorus content in mg. per plant was greater for phosphorus absorbed via leaves than for phosphorus absorbed via roots. Increasing the phosphorus supply to the roots increased this ratio for phosphorus absorbed either via leaves or roots.

Potassium absorbed by leaves was slightly more efficient in increasing dry weight than potassium absorbed at the same time by the root. A similar comparison was not possible for nitrogen or phosphorus.

The results of these and previous experiments indicate that all the nitrogen and potassium and over 80 per cent of the phosphorus applied to leaves was absorbed. The small amount of phosphorus remaining unabsorbed on the surface of the leaf was unaffected by phosphorus supply to the root.

- 5.9. THURSTON, J. M. (1957). Morphological and physiological variation in wild oats (*Avena fatua* L. and *A. ludoviciana* Dur.) and in hybrids between wild and cultivated oats. *J. agric. Sci.* **49**, 259-274.

In samples of wild oat panicles collected in England and Wales in 1951 only two species, *Avena fatua* L. and *Avena ludoviciana* Dur., occurred; both were very variable in grain characters, but most plants bred true. Plants of all except one type of *A. fatua* were upright in habit with few tillers and averaged 95 per cent dormant grains at harvest; plants of *A. ludoviciana* were procumbent or prostrate at the maximum tillering stage with numerous tillers, and the percentage of dormant grains was lower than in *A. fatua*.

The taxonomy of wild oats is discussed. Chromosome counts on eleven selections showed that $2n = 42$.

Types intermediate between wild and cultivated oats were compared with wild oats.

- 5.10. WARINGTON, K. (1957). The influence of the pH of the nutrient solution and the form of iron supply on the counteraction of iron deficiency in peas, soybean and flax by high concentrations of molybdenum. *Ann. appl. Biol.* **45**, 428-447.

The prevention of chlorosis in flax by high concentrations of molybdenum in a nutrient solution was associated with a delay in the precipitation of iron from ferric citrate, a slower drift of pH towards alkalinity and an increase in the iron content of the root. These effects were greater with ammonium than with sodium molybdate, and occurred with solutions started at pH 4.6 but not at pH 6.6.

When FeEDTA was the source of iron, a similar delay in pH drift in the solution and accumulation of iron in the root occurred, but there was no chlorosis or precipitation of iron in the control treatment, so the effect of high molybdenum could not be fully determined.

When ferric chloride was used, high molybdenum did not prevent chlorosis nor delay iron precipitation or cause accumulation of iron in the root, though the rate of pH drift resembled that of solutions containing the organic forms of iron.

Similar results were obtained with peas and soybeans receiving high molybdenum treatment, but suppression of chlorosis was only temporary.

It is suggested that the capacity of molybdenum to offset chlorosis is due to the formation, in acid solution, of a complex with phosphorus which renders iron more available by delaying the formation of ferric phosphate. This seems to occur only when iron is supplied in the organic form.

- 5.11. WARINGTON, K. (1958). Changes in the weed flora on Broadbalk Permanent Wheat Field during the period 1930-55. *J. Ecol.* **46**, 101-113.

The reduction in annual species achieved by the intensive fallow of 1926-29 has on the whole been maintained, that of *Papaver rhoeas* being the outstanding example, though since 1953 there have been signs of the return of this weed. *Alopecurus myosuroides*, another principal weed, on the other hand, has only been temporarily checked by the once-in-5-year fallow and has quickly re-established itself, though less noticeably so since 1953. Other species have become much more plentiful, e.g., *Ranunculus arvensis*, *Vicia sativa* and *Avena* spp., though the last has now been gradually eliminated by hand-pulling.

Germination results from soil samples agree remarkably well with field rating records, but comparison is limited to the species prevalent on the plots selected for sampling. Unfortunately no germination data are available for the period 1946-54 when considerable changes in weed flora took place.

Perennials were unimportant in 1930. Of the species then present *Sonchus arvensis* has failed to return, but *Cirsium arvense* has once more become a serious weed, chiefly since 1943. *Convolvulus arvensis* is also re-established, but *Tussilago farfara* and *Equisetum* remain relatively unimportant and of local occurrence only.

- 5.12. WATSON, D. J. (1958). The dependence of net assimilation rate on leaf area index. *Ann. Bot. Lond.*, N.S. **22**, 37-54.

The leaf-area index (leaf area per unit area of land, L) of field crops of kale and sugar beet was varied experimentally by removing different fractions of the plant population distributed uniformly through the crop. The net assimilation rate (E) was determined in subsequent periods of 10-14 days.

For kale, E decreased nearly linearly with increase in L throughout the range from 1 to 5. E for sugar beet was less affected by change in L , and was apparently not decreased until L rose above about 3.

Because of this dependence of E on L , the rate of dry-matter production per unit area of land, or crop growth rate (C , = EL), showed a curved relation to L ; for kale it increased to a maximum when L was between 3 and 4 and fell again at higher values of L . Maximal C for sugar beet occurred beyond the range of L tested, probably between $L = 6$ and $L = 9$. This optimal L for dry-matter production by sugar-beet crops probably lies near the upper limit of the current agricultural range, so there is little, if any, scope for increasing the dry-matter yield by further increase in L . For heavy kale crops L is already far in excess of the optimum, and it may be possible to increase the total dry-matter yield of kale by repeated thinning or defoliation to hold L near the optimum.

- 5.13. WATSON, D. J., THORNE, G. N. & FRENCH, S. A. W. (1958). Physiological causes of differences in grain yield between varieties of barley. *Ann. Bot. Lond.*, N.S. (In the press.)

In a field experiment on barley at Rothamsted with the high mean yield of 49 cwt. of grain/acre, the varieties Proctor and Herta produced 10-15 per cent more grain than Plumage Archer on plots that received no nitrogenous fertilizer. When nitrogen was applied the difference was increased to about 30 per cent, because the higher nitrogen supply caused the Plumage Archer crop to lodge and did not increase its yield, while Proctor and Herta remained standing.

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The three varieties did not differ in leaf-area index nor in net assimilation rate before ear emergence, so that all had the same total dry weight. After ear emergence, the leaf-area indices of Proctor and Plumage Archer were nearly equal, but that of Herta was smaller. Assuming that the photosynthetic efficiency of the leaves continued to be the same in all varieties, the higher grain yields of Proctor and Herta cannot be attributed to greater production of dry matter by the leaves, either before or after ear emergence.

The higher grain yield of Proctor and Herta than of Plumage Archer must therefore have come from additional photosynthesis in parts of the plant other than the leaves, i.e., in the ears themselves. An attempt to demonstrate this directly in a pot experiment by comparing the grain yields of plants with shaded or with unshaded ears was unsuccessful because the varieties behaved differently in pots; Proctor and Herta produced only about 6 per cent more grain yield than Plumage Archer, and though the decrease in grain yield by shading the ears was slightly greater for Proctor and Herta, the differences were not significant.

The sum of ear sizes per m.² in the field experiment was greater for Proctor and Herta than for Plumage Archer. Also the distribution of dry matter between developing ears and shoots apparently differed with variety, so that at ear emergence the dry weight of ears per m.² was greater in the two higher-yielding varieties. The increased amount of photosynthetic tissue in the ears of Proctor and Herta, as measured by size or weight, may not wholly explain their greater dry-matter production; ears of Herta may also have a higher photosynthetic efficiency.

No differences in nutrient uptake that could account for the varietal differences in grain yield were found. Plumage Archer absorbed more potassium and Herta less phosphorus than the other varieties.

Biochemistry Department

BOOKS

- 6.1. TRACEY, M. V. (1956). *Modern Methods of Plant Analysis*. Edited by K. Paech & M. V. Tracey. Vol. 1. Berlin: Springer Verlag.

GENERAL PAPERS

- 6.2. PIRIE, N. W. (1957). The Origins of Life: Moscow Symposium. *Nature, Lond.* **180**, 886-888.
- 6.3. PIRIE, N. W. (1957). Some assumptions underlying discussion on the Origins of Life. *Ann. N.Y. Acad. Sci.* **69**, 369-376.
- 6.4. (LE GROS CLARK, F.) & PIRIE, N. W. (1957). Introduction to the symposium on "The Biology of Ageing," edited by W. P. Yapp & G. H. Bourne. Institute of Biology, x-xvi.
- 6.5. PIRIE, N. W. (1958). Unconventional production of foodstuffs. "The Biological Productivity of Britain", Institute of Biology.
- 6.6. PIRIE, N. W. (1958). The unconventional production of foodstuffs. *Penguin Sci. News*.
- 6.7. TRACEY, M. V. (1957). Chitin. *Rev. pure & appl. Chem.* **7**, 1-14.
- 6.8. TRACEY, M. V. (1957). The role of cellulases in nature. Friday Harbor Symposium in Marine Biology. (In the press.)

RESEARCH PAPERS

- 6.9. KENTEN, R. H. (1957). The partial purification and properties of a thiaminase from bracken (*Pteridium aquilinum* (L.) Kühn). *Biochem. J.* **67**, 25-33.

A method for the estimation of small amounts of heteropyrithiamine (*N*-(4-amino-2-methylpyrimidin-5-yl)methylpyridine) in the presence of thiamine is described. It depends on the destruction of thiamine by incubation with strong alkali and subsequent oxidation of heteropyrithiamine to 2-methylpyrithochrome by ferricyanide. The 2-methylpyrithochrome is estimated spectrophotometrically at 386 m μ .

With the method it is shown that bracken thiaminase catalyses a transfer reaction between thiamine and pyridine with the formation of heteropyrithiamine. In the presence of excess of pyridine the amount of heteropyrithiamine formed accounts for 90-95 per cent of the thiamine added.

A relatively simple method for the measurement of bracken-thiaminase activity is described.

By fractionation with ammonium sulphate and calcium phosphate gel, concentrated partially purified thiaminase preparations have been made from water extracts of dried bracken leaves. The best preparation was obtained in 30 per cent yield and represented a purification of about 60-fold. It catalysed the formation of 3,150 μ moles of heteropyrithiamine/hour/mg. of N at 37°.

With the concentrated partially purified preparations, no evidence was obtained for the presence of a thermolabile factor capable of catalysing the hydrolytic fission of thiamine.

- 6.10. KENTEN, R. H. (1957). Latent phenolase in extracts of broad bean (*Vicia faba* L.) leaves. 1. Activation by acid and alkali. *Biochem. J.* **67**, 300-307.

Water extracts of broad-bean leaves contain much latent phenolase activity.

Active phenolase is released by brief exposure of the extracts to acid (pH 3-3.5) or alkaline (pOH 2.5-3) conditions or by incubating in the presence of ammonium sulphate at about pH 5.

Evidence has been obtained that the extracts contain little material capable of inhibiting broad bean phenolase.

The nature of the latent phenolase has not been elucidated, but it is suggested that either a phenolase precursor or a phenolase-protein inhibitor complex is present in the leaf extracts.

- 6.11. KENTEN, R. H. (1957). Latent phenolase in extracts of broad bean (*Vicia faba* L.) leaves. 2. Activation by anionic wetting agents. *Biochem. J.* **68**, 244-251.

The latent phenolase of extracts of broad-bean leaf is activated with anionic wetting agents at pH 6. A number of cationic and non-ionic wetting agents were without effect.

With the homologous series of sodium *n*-alkyl sulphates tested the concentration at which activation of the latent phenolase took place decreased with increase in chain length.

At pH 8 the rate of activation with sodium dodecyl sulphate and Aerosol OT was very slow or negligible compared with that at pH 6.

It is suggested that the anionic wetting agents activate through their capacity to combine with the cationic groups of protein. Dissociation of a phenolase-protein inhibitor complex or configurational changes in a phenolase might follow such combination.

- 6.12. PIERPOINT, W. S. (1957). The phosphoesterase of pea plants (*Pisum sativum* L.). *Biochem. J.* **67**, 466-472.

A purified preparation of a phosphatase from peas breaks the phospho-monoester bonds in a wide range of compounds. Pyrophosphate is an intermediate in the breakdown of tripolyphosphate to orthophosphate. The enzyme also breaks the diester bonds in trimetaphosphate, although not those in nucleic acids or diphenyl phosphate. The di- and mono-esterase activities

are not separated by a variety of protein fractionation procedures, including paper electrophoresis and ion-exchange chromatography. The chromatography resolves the phosphatase into two active components. This heterogeneity is not caused by the ammonium sulphate precipitation in the preparation of the enzyme.

- 6.13. PIERPOINT, W. S. (1957). Polyphosphates excreted by the wax-moth larvae (*Galleria mellonella* L. and *Achroia grisella* Fabr.). *Biochem. J.* **67**, 624-627.

The excreta of wax-moth larvae feeding on brood comb contains about 0.5-1.0 per cent of its dry weight as phosphorus. About half of this phosphorus is water soluble and hydrolysed to orthophosphate by boiling with normal hydrochloric acid for 10 minutes. The water-soluble phosphates excreted by *G. mellonella* were analysed by anion-exchange chromatography, and shown to consist of orthophosphate 14 per cent, pyrophosphate 23 per cent, tripolyphosphate 44 per cent, acid-stable phosphate 3 per cent and a fraction retained by the resin, probably polyphosphates of higher molecular weights, 16 per cent. Water-soluble phosphates were excreted by *A. grisella* larvae in similar proportions, but with slightly more orthophosphate (29 per cent) and less of the material retained by the resin (6 per cent).

- 6.14. PIRIE, N. W. (1957). Leaf protein as a human food. *Food Manufacture*, **32**, 416-419.

A brief account of the performance of the extraction machinery, of the methods used in getting an easily handled final product and of the trials that have been made of different techniques of cookery.

- 6.15. BAWDEN, F. C. & PIRIE, N. W. (1957). A virus inactivating system from tobacco leaves. *J. gen. Microbiol.* **16**, 696-710.

For summary see below No. 7.9.

- 6.16. BAWDEN, F. C. & PIRIE, N. W. (1957). The activity of fragmented and reassembled tobacco mosaic virus. *J. gen. Microbiol.* **17**, 80-95.

For summary see below No. 7.10.

- 6.17. TRACEY, M. V. & (YOUATT, G.) (1957). Cellulase and chitinase in two species of Australian termites. *Enzymologia*. (In the press.)

Extracts from both *Nasutitermes exitiosus* and *Coptotermes lacteus* contain cellulase and chitinase activity. The significance of these findings is discussed.

- 6.18. TRACEY, M. V. (1957). Cellulase and chitinase in plant nematodes. *Nematologica*. (In the press.)

Cellulase and chitinase were found in extracts of *Ditylenchus dipsaci*, *D. destructor* and *D. mycetophagus*. It appears probable that these enzymes are a product of the nematodes themselves and not of associated micro-organisms. Some figures for the gross composition of the eelworms are given.

Plant Pathology Department

GENERAL PAPERS

- 7.1. BAWDEN, F. C. (1957). Tobacco mosaic virus. (In: *Cellular biology nucleic acids and viruses*, New York Academy of Sciences.)
- 7.2. BAWDEN, F. C. (1958). The nature of plant viruses. *Outlook on Agric.* (In the press.)
- 7.3. BAWDEN, F. C. (1957). The role of plant hosts in microbial ecology. (In: *Symp. Soc. gen. Microbiol.* **7**: *Microbial Ecology*.)

- 7.4. BROADBENT, L. (1957). Insecticidal control of the spread of plant viruses. *Ann. Rev. Entom.* **2**, 339-354.
- 7.5. BROADBENT, L. (1958). The spread and control of plant viruses. *Sci. Hort.* **13**.
- 7.6. BUXTON, E. W. (1957). Problems of plant wilt diseases. *Agric. Rev.* **3** (7), 28-35.
- 7.7. HULL, R. (1957). Sugar Beet Yellows in Great Britain, 1956. *Plant Path.* **6**, 131.

RESEARCH PAPERS

- 7.8. BAWDEN, F. C. & KLECZKOWSKI, A. (1957). An electrophoretic study of sap from uninfected and virus-infected tobacco plants. *Virology*, **4**, 26-40.

The number and concentration of electrophoretically distinguishable components in sap from uninfected tobacco leaves varied with the position of the leaf on the stem, the age of the plants, their nutrition and conditions of growth. None of the distinguishable proteins seemed to be homogeneous. Sap from the lowest leaves contained something that aggregated the proteins and produced unstable electrophoretic patterns; stable patterns were obtainable when the proteins were precipitated with ammonium sulphate and redissolved.

Infection with tobacco mosaic virus or potato virus X, but not with tobacco etch or potato Y virus, introduced new components into the electrophoretic pattern. Unlike tobacco mosaic virus, potato virus X was stationary in pH 7 phosphate buffer; two minor components specific to sap from leaves infected with potato virus X had mobilities of -2 and -4×10^{-5} cm.²sec.⁻¹v⁻¹.

The concentration of normal proteins was not correlated with severity of leaf symptoms, and was not consistently affected by virus infection. Potato Y and tobacco etch viruses usually did not affect the concentration, but sometimes decreased it slightly. Potato virus X and tobacco mosaic virus sometimes considerably decreased the concentration of normal proteins, usually when young rapidly growing plants were used and the conditions favoured a high virus content, but even in these conditions the amount of normal proteins was sometimes unaffected. Simultaneous infection with potato X and tobacco mosaic viruses, each of which accumulated to the same extent as when present alone, had no more effect on the normal proteins than did infection with one or the other alone.

- 7.9. BAWDEN, F. C. & PIRIE, N. W. (1957). A virus-inactivating system from tobacco leaves. *J. gen. Microbiol.* **16**, 696-710.

Purified preparations of the Rothamsted tobacco necrosis virus made by sedimenting the virus from freshly expressed sap lose infectivity slowly at 0° and rapidly at 18°. Stable infective preparations can be made by ultracentrifugation provided the sap is first frozen or allowed to age; unstable preparations can be stabilized by prolonged centrifugation at 8,000g, or by incubation with citrate and azide. Stable virus preparations lose their infectivity when exposed to the material that sediments from leaf sap centrifuged at 4,000-8,000g. This inactivation demands air, and is prevented by the presence of azide, but when the sedimented material is kept in air at 0° for some hours a low-molecular-weight substance separates from it, and this inactivates the virus whether or not air or azide are present. The material sedimented from the sap of uninfected tobacco leaves, or leaves infected with tobacco mosaic virus, inactivates virus less readily than does material from leaves infected with tobacco necrosis or tobacco ringspot virus. The sediments inactivate tobacco ringspot but not tobacco mosaic virus. The nature of the inactivating substance made by the sediments is unknown, but aldehydes and derivatives of ascorbic acid have comparable effects. Inactivated virus preparations are still serologically active and resemble active ones in all other properties studied.

- 7.10. BAWDEN, F. C. & PIRIE, N. W. (1957). The activity of fragmented and reassembled tobacco mosaic virus. *J. gen. Microbiol.* **17**, 80-95.

Studies of the products obtained when tobacco mosaic virus (TMV) is disrupted with alkali or phenol suggest that immunological specificity is primarily an attribute of the protein and infectivity of the nucleic acid. Although exposing the virus to alkali produces infective fragments, it also causes much inactivation, and much of the nucleoprotein sedimented when preparations are ultracentrifuged at pH 6 is not infective. The unsedimented protein fragments are inhibitors of infection; from such unsedimentable material which at 5 g./l. produced no lesions when inoculated to *Nicotiana glutinosa*, some infective nucleoprotein could sometimes be separated by precipitation with ammonium sulphate, followed by ultracentrifugation. The infectivity of fragmented TMV is ephemeral, but it is stabilized when the fragments are reunited. Nucleic acid preparations made by phenol are quickly inactivated by ribonucleases from pancreas or leaves; pancreatic ribonuclease also inactivates alkali-made fragments, but the infectivity of these is stabilized by leaf ribonuclease. Phenol-made preparations are much less infective per unit of phosphorus than intact TMV, but measurements of the relative infectivities of the two kinds of inocula are complicated because the two respond differently to dilution and they are not equally able to infect *N. glutinosa* leaves in different physiological states. Although urea does not inactivate phenol-made preparations, nucleic acid made by exposing TMV to urea has little or no infectivity. The possibility that infective TMV can be reassembled *in vitro* from previously non-infective components cannot be excluded, but all the results that could be interpreted as suggesting this are also interpretable in other ways, either by the removal of inhibitors of infection or by the stabilization of infective fragments that otherwise would have become inactive before testing.

- 7.11. BROADBENT, L., BURT, P. E. & (NIX, J. S.) (1957). The cost of using insecticides to maintain the health of potato seed in England and Wales. *N.A.A.S. Quart. Rev.*, **38**.

The useful life of potato seed stocks in the south and east of Britain can be prolonged by spraying with insecticides which check the spread of aphid-borne viruses, especially of leaf roll from infected to healthy plants within a crop. Spraying, combined with removing the plants that become infected by aphids bringing viruses into healthy stocks, costs £8 to £11/acre less per year than buying new "A" or Stock Seed, but the saving depends on the method adopted and current market prices. The cheapest method is to spray and rogue a ware crop and save seed from this, but there may sometimes be advantages to offset the slightly greater cost of growing a crop specially for seed.

- 7.12. BROADBENT, L., (GREEN, D. E. & PATON, J. B.) (1957). Virus diseases in the Narcissus Trial at Wisley. *J. R. hort. Soc.* **82**, 395-401.

The Narcissus stocks were freed from severe virus diseases by roguing obviously diseased plants and by planting the plots between barriers of rye, but each year new stocks sent for trial by British and Dutch growers contained diseased plants. Many infected plants showed symptoms in some years, but not in others.

- 7.13. BROADBENT, L., HEATHCOTE, G. D., (MCDERMOTT, N. & TAYLOR, C. E.) (1957). The effect of date of planting and of harvesting potatoes on virus infection and on yield. *Ann. appl. Biol.* **45**, 603-622.

Experiments during 1953-56 tested the effects of early and late planting of King Edward potatoes on the incidence of virus diseases in the tubers and the suitability of the tubers for use as seed. Plantings were made each month from April to August, and tubers were lifted after 12 weeks' growth or after the haulms had died.

Aphids began to colonize the early planted plots about mid-June each year, but their multiplication and flying were influenced by weather and varied greatly from year to year. The May-planted plots usually carried the most aphids. Winged aphids visited the July and August plantings, but few bred extensively though the plants were young and green. The incidence of virus diseases in the tubers was not related to the maximum aphid populations on the plants. Most of the plants that became infected became so by aphids flying from diseased potato plants in the same field, and the late-planted plots did not escape. Crops planted in mid-April and harvested in early July produced the fewest virus-infected tubers.

Planting in April and lifting at the end of the season produced most ware-sized tubers. In plots lifted after 12 weeks, May or June planting produced more ware than April planting. Few or no ware-sized tubers were produced from July or August planting, and yields of seed-sized tubers were also poor. Most seed-sized tubers were produced by the late-lifted May or June plantings. The date of lifting had little effect on the total number of tubers, but the date of planting affected it greatly. Most tubers were usually set by the May plantings, and the number decreased with successive plantings. Early lifted immature tubers were easily damaged and were difficult to store. Blighted tubers occurred only in the July or August plantings, which also suffered most from slug and cutworm damage.

Infection with leaf roll virus reduced yield by about three-quarters, whether the seed had been lifted early or late the previous year. Healthy or virus-infected mature seed produced a bigger crop the next year than immature seed obtained by early lifting or late planting.

Late-planted tubers produced more main stems than those planted at the normal time, but growth of axillary shoots was reduced and total leaf area remained small, even when the plants were not attacked by blight.

- 7.14. BROADBENT, L., HEATHCOTE, G. D. & (MASON, E. C.) (1958). An Essex farm trial on the insecticidal control of potato virus spread. *Plant Path.* **7**.

A stock of originally healthy King Edward potatoes sprayed each year for 4 years, three times at monthly intervals, with the systemic insecticides dimefox or demeton, or six times at fortnightly intervals with parathion, contained in the fourth year 0.5 per cent of plants with leaf roll, whereas an unsprayed stock contained 26 per cent. The insecticides failed to prevent the spread of virus Y; the incidence of infected plants in the fourth year was 19 per cent in the parathion-sprayed stock, 31 per cent in those treated with systemic insecticides and 35 per cent in the untreated.

- 7.15. BUXTON, E. W. (1957). Differential rhizosphere effects of three pea cultivars on physiologic races of *Fusarium oxysporum* f. *pisi*. *Trans. Brit. mycol. Soc.* **40**, 305-317.

Pea cultivars Onward, Alaska and Delwiche Commando, differential hosts for three physiologic races of *Fusarium oxysporum* f. *pisi* (cause of pea wilt), exert different effects on the soil microflora. Cultivar Onward, susceptible to race 1, supports more fungi, bacteria and Actinomycetes near its root surface than do either Alaska or Delwiche Commando, which resist race 1. Qualitative differences between rhizosphere populations of the three cultivars are most apparent in *Fusaria* and bacteria.

The germination of spores of the three physiologic races of *F. oxysporum* f. *pisi* was affected by water extracts of the three rhizosphere soils in the same way as earlier with root exudates from the three cultivars. Spores of a race able to wilt a particular cultivar germinate well in rhizosphere soil extract from that cultivar. Germination is decreased, on the other hand, in extracts from the rhizosphere of a resistant cultivar. Spores of race 3, however, were not able to germinate well in rhizosphere extract of cultivar Alaska, which is susceptible to this race.

Soils in which each of the three pea cultivars had grown were inoculated with spores of race 1 and planted with seedlings of the susceptible cultivar Onward. Plants became severely wilted in pots in which Onward had grown and in control pots which had not grown peas, but wilting was less and developed more slowly in pots which had previously been cropped with cultivars Alaska and Delwiche Commando (which resist race 1). It is suggested that substances

exuded by roots of cultivars resistant to race 1, together with the effect of altering the soil microflora, prevent race 1 from germinating, thus lowering the amount of effective inoculum and delaying the onset of wilt.

- 7.16. BUXTON, E. W., LAST, F. T. & NOUR, M. A. (1957). Some effects of ultraviolet radiation on the pathogenicity of *Botrytis fabae*, *Uromyces fabae* and *Erysiphe graminis*. *J. gen. Microbiol.* **16**, 764-773.

Ultra-violet irradiation of spores of three leaf-infecting fungi, *Botrytis fabae*, *Uromyces fabae* (causes of "chocolate spot" and rust of broad beans, respectively) and *Erysiphe graminis* (cause of barley powdery mildew), decreased their pathogenicity, as assessed by counts of local lesions or pustules. The infectivity of *B. fabae* was lost more rapidly than the ability to form colonies on agar; with *E. graminis* infectivity was lost more rapidly than the ability to germinate. Ultra-violet radiation damage to spores of all three fungi was mitigated by exposure to daylight after irradiation. The extent of such photoreactivation of *B. fabae* was the same whether the spores were on the host plant or *in vitro*. Ultra-violet irradiation of leaves before inoculation decreased the number of pustules of *E. graminis* on barley, had no effect on the pustule number caused by *U. fabae* and increased the number of lesions caused by *B. fabae* on broad beans. Rubbing leaves with "Celite" before inoculation also increased the number of *B. fabae* lesions. Retaining irradiated broad-bean plants in daylight or darkness after inoculation with unirradiated spores of *B. fabae* did not significantly alter the lesion number. In contrast, more pustules of *E. graminis* developed on irradiated barley leaves kept in daylight than in darkness.

- 7.17. CORNFORD, C. E. & POWELL, D. B. (1957). Effect of gamma rays on the sprouting of stored mangolds. *Nature, Lond.* **180**, 996.

Gamma rays prevented stored mangolds from sprouting.

- 7.18. GLYNNE, M. D. & SLOPE, D. B. (1957). The effect of seed rate and nitrogen on lodging and yield of spring barley (Field experiments 1954 and 1955). *J. agric. Sci.* **49**, 454-458.

The extent to which spring barley crops lodged at Rothamsted increased with seed rate and with nitrogen, and was larger in the wet summer of 1954 than the dry one of 1955. Although in 1954 all plots were extensively lodged by harvest, there were great differences in date of lodging; 50 per cent of the area was lodged later in plots sown with 1 than with 3 bushels/acre, the delay being 8 days with 1½ cwt. sulphate of ammonia, 14 days with 3 cwt. and 21 days with 4½ cwt. The weight of unit length of the basal part of the straw was reduced by higher seed rate and to a smaller extent by nitrogen.

Yield of total grain was only slightly affected by treatments; yield of dressed grain was decreased by higher seed rate in one year and by nitrogen in both years.

- 7.19. GREGORY, P. H. & HIRST, J. M. (1957). The summer air-spora at Rothamsted in 1952. *J. gen. Microbiol.* **17**, 135-152.

The air over an arable field at Rothamsted Experimental Station, Harpenden, was sampled from 1 June to 25 October 1952 at 2 m. above ground with an automatic volumetric spore trap. Each day's slide was scanned and all the spores counted on an area representing a sample volume of 41 litres of air. Spores were classified in twenty morphological groups and a miscellaneous one. Seasonal periodicities are presented as 6-day running means of the daily average number of spores/m.³ air, and then related to meteorological data. *Cladosporium* conidia accounted for 46 per cent of the total catch; hyaline basidiospores (chiefly *Sporobolomyces*) for 31 per cent; and pollen only 1 per cent. The relative frequency of various spore types differs from that recorded by earlier workers because the suction trap catches spores of all sizes with almost equal efficiency and is little influenced by external conditions. The results, which should be representative of large rural areas of central and south England, show that the major changes of spore concentration depend on the weather and the phenology of the local vegetation and its associated fungal

flora. During 24 days in late June and July comparable estimates of spore concentration were made with another trap 24 m. above ground. The spore concentration of the twelve commonest groups at 24 m. totalled 82 per cent of that at 2 m.

- 7.20. HEATHCOTE, G. D. (1957). The comparison of yellow cylindrical, flat and water traps, and of Johnson suction traps, for sampling aphids. *Ann. appl. Biol.* **45**, 133–139.

Different traps were compared to find the type most suitable for studying aphid vectors of plant viruses quantitatively.

A Moericke water trap caught more aphids than a flat sticky trap of equal area. A flat sticky trap (930 sq. cm.) caught half as many aphids as a cylindrical trap (945 sq. cm.), which caught about one-third as many as a water trap (1,200 sq. cm.), or a Johnson suction trap (9-inch fan) when operated at between 2 and 3 feet over bare soil.

Yellow traps caught proportionally more *Tuberculoides annulatus*, and in summer more *Capitophorus* species than a suction trap, but significantly fewer *Anoecia corni*, *Sitobium* spp. and *Pemphigus bursarius*. Traps with a level surface caught proportionally more *Brevicoryne brassicae*, *Aphis fabae* and *Myzus persicae*, but fewer *Anoecia corni* and *Drepanosiphum plantanoides* than vertical cylindrical traps. Attraction by colour influences the catch on horizontal traps more than on cylindrical traps because there is less impaction by the wind.

Only suction traps indicate the number of aphids per unit volume of air and are non-selective, but they are expensive and require an electric power supply. Water traps effectively catch those aphids that are attracted to yellow, but they require frequent attention. Sticky traps catch fewer aphids than either suction or water traps, but they can be left unattended for about 2 weeks. Flat, sticky traps catch aphids likely to land on a crop, and cylindrical traps show when aphids are in the air, but not if those aphids are able or wanting to land. For routine work cylindrical sticky traps have other advantages; they are cheap and do not require skilled handling, and their catches of alate *Myzus persicae* have been correlated with the spread of some plant viruses.

- 7.21. HEATHCOTE, G. D. (1957). The optimum size of sticky aphid traps. *Plant Path.* **6**, 104–107.

Cylindrical sticky traps 12 cm. wide usually caught more aphids than traps 6 cm. wide, which caught more than traps 3 cm. wide, but doubling the surface area did not double the catch. In windy weather a greater proportion of aphids are swept past a wide cylinder in the divided air stream than past a narrow one, so that narrow traps catch more per unit area than wide ones.

Yellow traps caught more aphids per unit area than black ones. Square horizontal traps, 225, 900 and 3,600 sq. cm. in area, caught increasing numbers of aphids with increase in size; the catch per unit area was greatest on the 900-sq. cm. and least on the 3,600-sq. cm. trap.

- 7.22. HEATHCOTE, G. D. (1957). Effect of height on catches of aphids in water and sticky traps. *Plant Path.* **6**.

The numbers of aphids caught on yellow traps over bare ground decreased with increase in trap height from ground level to 152 cm. A water trap level with the tops of the plants in a potato field caught more than one at ground level among the plants. The early migrants of the chief species that transmit virus were few during the period of these experiments, but they were caught by both cylindrical and water traps.

- 7.23. HIRST, J. M. (1957). A simplified surface-wetness recorder. *Plant Path.* **6**, 57–61.

The spores of many plant pathogens need persistent water deposits in which to germinate and penetrate their hosts. An earlier balance continuously recorded changes in weight of external water on living shoots, but in this new instrument these are replaced by a block of expanded polystyrene, which makes it more suitable for routine use. Except during the early stages of

dew formation, these surfaces remained wet for the same time to within ± 1 hour, as did living apple shoots. Agreement was less close with potato foliage, perhaps because of different characters of the leaf surface, or because of the difficulty of exposing a single test surface so that it represents both the upper and lower leaves.

- 7.24. HIRST, J. M. & (MOORE, W. C.) (1957). *Phytophthora infestans* on Petunia and Datura. *Plant Path.* **6**, 76.

Phytophthora infestans was found infecting Petunia and *Datura stramonium* out of doors in August 1956.

- 7.25. (HOLLINGS, M.) & KASSANIS, B. (1957). The cure of chrysanthemums from some virus diseases by heat. *J. R. hort. Soc.* **82** 339-342.

Chrysanthemum plants infected with seven different viruses were kept for 4 weeks at 36° C. and cuttings were taken at the end of this treatment. Infectivity tests have shown that several of the cuttings have been freed from tomato aspermy virus and from chrysanthemum stunt and ring pattern viruses, but none from an unidentified virus and from chrysanthemum B, D and vein mottle viruses.

- 7.26. KASSANIS, B. (1957). The multiplication of tobacco mosaic virus in cultures of tumorous tobacco tissues. *Virology*, **4**, 5-13.

The concentration of tobacco mosaic virus in extracts from infected tobacco tumorous tissues is about $\frac{1}{30}$ of that usual in sap from leaves of infected tobacco plants grown in soil. In constant conditions the virus concentration of tissues remains constant and is not influenced by their growth. Increasing the phosphate content of the medium increased the growth of the tissues but diminished the concentration of the virus, and diminished it more at high than at low concentrations of glucose. Virus concentration is not affected by increasing the nitrogen content of the medium. Some other substances affected the growth and some the virus concentration of the tissues, but there was no correlation between the two effects. The dry matter in extracts from the tissues is about the same as the dry matter of leaf sap, but there is much less protein in tissue extracts than in leaf sap.

- 7.27. KASSANIS, B. (1957). The use of tissue cultures to produce virus-free clones from infected potato varieties. *Ann. appl. Biol.* **45**, 422-427.

By growing the excised apical meristems of sprouts from the potato varieties King Edward and Arran Victory, infected respectively with potato parinkle virus and potato virus S, virus-free plants were obtained. Although the method failed to produce virus-free plants from varieties infected with potato virus X, this virus also seems not to be present in apical meristems, for no virus could be demonstrated in callus tissue that developed from excised meristems less than 200 μ across. The concentration of tobacco mosaic virus in tomato roots and tobacco stems is also much less near the growing point than in older cells, but there is no evidence that the meristematic region is virus-free.

- 7.28. KASSANIS, B. (1957). Some effects of varying temperature on the quality and quantity of tobacco mosaic virus in infected plants. *Virology*, **4**, 187-199.

From tobacco plants inoculated with isolates of virulent tobacco mosaic virus recently derived from single lesions, avirulent variants were readily obtained when the tobacco plants were maintained at 36° but not when they were maintained at 20°. The avirulent variants reached higher concentrations than the parent strain in plants kept at 36°. Both types reach much the same concentration in plants at 20°, and only occasionally can virulent variants be isolated from tobacco plants inoculated with the avirulent ones and kept at 20°.

The relative concentrations reached at 20° and 36° depend not only on the identity of the strain of tobacco mosaic virus used but also on the species of plant inoculated. Some strains seem unable to initiate infection in *Nicotiana*

glutinosa at 36°, although they persist at this temperature in cells that are infected at 20°.

Type tobacco mosaic virus is unstable in tobacco plants at 36°, and the virus content of sap slowly decreases when plants are kept at this temperature.

- 7.29. KASSANIS, B., TINSLEY, T. W. & (QUAK, FREDERIKA) (1958). The inoculation of tobacco callus tissues with tobacco mosaic virus. *Ann. appl. Biol.* **46**, 11-19.

Although cultures of normal and conditioned tobacco callus tissue occasionally became infected when dilute solutions of tobacco mosaic virus were poured over them, injuries were usually required, and the number of infections depended on the type and number of injuries. Tissues infected by superficial injuries usually became virus-free after sub-culturing, whereas those infected by needle-prick remained infected permanently. Although no plasmodesmata were found joining cells in the tissue cultures, tobacco mosaic virus moved between them at a rate of about 1 mm./week, approximately the same rate as it moves through cells of the leaf parenchyma.

- 7.30. KLECZKOWSKI, A. (1958). An electrophoretic study of the mechanism of precipitin reactions. *Immunology*, **1**, 36-45.

The compounds formed by tobacco mosaic virus and by human serum albumin with their antibodies were studied electrophoretically. Those formed by the virus at various antigen/antibody ratios in the reacting mixtures differed greatly in their electrophoretic mobility, which ranged from the mobility of free antigen to the mobility approaching that of free antibody. The differences in the mobility probably resulted from corresponding variations in antigen/antibody ratios in the compounds. By contrast, human serum albumin formed compounds of constant or nearly constant electrophoretic mobility irrespective of antigen/antibody ratios in the reacting mixtures, and when the precipitate formed at equivalence was dissolved in a solution of antigen, the amount of free antigen separated from the compound by electrophoresis was apparently the same as that in which the precipitate was dissolved. This and other evidence suggests that the albumin combined with its antibody at a constant ratio to form a compound that was stable during electrophoresis. The ratio was that of equivalence. More antigen combined with antibody when the antigen was in excess so that a soluble compound was formed, but then the combination was so loose that the compound dissociated during electrophoresis. The compound with the equivalence ratio was reconstituted and separated from free antigen by electrophoresis. It precipitated in the electrophoretic cell.

- 7.31. LAST, F. T. (1957). The effect of date of sowing on the incidence of powdery mildew on spring-sown cereals. *Ann. appl. Biol.* **45**, 1-10.

Delaying the date of sowing of spring-sown barley in 1953 and wheat in 1954 from February to April increased the incidence of powdery mildew, *Erysiphe graminis* DC., from May onwards. Before then, conditions did not favour the rapid spread of mildew.

From mid-June, infected barley produced necrotic lesions. These developed sooner on the early- than on the late-sown crops, and on the lower than upper leaves. Perithecia were first seen on 29 June. They were abundant on the wheat by 20 July.

Mildew reduced the yield of barley sown on 30 March and 28 April 1955 by 8 cwt./acre. The percentage loss was greater in the late- than in the early-sown crops. The number of ears per metre of row, the weight of 100 ears and the 1,000-grain weights were reduced. Altering the seed rate from 1½ to 2½ bushels/acre did not affect the incidence, or the effect, of mildew on grain yield.

- 7.32. SLOPE, D. B. (1957). *Opomyza florum* on early-sown winter wheat. *Plant Path.* **6**, 110.

Cappelle wheat sown in September, October, November and December had 8.0, 1.2, 0, 0.1 per cent shoots infested by larvae of *Opomyza florum* in May

1956 and 36.4, 8.6, 1.9, 1.6 per cent shoots infested in April 1957. The larvae mostly attacked late-formed tillers, and grain yields were not seriously decreased; in spite of the heavy infestations, early sown wheat yielded more than late.

Nematology Department

- 8.1. FENWICK, D. W. (1957). Preliminary studies on the effect of ethylene dibromide fumigation on the hatchability of *Heterodera rostochiensis* (Woll.). *Nematologica*, **2**, 242-249.

The effect of fumigation of *Heterodera rostochiensis* cysts on the hatchability of their egg contents was investigated. In a preliminary experiment at 20° C. and 100 per cent humidity in a saturated atmosphere of ethylene dibromide, hatchability was reduced and the point of inflection of the hatching curve occurred at 28 days for fumigated cysts compared with 7½ days for controls. Similar results were obtained following fumigation at 15°, 20°, 25° and 30° C. If the hatching test was delayed several months, then hatchability was still further decreased and the delay in the attainment of the point of inflection was still apparent. These results indicate that hatching tests continued for a short fixed time may give misleading results, and it is suggested that tests should be carried on to completion.

- 8.2. FENWICK, D. W. (1957). Some experiments on the vacuum distillation of potato-root diffusate. *Nematologica*, **2**, 277-284.

Experiments were carried out on the stability of potato-root diffusate at different temperatures. Only negligible loss of activity resulted from 8 hours' exposure to 30° or 40° C. or 3 hours' exposure to 50° C. Laboratory distillation at 30-35° C. resulted in a reduction in volume to $\frac{1}{10}$ or $\frac{1}{20}$ of the original volume with an efficiency of about 80 per cent. In experiments carried out on a commercial scale at the University of Reading efficiency was very variable, but high levels were obtained on occasions. It is concluded that vacuum distillation is a practicable method of reducing diffusate volume for storage.

- 8.3. FRANKLIN, M. T. (1957). Note on the nomenclature of the cereal-root eelworm. *Nematologica*, **2**, 149.

This note points out that the correct name of the cereal-root eelworm, according to the International Rules of Zoological Nomenclature, is *Heterodera major* O. Schmidt, 1930, and not *H. avenae* Mortensen, Rostrup & Kølpin Ravn, 1908.

- 8.4. FRANKLIN, M. T. (1957). *Aphelenchoides composticola* n.sp. and *A. saprophilus* n.sp. from mushroom compost and rotting plant tissues. *Nematologica*, **2**, 306-313.

Descriptions of two new species of *Aphelenchoides* with characters distinguishing them from their nearest relatives are given.

- 8.5. GOODEY, J. B. (1957). *Hoplolaimus proporicus* n.sp. (Hoplolaiminae: Tylenchida). *Nematologica*, **2**, 108-113.

The nematode is described and figured. It was found associated with the roots of the oil palm *Elaeis guineensis*, and is differentiated from all other species of *Hoplolaimus* in that there are no lateral fields, the annules going right round the body except at each end, where they are slightly interrupted in the lateral line.

- 8.6. (HAGUE, N. G.) & HESLING, J. J. (1958). Population studies on cyst forming eelworms of the genus *Heterodera*. *Proc. Linn. Soc.* **169**, 86-92.

The size of the initial population of *H. rostochiensis* and *H. major* has an important influence on the behaviour of these two eelworms. Low initial populations favour high eelworm increase, and vice-versa. The final eelworm population appears to rise to a maximum with increase of inoculum; further inoculum increase produces a final population lower than the maximum.

- 8.7. HESLING, J. J. (1957). The hatching response of *Heterodera major* (O. Schmidt) to certain root diffusates. *Nematologica*, **2**, 123–126.

Root diffusates of eight species of cereals and grasses (with soil water control) were tested for hatching activity on cysts of the cereal-root eelworm *H. major*. No stimulatory effect was observed.

- 8.8. HESLING, J. J. (1957). *Heterodera major* O. Schmidt 1930 on cereals—a population study. *Nematologica*, **2**, 285–299.

Oats, wheat and barley were grown in pots containing nine infestation levels (including control) of the cereal-root eelworm *H. major*. The height of the plants decreased with increase of the eelworm infestation, oats being most susceptible, followed by wheat and barley. Low initial infestation favoured high eelworm increase; this was greatest in oats, followed by barley and wheat. Barley produced relatively more large cysts. Relatively more small cysts were produced from the high infestation level, but cysts of the same size had similar egg content irrespective of the infestation level from which they were derived.

- 8.9. JONES, F. G. W. (1957). Resistance-breaking biotypes of the potato-root eelworm (*Heterodera rostochiensis* Woll.). *Nematologica*, **2**, 185–192.

Tests made with populations of potato-root eelworm from twenty localities indicate that biotypes capable of breaking the resistance of *Solanum tuberosum* ssp. *andigena* and of crosses between the above and *S. tuberosum* ssp. *tuberosum* occur widely. In the populations tested the percentage of resistance-breaking females ranged from less than 1 to 75 per cent. Slight evidence of the breakdown of resistance in first backcrosses was obtained in one population.

- 8.10.* JONES, F. G. W. (1957). Soil populations of beet eelworm in relation to cropping. III. Further experiments with microplots and with pots. *Nematologica*, **2**, 257–272.

Further experiments with beet eelworm (*Heterodera schachtii* Schm.) in microplots are described. Four years' results from a rotational experiment are given, together with criticisms of the lay-out. An experiment was conducted in a peaty clay soil to test the effects of three host plants (sugar beet, cress and charlock) when grown at different population levels. All treatments caused a fall in population level. At the end of the experiment cyst and egg populations were highest after cress and lowest after charlock; they were also highest at the higher plant population levels, but the differences were mainly insignificant. The effects of a range of host plants was tested on a plant-for-plant basis in two types of fine sandy loam. That containing an appreciable coarse fraction (19 per cent) gave no response, but that containing a very fine fraction bordering on silt (74 per cent) gave increases with most Chenopodiaceous and Cruciferous hosts. In a pot experiment using low inoculum levels, a significant increase in yield occurred at the lowest inoculum level, and there was a significant inverse regression between yield and log inoculum level. The maximum population increases were 19 times and 84 times for cysts and eggs respectively at the lowest inoculum level. There was no evidence of a "ceiling" effect. The difference in behaviour of the beet-eelworm populations in the microplot soils may be due to soil structure/moisture relationships, but also possibly to biological properties.

- 8.11. MURPHY, P. W. & DONCASTER, C. C. (1957). A culture method for soil meiofauna and its application to the study of nematode predators. *Nematologica*, **2**, 202–214.

For summary see below No. 10.14.

- 8.12. WALLACE, H. R. (1957). The stimulatory properties of some organic substances on cysts of the beet eelworm, *Heterodera schachtii* Schmidt. *Ann. appl. Biol.* **45**, 251–255.

Techniques for determining the influence of various substances on the rate of larval emergence from cysts of the beet eelworm are described. There

* Work begun in the School of Agriculture, University of Cambridge.

is no significant difference between the rates of larval emergence in glutamic acid, galactinol, inositol and water; the rate of larval emergence in beet diffusate, on the other hand, was significantly higher. Studies of larval emergence in carbohydrates suggest that the cyst population used in the experiments was heterogeneous, consisting of two types of cyst which have different reactions to stimulation at different concentrations. The significance of root exudates in relation to beet eelworm is discussed.

- 8.13. WALLACE, H. R. (1957). Movement of eelworms. I. The influence of pore-size and moisture-content on the migration of larvae of the beet eelworm, *Heterodera schachtii* Schmidt. *Ann. appl. Biol.* **46**, 74-85.

Experiments on vertical migration through saturated soil fractions, horizontal migration through soil fractions at different suctions and migration in single layers of particles showed that the beet eelworm, *Heterodera schachtii* Schmidt, attained maximum speed when the pore diameters were between 30 and 60 μ . Speed of the eelworms increased as lateral displacement of the body was restricted by external resistances acting perpendicularly to the body axis; at the maximum speed there was no lateral movement, each part of the body following the part immediately in front of it. The speed of beet-eelworm larvae in water films of various thickness was measured; maximum speed occurred in a film 2-5 μ thick. Four arbitrarily classified types of progression were observed in the pore spaces. It is suggested that the "moisture characteristic" supplies most of the information required about the physical properties of the soil in relation to eelworm movement. By examining such a curve the pore-size distribution and water distribution can be ascertained and the probable behaviour of beet-eelworm larvae in the medium predicted.

- 8.14. WIDDOWSON, E. (1958). Potato-root diffusate production. *Nematologica*, **3**, 6-14.

Pot tests are described in which the effects of age, variety and an infestation of potato-root eelworm were observed on the root diffusate production of potatoes. The plants were grown in 6½-inch pots of coarse sand and leached with 250 ml. of water. The most active diffusate was produced up to 4 weeks after the emergence of the shoot, a period of very rapid root growth. After 6 weeks the activity of the diffusate declined. Ten commercial potato varieties were compared and gave diffusates of approximately the same activity; with the varieties Eclipse and Majestic the most active and Duke of York and King Edward the least active in two seasons. When potatoes were grown in sand artificially inoculated with 21, 45 and 102 eggs/g. of potato-root eelworm, increased diffusate output was observed from the plants at the medium and low levels. Although the high population level caused the most root growth up to 6 weeks from the emergence of the shoot in both seasons, there was no corresponding increase in diffusate production; in fact, in the second season it was reduced. A comparison between potatoes and tomatoes showed that potatoes produced the most diffusate per unit weight of root up to 2 weeks after emergence of the potato shoot, with an indication that tomatoes produced more after 9 weeks.

- 8.15.* WINSLOW, R. D. & (LUDWIG, R. A.) (1957). Studies on hatching stimulation in the beet eelworm, *Heterodera schachtii* Schmidt. *Canad. J. Bot.* **35**, 619-634. (Contribution No. 106, Science Service, Laboratory, Canada Department of Agriculture, London, Ont.)

Hatching of the beet nematode from Ontario beet fields was stimulated by root diffusates from host plants. Various aspects of the production of potent diffusates from rape and beet plants and germinating rape seedlings were investigated. Tops, roots and various root portions from rape seedlings all produced stimulatory substances. The concentration of diffusates by vacuum distillation and attempted extraction of the active principle with charcoal, phenol, 1-butanol and ion exchange are described.

- 8.16.* WINSLOW, R. D. & (WILLIAMS, T. D.) (1957). Amoeboid organisms attacking larvae of the potato root eelworm (*Heterodera rostochiensis* Woll.) in England and the beet eelworm (*H. schachtii* Schm.) in Canada. *Tijdschr. PlZiekt.* **63**, 242-243.

Amoeboid organisms were found attacking *Heterodera rostochiensis* in England and *H. schachtii* in Canada, the attacks occurring on larvae emerging from cysts in water or root diffusate in glass dishes in the laboratory. The English form was recovered with potato-eelworm cysts from two locations in Feltwell Fen, Norfolk, and the Canadian form with eelworm cysts from a field infested with *H. schachtii* in the Blackwell district, Essex County. The organisms appear very similar to *Thecatomyxa weberi* Zwillenberg; slight differences between the behaviour of the English and Canadian organisms and the latter may be due to differences in cultural conditions.

- 8.17. (WOOD, F. C.) & GOODEY, J. B. (1957). Effects of gamma ray irradiation on nematodes infesting cultivated mushroom beds. *Nature, Lond.* **180**, 760-761.

Mushroom compost infested with *Ditylenchus* sp. and *Rhabditis* sp. was irradiated by gamma rays. The nematodes were counted before and after treatment and their rates of reproduction assayed on mushroom compost and agar plates sown with yeast. Doses between 48,000 and 96,000 reps inhibited reproduction of both species.

Insecticides Department

GENERAL PAPERS

- 9.1. McINTOSH, A. H. (1957). Temperature and toxicity of insecticides. *Chem. & Ind.* 2-4.

RESEARCH PAPERS

- 9.2. BROADBENT, L., BURT, P. E. & (NIX, J. S.) (1957). The cost of using insecticides to maintain the health of potato seed in England and Wales. *N.A.A.S. Quart. Rev.*

For summary see above No. 7.11.

- 9.3. BUXTON, E. W., LAST, F. T. & NOUR, M. A. (1957). Some effects of ultraviolet radiation on the pathogenicity of *Botrytis fabae*, *Uromyces fabae* and *Erysiphe graminis*. *J. gen. Microbiol.* **16** (3), 764-773.

For summary see above No. 7.16.

- 9.31. ELLIOTT, M. (1956). The preparation of cyclopentenones from the products of Stobbe condensations with aliphatic ketones. *J. chem. Soc.* 2231-2241.

- 9.4. McINTOSH A. H. (1957). Particle size of insecticidal suspensions and their contact toxicity. VI. Effect of temperature on relative toxicity. *Ann. appl. Biol.* **45** (1), 189-205.

Two aqueous suspensions, one containing crystals of uniform size and the other containing colloidal particles, were made with each of seven solid contact poisons (two DDT-analogues, DDT, rotenone, 2-bromomercurithiophen, dieldrin and endrin). The relative toxicity of each pair of suspensions was found in dipping or measured-drop tests on as many as possible of the species *Oryzaephilus surinamensis* L., *Tribolium castaneum* Herbst and *Tenebrio molitor* L. In addition, some tests were made by injection of colloidal suspensions.

* Work done in Canada.

In each test, insects were kept after treatment at two temperatures: 28° C. and 11°, 17° or 20° C.; counts of kill were made after 24 hours. The tests measured three different kinds of temperature coefficient of insecticidal action.

In the contact tests, the colloid was nearly always more toxic than the crystals. In all the tests, except those with dieldrin, the relative toxicity (colloid : crystals) was greater at the lower after-treatment temperature, i.e., the *temperature coefficient of the relative toxicity* was negative. But in the case of dieldrin, the coefficient was positive.

The DDT-analogues, DDT, rotenone and endrin were more toxic at the lower after-treatment temperature, i.e., they had negative *temperature coefficients of kill by contact action*. In all these cases the temperature coefficient of kill by contact action was greater for colloid than for crystals. Dieldrin and 2-bromomercurithiophen had positive temperature coefficients of kill by contact action. With dieldrin, the temperature coefficient was greater for colloid than for crystals; but with 2-bromomercurithiophen, the reverse was true.

The *temperature coefficient of kill by injection* was negative for DDT, but positive for dieldrin and endrin; the other poisons were not tested by injection.

A possible explanation for the results of the contact tests is given in an Appendix. The explanation is based on a number of assumptions about the penetration of insect cuticle by solid poisons. These assumptions lead to the conclusion that the effect of temperature on the relative toxicity depends on the temperature coefficient of kill by internal action of the poison on the insect. This can be measured by injection tests. If it is negative or zero, the ratio of toxicities (colloid : crystals) by contact action, measured quite soon after treatment of the insects, will be greater at a low temperature after treatment than at a high temperature after treatment; but if the coefficient is positive, the effect of temperature on relative toxicity cannot be foretold. The experimental results seem to confirm the assumptions.

- 9.5. POTTER, C. & GILLHAM, E. M. (1957). Effect of host-plant on the resistance of *Acyrtosiphon pisum* (Harris) to insecticides. *Bull. ent. Res.* **48**, 317-322.

By means of a laboratory spraying technique, ten comparisons were made of the resistance to rotenone of samples of adult apterous viviparous parthenogenetic females of the Pea Aphid, *Acyrtosiphon pisum* (Harris), reared on broad bean and on clover, respectively. In nine of the tests, the Aphids from clover were more resistant than those from broad bean, the ratios ranging from 1.1 to 2.5. These differences were not all significant. In the remaining test the Aphids from broad bean showed a very small increase in resistance over the Aphids from clover, which was not significant.

The Aphids from the clover were generally smaller than those from broad bean. Figures are given to show that while the total amount of poison retained by the larger individuals from broad bean was more than that retained by the smaller individuals from clover, the amount of poison retained per unit body weight was greater with the smaller individuals. It appears, therefore, that while the results obtained might be due, at least partially, to the greater total weight of poison retained by the larger individuals from broad bean, the difference in resistance between the insects from broad bean and clover, respectively, might be even greater if the poison were applied on the basis of equal weight of poison per unit of body weight. Since the difference in resistance between the Aphids from the two host-plants did not appear to depend primarily on difference in size, the assumption might be made that it is due to difference in nutrition. It was found that Aphids reared on clover had a significantly higher proportion of dry matter in their composition than those reared on broad bean, which may be taken as evidence that differences due to nutrition are being produced. These may lead to differences in resistance.

- 9.6. POTTER, C., LORD, K. A., KENTEN, J., SALKELD, E. H. & HOLBROOK, D. V. (1957). Embryonic development and esterase activity of eggs of *Pieris brassicae* in relation to TEPP poisoning. *Ann. appl. Biol.* **45**, 361-375.

The embryological development of eggs of *Pieris brassicae* was studied in relation to the occurrence of enzymes hydrolysing phenyl acetate and acetylcholine. Phenyl acetate is hydrolysed at a high rate at all stages of develop-

ment of the embryo. Hydrolysis of acetylcholine only becomes appreciable in the later stages of development. The first significant level of hydrolysis of acetylcholine can be correlated with the development of a nervous system in the embryo to a stage where it may be functional.

Aqueous solutions of TEPP were applied to eggs soon after they were laid. Low doses of TEPP allowed a high percentage of eggs to develop to the point of hatching before death occurred. Most fully developed embryos became active before they died. As the dose was increased less development took place and with very high doses little development occurred.

The significance of these results is discussed. The available evidence does not indicate that the poison penetrates slowly nor that it is "locked up" and later released. The explanation that seems to fit the evidence best is that the poison penetrates rapidly and reacts irreversibly with, probably phosphorylates, one or more components of the egg, the extent of subsequent development depending upon the proportion of a biochemical system or the number of systems inactivated. Whilst inhibition of cholinesterase may play a part in the poisoning process, at least under some conditions, the evidence indicates that the death of the embryo may result from some other cause.

- 9.7. RAW, F. & POTTER, C. (1958). Studies on the chemical control of wireworms (*Agriotes* spp.). II. Direct and residual effects of BHC, DDT, aldrin and chlordane. *Bull. ent. Res.* (In the press.)

For summary see below No. 10.18.

- 9.8. WAY, M. J. & NEEDHAM, P. H. (1957). Control of some bean and potato pests using a systemic insecticide applied to the soil and seed. *Plant Path.* **6**, 96-103.

A systemic insecticide used as a seed dressing or drilled with the seed can subsequently kill insects attacking the aerial parts of the plant (Andersson and Ossiannilsson, 1951; Ashdown and Cordner, 1952; Unterstenhöfer, 1953). This paper gives results of field experiments with the systemic insecticide demeton applied at sowing time for control of the black bean aphid *Aphis fabae* Scop., the vetch aphid *Megoura viciae* Buckt., the green peach aphid *Myzus persicae* Sulz. on potatoes and the pea and bean weevil *Sitona lineatus* L. on field beans.

Entomology Department

RESEARCH PAPERS

- 10.1. DOBSON, R. M., STEPHENSON, J. W. & LOFTY, J. R. (1957). Quantitative studies of adult populations of Wheat bulb fly, *Leptohylemyia coarctata* (Fall) in the field. *Ann. appl. Biol.* **45**, 385-386.
- 10.2. FRENCH, R. A. (1957). Migration records for 1956. *Entomologist*, **90**, 227-238.
- 10.3. HAINE, E. (1957). Periodicity in aphid moulting and reproduction in constant temperature and light. *Z. angew. Ent.* **40**, 100-124.

Preliminary experiments on the moulting rates of *Aphis fabae*, *Myzus persicae* and *Neomyzus circumflexus* suggested that there might be a diurnal rhythm even in constant conditions. Further extensive experiments on moulting in *A. fabae* gave a significant depression of numbers at about midday. Both parturition and moulting in *M. persicae*, with several different pre-treatments, were found to produce rhythmic rates which changed significantly at certain times. However, coincidence of such changes in processes so different as parturition and moulting, and coincidence in changes in the same process between different species, suggests strongly that the rhythm was imparted by external conditions. The insects must have been very sensitive to these environmental factors, which could not be detected.

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- 10.4. JOHNSON, BRUCE (1954). The flight capacity of aphids in relation to the spread of viruses. *Proc. 2nd Conf. Potato Virus Diseases*, 70-74.

The life of the alate *Aphis fabae* consists of two distinct stages: when they are young and can fly, and when they are settled down on a host plant and have lost the ability to fly. The transition from one stage to the other, settling, is affected by the aphids' previous experience, i.e., the amount of flight undergone and the number of previous alightings, the quality of the host upon which it settles, the weather which may make further take-off impossible and the extent to which the aphid has progressed towards flight-muscle histolysis.

- 10.5. JOHNSON, BRUCE (1956). Function of the antennae of aphids during flight. *Aust. J. Sci.* **18**, 199-200.

The flight reflex of alate aphids can readily be stimulated by dropping them, or by a slight puff of air when they are suspended on a pin. By amputating various parts of the antennae, replacing with artificial antennae and by sealing the joints with paint it was shown that the site of sensorial response is between the second and third segments, where the intersegmental membrane is innervated by the Johnston's organ.

- 10.6. JOHNSON, BRUCE (1957). Studies on the degeneration of the flight muscles in alate aphids. I. A comparative study of the occurrence of muscle breakdown in relation to reproduction in several species. *J. Insect Physiol.* **1**, 248-256.

When alate aphids of several species were allowed to settle down on their host plants their flight muscles began to break down within a few days. The onset of muscle degeneration could be delayed by preventing the aphids from settling down, either by denying them their host altogether or by leaving them on a poor host in darkness for several days.

The reproductive capacity of alatae before they lost the ability to fly varied for different species. Embryo development was arrested in alatae of all the species that were studied after the end of the teneral condition following final ecdysis, and was resumed when they settled down on a new host. Some species of aphids contained a number of fully formed embryos at the time embryo development was arrested, and these plus a few additional embryos whose development had been completed after the aphids settled down were born before the ability to fly was lost. In other species the young alatae contained only rudimentary embryos that required several days to develop to the stage at which they were normally born; in these species no larvae were born until the muscles had begun to degenerate and the ability to fly was lost. Other species fell between these two groups and in one species, *Macrosiphum euphorbiae* (Thomas), whether or not the aphids reproduced at all before losing the ability to fly, depended upon their size.

The ability of alatae of *Aphis fabae* Scop. to engage in long flights of 1 hour or more was retained for as long as the aphids retained the ability to fly.

- 10.7. JOHNSON, C. G. (1957). The vertical distribution of aphids in the air and the temperature lapse rate. *Q. J. R. met. Soc.* **83**, 194-201.

Aphid density diminishes with height above the ground; the linear regression coefficient, $-b$, of log density on log height is an approximate expression of the vertical density profile. A low negative value of b suggests a relatively high degree of upward transport, and a high value the reverse.

From May to October 1948 aphid densities were estimated simultaneously at heights from 50 to 2,000 feet over 2-hour periods during the day: lapse rates to 2,000 feet were also measured. The regression coefficient, $-b$, of log density on log height was inversely correlated with the mean lapse rate between months; September and October were associated with low lapse rates and steep density gradients.

Correlation coefficients of b with lapse for 2-hour periods were negative above a lapse of 10° F./2,000 feet, and became statistically significant in the afternoon. Below the 10° F. value no significant correlation existed, probably

because low lapse rates occurred usually in the early morning when densities were low and factors other than atmospheric mixing could affect the profile.

Two examples of the change in the vertical profile from hour to hour throughout the day are given to illustrate the association of high lapse rates with high-altitude dispersal and the limitation of upward transport when lapses are low; but biological factors also play a part in determining the form of the profile, and these are briefly discussed.

- 10.8. JOHNSON, C. G. (1957). The distribution of insects in the air and the empirical relation of density to height. *J. anim. Ecol.* **26**, 477-492.

The main data of Hardy and Milne, Glick, Freeman and Johnson, giving insect density at various heights, have been fitted to the empirical formula $f(z) = C(z + z_0)^{-\lambda}$, where $f(z)$ is insect density at height z , C is a scale factor related to population size, λ is an index of the rate of diffusion and z_0 is a constant specific to each set of data. This shows that the distribution process is continuous up to thousands of feet, and integration enables the total numbers of insects between given heights to be assessed.

- 10.9. JOHNSON, C. G., HAINE, E., COCKBAIN, A. J. & TAYLOR, L. R. (1957). Moulting rhythm in the alienicolae of *Aphis fabae* Scop. (Hemiptera: Aphididae) in the field. *Ann. appl. Biol.* **45**, 702-708.

In a natural population of alienicolae of *Aphis fabae* Scop. on field beans in July 1952, the frequency of moulting of the last larval instar into the alate form was usually relatively high between about 0400 and 0800 hours G.M.T. This high rate was followed by a decline to a lower fluctuating rate for the rest of the day. The moulting rate at night was usually very low.

Changes in moulting rate during the rest of the day are correlated with temperature and with time, both independently. A rise of 1° C. ambient temperature is associated with an 11.6 per cent rise in moulting rate; a fall of 1° C., with a drop of 10.5 per cent and a lapse of 1 hour in time by a 5.4 per cent drop in the rate. Sunshine and humidity show no simple correlation with moulting rate.

- 10.10. JOHNSON, C. G. & TAYLOR, L. R. (1957). Periodism and energy summation with special reference to flight rhythms in aphids. *J. exp. Biol.* **34**, 209-221.

Summer populations of *Aphis fabae* often show a bimodal curve of flight activity. The origin of the two peaks of activity is quite distinct.

Flight takes place, weather permitting, at the end of a variable interval (the teneral period) after the final moult. The lengthening and shortening of this period with the daily fluctuations in temperature produces a unimodal curve of "flight mature" aphids with its peak in the afternoon. A graphical method for the integration of the daily temperature curve, after conversion by the response curve of the aphid, to produce this "flight maturity curve" from either a constant or measured moulting rate, is given.

But aphids will not fly in the dark or at low temperatures, hence those maturing after dark will wait until temperature rises to their threshold in the morning. This threshold appears in a population as a frequency distribution against temperature, and has been measured in laboratory experiments. The morning peak of flight consists of those aphids which were delayed overnight taking flight in a peak shaped according to this frequency distribution.

Thus the apparent flight periodicity of aphids is purely a population phenomenon. The aphids take-off once and leave the vicinity, and only by the synchronization of this single act within the population is a periodicity apparent. The synchronization is due to an energy limited developmental process, and is periodic only because temperature is diurnally periodic. The process could equally well apply to seasonally periodic processes, such as population growth and decline, or to the period activity of organs in which the development or secretion of a population of cells is energy dependent and the energy supply (light or heat) is periodic.

- 10.11. JOHNSON, C. G., TAYLOR, L. R. & HAINE, E. (1957). The analysis and reconstruction of diurnal flight curves in alienicolæ of *Aphis fabae* Scop. *Ann. appl. Biol.* **45**, 682-701.

The relationship of teneral period to temperature, together with the measured rate of moulting and a continuous record of temperature, have been used to construct theoretical daily curves for numbers flying from a bean crop. These curves have been matched against the observed curves for the same days.

The differences between curves so constructed for a period of 17 days and the observed curves for the same period are of the same order and kind as the differences between two measured curves in different sites at the same time.

The different types of daily flight curve can thus be accounted for in terms of the rate of production of alatae by moulting, the effect of temperature on the teneral ("drying out") period and the effect of low light intensity and temperature on take-off behaviour.

- 10.12. LONG, D. B. (1957). Oviposition of Wheat Bulb Fly, with special reference to crop and site selection. *Ann. appl. Biol.* **45**, 388.

- 10.13. MURPHY, P. W. (1957). Soil faunal investigations. *For. Comm. Rept. For. Res.*, 1955-56, 91-94.

- 10.14. MURPHY, P. W. & DONCASTER, C. C. (1957). A culture method for soil meiofauna and its application to the study of nematode predators. *Nematologica*, **2**, 202-214.

Methods for culturing Acarina, Collembola and other small soil animals are reviewed, and two new types of culture chamber described. One of these is particularly suitable for collecting live material from litter and soil with a funnel-type extractor.

Laboratory observations were made of Collembola as predators of free-living and plant-parasitic nematodes, especially *Heterodera cruciferae*. At least 9 per cent of *H. cruciferae* cysts in a pot culture were found to have been damaged by Collembola. *Isotoma viridis*, *Hypogastrura* sp., *Orchesella villosa* and *Onychiurus armatus* were observed feeding on cysts of *H. cruciferae*. The last named, the most important predator cultured, also fed on inactive nematodes of the genera *Dorylaimus* and *Mononchus*.

- 10.15. NIJVELDT, W. (1957). Aphid-eating Gall Midges (Cecidomyiidae) with special reference to those in the Barnes collection. *Ent. Ber.* **17**, 233-239.

- 10.16. RAW, F. & LOFTY, J. R. (1957). Estimating crop losses due to Wheat Bulb Fly. *Plant Path.* **6**, 51-56.

An estimate of the crop losses caused by an insect is necessary when assessing its economic importance. In practice, an estimate is difficult to make because of the difficulty of establishing different levels of infestation experimentally. It is shown that this can be done without using insecticides or affecting conditions for plant growth by utilizing the oviposition response of wheat-bulb fly to certain soil conditions and by screening plots to prevent oviposition. Data from experiments of Broadbalk and Pennell's piece are presented to show how crop losses can be estimated in this way.

- 10.17. RAW, F. & STOKES, B. M. (1958). Field observations on the infestation of alternative host plants by wheat bulb fly. *Plant Path.* (In the press.)

A small, relatively isolated, fallow plot was found to have an infestation of about eleven wheat-bulb-fly eggs per square foot. Weeds and grasses, some of them known or suspected host plants of wheat-bulb fly, germinated in the fallow, but plant counts revealed an extremely low infestation rate. These observations support the results of pot experiments, which suggest that some alternative host plants are less readily infested than winter wheat.

- 10.18. RAW, F. & POTTER, C. (1958). Studies on the chemical control of wireworms (*Agriotes* spp.). II. The direct and residual effects of BHC, DDT, aldrin and chlordane. *Bull. ent. Res.* (In the press.)

An account is given of an experiment carried out on Geescroft Field, Rothamsted, from 1951 to 1954 to investigate the direct and residual effects of BHC, DDT, aldrin and chlordane applied to control wireworm damage to wheat.

In the year of application, the first out of old grass, when wireworm attack was slight, the plots treated with BHC, aldrin and chlordane combine-drilled gave significantly greater yields than the control plots. In the following year when wireworm attack was heavier, residual effects on yield were observed on plots initially treated with BHC, DDT, aldrin and chlordane combine-drilled. The next year residual effects on yield were observed on the plots initially treated with BHC and aldrin combine-drilled.

No direct or residual effect of BHC seed dressing was observed.

The residual effects are closely associated with the effect of the treatments on the wireworm population.

The results are compared with those of previous experiments, and the economic returns from the various treatments are discussed briefly.

- 10.19. SOUTHWOOD, T. R. E. (1955). The morphology of the salivary glands of terrestrial Heteroptera (Geocorisae) and its bearing on classification. *Tijdschr. Ent.* **98**, 77-84.

The structure of the salivary glands depends more on the taxonomic relationship of the species than on feeding habits or on the nature of the secretions, and the use of salivary-gland structure in higher classification is proposed. Accessory glands are diagnostic for each of the basic divisions of terrestrial Heteroptera, the Pentatomomorpha possessing tubular and the Cimicomorpha vesicular accessory glands. Some suggested characteristics of the salivary glands of most superfamilies and families in the Geocorisae are given.

- 10.20. SOUTHWOOD, T. R. E. (1956). The structure of the eggs of the terrestrial Heteroptera and its relationship to the classification of the group. *Trans. R. ent. Soc. Lond.* **108**, 163-221.

The development, structure and hatching of the eggs of the terrestrial Heteroptera are shown to support the division of the Geocorisae (*sensu* Dufour, 1833) into the Pentatomomorpha and Cimicomorpha. The micropylar apparatus is of two types, the micropylar processes of the Pentatomomorpha and the pseudomicropyles and true micropyles of the Cimicomorpha. A true operculum is present only in the Cimicomorpha. The Pentatomomorphan egg normally lacks a distinct egg cap, but when one is present it is not homologous with the operculum of the Cimicomorpha and is called a pseudoperculum. Hatching spines and ridges are present in both the Pentatomomorpha and Cimicomorpha, but a median egg-burster is confined to the Pentatomomorpha.

From the present work and that of earlier authors structural characteristics of the egg are given for each family and many subfamilies. It is suggested that this evidence from egg structure should be considered, together with other evidence, when discussing the status of various groups and their phylogenetic relationships.

- 10.21. SOUTHWOOD, T. R. E. & JOHNSON, C. G. (1957). Some records of insect flight activity in May 1954, with particular reference to the massed flights of Coleoptera and Heteroptera from concealing habitats. *Ent. Mon. Mag.* **93**, 121-126.

- 10.22. SOUTHWOOD, T. R. E. & SCUDDER, G. G. E. (1956). The bionomics and immature stages of the Thistle Lace Bugs (*Tingis ampliata* H.-S. and *T. cardui* L.; Hem., Tingidae). *Trans. Soc. Brit. Ent.* **12**, 93-112.

- 10.23. SOUTHWOOD, T. R. E. & SCUDDER, G. G. E. (1956). The immature stages of the Hemiptera-Heteroptera associated with the stinging nettle (*Urtica dioica* L.). *Ent. Mon. Mag.* **93**, 313-325.
- 10.24. STOKES, B. M. (1957). Laboratory experiments on larval behaviour on Wheat Bulb Fly. *Ann. appl. Biol.* **45**, 386-387.
- 10.25. STOKES, B. M. (1957). *Mayetiola dactylidis* Kieffer in cocksfoot grass. *Plant Path.* **6**, 127-130.
- 10.26. TAYLOR, L. R. (1957). Temperature relations of teneral development and behaviour in *Aphis fabae* Scop. *J. exp. Biol.* **34**, 189-208.

Experiments in which alate aphids were marked immediately after emergence and observed until they took flight showed that this interval, called the teneral period, is usually related to temperature by a curve of the form typical of developmental processes. This is true for the fluctuating temperatures found in the field, and was confirmed at constant and varying temperatures in the laboratory. Other climatic factors were found to have no distinguishable effect. The variation due to individual aphids is a constant proportion of the mean teneral time at all temperatures. The behaviour of aphids towards the end of the teneral period has a typical pattern, and it is found to be closely similar in other insects.

Flight may be delayed in aphids if the teneral period ends in darkness or low temperature. This is due to the take-off behaviour of the insect, and the thresholds for activity are shown by trap catches. Behaviour and development are separated by inspection at each stage in the analysis which is by successive approximation.

- 10.27. TAYLOR, L. R. (1957). Aphid dispersal and diurnal periodicity. *Proc. Linn. Soc. Lond.* **169**, 67-73.

The periodic nature of aphid flight activity over a host crop depends upon processes in the development of the flight-immature individuals of the population; the flying aphids are only a few hours old. Since the total aerial population up to thousands of feet shows similar periodic fluctuations, it therefore appears that the aphids, however high they reach, fly only for a very few hours.

Locust swarms maintain themselves by the constantly repeated take-off of the individuals after landing. It appears that the circulatory processes responsible for taking up aphids and locusts are similar and the difference in sustaining aerial activity is largely a function of behaviour. There is some observational evidence for this.

The first problem of wind-assisted dispersal of this kind is to cross the "boundary layer" of relatively still air near the ground at take-off. This is a problem common to insects and spores, although the layer is of different depth and is defined in different ways.

Bee Department

GENERAL PAPERS AND REVIEWS

- 11.1. BAILEY, L. (1957). Comb fumigation for Nosema disease. *Amer. Bee J.* **97**, 24-26.

A method of fumigation, with acetic acid vapour, of combs contaminated with spores of *Nosema apis* is described. The results of a 3-year experiment on the control of *Amoeba* disease are also given, and it is shown that this latter disease can be effectively controlled by the same methods as *Nosema* disease.

- 11.2. BUTLER, C. G. (1957). Some work at Rothamsted on the social behaviour of honeybees. [Lecture.] *Proc. roy. Soc. B*, **147**, 275-288.

A brief review of some of the work carried out in recent years in the Bee Department on the social behaviour of honeybees.

- 11.3. BUTLER, C. G. (1957). Beekeeping. *Bull. Min. Agric. Fish. & Food*, **9**.

A revision of the Bulletin written by C. G. Butler and first published in 1945.

- 11.4. SIMPSON, J. (1958). The factors which cause colonies of *Apis mellifera* to swarm. [Lecture.] *Insectes soc.* (In the press.)

RESEARCH PAPERS

- 11.5. BAILEY, L. (1957). The cause of European Foul Brood. *Bee World*, **38**, 85-89.

Results of infection experiments made in 1956 are given. Disease was repeatedly caused in healthy colonies by spraying their brood with suspensions of *Streptococcus pluton* + *Bacterium eurydice*; these organisms having been grown in a mixed culture. Simultaneous infection with pure cultures (fifth subcultures) of each of these organisms did not cause disease. Disease appeared on one occasion after the comb, which had been inoculated with a pure culture of *S. pluton*, was twice resprayed with watery suspensions of larvae taken from the comb 5 and 10 days after inoculation. However, *B. eurydice*, as well as *S. pluton*, was then isolated from the diseased larvae. This made it appear that healthy colonies may contain *B. eurydice*, but as this organism had not been isolated from such colonies, it was concluded that its distribution was likely to be sparse.

- 11.6. BAILEY, L. (1957). The isolation and cultural characteristics of *Streptococcus pluton* and further observations of *Bacterium eurydice*. *J. gen. Microbiol.* **17**, 39-48.

Details of the way in which *Streptococcus pluton* was eventually isolated are given. The organism normally grows anaerobically as a lanceolate coccus, but can be trained to grow aerobically, which it does in the form of a thick rectangular rod. Its anaerobic cultural requirements are very critical, but the aerobic rod will grow on ordinary media. *Bacterium eurydice* was found to be quite distinct in its cultural characteristics from *S. pluton*; its anaerobic growth is greatly enhanced by glucose + fructose (or honey); either sugar alone supports only feeble anaerobic growth.

- 11.7. BAILEY, L. (1957). European Foul Brood: a disease of the larval honeybee (*Apis mellifera* L.) caused by a combination of *Streptococcus pluton* (*Bacillus pluton* White) and *Bacterium eurydice* White. *Nature, Lond.* **180**, 1214-1215.

The use of honey in the culture media facilitated the early separation of *Streptococcus pluton* and *Bacterium eurydice* into pure cultures. An infection experiment was carried out with second subcultures of the organisms; either organism alone did not cause disease, but a mixture of the two caused extensive European Foul Brood disease.

- 11.8. BUTLER, C. G. (1957). The process of queen supersedure in colonies of honeybees (*Apis mellifera* L.). *Ins. soc.* **4**, 211-223.

In the process known as "queen supersedure" the workers of a colony rear a new queen in the presence of the old one, without swarming. Various suggestions that have been made to account for this process are examined and shown to be untenable. It is demonstrated that a queen, who had actually been superseded by her workers, was nevertheless capable of inhibiting queen rearing in small, but not in large, colonies. Since it has been shown that a substance which workers obtain from their queens (queen substance) inhibits them from rearing further queens, provided that the quantity is sufficient

for the number of bees present in their colonies, it is probable that this queen was producing insufficient queen substance to inhibit queen rearing in a large colony. It is concluded that shortage of queen substance is the only *immediate* cause of queen supersedure, and that any other factors which tend to cause a queen's supersedure do so by reducing her output of queen substance.

- 11.9. BUTLER, C. G. (1957). The control of ovary development in worker honeybees (*Apis mellifera*). *Experientia*, **13**, 256-258.

The results are given of experiments which demonstrate that an acetone extract of a queen honeybee is sufficient to inhibit development of the ovaries of a group of queenless worker bees when added to their food. In order to be effective it does not have to be presented to them on the body of a dead worker bee or other queen-like object as has been suggested.

- 11.10. BUTLER, C. G. & GIBBONS, DOREEN A. (1958). The inhibition of queen rearing by feeding queenless worker honeybees (*A. mellifera*) with an extract of "queen substance". *J. Insect Phys.* **2**. (In the press.)

It is demonstrated that the residue from an ethanol extract of queen honeybees (i.e., of "queen substance") is, when given to queenless worker honeybees, either in sugar syrup on the bodies of dead worker bees or in distilled water in a gravity feeder, sufficient to inhibit them from attempting to rear a new queen.

- 11.11. FREE, J. B. (1957). The food of adult drone honeybees (*Apis mellifera*). *Brit. J. Anim. Behav.* **5**, 7-11.

For the first few days of their lives, drones are fed entirely by workers. This is followed by a period in which they are both fed by workers, though not to such an extent as previously, and also feed themselves from honey cells. After they are about a week old they tend to feed themselves entirely and do not beg food from workers.

Worker bees 2-26 days old were seen to feed drones, although those 4-6 days old were the most active in so doing. It is most probable that the workers feed drones with brood food.

The behaviour of a worker towards a drone appears to depend on his age; at the same time as some of the older drones in a colony are being attacked by workers, the younger drones present are still being fed. The workers who attack drones are probably unemployed foragers.

- 11.12. FREE, J. B. (1957). The transmission of food between worker honeybees. *Brit. J. Anim. Behav.* **5**, 41-47.

There is a general tendency for food to pass from the older to the younger workers of a colony, although there is a considerable passage of food in the opposite direction. Younger bees generally receive food more frequently than they give it. As worker bees grow older the mean ages of the bees who feed them and to whom they give food also increase. When undertaking certain duties, bees probably retain more food than when occupied with other duties. A bee's past experience also plays a part in determining the amount of food in her honeystomach when she offers, or begs for, food.

- 11.13. FREE, J. B. (1957). The effect of social facilitation on the ovarian development of bumblebee workers. *Proc. R. ent. Soc. (A)*, **32**, 182-184.

The extent to which the ovaries of a bumblebee worker develop, and the number of eggs she lays, increases, within certain limits, with the number of other workers present with her.

- 11.14. FREE, J. B. (1958). The defence of bumblebee colonies. *Behaviour*, **12**, 233-242.

The members of a bumblebee colony possess a common odour, and bumblebees are able to recognise intruding bumblebees from other colonies by their scent alone. Under experimental conditions the scent of a strange colony

can become absorbed on to the body surface of a bee, with the result that she is subsequently attacked by members of her own colony.

Large colonies have guards at the entrances of their nests; in smaller colonies, although no guard bees are present, some bees more readily attack intruders than others. The aggressiveness of such bees appears to be related to the relatively high degree of development of their ovaries.

- 11.15. SIMPSON, J. (1957). The incidence of swarming among colonies of honeybees in England. *J. agric. Sci.* **49**, 387-393.

Some published figures relating to the incidence of swarming are examined, and records obtained in the routine examinations of colonies in honey-producing apiaries are analysed. It is concluded that in these apiaries between 10 and 40 per cent of colonies would swarm in an average year, if they were given excess of hive space and otherwise left alone. The proportion of colonies which began queen rearing varied from year to year and from one apiary site to another. This variation was presumably due to environmental factors, but it was substantially independent of those factors which determined honey yield. There was no evidence that it was due to the effects of conditions in the years when the queens were reared. After the end of June, at least, the tendency for colonies to rear queens was markedly less with queens of the current year than with queens of the previous year, and was probably also less with queens of the previous year than with still older queens. Occupied queen cells were most frequently observed in colonies in the latter half of May and in June and July. The mean time of queen-rearing varied from year to year. Many colonies which began to rear queens eventually ceased to do so with no other treatment than removal of queen cells. Queen rearing did not begin and end in all colonies at the same time; many colonies began rearing queens after others had stopped.

- 11.16. SIMPSON, J. (1957). Observations on colonies of honeybees subjected to treatments designed to induce swarming. *Proc. R. ent. Soc. Lond. (A)*, **32**, 185-192.

None of the treatments applied were shown to be effective methods of inducing colonies to swarm. Colonies deprived of larval brood showed evidence of a surplus of brood food; those given additional brood to feed were unable to do so effectively, although queen larvae were adequately fed while worker larvae were receiving insufficient food. Brood food surplus is probably not an essential condition for the commencement of swarm preparations, and when acting alone is insufficient to cause such preparations. It was found possible for a colony to swarm without any noticeable reduction in the egg output of its queen and with a large number of empty cells in its combs. Colonies which began rearing young queens frequently destroyed them, sometimes even in the pupal stage; the onset of queen rearing in a colony does not necessarily indicate that it will swarm or even rear queens to maturity.

- 11.17. SIMPSON, J. (1958). The factors which cause colonies of *Apis mellifera* to swarm. *Insectes soc.* **5**, 77-95.

This paper consists of a review and discussion of published (and some unpublished) evidence concerning the factors which induce colonies to swarm. It is concluded that most colonies can be induced to swarm by insufficiency of space for bees in their hives, and that in the absence of this factor swarming only occurs in colonies whose queens are unable to supply them with enough queen substance to inhibit them from rearing queens. The amount of queen substance produced by a queen appears to diminish as she becomes older. Queen "supersedure" (the replacement of the queen of a colony without the emergence of a swarm) is also induced by insufficiency of queen substance—see Butler (11.8) above. It seems possible that environmental conditions and the size of the colony decide which process will occur. Large colonies and abundance of nectar and pollen in the field appear to favour swarming rather than supersedure.

The processes which may occur in colonies in the course of preparations to swarm and the factors which may possibly initiate the actual emergence of swarms are also discussed.

Statistics Department

GENERAL PAPERS

- 12.1. (PAGE, J. O., DADD, C. V. T.) & BOYD, D. A. (1957). Cultivation and manuring of potatoes. "Potatoes": Bull. 94, Ministry of Agriculture, Fisheries and Food, pp. 11-21. London: H.M.S.O.
- 12.2. YATES, F. (1958). "Statistical methods and scientific inference." Comments on D. V. Lindley's review. *Heredity*. (In the press.)
- A reply to Lindley's criticisms of Sir Ronald Fisher's new book.

RESEARCH PAPERS

- 12.3. LEECH, F. B. (1958). A national survey of diseases of the dairy cow: the sample of herds. *Vet. Rec.* **70**, 32-34.
- A discussion of the factors taken into account when specifying a sample of herds suitable for this survey is followed by a description of the technique of drawing the sample by random selection.
- 12.4. MANN, H. H. & BOYD, D. A. (1958). Some results of an experiment to compare ley and arable rotations at Woburn. *J. agric. Sci.* (In the press.)
- For summary see below No. 15.2.
- 12.5. (O'CONNOR, L. K.) & LIPTON, S. (1957). Estimation of lactation fat per cent with differing sampling intervals. *Milk Marketing Board report no. 7, 1956/7*. Report of the Production Division. (Addendum to Section on National Milk Records, pp. 25-27.)
- Estimates of the average lactation fat per cent were obtained using sampling intervals of 7, 14, 28, 42, 56 and 63 days on eighteen lactations, and these estimates were compared with the true actual lactation fat per cent. As expected, the larger the sampling interval, the less accurate the estimates. However, the reduction in accuracy when a 56- or 63-day interval is used instead of a 42-day interval is relatively small. A 28-day interval appears to give a reasonably accurate estimate.
- 12.6. (REEVE, E. C. R.) & GOWER, J. C. (1958). Inbreeding with selection and linkage. 2. Sib-mating. *Ann. hum. Genet.* (In the press.)
- The rate of progress to homozygosity of a locus (a, b) linked to a locus (A, B) with recombination frequency (y) is investigated, when a proportion (x) of homozygotes (AA), (BB) survive. The inbreeding system used is full sib-mating, which leads to a 19×19 generation matrix.
- 12.7. SIMPSON, H. R. (1957). The effect of sterilized males on a natural tsetse fly population. *Biometrics*. (In the press.)
- The use of artificially sterilized males has been suggested as a means of controlling tsetse populations. A mathematical model of a natural tsetse population is set up, and the theoretical effect of the introduction of sterilized males is examined. Numerical results obtained on the Rothamsted computer are presented and discussed.
- 12.8. SIMPSON, H. R. (1958). The estimation of linkage on an electronic computer. *Ann. hum. Genet.* (In the press.)
- A programme for analysing linkage data from two-generation families on an electronic computer is described. In particular, the coding of the data in a suitable form and the computing time are discussed. Suggestions are made for extending the programme to handle data from three or more generation families.

- 12.9. YATES, F. & PATTERSON, H. D. (1958). A note on the six-course rotation experiments at Rothamsted and Woburn. *J. agric. Sci.* (In the press.)

The results of an interim examination of the experiments at Rothamsted and Woburn on the effects of nitrogen, phosphate and potash on a six-course rotation of crops are reported.

It has become apparent that the main aim of the experiments, to relate the effects of the fertilizers to weather conditions, is not being fully realized. This is in part a consequence of the design, which has inherently low accuracy and results in low responses to phosphate and potash. In addition, faulty randomization and, at Woburn, fertility irregularities and pest damage have further reduced the accuracy attained.

The faulty randomization also seriously affects the estimates of experimental error given by deviations from smoothed response curves. Alternative estimates of error are provided to overcome this difficulty.

The mean yields and mean standard responses over the period 1931-55 are presented.

There is very little year-to-year variation in the responses to phosphate, but the responses to nitrogen and, for some crops, the responses to potash show sufficient variation to justify further analysis. As a first step the regressions of the responses to nitrogen on winter rainfall and on rainfall during the growing season and, for the root crops only, the regressions on sowing or planting date are briefly considered.

REPORTS

- 12.10. (BLOOD, J. W., *et al.*), BOYD, D. A., HILLS, M. & SIMPSON, H. R. Preliminary results of the Survey of Fertilizer Practice, 1957. [Duplicated report.]

Field Experiments Section

GENERAL PAPERS

- 13.1. DYKE, G. V. (1957). Hand and machine planting of potatoes. *Exp. Husbandry*, 3. (In the press.)
A summary and discussion of Rothamsted experiments.

BOOKS

- 13.2. GARNER, H. V. & (GARDNER, H. W.) (1957). *The use of lime in British agriculture*. 1st popular edition. London: E. & F. Spon, 15/-.
- 13.3. GARNER H. V. (1958). *Manures and fertilizers* (Bull. Min. Agric. 36; 10th edition). London: H.M.S.O. (In the press.)

Woburn Experimental Section

- 15.1. MANN, H. H. & BOYD, D. A. (1958). Some results of an experiment to compare ley and arable rotations at Woburn. *J. agric. Sci.* (In the press.)

The effect of short leys and arable cropping on the yields of the following arable crops has been tested since 1937 at Woburn Experimental Farm, Bedfordshire. The leys were a 3-year grazed ley and 3 years of lucerne cut for hay, and the arable cropping was potatoes, winter cereal and either a 1-year ley or a third tillage crop. The effects of these crop-sequences were measured

by test crops of potatoes and barley, uniformly treated except that 15 tons farmyard manure is applied on one-half of each plot for potatoes.

Without farmyard manure, the yield of potatoes after the grazed ley was higher than after three tillage crops by an average of about 3 tons/acre; after lucerne it was about 2 tons/acre more than after the tillage crops, and after the 1-year ley under 1 ton/acre more. With farmyard manure the benefit from leys was less (about 2 tons/acre for both lucerne and the grazed ley). The average effect of the farmyard manure was about 2.8 tons, except after the grazed ley, where the increase has been only 1.6 tons/acre.

Effects of the previous cropping on the yield of barley were small in the early years of the experiment, but in the last 5 years the yield after ley and lucerne has exceeded that after the tillage crops by about 15 per cent.

Part of the difference in potato yield between the ley and arable sequences can be attributed to the differential incidence of potato-root eelworm, which has reached a high level of infestation on some of the arable plots. Much of the remainder may be ascribed to the low level of basal manuring which has affected the yield of all plots, but particularly those under tillage crops. How far the observed differences can be explained by these considerations remains a matter for speculation, but may to some extent be clarified when further results are obtained from a revised scheme of cropping and manuring.

- 15.2. THOROLD, C. A. (1957). A chlorosis disease of cocoa in the Southern Cameroons. *J. West Afr. Sci. Ass.* **3**, 96–106.

It has not been possible to transmit this chlorosis to healthy plants by grafting nor by mealybugs. A claim that the chlorosis is a nutritional deficiency has not been substantiated. Until the cause is fully understood, there remains some apprehension that the chlorosis is an insidious menace to the cocoa industry of the Southern Cameroons.

Tropical Soils

- 16.1. GREENE, H. (1957). Soil resources: Chap. 7 in *Guide book to research data for arid zone development*. Paris: UNESCO. (*Arid zone research*, **10**, 107–120.)
- 16.2. GREENE, H. (1956). Foreword in *Minerals in Pasture: Deficiencies and excesses in relation to animal health*. (Tech. Commun. 15, Commonwealth Bureau of Animal Nutrition.)

Soil Survey of England and Wales

- 17.1. AVERY, B. W. (1958). A sequence of beechwood soils on the Chiltern hills England. *J. Soil Sci.* **9**. (In the press.)

Under beechwoods, the Chalk and associated superficial deposits of the Chiltern hills give rise to a sequence of soils ranging from rendzina through brown earth (*sol lessivé*) to podzol, closely paralleled in developmental sequences established elsewhere on uniform calcareous materials. The salient features of the genetic soil types represented are described and their evolution discussed in relation to vegetation and site characteristics. On base-deficient soils, mor formation under beech is conditioned by local climatic conditions and management practices, as well as by inherent fertility variations, and is only associated with advanced podzolization on appreciably sandy materials. On silty plateau soils with imperfect drainage, "micro-podzols", which may be transitory, are formed.

- 17.2. OSMOND, D. A. (1957). Recent advances in pedology. *Sci. Progr.* **45** 292–296.

- 17.3. OSMOND, D. A. & STEPHEN, I. (1957). Micropedology of some red soils from Cyprus. *J. Soil Sci.* **8**, 19–26.

The micromorphology and mineralogy of terra rossas and rotlehms associated with calcareous sediments and igneous rock material respectively are described. The investigations confirm differences observed in the field and assist in the differentiation and classification of the soils.

General Publications

- 18.1. BOALCH, D. H. *Prints and paintings of British farm livestock 1780–1910: a record of the Rothamsted collection*. Harpenden, Rothamsted Experimental Station, 1958.