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PUBLICATIONS

Physics Department

GENERAL PAPERS

1. PENMAN, H. L. (1954). Irrigation will increase production. *Fmr & Stk-Breed.* **68**, 13 & 14 April, p. 50.
2. PENMAN, H. L. (1954). Irrigation needs. *Soils & Fert.* **17**, 399.
3. PENMAN, H. L. (1954). Evaporation over the British Isles. *J. Instn Wat. Engrs.* **8**, 415. (Originally published in *Quart. J. R. met. Soc.* **76** (1950).)

RESEARCH PAPERS

4. EMERSON, W. W. (1954). Limitations of existing methods for determining the stability of soil crumbs. *J. Soil Sci.* **5**, 233.

The breakdown of soil crumbs in conventional water-stability tests is a result of the combined effects of slaking and dispersion. The various factors influencing the effectiveness of these two processes have been divided into those determined by properties of the crumbs themselves and those dependent on the technique used. Two of the latter have been considered in detail, namely the method of wetting and the electrolyte content of the wetting liquid. It has been concluded from a comparison of the rates of water uptake by crumbs containing various amounts of organic matter that water has an appreciable advancing contact angle with air-dry organic matter. This may have been the main cause of the correlation found by previous workers between water stability and organic matter for soils high in organic matter.

It has been shown that calcium-saturated crumbs are metastable in distilled water but will disperse if mechanically disturbed. In conventional water-stability tests some continuous mechanical disturbance of the crumbs is inevitable, so that the apparent stability of the crumb always decreases with time. Also in these tests the crumbs are always immersed in a large excess of distilled water, so that the results obtained are independent of the calcium-ion concentration of the soil solution. In the field any increase in this concentration will make the crumbs more resistant to mechanical action.

5. EMERSON, W. W. (1954). A new method for determining the stability of moist soil crumbs. *J. Soil Sci.* **5**, 240.

A new method for characterizing the stability of moist soil crumbs which avoids breakdown due to slaking has been described. The crumbs are slowly wetted under suction with a strong sodium chloride solution and then leached with this solution until sodium-saturated. The crumbs are then percolated with increasingly dilute concentrations of sodium chloride and the changes with time of the permeability of the crumbs and the concentration of salt in the leachate are measured. The concentration at which the crumbs completely break up and their permeability falls effectively to zero is called their critical concentration. The critical concentration for two plots from Barnfield 80 and 2N (the first having received no fertilizer or organic manure and the second 14 tons/acre farmyard manure and balanced artificial manuring annually for 80 years), and the adjoining permanent grass, with the same mineralogical constitution, were found to be 34, 5 and less than 0.3 mN. NaCl respectively, indicating the very marked differences in the cohesive strength of the crumbs.

By observing the effect of adding dilute alkali and acid on the concentration of electrolyte required to flocculate sodium-saturated suspensions of pure illite and montmorillonite, it was inferred that positive charges were present on the edges of the platelets, as shown already for kaolinite by Schofield and Samson (1953). The flocculation concentration for illite with sodium alginate added was found to be between 250 and 300 mN. NaCl. This agrees well with determinations of the flocculation concentration for montmorillonite and kaolinite found by other workers using certain large organic molecules.

The flocculation concentrations of sodium-saturated suspensions of the Barnfield 80 and Willaluka soils were found to be equal, namely 30 mN. NaCl.

This is the same as the critical concentration for crumbs of these soils. In the virtual absence of organic matter, therefore, flocculation appears to be a reversible state of equilibrium. The concentration of NaCl required to flocculate sodium-saturated suspensions of the grassland soil was 200 mN., which is about the same as that for suspensions of pure clay minerals in the presence of grassland crumbs.

It is suggested that the additional cohesive force of grassland crumbs is due to linkage of the positive edges of clay crystals by long-chain organic molecules. The reduced attractive forces in suspensions of the grassland soil compared with Barnfield 80 soil may be due to the absence of positive edge-negative face attraction as a result of each molecule being linked to the edge of one clay crystal only.

6. EMERSON, W. W. (1954). Water conduction by severed grass roots. *J. agric. Sci.* **45**, 241.

It is suggested that part of the increased permeability of soil recently ploughed out from grass could be due to water conduction through severed roots. Microtome sectioning of a root of *Lolium p.* showed a continuous metaxylem element of about 30 μ diameter, with only minor restriction, forming a natural capillary tube. Further, being at the centre of the stele, the metaxylem should persist for some time after the grass has been killed. Hydraulic diameters calculated from laboratory experiments on the rates of water conduction by several *Lolium p.* roots were in reasonable agreement with the diameter of the metaxylem measured by direct sectioning.

Similar experiments on *Phleum p.* were more difficult to interpret due to the complexity of the metaxylem, the number of elements not being constant along the root. The rate of water conduction by roots of *Dactylis g.* was found to be small compared with the other grasses, for although having the largest number of elements, they are the smallest in size of any grass examined.

The permeability of a severed *Lolium p.* root system, calculated on the basis of the surface density of roots found on 4-year-old plots, indicated that the root system should significantly increase the unsaturated permeability of soil at low suctions. To obtain maximum benefit the "capillary tubes" should be severed immediately under the turf and not at ploughing depth. Accordingly, two plots were laid out on old grassland to compare normal autumn ploughing with shallow rototilling on the subsequent germination and growth of spring wheat. In spite of repeated rototilling, however, it proved impossible to kill the grass in the wet winter conditions, and the wheat was smothered. A comparison of the suctions developed at 5 cm. in the two plots showed that the unsaturated permeability of the rototilled plot was higher.

Although the laboratory results are encouraging, there is as yet no conclusive evidence that the natural water supply and drainage system formed by the severed roots is important under field conditions.

7. EMERSON, W. W. (1955). The rate of water uptake of soil crumbs at low suctions. *J. Soil Sci.* **6**, 147.

Soil crumbs dried initially to the wilting point have been slowly percolated with $1 \times 10^{-2}M.$ calcium chloride through a capillary siphon. It has been shown by weighing the crumb at intervals that although excess solution is discharged from its base, after the first or second day the crumb continues to take up solution at a decreasing rate over the next 3 months. This is attributed to the re-arrangement of the individual clay crystals, as the thickness of the water films on the crystals increases with decreasing suction. It has been shown theoretically that the equilibrium thickness of these films will increase markedly as the suction approaches zero.

The slow swelling of the clay will be accompanied by a corresponding decrease in the permeability of the crumbs as the larger pores are reduced in size. This is of great practical importance in the drainage of heavy clay soils, since it means that the permeability of the soil as a whole may be improved over the winter by using a deep-rooted crop to dry the subsoil out during the summer. This has been shown by comparing the drainage records of three fields; one after fallow, one after winter wheat and the third in permanent grass on the Gault of the Cambridge University Farm for the winter of 1932-33. It was also possible to infer from the dates at which the drains started running and the volume of water discharged that considerable delayed water uptake occurs as the clay slowly swells.

Delayed swelling also affects the concept of field capacity, since the moisture content of the soil at "field capacity" will increase during the winter with each succeeding fall of rain.

8. EMERSON, W. W. (July 1954). The effect of various grasses and lucerne on the cohesion of soil crumbs. *5th int. Congr. Soil Sci.*

The increase in crumb cohesion produced in 4-year-old herbage plots on an old arable field has been measured by a new sodium saturation technique. The grasses examined appear to be similar in their structure-forming ability, but lucerne is relatively ineffective. The principal difference between the improvement in crumb stability under a ley and under very old grassland seems to be the depth to which this improvement extends.

9. EMERSON, W. W. (1955). A note on the sodium saturation test for determining the stability of moist soil crumbs. *J. Soil Sci.* **6**, 160.

10. PENMAN, H. L. Evaporation over parts of Europe. *Ass. int. Hydrologie sci.*, Rome 1954. (To be published.)

Weather records from thirty-one meteorological stations in Europe are used to calculate the potential evaporation rate from neighbouring land surfaces and thence the estimated actual evaporation rate after correcting for shortage of summer rainfall. In northern Europe special consideration has had to be given to periods when snow covers the ground. Annual values range from about 20 cm./year in northern Norway to 60 cm./year in Italy and the Balkans; from west to east there is little change in total between Britain and Russia near Moscow, though the seasonal distribution differs markedly. A general check has been obtained from mean annual values of rainfall and run-off from forty-four catchment areas—not so well distributed as the weather stations—and the agreement is usually within 10 per cent in comparable environments.

11. PENMAN, H. L. (1955). Components in the water balance of a catchment area. *Quart. J. R. met. Soc.* (In the press.)

The paper presents and discusses data on the amplitudes and phases of the annual changes in monthly rainfall, run-off, ground water storage, evaporation and soil moisture deficit over a period of 5 years (1931–36) for the Thames basin above Teddington Weir.

12. SCHOFIELD, R. K. & TAYLOR, A. W. (1955). Measurements of the activities of bases in soils. *J. Soil Sci.* **6**, 137.

The activities of aluminium, calcium, potassium and sodium hydroxides have been determined in suspensions of soil chloride solutions of widely differing concentrations by measuring the ratio of activity of the metal chloride to the activity of hydrochloric acid. This procedure avoids the uncertainties inherent in attempts to measure the activities of individual ions.

For each of the four ions used there is a range of dilute chloride solutions within which the hydroxide activity is easily measurable and is nearly independent of the chloride concentration. The method is inapplicable in the absence of chloride, and experimental difficulties were encountered at the lowest concentrations used.

At higher salt concentrations there is a distinct rise in the hydroxide activity with increase in salt concentration. Both this rise and the substantial constancy at the lower chloride concentrations are to be expected for suspensions of negatively charged colloids exerting buffer action. The constant hydroxide activity approached as the chloride concentration is reduced is evidently a characteristic of the soil sample in question.

13. SCHOFIELD, R. K. & TAYLOR, A. W. (1954). The hydrolysis of aluminium salt solutions. *J. chem. Soc.* p. 4445.

The value of the equilibrium constant of the reaction $(\text{Al}_6\text{H}_2\text{O})^{3+} + \text{H}_2\text{O} \rightleftharpoons (\text{AlOH}_5\text{H}_2\text{O})^{2+} + \text{H}_3\text{O}^+$ has been determined by direct measurement of the pH values of a series of aluminium salt solutions, and a pK value of 4.98 at 25° C. ($K = 1.05 \times 10^{-5}$) has been obtained. The temperature coefficient of -0.03 units/° C. suggests that the mechanism of the reaction is similar to the

dissociation of water. The results obtained are compared with those of a previous determination by Brönsted and Volquartz (*Z. phys. Chem.* 1928, **97**, 134).

Chemistry Department

GENERAL PAPERS

14. BREMNER, J. M. (1955). Recent work on soil organic matter at Rothamsted. *Z. PflErnähr. Düng.* (In the press.)

Results obtained at Rothamsted in recent work on the nitrogenous and lignin-like complexes of soil are discussed. (Paper read at Conference on Soil Organic Matter at Braunschweig, Germany, 31 March–4 April, 1954.)

15. COOKE, G. W. (1954). Fertilizer placement. *FATIS Review*, no. 3, p. 8 (O.E.E.C., Paris).

A general account of fertilizer placement research in England. The advantages of placement for all important crops are stated. A brief account of fertilizer placement research in other European countries is also given.

16. COOKE, G. W. (1954). The importance of organic matter in relation to crop nutrition. *Bull. Cent. int. Engrais chim.* no. 2 (December 1954), p. 7.

A review of the functions of organic matter in crop production.

17. COOKE, G. W. (1954). Off to a good start—with phosphate. *Fmr & Stk-Breed.* 7 September, p. 69.

An article for farmers. The uses of various types of phosphate fertilisers are described. The value of rock phosphates for certain crops on acid soils is stressed, as are the benefits of water-soluble phosphate for starting crops. Methods of maintaining soil phosphate reserves are described.

18. COOKE, G. W. (1954). The use of fertilizers for peas. *E. Riding Fmrs' J.* **6**, 26.

Experiments testing the value of fertilizers for peas are described. Nitrogen and phosphate gave little or no response when broadcast for threshed peas; there were small but consistent gains from broadcast potash fertilizer. When dressings of phosphate-potash fertilizer were placed at the side of the seed, larger and more profitable responses were obtained. The value of soil analysis in making recommendations for manuring peas is stressed.

19. COOKE, G. W. (1954). Nitrogen and phosphorus fertilisers in North-Western Europe. *Proc. Fertil. Soc.* no. 27.

The amounts of fertilizer used in several European countries are stated, and current trends in consumption are examined. As fertilizer usage expands there is a tendency for the amounts of nitrogen and potassium to increase more rapidly than the amounts of phosphorus. The forms of nitrogen and phosphorus fertilizers used in different countries are examined. Consumption of ammonium nitrate (usually as mixtures with limestone) has increased rapidly in several countries, increases in usage of other nitrogen fertilizers have been smaller. Superphosphate and basic slag supply most of the phosphorus used in North-Western Europe. In the United Kingdom and France large proportions of the nitrogen and phosphorus used are sold in the form of compound fertilizers; compounds are relatively uncommon in other countries.

The manufacture and use of dicalcium phosphate and nitrophosphates as alternatives to superphosphate are described. The valuation of these fertilizers in France, Belgium, Holland and the United Kingdom by laboratory tests and by glasshouse and field experiments is discussed. British experience does not confirm the Continental view that agricultural tests on powdered dicalcium phosphate dihydrate can be used as evidence on the value of granulated compound fertilizers containing anhydrous dicalcium phosphate. In Britain

the immediate effects of phosphorus fertilizers are stressed, but in other countries the residual effects are emphasized. The physical properties of granular fertilizers containing water-insoluble phosphate may be very important, and some of the agricultural value of dicalcium phosphate may be lost when it is granulated. The agricultural superiority of fine powders and the superiority of coarse granules in production and for distribution may be reconciled by making granules which break up rapidly when wetted. Granular products are usually ground before they are analysed, and the results of solubility tests on the ground products apply only to such powders. Grinding may obscure physical properties of granules—such as the presence of a hard surface skin—which are important agriculturally.

The newer types of processes which produce phosphorus fertilizers insoluble in water are discussed in relation to possible expansion and changes in fertilizer production in Britain. It is possible that nitrophosphates or ammoniated superphosphate may be made here. Both kinds of fertilizers contain dicalcium phosphate. Much more laboratory and field work is necessary before a precise valuation can be made of water-insoluble phosphorus contained in granular fertilizers. Conventional extractants may be satisfactory for powdered fertilizers, but they are not likely to be satisfactory for valuing granular materials. The valuation of granulated insoluble phosphates is an urgent and important problem which must be solved before such materials can be introduced widely in this country.

20. COOKE, G. W. & GARNER, H. V. (1954). The importance of organic matter in crop production. *J. R. agric. Soc.* **115**, 27.

Organic matter is not essential for plant growth, but in normal cropping it influences supplies of nutrients, water and air. The value of organic manures to farmers must be measured by field experiments. By testing fertilizers at the same time it is possible to estimate how much importance should be given to the nutrients supplied by the organic matter. Increases in crops over those caused by the added nutrients may be ascribed to improvements in soil "condition".

Older continuous experiments show that adequate fertilizers, continuously applied, may give as good or better crops than farmyard manure. More recent annual experiments show that extra yields are produced by using organic manures for crops which received fertilizers as well. No modern experiments in Britain have tested organic manures in the presence of optimum fertilizer dressings. Until this is done the physical effects of organic manures cannot be measured with certainty.

Methods of maintaining soil fertility by organic manures are discussed. Ploughing-in straw may reduce yields unless adequate nitrogen is applied; much of the value of straw lies in the potassium it contains. Straw composts are uneconomic if there are serious losses of plant food in the composting process.

Organic matter may be added to soils by ploughing in green manures or leys. There is no certain evidence that green manures improve soil condition, since much of the organic matter they contain is rapidly oxidized. If temporary leys are used to keep up fertility they must be dressed with nitrogen unless they contain abundant clover. Increased yields following ploughed-up leys have been demonstrated; the effects are partly due to improvements in soil structure and partly to nitrogen fixed by legumes. Where the system of management results in much herbage being removed from a field, there may be a serious drain on soil potassium. Unless extra potassium fertilizers are given the yields of arable crops following the ley may be reduced.

The following suggestions are made: (i) On *coarse, sandy soils*, where aeration and drainage are good, additions of organic matter are not *essential* for fairly good yields, providing adequate lime and fertilizers are given. (ii) On *clay soils*, where the actions of frost or judicious cultivations produce stable crumb structure, the physical improvements following extra organic matter are not essential for profitable cropping, provided sufficient fertilizer is used. (iii) On other soils, usually consisting of fine sand and silt, some action must be taken to maintain structure if profitable arable crops are to be grown. These soils become difficult to work as organic matter falls, crumbs formed by cultivation are not water-stable and the soils "run together" and cap in wet weather. The problem in farming such intractable soils is that of maintaining income levels while growing grass or other crops which build stable crumb structure.

21. CROWTHER, E. M. (1954). The production and use of fertilizers : some current trends and problems. Jubilee Memorial Lecture of the Society of Chemical Industry. *Chem. & Ind.* 1400.

The lecture presents by means of diagrams a critical survey of the world uses of the main fertilizer elements. The long trend of world production of phosphate rock, rising from 5,000 tons per annum in 1850 to 25,000,000 at the present time, has been very near to doubling every 10 years. This is a biological type of growth, and is interpreted as growth of a body of knowledge likely to extend far into the future. The present tendency is for the use of N and K to increase more rapidly than P. Countries like India use only one-hundred part of the amounts used by countries like Holland. Countries with settled agricultural systems, such as Western Europe, tend to use about equal amounts of N, P₂O₅ and K, while those with mainly irrigated farming use mainly N, and pastoral district mainly P.

In the United Kingdom the use of N and K trebled and P doubled in the period 1939-54, but in spite of this the use on most crops is well below the most profitable dressings which have been established by experimental field work. These optimum rates are given for various crops with adjustments to be made to allow for different soils and climates and for varying price relationships. It is pointed out that in the past experiments to compare different kinds or rates of fertilizer have very often been rendered unsuitable for this purpose because the rates chosen have been too high to extend into the sensitive range. Residual values of prolonged P and K treatments are dealt with and the effectiveness of the special placement of these elements as starter doses for crops.

A close study is made of the significance of ratios and limits of variation in the definition of compound fertilizers, and a strong plea is made for the advantages which could accrue from rationalizing and simplifying present codes.

The main purpose of fertilizer is not to maintain soil fertility but to raise it so that new kinds of crops can be grown profitably and more cheaply under better and more productive systems of farming.

RESEARCH PAPERS

22. BREMNER, J. M. (1955). Nitrogen transformations during the biological decomposition of straw composted with inorganic nitrogen. *J. agric. Sci.* (In the press.)

Nitrogen transformations during the decomposition of straw composted with ammonium carbonate were studied by following the changes in: (a) the amounts of inorganic and organic nitrogen; (b) the amounts of ammonia-volatile base-, α -amino- and amino-sugar-N liberated by acid hydrolysis of the organic nitrogen complexes; and (c) the amino-acid composition of acid hydrolysates of the composts. The results showed that synthesis of organic nitrogen during the biological decomposition of straw composted with ammonium carbonate was not accompanied by any gross change in the distribution of the forms of organic nitrogen. A large fraction of the organic nitrogen synthesized was in the form of protein; a smaller fraction was in the form of amino-sugar. The amino-acid composition of acid hydrolysates of the rotted and unrotted straws were not greatly different. The rotted, but not the unrotted, straw hydrolysates contained β -alanine and a substance provisionally identified as α , ϵ -diaminopimelic acid.

23. BREMNER, J. M. (1954). Identification of hydroxylamine and hydrazine by paper chromatography. *Analyst*, **79**, 198.

A method for the separation and identification of microgram quantities of hydroxylamine and hydrazine is described. It involves paper chromatography with acidic solvents and identification by R_f values and by the colours produced with picryl chloride and other detecting reagents.

24. BREMNER, J. M. (1954). A review of recent work on soil organic matter. Part II. *J. Soil Sci.* **5**, 214.

A review of recent work on the extraction and fractionation of soil organic matter, the interaction of organic and inorganic soil colloids, the humic and fulvic fractions and the lignin-like complexes of soil organic matter.

25. BREMNER, J. M. & SHAW, K. (1954). Studies on the estimation and decomposition of amino sugars in soil. *J. agric. Sci.* **44**, 152.

The amounts of amino-sugar-N present in acid hydrolysates of six soils with nitrogen contents ranging from 0.17 to 2.82 per cent have been estimated by colorimetric and alkaline decomposition methods. Recovery of amino-sugar-N after hydrolysis of chitin or glucosamine was found to be unaffected by the presence of soil during hydrolysis. Substances known to interfere with the methods of amino-sugar analysis employed were not detectable in the soil hydrolysates. From the amounts of amino-sugar-N liberated by acid hydrolysis it is deduced that 5–10 per cent of the total nitrogen of the soils examined was in the form of amino-sugars. The decomposition of amino-sugars in soils has been studied by comparing the rates of decomposition of chitin, glucosamine, casein and yeast nucleic acid when incubated with soil under conditions found to produce rapid nitrification of ammonium sulphate. Glucosamine and chitin are readily decomposed by soil micro-organisms, but not so rapidly as casein or yeast nucleic acid.

26. COOKE, G. W. (1954). Recent advances in fertilizer placement. II. Fertilizer placement in England. *J. Sci. Fd Agric.* **5**, 429.

Phosphorus and potassium fertilizers used for cereals should be drilled with the seed; half dressings applied in this way have produced as much grain as full-dressings broadcast.

Where potatoes are hand-planted in furrows, fertilizer may be concentrated near the seed satisfactorily by broadcasting it over the furrows before planting. When a mechanical potato planter was used on flat land, fertilizer dressings applied in bands beside the seed produced higher yields and more profit than broadcast dressings.

Fertilizer placed near the seed produced higher yields of beans and peas and several kinds of horticultural crops than the same quantities of broadcast fertilizer. For high-value cash crops, placement may be very profitable. Absence of crop responses in field experiments may be due to fertilizers having been applied in the wrong place.

Some crops, e.g., sugar beet, mangolds and kale, made better early growth when complete NPK fertilizer was placed beside the seed than when fertilizer was broadcast, but at harvest the two methods of application gave similar yields.

PK fertilizers broadcast over established temporary and permanent herbage crops gave higher yields than dressings placed in bands below the surface. Placing PK fertilizers in bands at the side of lucerne seed was not superior to broadcasting. When light dressings of superphosphate were placed directly below the seed as a "starter", lucerne grew more rapidly and produced higher yields than when superphosphate was broadcast.

Fertilizers broadcast and incorporated deeply with the soil have advantages over dressings worked in shallowly in dry seasons and for deep-rooting crops.

Root growth of most crops was stimulated by dressings of mixed fertilizers placed near the seed. Nitrogen, phosphorus and potassium fertilizers placed near the seed of peas each stimulated extra root growth. The factors that affect the value of fertilizer dressings are discussed, with particular reference to the kinds of root systems developed by crops.

27. COOKE, G. W. & NIXON, H. L. (1955). The value of sewage sludge ashes as phosphorus fertilizers. *J. Sci. Fd Agric.* **6**, 79.

When sewage sludge is incinerated, the ash contains most of the phosphorus present in the sludge. The fertilizer value of phosphorus in ashes prepared from three sewage sludges was investigated by pot experiments.

One sludge prepared from domestic sewage contained phosphorus which appeared to be equivalent to water-soluble phosphorus in a pot experiment on turnips. After this sludge was burnt at 900° the phosphorus in the ash remaining was of very little value.

Three sewage sludges were burned at approximately 350°, 600° and 900°, and the ashes were compared as phosphorus fertilizers with superphosphate in a pot experiment on radishes. Ashes prepared at low temperatures contained phosphorus of some value to radishes. Ashes prepared at higher temperatures from two digested sludges containing some calcium carbonate were useless. High-temperature burning of a third sludge prepared by acid precipitation

from sewage containing wool residues gave products which had some value as phosphorus fertilizers.

The 2 per cent citric acid test used for basic slags did not differentiate between sewage sludge ashes of varying fertilizer value.

Ash remaining after burning most sludges is not likely to have much value as a phosphorus fertilizer, but any product made in quantity may be worth biological testing.

28. CROWTHER, E. M., WARREN, R. G. & BENZIAN, B. (1954). Nutrition problems in forest nurseries, Summary report for 1952. *Rep. For. Res., For. Comm., for 1952-53*, 84.

29. HAINES, W. B., CROWTHER, E. M. & THORNTON, G. J. (1954). Manuring heavea. V: Long-term effects in the Dunlop (Malayan) experiments. *Emp. J. exp. Agric.* **22**. (In the press.)

The paper reports growth and yield measurements taken after the Japanese Occupation on experiments with rubber trees of many years standing. Treatments went on from 1934 until 1941, and then ceased. The measurements reported were made in 1948, and showed that on the whole the trees had maintained the advantages gained earlier, while in some cases there had been further gains attributed to effects of residuals. Measurements are given to show the considerable gains which boundary trees may make by poaching fertilizer from neighbouring plots.

30. TALIBUDEEN, O. (1954). The determination of isotopically exchangeable phosphorus in some Rothamsted soils. *Proc. Radio-Isotope Conf.*, Atomic Energy Research Establishment, Harwell, **1**, 405.

A method is suggested for determining the surface phosphorus in soils by measuring the true "surface exchange" of the orthophosphate ion. "Surface phosphorus" and "isotopically exchangeable phosphorus" values of five Rothamsted soils varying in their previous cropping and manuring, the pH of their soil solution, and their CaCO_3 content, are determined. In preliminary experiments it is also shown how the method can be used to investigate: (a) the recovery of added phosphorus, and (b) the nature of soil phosphate, in two soils.

31. TALIBUDEEN, O. (1955). Complex formation between montmorillonoid clays and amino-acids and proteins. *Trans. Faraday Soc.* **51**, 582.

The stability of complexes formed by montmorillonite with amino-acids and proteins is found to increase as the cationic nature of the zwitterion predominates increasingly. Accurate measurement of the $d(001)$ spacing of the complexes is made possible by the use of oriented montmorillonite flakes for adsorption. The differences between the observed and calculated Van der Waal thicknesses of adsorbed amino-acid molecules is ascribed to H-bonding of the C—H---O type. This information is used to derive the actual thicknesses of one and two close-packed polypeptide chains of the β -keratin type.

Pedology Department

32. BLOOMFIELD, C. (1955). The deflocculation of kaolin by tree leaf leachates. *Trans. 5th int. Congr. Soil Sci.* (In the press.)

Texture differentiation, often found in podzolized soils, may result from the accumulation of clay in the B horizon. Results reported here indicate that physical transportation of clay can result from the action of rain-water containing organic compounds leached from the A_0 horizon. The aqueous leachates of some fifteen species of broad-leaved and coniferous trees, at low concentrations, have a marked deflocculating effect on kaolin suspensions. In most cases, as the concentration of plant extract is increased, the extent of deflocculation reaches a maximum and then decreases, more or less abruptly depending on the species.

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33. BLOOMFIELD, C. (1955). The movement of sesquioxides and clay in the soil. *Afr. Soils, Paris*. (In the press.)

A review of work on the effect of plant-remains on soil sesquioxides.

34. BROWN, G. (1954). Degrading Illite and potash fixation. *Nature, Lond.* **173**, 644.

Irish soils found to fix potassium contained "degrading illite". The diffraction patterns of air-dry clay in an evacuated camera show a band from 10 Å. to higher spacings which generally merges with the background at 12–13 Å. and never extends beyond 14 Å. Treating the clay with glycerol causes the band to resolve into lines at 10 Å. and 14 Å., and heating at 350° C. for 12 hours causes the band to disappear. It is suggested that "degrading illite" fixes potassium.

35. BROWN, G. & GREENE-KELLY, R. (1954). X-ray diffraction by a randomly interstratified clay mineral. *Acta cryst., Camb.* **7**, 101.

Preheated lithium montmorillonite when treated with glycerol shows random interstratification effects which appear to follow those predicted by the Hendricks and Teller treatment for a two-component system of 9.4 and 17.7 Å. repeat distances.

36. GREENE-KELLY, R. (1955). Sorption of aromatic compounds by montmorillonite. Parts I & II. *Trans. Faraday Soc.* (In the press.)

Part I. The sorption complexes of montmorillonite and aromatic molecules have been studied by X-ray spacing measurements and one-dimensional Fourier synthesis. The results have shown that two orientations are common. The first, which is generally stable at low surface concentrations, has the plane of the ring of the molecule parallel to that of the silicate sheet, but at higher surface concentrations the molecules reorient so that their planes are perpendicular to that of the silicate sheet. The contact distances between the surface oxygens of the silicate sheet and the atoms of the organic molecules have been confirmed as being shorter than the normal Van der Waal's distance. It has been found, however, that the calculated shortening does not vary much between complexes, provided the correct structure is allocated.

Part II. Vapour- and liquid-phase isotherms have been determined for the montmorillonite-pyridine system. The simultaneous examination of the adsorbent by X-ray diffraction has permitted the points on the isotherm corresponding to orientation changes of the sorbed pyridine to be identified. In the light of this evidence the packing of pyridine between the silicate sheets of montmorillonite is discussed.

37. GREENE-KELLY, R. (1955). Dehydration of the montmorillonite minerals. *Miner. Mag.* (In the press.)

Neither of the two closely related systems, Li-montmorillonite-beidellite and Li-Na-montmorillonite is a uniform one. In the former it seems that there must be differences in composition between silicate sheets bound in the same crystallite, and in the latter the majority of the sodium ions aggregate to form a sodium-rich "phase". The effect of heating on the internal surface available to glycerol of the Li-saturated montmorillonite-beidellite is shown to be correlated with the amount of octahedral substitution, less than 70 per cent leading to some glycerol penetration. In the Li-Na-montmorillonite system, if there is less than 70 per cent Li ions in the interlamellar spaces, expansion also occurred after heating. No evidence was found of an intermediate state of expansion at 14 Å.

38. SINGH, S. (1954). A Study of black cotton soils with special reference to their coloration. *J. Soil Sci.* **5**, 289.

Treatment of calcareous soils with H_2O_2 has almost no effect on their coloration if MnO_2 is present, but destruction of this and carbonate leads to decoloration. The apparent resistance of the organic carbon of black soils compared with the associated red soils is due to Ca-saturation. The clay fractions of the black contain less resistant carbon than those of the red soils. The regur soils of central and peninsular India and the "Kabar" soils of

Bundelkhand contain organic matter which behaves similarly on peroxidation to that of the "Karail" soils of the Gangetic alluvium, suggesting that their formation occurs under somewhat similar intermittent anaerobic conditions.

39. (SMITHSON, F.) (1954). The petrography of dickite sandstones in North Wales and Northern England, with an Appendix on the differentiation of dickite and kaolinite by G. Brown. *Geol. Mag.* **91**, 177.

The identifications were divided into four classes, and the appendix explains their significance.

40. STEPHEN, I. (1954). An occurrence of palygorskite in the Shetland Isles. *Miner. Mag.* **30**, 471.

Palygorskite occurring in montmorillonitized syenite has been studied by optical, X-ray and chemical methods and by D.T.A. and electron microscopy. Samples of other minerals, known as pilolite (Heddle, 1879, *Miner. Mag.* **2**, 206), "mountain leather" and "mountain cork", have also been examined, and these have been found to give X-ray diagrams identical with that of the Shetland Palygorskite.

Soil Microbiology Department

41. BROMFIELD, S. M. (1954). Reduction of ferric compounds by soil bacteria. *J. gen. Microbiol.* **11**, 1.

Reduction of ferric lactate by washed-cell suspensions of *Bacillus circulans*, *B. megaterium* and *Aerobacter aerogenes* takes place in the presence of suitable hydrogen donors. Ferric hydroxide is reduced when $\alpha\alpha'$ -dipyridyl is present in the cell + substrate system. The reduction of ferric compounds by washed cells + substrate is similar to the reduction of methylene blue. Culture fluids of *B. circulans* do not reduce ferric iron in the absence of normal cells.

42. KLECZKOWSKA, J. & KLECZKOWSKI, A. (1954). The effect of ribonuclease on phage-host interaction. *J. gen. Microbiol.* **11**, 451.

Pancreatic ribonuclease inhibits the multiplication of a *Rhizobium* bacteriophage in liquid bacterial cultures by preventing permanent combination between phage and host. The addition of ribonuclease after phage has already combined with the bacteria does not prevent phage from multiplying, but it does decrease the rate of multiplication; the enzyme also interferes with multiplication of the bacteria. Experiments with ribonuclease in conjunction with chymotrypsin suggest that phage and bacteria unite in the presence of ribonuclease but that the union is only transitory and ends by the release of still active phage. In the presence of chymotrypsin, however, the phage becomes inactive during this transient union.

43. MEIKLEJOHN, J. (1954). Some aspects of the physiology of the nitrifying bacteria. In *5th Symp. Soc. gen. Microbiol.* ('Autotrophic micro-organisms'), p. 68.

44. MEIKLEJOHN, J. (1954). Microbiology of the soil. *Biology*, **19**, 107.

45. MEIKLEJOHN, J. (1954). Notes on nitrogen-fixing bacteria from East African soils. *Trans. 5th Int. Congr. Soil Sci.* (In the press.)

About forty samples of East African soils were examined for the presence of nitrogen-fixing bacteria. An impure culture of *Azotobacter* sp. was obtained from a calcareous sandy soil, but this was the only sample of those examined which contained *Azotobacter*. Anaerobic nitrogen-fixing *Clostridium* spp. were isolated from every sample. A species of *Beijerinckia* which forms a green fluorescent pigment, and which is an effective nitrogen-fixer, was isolated from an acid sandy soil (pH 4.5).

46. MEIKLEJOHN, J. (1955). The effect of bush burning on the microflora of a Kenya upland soil. *J. Soil Sci.* (In the press.)

Soil samples were taken from the surface of three sites at Muguga, Kenya, before and at intervals after the vegetation covering the sites was burnt.

The numbers of micro-organisms estimated by a direct-counting method fell after burning on all three sites. *

There was also a reduction after burning in the numbers estimated by plate counts, especially in the number of fungi, which disappeared completely for a time on two of the sites.

Aerobic nitrogen-fixers are apparently killed by burning; but anaerobic nitrogen-fixers, though not very efficient at any time, appear to survive burning.

The nitrifying bacteria are either killed or reduced to very few by burning.

47. NUTMAN, P. S. (1954). Symbiotic effectiveness in nodulated red clover. I. Variation in host and in bacteria. *Heredity*, **8**, 35.

From a comparative study in red clover of variation in symbiotic effectiveness, the following results were obtained :

(1) With effective or partially effective strains of bacteria, the response of individual plants in a variety, in terms of amount of growth made on nitrogen-free medium showed a skew distribution.

(2) In general, distribution curves of host response with such strains show a primary mode of effectively, and a secondary mode of ineffectively responding plants.

(3) The relative sizes, but not usually the positions, of these modes vary with bacterial strain.

(4) With ineffective strains of bacteria the distribution curve is negatively skew and shows a single mode only.

(5) Preliminary breeding experiments show that the host-plant differences are inherited.

48. NUTMAN, P. S. (1954). Symbiotic effectiveness in nodulated red clover. II. A major gene for ineffectiveness in the host. *Heredity*, **8**, 47.

Clover plants with a simple recessive host factor, i_1 , show a completely ineffective response when inoculated with the normally effective bacterial strain A. Plants homozygous for i_1 give an effective response with other effective strains of bacteria unrelated to strain A as well as with a stable variant of strain A (substrain A211). Other bacterial variants of strain A were isolated which give rise to mixed responses in i_1 homozygotes. A recessive suppressor m_1 is also inferred which restores $i_1 i_1$ plants to complete effectiveness with strain A.

49. SKINNER, F. A. (1955). Antibiotics. In Modern methods of plant analysis. Edited by K. Paech & M. V. Tracey, vol. 3. Berlin: Springer-Verlag. (In the press.)

50. STEVENSON, I. L. (1954). Antibiotic production by actinomycetes in soil demonstrated by morphological changes induced in *Helminthosporium sativum*. *Nature, Lond.* **174**, 598.

A preliminary account of studies dealing with the presence and activity of antibiotics in soil, particularly in micro environments. Use is made of a new technique for the detection of soil antibiotics based on the effects of these substances on the morphology of the test fungus.

51. STEVENSON, I. L. (1954). Antibiotic production by actinomycetes in soil and their effect on root-rot of wheat. *8th Int. Congr. Bot. Sect.* **24**, p. 69.

52. THORNTON, H. G. (1954). The nodule bacteria and their host legumes: some problems that they still present. *Sci. Progr.* no. **166**, 185.

53. TRECCANI, V., WALKER, N. & WILTSHIRE, G. H. (1954). The metabolism of naphthalene by soil bacteria. *J. gen. Microbiol.* **11**, 341.

The early stages in the oxidation of naphthalene by five micro-organisms were investigated. In all the organisms D-*trans*-1 : 2-dihydro-1 : 2-dihydroxy-naphthalene, salicylic acid and catechol appeared to be intermediate oxidation products. Washed cells grown on naphthalene oxidized α - and β -naphthol, but whether these compounds are true intermediates remains undecided.

54. TURNER, E. R. (1955). The effect of certain adsorbents on the nodulation of clover plants. *Ann. Bot., N.S.* **19**. (In the press.)

The addition of charcoal to the rooting medium of clover plants inoculated with effective and ineffective strains of *Rhizobium* leads to a stimulation in nodule production. The time interval between inoculation and the first appearance of the nodules is reduced in the presence of charcoal. Several explanations of this phenomenon have been investigated, and it is concluded that the stimulation is due to the adsorption by the charcoal of inhibitory compounds secreted by the clover roots. These compounds have been eluted from the charcoal and have been shown to affect nodule production. As a result of these experiments it is suggested that, depending on the concentration of the secretions in the elutes either a stimulation or inhibition of nodule production may occur.

Other adsorbents have also been added to the clover plants, but no consistent stimulation of nodule production has been observed.

Botany Department

55. OWEN, P. C. (1955). The respiration of tobacco leaves in the 20-hour period following inoculation with tobacco mosaic virus. *Ann. appl. Biol.* **43**, 114.

The effect of infection with TMV on the respiration of detached tobacco leaves in the 20 hours immediately after inoculation differed at different times of year. During winter, infection increased respiration rate, and in summer decreased it. In winter-grown plants, increasing the light intensity before inoculation decreased respiration rate after infection. Extending the day length for winter-grown plants did not alter the effect of infection. Changes in respiration rate began in less than one hour after inoculation and are, therefore, unlikely to be associated with the formation of new virus.

56. OWEN, P. C. (1955). The respiration of tobacco leaves after systemic infection with tobacco mosaic virus. *Ann. appl. Biol.* **43**. (In the press.)

The rate of CO₂ production per g. dry matter of the younger leaves of tobacco plants systemically infected with TMV was about 10 per cent less than that of comparable healthy leaves. Older infected leaves had the same respiration rate as comparable healthy leaves. These results were independent of seasonal change in light conditions during the growth of the plants. Older leaves, but not younger leaves, of infected plants had a lower initial water content, and both absorbed less water during the experimental period than leaves from healthy plants. The effects of TMV infection on water content were so great that the rate of CO₂ production per g. fresh weight was sometimes significantly increased by infection. Other causes for contradictory results are discussed.

57. THORNE, G. N. (1955). Interactions of nitrogen, phosphorus and potassium supplied in leaf sprays or in fertilizer added to the soil. *J. exp. Bot.* **6**, 20.

Sugar beet plants absorbed nitrogen, phosphorus and potassium from leaf sprays supplying the three nutrients separately or in all combinations. Absorption of any one of the nutrients from a spray containing more than one nutrient was unaffected by the presence of others in the spray, but spraying with nitrogen-containing solutions increased the absorption of phosphorus and potassium from the soil, and potassium in sprays increased the uptake of phosphorus from the soil.

Nitrogen fertilizer applied to the soil increased leaf area, and hence it also increased the quantity of nitrogen, phosphorus and potassium deposited on the leaves from sprays and absorbed into the plants. Nitrogen fertilizer increased the apparent percentage recovery in the plant of phosphorus and potassium from leaf sprays. Phosphorus fertilizer had no effect on uptake from sprays, and potassium fertilizer appeared to reduce the percentage recovery of potassium from sprays. The significance of these percentage recovery figures is discussed.

Nutrients from sprays produced smaller increases in total dry weight and in dry weight per unit of nutrient absorbed than the same nutrient from fertilizer. Application of a nutrient in leaf spray reduced the response in dry weight and sugar yield to the same nutrient applied in fertilizer to the soil.

58. THURSTON, J. M. (1954). A survey of wild oats (*Avena fatua* and *A. ludoviciana*) in England and Wales in 1951. *Ann. appl. Biol.* **41**, 619.

In 621 samples of wild oats, collected in England and Wales by National Agricultural Advisory Service and National Institute of Agricultural Botany Officers, only two species (*Avena fatua* and *A. ludoviciana*) were found, but both were very variable. *A. fatua* occurred in all wheat- and barley-growing areas, in both winter and spring corn and on all soil types. *A. ludoviciana* occurred (with two exceptions) only within approximately 80 miles radius of Oxford, mainly on heavy soils and chiefly in winter corn.

The amount of wild oats present appeared to depend on the frequency in the rotation of corn or other crops in which wild oats would shed seed. Deep ploughing often increased the infestation. The data did not show whether a field could be freed of wild oats by grassing down for a number of years, nor what is the maximum period of survival of buried wild oat seeds.

59. WARINGTON, K. (1954). Trace elements. *Thorpe's Dictionary of applied chemistry*, **11**. London: Longmans, Green.
60. WILSON, J. H. (1955). Effects of nutrition and light intensity on symptoms of leaf roll virus infection in the potato plant. *Ann. appl. Biol.* **43**. (In the press.)

Increased nitrogen supply to potato plants infected with leaf roll virus greatly reduced the intensity of leaf symptoms, and caused a smaller and less consistent reduction in phloem necrosis. Application of phosphatic fertilizer initially reduced leaf symptoms, but later increased them; it increased phloem necrosis at all stages of growth. Potash slightly intensified leaf symptoms, but not phloem necrosis. Shading, which approximately halved the light intensity, reduced leaf symptoms but had no effect on phloem necrosis.

The masking of leaf symptoms by nitrogen, and by phosphorus in the early stages of growth, was closely correlated with increases in relative leaf growth rate produced by these nutrients.

Leaf rolling and phloem necrosis are considered to be independent symptoms not causally related, because they were differentially affected by nutrient supply and shading, and each could occur without the other.

Biochemistry Department

BOOKS

61. TRACEY, M. V. (1954). *Principles of biochemistry: A biological approach*. London: Sir Isaac Pitman & Sons Ltd.
62. TRACEY, M. V. (1955). *Modern methods of plant analysis*. Edited by K. Paech & M. V. Tracey. Vol. 2. Berlin: Springer-Verlag.

GENERAL PAPERS

63. KENTEN, R. H. (1955). Gasometric analysis in plant investigation. *Modern methods of plant analysis*, edited by K. Paech & M. V. Tracey. Berlin: Springer-Verlag. Vol. 1. (In the press.)

64. PIRIE, N. W. (1954). On making and recognizing life. *New Biol.* **16**, p. 41.
65. PIRIE, N. W. (1954). Factors controlling biological multiplication. *Nature, Lond.* **174**, 815.
66. PIRIE, N. W. (1954). Food and the future. *Laden Wain, Reading*, p. 12.
67. PIRIE, N. W. (1954). Food or frivolities. *Sci. Wkr*, **9**, 8.
68. PIRIE, N. W. (1955). General methods for separation. *Modern methods of plant analysis*, Vol. 1, p. 26.
69. PIRIE, N. W. (1955). Proteins. *Modern methods of plant analysis*, Vol. 4, p. 23.
70. TRACEY, M. V. (1955). Chitin. *Modern methods of plant analysis*, Vol. 2, p. 264.

RESEARCH PAPERS

71. HOLDEN, M. & PIRIE, N. W. (1955). The partial purification of leaf ribonuclease. *Biochem. J.* **60**, 39.

From pea seedlings ribonuclease preparations have been made which attack P-containing substrates other than ribonucleic acid so slowly as to make it unlikely that the enzyme has an unspecific action.

The enzyme differs from pancreatic ribonuclease in that it hydrolyses nucleic acid so completely that no acid precipitable "core" is left.

Less thoroughly fractionated preparations have been made from tobacco leaves, and some properties of the enzyme in other leaves are described.

72. HOLDEN, M. & PIRIE, N. W. (1955). The preparation of ribonucleic acid from yeast, tobacco leaves and tobacco mosaic virus. *Biochem. J.* **60**, 46.

Most of the nucleic acid in suitably prepared extracts from yeast, tobacco leaf microsomes and TMV can be precipitated at pH 3-4 by NaCl. A small part of the nucleic acid in commercial products can also be precipitated.

Preparations of nucleic acid made from yeast in this way appear to have a high mean particle weight and to contain less than 1 per cent of nitrogen. Their contents of Ca, Fe and Mg are low, and probably the results of contamination. Those from TMV contain significant amounts of deoxyribose nucleic acid, but the other two are substantially free from it.

73. HOLDEN, M. & PIRIE, N. W. (1955). A comparison of leaf and pancreatic ribonuclease. *Biochem. J.* **60**, 53.

The effect of variation in the conditions on the completeness of the precipitation of yeast nucleic acid by uranyl nitrate and trichloroacetic acid is investigated.

Ribonuclease from pea leaves hydrolyses nucleic acid more extensively than the pancreatic enzyme. There are also differences in thermostability and pH optimum.

The leaf enzyme is the more easily affected by several inhibitors.

74. HOLDEN, M. & PIRIE, N. W. (1955). Treatments affecting the ultra-violet absorption spectrum of ribonucleic acid from three sources. *Biochim. biophys. Acta*, **16**, 317.

The intensity of absorption in the 260-m μ region by three different types of ribonucleic acid and by the fraction of YNA that resists attack by pancreatic ribonuclease, is increased during several types of hydrolysis to an extent that parallels the extent of hydrolysis.

Exposure to strong urea solutions has a small and irregular effect on the absorption by nucleic acid, but diminishes the absorption by TMV.

75. KENTEN, R. H. (1955). The oxidation of indolyl-3-acetic acid by waxpod bean root sap and peroxidase systems. *Biochem. J.* **59**, 110.

The oxidation of indolyl-3-acetic acid (IAA) by O_2 is catalysed by highly purified peroxidase preparations. The rate of oxidation is increased in the presence of certain thermostable factors such as monophenols, aniline, resorcinol, manganese, and maleic hydrazide. With the exception of manganese and maleic hydrazide, all the active factors are known, or have been shown, to be peroxidase substrates. Other peroxidase substrates, e.g., catechol, hydroquinone, pyrogallol and *p*-phenylenediamine (10^{-4} – $10^{-5}M.$) strongly inhibit the peroxidase-catalysed oxidation of IAA.

The IAA oxidase of waxpod bean root sap consists of a thermolabile fraction, which appears to be a peroxidase and which can be replaced by horseradish peroxidase, and a thermostable fraction, the activity of which largely depends on the presence of peroxidase substrates.

The oxidation of IAA when catalysed by horseradish peroxidase in the absence or presence of waxpod bean root thermostable fraction proceeds with the consumption of 1 mole O_2 /mole IAA oxidized and the formation of 1 mole CO_2 /mole O_2 consumed.

Possible mechanisms of the reaction are discussed, and evidence is presented suggesting that the oxidation of IAA by the peroxidase systems studied is not dependent on the presence of flavoprotein.

76. KENTEN, R. H. & MANN, P. J. G. (1954). A simple method for the preparation of horseradish peroxidase. *Biochem. J.* **57**, 347.

A simple method is described for the preparation of highly purified peroxidase from horseradish roots. Stable, dry preparations are obtained with P.Z. 1040–1120 and haemin contents of 1.1–1.2 per cent.

77. MANN, P. J. G. (1955). Purification and properties of the amine oxidase of pea seedlings. *Biochem. J.* **59**, 609.

A method is described by which the amine oxidase of pea seedling extracts can be purified up to 300-fold.

The purified enzyme preparations catalyse the oxidation not only of diamines but also, though less readily, that of phenylalkylamines, aliphatic monoamines and of L- and D-lysine.

Hydrogen peroxide is formed during the oxidation of all the substrates. The inactivation of the enzyme by hydrogen peroxide has been confirmed, and the conditions of this inactivation have been investigated.

The enzyme is inhibited not only by cyanide and semicarbazide, as previously reported, but also by diethyldithiocarbamate, salicylaloxime and potassium ethyl xanthate. Salicylaloxime and thiourea are oxidized by the hydrogen peroxide formed in the primary reaction. This oxidation of salicylaloxime is catalysed by peroxidase.

It is suggested that one enzyme—plant amine oxidase—catalyses the oxidation of diamines, phenylalkylamines and of L- and D-lysine and that this enzyme may be a metalloprotein.

78. (CHIBNALL, A. C.) & WILTSHIRE, G. H. (1954). A study with isotopic nitrogen of protein metabolism in detached runner bean leaves. *New Phytol.* **53**, 38.

A cycle of protein breakdown and synthesis was demonstrated in leaves kept for 4 days in the dark. The α - and ϵ -amino-groups of lysine isolated from leaf protein were equally labelled with isotopic nitrogen.

TRECCANI, V., WALKER, N. & WILTSHIRE, G. H. (1954). The metabolism of naphthalene by soil bacteria. *J. gen. Microbiol.* **11**, 341.

For summary see no. 53.

Plant Pathology Department

GENERAL PAPERS

79. BAWDEN, F. C. (1954). Inhibitors and plant viruses. *Advanc. Virus Res.* **2**.
80. BAWDEN, F. C. (1954). Cellular metabolism and virus growth. *Int. Symp., The Dynamics of Virus and Rickettsial Infections, Detroit*, p. 59.
81. BAWDEN, F. C. (1954). The development of knowledge on plant viruses and virus diseases. *J. sci. industr. Res., Ser. A*, **13**, 106.
82. BAWDEN, F. C. (1954). The spread and control of plant virus diseases. *Ann. appl. Biol.* **42**, 140.
83. BAWDEN, F. C. (1954). Tom Goodey (1885–1953). *Obituary Notices of Fellows of the Royal Society*, **9**, 141.
84. BAWDEN, F. C. (1954). Combating plant diseases. *Financial Times*, 15 November.
85. BROADBENT, L. (1954). Potato seed can be saved. *Fmrs' Wkly*, **40**, 79.
86. GLYNNE, MARY D. (1954). Causes of variation in wheat yields. *Rapp. Commun. Int. Bot. Congr. Sect.* 18–20, p. 134.
87. GLYNNE, MARY D. (1954). Soil-borne diseases of cereals. *J. R. agric. Soc.* **115**, 41.
88. HULL, R. (1954). Sugar beet yellows in Great Britain, 1953. *Plant Path.* **3**, 130.
89. HULL, R. (1954). Sugar Beet Yellows. Recent developments in control. *Brit. Sug. Beet Rev.* **22**, 113.
90. HULL, R. (1954). Control of Yellows in sugar beet seed crops in Great Britain. *Agriculture, Lond.* **61**, 205.
91. HULL, R. (1954). The control of Virus Yellows in steckling beds. *Seed Tr. Rev.* **6**, 87.

RESEARCH PAPERS

92. BENDA, G. T. A. (1955). Some effects of ultra-violet radiation on leaves of French bean (*Phaseolus vulgaris* L.). *Ann. appl. Biol.* **43**, 71.

Exposing the primary leaves of French bean to ultra-violet light produces a variety of effects, their magnitude depending on the extent of the exposure and the subsequent treatment of the leaves. Effects include some that are externally obvious, such as glazing and bronzing; others are detectable by changes in susceptibility to virus infection, by increased sensitivity to damage by ultra-violet and by an increased tendency for cells to collapse when the leaves are kept in darkness. Some of the effects can be counteracted by exposing leaves to visible light. Effects of radiation are not confined to epidermal cells, and measurements with detached epidermis indicate that from a quarter to a half of incident radiation of wavelength 2536 Å. may be transmitted by the epidermis.

The susceptibility of irradiated leaves to infection by a tobacco necrosis virus, as measured by the number of lesions produced by a given inoculum, depends on the irradiation dose, the time elapsing between irradiation and inoculation, and on whether the plants are in the light or dark after the treatments. When inoculated immediately after irradiation, leaves produce fewer lesions than unirradiated ones, even if they are kept in the light, but the

difference is much enhanced if they are in the dark. When leaves are inoculated a day after irradiation, provided the dose was not excessive, those kept in daylight after irradiation produce more lesions than unirradiated ones, whereas those kept in the dark produce many fewer. Thus, the temporary resistance produced by ultra-violet irradiation is not only counteracted by exposure to visible light, but is succeeded by a period of enhanced susceptibility, a period that extends over several days.

93. CORNFORD, C. E. (1954). Effect of downy mildew on yield of sugar beet. *Plant Path.* **3**, 82.

Field trials showed that sugar beets inoculated in June produced up to 80 per cent of infected plants, which decreased the yield of plots by nearly 2½ tons/acre of washed roots. Later inoculations caused less loss. When the weights of roots from individual plants of known history were compared, losses up to 37 per cent were measured in plants that developed symptoms in July.

94. GATES, L. F. & HULL, R. (1954). Experiments on black leg disease of sugar-beet seedlings. *Ann. appl. Biol.* **41**, 541.

Phoma betae was usually the predominant pathogen attacking sugar-beet seedlings in the field in eastern England, but *Pythium* species sometimes predominated when the seedlings were very young. *Fusarium* species were associated with acid soils. *Rhizoctonia solani* only occasionally caused severe losses.

Black leg, caused chiefly by *P. betae*, was most prevalent at low soil temperatures when, in stands from untreated seed, up to 45 per cent of the seedlings were attacked. Disease incidence decreased by 0.8–2.4 per cent per 1° F. rise in soil temperature. Seed treated with "Panogen", thiram and ethyl mercury phosphate regularly gave better stands in small-scale trials than seed treated with "Ceresan" or "Agrosan".

In large-scale experiments average increase in seedling emergence following treatment with "Panogen", thiram and "Agrosan" varied in different years between +6.4 and +19.2 per cent. Average response to BHC soil dressing was +4.2 and +8.6 per cent. Response to seed dressings increased as the time taken for emergence increased and as percentage emergence decreased; when emergence was 50 per cent of the possible, dressing gave on average 20 per cent more seedlings. Response to dressing increased as soil became more acid or alkaline than the optimum for beet, and was lower on heavy soils and on soils dressed with farmyard manure.

Maximum emergence varied from year to year between 2,100 and 2,700 seedlings per ounce seed; minimum between 690 and 1,050. Emergence of both treated and untreated seed varied greatly, and was related to time taken for emergence, suggesting that effects of soil moisture, temperature or texture are important. Seed rate, cultural operations and drill type had no obvious effect. A 1 per cent increase in seedling stand increased final plant population on average by 0.2 per cent.

95. GREGORY, P. H. (1954). The construction and use of a portable volumetric spore trap. *Trans. Brit. mycol. Soc.* **37**, 390.

For sampling air-borne spores a portable volumetric trap (which impacts spores down to 4 μ diameter on a stationary glass slide for microscopic examination) is operated manually by a light sliding-vane pump. Samples of 50–100 l. are taken in from 5 to 10 minutes. It is suitable for use when spore concentrations are high, and is particularly useful when an accurate time differentiation between samples is required.

96. HAMLYN, BRENDA M. G. (1955). Aphid transmission of cauliflower mosaic. *Plant Path.* **4**. (In the press.)

Cauliflower mosaic has been considered as a non-persistent virus because it is acquired by *Myzus persicae* during 30 seconds' infection feeding, is transmitted during a few minutes' test feeding, and because aphids that are fasted before a short infection feed transmit more readily than do unfasted aphids. The response to preliminary fasting by *M. persicae* is smaller and less consistent than with other non-persistent viruses, and *Brevicoryne brassicae* gives little or no response. Aphids remain infective with cauliflower mosaic virus even after feeding for several hours on healthy plants.

97. HIRST, J. M. (1954). A method for recording the formation and persistence of water deposits on plant shoots. *Quart. J. R. met. Soc.* **80**, 227.

Apparatus has been designed to record the amount of water deposited on plant shoots by rain, dew and guttation, and how long the surfaces remain wet. These factors greatly influence the extent to which plants are infected by fungi causing such diseases as potato blight.

The water on a cut potato shoot, sealed into a water-filled chamber placed on a balance, can be weighed by recording, on a rotating drum, the changes in equilibrium of the beam. Deposits from rain appear rapidly; their persistence depends on the weather. In contrast, dew is deposited slowly over a long period, and dries more rapidly. The heaviest dew deposit recorded was 6.9×10^{-3} g./cm.² compared with 9.6×10^{-3} g./cm.² for the amount of water retained during rain.

98. HIRST, J. M. (1955). The early history of a potato blight epidemic. *Plant Path.* **4**. (In the press.)

Of 246 tubers infected with *Phytophthora infestans*, only two produced aerial shoots that were invaded by the fungus growing from the tuber. Plants near to the first of these developed blight lesions in late May, and the disease spread on at least five other occasions before it became widespread in the district at the end of July. Periods of spread usually coincided with potato-blight warnings by Beaumont's method.

99. KASSANIS, B. (1954). Heat-therapy of virus-infected plants. *Ann. appl. Biol.* **41**, 470.

Virus-free plants were produced from parents systemically infected with the following five viruses: tomato bushy stunt, carnation ring spot, cucumber mosaic, tomato aspermy and *Abutilon* variegation. The leaves formed while the infected plants were kept at 36° C. were free from symptoms, and test plants inoculated from these remained uninfected. When cuttings were taken from the infected plants at the end of the treatment most grew into healthy plants. The treated plants themselves usually developed symptoms after varying lengths of time at 20° C., but some that before treatment were infected with tomato aspermy, cucumber mosaic or *Abutilon* variegation viruses remained permanently healthy.

The same method failed to cure plants infected with tomato spotted wilt, potato virus X and tobacco mosaic virus, although it decreased their virus content. Heat-therapy seems not to be correlated with the thermal inactivation end point of the virus *in vitro*.

100. KASSANIS, B. (1954). A virus latent in carnation and potato plants. *Nature, Lond.* **173**, 1097.

A virus detected by serology and electron microscopy in apparently healthy carnation plants is serologically related to a virus present in many normal-looking potato plants of several varieties.

101. KASSANIS, B. (1955). Some properties of four viruses isolated from carnation plants. *Ann. appl. Biol.* **42**, 103.

Four viruses isolated from commercial carnation varieties were transmitted to sweet william plants (*Dianthus barbatus* L.), which react characteristically with them. Two, carnation ring spot virus and carnation mottle virus, have spherical particles, the first about 19 m μ and the second about 32 m μ in diameter. Both survive heating for 10 minutes at 85° C. but not at 90° C. and remain active at room temperature in sap from sweet william for more than 2 weeks. They are not serologically related, and have not been transmitted by *Myzus persicae*.

The other two viruses are transmitted mechanically and by *M. persicae*. Carnation vein mottle virus inactivates in 10 minutes between 50° and 55° C. and at room temperature between 10 and 14 days; attempts to produce an antiserum against it failed; rod-like particles not seen in sap from healthy sweet william were occasionally seen in sap from infected plants. Carnation latent virus has rod-shaped particles. It produces no symptoms in carnation and sweet william plants; its presence is readily detected by serological tests. When transmitted by aphids to sugar beet, it sometimes causes the older

leaves to become yellow. Carnation latent virus inactivates in 10 minutes between 60° and 65° C. and at room temperature between 2 and 3 days. A virus serologically related to carnation latent virus occurs in apparently healthy potato plants of many different varieties.

102. KLECZKOWSKI, A. (1954). Inactivation of antibodies by ultra-violet radiation. *Brit. J. exp. Path.* **35**, 402.

When sufficiently concentrated mixtures of different serum proteins are exposed to ultra-violet radiation, complexes, i.e., mixed aggregates composed of molecules of different proteins, are formed. Such complexes can also be formed between irradiated, but still active, antibodies and other serum proteins. The behaviour in flocculation tests of complexes formed between antibodies and an excess of serum albumin depends on the character of the antigen.

Inactivation of antibodies by ultra-violet radiation follows the course of a first-order reaction. The quantum yields for inactivation by the radiation of λ 2537 are *c.* 2.4×10^{-3} for the antibody to clover nodule bacteria and *c.* 0.96×10^{-3} for the antibodies to tomato bushy stunt and tobacco mosaic viruses.

- KLECZKOWSKA, J. & KLECZKOWSKI, A. (1954). The effect of ribonuclease on phage-host interaction. *J. gen. Microbiol.* **11**, 451.

For summary see no. 42.

103. LAST, F. T. (1954). The effect of time of application of nitrogenous fertilizer on powdery mildew of winter wheat. *Ann. appl. Biol.* **41**, 381.

Applying nitrogenous fertilizer (N) to wheat plants of different ages affected the incidence of powdery mildew, *Erysiphe graminis* DC, differently. When N was applied before the flag leaf had emerged, the infection-index (number of pustules per 100 sq. cm. of leaf blade) increased to a maximum and then declined. If N was applied after the flag leaf had emerged, the infection-index increased steadily without reaching a peak, and the increased susceptibility was not associated with an increased relative growth rate as when N was applied earlier.

The integral of the number of pustules per unit area with time, and the number of perithecia on the leaves of the main stem, both increased with increasing delay in the application of N. Plants given N in either April or May had at least three times as many pustules as those given N in January. The time when N was applied did not affect the date when perithecia appeared.

After adding N to nitrogen-deficient plants, the already mature leaves which had resisted mildew infection became susceptible. This change is not associated with changes in the epidermal wall.

104. LAST, F. T. (1955). The seasonal incidence of *Sporobolomyces roseus* Kl. et v.N. on cereal leaves. *Trans. Brit. mycol. Soc.* **38**. (In the press.)

The numbers of *Sporobolomyces roseus* Kl. et v.N. colonies developing on leaves of three crops (winter- and spring-sown wheat and spring-sown barley) were estimated by sampling at 14-day intervals, using a technique that selects fungi that grow on artificial media and whose spores are forcibly discharged.

After the internodes elongated and the crops became dense, the changes in numbers of *S. roseus* were similar in all three crops; leaves produced few colonies until they had lived half their lives, when the number of colonies progressively increased, to reach a maximum after the leaves died. Before the internodes elongated and the crop was still sparse, winter-sown wheat also produced colonies on still-living leaves, but in spring-sown wheat and barley colonies occurred in still-sparse crops only on dead leaves.

Dead leaves in summer had three times as many colonies per unit area as dead leaves in winter. The upper and lower surfaces of ageing leaves carried equal numbers of colonies, but the distal parts carried more than the proximal. The number of colonies seemed to be correlated with a high humidity that enables *S. roseus* to spread, and, perhaps, with exudations from ageing leaves of substances that encourage its growth.

The occurrence of *S. roseus* colonies seemed not to influence the develop-

ment of leaf parasites or to be influenced by them, but *Tilletiopsis minor* Nyland, another innocuous fungus that occurred only in July and August, greatly decreased the number of colonies, particularly on the spring-sown barley. In addition to these two species, *Cladosporium* spp. were regularly isolated from dead leaves, more abundantly during summer than winter, and *Bullera alba* (Hanna) Derx sporadically. It is suggested that, as with roots and the "rhizosphere", leaves have a "phyllosphere", with a characteristic micro-flora that may contain many species.

105. LAST, F. T. (1955). Effect of powdery mildew on the yield of spring-sown barley. *Plant Path.* **4**, 22.

Spraying five times with lime sulphur did not affect the yield of the variety Haisa II, which resisted *Erysiphe graminis* DC, but much increased yields of the susceptible variety Plumage Archer. Mildew decreased the yield of Plumage Archer sown on 22 March by 13 per cent, on 5 April by 22 per cent.

106. NIXON, H. L. & SAMPSON, JOAN (1954). A study of healthy and virus-infected plant cells by thin-section methods. *Proc. int. Conf. Electron Microscopy, London.* (In the press.)

Electron microscopy of very thin sections was used to study changes when tobacco-leaf parenchyma cells became infected with tobacco mosaic virus. The little change detectable in early stages of infection probably reflects the small proportion of cells invaded. The chloroplasts of infected cells show characteristic changes, the regular layered structure of the grana being replaced by granular vacuolate material. The size of the granules corresponds to that of cross-sectioned rods of the virus, and the cut surfaces, when shadowed, resemble the shadowed cut surfaces of intracellular inclusion bodies.

When chloroplasts extracted from infected leaves are digested with trypsin, rod-shaped virus particles are liberated in small amounts. The virus liberated by trypsin may correspond to the granular material filling the damaged chloroplasts.

COOKE, G. W. & NIXON, H. L. The value of sewage sludge ashes as phosphorus fertilizers. *J. Sci. Fd Agric.* (In the press.)

For summary see no. 27.

Nematology Department

GENERAL PAPERS

107. DONCASTER, C. C. (1954). Nematology and eelworm pests in agriculture and horticulture. *Biology*, **20**, 17.
108. PETERS, B. G. (1954). Control of plant nematodes. *Rep. Progr. appl. Chem.* **38**, 629.

RESEARCH PAPER

109. (LONDSBERY, B. F.) & PETERS, B. G. (1954). The relation of the tobacco cyst nematode to tobacco growth. (Abstract of meeting.) *Phytopathology*, **44**, 497.

When tobacco plants were grown in pots of soil artificially infested with cysts of *Heterodera tabacum* at four densities from 50 to 3,200 larvae/g. of soil, it was found that heights at various dates and final weights of the plants were inversely proportional to log density. Thus, in normally fertilized plants, every ten-fold increase in density led to a weight loss of 139 g. The highest density to maintain itself at the end of the experiment was about 1,000 larvae/g. In a field experiment where the natural density had been reduced on some plots by prior injection of DD mixture, a broadly similar relation between height and log density was found, but here the DD led to such complicating effects as an increase in soil ammonia N at the expense of nitric N.

Insecticides and Fungicides Department

GENERAL PAPERS

110. POTTER, C. (1953). The mechanism of action of insecticides. *3rd int. Congr. Phytopharm. Paris, 1952.* **1**, no. spéc.
111. WAY, M. J. (1954). A problem of insecticides and biological control in East Africa. *Colston Pap.* **6**. (Proc. 6th Symp. Colston Research Soc., Bristol, 1953.)

RESEARCH PAPERS

112. ELLIOTT, M. (1954). Allethrin. *J. Sci. Fd Agric.* **5**, 505.

Synthetic work leading to the commercial preparation of allethrin (the ester of (\pm) -*cis-trans*-3-isobutenyl-2:2-dimethylcyclopropane-1-carboxylic acid [(\pm) -*cis-trans*-chrysanthemic acid] with (\pm) -2-allyl-3-methylcyclopent-2-en-4-ol-1-one [(\pm) -allethrolone]) is reviewed briefly. The relative insecticidal activity and abundance of the eight isomeric esters present in allethrin are deduced, and the most effective is shown to be (+)-allethronyl (+)-*trans*-chrysanthemate. The effect of various changes in the molecule of allethrin on insecticidal activity is described. The biological action of allethrin appears to be of a similar nature to that of the natural pyrethrins, and is associated with the particular stereochemical conformation in which the various parts of the molecule are held with respect to each other and with the chemical and physical properties of the groups so positioned. Although allethrin is inferior to the natural pyrethrins against most species of insects and by most methods of application, it is highly biologically active and, unlike many modern synthetic insecticides, has, so far, been found harmless to mammals.

113. GLYNNE JONES, G. D. & CONNELL, J. U. (1954). Studies of the toxicity to worker honeybees (*Apis mellifera* L.) of certain chemicals used in plant protection. *Ann. appl. Biol.* **41**, 271.

Laboratory techniques are described for the estimation of the stomach poison, direct and residual film contact poison and fumigant poison effects of chemicals to adult worker honeybees.

The toxicity of eleven chemicals used in plant protection has been investigated by these methods. The order of effectiveness as stomach and contact poisons was: parathion, TEPP, γ -BHC, dieldrin, aldrin, chlordane, *o, o*-diethyl-*o*-ethylmercaptoethyl thiophosphate (constituent of "Systox"), bisdimethylamino fluorophosphine oxide, toxaphene and the sodium salts of 2:4-D and MCPA: as residual films, dieldrin, aldrin, γ -BHC, parathion, chlordane and *o, o*-diethyl-*o*-ethylmercaptoethyl thiophosphate (constituent of "Systox"); toxaphene, TEPP and bisdimethylamino fluorophosphine oxide had no measurable effect; as fumigants, dieldrin, γ -BHC, aldrin, parathion and chlordane; the remainder had no measurable effect.

114. (KALMUS, H.), KERRIDGE, J. & TATTERSFIELD, F. (1954). Occurrence of susceptibility to carbon dioxide in *Drosophila melanogaster* from different countries. *Nature, Lond.* **173**, 1101.

Until recently, all virus-induced susceptibility to carbon dioxide of *Drosophila melanogaster* seemed derived from one stock, and repeated search for another occurrence in many laboratory stocks remained unavailing. Some years ago, one of us (F. T.) discovered that *D. melanogaster* flies, recently trapped in the neighbourhood of Rothamsted Experimental Station, Harpenden, Herts., showed the characteristic hereditary carbon dioxide susceptibility, but as the other of us (H. K.) had kept at Rothamsted a few years earlier a substrain of L'Héritier's original stock, it was impossible to be sure that an escape was not responsible. However, a recent report has made it clear that carbon dioxide-susceptible flies, far from being rare, occurred in about one-third of all freshly trapped strains of *D. melanogaster* in France. In addition, we are indebted to a personal communication from Prof. L'Héritier, in which he states that he found susceptible flies in cultures from Israel but could not detect the susceptibility in flies from Africa or Japan.

In our own investigation, single flies trapped by ourselves, their offspring

or flies supplied by other institutions were bred in vials at 24° C. and tested about 1 week after emergence. *D. melanogaster* is often transported with fruit, and the place of trapping need not necessarily be the place of origin.

Our results show that carbon dioxide susceptibility occurs widely, but that flies from the same locality may sometimes be carbon dioxide-susceptible and sometimes carbon dioxide-resistant. The virus responsible for the susceptibility seems to be lost more or less quickly under laboratory conditions, which probably accounts for the fact that the susceptibility has not been rediscovered before.

The great differences among the resistant females from different strains in the rates of infection by susceptible males are probably due to some genetical and cytoplasmic properties of these strains, but it is at present difficult to correlate these with any environmental factor.

It should be mentioned that two trapped strains, which were shown by crossing to be *D. simulans*, were not susceptible.

115. KERR, R. W. (1954). Rearing *Drosophila melanogaster* Mg. for insecticide investigations. *Bull. ent. Res.* **45**, 313.

A method is described for rearing *Drosophila melanogaster* Mg., which provides a high and consistent yield of adult flies, of uniform age and size, for insecticide studies.

116. KERR, R. W. (1954). A method for the topical application of small measured doses of insecticide solutions to individual insects. *Bull. ent. Res.* **45**, 317.

A microburette made from glass capillary tubing is mounted on the mechanical stage of a microscope and filled with insecticide solution to a point at which the meniscus is in the field of the microscope. The magnified images of the meniscus and a calibrated micrometer scale in the eyepiece are projected on to a small screen mounted close to the tip of the microburette so that the scale and the insect being dosed can be seen simultaneously. This feature renders the apparatus particularly suitable for topical application work, in which accurate positioning of the dose on the insect is required. When an insect, held in a suction device described, is applied to the tip of the burette, the solution flows out unaided, and stops immediately the insect is removed. With the microburette described, doses from 0.005 to 0.035 μ l. can be dispensed to within ± 0.00035 μ l. The apparatus can be made to cover several other dosage ranges, either lower or higher, by simple modifications which are discussed.

117. KERR, R. W. (1954). Variation with age in the susceptibility to DDT and the respiration rate of male and female *Drosophila melanogaster* Mg. *Bull. ent. Res.* **45**, 323.

DDT in odourless distillate was topically applied to individual males and females of the Rothamsted wild type of *Drosophila melanogaster* Mg. The lines for the regression of mortality in probits on log dosage of DDT for males and females, 5 days old, were parallel, and males were 1.86 times as susceptible as females. Susceptibility was high in young flies, but rapidly decreased with age, to a minimum at about 5 days, thereafter increasing rapidly in males and not significantly in females. The need for sexing and standardizing age in flies used for toxicological investigation was thus demonstrated.

Respiration rate in untreated flies was measured by a modified Barcroft method. In males it increased with age up to 5 days, and then decreased; in females it increased with age up to 9 days. Variations with age in respiration rate and susceptibility to DDT were negatively correlated.

118. LORD, K. A. & POTTER, C. (1954). Organo-phosphorus insecticides. Insecticidal and anti-esterase activity of organo-phosphorus compounds. *Chem. & Ind.* p. 1214.

All available data indicate that esterases differ from one species of insect to another, and therefore it seems arbitrary to assume the ubiquitous occurrence of acetyl choline and enzymes which hydrolyse it. There is no doubt that in many species of insects acetyl choline hydrolysing enzymes occur and

that they are inhibited by organo-phosphorus insecticides, but there are other esterases which do not hydrolyse acetyl choline and are more readily inhibited by organo-phosphorus insecticides *in vitro*. These other enzymes may sometimes play an important part in the insecticidal action of organo phosphorus compounds.

119. LORD, K. A. & POTTER, C. (1954). Differences in esterases from insect species: toxicity of organo-phosphorus compounds and *in vitro* anti-esterase activity. *J. Sci. Fd Agric.* **5**, 490.

Two types of esterase, the one capable of hydrolysing phenyl acetate and not acetyl-choline, the other able to hydrolyse acetylcholine, have been examined in adults of four species of insect—*Tenebrio molitor* L., *Tribolium castaneum* Hbst., *Dysdercus fasciatus* Sign. and *Blatella germanica* L.

The *in vitro* inhibition of both types of enzyme from each species has been examined with five organo-phosphorus compounds: tetra-ethyl pyrophosphate, paraoxon, parathion, OO-diethyl S-*p*-nitrophenyl phosphorothiolate and OS-diethyl O-*p*-nitrophenyl phosphorothiolate. Both types of esterase were inhibited by high dilutions of inhibitors. Susceptibility of both types of enzyme appeared to vary from species to species, and may provide a basis for specific differences in resistance to insecticides.

There is no consistent correlation between the toxicity of the compounds examined and the *in vitro* inhibition of either kind of esterase. Parathion did not inhibit any of the esterases. The other four substances were, in general, less potent inhibitors of the esterases that hydrolysed acetylcholine than those that did not. Therefore both types of esterase are worthy of further investigation, since there are insufficient data to decide which type of esterase is involved in the insecticidal action of organo-phosphorus compounds.

120. McINTOSH, A. H. (1954). Temperature coefficients of insect kill by volatile solid insecticides. *Bull. ent. Res.* **45**, 137.

Three volatile solid insecticides (DFDT, γ -BHC and aldrin) were tested against two species (*Oryzaephilus surinamensis* and *Tribolium castaneum*) at two temperatures (30° and 11° C.) in simple laboratory fumigation tests. DFDT killed both species faster at 11° than 30° C.; γ -BHC killed *O. surinamensis* faster at 11° than 30° C., but *T. castaneum* faster at 30° than 11° C.; aldrin killed both species faster at 30° than 11° C.

121. POTTER, C., HEALY, M. J. & FEUELL, A. J. (1954). A comparison of the chemical and biological assays of several strains of pyrethrum flowers. *Colon. Pl. Anim. Prod.* **4**, 59.

The collaborative experiment as a whole seems unsatisfactory because of the lack of clear-cut results, and because of some results which are conflicting.

Both the biological and chemical results show that the sample of C47 strain has marked disadvantages when compared with the samples of Mweiga and C1 strains.

The C47 sample appears more specific in action than the other two strains. While no major differences in toxicity appear with houseflies, it appears to be markedly inferior against some other species.

The rate of deterioration of flowers on storage is much greater with the C47 sample than with the other two, although a considerable amount of deterioration occurred with the C1 strain. There is some biological evidence to show that the deterioration is greater and certainly not less than the chemical figures indicate, and it seems that this strain may not easily be susceptible to the current methods of analysis.

It must be recognized that all these remarks apply only to the samples tested. The flowers from the so-called strains C1 and C47 are, in fact, taken from plants grown from the seed produced from crosses between two clones. These plants have a very large individual variation, and there is therefore a great liability to sampling error. Some figures are available for C47 which indicate that variations in the ratio of the pyrethrins do, in fact, occur with different samples.

However, the figures are enough to show that the C47 cross is not satisfactory as it stands, and that any strain that is subsequently developed should be carefully examined, both biologically and chemically, before going into production.

122. WAY, M. J. (1954). The effect of body weight on the resistance to insecticides of the last-instar larva of *Diataraxia oleracea* L., the tomato moth. *Ann. appl. Biol.* **41**, 77.

At a constant temperature of 24° C. the final larval instar of *Diataraxia oleracea* lasts about 10 days, during which its resistance to DDT and γ -BHC as contact insecticides progressively increases up to the 5th or 6th day. It then suddenly decreases, this coinciding with cessation of feeding and the beginning of prepupal formation.

Between the 2nd and the 6th days the gross body weight of the last-instar larva increases from about 0.27 to 0.65 g. Under the conditions of the experiments, the LD50 of parathion, as a stomach poison, was linearly related to body weight; on the same basis TEPP was slightly less, and lead arsenate, slightly more, toxic to the larger than to the smaller larvae. However, DDT as a stomach or contact insecticide, and γ -BHC as a stomach poison were notably less toxic to the larger larvae. For example, the increase in LD50 for an increase in larval body weight of $\times 2$ was about $\times 11$ for DDT as a stomach poison and about $\times 12$ as a contact insecticide.

The order of effectiveness of the above insecticides as stomach poisons for the last-instar larva of *D. oleracea* was parathion > DDT > γ -BHC > TEPP = lead arsenate. Zinc fluoarsenate and rotenone were relatively non-toxic. Larvae of *D. oleracea* were repelled by food leaf treated with an extract of natural pyrethrins.

123. WAY, M. J. (1953). Studies on *Theraptus* sp. (Coreidae); the cause of the gumming disease of coconuts in East Africa. *Bull. ent. Res.* **44**, 657.

Theraptus sp. is widespread in the coastal region of British East Africa, where it severely damages developing coconut fruits.

The female may lay over 100 eggs. There are five nymphal instars and, in the field, it is probable that about nine generations are produced each year.

Damage to coconuts is similar to that caused by *Amblypelta cocophaga* China in the Solomon Islands. Female coconut flowers and young nuts may be destroyed by a single feeding puncture. Damaged 10–16-week-old nuts may reach maturity, but are undersized and often distorted by lesions from which gummy material exudes.

Over 70 per cent of 5–10-week-old nuts may fall "naturally"; thus *Theraptus* damages many nuts which would fall in any case. However, after natural nut-fall has ceased, the pest becomes concentrated on the few remaining nuts, which are susceptible to damage for about 4 weeks more. One *Theraptus* may make over 200 feeding punctures in its lifetime. Consequently, a population density of less than two per palm may cause severe damage.

Palms bearing many female flowers per spadix suffer more severely from attack than those bearing few, although normally they give higher nut yields.

124. WAY, M. J. (1953). The relationship between certain ant species with particular reference to biological control of the Coreid, *Theraptus* sp. *Bull. ent. Res.* **44**, 669.

In the coastal region of British East Africa three ant species, *Anoplolepis custodiens*, *A. longipes* and *Pheidole punctulata*, may destroy the ant *Oecophylla longinoda*, which is a valuable predator on the coconut pest *Theraptus* sp. (Coreidae). The three first-named species do not prey on *Theraptus*, which may severely damage palms occupied by them.

Nesting habits of the three ants species and their behaviour towards *O. longinoda* and certain other insects are described.

O. longinoda has been exterminated in the limited areas occupied by the two *Anoplolepis* species. *P. punctulata* is widespread, and is usually common in areas occupied by *O. longinoda*, and is also present, though relatively less common, in *A. longipes* areas.

The distribution of the *Anoplolepis* species, particularly *A. custodiens*, is correlated with sandy soils bearing a sparse ground vegetation. Where there are heavy soils or a thick ground vegetation of grasses and creepers the *Anoplolepis* species are absent and *O. longinoda* is usually present. It is suggested that the *Anoplolepis* species are limited by the relatively low temperature of soils shaded from sunlight by thick vegetation.

P. punctulata is not limited by thick ground vegetation, but, under these

conditions, *O. longinoda* is also abundant; probably adequate food is available in ground vegetation for *P. punctulata*, which thus does not compete for it with *O. longinoda* in the crown of coconut palms and other trees.

Cultural and chemical methods of controlling the harmful ant species are mentioned.

125. WAY, M. J. (1954). Studies of the life history and ecology of the ant *Oecophylla longinoda* Latreille. *Bull. ent. Res.* **45**, 93.

In British East Africa *Oecophylla longinoda* (Latr.) var. *textor* Santschi is locally common in the coastal region. Inland it is absent from higher altitudes and from areas where there is a pronounced dry season.

In Zanzibar Island *O. longinoda* colonizes at least eighty-nine species of trees and shrubs; the largest populations occur on the clove (*Jambosa caryophyllus*), *Citrus* spp., *Bridelia micrantha* and *Canthium zanzibaricum*.

The nesting habits and colony composition of *O. longinoda* are such that one colony may spread over a number of adjacent trees; it contains only one gravid queen.

Winged virgin sexual forms are released at the beginning of the wet seasons, and new colonies are initiated by a single queen, who uses her food reserves to bring the first batch of brood to maturity.

In Zanzibar *O. longinoda* tends a wide range of Homoptera that produce honey-dew, but apparently "prefers" certain Coccids, notably *Saissetia* spp.

The degree of attention afforded by an ant species determines the species of Homoptera which it is able to attend.

The insect species preyed upon by *O. longinoda* include the honeybee, *Apis mellifera*, and the driver ant, *Dorylus nigricans*, of which large numbers may be destroyed.

O. longinoda is of undoubted value for controlling certain coconut pests, notably *Theraptus* sp. (Coreidae), and its efficiency in coconut plantations could probably be much enhanced.

126. WAY, M. J. (1954). Studies on the association of the ant *Oecophylla longinoda* (Latr.) (Formicidae) with the scale insect *Saissetia zanzibarensis* Williams (Coccidae). *Bull. ent. Res.* **45**, 113.

A close association exists between the ant *Oecophylla longinoda* (Latr.) and the scale insect *Saissetia zanzibarensis* Williams.

Several factors cause the scale to be rare in the absence of the ant. Contamination by honey-dew and sooty moulds prevents increase of the *S. zanzibarensis* population above a relatively low level, while, in addition, insect parasites and probably predators virtually exterminate the scale. A fungal parasite may destroy honey-dew-contaminated *S. zanzibarensis* under humid conditions.

The attendant *O. longinoda* prevents contamination of the scale by honey-dew. It gives absolute protection from Coccinellid predators and, although parasitism by *Coccophagus* spp. and predation by *Eublemma* spp. is not prevented, the mortality of *S. zanzibarensis* which they cause is thought to be of little significance.

O. longinoda workers benefit *S. zanzibarensis* in other ways. They remove debris from the scale clusters; they transport the nymphs and establish them at suitable feeding sites. The effect of these benefits is most marked when the ant population is high relative to that of the scale.

The silken shelters built by *O. longinoda* over *S. zanzibarensis* clusters protect the ant during adverse weather, and may only incidentally benefit the scales.

S. zanzibarensis and other honey-dew-producing Homoptera are the major food source for *O. longinoda*. Other sources are sufficient to maintain only relatively low populations of the ant.

The level of the *S. zanzibarensis* population depends on the level of the attendant *O. longinoda* population. Scales providing honey-dew in excess of the requirements of an ant colony are killed.

The *O. longinoda* worker shows two distinct patterns of behaviour towards *S. zanzibarensis*. When it is not being attracted by the desire for honey-dew its behaviour resembles that adopted towards insects on which it normally preys.

127. WAY, M. J., SMITH, P. M. & POTTER, C. (1954). Studies on the bean aphid (*Aphis fabae* Scop.) and its control on field beans. *Ann. appl. Biol.* **41**, 117.

Field trials on chemical control of *Aphis fabae* Scop. attacking spring-sown field beans were carried out during the years 1950-52. The insecticide sprays were applied once only, soon after primary aphid migration into the bean crop had ceased. Destruction of the few aphids present at this early date stops build-up of the big populations that often develop later.

An 0.2 per cent (w/v) parathion spray was used in all three field trials. This gave excellent control of *A. fabae*, as did the systemic insecticides "Isopestox" and "Systox" at 0.05 per cent (w/v) active ingredient, and nicotine at 0.1 per cent (w/v). Sprays containing allethrin (0.05 per cent (w/v) pure material), pyrethrins (0.05 per cent and 0.02 per cent (w/v) total pyrethrins plus piperonyl butoxide) and an 0.1 (w/v) DDT emulsion gave moderate control. *A. fabae* was not controlled in plots treated with an 0.1 per cent (w/v) DDT crystalline suspension, and the aphid population reached a higher peak than in the untreated plots; the suspension is not only relatively ineffective against the aphid, but is more toxic than the DDT emulsion to its Coccinellid predators.

On the bean plant the 0.05 per cent (w/v) "Systox" spray showed some residual toxicity to *A. fabae* for at least 5 days after application, but stopped causing 100 per cent kill within 24 hours. 0.02 per cent (w/v) parathion and 0.1 (w/v) DDT emulsion had slight, and 0.02 per cent (w/v) pyrethrins and 0.1 per cent (v/v) nicotine, no residual toxicity.

In the year 1950 aphid attack on the field plots was slight and damage insignificant. In 1951 there was a moderate attack, and the yield of bean seed was significantly increased by all insecticidal treatments; where aphid control was most efficient (parathion and "Isopestox" treatments) the yield (16.7-17.1 cwt./acre) was about $\times 2.7$ that of the untreated control (6.3 cwt./acre). In 1952 there was severe aphid attack, and the mean seed yield of the untreated control plots was 1.4 cwt./acre. Plots treated with the DDT suspension yielded 1.3 cwt. seed/acre, but all other insecticides, including the DDT emulsion, increased the seed yield to 10.3-14.8 cwt./acre.

All preparations used in 1952, except nicotine, were destructive to adult Coccinellid predators of *A. fabae*; *Adalia bipunctata* was more susceptible than *Coccinella septempunctata*. However, in 1952 predators on the experimental area were too uncommon to be economically important.

Entomology Department

128. BANKS, C. J. (1954). A method for estimating populations and counting large numbers of *Aphis fabae* Scop. *Bull. ent. Res.* **45** (4), 751.
- 128a. BANKS, C. J. (1954). Random and non-random distributions of Coccinellidae. *J. Soc. Brit. Ent.* **4** (9), 211.
129. BARNES, H. F. (1953). Investigations into the gall midges of *Chrysanthemum* flowers. *Entomologist*, **86**, 292.

Of the seven gall midges that live in the flowers of wild Ox-eye Daisy (*Chrysanthemum leucanthemum*), four are primary and may do damage, one lives as an inquiline, one is predaceous on the larvae of other gall midges and one is predaceous on aphids that occur in the flowers. One of the primary species has already become a pest on cultivated chrysanthemums (Esther Read variety of *C. maximum*) and can breed also on *C. carinatum* and *C. frutescens*. Another primary species can develop on Esther Read, but has not yet been recorded on commercial crops. A provisional host-plant range list of all these gall midges is given.

130. BARNES, H. F. (1954). The study of gall midges at Rothamsted. *Marcellia*, **30**, Suppl., p. 15.

An account of how far the aims and objects of the gall-midge section of the Entomology Department have been accomplished, in building up an international collection and library while carrying out long- and short-term biological researches, particularly on fluctuations in numbers and host-plant range, as well as providing facilities for training other workers.

131. BARNES, H. F. (1954). Gall midge larvae as endoparasites, including the description of a new species parasitizing aphids in Trinidad, B.W.I. *Bull. ent. Res.* **45**, 769.

A review of the available information indicating the present locations of the type and other material. *Pseudendaphis maculans* gen. et sp. n. is described as an internal parasite of aphids, especially *Toxoptera aurantii* Boyer.

132. BARNES, H. F. (1954). Gall midges living in White Clover flowers. *Entomologist*, **87**, 258.

Preliminary information on the biology and distribution in England and Wales of *Brachyneura* sp., *Dasyneura* sp., *Lestodiplosis* sp. and *Clinodiplosis* sp. in White Clover flowers, as well as of *Dasyneura* sp., *Lestodiplosis* sp., *Clinodiplosis* sp. and *Hadrobrema* sp. in Red Clover flowers. The White Clover *Dasyneura* will intermate with a Red Clover *Dasyneura* and will breed in Red Clover flowers.

133. BARNES, H. F. (1954). A new species of *Trotteria* Kieffer (Cecidomyiidae) reared from unopened flower-buds of Privet (*Ligustrum vulgare* L.). *Ent. Rec.* **66** (12), 281.

The description of *Trotteria ligustri* sp. n. from Norfolk, with a discussion of the possible larval feeding habits of the known *Trotteria* species.

134. BARNES, H. F. (1954). The Sorghum Midge problem. *Rep. 6th Comm. ent. Conf.* p. 101.

An exposition of the importance of gall midges, especially the Sorghum Midge, in the production of Sorghum throughout the world.

135. BARNES, H. F. (1954). Memorandum on the gall midges living on the Sorghums, The Panicum Millets and Rice. *Rep. 6th Comm. ent. Conf.*, Appendix B, 155.

The available information, published and previously unpublished.

136. BARNES, H. F. & NAYAR, K. K. (1954). The Black Medick or "Trefoil" Gall Midge. *Plant Path.* **3** (2), 51.

Dasyneura lupulinae Kieffer has three generations a year on *Medicago lupulina*. It has not been possible to make it breed on Lucerne (*Medicago sativa*).

137. BARNES, H. F. & (NIJVELDT, W.) (1954). A new gall midge, *Coccomyza leefmansi* sp. n., predaceous on the eggs of *Pulvinaria polygonata* in Indonesia. *Ent. Ber.* **15**, 91.

138. DOBSON, R. M. (1954). A new species of *Carpophilus* Stephens (Col., Nitidulidae) found on stored produce. *Ent. mon. Mag.* **90**, 299.

Carpophilus halli, a new species found on stored produce, is described. The aedeagus of the male is figured, and a table enabling the new species to be distinguished from the closely related *C. dimidiatus* (F.) and *C. mutilatus* Er. is given.

139. DOBSON, R. M. (1954). The species of *Carpophilus* Stephens (Col., Nitidulidae) associated with stored products. *Bull. ent. Res.* **45**, 389.

A key to most of the species of *Carpophilus* associated with stored produce is given, several species are redescribed, and new taxonomic characters are introduced and illustrated. Recent importations of the species into Britain are summarized.

140. DOBSON, R. M. (1954). A note on the anatomy and morphology of the external genitalia of *Carpophilus obsoletus* Er. (Col., Nitidulidae). *Proc. R. ent. Soc. Lond. (A)*, **29**, 45.

The external genital organs of both sexes of the species are described and figured, and the nomenclature of the various parts is discussed.

T. ampliata is *C. arvensis*. An account is also given of the colonization of thistle plants in the spring and the population during oviposition as shown by a marking and recapture experiment, of a Mymarid egg parasite, of the immature stages and their structure and of the presence of surface wax in the adults. A key to the larvae and the maps of world distribution of both species are included.

153. (LESTON, D., PENDERGRAST, J. G.) & SOUTHWOOD, T. R. E. (1954). Classification of the terrestrial Heteroptera (Geocorisae). *Nature, Lond.* **174**, 91.

The division of the Geocorisae into two main groups, the Pentomomorpha and the Cimicomorpha, is proposed as a result of studies of male genitalia; wing venation, spermatheca, eggs, salivary glands and other structures.

154. (LESTON, D.) & SOUTHWOOD, T. R. E. (1954). The structure of the egg and egg-burster of *Sehirus bicolor* (L.) (Hem., Cydnidae). *Ent. mon. Mag.* **90**, 291.

155. STOKES, B. M. (1955). Host plants of Wheat Bulb Fly. *Plant Path.* (In the press.)

Experiments carried out with grasses and cereals showed that wheat bulb fly (*Leptohylemyia coarctata* Fall.) could develop from newly-hatched larvae to maturity on at least thirteen different plant species, of which eight were not previously suspected. Evidence was obtained that a number of other grasses may also be host plants.

156. TAYLOR, L. R. (1955) (with an appendix by W. S. Coleman). The standardization of air-flow in insect suction traps. *Ann. appl. Biol.* (In the press.)

The amount of air sampled and its possible variation in field conditions has been measured for all the six types of trap available in the department; estimates of insect density obtained in different times and places by the same or by different types of suction traps can, therefore, now be compared. This information is presented in tabular form with a brief analysis of fan and trap construction in relation to variability of air-flow.

157. TAYLOR, L. R. & (KALMUS, H.) (1954). Dawn and dusk flight of *Drosophila subobscura* Collin. *Nature, Lond.* **174**, 221.

The strictly bi-diurnal activity of *D. subobscura*, hitherto known only as a feeding reaction to bait, was shown by suction trapping to exist normally as a flight periodicity in a natural population. It was suggested that the periodicity reflected an optical adaptation to dim light.

158. WESTMACOTT, M. H. & WILLIAMS, C. B. (1954). A migration of Lepidoptera and Diptera in Nepal. *Entomologist*, **87**, 232.

An account of a migration of four species of butterflies and two species of Diptera in Nepal in March 1953, with comments on other similar Indian records.

159. WILLIAMS, C. B. (1954). Some bioclimatic observations in the Egyptian Desert. *Proceedings of Institute of Biology Symposium on "Biology of Hot and Cold Deserts"*, pp. 18-27.

A summary of microclimatic observations made in the desert near Cairo in 1923-24, chiefly demonstrating the range of temperatures and humidities available within a short distance to an animal capable of movement.

160. WILLIAMS, C. B. (1954). Notes on a small collection of Sphingidae from Nigeria. *Niger. Fld.* **19** (4), 176.

A collection of sixty-five individuals belonging to nineteen different species was made in a light trap during April 1953. The species and relative frequency are discussed from the point of view of migration and of population balance.

161. WILLIAMS, C. B. (1954). Notes on some migrations of butterflies in West Africa. *Entomologist*, **87**, 203.

A brief account of observations on migrations, chiefly of *Libythea labdacca* Westw., seen during a visit in April 1953 or reported by local naturalists.

162. WILLIAMS, C. B. (1954). Phenology—the Study of the Seasons. Presidential Address to Section X of the British Association. *Advanc. Sci.* **11** (43), 267.

A discussion of the co-operation of amateur and professional naturalists chiefly as illustrated by work on the phenology of plants, birds and insects.

163. WILLIAMS, C. B., FRENCH, R. A. & HOSNI, M. M. (1955). A second experiment in testing the efficiency of insect traps. *Bull. ent. Res.* (In the press.)

An account of a comparison of two types of light-traps and two types of illumination, in an experiment which enabled us to separate the effects of position, night, trap and light, and also the previous night's trapping, in different groups of insects.

Bee Department

GENERAL PAPERS

164. BAILEY, L. (1954). Nosema disease. *Bee World*, **35**, 69.

165. BAILEY, L. (1954). Bee poisoning. *Bee World*, **35**, 221.

166. BUTLER, C. G. (1954). The importance of "queen substance" in the life of a honeybee colony. *Bee World*, **35**, 169.

167. BUTLER, C. G. (1954). Some observations relating to queen introduction. *Rep. cent. Ass. Brit. Beekeep. Ass.*

168. RIBBANDS, C. R. (1953). New evidence concerning the "language" of honeybees. *Advanc. Sci., Lond.* **10**, 24.

169. RIBBANDS, C. R. (1955). The scent language of honeybees. *Discovery*, **16**, 22.

RESEARCH PAPERS

170. BAILEY, L. (1954). The control of Nosema disease. *Bee World*, **35**, 111.

The results of final experiments on the effect of transferring colonies on to clean comb are given. The disease was eliminated when bees were transferred on to clean comb and were allowed to recover their brood and stores from the old comb before the latter was removed. Methods and results of sterilizing old comb with acetic acid and formalin are given.

171. BAILEY, L. (1954). The filtration of particles by the proventriculi of various aculeate Hymenoptera. *Proc. Roy. ent. Soc.* **29**, 119.

The correlation between the anatomy of the proventriculi of various hymenoptera and their efficiency in filtering particles from liquid suspension in the crop is described. The physiological significance of this function is discussed.

172. BAILEY, L. (1954). The respiratory currents in the tracheal system of the adult honeybee. *J. exp. Biol.* **31**, 589.

The inactive bee inhales and exhales via the first thoracic spiracle. In air containing a high concentration of CO₂ the propodeal spiracle becomes active and its opening movements are synchronous with abdominal pumping. Under these conditions there is a marked current of air through the thorax, entering via the first thoracic spiracle and leaving via the propodeal spiracle.

173. BUTLER, C. G. (1954). The method and importance of the recognition by a colony of Honeybees (*A. mellifera*) of the presence of its queen. *Trans. R. ent. Soc. Lond.* **105**, 11.

Data are given in support of the theory that bees normally obtain something from their queens which inhibits them from rearing further queens. The results of experiments and observations indicate that a small number of the worker bees of a colony obtain this "queen substance" by licking all parts of the body surface of their queen, and subsequently share it with the other members of their colony. An adequate supply of "queen substance" inhibits worker ovary development as well as the production of new queens. It is suggested that in ants, bees and termites the collection and distribution of "queen substance" is the most important single factor in the maintenance of colony cohesion.

174. FREE, J. B. (1954). The behaviour of robber honeybees. *Behaviour* **7**, 233.

It is shown that the characteristic, hesitant, swaying flight of robber bees is an innate response to the sight of a congestion of bees, either of their own or from another colony, near the entrance of the hive they wish to enter. When the entrance of a hive is not crowded with bees, robbers will enter without hesitation, even when the hive contains a colony of bees. It is concluded that guard bees quickly recognize would-be robber bees by their characteristic flight behaviour, and subsequently confirm their identity by olfactory examination.

175. RIBBANDS, C. R. (1954). Nitrous oxide anaesthesia does not encourage reorientation of honeybees. *Bee World*, **35**, 91.

Fully controlled experiments showed that anaesthesia with either "ammonium nitrate fumes" or nitrous oxide had no effect on reorientation. After carbon dioxide anaesthesia *more* bees returned to their original home. All the foragers from a nucleus which is taken from and placed near to its parent colony are likely to return to the latter, whether they have been anaesthetized or not; a variable proportion of the nucleus will consist of non-foragers, who are likely to remain in it.

176. RIBBANDS, C. R. (1954). The defence of the honeybee community. *Proc. Roy. Soc., B.* **142**, 154.

Pairs of colonies of differently coloured bees were placed with their entrances only 2 inches apart, and many bees tried to join the wrong colony, as if it were their own. Strangers were recognized by their different scent, and their reception varied according to foraging conditions. During "nectar flows" there was no hostility, and the bees of both colonies mingled indiscriminately. In fairly good conditions there was no hostility, but partial separation was maintained through the discrimination shown by incoming foragers. In dearth conditions, when bees try to rob other colonies, all strangers were received with hostility; most were thrown out, and many were killed. In dearth conditions marked foragers from one of the two colonies were fed with sugar syrup, but they were nevertheless repelled when they tried to enter the hive of the unfed colony; on the other hand, unfed strangers were more readily admitted into the fed colony. Thus hostility to strangers increased when forage was scarce; the condition of the community whose hive was to be entered was important, but the carriage of food by the intruder was not. These results are discussed in relation to defence of the community against both robber bees and strange queens.

177. SIMPSON, J. (1954). Effects of some anaesthetics on honeybees: nitrous oxide, carbon dioxide, ammonium nitrate smoker fumes. *Bee World*, **35**, 149.

Worker honeybees were apparently unaffected by atmospheric oxygen concentrations between 7 and 100 per cent, and only became motionless when the oxygen concentration was less than 2 per cent. The effects of nitrous oxide-oxygen mixtures differed little, if at all, from those of nitrogen-oxygen mixtures. Bees were not visibly affected by carbon dioxide concentrations up to 10-15 per cent, but became motionless if the concentration exceeded 40-45 per cent.

Fumes produced by adding ammonium nitrate to the burning fuel in a beekeeper's smoker were found to contain hydrogen cyanide or cyanogen. Their effectiveness as an anaesthetic may be due to this or to some unidentified component, but not to nitrous oxide. All these anaesthetics caused foraging bees to stop collecting pollen and accelerated the retrogression of the pharyngeal glands of young bees. The conclusion is reached that these anaesthetics do not encourage reorientation to a new hive site.

Statistics Department

RESEARCH PAPERS

178. CHURCH, B. M. (1955). Problems of sample allocation and estimation in an agricultural survey. *J. R. statist. Soc., B.* (In the press.)

A sampling method which has been used in fertilizer surveys in England and Wales is described. The relative efficiencies and biases of several methods of estimating average fertilizer dressings are determined from the results of eight surveys carried out in 1950. The unbiased method of estimation is found to be 65 per cent efficient relative to the unweighted mean of the field observations; this latter method is only slightly biased. An alternative method of estimation, eliminating any gross bias which might occur in the unweighted mean, has a relative efficiency of 90 per cent.

179. CHURCH, B. M. & (STRICKLAND, A. H.). (1954). Sampling cabbage aphid populations on Brussels sprouts. *Plant Path.* **3**, 76.

The limitations of visual methods of assessing cabbage aphid density in the field are discussed. The technique of "three-leaf sampling" is described. Results obtained by laboratory counting of such samples are presented and the sampling errors examined. The method is shown to be much more efficient than the counting of aphid populations on whole plants. Attention is drawn to the problem of how intensively to sample individual Brussels sprout fields if an estimate of average aphid density is required for a whole sprout-growing area or region.

180. GRUNDY, P. M., HEALY, M. J. R. & REES, D. H. (1954). Decision between two alternatives—how many experiments? *Biometrics*, **10**, 317.

When a new process is suggested for use in agriculture or technology it is usually necessary to carry out experiments to estimate the increase in output that would result if the new process replaced that in current use. If the cost of experimentation and the scale of potential application of the new process are known, one method of arriving at an optimum amount of experimentation is to minimize the total risk given by the sum of the cost of the experiment plus the expected loss due to wrong decisions. The main difficulty is that the last quantity depends on the true increase in output due to introducing the new treatment, which can only be estimated from the results of the experiments. The paper discusses the case where an initial experiment is carried out, and it is required to decide whether to accept or reject the new treatment at once or else to carry out further experimentation. In the latter case the optimum amount of further experimentation has also to be decided. A solution is provided by minimizing the risk after eliminating the unknown parameter by averaging over its fiducial distribution based on the evidence from the initial experiment. Means for applying the resulting decision rule in practice are provided, and its performance under various circumstances is discussed.

181. GRUNDY, P. M. (1955). A method of sampling with probability exactly proportional to size. *J. R. statist. Soc., B.* (In the press.)

A practical method of drawing sampling units with probabilities exactly proportional to size is described, in which both preliminary calculations and the addition of a large number of sizes are avoided.

182. HEALY, M. J. R. (1955). Statistical techniques for inspection sampling. *Trop. Agriculture, Trin.* **32**, 10.

An expository article describing methods of fixing sample sizes in single, double and sequential sampling schemes.

183. (BOOTH, V. H., COATES, N. E., COX, C. P., THOMPSON, S. Y.) & HEALY, M. J. R. (1954). Stability of caroten from dried grass meal and synthetic vitamin D₃ in chick mash. *J. Sci. Fd Agric.* (In the press.)

184. (EDWARDS, D. A. W., HAMMOND, W. H.) & HEALY, M. J. R. (1955). Design and accuracy of calipers for measuring subcutaneous tissue thickness. *Brit. J. Nutr.* (In the press.)

This paper describes a series of experiments carried out at the request of the Medical Research Council Committee on Growth and Form, aimed at improving and standardizing the design of calipers used for measuring skinfolds. These measurements are becoming widely used as an assessment of body fat in many branches of human biology. The results of the experiments led to the laying down of a set of requirements for skinfold caliper design to ensure the best possible consistency between repeated measurements of the same fold. A new design of caliper fulfilling these requirements was introduced, and gave results markedly superior to most types of caliper in current use. A second set of experiments is described, in which the characteristics of the new type of caliper were assessed.

(POTTER, C.), HEALY, M. J. R. & (FEUELL, A. J.). (1954). A comparison of the chemical and biological assays of several strains of pyrethrum flowers. *Colon. Pl. Anim. Prod.* **4**, 59.

For summary see no. 121.

185. LEECH, F. B., (EGDELL, J. W., HESKIN, P. & THOMAS, S. B.). (1955). Methods of milk production: some results of a survey in four areas of England and Wales. *J. agric. Sci.* (In the press.)

Methods, buildings and equipment used for milk production in Caernarvonshire, Hertfordshire, Pembrokeshire and Wiltshire have been ascertained by a random sample survey carried out in 1948-49. The results showed marked differences between counties in practically every respect. These differences are set out in thirty-one tables of results. As there have been marked changes in equipment, methods and materials available since the date of the survey, its main value is as an historical record of conditions at about the time these changes began. A later report will deal with the relationship between conditions on the farm and the keeping quality of the milk produced.

186. (SELLERS, H. C.) & LEECH, F. B. (1955). Survey of losses associated with pregnancy and parturition in Yorkshire sheep. *J. agric. Sci.* (In the press.)

Data concerning a random sample of about 4 per cent of the flocks in Yorkshire were collected in the form of answers to a questionnaire. The information required was given by 98 per cent of the farmers in the sample.

The survey has shown the extent of losses associated with pregnancy and parturition in 1952-53 and the areas in which they were most severe; it has also given some indication of the factors that might be affecting losses of different kinds. In addition to this information, the survey has provided statistics concerning feeding and husbandry and the relative importance of different breed types in Yorkshire.

WESTMACOTT, M. H. & WILLIAMS, C. B. (1954). A migration of Lepidoptera and Diptera in Nepal. *Entomologist*, **87**, 232.

For summary see no. 158.

REVIEWS

187. HEALY, M. J. R. (1955). "Design and analysis of industrial experiments", by Owen L. Davies. *Sci. Progr.* (In the press.)
188. HEALY, M. J. R. (1955). "Biometrika tables for statisticians", edited by E. S. Pearson and H. O. Hartley. *Sci. Progr.* (In the press.)
189. HEALY, M. J. R. (1954). Third International Biometric Conference. *Nature, Lond.* **173**, 1027.

REPORTS

190. BOYD, D. A. (1954). Suggested experimental designs for co-operative research projects. Working Party on Mediterranean Pasture and Fodder Development. FAO/54/4/2023.
191. (ELLISON, W.), BOYD, D. A. & CHURCH, B. M. (1954). Survey of hill and livestock rearing farms. (Mimeographed Report to the Agricultural Research Council.)
192. (BLOOD, J. W.), CHURCH, B. M. & DAVIS, M. E. (1954). The survey of fertilizer practice, Northamptonshire, 1950-51. (Ministry of Agriculture mimeographed report.)
193. Church, B. M., (Blenkinsop, A. *et al*). (1954). The survey of fertilizer practice, 1953. (Ministry of Agriculture mimeographed report.)

Woburn Experimental Station

194. MANN, H. H. (1955). Variation of sulphur in soils under a continuous grain crop. *J. Soil Sci.* **6**. (In the press.)

A study of the content of sulphur in various forms in a soil which has grown spring barley each year for 50 years with various manures, makes it clear that under normal rural conditions the sulphur received by this soil from rain and other atmospheric sources is amply sufficient to maintain its sulphur content. This applies whether the soil is unmanured or has an application of ammonium salts, nitrate of soda, or these materials with superphosphates, potash and other mineral manures. During the 50 years when the application of these materials was made every year, without any organic manures, the carbon content of the soil was reduced and the amount of total and organic sulphur was reduced to almost the same extent, but the humus sulphur remained very much more steady. In a free-draining soil such as that under study there is no evidence of a tendency of the sulphur to be carried down and remain in the subsoil within the range of barley roots.

Tropical Soils

195. GREENE, H. (1954). Trace elements in tropical and subtropical soils. *World Crops*, **6**, 123.
196. GREENE, H. (1954). Tropical soils. *J. Sci. Fd Agric.* **5**, 65.
197. GREENE, H. (1954). Fertilizers in colonial agriculture. *Afr. Soils*, **3**, 1.
198. GREENE, H. (1954). Fertilizer prospects in Africa. *Proc. 5th int. Congr. Soil Sci.* (In the press.)
199. (GROVES, A. W.) & GREENE, H. (1954). Goldschmidt's Geochemistry. *Soils & Fert.* **17**, 199.

Soil Survey of England and Wales

200. The soils of the Wem district of Shropshire. (1954) London : H.M. Stationery Office.

General Publications

201. BOALCH, D. H., ed. (1954). *Catalogue of serial publications in the library of Rothamsted Experimental Station, 1953*. Harpenden : Rothamsted Experimental Station.