ROTHAMSTED RESEARCH

Report for 1935

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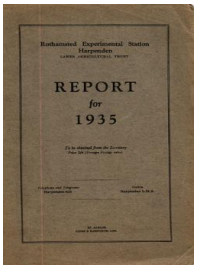

Microbiology

Rothamsted Research

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XLIII. ALAN WALKLEY. *"An Examination of Methods for Determining Organic Carbon and Nitrogen in Soils."* Journal of Agricultural Science, 1935, Vol. XXV, pp. 598-609.

The details of the Dennstedt dry-combustion method for determining carbon in soils were described, and some simplifications suggested.

The Bangor modified Kjeldahl method for carbon and nitrogen in soils requires carefully standardised heating. Error may arise from contamination of sandy soils by material abraded during grinding in iron or porcelain mills.

For many heavy soils the addition of water before the Kjeldahl digestion is convenient but not essential. For heavy alkaline soils with little organic matter it is advisable to grind the soil very finely and to add water.

The rapid dichromate titration method of Walkley and Black for soil carbon gave satisfactory approximate results. The details of the technique were improved and methods were devised for overcoming disturbances due to chlorides. The method should be useful in advisory and survey work in which the errors of soil sampling in the field are inevitably high.

MICROBIOLOGY

(Departments of Bacteriology, Chemistry, Fermentation and General Microbiology)

(*a*) BACTERIA

XLIV. C. B. TAYLOR. *"Short-period Fluctuations in the Numbers of Bacterial Cells in Soil."* Proceedings of the Royal Society of London, B, 1936, Vol. CXIX, pp. 269-295.

Significant changes in total bacterial numbers, as counted microscopically by the ratio method, have been shown to take place from day to day, in (*a*) soil freshly taken from the field; (*b*) soil incubated at constant temperature and moisture conditions; (*c*) sterilized and re-inoculated soil incubated at constant temperature and moisture conditions.

Using mannite-salts and soil extract media with the plate count method, significant day-to-day changes in bacterial numbers have been recorded in fresh soil.

Significant changes in bacterial numbers at two-hourly intervals have been obtained in fresh soil by both total and plate count methods.

In fresh soil, fluctuations in bacterial numbers have been correlated with moisture on one occasion only, when intermittent rainfall may have been a limiting factor. In the experiment here described fluctuations were at all times independent of soil temperature changes.

By incubating soil under constant conditions of temperature and moisture it has been shown that the bacterial population may change in spite of those conditions being kept uniform.

There is evidence that fluctuations in total numbers are made

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up of a series of fluctuations occurring independently in different groups of bacteria.

XLV. H. G. THORNTON and C. B. TAYLOR. "*Short-period Fluctuations in Bacterial Numbers in Soil.*" Transactions of the Third International Congress of Soil Science, 1935, Vol. I, pp. 175-179.

Methods used for the estimation of bacterial numbers in soil fall into two groups, plating methods and microscope counts of bacterial cells in a film of soil suspension. The accuracy of both types of method is discussed. The latter alone can give an absolute figure and has attained a satisfactory degree of accuracy with the development of the "ratio method," which is described. The method is based on obtaining the ratio between counts in a soil film of bacterial cells and of indigo particles, a known number of which have been added to a known mass of the soil.

Both plate and ratio methods show that the bacterial population of soil fluctuates at short intervals during the day and night. These fluctuations are commonly independent of changes in soil moisture or temperature and also take place when soil is kept in an incubator. Their cause is as yet undetermined.

XLVI. H. G. THORNTON. "*The Symbiotic Relationship between Soil Bacteria and Higher Plants, as exemplified by the Leguminosae.*" Transactions of the Third International Congress of Soil Science, 1935, Vol. II, pp. 81-94.

The normally beneficial relationship between the nodule bacteria and their host plant can be disturbed by changes in the physiology of the latter, especially where these lead to a narrowing of the ratio of available carbohydrate to nitrogen in the tissues. Where narrowing is due directly to a shortage of carbohydrate, the bacteria tend to become actively parasitic and to destroy the nodule tissues. Where the ratio is narrowed by excess of inorganic nitrogen uptake, host resistance both to infection of the root-hairs and to growth of the nodule sets in.

Different examples of host resistance are apparently specific to the variety of nodule organism. These include a resistance to infection by nodule bacteria derived from most other legume species. There are also experiments which suggest that nodules produced by one strain may confer an acquired immunity against infection by certain other strains normally capable of infecting the plant in question.

This problem is of special importance owing to the discovery that some strains produce nodules that do not benefit the host plant, owing to causes as yet unexplained.

(*b*) AMOEBAE

XLVII. D. WARD CUTLER and L. M. CRUMP. "*The Effect of Bacterial Products on Amoebic Growth.*" Journal of Experimental Biology, 1935, Vol. XII, pp. 52-58.

The two common soil amoebae *Hartmanella hyalina* and

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Naegleria gruberi were grown in pure culture with the addition of filtrates from bacterial cultures, and also with the filtrate derived from a suspension of crushed bacterial cells. Filtrates prepared from young cultures of two bacteria, both of which could be used as food by the amoebae, were without effect on *H. hyalina*; a filtrate prepared from the crushed cells of *B. mycoides* inhibited reproduction in *N. gruberi*, and also hastened the onset of cyst formation.

(*c*) Biological Activities

XLVIII. C. N. Acharya. "*Studies on the Anaerobic Decomposition of Plant Materials. IV. The Decomposition of Plant Substances of Varying Composition.*" Biochemical Journal, 1935, Vol. XXIX, pp. 1459-1467.

In the anaerobic decomposition of oat, wheat, rice and barley straws, bracken leaves, young grass mowings and rape seed cake, it was found that in all cases the chief decomposition products were acetic and butyric acid, CH_4 and CO_2. The materials richer in nitrogen yielded more butyric acid and CH_4. Addition of nitrogen had only a slight stimulating effect on the decomposition of materials of low nitrogen content (e.g., straw). Hemicellulose and to a less extent cellulose was decomposed, whilst lignin appeared to remain unchanged. Lignin has a marked inhibiting effect on the decomposition of protein and other constituents.

XLIX. S. H. Jenkins. "*The Biological Oxidation of Carbohydrates. V. The Decomposition of Cellulose in the Activated Sludge Process and in Percolating Filters.*" Biochemical Journal, 1936, Vol. XXX, pp. 497-505.

Cellulose is one of the constituents of sewage and trade effluents which decomposes readily under anaerobic conditions with the formation of methane. As little is known about its rate of decomposition in the aerobic processes used for purifying sewage, suspensions of pulp cellulose were added to an activated sludge and the rate of decomposition under different conditions found when air was blown through the mixture. In another experiment the cellulose was passed through biological filters. Contrary to expectations, as much cellulose disappeared in the activated sludge process when the C/N ratio in the mixtures supplied was 80/1 as when it was 8/1. But in the filtration experiments 10 per cent. more cellulose was oxidised with the lower ratios. The results showed that the amount of N used by micro-organisms decomposing cellulose may vary within wide limits depending upon the amount of N supplied. Thus, by providing plenty of N in the filtration experiments, for every 100 parts of C decomposed 4.3 of N were used; with a small supply, 100 of C used 1 of N; while Hutchinson and Richards found that for straw to decompose properly the initial requirement of 100 parts of C was 2.5 of N.

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L. N. W. BARRITT. "*The Treatment and Disposal of Milk Factory Effluents. I. By Means of Percolating Filters and Septic Tanks.*" Journal of the Society of Chemical Industry, 1936, Vol LV, pp. 48T-54T.

Milk factory effluents equivalent in strength to 1 per cent. of fresh milk contain the organic and inorganic substances required for bacterial growth and in this respect are suitable for treatment by biological oxidation in percolating filters. Mechanical separation of the fat, however, with its accumulation in the filter, inhibits its own oxidation and causes clogging of the filter, resulting in a low rate of purification. This effect appears to be associated with an abnormal growth of fungi.

Preliminary treatment in a septic tank brings about separation of fat, and thus avoids this difficulty in subsequent treatment on a percolating filter. A rapid lactic acid fermentation also occurs, the effect of which depends on the buffer capacity of the salts in solution. With distilled water containing 1 per cent. of milk the reaction of the liquid falls below *p*H 4.6 (the isoelectric point of casein) and causes precipitation of casein and inhibition of proteolysis. When hard tap water is used the *p*H of the liquid may not fall below 5.5 ; the casein then remains in solution and undergoes digestion by proteolysis. Such a liquid is quite suitable for treatment on a percolating filter at a rate of 100 gallons per cubic yard per day and leaves behind a tank sludge of low nitrogen content.

The use of alkali in the wash waters also favours proteolysis in the storage tank, but the addition of waste waters containing sugar will result in abnormally high acidities and may cause precipitation of casein even in solutions of high buffer capacity. Such tank effluents, especially if of high biochemical oxygen demand, have wide C/N ratio and would not be particularly suitable for treatment on a percolating filter without addition of available nitrogen and probably also of phosphates.

LI. A. G. NORMAN. "*The Decomposition of Lignin in Plant Materials.*" Transactions of the Third International Congress of Soil Science, Oxford, 1935, Vol. III, pp. 105-108.

Knowledge of the defects in the determination of lignin have permitted conclusions as to the availability of lignin to be placed on a surer basis. The determination of lignin is affected by the presence of pentose units and proteins unless special precautions be taken. Determinations made on decomposing materials are apt to be misleading because pentose-containing constituents are progressively removed and microbial protein concurrently synthesised. When these disturbing factors are taken into account it may be shown that lignin under aerobic conditions is slowly but steadily fermented. Over 40 per cent. and probably more than 50 per cent. of the lignin of oat straw was removed in twelve months.

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LII. H. L. RICHARDSON. "*The Nitrogen Cycle in Grassland Soils.*" Transactions of the Third International Congress of Soil Science, 1935, Vol. I, pp. 219-221.

In normal grassland soils the equilibrium levels of ammonia and nitrogen are low, the level of ammonia being consistently above that of nitrate. These equilibrium values show no clear seasonal changes or effects of long-continued manurial treatments. They are rapidly restored after the addition of nitrogenous fertilisers. Added ammonia nitrogen appears to be absorbed by the herbage no less rapidly than nitrate nitrogen. Incubation experiments on soil from the Park Grass plots showed that the amount of mineralisable nitrogen rose to a maximum in early spring and fell to a minimum in late summer, unless the summer were unusually dry.

THE PLANT IN DISEASE: CONTROL OF DISEASE

(Departments of Entomology, Insecticides and Fungicides, and Plant Pathology)

(*a*) INSECTS AND THEIR CONTROL

LIII. C. B. WILLIAMS and P. S. MILNE. "*A Mechanical Insect Trap.*" Bulletin of Entomological Research, 1935, Vol. XXVI, pp. 543-551.

The trap consists of two nets in the mouth of which are electric fans which blow a current of air and the insects therein into the nets. The arm bearing the two nets revolves slowly and the level can be altered.

LIV. C. B. WILLIAMS and F. J. KILLINGTON. "*Hemerobiidae and Chrysopidae* (*Neur.*) *in a Light Trap at Rothamsted Experimental Station.*" Transactions of the Society for British Entomology, 1935, Vol. II, pp. 145-150.

A list of the species of two families of Neuroptera captured in the light trap together with an analysis of their sexes, times of appearance during the year and times of flight during the night.

LV. C. B. WILLIAMS, "*The Times of Activity of Certain Nocturnal Insects, chiefly Lepidoptera, as indicated by a Light Trap.*" Transactions of the Royal Entomological Society of London, 1935, Vol LXXXIII, pp. 523-555.

The paper contains a description of the light trap with its bottle-changing mechanism which enables the insects to be sorted according to the time of night that they enter the trap. Tabulations are given showing the time of flight at night of about eighty species of Lepidoptera, as well as some species of other orders and also certain families and orders. The results obtained in two years are shown to be very similar.

LVI. C. B. WILLIAMS. "*Further Evidence for the Migration of Butterflies.*" Bulletin de la Société Royale Entomologique d'Egypte, 1935, pp. 250-261.

A collection of about thirty records of directional movements of butterflies in various parts of the world published as evidence of migration.

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