

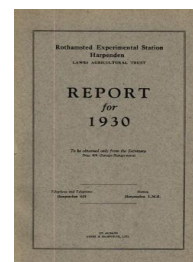
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## Report for 1930

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## The Soil

### Rothamsted Research

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## THE SOIL

(Chemical and Physical Departments)

(a) General

XXXI. E. M. CROWTHER. "*The Relationship of Climatic and Geological Factors to the Composition of Soil Clay, and the Distribution of Soil Types.*" Proceedings of the Royal Society (B), 1930. Vol. CVII, pp. 1-30.

An attempt has been made to separate the effects on soil formation of quantitative climatic factors (mean annual rainfall and temperature) and a qualitative geological grouping by the examination of American data for the composition of colloidal clay, using a statistical method which is capable of application to other geographical and ecological problems. Earlier contradictory statements on the relation of temperature to the composition of the clay fraction are shown to depend on a failure to recognise the positive correlation of rainfall and temperature over the greater part of U.S.A. The ratio of silica to alumina in the clay fraction is now shown to be correlated negatively with rainfall and positively with temperature, and the relative effects are such that for similar parent materials constant  $\text{SiO}_2/\text{Al}_2\text{O}_3$  ratios are found when an increase of mean annual temperature of  $1^\circ\text{C}$  is accompanied by an increase of 4 cms in annual rainfall. It is suggested that this factor provides a rough measure of the joint action of rainfall and temperature on drainage and leaching in soils. The relative effects on clay of rainfall and temperature on clay composition are closely parallel to their effects on the amount of drainage in Rothamsted lysimeter experiments, if the mean monthly values of the latter be regarded as samples of different climates.

If the average rainfall and temperature factors are used to calculate the contribution of soil clay in the representative and essentially immature American soils studied by Robinson and Holmes, increasingly siliceous clays are obtained as the parent material changes through the series: hard rocks, alluvium from hard rocks, limestone, marine deposits, glacial and loessial deposits, alluvium from loess. This is roughly according to the amount of reworking in water. Highly siliceous clays may be produced either in arid climates or from repeatedly reworked material in humid ones.

A statistical attempt has been made to deduce the relative importance of rainfall and temperature in soil formation from the distribution of established soil types in U.S.A. Among Marbut's Pedocals rainfall is the more important factor but among his Pedalfers temperature is more closely correlated with the distribution of soils.

The iron-aluminium ratio of the colloidal clay changes in characteristic manner through the soil profile and it appears that its fuller examination may provide a more definite criterion for distinguishing between types of leached soils.

(b) Mechanical Analysis

- XXXII. B. A. KEEN AND R. K. SCHOFIELD. "*Formation of Streamers in Sedimentation.*" *Nature*, 1930. Vol. CXXVI, pp. 93-94.

A discussion is given of the system proposed by C. E. Marshall for mechanical analysis of clays with the aid of a high-speed centrifuge. The method consists essentially in pouring a thin layer of aqueous clay suspension on the top of a sugar solution. The streamers which form when this system is left under the influence of gravity, are attributed to the formation of a clay laden layer of sugar solution immediately below the aqueous layer. This layer, having a greater density than the solution below, breaks up and streams downwards. The authors inquire whether this phenomenon may not render invalid Marshall's calculation, in which it is supposed that the particles sediment individually through the sugar solution.

(c) Physical Properties

- XXXIII. B. A. KEEN. "'Single Value' Soil Properties. A Study of the Significance of Certain Soil Constants. IV. A Further Note on the Technique of the 'Box' Experiment." *Journal of Agricultural Science*, 1930. Vol. XX, 414-416.

Experiments on the effect of impacts on the amount of precipitated silica that can be packed into a Keen-Raczkowski box, suggest that, like the weight per unit volume, the "swelling" is a function of the degree of packing to which the material is subjected during the filling of the box. Further, the fact that such inert material as precipitated silica can show a "swelling" when saturated with moisture, raises the question as to how far imbibitional moisture is concerned in the volume expansion of soil.

- XXXIV. W. B. HAINES. "*Studies in the Physical Properties of Soil, V. The Hysteresis Effect in Capillary Properties, and the Modes of Moisture Distribution associated therewith.*" *Journal of Agricultural Science*, 1930. Vol. XX, pp. 97-116.

A further study is made of water distribution in an ideal soil by means of carefully piled bronze balls and paraffin oil. A distinction is drawn between the conditions of rising and falling "moisture." For falling moisture the pressure deficiency, for which the meniscus can retreat into the internal cellular structure, is in the neighbourhood of 12 T/r, while for rising moisture the liquid can return whilst still under a pressure deficiency of 6.9 T/r. An examination of water equilibrium in "glistening dew," forms a link with the behaviour of soil, and the investigation illustrates the importance of hysteresis in capillary properties of soil.

- XXXV. R. K. SCHOFIELD AND G. W. SCOTT BLAIR. "*The Influence of the Proximity of a Solid Wall on the Consistency of Viscous and Plastic Materials.*" *Journal of Physical Chemistry*, 1930. Vol. XXXIV, pp. 248-262.

If, in considering the flow of a plastic material through a narrow tube, it be assumed that the velocity gradient at any point depends only on the stress at that point, it necessarily follows that the mean

velocity for a given stress at the wall of the tube should be directly proportional to the radius of the tube. Although thick soil pastes conform closely to this requirement, thinner pastes, whether they show rigidity or not, give marked discrepancies. These discrepancies can be accounted for by assuming that in the immediate proximity of the wall a modification of the plastic properties occurs, which imparts an additional velocity to the bulk of the material. By first subtracting this velocity a viscosity constant is obtained, independent of the dimensions of the tube.

XXXVI. G. W. SCOTT BLAIR. "*A Further Study of the Influence of the Proximity of a Solid Wall on the Consistency of Viscous and Plastic Materials.*" *Journal of Physical Chemistry*, 1930. Vol. XXXIV, pp. 1505-1508.

In a previous paper (R. K. Schofield and G. W. Scott Blair) it had been shown that in order to account for the flow properties of clay pastes, an anomalous region must be postulated in the neighbourhood of the wall of the tube through which the paste is caused to stream. It was assumed that this layer was relatively thin, and a single correction is made for its effect in the modified Poiseuille formula used. In this paper the modified layer is accorded a separate term in the integration, assuming for it consistency constants differing from those of the bulk of the material. The earlier "correction" term is then expressible in terms only of these consistency constants (modified and normal); of the thickness of the modified layer; and of the radius of the tube.

(d) Soil Cultivation

XXXVII. B. A. KEEN AND THE STAFF OF THE SOIL PHYSICS DEPARTMENT. "*Studies in Soil Cultivation. V. Rotary Cultivation.*" *Journal of Agricultural Science*, 1930. Vol. XX, pp. 364-389.

Experiments in rotary cultivation extending over four years (1926-1929) yielded the results that with spring-sown crops—swedes and barley—rotary cultivation gives earlier and better germination and better early growth. In every experiment, however, the final yield has either been no better or else significantly below that obtained for the plots cultivated in the usual way. Meteorological factors exercise a predominating influence—the implement used being only secondary. Rotary cultivation appears to be most effective on an unkindly soil. Sieving measurements show that it does not produce an appreciably finer tilth than the usual implements, but leaves the soil initially in a much looser condition.

(e) Physical Chemistry

XXXVIII. E. M. CROWTHER AND S. G. HEINTZE. "*Report of the Soil Reaction Committee of the International Society of Soil Science. I. Results of Comparative Investigations on the Quinhydrone Method. II. Conclusions and Recommendations.*" *Soil Research*, 1930. Vol. II, pp. 28-139, 141-152.

This is the report of a Committee set up at Budapest in 1929 as a result of criticism of the standard quinhydrone method for soil reaction measurements made by S. G. Heintze and E. M. Crowther (Paper

XVIII, Report, 1929, p. 58) and others. Comparative determinations in seven laboratories confirmed the conclusions that in many common soils the quinhydrone method may give quite erroneous results. It was recommended that a rapid preliminary test of the suitability of the soil for the quinhydrone technique should precede all precise measurements. In a special section of Part I, E. M. Crowther and S. G. Heintze bring forward additional evidence that the errors are due to the reduction of manganese dioxide to an alkaline product.

(f) Soil Organic Matter

- XXXIX. H. J. PAGE. "*Studies on the Carbon and Nitrogen Cycles in the Soil. I. Introductory.*" *Journal of Agricultural Science*, 1930. Vol. XX, pp. 455-459.

The term "humic matter" is defined as the dark coloured, high molecular, colloidal organic matter which is a characteristic constituent of the soil, and "non-humic matter" includes colourless chiefly soluble organic substances and undecomposed plant residues.

- XL. C. W. D. ARNOLD AND H. J. PAGE. "*Studies on the Carbon and Nitrogen Cycles in the Soil. II. The Extraction of the Organic Matter of the Soil with Alkali.*" *Journal of Agricultural Science*, 1930. Vol. XX, pp. 460-477.

Although the total organic carbon in the soils of various plots of the classical permanent experiments at Rothamsted receiving, respectively, organic, artificial and no manures, varied between 0.81 and 2.91 per cent, and in the subsoils between 0.54 and 1.04 per cent of the oven dry samples, there was a marked similarity between the properties of their organic matter, especially in its behaviour on extraction with cold and hot dilute caustic code. Colorimetric examinations of the extracts indicate that the organic carbon of the surface soils is more deeply coloured than that of the corresponding subsoils, that the organic carbon is most deeply coloured in extracts from surface soils receiving annual dressings of dung, and that that from subsoils of plots receiving no manure is least coloured.

- XLI. H. M. S. DU TOIT AND H. J. PAGE. "*Studies on the Carbon and Nitrogen Cycles in the Soil. III. The Formation of Natural Humic Matter.*" *Journal of Agricultural Science*, 1930. Vol. XX, pp. 478-488.

Decomposition experiments in which soil extracts and nutrient salts were added to plant materials such as wheat straw, clover hay, maize cobs and pine sawdust, and to purified preparations of plant constituents, including lignin, cellulose, xylan, xylose, potato starch, dextrose and protein in the form of commercial blood fibrin, indicate that the formation of humic matter is more closely related to the change in lignin content of the original material than to the change in content of any other groups of plant constituents estimated.

(g) Analytical

- XLII. R. G. WARREN AND A. J. PUGH. "*The Colorimetric Determination of Phosphoric Acid in Hydrochloric Acid and Citric Acid Extracts of Soils.*" *Journal of Agricultural Science*, 1930. Vol. XX, pp. 532-540.

The existing macromethods for the determination of phosphoric acid in soils are unsuitable for large numbers of analyses as the time and labour involved are excessive, especially for such empirical determinations as "Available Phosphoric Acid," by means of citric acid. Further in certain cases these methods are not free from serious errors. These disadvantages have prevented extensive work on soil phosphorus and attention has therefore been given to the application of colorimetric methods so that analyses may be made rapidly.

Accurate colorimetric determination of phosphoric acid in soil extracts demands not only the absence of large amounts of silica and organic matter, and a controlled acidity for development of colour, but also the absence of ferric iron. To satisfy these conditions a method was devised in which the organic matter, including citric acid, was oxidised by sodium permanganate in hydrochloric acid solution. Silica was only removed from solution for soils that contained less than .02 per cent  $P_2O_5$  soluble in hydrochloric acid. Ferric iron was precipitated with potassium ferrocyanide, and the excess which would redissolve the iron and cause interference during colour development, was removed by ensuring the presence of sufficient manganese. Finally, the acidity was adjusted by utilising the blue to purple colour change of the precipitated ferrocyanide instead of an added indicator. Two colorimetric methods, Deniges and Fiske-Subbarow, were applied to solutions prepared in this way, and good agreement was obtained with the gravimetric method. In this method lengthy operations such as quantitative filtration, evaporation and ignition of organic matter were eliminated or reduced to a minimum.

*Correction to above paper.* On p. 539, l. 5, should read: "Rinse into a 1 litre graduated flask containing 500 cc. of 10 N sulphuric acid."

THE SOIL POPULATION AND ITS BEHAVIOUR

(Bacteriological and General Microbiological Departments)

- XLIII. H. G. THORNTON. "*The Influence of the Host Plant in Inducing Parasitism in Lucerne and Clover Nodules.*" *Proceedings of the Royal Society (B)*, 1930. Vol. CVI, pp. 110-122.

The formation of fresh nodules upon inoculated lucerne seedlings placed in the dark soon ceases, and there is a cessation of cell division throughout the root. The bacteria become parasitic upon the host tissues. In old nodules on lucerne and clover plants growing in the light, the bacteria behave similarly. Bacteria from the original infection thread invade the nodule tissue, causing it to disintegrate. It is suggested that lack of carbohydrate is the basal factor in both conditions. When the air supply to lucerne seedlings growing in agar is limited, the nodules do not function normally but, carbohydrate supply not being the limiting factor, the host tissue is not then injured.