

zons. There are traces in the Trenton (Ordovician); small quantities are obtained from four distinct Silurian series. The largest quantity of oil comes from the Onondaga beds, which are Devonian. The author mentions both the organic and inorganic theories of the origin of petroleum; he expresses no definite preference, but appears to be inclined to the latter, and some of the facts stated in the memoir indicate why some Canadian geologists are firmly attached to that view. The most interesting evidence is based on the uniform composition of the associated natural gas, which is advanced as incompatible with its local origin; but the balance of the evidence stated seems difficult to reconcile with the inorganic hypothesis.

Each of the three memoirs is a useful contribution to Canadian geology.

J. W. G.

RADIO-ACTIVITY AND PLANT GROWTH.

FOR some time past Mr. Martin Sutton has been making experiments on the effects of radio-active ores and residues on plant growth. A preliminary account of the experiments was given in *NATURE* for October 7, 1915, and the detailed report now to hand, issued as Bulletin No. 7, from Messrs. Sutton, of Reading, confirms the conclusions then drawn. The experiments were soundly conceived and well carried out; the results showed that radium compounds have no sufficient effect on plant growth to justify any hopes of practical application in horticulture or agriculture.

The experiments were made with tomatoes, potatoes, radishes, lettuces, vegetable marrows, carrots, onions, and spinach beets; some of the plants were grown in pots, and others in the open ground. Pure radium bromide was used in some experiments, and radium ores in others. In order to eliminate the effect of substances other than radium present in the ores, a mixture of these was made and applied to some of the plants. In certain cases small increases in growth over the unmanured plants were obtained, but nothing approaching the increases given by artificial fertilisers or farmyard manure.

A number of rather extravagant claims are thus disposed of, including one to the effect that radium treatment caused plants to take on certain flavours that they do not naturally possess. Thus a previous investigator had claimed that vegetable marrows grown in presence of radium compounds assume the flavour of pineapples; Mr. Sutton's marrows were cooked and tasted by a distinguished exponent of horticultural science, whose tastes in these matters are recognised as being beyond reproach, and were found to be indistinguishable from the others. Mr. Sutton has rendered good service by disposing of this and other of the hares started in the field of horticulture that were distracting attention from the larger problems with which the horticulturist has to deal.

THE ORGANISATION OF INDUSTRIAL SCIENTIFIC RESEARCH.¹

I.

IF one attempted to formulate the common belief concerning the origin and development of modern technical industries, it would probably be found that stress would be laid upon financial ability or manufacturing skill on the part of the founders; but if, instead, we were to make a historical survey of the subject, I think that we should find that the starting and development of most manufacturing businesses depended upon discoveries and inventions being made

¹ An address delivered at Columbia University by Dr. C. E. Kenneth Mees, director of the Research Laboratory, Eastman Kodak Co., Rochester, N.Y.

by some individual or group of individuals who developed their original discoveries into an industrial process. Indeed, if the localities in which various industries have developed be marked on the map, they will often be found to have far more relation to the accidental location, by birth or otherwise, of individuals than to any natural advantages possessed by the situation for the particular industry concerned. The metallurgical industries, of course, are situated chiefly near the sources of the ores or of coal, but why should the chief seat of the spinning industry be in Lancashire or of modern optical industry in Jena, except that in those places lived the men who developed the processes which are used in the industry? And, moreover, industries are frequently transferred from one locality to another, and even from one country to another, by the development of new processes, generally by new individuals or groups of workers.

The history of many industries is that they were originated and developed in the first place by some man of genius who was fully acquainted with the practice of the industry and with such theory as was then known; that his successors failed to keep up with the progress and with the theory of the cognate sciences; and that sooner or later some other genius working on the subject has rapidly advanced the available knowledge, and has again given a new spurt to the development of that industry in another locality.

Thus, in the early days of the technical industries the development of new processes and methods was often dependent upon some one man, who frequently became the owner of the firm which exploited his discoveries. But with the increasing complexity of industry and the parallel increase in the amount of technical and scientific information, necessitating increasing specialisation, the work of investigation and development which used to be performed by an individual has been delegated to special departments of the organisation, one example of which is the modern industrial research laboratory.

The triumphs which have already been won by these research laboratories are common knowledge. The incandescent lamp industry, for instance, originated in the United States with the carbon lamp, but was nearly lost to the United States when the tungsten filament was developed, only to be rescued from that danger by the research laboratory of the General Electric Company, who fought for the prize in sight and developed, first, the drawn-wire filament, and then the nitrogen lamp; and we may be sure that if the theoretical and practical work of the research laboratory of the General Electric Company were not kept up the American manufacturers could by no means rest secure in their industry, as, undoubtedly, later developments in electric lighting will come, and the industry might be transferred, in part, if not completely, to the originators of any improvement. Manufacturing concerns, and especially the powerful, well-organised companies who are the leaders of industry in this country, can, of course, retain their leadership for a number of years against more progressive but smaller and less completely organised competitors, but eventually they can ensure their position only by having in their employ men who are competent to keep in touch with, and themselves to advance, the subject, and the maintenance of a laboratory staffed by such men is a final insurance against eventual loss of the control of its industry by any concern.

There was a time when the chief makers of photographic lenses were the British firms, the owners of which had been largely instrumental in developing the early theory of lens optics, but that position was lost entirely as a result of the scientific work of the German opticians, led by Ernst Abbe; in a smaller divi-