which occur in places where phosphorus or silicon undergo 'spontaneous' changes.

This brings the discussion back from a contemplation of the functions of chemistry in micro-geology to the question of the significance of the free-living cell in its natural habitat, a question which has already been referred to as fundamental. It seems appropriate at this juncture to substantiate this contention by a further example.

Where micro-organisms develop in their natural habitats they do so at the expense of substances which can serve their energy requirements. Such substances may range from highly complex organic compounds to simple elements. The result of the action of micro-organisms on them will inevitably be a change in their chemical composition, a change which, if undesirable from a human point of view, will be characterized as destructive.

The destructive activities of micro-organisms are too manifold to enumerate, ranging as they do from the taking of human life to the elimination of dead vegetation; from the spoilage of milk and all other foods to the mildewing of fabrics; from the contamination of gas stored in gasometers to the destruction of natural rubber, or the breakdown of liquid fuels, or the corrosion of metallic structures. A study of all such destructive activities and a clarification of their significance must always constitute a major function of microbiological research, worthy of a degree of attention at least equal to that devoted to the adoption of micro-organisms as catalysts in the production of organic substances.

What bearing, it may finally be asked, has all this on the planning of future microbiological research? It implies that the biological aspect should be safeguarded in greater measure than has been done in the past, and that a more general approach to the subject should be encouraged, not, be it understood, at the expense of specialized investigations, but in addition to and in amplification of them.

There will be needed in future a more comprehensive survey of the natural habitats of the microscopic world than has hitherto been undertaken. There is need to-day for a much more thorough exploration of the destructive activities of micro-organisms than has so far been conducted. There is need for a better understanding of the symbiotic and antagonistic activities of micro-organisms, and of the adaptive properties of the microscopic world in its natural habitats. There is need for more work connected with the classification and preservation of type cultures, and for a fresh approach to an understanding of the biological and biochemical principles underlying established microbiological processes. Improvements in such processes could not fail to result from such work. Finally, there is need for the training of workers in general microbiological principles.

Planning of microbiological research on the above lines is unlikely to be effectively undertaken in laboratories designed for specialized purposes such as pathology, dairying, soil investigations or biochemistry.

A homestead for general microbiological research is needed suitable for carrying out also the training of workers on more general lines than has been customary in the past. By whom such an establishment should be conducted, by universities or under Government auspices, may be a matter for discussion. Of its usefulness there can be but one opinion.

OILFIELDS IN GREAT BRITAIN*

By DR. G. M. LEES
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IN *Nature* of March 31, 1934, an article on "Petroleum in Great Britain" gave the following conclusion on the prospects:

"Oil pools of commercial magnitude (*pace* natural gas, shale oil and allied indications and potentialities) cannot reasonably be anticipated in any known area in Great Britain. Many years of official geological survey—a centenary in 1935 in point of fact—together with much independent work, leave few spots unknown, if not in detail, at least in sufficient outline to preclude even faint hope".

On December 6, 1944, G. M. Lees and A. H. Taitt read a paper to the Geological Society of London on "The Geological Results of the Search for Oilfields in Great Britain" and the president of the Society, Prof. W. G. Fearnsides, on opening the discussion, said that "Never before had so much exact and new information about the underground geology of Britain been presented to the Society. . . . The D'Arcy Exploration Company's [the exploration subsidiary of the Anglo-Iranian Oil Co.] delivery of some 300,000 tons of native oil had been a notable contribution to the war effort, but the by-product of knowledge gained of Carboniferous rocks, under and about the edges of the coalfields, was not less vital in the interests of the nation".

The pessimistic, though confident, opinion of 1934 was presumably written without a full appreciation of the capacity of the modern technique of geophysics and of rapid exploration drilling to probe the structural and stratigraphical secrets below the unconformable cover of Permian and Mesozoic strata. This blanket completely obscures the older rocks throughout extensive areas in the Eastern Midlands, East Anglia and south-central England, and such borings as had penetrated below the unconformity were too few and too scattered to allow any satisfying deductions to be drawn from their results. These areas were, therefore, virtually *terra incognita* at depths below a few thousand feet, or less, from surface.

The exploration programme of the D'Arcy Exploration Company has extended over a number of separate and unrelated geological prospects—the Mesozoic in southern England, the Carboniferous in the western and eastern Midlands, the Permian in North Yorkshire and the Calciferous Sandstone Series in Scotland. During the course of the past ten years, intensive geological and geophysical work and the drilling of fifty-two deep and forty-three shallow exploration borings by the Company have yielded an immense amount of new information. They have proved five oilfields and two areas of natural gas, and these fields are now producing from 243 wells. The total production up to the end of 1944 was 337,000 tons. The crude oil is of good quality, with good light and lubricating oil fractions. The specific gravity ranges from 0·83 to 0·89.

The oilfields are situated about eight miles north-west of Newark at Eakring, Duke's Wood, Caunton and Kelham Hills, and there is one isolated small field at Formby, between Liverpool and Southport. The Nottinghamshire oilfields produce from depths of 1,900–2,500 ft. from sandstones in the Millstone Grit Series and, to a lesser extent, from sandstones

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in the basal part of the Coal Measures. The oil is concentrated in the crestal parts of minor anticlines forming part of a major anticlinal area which extends from the Trent at Rolleston to the vicinity of Ollerton. The Formby oilfield is a small accumulation in Keuper Waterstones sealed upwards by Glacial clay, and in this case the oil is produced from a depth of 100–120 ft. The structure is a faulted monocline, but it is thought probable that the oil has migrated upwards from a lower source, perhaps in the Carboniferous. Two deep borings have been made to explore the lower possibilities, but so far without result.

The gas-fields are at Aislaby in Eskdale, North Yorkshire, and at Cousland near Dalkeith, Scotland. In the former case the reservoir rock is a Permian limestone, and in the latter it is the sandstones of the Oil Shale Group of the Calciferous Sandstone Series. Short tests have indicated that the gas may be present in sufficient quantity to justify commercial exploitation.

The discovery of the Nottinghamshire oilfields resulted from geophysical work carried out, for the most part, by the staff of the Anglo-Iranian Oil Company. Seismic refraction arc surveys have proved to be the most successful method, whereas the reflexion method has given disappointing results. Gravity and magnetometer methods have also been used. These geophysical surveys have revealed the presence of a number of structural highs in extensive areas in eastern Nottinghamshire and in Lincolnshire, and a number of these have already been tested by drilling; although the ratio of success to failure has been low, the search continues.

An immense amount of new geological information on the stratigraphy and structure of the Carboniferous rocks below the Permian unconformity has been revealed by these borings. Coal seams of significant thickness have been penetrated by borings at Spital, Dunston and Stixwould, north, south and south-east respectively of Lincoln City. The coal seams lie at about 4,000 ft. depth, and although for this reason they are not likely to be mined in the near future, they represent a substantial addition to the known British reserves of coal. It is possible that coal seams at shallower depth may be present underground in the surroundings of the Wash or even in north Norfolk; the former possibility was already envisaged by Prof. Kendall many years ago. On the debit side of the coal account, the area north of Newark, both east and west of the River Trent, has been proved to lack coal seams of important thickness, while to the south of Newark there is a considerable area in which there is an exceptional development of volcanic rocks within the Coal Measures, at the expense of workable seams. Farther south, however, there is an improvement, as a boring at Widmerpool, eight miles south-east of Nottingham, has proved two good seams.

Another important by-product of the search for oil has been the discovery of potash salts of Permian age in Eskdale, North Yorkshire. Both sylvite and polyhalite are present, and this result shows that the potash deposits of the Zechstein Sea, which have such economic importance in north-west Germany, extend also into north-eastern England. The potash beds in Eskdale are at a depth of 3,650–4,775 ft. and, while this may exceed easy mining depth, there is a possibility that the deposits may extend farther north towards the Tees valley and rise to a lesser depth.

Inevitably, after several decades of rural spoliation by uncontrolled industry, a certain apprehension has been felt lest the development of oilfields might be at the expense of the amenities of the countryside of Britain, but it need not and has not been so. Every care has been taken to cause as little disturbance as possible; after a well has been drilled, the derrick is removed and only a small pumping jack marks the position of the boring. Electric power is used for pumping, and the motors are both small and silent. Buried pipelines carry the oil from the fields to a railway siding whence it is transported in tank cars to a refinery.

OBITUARIES

Engineer Vice-Admiral Sir George Goodwin, K.C.B.

ENGINEER VICE-ADMIRAL SIR GEORGE GOODWIN GOODWIN, who died at Havant on April 2, was the sixth to hold the important position of engineer-in-chief of the Fleet—an office created in 1847. The first two holders, Thomas Lloyd and Sir James Wright, were civilians, but after the latter retired in 1887, the holders have all been naval engineer officers: Richard Sennett, an inspector of machinery, following Wright and he in turn being succeeded by Engineer Vice-Admirals Sir John Durston, Sir Henry Oram, F.R.S., and Sir George Goodwin. These four distinguished officers were all products of the admirable system of training inaugurated by the Admiralty in the dockyards and at the Royal Naval College, Greenwich.

Goodwin, who was born in 1862, became an engineer student at Portsmouth and received part of his education in the Dockyard School. While still a boy, he attained the highest position in the Cambridge Local Examinations and thereby became available for a scholarship at the University of Cambridge. He chose to continue his naval career, however, passed through Greenwich with distinction and, except for about four years afloat, was afterwards employed either at Chatham Dockyard or at the Admiralty. He rose through the old ranks of assistant engineer, engineer and chief engineer, to the new ranks of engineer commander, engineer captain and engineer rear-admiral before, in 1917, on his succeeding Oram, reaching the highest rank at present open to a naval engineer officer.

In Goodwin's early days, there were many ships with low-pressure boilers and simple-expansion engines. He saw these types of machinery give way to compound- and triple-expansion engines, steam turbines, water-tube boilers and other important innovations. Known to a large number of officers afloat and ashore, he helped to bridge the gulf which existed between the engineering staff at the Admiralty and engineer officers in the Fleet, and on his retirement was entertained at dinner in the Grand Hotel, London—a unique occasion.

Among Goodwin's honours was that of the honorary degree of LL.D. conferred upon him when he attended the James Watt centenary celebrations at Birmingham in 1919, as the Admiralty representative. He was the first naval engineer to be so recognized by any university in Britain.

After his retirement from the naval service, Sir George Goodwin threw himself heart and soul into the work of various technical institutions, and in 1925 joined the old-established shipbuilding and engineering firm of J. Samuel White and Co., Ltd., of East Cowes, of which he became chairman.