micro-organisms, which in turn produce a structure out of structureless material. The cementing together of individual soil particles to form aggregates is essentially a physico-chemical process, but the building of the aggregates into a stable granular structure is dependent on the activity of living organisms. The agencies are varied and include organic acids and polysaccharides, bacterial gums and fungal hyphæ and mycelia, all stages in the decomposition of organic residues. There is also the action of plant roots in binding soil particles and giving rise to a porous crumb, and of earthworms in not only producing casts of mineral-organic aggregates but also of making channels for æration and water movement. Indeed, much of the organic matter in the soil consists of excrement from soil fauna.

The soil medium becomes, therefore, a climax association of plant and fauna with a definite level of productivity. This productivity can be enhanced by man, through the physical and chemical modifications brought about by cultivation and manuring; but it can also be reduced by destroying the environment built by natural agencies. It is possible to grow healthy plants without soil, but that is a specialized business; so long as soil is used the grower must endeavour to preserve or improve its structure.

A. M. SMITH

RESOURCES OF PETROLEUM: HOW MUCH OIL?

EVER since petroleum became a world-wide commercial proposition and the industry thus firmly established, the phenomenal and rapid developments of the world's oilfields with concomitant expansion of production, especially in the United States since the turn of the century, have periodically posed these questions: How long will oil resources last, is production outstripping supply? Economists, perhaps even more vociferous than technologists, have from time to time uttered dire warnings that the day may come when oil will become scarce; that other sources of fuel and energy must be harnessed to make up any deficiences in supply. For example, there was a memorable occasion in 1923 when it was thought that the United States had passed peak production; thenceforward a downward trend was predicted, with some 15–20 years ahead before calamity overtook the industry. In 1925 I myself stated: "Petroleum production has hitherto been, still is, and for some time is likely to be entirely dominated by the output from the United States. With the average figure of 15 per cent as representative of the rest of the world's contribution to total production, we have probably not got a real assessment of the potentialities of other countries, since their economic activities must largely be subservient to the greater influence. In other words, it is quite conceivable that in the event of material decline in United States output, more could be made good by external oil production than appears at first glance. Factors tending to this end include increased geological exploration, increased production from shut-in reserves, and a higher technique in petroleum engineering". "The possibilities of the world's 'peak' of production of oil having been passed in 1923 have been shown to be open to considerable doubt" (*Mining Magazine*, November 1925).

Subsequent events have more than justified that opinion and the present position is adequate answer to pessimistic prophecies of the years between. It is a fact that one-third of the world's proved reserves of petroleum to-day are in oilfields that were literally unknown, probably still less imagined, before 1950. This fact, its significance and the theme "How Much Oil" are the substance of an article by Mr. M. J. Rathbone, chairman of the Standard Oil Co. (New Jersey), in a recent issue of the house-journal, *The Lamp* (45, No. 2; 1963). Therein he speaks with authority and makes some cogent comments on the present world oil situation. A nice distinction is rightly drawn between 'reserves' and 'resources', two words often loosely applied and economically misleading out of proper context. He comments, "If you read that the world's proved oil reserves are estimated at 300 billion barrels, that oil is being consumed at the rate of nearly 9 billion barrels a year, and that this rate of consumption will probably double by 1980—you may well wonder how soon we will reach the bottom of the barrel . . . that figure of 300 billion barrels of 'proved reserves' . . . is one of our most misunderstood statistics. It does not measure the world's true oil resources at all. It is no more than an estimate of the oil we can obtain from fields already discovered, using present recovery techniques. Despite rising world consumption rates, 'proved reserve' figures go up every year". The fact is that petroleum to-day is being discovered faster than it can be used. More oil is being obtained from old fields, new fields are being proved simultaneously. Submarine oilfields, often in extension of known continental developments, have to be reckoned with. One example is the shelf region off the Louisiana coast, opened to exploration only last year and, according to Mr. Rathbone, now proved to contain billions of barrels of oil. Another case he cites is that of Libya, where six years ago there were no known oil reserves, but to-day considered to be a major source of supply.

Thus, reserves are proved on a very large scale. Resources, that is, extensive land-areas of the world potentially oil-bearing but as yet untouched by the drill, remain to be explored quite apart from under-water researches. In view of the drastic readjustment of our ideas concerning geographical distribution of favourable oil-pool structures, occasioned by the discoveries of the past decade, the location of oil and gas-fields in regions where twenty or thirty years ago no hopes whatever were entertained, then we may agree with Mr. Rathbone's contention that ". . . we have solid grounds for reassurance that petroleum resources are abundant relative to foreseeable demand".

H. B. MILNER

MONOMER – DIMER FORMS OF BENCE JONES PROTEINS

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BENCE JONES proteins, the abnormal biosynthetic products excreted in the urine of myeloma patients, are defined as low-molecular-weight proteins, antigenically and chemically related to γ-globulin[1,2], which precipitate when heated to temperatures near 50° C, dissolve on boiling, and reprecipitate on cooling[3]. Isotopic investigations have shown that this protein probably represents an aberrant synthetic portion of γ-globulin[4]. Edelman and