of São Paulo and elsewhere. In 1885 and 1886 he went to Hamburg to study dermatology. In 1887 he moved to the city of São Paulo until the pandemic of yellow fever in Campinas in 1889, and he was later summoned to Hawaii to investigate leprosy. Although he was busy as a country doctor, Lutz found time to publish papers on helminthology and medicine, among which was a monograph on *Ankylostoma duodenale* and ankylostomiasis, and others on ascariasis and the mode of infection with the tapeworm *Taenia*. On the latter subject he experimented on himself. In 1886 he published a paper on the structure of the organism that causes leprosy, proposing to include it in a new genus called *Coccothrix*, including the causal organism of tuberculosis in the same family, but the name *Coccothrix* was not adopted, although the relationship of the two organisms is nowadays recognized. In 1885 he discovered a new disease of children, now known as pink disease, and he published further papers on leprosy, based on his observations made in Brazil. Working in Honolulu he published papers on dermatology, and in 1891 a paper in which he separated amoebic from bacillary dysentery.

In Honolulu he met and married an Englishwoman, Amy Fowler, who had gone there as a volunteer nurse. After a spell in San Francisco, he and his wife returned to Brazil in 1893, where two children were born to them. In the same year Lutz was appointed vice-director of the new Bacteriological Institute of the State of São Paulo, founded by Felix Le Dantec, and later he became its director. Here he did much work on yellow fever, malaria and typhoid fever, making possible the accurate diagnosis of these endemic diseases, and directing campaigns against them. Hearing that the transmission of yellow fever by mosquitoes had been proved, Lutz, together with his colleague Ribas, director of the State sanitary service, instituted, in spite of much opposition, measures against the mosquitoes. He also worked at this time (1899-1906) on cerebrospinal meningitis, plague and myiasis, and published papers on them. In 1897-98 he discovered the sylvan form of yellow fever in the area between São Paulo and Santos, and rightly ascribed the transmission of this to the forest mosquitoes rather than to *Aedes aegypti* (*Stegomyia fasciata*).

In 1907-08 he discovered and described two new diseases caused by fungi, namely, a sporotrichosis of man and rats, and the disease later known as the mycosis of Lutz. From 1903 onwards Lutz began to work on medical entomology, publishing papers on the technique of the study of mosquitoes, on bloodsucking Diptera and on new species of Culicidae and Tabanidae.

He also did pioneer work on veterinary medicine in Brazil, investigating among other diseases equine trypanosomiasis. Later he was asked to join the staff of the Instituto Oswaldo Cruz, becoming chief of the Division of Medical Zoology. This post gave him time for work on medical entomology and helminthology, and for work on snakes and amphibians. He also wrote papers on Tabanidae and a monograph on the Simuliidae, parasitic Hippoboscidae and the forest flies and Ceratopogonidae, contributing chapters on insects of medical importance to the *Handbuch der pathogenen Organismen*.

From 1916 onwards he returned to work on helminthology, doing pioneer work on schistosomiasis in Brazil, studying the biology and ecology of the intermediate hosts involved. Later papers were on trematodes and scorpions in connexion with his lectures on poisonous animals. His earlier interest in leprosy was retained to the end of his life, and increasingly he regarded it as a disease transmitted by mosquitoes. Lutz travelled widely in Brazil in the course of his studies, and in 1928 he warned the country of the danger of outbreaks of malaria when *Anopheles gambiae* was carried from Africa to South America. It later caused, in north-eastern Brazil, one of the most disastrous outbreaks in the history of the disease.

In the course of his life Lutz named many insects, worms, molluscs and frogs, and many species were named in his honour. He was an honorary and corresponding member of many learned societies, and received many honours. On the first centenary of his birth the Brazilian Government issued a stamp with his portrait on it, and several towns in the State of São Paulo, where he did much beneficent work, named streets after him. His research extended over 61 years, and a complete edition of his publications, of which there are more than two hundred, is being planned.

G. LAPAGE

ROTHAMSTED EXPERIMENTS

IN 1919, Sir Alfred Hall wrote that the purpose of the Rothamsted Experiments was "to ascertain the conditions under which the plant grows and the soil supplies it with nutrient". Since then agricultural research has developed in many spheres, and it is clear from the annual report of the Rothamsted Experimental Station for 1963* that at present the classical investigations, initiated by Lawes and Gilbert over one hundred and twenty years ago, form only a part of the manifold activities of the Station.

The report follows the same pattern as in previous years, consisting of reports from twelve research departments, the farms at Rothamsted and Woburn, Broom's Barn and Woburn Experimental Stations, and a summary of the work of the Soil Survey for England and Wales. In an admirable general report, the director, Mr. F. C. Bawden, has commented on a few of the subjects of research carried out, but emphasizes that his introduction is merely an indication of the range of work of the Station, and is in no way a summary. Similarly, in a short review it is possible to mention only a few of the items contained in the report, and I can only hope that the interested reader will explore the report further for himself.

Some of the most interesting and important scientific developments have come from the research of the Depart-

ments of Physics and Botany into the phenomena involved in crop physiology. Detailed investigations into the physical conditions within crops and the growth of species under different sets of conditions have been carried out to obtain information about the factors which limit the productivity of healthy crops receiving adequate water and nutrients. As the director pointed out, until such knowledge is available it will be impossible to say with certainty whether a variety is producing its maximum yield, or what conditions increase yielding capacity. The Physics Department has been concerned with the energy involved in photosynthesis, and carbon dioxide flux measurements. Already several important trends have emerged, and some earlier ideas have had to be modified. For example, the soil's contribution to carbon dioxide uptake is much less than had been thought. Evapo-transpiration studies have been continued, in particular the estimation of insolation from cloudiness records, and the calculation of net radiation from measured solar radiation, analysis of evaporation and records of heat balance. The value of these evapo-transpiration measurements as a basis for assessing irrigation needs should be fully realized when the new irrigation scheme is installed at Rothamsted. In the Botany Department, controlled environment rooms have been used to examine the effects of varying temperature and humidity on plant growth. Apart from the controlled

*Lawes Agricultural Trust. Report of the Rothamsted Experimental Station for 1963. (Harpenden: Rothamsted Experimental Station, 1964.) 15s.

environment studies, other aspects of crop physiology, such as photosynthesis of ears of cereals, and dependence of the grain : leaf ratio on radiation, have been studied. These physiology studies, in conjunction with the work of the Physics Department, should yield fundamental information of far-reaching practical consequence.

In a year in which much has been written and spoken about the harmful effects of pesticides on Nature, it is gratifying to record that several departments have devoted considerable time and effort to pesticide evaluation. Although the investigations are of widely varying character, they have all been carried out with a common purpose—"to increase the efficacy of pesticides while decreasing the risk of unwanted side-effects". The Insecticides and Fungicides Department has been concerned with the search for effective new substitutes for the more persistent organic chlorine compounds and has experimented with organo-phosphorus compounds. Initial experiments have shown that yields of wheat in a wireworm-infested field were considerably increased by applying some of these latter compounds, but further work is required to determine whether their application is a commercial proposition. In the Entomology Department, the experiment on the long-term effect of DDT and aldrin has been continued. The extent to which insecticides such as aldrin, dieldrin and DDT accumulate in worms and other soil invertebrates is being studied. Results so far indicate that the concentration of dieldrin in earthworms is several times greater than in the soil itself. Another important aspect of these investigations is the re-colonization of sterilized soil by soil invertebrates which help to maintain soil fertility.

In agricultural entomology, although much time and effort has been spent in studying pests themselves, comparatively little work has been done on their relations with the growing plant, especially on the way in which pest populations of different sizes affect the growth and yield of plants at different stages in their development. Such an investigation has been commenced at Rothamsted on both root and seed crops.

The Biochemistry Department is pursuing its interest in the extraction of leaf protein as a contribution to the improvement of protein supplies in the underdeveloped countries. Three protein-extraction units have been set up in Lincolnshire, Lucknow and Jamaica, and a pulping machine has been sent to Makerere for an investigation into the prospects of using leaf protein in Uganda. The factors which control the suitability of a crop for leaf-protein extraction are the amount of protein which accumulates in the leaf and the readiness with which it can be extracted. Maize has been found to be particularly useful, as good extraction rates are obtained over a

substantial part of the growing period, thus allowing continuity of production throughout the summer and autumn.

In the Chemistry Department, work on organic manures, soil structure and nutrient uptake has been continued. Attempts have been made to relate laboratory measurements of easily soluble nutrients to nutrient uptake in the field. Variations in such correlations in the past have been caused by variation in the structure of the same soil in different years. Ways of altering the soil structure have been tried in order to distinguish between the nutrient and physical effects of organic manures. Experiments carried out to investigate the way in which root growth and crop nutrition are influenced by soil structure have confirmed the theory that it is the rigidity of pore spaces in the soil rather than their size or continuity which affects root growth. Fertilizer placement experiments and work on nitrogen fertilizers, particularly ways of lessening losses of nitrate by leaching and denitrification, should prove to be of considerable practical significance.

The lay-out of the report, whereby the work of each department is recorded separately, often makes it difficult to deduce how much collaboration there has been between departments. The Plant Pathology report, however, includes an outstanding example of such collaboration, in the work on the cause of farmer's lung disease, which involved the Departments of Soil Microbiology, Plant Pathology and Biochemistry, and the Institute of Diseases of the Chest. Many of the problems in agriculture can only be tackled by interdepartmental co-operation, and it is hoped that the extent of such co-operation might be more clearly indicated in future.

The report contains two special reviews, on mobilization phenomena in soils and on the classic Park Grass Experiment. The character of these two reviews reflects the satisfactory blending of applied and pure scientific research conducted at Rothamsted. In his excellent review of mobilization phenomena, C. J. Bloomfield combines a summary of his own well-known work on the movement of iron in soils with a critical survey of the contributions of other workers in this field. Among the many important points he raises are the need to record the presence or absence of sulphate in investigations of the chemistry of waterlogged soils, and the difficulties involved in ferrous iron determinations in soils containing organic matter.

The report ends with a series of abstracts of papers published by the staff over the year. In all, two hundred and forty papers have been written, which is in itself a fair indication of the substantial contribution made by Rothamsted to present-day agricultural research.

D. A. MACLEOD

THE ELECTRICAL RESEARCH ASSOCIATION

THE activities of the Electrical Research Association throughout the year 1963 are recorded in the forty-third report presented to the annual general meeting held on April 29*.

Perhaps the most notable development is the building up of a substantial research programme in the electronics field. This work, which is concentrated on thin films, is directed towards helping the manufacturer of thin-film devices first by accumulating information about the production of films, the effects of impurities and the factors determining the suitability of materials for particular applications. By providing information on manufacturing techniques such as methods of deposition and on the effect of different vacuum conditions on the performance of products, and by assistance in the analysis

of faults occurring after manufacture, the Association should be able to provide much of the technical background required by industry.

Silicon monoxide, which is widely used for making insulating layers in cryatrons and microcircuits, is being investigated as its dielectric properties are known to be variable and dependent on uncontrolled deposition parameters. The evaporation of films and the investigation of their electrical properties are being carried out using an ultra-high-vacuum system in which the residual gas pressure can be reduced to 10^{-9} torr.

In relation to the deposition of thin metal films, an investigation is proceeding on the production, collimation and control of a beam of metal ions which can be directed at a suitable receiving surface. An arc discharge *in vacuo* between copper electrodes is being used to produce a high density of copper ions. It is thought that this technique will be of importance in the fabrication of thin-film

* The Electrical Research Association, 43rd Annual Report for the year ended 31st December, 1963. Pp. 92. (Leatherhead: The Electrical Research Association, 1964.)