and BrF_4^-, has been demonstrated clearly by conductiometric methods. Bromine trifluoride can function as an ionizing solvent. Thus, those substances such as $BrF_2^+SbF_6^-$, which contain the BrF_2^+ ion, can act as acids, while those such as $K^+BrF_4^-$, which contain the BrF_4^- ion, can act as bases.

Prof. Emeléus then dealt with a new field of chemistry which he and his colleagues have recently opened up and which clearly demonstrates the overlap between organic and inorganic chemistry. It concerns the use of the halogen fluorides as fluorinating agents for organic substances, and of metallic derivatives of fluorocarbons. Iodine pentafluoride can be used to prepare $Hg(CF_3)_2$, $HgCF_3I$ and $Hg(C_2F_5)_2$. Furthermore, the reaction between iodofluoromethane or iodofluoroethane and olefinic hydrocarbons and fluorocarbons has led to a new range of fluorocarbons of high potential importance.

The final paper was given by Prof. M. Stacey (Birmingham), who considered organic fluorine compounds. He dealt initially with methods available for the introduction of fluorine into organic compounds, discussing first those reactions which do not require the use of elementary fluorine. They involve chiefly the replacement of chlorine, bromine or iodine in an organic halide by agents such as the fluorides of hydrogen, silver, mercury, antimony, etc.; and the merits and special applications of these were demonstrated. The influence and stability of fluorine atoms in different positions and in different groups in certain molecules were outlined, and the point made that, in general, elementary fluorine is necessary for complete replacement reactions to give 'φ' or perfluoro compounds. The methods for using elementary fluorine as a fluorinating agent need either fluorine-inert liquid diluting agents or a metallic catalyst such as gold-plated copper. Other fluorinating methods utilize inorganic fluorides such as cobalt trifluoride or silver perfluoride, which at suitable temperatures readily give the lower fluorides of the metal and atomic fluorine. These methods need further study in order to control them for partial fluorinations. Prof. Stacey also dealt with the polymerization of fluoro- and fluorochloro-ethylenes and -butadienes as initial material for fluorocarbon production. The stability of the $-\overset{|}{\underset{|}{C}}-F$ bond may endow fluorocarbons with remarkable chemical and thermal stabilities.

Attention was directed also to many of the unusual properties of fluorocarbons, some of which, for example, the 'Freon' refrigerants and the polytetrafluoroethylene plastics, are already in use in industry. Other uses suggested were for non-inflammable lubricants, hydraulic fluids and plastics; heat-transfer agents, fire extinguishers, and so on. The striking properties of trifluoroacetic acid and its derivatives were described, and the highly toxic nature of substances containing the CH_2F-CO groups, as shown by Dr. B. C. Saunders *et al.* in Cambridge, was used to illustrate how important the organic fluorine compounds may become in biology. It appears that a vast new field of organic chemistry and technology is ahead.

During the discussion which followed, numerous questions were asked of the speakers, and the audience gave a great welcome to Dr. N. V. Sidgwick, who mentioned some anomalous properties of certain fluorine metal bonds.

In connexion with the symposium an exhibition of fluorine cells and fluorine compounds was arranged.

M. STACEY

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

REPORT FOR 1947–48*

THE thirty-third report of the Department of Scientific and Industrial Research covers the year 1947–48, and is almost exactly half the length of the twenty-third report, the last published report of the Department. That report covered the year 1937–38, and it now appears from a note to the present report that the intervening reports, though prepared and formally submitted to Parliament as required by Order in Council, will not be published.

The present report departs considerably in arrangement and content from the pre-war reports. It includes, like them, indeed, the report of the Committee of the Privy Council for Scientific and Industrial Research, signed by the Lord President, Mr. Herbert Morrison, and the report of the Advisory Council over the signature of its chairman, Sir Geoffrey Heyworth. There are the customary lists of assessors and of members of research boards and committees of the Department, of establishments and research associations, statistics of maintenance allowances, research awards and grants, and the expenditure over the whole period is summarized in the usual form. The lists of departmental publications and of publications by individuals in receipt of grants are not, however, appended, either for the year or for the whole period.

The omission is the more noteworthy in that there is nowhere a clear account of the work of the Department during the particular year under review. Much of the Advisory Council's report consists of a review of the years 1938–48, including sections on the post-war development of existing establishments, on the research associations and on other general or broad topics. Scientific workers and industrialists alike will conclude that if the substance of the intervening reports is, indeed, incorporated in the present report, a miracle of compression has been performed.

The largest section of the report of the Committee of the Privy Council is that dealing with the post-war period. Reference is made to the creation of various new organisations, such as the Pest Infestation Research Organisation, in 1940, the Joint Fire Research Organisation of the Department and the Fire Offices' Committee, in 1946, of a separate Radio Research Organisation to absorb and develop the work of the Radio Division of the National Physical Laboratory, and the creation of a new Mathematics Division of the National Physical Laboratory. As a result of reviews of their fields by each of the existing research boards, proposals have been formulated and generally approved for extending the scope of the Department's other research organisations. Between 1937 and 1947 the number of research associations increased from twenty-two to thirty-five, and their total income from a little more than £400,000 to nearly £2·5 million. The expenditure of the whole Department increased from £682,180 in the year ending March 31, 1939, to £1,239,570 in 1945–46, £1,961,293 in 1946–47, and £2,694,061 in 1947–48. In that year net expenditure on the National Physical Laboratory was £381,327, on building research £203,663, on chemical research £51,073, food investigation £116,571, forest products research £71,477, fuel research £149,815, radio research £85,023, road

* Department of Scientific and Industrial Research. Report for the year 1947–8, with a Review of the Years 1938–48. (Cmd. 7761.) Pp. iv+103. (London: H.M. Stationery Office, 1949.) 2s. net.

research £160,979, Geological Survey and Museum £108,306, research association grants £953,387, and grants to students, etc., £204,373. In his survey, the Lord President lays stress on the way effort has been deflected from extended programmes of basic research, and on the extent to which information and advisory services and short-term investigations dominate the Department's work at present. During the period the total staff of the Department increased from 2,153 in 1939, to 2,944 in 1946, 2,989 in 1947, and 3,090 in 1948.

The report of the Advisory Council begins with a brief historical survey and a short note on the Department's work in preparation for war as well as on its war-time activities. The Advisory Council believes that the decision to maintain the Department and its research stations as units and to devise means for applying their resources in whatever directions the changing needs of war should dictate was right, as was the extension of the policy to cover research teams in industry. The procedure was important in holding together research units used to attack special problems arising out of technical developments in warfare. Commenting on the work of the Department in war-time, the Advisory Council refers to the degree of adaptability shown by scientific workers, and this characterized, perhaps in even greater degree, the university scientific men who entered Government research establishments. Brief references are made to the Department's part in the development of the atom bomb and to its pioneer work on radar, but not all the peace-time researches were abandoned. In May 1944 a committee, with Sir Frank Smith as chairman, was appointed to review the whole scope, policy and activities of the Department in relation to post-war needs. Reporting in October 1944, this committee suggested that the needs of firms too small to maintain research staffs of their own required examination and that these needs might be met by a scheme of industrial fellowships. Special consideration of the need for research in mechanical engineering, for more fundamental research on radio, the inclusion of a programme of deep boring as a normal feature of the work of the Geological Survey, and the consideration of formal arrangements for sociological research were also recommended.

Generally, in considering this report, the Advisory Council formed the opinion that the chief need of the Department was that it should equip itself to take the initiative in giving advice and assistance to industry in the use of scientific research and in ensuring that the potential industrial value of new discoveries in science would be recognized and explored without delay. For this purpose a considerably enlarged central Intelligence and Information Division has been established which represents a charge of £23,978 in the year 1947–48. It was decided as a result of inquiry by a special committee, under the chairmanship of Mr. W. F. Lutyens, to leave open for review the question of arrangements for meeting the needs of small firms; but the adoption of proposals for increasing the activities of the Geological Survey involves an increase in expenditure from the 1938–39 figure of £75,000 to about £200,000, with a further £300,000 over five years for the deep-boring programme. Expansion of the work of the Fuel Research Station to a level of £250,000–£300,000, including the work undertaken by the Department on atmospheric pollution; of the Food Investigation Organisation to an eventual £150,000, including doubling the size of the Torry Research Station, Aberdeen; of that of the Building Research Station to at least £250,000 for the next few years; and of the Chemical Research Laboratory to an ultimate scale of £150,000, as compared with £26,000 pre-war, are also recommended. Other proposals approved include those for a new radio research station with a scientific staff of 160 and an eventual annual expenditure of £225,000; for the expansion of work on forest products to a level of £100,000; on the Water Pollution Research Laboratory from the pre-war £9,000 to £50,000; on the Road Research Laboratory to £250,000; while the new Mechanical Engineering Research Laboratory at East Kilbride will call for expenditure of £250,000–£350,000 per annum. The new Fire Research Organisation is expected to operate at a level of about £50,000 per annum, and the Pest Infestation Research Laboratory to a similar level. A review of civil engineering and hydraulics research by a committee under the chairmanship of Sir William Halcrow indicated that the chief gap was in the provision for research on marine works and waterways, and the Advisory Council has approved the committee's recommendation to establish a Hydraulics Research Organisation to operate on a scale represented by expenditure of about £45,000 per annum.

These plans represent an estimated annual expenditure of £2·1 million, and with £500,000 for the National Physical Laboratory and £150,000 for headquarters administration and overseas liaison, bring the figure for the Department's own research programmes at 1946 rates to some £2·75 million. With grants to research associations of £1 million and scientific grants at £100,000, the expenditure of the Department is put at the round figure of £4 million at the costs then ruling. Comparison of this total and of the individual items with the figures already cited shows how far from realization are these planned developments. Rising costs invalidate a strict comparison of figures, and the report emphasizes that staff numbers give a more accurate measure of the advance already made. The scale of expenditure planned represents, at 1946 rates, an increase in the staff of the Department's own organisations from 2,750 to something more than 5,000. The 1948 figure already quoted represents an annual increase of about 170 a year, and unless this rate of expansion is improved it will be many years before the plans can be realized.

Grants to research associations in 1947–48 almost reached the estimate and represent a substantial expansion even when allowance is made for rising costs. A lengthy section of the report reviews the broad policy pursued towards research associations, but it will suffice here to quote the Advisory Council's opinion that it is satisfied that the research association is a sound and effective way of bringing science and industry together. Grants to students and research workers during 1947–48 were double the estimate, but a large proportion is for grants for nuclear physics research, and the Advisory Council, pointing out that the policy of awarding these grants has become more liberal, believes that the grants are achieving their aim of giving full opportunity to potential scientific leaders.

The chief factors limiting the development of the Department's plans have been shortage of staff and lack of suitable buildings, and the Advisory Council clearly recognizes that the Department's claims have to be considered in relation to other claims on the nation's resources. Most of the projects which have had to be set on one side are long-range investigations designed to further our knowledge and understanding of basic principles. The Advisory Council emphasizes in conclusion, however, that the question of striking the right balance between short-range and long-range work, of balancing the need for giving assistance on problems of immediate and pressing importance and the need for providing the basis for more far-reaching advance in industrial technique and practice, on which the continued prosperity of the country must ultimately depend, is the major problem of policy at the present time and is likely to remain so while staff and facilities are limited.

OBITUARIES

Prof. Birbal Sahni, F.R.S.

PALÆOBOTANISTS in many countries heard with regret the news of the sudden death of Birbal Sahni on April 10. His slight figure, his modest personality and polished manners were well known at international gatherings of botanists and geologists; few Indian men of science can have been more widely respected. He was not only a diligent research worker but also a stimulating teacher and a good organiser. He did much to develop his own subject and the cause of natural science in India.

He was born in 1891, the son of Prof. R. R. Sahni, and was educated at Lahore and Cambridge, where he held a Foundation Scholarship at Emmanuel College. After graduating in 1914, he began research under Prof. A. C. Seward on living pteridophytes, gymnosperms and their fossil ancestors. This led to a series of remarkably able papers, several of which were published in the *Philosophical Transactions of the Royal Society*.

Returning to India in 1919, Sahni became professor of botany at Benares for one year, then moved to Lahore, and in 1921 went to Lucknow, where he remained for the rest of his life. There he carried out a long series of investigations on the fossil plants of India, and gathered around him a band of enthusiastic young workers in the same field. New discoveries were made in many different areas, which contributed to knowledge of the vegetation of past ages and often indicated the geological age of the plant-bearing rocks. In recent years he developed the study of micro-fossils and carried out an intensive study of the minute organic remains in the Saline Series of rocks in the Salt Range. These rocks had often been regarded as of Cambrian or Pre-Cambrian age, owing to their occurrence in the field, but they were found to contain a wide variety of micro-fossils which could not be older than Tertiary.

Sahni played a large part in the development of scientific societies in India. He was one of the founders of the Indian Botanical Society and was its president in 1924. He was president of the Indian Science Congress in 1940, twice president of its botanical section and once of its geological section. He had been foreign secretary and president of the Indian National Academy of Sciences. He was awarded the degree of Sc.D. at Cambridge in 1929 and was elected a fellow of the Royal Society in 1936. At the International Botanical Congresses of 1930 and 1935, he was a vice-president of the Palæobotany Section.

During the last ten years Sahni devoted much time to the organisation of an Indian Institute of Palæobotany. Considerable progress had been made with this scheme, and its activities had commenced. A new building to accommodate collections, library and research workers was planned, and its foundation-stone was laid by the Prime Minister, Pandit Nehru, on April 3. It is hoped that this Institute will be a lasting memorial to the distinguished man who was its founder and first director. Sahni was married to a beautiful and talented wife who was his constant companion and helper, and who now presides over the governing body of the Institute.

H. HAMSHAW THOMAS

Prof. G. H. Henderson, O.B.E., F.R.S.

GEORGE HUGH HENDERSON, [illegible]. E. Smith professor of physics, Dalhousie University, and chief superintendent of the Naval Research Establishment at Halifax, died suddenly at the age of fifty-six on his way to a New Brunswick fishing camp. He is survived by his wife, Ruth Wallace Ross Henderson, and two daughters, Nancy and Margaret, the former a science student at Dalhousie.

Chiefly as a result of over-work during the War, his health became seriously impaired in 1944, but he would not give up work until he had a serious breakdown in March 1948. He partly recovered, but still refused to take life more easily. During the last two weeks of his life he took part in the meetings of the Royal Society of Canada, presenting six papers, and attended meetings of the Defence Research Board and the National Research Council.

Prof. Henderson received his B.A. and B.Sc. degrees from Dalhousie University in 1914 with high honours in physics and the Governor-General's Gold Medal. Two years later he received his master's degree and was awarded an 1851 Exhibition research scholarship. Three years later he proceeded to the Cavendish Laboratory, Cambridge, and in 1922 obtained his Ph.D. there. He then went back to Canada as a professor at the University of Saskatchewan, and in 1925 returned to his Alma Mater as professor of mathematical physics. He became a Fellow of the Royal Society of Canada in 1927, and in 1941 was elected to the Royal Society of London.

Prof. Henderson's strong sense of duty led him to serve his country during the two World Wars—in the first as an engineer officer in the Army, and in the second he gave outstanding service to the Royal Canadian Navy in his capacity as a physicist and also in the field of operational research. For his outstanding contributions as superintendent of the Naval Research Establishment he was made an O.B.E. in 1943.

The first of Henderson's twenty-five scientific papers was published while he was still an undergraduate. It was in the comparatively new field of radioactivity, which continued throughout life to be his major research interest. His study of pleochroic haloes and his development of a new method for estimating the age of minerals containing them attracted much attention from both physicists and geologists.

Not only was Prof. Henderson a scientific investigator, but he was also an able teacher. He was revered by his students. He never spared himself and was always ready to spend time and trouble to help serious students. Two characteristics in his character stand out which would seem to conflict but did not. He was an individualist, independent, did his own thinking and made his own decisions.