COLONIAL OFFICE

COLONIAL RESEARCH 1950—1951

REPORTS OF THE

Colonial Research Council
Colonial Products Research Council
Colonial Social Science Research Council
Colonial Medical Research Committee,
Committee for Colonial Agricultural,
Animal Health and Forestry Research
Colonial Insecticides Committee
Colonial Economic Research Committee
Tsetse Fly and Trypanosomiasis Research Committee
Colonial Fisheries Advisory Committee
Director, Anti-Locust Research Centre

Presented by the Secretary of State for the Colonies to Parliament
by Command of His Majesty
July 1951

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REPORTS IN THIS VOLUME

(Each Report is preceded by a full list of Contents)

Colonial Research Council Annual Report on Colonial Research 1950-1951

The Church House,
Great Smith Street,
Westminster, S.W.1
7th June, 1951.

SIR,

As Chairman of the Colonial Research Council, I have the honour to transmit to you the Council's Annual Report on Colonial Research for the year 1950–51.

I have the honour to be,
Sir,
Your obedient servant,
(sgd.) J. DUGDALE.

The Right Honourable James Griffiths, M.P.,
Secretary of State for the Colonies.

COLONIAL RESEARCH COUNCIL

Membership

THE MINISTER OF STATE FOR THE COLONIES (*Chairman*).

THE DEPUTY UNDER-SECRETARY OF STATE IN CHARGE OF ECONOMIC AFFAIRS (*Vice-Chairman*).

SIR ALEXANDER CARR-SAUNDERS, M.A., LL.D. (Chairman, Colonial Social Science Research Council).

DR. W. J. HALL, C.M.G., M.C. (Chairman, Colonial Insecticides, Fungicides and Herbicides Committee).

THE RT. HON. LORD HANKEY, G.C.B., G.C.M.G., G.C.V.O., F.R.S. (Chairman, Colonial Products Research Council).

DR. H. P. HIMSWORTH, M.D., F.R.C.P. (Chairman, Colonial Medical Research Committee).

SIR BEN LOCKSPEISER, K.C.B., D.Sc., M.I.Mech.E., F.R.AE.S., F.R.S. (Department of Scientific and Industrial Research).

SIR ARNOLD PLANT (Chairman, Colonial Economic Research Committee).

SIR EDWARD SALISBURY, C.B.E., D.Sc., F.R.S. (Secretary, The Royal Society).

SIR JOHN SIMONSEN, D.Sc., F.R.S. (Director of Colonial Products Research).

PROFESSOR R. H. TAWNEY (Professor of Economic History, University of London).

DR. NORMAN WRIGHT, M.A., F.R.I.C. (Chairman, Committee for Colonial Agricultural, Animal Health and Forestry Research).

MR. J. G. HIBBERT, C.M.G., M.C. (*Secretary*).

Terms of Reference

The terms of reference of the Council are to advise the Secretary of State for the Colonies on general questions relating to research policy in the Colonial Empire or for its benefit; to co-ordinate the work of the various committees which at present advise the Secretary of State on special aspects of research; and to tender advice to the Secretary of State on research matters not falling within the province of any of these committees.

COLONIAL RESEARCH COUNCIL

ANNUAL REPORT ON COLONIAL RESEARCH FOR 1950–51

CONTENTS

The following fields of research are dealt with in the accompanying separate reports:—

Agriculture, Animal Health and Forestry.

Colonial Products.

Economic.

Fisheries.

Insecticides.

Locust Research and Control.

Medical.

Social Science.

Tsetse Fly and Trypanosomiasis.

COLONIAL RESEARCH COUNCIL

(1950-1951)

INTRODUCTORY

1. As in previous years, the report of the Council deals with research matters not covered by the reports of the specialist advisory research committees, which are annexed to it. The latter have hitherto comprised Agricultural, Animal Health and Forestry, Colonial Products, Economic, Insecticides, Fungicides and Herbicides, Medical and Social Science research, but this year they are being augmented by reports on Fisheries research, Anti-Locust research and Locust control and Tsetse and Trypanosomiasis research, as it has been felt that the great importance of these three fields justifies their being made the subject of individual reports.

2. Dr. Alexander King ceased to be a member of the Council at the beginning of the year following his transfer to the Department of Scientific and Industrial Research. Dr. W. J. Hall, C.M.G., M.C. replaced Professor P. A. Buxton, C.M.G., F.R.S. as a member of the Council, on succeeding the latter as Chairman of the Colonial Insecticides, Fungicides and Herbicides Committee.

3. The following visits to Colonial territories on scientific business were paid by members of the Council during the year under review:—Sir Alexander Carr-Saunders and Dr. Wright to East Africa, Dr. Himsworth to West and East Africa, Sir Arnold Plant to the West Indies and Sir John Simonsen to Trinidad and Jamaica.

I. GENERAL

Colonial Development and Welfare Research schemes made in 1950/51 *and their cost.*

4. A list of the schemes made during the year and the grant allotted in each case from Colonial Development and Welfare funds is given in Table I of the Appendix. The schemes comprise 57 new schemes and some 60 supplementary schemes, and the total sum allotted to them amounted to £2½ million, which, as shown in Table II, is the highest annual figure recorded and brings the total sum granted for research schemes since 1940 to about £10¼ million. From this last figure must, however, be deducted some £600,000 arising from unspent balances on completed schemes, revision of schemes, etc., so that the net expenditure and commitment on the 31st March, 1951, was of the order of £9·6 million, of which slightly over £9·3 million is chargeable against the funds provided by the 1945 and 1950 Colonial Development and Welfare Acts. The financing of many of these schemes is assisted by Colonial Governments from their own resources. It is estimated that the additional assistance provided in cash or in kind by Colonial Governments or industry since 1940 can be represented by a figure of the order of £2 million. Table III shows the actual disbursements made during each of the financial years since 1940/41. It will be noted that the disbursement during the year under review, £1,406,651, out of a total of £4,256,464, is the highest recorded and indicates that many of the major schemes whose progress has been hampered by shortages of scientific personnel, labour, building material and equipment, are now getting well under way.

5. About 31·5% of the gross allocation of £10¼ million has been for agricultural, animal health and forestry schemes, 14·4% for fisheries research, 13·7% for medical research, 11·9% for tsetse and trypanosomiasis research, 8·4% for social science and economic research, 6·3% for insecticides research, 4·6% for research sponsored by the Colonial Products Research Council, 3·3% for anti-locust research and 5·9% for miscellaneous schemes, including industrial and engineering projects. Approximately 38·8% of the gross allocation has been for schemes to benefit the East African territories, 17·2% for the West African group, 10·3% for the South-East Asian territories and Hong Kong, 10·0% for the West Indian Colonies, British Guiana and British Honduras, 7·6% for the Central African territories (Northern Rhodesia and Nyasaland) and 16·1% for other territories and for schemes of general interest.

6. The 1945 Act provided a total sum of £120 million available until the 31st March, 1956, for schemes to promote Colonial development and welfare, and this total was increased to £140 million by the 1950 Act. Out of this sum it has been found possible to allocate a total of £13 million for Colonial research schemes. By the middle of 1950 it became evident that the commitments against these funds were becoming formidable, and at the 30th September, 1950, they had reached the approximate figure of £8·3 million. The Secretary of State decided that the balance of £4·7 million must be apportioned between the various fields of research, after setting aside a certain sum as a reserve to meet unforeseen contingencies during the next 5½ years. The position was carefully reviewed in the Colonial Office and the Council were invited to consider the apportionments which the examination had suggested would be fair and reasonable. The Council in December recommended that the following apportionments should be made:—

	£
General reserve	425,000
Agriculture, Animal Health and Forestry research	1,300,000
Work sponsored by the Colonial Products Research Council...	200,000
Anti-Locust research	100,000
Insecticides (including fungicides and herbicides) research ...	550,000
Tsetse and Trypanosomiasis research	425,000
Fisheries research	475,000
Medical research	600,000
Social Science research	325,000
Economic research	100,000
Miscellaneous research (including industrial and engineering research)	200,000
	£4,700,000

7. The Council endorsed a proposal of the Colonial Office that the various specialist advisory research committees and councils should be asked to make recommendations as to how the funds apportioned to their respective fields of research could most profitably be employed to meet all new money required during the next five years, including provision for the renewal of important schemes whose currency was due to expire within that period. The Council also supported a suggestion by the Colonial Office that the specialist committees should be invited to earmark about 15% of the apportionments as a reserve

against unforeseen contingencies, these reserves constituting, as it were, the first line of defence, and the general reserve of £425,000 the second line. In this way about one-quarter of the sum of £4·7 million would be put aside as a reserve. The Council recommended that any unspent balances arising from completed schemes should be added to the funds apportioned to the field of research to which the schemes related.

8. The Secretary of State accepted the recommendations of the Council, and by the end of the year under review the specialist advisory committees had begun their task of assessing priorities. All Colonial Governments were informed of the position described above in a circular despatch dated the 25th January, 1951, and urged to do their utmost to aid the position by contributing the maximum assistance they could from their own resources.

9. The limitation of funds will inevitably affect the progress which has hitherto been made, and the next few years will largely have to be spent in consolidating work begun. The money available should enable important long-term major projects to be continued on a limited scale or started, but a heavy curtailment in short-term and *ad hoc* projects will be inevitable.

10. The schemes made during the year under review include grants for the training at the headquarters of the East African Agriculture and Forestry Research Organisation of ecologists for the Colonial Empire under the supervision of Mr. C. G. Trapnell, lately Ecologist in the Northern Rhodesia Department of Agriculture, and of termite research workers under Mr. W. V. Harris, lately Senior Entomologist in the Uganda Department of Agriculture; for the award of agricultural and veterinary research studentships prior to appointment in Colonial territories; for the institution of agricultural research and for silvicultural and ecological investigations and the establishment of forestry research centres in Northern Rhodesia; for the establishment of an agricultural research and experimental station in Nyasaland; for the erection of laboratories for research into animal diseases by the East African Veterinary Research Organisation; for the establishment and maintenance of a marine fisheries research station in Singapore to serve the South East Asian group of territories and for the maintenance of the West African Fisheries Research Station in Sierra Leone; for the work of the East African Medical Survey and Filariasis research unit, and for the continuance of the work of the scrub typhus research team in Malaya and for malaria research in North Borneo, Sarawak and Brunei; for the continuance of the successful work on mosquito eradication in Mauritius and of the insecticides research team assisting the campaign; for the further work of the Colonial Insecticides research team in the United Kingdom; for the Desert Locust Survey operating in East Africa and other affected territories, and for preliminary aerial curtain anti-locust experiments in East Africa; for the establishment and maintenance of the East African Central Trypanosomiasis Research Institute and West African Trypanosomiasis Research Institute, and the services of the East African Tsetse and Trypanosomiasis Research and Reclamation Organisation; for the work of the Colonial Microbiological Institute in Trinidad; for the continuation of the work of the Colonial Building Research Liaison Officer and his staff; for the establishment and maintenance of the East African Institute of Social and Economic Research; for experiments in the mechanical handling and retting of jute in the United Kingdom, Nigeria and British Guiana; and to cover the sterling expenditure involved by investigations by American experts nominated by the Economic Co-operation Administration into flood conditions on the Kafue Flats in Northern Rhodesia, and into schistosome-transmitting snails in West Africa.

Colonial Research Service

11. Following the recommendations of the Chorley Committee on Remuneration of the Higher Civil Service and the resulting revision of the salary scales for the grades of Chief Scientific Officer, Deputy Chief Scientific Officer and Senior Principal Scientific Officer in the United Kingdom Scientific Civil Service, it became necessary to apply these revised scales to posts in those grades in the Colonial Research Service, since the United Kingdom Scientific Civil Service salary scales form the basic salary scales for research workers other than medical research workers in the Colonial Research Service. The recently revised salary scale for the Principal Scientific Officer grade has also been adopted for the Colonial Research Service.

12. The application of these revised scales and the consequential adjustment of the rates of overseas research allowance is under consideration in consultation with Colonial Governments.

13. The Colonial Superannuation Scheme was introduced on the 1st January, 1951, and steps are being taken to admit to the scheme members of the Service.

Research Appointments

14. Appointments made during the year under review include the Directors of the East African Marine Fisheries Research Station in Zanzibar and the Fish Culture Research and Training Institute in Penang, and the Secretary for West African Agricultural and Forestry Research. Twenty appointments have been made to the Colonial Research Service since the announcement of the introduction of the Service was made on the 31st January, 1950. Over eighty qualified research workers employed in the Colonies on research under Colonial Development and Welfare Research schemes at the time the Colonial Research Service was introduced have been recommended to the Colonial Governments concerned for transfer to the Service. Recommendations are also being made to the Colonial Governments concerned for the admission to the Service of qualified research workers engaged on research in the Departments of the Colonial Administrations.

Colonial Research Fellowships

15. One Fellowship was awarded during the year to a graduate from Canada to undertake a study of one of the ungulates in Tanganyika.

Colonial Research Studentships

16. Fifteen students who have been awarded Colonial Research studentships in various fields are receiving training in research with a view to appointment as research workers in the Colonies. Further Colonial Research studentships will be awarded which will be tenable for training in research from October, 1951.

Establishment of a Scientific Council for Africa South of the Sahara

17. The setting up of this Council was forecast in paragraph 15 of last year's Report, in which was given an outline of the Council's main functions. All the Governments concerned agreed to the proposal, and the Council was duly established. The Chairman is Dr. P. J. du Toit (Union of South Africa) and Dr. E. B. Worthington, at present Scientific Secretary to the East Africa High Commission, has accepted appointment as Secretary-General. Sir Alexander Carr-Saunders is a member of the Council.

18. The Council held its first meeting at Nairobi last November. At the meeting it was agreed that one of its more important functions would be to

examine and, where necessary, encourage and aid the development of long-range and fundamental research projects, which might have an important influence on the development of Africa but whose ultimate success could not be guaranteed, and to assist the various Governments by drawing attention to scientific knowledge acquired and available in Africa which could usefully be brought to bear on practical problems. The Council reviewed the various recommendations made by the 1949 African Regional Scientific Conference and classified them in orders of priority.

Co-operation between Colonial Governments and the Department of Scientific and Industrial Research.

19. The progress made in the fields of building, road and water pollution research is recorded in the second part of this report. It has unfortunately not yet been possible to find a suitable officer for appointment as Colonial Liaison Officer with the Pest Infestation Laboratory.*

20. The possibility of appointing a Liaison Officer at the Torry Research Station in Aberdeen and Colonial official correspondents with that Station is being examined by the Colonial Office and the Department of Scientific and Industrial Research.

Assistance by American scientists provided by the United States Economic Co-operation Administration under Marshall Aid.

21. During the year under review an American hydrologist and an expert engineer were engaged to carry out a survey of flood conditions on the Kafue Flats in Northern Rhodesia, and a malacologist was secured to undertake an investigation into the schistosome-transmitting snails in West Africa. A fourth scientist has been assisting on locust research at Cambridge. A plant pathologist will visit British Guiana in the immediate future to advise upon the leaf scald disease of sugar which is causing grave anxiety, and a soil physicist will study soil laterisation phenomena in West Africa.

Colonial Research Publications

22. The following reports were approved during the year for publication by His Majesty's Stationery Office.

Colonial Research Publications series:

Locust Research and Control, 1929–1950, by Dr. B. P. Uvarov, C.M.G., D.Sc., F.R.S., Director of the Anti-Locust Research Centre. (Publication No. 10. 5s. 0d. net.)

Colonial Research Studies series:

No. 1. Social Science Research in Sarawak, by E. R. Leach, M.A., Ph.D. (8s. 6d. net.)

No. 2. Report on Buildings of Architectural or Historic Interest in the British West Indies, by A. W. Acworth, B.Litt., M.A. (4s. 0d. net.)

No. 3. Two Studies in Applied Anthropology in Kenya, by U. P. Mayer, Ph.D. (2s. 6d. net.)

No. 4. Nandi Work and Culture, by G. W. B. Huntingford, B.Sc. (8s. 6d. net.)

Mr. J. S. Watson's report on the Rat Problem in Cyprus, referred to in last year's report, has issued as Colonial Research Publication No. 9 (3s. 6d. net), and Mr. E. O. Longley's report on Contagious Caprine Pleuro-pneumonia in Nigeria has issued as Publication No. 7 (4s. 0d. net.)

* Since the preparation of this Report, an appointment has been made.

II. RESEARCH MATTERS NOT COVERED BY THE ACCOMPANYING REPORTS OF THE SPECIALIST ADVISORY BODIES

A. *African Administration (including Local Government, Land Tenure and Native Law).*

23. The African Studies Branch of the Colonial Office continued to carry out research into the problems of African administration and to provide comparative information on a number of questions as they arose. Members of the Branch attended meetings of many research committees and continued to help to maintain a liaison between research workers and the African administrations. Following the survey of racial discrimination in the African trust territories, a further survey was made of racial differentiation in the laws of all the African territories. The detailed study of present African constitutions mentioned last year was completed. In addition, other studies were made including a comprehensive one of the various proposals for local government in the Gold Coast. The Branch also assisted largely in the preparation of material covering general policy and practice relating to land law, tenure, alienation and utilization in the Trust Territories in Africa for the Trusteeship Council of the United Nations Organisation. Digests were made of all legislation and reports on local government, native law and land tenure for publication in the *Journal of African Administration* which is edited in, and produced quarterly by the Branch.

24. The preliminary papers for consideration by Colonial Service Officers at the 1951 Conference on African Administration were prepared by the Branch on the following aspects of local government:

(i) the political aspect;
(ii) the machinery of local government;
(iii) the financing of local government;
(iv) local government and community development;
(v) local government and law and order;
(vi) the Administrative Officer, the Technical Officer and local government.

25. Mr. R. S. Hudson, C.M.G., the Head of the Branch, visited Nyasaland during the latter half of 1950 with the object of making a first-hand study of the system of local government there.

26. The Survey by Lord Hailey, *Native Administration in the British African Territories*, has been published by His Majesty's Stationery Office in four parts. Part I deals with Uganda, Kenya and Tanganyika; Part II deals with Nyasaland, Northern Rhodesia and Zanzibar; Part III with Gambia, Gold Coast, Nigeria and Sierra Leone; and Part IV contains Lord Hailey's Summary and observations on the report.

27. *Land Tenure.* The Colonial Land Tenure Advisory Panel met under its Chairman, Lord Hailey, to advise on proposed investigations into native land customs in the British Solomons Islands Protectorate and into the system of land tenure in the Somaliland Protectorate. The compilation of an annotated bibliography of published sources relating to land tenure in the South-East Asia and Pacific Colonial territories prepared under the direction of the Panel has been completed and arrangements have been made for it to be reproduced. Work on the revision of the two parts of a provisional paper on land registration by the late Sir Ernest Dowson and Mr. V. L. O. Sheppard has now been completed by Mr. Sheppard and arrangements are in hand for the publication of these, together with certain articles written by the authors

for *Empire Survey Review*, and short descriptions of the systems of land registration in certain foreign jurisdictions, in the form of a standard text-book on the subject.

28. *Local Government.* The Colonial Local Government Advisory Panel has met frequently during the year to consider problems arising from the development of local government in the African territories. The Panel has discussed the Reports arising from the visits to Sierra Leone of Mr. R. S. McDougall, and to Trinidad of Sir John Imrie and Sir Charles des Forges. The Panel has given advice on two Mauritius Local Government Bills, and a sub-committee has been engaged in studying the question of local government finance in the African territories.

29. *Native Law.* The Colonial Native Law Advisory Panel met to discuss the Tanganyika Local Courts Bill, which was referred to it by that government for comments.

B. *Building Research.*

30. The Colonial Building Research Liaison Officer presented his report on his visit to Africa in the autumn of 1949, which was considered and endorsed generally by the Council at a meeting attended by the writer. In his report Mr. Atkinson emphasised the need for encouraging the better use and improved manufacture of local materials and more economic building design. He pointed out that one of the main deterrents to the greater use of locally-made building materials was their poor, and especially their variable, quality. Mr. Atkinson considered that a remedy for this could be found by strengthening or establishing facilities for the testing of building, and civil engineering facilities, and instanced the example set in Kenya, whose Public Works Department had a materials laboratory in charge of a senior officer who was able to advise the Director of Public Works on the development of materials as well as being responsible for the work of the laboratory. Mr. Atkinson felt that any such laboratories could be concerned both with building and road materials. As regards research and experiment, problems which required urgent study included the behaviour of materials in tropical climates, the development of material manufactures and methods of construction suitable for African conditions, the design of buildings for comfort in hot climates and low-cost housing for the rapidly increasing African urban population. Amongst the materials requiring study were paints and bitumens. Research was also needed into the penetration of moisture through building materials, and how the resistance of native materials to insect and mould attack could be fortified. The behaviour of black cotton and other unstable soils, and the design of satisfactory but economical foundations in such soils were other important questions. This last problem was discussed by Mr. Atkinson with the Kenya authorities in the course of a brief visit paid by him in June.

31. The report has been sent to the various Colonial Governments concerned for their examination and observations, and also a report by Mr. Atkinson dealing with " School Buildings in the Colonies ".

32. In the last three months of the year under review Mr. Atkinson visited the Colonial territories in the Caribbean area.

33. As regards the activities conducted from the Building Research Station, much of the information conveyed by Mr. Atkinson to his official Colonial correspondents by means of circular letters proved to be of wide interest

and many requests for further copies were received. To meet this demand, a new series of illustrated " Colonial Building Notes " was started, which is now circulated to some 500 interested individuals and organisations, more personal contacts being maintained through the circular letters. Discussions took place with many visitors from the Colonies, and with some organised groups, including a group of Colonial Directors of Education concerned with the provision of schools. A ten-day course at the Station was organised in September, and was attended by sixteen Colonial architects and engineers.

34. Enquiries received and dealt with by correspondence markedly increased during the year. Many of these concerned the selection of building materials for various applications. For example, advice was given to British Honduras on the probable performance of different types of cement in foundations in contact with ground water of high sulphate content, and to the South Pacific Commission on the use of coral for buildings. Much interest was also shown in earth construction.

35. A number of Colonial Governments have signified that they will be represented at the Building Research Congress which is being convened in London in September, 1951.

36. The manual relating to the protection of buildings and timber against termites, referred to in paragraph 41 of the Council's report for 1949–50, has been published.*

C. *Demography and Censuses.*

37. It is hoped that Volume III of the " Demographic Survey of the British Colonial Empire ", based on material prepared by the late Dr. R. R. Kuczynski, will be published in the course of the forthcoming year.

38. As indicated in last year's report, at the beginning of 1950 there were few Colonial territories which had not taken a population census since the outbreak of the war. The First Conference of Colonial Government Statisticians, held in the Colonial Office in March, 1950, recommended that the few territories which had not held a census during recent years should be encouraged to do so as soon as possible; and that territories which had held a census during the war or early post-war years should endeavour to arrange their next census to fall approximately at the middle of the period between the date of their last census and 1960.†

39. A census was held in Bermuda during October, and one will be taken in North Borneo in 1951. A census in Lagos was held in February, 1950, and one covering the whole of Nigeria is being planned to take place during the winter of 1952–53. During the latter part of 1950 a detailed sample survey of the African population was made in Northern Rhodesia, the survey in rural areas being based on a sample of about 1 in 20 villages. The information on births and deaths obtained from this survey should enable estimates to be framed of the rate of growth of the population, a matter of fundamental importance. A census of non-Africans and of Africans in employment in Northern Rhodesia will be made in 1951.

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* " The Protection of Buildings and Timber against Termites " by W. D. MacGregor, C.B.E., B.Sc.—Department of Scientific and Industrial Research: Forest Products Research Bulletin No. 24. (H.M.S.O. 1950 1s. 9d. net).

† First Conference of Colonial Government Statisticians, 1950, Report (Colonial No. 267). (H.M.S.O. 9d. net).

D. *Engineering Research.*

40. The Crown Agents' Engineering Advisory Branch, although principally concerned with the furnishing of practical technical information, maintained close contact with the Colonial Liaison Officers of the Road Research Laboratory and the Building Research Station. The question of the value of certain vegetable products of tropical origin for improving the standard of construction of low cost roads in the tropics was taken up with the Road Research Laboratory, but no definite conclusion has so far been reached. The Branch undertakes the arrangement of technical study courses and visits to works of modern professional interest, when such facilities are required for Colonial Officers on leave.

41. Research matters dealt with in the " Crown Agents Review " during the past year included an article on the " Composition of Earth Roads " by a member of the Road Research Laboratory, an article on locust research, a note on the Mechanical Engineering Research Organisation and an article on " Science and Paint Manufacture ".

E. *Geodetic and Topographical Surveys.*

42. The work of the Directorate of Colonial (Geodetic and Topographic) Surveys continued mainly on topographic surveys.

43. Recruitment of staff has progressed. In the cartographic grades the intake now consists almost entirely of " teen-agers " and training is necessarily longer. This fact, coupled with a drain to National Service a year or so after recruitment, has slowed up expansion of map production. All grades of staff within the Directorate can now be considered for establishment and the necessary steps are being taken to fill permanent posts.

44. A new building for the Headquarters of the Directorate is nearing completion at Tolworth. It is hoped to move the Headquarters early in the summer and conditions of work will be a great improvement upon the present overcrowded building.

45. Field Survey work has continued, mainly in Africa. Small parties have been continuously in the field in British Guiana and North Borneo, have completed a task in eastern Uganda, commenced work in Basutoland and recommended work on geodetic triangulation in Nyasaland. The main effort has, however, been on the East and Central African rail-link areas. Parties have worked from Utengule in Tanganyika westwards to Mbeya, south westwards through Tunduma to Kasama and south through Mpika to Kpiri Mposhi. Control has been supplied for mapping a belt of country astride the proposed route despite difficult country and adverse weather; the total area covered being about 20,000 square miles.

46. The Royal Air Force continued air-photography in East, Central and West Africa. In the first months of the year under review all available resources were concentrated on completion of the rail-link area. Owing to adverse weather, gaps still exist, particularly east of Lake Nyasa, which it is hoped to fill in 1951. In addition, Basutoland was photographed. In August the Squadron moved to West Africa and operated in Northern Nigeria and in the Gold Coast. The weather was good in Nigeria and 130,000 square miles have been successfully photographed. In the Gold Coast weather was good in the north but far less favourable in the Volta River areas where gaps still exist. Some photography has also been achieved in Sierra Leone. A contract was placed commercially for air photography in the Caribbean area. 8,000 square miles have been successfully photographed in British Guiana.

Other areas photographed are British Honduras (about 2,000 sq. miles) Jamaica (about 600 sq. miles), Trinidad (about 560 sq. miles), Barbados (complete cover), Grenada (complete cover), also some photography in St. Vincent, St. Lucia and Dominica. Contracts have also been placed commercially for air photography in Fiji and Bechuanaland.

47. Mapping has increased; over 200 preliminary plots have been published at scale 1:50,000 including over 80 in the rail link area. The actual plotting of maps being the last of the three main operations (field survey, air-photography and mapping), the rush on the rail-link areas was not really felt until early in 1951 and overtime working was necessary to complete the programme in time. Other maps have been produced varying from small scale maps of Grahamland to large scale contoured town plans of North Borneo. Work has continued on a new edition of the map supplement to the Colonial Office List.

F. *Geological Surveys*:

48. In addition to completing more geological mapping than in any previous year, considerable progress has been made in the investigation of mineral deposits. For instance, promising deposits of bauxite (aluminium ore) have been found in Sarawak; seams of good quality coal are being investigated in the Benue Province of Nigeria, 60 miles north of the Enugu Colliery; lead-zinc deposits are undergoing examination in Southern Nigeria; and the soils of the Tororo carbonatites in Uganda are being examined as possible economic sources of iron and phosphate. Geological studies have been made of large engineering projects and a great deal of successful water-supply work has been done.

49. There are geological survey departments in Nigeria, the Gold Coast, Sierra Leone, Uganda, Kenya, Tanganyika, Nyasaland, Swaziland, Bechuanaland, the Federation of Malaya, Sarawak and North Borneo, British Guiana and Jamaica, and small surveys have also been started in Northern Rhodesia, the Aden Protectorate, British Honduras, Cyprus and the British Solomon Islands Protectorate. There is a Government Geologist also in Trinidad who includes in his programme the preparation of a geological map which will contain the results of the investigations by the different Trinidad oil companies.

50. During the year, 52 additional geologists, geophysicists and chemists were appointed and most of the Colonies have now practically completed the expansion of their Geological Survey Departments made possible by grants under the Colonial Development and Welfare Act. In addition, as anticipated in the Reports of the last two years, eighteen American and Canadian geologists and allied technicians have been secured this year through the Economic Co-operation Administration and these men are supernumerary to Establishments, and do not occupy posts open to British and Commonweath geologists. With these staff increases the Colonies have been able to give their neighbours increased help in geological problems; Nigeria seconded a senior officer to Aden and a senior officer of British Guiana is spending one year in British Honduras to see whether there are possibilities of mineral deposits in certain areas; the Director of Geological Survey, British Guiana has visited the Leeward Islands and other West Indian dependencies and has assisted in preparing various schemes to provide geological assistance.

51. The Universities are continuing their investigations into problems of Colonial geological research and they are now being asked to extend their interest still further. Two members of the teaching staff of Imperial College,

London, visited Tanganyika; the Professor of Geology of the University of Sydney took a party to the British Solomon Islands, and it is expected that the expedition will be repeated in subsequent years and that some continuity of research will continue there; a Geophysicist from the University of Glasgow spent his long vacation making a gravimeter survey in the Albert Rift Valley of Uganda.

52. Dr. F. Dixey, Geological Adviser to the Secretary of State and Director of Colonial Geological Surveys, visited Accra to attend the first Conference of Directors of the West African Geological Surveys, and there were present also the Assistant Director of Mines of French West Africa, and the Professor of Geology at the new University College of Accra. Arrangements were made for co-operation between the British and French Geological Surveys in the solution of certain geological problems of correlation. Afterwards, Dr. Dixey visited the West African Colonies to discuss Geological Survey activities, organisation and staff, and to see something of the latest developments of the mining industries. He again visited West Africa in order to attend the second Conference, which was held in February, 1951, at Jos in Northern Nigeria. French observers from Paris, Dakar and the Cameroons attended this Conference; leading members of the Nigerian mining community also took part, and assisted in the subsequent field excursions to places of mining and geological interest. A Conference of East African Geological Surveys was held at Nairobi, and the Geological Surveys of British Guiana, Dutch Guiana and French Guiana met in Surinam to discuss certain common problems.

53. The Directorate in London arranged various courses of instruction for geologists and chemists on leave from overseas and for newly-appointed men. A three-weeks course in photogeology was attended by 32 geologists. The Mineral Resources Division of the Directorate has continued to be actively engaged on a wide range of chemical analyses and other investigations connected with Colonial mineral resources. It has also dealt with numerous enquiries regarding mineral occurrences, products and trade received from officials, firms, and individuals at home and overseas, and it has prepared a number of reports. This Division is responsible for the new periodical " Colonial Geology and Mineral Resources ", the first issues of which have already appeared. It succeeds the Mineral Resources section of the former Bulletin of the Imperial Institute but is planned on more comprehensive lines and with a definite Colonial viewpoint.

54. The Directorate also has a Photogeological Section which has maintained liaison with Directors of Geological Survey and prepared photogeological maps of suitable areas. These include provisional maps prepared in advance of field work, extensions of areas already mapped in the field, or maps supplementing field reconnaissance mapping; photogeological maps were prepared, for example, of large areas in Sarawak, Uganda, and Tanganyika, and of a smaller area in Nyasaland. The Section is stationed at Bushy Park at the headquarters of the Colonial Geodetic and Topographic Surveys, where it has ready access to a very large number of air photographs.

55. Dr. Shaw of the Directorate visited the headquarters of the United States Geological Survey and also the Geological Survey of Canada to study their photogeological and geophysical organisations. By arrangement with the Nigerian Geological Survey, he later spent six weeks on the Plateau Tinfields of Northern Nigeria making a trial application of magnetic and resistivity methods in the location of sub-basaltic tin leads.

G. *Meteorology.*

56. The main emphasis has again been on developing the Colonial meteorological services, where the principal development has been the progress towards a West Indies Meteorological Service, covering the West Indian Colonies and the Bahamas, with headquarters in Trinidad. A conference of representatives of the Colonies concerned met in January, 1951, and recommended the basis on which the unified service should be established. It is hoped that the service will be formally established before the middle of 1951. There has also been further progress towards establishing and defining the scope of the meteorological service covering the territories in the South-East Asia region, with headquarters in Singapore.

57. This preponderant attention to administrative and development questions has not hindered progress in the programme of radio sonde/radar wind stations and the facilities they will provide for the study of upper wind conditions. The meteorological research being undertaken by the Falkland Islands Dependencies Survey has continued, and programmes of research into a variety of meteorological matters, including ionospherics and geomagnetics, are being considered.

58. A memoir dealing with " The Properties of the Upper Air over Singapore " by Mr. I. G. John, B.Sc., Malayan Meteorological Service, based on data obtained from flights carried out by aircraft of the Far East Air Force, R.A.F. during the period December, 1946, to July, 1948, was published during the year.* In Hong Kong, steps are being taken by the Royal Observatory to restore the seismological station which existed before the war, and studies of atmospheric pollution, rainfall intensity and evaporation are also planned. A paper by Mr. L. Starbuck, Assistant Director of the Observatory, entitled " A Statistical Study of Hong Kong Rainfall " was published during the year, and one on " Hong Kong Typhoons " by the Director, Mr. G. S. P. Heywood, was being printed at the end of the year.

H. *Oceanography.*

59. The National Institute of Oceanography, whose establishment was referred to in last year's report, published its first annual report in February, 1951.† The Institute is administered by a National Oceanographic Council, incorporated by charter, on which the Secretary of State is represented, and has taken over the Oceanographic Group of the Royal Naval Scientific Service at the Admiralty Research Laboratory at Teddington. The Director is Dr. G. E. R. Deacon, F.R.S.

60. Although the Institute will be concerned with a number of immediate problems bearing on navigation and natural resources in the oceans, including whaling, it will aim at undertaking such basic research as is likely to lead to a clearer understanding of the natural processes which underly all physical and biological events in the oceans, and be useful to every systematic attempt to improve the use of the sea and its products. The larger part of its staff will be concerned with the physical aspects, and will extend work already done on waves and associated phenomena to a detailed investigation of the cause and effect of all large and small scale water movements in the oceans.

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* Memoirs by the Malayan Meteorological Service No. 4. (Government Printer, Singapore).

† Annual Report of the National Institute of Oceanography, 1949–50. (Cambridge University Press—5s. net).

61. On the biological side, one of the duties of the Institute is to complete the investigations carried out by the former Discovery Committee. The R.R.S. " Discovery II " left Plymouth in May, 1950, to carry out surveys in parts of the Indian, Australian and Pacific sectors of the Southern Ocean. Observations in the Falklands sector during the winter were also planned. The principal object, as on previous voyages, was to secure information regarding the major oceanographical features of that ocean, i.e. the disposition, limits and movements of the main water masses and the sea-ice; the bottom topography; and the distribution, circulation and seasonal variations in the ocean flora and fauna. Another essential aim was to acquire a proper understanding of the distribution and migration of whales. The ship is expected to return to England at the end of 1951. The R.R.S. " William Scoresby " left London in January, 1950, to mark whales in the South Atlantic and Indian Oceans and to carry out a survey of the special water and biological conditions in the region of the Benguela Current off South-West Africa.

62. One of the Institute's main preoccupations is the encouragement and training of young post-graduate students to apply their specialised knowledge to marine research. It is in this field that its work is most likely to benefit marine investigation in the Colonies.

63. A Scientific Bureau has been established in London to deal with specimens and data accumulated by the Falkland Islands Dependencies Survey.

I. *Road Research.*

64. During September and October of 1950 the Colonial Road Research Liaison Officer (Mr. H. W. W. Pollitt) visited Kenya, Uganda, Tanganyika and Zanzibar to make personal contacts, to see at first hand the road problems of East Africa, and to consider how these might be tackled. A report on his visit is shortly to be issued; the following are some of the main conclusions:—

(i) The fundamental problem of large road mileages and inadequate funds exists in East Africa as in West Africa.

(ii) The more technical road problems of East Africa are broadly similar to those of West Africa but are aggravated by the greater prevalence of poor quality soils and roadstones.

(iii) There is an urgent need for research on the properties of colonial soils, and roadstones, and of indigenous materials such as " kankar ", coral, soda, wood-tar and agricultural wastes; and to determine the minimum thickness and quality of road suitable for colonial conditions.

(iv) It is clear that there are many problems requiring solution in both East and West Africa, and in view of the difficulty in finding staff for the proposed laboratory in West Africa the question of the research facilities to cover African problems requires careful consideration. In the meantime the Road Research Laboratory could assist by making fundamental and other investigations into colonial soils and indigenous materials and by planning and assisting in the conducting of certain full-scale road experiments in the colonies.

65. One of the Colonial Liaison Officer's main tasks during the year has been to encourage Colonial Public Works Departments to co-operate in a programme of simple experiments designed to study the movement of moisture in soil under colonial conditions. This study is of fundamental importance to colonial engineers and was suggested by the Soils Committee of the Road Research Board. Following preliminary correspondence, detailed proposals have now been circulated to the Laboratory's official correspondents with various territories and their final views are now awaited.

66. During the first few months following the Liaison Officer's appointment there was little change in the nature and volume of the correspondence reaching the Laboratory from the Colonies. In recent months, however, there has been a significant increase in volume and this is expected to continue.

67. During the year tests have been made at the Laboratory on samples of 20 colonial soils from Nigeria, Kenya, Gold Coast, Gambia and elsewhere. Special attention has been paid to the properties of cottonsoils. A report has been issued on laboratory experiments on the burning of cottonsoil to produce low-grade road aggregate and investigations are in hand on the stabilization with lime, and on the clay-mineral composition of cottonsoils.

68. Tests have been made on samples of wood-tar from the Gold Coast, and experiments are in hand to determine suitable compositions for sand-bitumen carpets to be laid in the Gambia; a report will be issued on completion of this last-mentioned work. Assistance has been given to the Colonial Development Corporation in connection with the use of bituminous treatments on the proposed new Bartica–Potero road in British Guiana. Finally, a report was issued on the properties of Barbados " tar-sand "; the test results suggested that the admixture of filler might considerably improve the " tar-sand " as a road material.

J. *Water Pollution Research.*

69. As a result of the nomination by Colonial Governments of official correspondents with the Water Pollution Research Laboratory, a number of requests for information were received by the Laboratory during 1950. Subjects on which information was required by various Colonies included the treatment of water to prevent deposition of calcium carbonate and to remove fluorides, the treatment of waste waters from abattoirs, calico printing works, and laundries, the treatment of sewage in hot climates, and the effects of various substances on biological processes of sewage treatment. Visits have been paid to the Laboratory by several of the officials nominated as correspondents.

APPENDIX I

Table I

LIST OF SCHEMES APPROVED FOR RESEARCH GRANTS UNDER THE COLONIAL DEVELOPMENT AND WELFARE ACTS DURING THE PERIOD 1ST APRIL, 1950, TO 31ST MARCH, 1951

Scheme No. (Prefix 'R')	Benefiting Territory	Description of Scheme	Amount
			£
396	General	Training of ecologists for service in the Colonial Empire. Initial scheme to provide for appointment of Officer in charge of training for 3 years and certain necessary capital expenditure.	17,000
258C 258D 258E 258F	do.	Study of Colonial monetary systems by Miss I. Greaves (supplementary provision).	700
47D	do.	Preparation and publication of the "Demographic Survey of the British Colonial Empire" (supplementary provision).	545
243A	do.	Colonial Insecticides, Fungicides and Herbicides Committee. Salaries, etc. of headquarters staff to cover years 1951/52 to 1953/54 inclusive.	10,900
168A	do.	Continuance for 3 years of fundamental insecticides research in the United Kingdom by research workers employed under supervision of the Colonial Insecticides, Fungicides and Herbicides Committee.	16,750
413	do.	Insecticides research at the University of Bristol Research Station (3 years).	2,568
420 421 428 428A	do.	Experiments in the mechanical handling, production and retting of jute and jute substitute fibres in U.K., Nigeria and British Guiana.	17,750
239A	do.	Research by Dr. E. M. Chenery into aluminium accumulating plants (supplementary provision).	250
361A	do.	Colonial Medical Research Studentships (supplementary provision).	3,350
241E	do.	Anti-Locust Research Centre: employment of an additional worker for short period (supplementary provision).	250
447	do.	Anti-Locust Research Centre: extramural research (1951/52–1955/56). (In continuation and replacement of Schemes R.241 and 241A–E).	25,000
430	do.	Contribution towards cost of establishment and maintenance of a Unit of Experimental Agronomy under the Agricultural Research Council for period 1.8.1950 to 31.3.1952. (Grant represents one-fifth of total estimated cost for above period).	5,460

Scheme No. (Prefix 'R')	Benefiting Territory	Description of Scheme	Amount
			£
430A	**General**	Visits to Colonies by specialist officers of the Agricultural Research Council's Unit of Experimental Agronomy (3 years).	2,000
435	do.	Institution of post-graduate Agricultural Research Studentships (spread over 3 years).	7,820
436	do.	Institution of Veterinary Research Studentships (spread over 3 years).	8,960
247C	do.	Contribution towards maintenance of the Common Services Section of the British Commonwealth Scientific Offices in London during year 1951/52.	350
328B	do.	Research on termites (recurrent expenditure for 5 years).	30,000
76C	do.	Appointment of a Secretary to the Committee for Colonial Agricultural, Animal Health and Forestry Research (for a further 5 years).	14,000
438	do.	Research at the Lister Institute of Preventive Medicine into the preparation of precipitin sera for entomological investigations of malaria, trypanosomiasis — provision for collecting work in East Africa for 3 years (in continuation of Schemes R.295, 302 and 379).	10,767
399	**Africa, General** ...	Visit to East and West Africa by Mr. J. N. D. Anderson, Lecturer in Islamic Law, School of Oriental and African Studies, to carry out a survey of the administration of Islamic law and the problems arising therefrom.	1,830
403	do.	Trypanosomiasis research. Assistance towards preparation of a monograph on the African Tabanidae by Mr. H. Oldroyd, British Museum (Natural History).	30
28F	do.	Preparation of Handbook of African Languages: grant for 1940/51.	2,055
415 415A	do.	Assistance towards establishment of the Scientific Council for Africa South of the Sahara (5 years).	30,250
431	do.	Preparation of a book on Land Tenure in British Africa by Dr. C. K. Meek: honorarium and other expenses spread over 2½ years.	3,000
434	do.	Contribution towards cost of a visit to West and East Africa by Dr. H. P. Himsworth, Chairman, Colonial Medical Research Committee.	250

Scheme No. (Prefix 'R.')	Benefiting Territory	Description of Scheme	Amount
			£
401	**West Africa, General**	Employment of an American Malacologist to make a survey of schistosome transmitting snails of West Africa.	1,200
140B	do.	West African Institute of Trypanosomiasis Research: maintenance for year 1950/51 (supplementary provision). (Grant represents two-thirds of estimated provision required: the other one-third is being defrayed by the West African Governments).	11,933
424	do.	West African Trypanosomiasis Institute: establishment and maintenance for 5 years 1951/52 to 1955/56. (Grant represents one-half of £50,000 capital and of £250,000 recurrent expenditure; the other moiety is being defrayed by the West African Governments)	150,000
433	do.	Appointment of a Secretary for West African Agricultural and Forestry Research. (This entails the reduction of the provision made under Scheme R.305 from £20,000 to £9,000).	6,615
326A	do.	Establishment of the West African Institute of Social and Economic Research (supplementary provision)	8,275
332A 332B	do.	Enquiry by Mr. P. T. Bauer into the organisation and structure of trade in West Africa (supplementary provision).	875
273A	do.	Establishment of the West African Fisheries Research Institute (supplementary provision). (Grant comprises £20,800 in respect of further capital expenditure and one-half of recurrent expenditure estimated at £227,889 over 5 years. The other moiety of the recurrent expenditure is being defrayed by the West African Governments).	134,745
406	**Gold Coast** ...	Sociological research by Mr. J. Goody (2 years).	3,000
407	do.	Psychological research by Dr. G. Tooth (2¼ years).	5,000
417	do.	Sociological research by Mr. A. N. Allott, School of Oriental and African Studies.	900
268A	do.	Historical research by Miss Freda Wolfsen (supplementary provision).	25
397	**Nigeria**	Assistance towards research on guinea worm at the University College, Ibadan, Nigeria (2 years).	1,050

Scheme No. (Prefix 'R')	Benefiting Territory	Description of Scheme	Amount
			£
410	**Nigeria**	Investigation by Professor G. Walker, of the University of Birmingham, into the transport economics of Nigeria. (Grant represents one-half of the estimated cost: the other moiety is being defrayed by the Nigerian Government).	635
414	do.	Study of the national income of Nigeria (2 years). (Grant represents one-half of the total estimated cost: the other moiety is being defrayed by the Nigerian Government).	3,470
419	do.	Anthropological survey of the Idoma peoples in the Benue Province by Mr. R. G. Armstrong (2 years).	4,250
426	do.	Visit of Dr. N. A. Barnicot, University College, London, to undertake a laboratory and field project at the Hot Climate Physiological Research Laboratory.	620
342A	do.	Sociological research by Mr. W. B. Schwab (supplementary provision).	333
443	do.	Field study of the nomadic Fulani of Northern Nigeria by Mr. D. J. Stenning (2 years). (Grant represents one-half of the estimated cost).	1,000
450	do.	Pre-Pilot survey of the market potentialities and of the practicability of local manufacture or articles suitable for marketing, in order to assist industrial development. The enquiry will be carried out by the British Export Trade Research Organisation.	1,000
320A	do.	Sociological research by Mr. M. G. Smith (supplementary provision).	230
291A	**Sierra Leone** ...	Appointment of a Director at the Sir Alfred Jones Medical Laboratory in Freetown (3 years).	6,300
297A	do.	Study by Dr. Hofstra of the Mende people (supplementary provision).	4
429	do.	Visit by Mr. A. N. Prentice, Empire Cotton Growing Corporation, to explore possibilities of increasing cotton production.	300
341A	do.	Sociological research by Mr. G. R. Collins and Miss E. M. Richardson (supplementary provision).	854
402	**East Africa, General**	Capital expenditure for establishment of East African Medical Survey and Filariasis Research Unit.	135,000

Scheme No. (Prefix 'R')	Benefiting Territory	Description of Scheme	Amount
			£
408	**East Africa, General**	East African Medical Survey: recurrent expenditure for 3 years.	78,750
325A	do.	Filariasis Research Unit: recurrent expenditure for 3 years. (Grant represents two-thirds of the estimated expenditure; the remaining one-third is being defrayed by the East African Governments).	16,000
233A	do.	Research into Music in East Africa (supplementary provision).	2,432
418	do.	Marine Fisheries research in East Africa: cost of refitting research vessel.	4,500
386A	do.	Addition of a second entomologist to the East African Insecticides Research team.	2,225
409 409A 409B	do.	East African Institute of Social Research: recurrent expenditure for five years. (These schemes enable the grant provided under Scheme R.85 to be reduced from £66,915 to £6,665).	126,048
452	do.	Maintenance of the East African Tsetse and Trypanosomiasis Research and Reclamation Organisation during the 5 years 1951–52 to 1955–56. (Grant represents one-half of the estimated expenditure: the other moiety is being provided by the East African Governments).	200,000
423	do.	Establishment and maintenance for five years of the East African Central Trypanosomiasis Research Institute. (Grant represents £195,000 in respect of capital expenditure and £85,000 in respect of one-half of the estimated recurrent expenditure; the other moiety is being defrayed by the East African Governments).	280,000
216C 216D	do.	Tsetse and trypanosomiasis research in East Africa: report by Miss L. M. Kellas (supplementary provision).	730
301B 301C	do.	East African Veterinary Research Organisation. Supplementary capital expenditure for construction of buildings for animal diseases research and for development and production of biological products.	263,000
439	do.	Research into meteorological data and agro-climatology (1½ years) (in continuation of Schemes R.276 and 276A).	3,000
448	do.	Anti-Locust Research. Provision for preliminary aerial curtain experiments and purchase of insecticides.	8,300

Scheme No. (Prefix 'R')	Benefiting Territory	Description of Scheme	Amount
			£
449	**East and Central Africa**	Economic survey of the structure and organisation of the distribution industries in Tanganyika, Nyasaland and Zanzibar.	745
354A	**East Africa and Middle East, General**	Desert Locust Survey. Contribution towards maintenance during calendar year, 1950.	9,023
354B	do.	Desert Locust Survey. Contribution towards maintenance during calendar year, 1951.	12,627
399	**Kenya**	Provision for an Animal House and Insectarium at the Medical Research Laboratory, Nairobi. (The total cost is estimated at £14,335: the balance is being contributed by the Kenya Government.)	6,000
427 427A	do.	Study of the Galla tribe in N.E. Kenya by Mr. P. W. T. Baxter (2½ years).	5,374
366A	**Somaliland Protectorate**	Linguistic research by Mr. B. Andrzejewski (supplementary provision).	416
425	**Tanganyika** ...	Sociological study of the Barabaig people by Mr. Gordon Wilson (2½ years).	3,900
432	do.	Studies in Tanganyika by Mr. B. W. Thompson on micro-climates in connection with dissemination of insecticides (1 year).	2,500
451	do.	Insecticides research: experimental work to determine effects of larvicidal air spraying on mosquito breeding grounds.	2,000
404	**Uganda**	Sociological research by Mr. P. H. Gulliver (14 months).	1,745
422	do.	Study by Mr. P. G. Powesland, Makerere College, of the economic history of the Banya-Ruanda migratory movement.	190
351A	do.	Sociological research by Mr. J. F. M. Middleton (supplementary provision).	175
400	**Central Africa, Northern Rhodesia**	Appointment of a Forestry Research Officer to undertake silvicultural and ecological investigations (5 years). (The grant covers £6,000 for capital expenditure and £6,750 as one-half of the estimated recurrent expenditure; the other moiety is being defrayed by the Northern Rhodesia Government.)	12,750

Scheme No. (Prefix 'R')	Benefiting Territory	Description of Scheme	Amount
			£
405	**Central Africa, Northern Rhodesia**	Forestry research; compilation of a check list of trees and economic plants. (Grant represents one-half of the estimated expenditure; the other moiety is being defrayed by the Northern Rhodesia Government).	2,500
416	do.	Promotion of agricultural research in Northern Rhodesia. (Grant represents £134,728 in respect of capital expenditure, and £82,500 in respect of one-half of the estimated recurrent expenditure over five years; the other moiety is being defrayed by the Northern Rhodesia Government. This scheme cancels the Schemes R.235 and R.235A.)	217,228
444	do.	Establishment of two Forestry Research Plantation Centres. (Grant represents 30 per cent. of the estimated capital and recurrent expenditure over 5 years; the balance is being provided from the Northern Rhodesia Development allocation and from territorial funds.)	20,700
445	do.	Investigation by experts nominated by the United States Economic Co-operation Administration into flood conditions on the Kafue Flats (1½ years). (Grant is to cover estimated sterling expenditure involved.)	3,700
157B	**Nyasaland**	Assistance up to 1952 towards establishment of an Agricultural Research and Experimental Station in Nyasaland. (Grant represents £25,590 capital expenditure and £3,393 in respect of one-half of recurrent expenditure, the other moiety being defrayed by the Nyasaland Government).	28,983
437	do.	Research by Miss K. F. Salmond into pest infestation of stored grain (3 years). (Grant represents one-half of the estimated expenditure: the other moiety is being defrayed by the Nyasaland Government).	1,625
195C	**South African High Commission Territories, Basutoland**	Sociological research in Basutoland by Mr. V. G. J. Sheddick (supplementary provision).	175
214D	**Middle East, Aden**...	Fisheries research in the Gulf of Aden (supplementary provision). (The making of this scheme cancels Scheme R.393).	660
227A 227B	**Indian Ocean, Mauritius**	Insecticides research—mosquito eradication (supplementary provision (£2,880) for period up to 31.3.51, and provision to cover work of research team and other eradication work for a further three year period).	82,880

Scheme No. (Prefix 'R')	Benefiting Territory	Description of Scheme	Amount
			£
158C	**South-East Asia, General**	Malaria research in North Borneo, Sarawak and Brunei under the direction of Dr. J. McArthur (supplementary provision for further 2 years).	19,300
161B	do.	Preparation of an annotated bibliography of land tenure in the Far East (supplementary provision).	25
288C	do.	Establishment of Institute for Research and Training in Fish Farming, Penang (supplementary provision).	1,500
440	do.	Establishment of a Marine Fisheries Research Station in Singapore. (Grant comprises £180,000 in respect of capital expenditure and one-half of recurrent expenditure estimated at £160,000 over 5 years. The other moiety of the recurrent expenditure is being defrayed by the Government of the Federation of Malaya, Singapore, North Borneo, Sarawak and Brunei).	260,000
177D	**Federation of Malaya**	Scrub typhus research in Malaya: provision to cover work of team during year ending 31.12.51.	12,000
321A	**North Borneo** ...	Sociological research by Miss M. Glyn Jones (supplementary provision).	453
270C 270D 270E 270F	**Sarawak**	Sociological research by various workers (supplementary provision).	2,017
372A	**Singapore**	Sociological research by Mr. A. J. Elliott (supplementary provision).	1,000
281B	do.	Sociological research by Mr. and Mrs. Freedman (supplementary provision).	1,100
93C(*c*)	**West Indies, General**	Psychological research in the West Indies by Mr. Deans Peggs (supplementary provision).	294
236E	do.	Completion of the Colonial Microbiological Institute in Trinidad (supplementary provision).	84,525
5D	do.	Low temperature research at the Imperial College of Tropical Agriculture, Trinidad (supplementary provision).	475

Scheme No. (Prefix 'R')	Benefiting Territory	Description of Scheme	Amount
			£
251D	**West Indies, General**	Establishment of the West Indian Institute of Social and Economic Research (supplementary capital expenditure).	8,100
441	**British Guiana** ...	Sociological study of the Arecuna and Akowoio peoples by Miss A. Butt, Institute of Social Anthropology, Oxford University, for 2 years. (Grant is to supplement financial assistance provided from other sources).	600
446	do.	Study of the negro coastal communities by Mr. R. T. Smith (2½ years).	2,700
442	**Jamaica**	Appointment of a Scientific Secretary and subordinate staff to the Jamaica Industrial Development Committee (3⅓rd years). (Grant represents one-third of the estimated expenditure).	4,315
350A	**Trinidad**	Malaria research by Mr. R. A. Senior White (supplementary provision).	7,050
312A	**Atlantic, Falkland Islands**	Establishment and maintenance of Falkland Islands Dependencies Survey Scientific Bureau (supplementary provision).	1,000
		TOTAL	£2,496,784

Table II

ALLOCATIONS FOR RESEARCH UNDER THE COLONIAL DEVELOPMENT AND WELFARE ACTS, 1940, 1945 AND 1950

Period to	Totals	
	Allocation for period	Cumulative allocation
	£	£
31st October, 1942	57,158	57,158
31st March, 1943	15,340	72,498
31st March, 1944	224,835	297,333
31st March, 1945	116,795	414,128
31st March, 1946	660,776*	1,074,904*
31st March, 1947	1,099,382*	2,174,286*
31st March, 1948	2,073,340*	4,247,626*
31st March, 1949	1,666,229*	5,913,855*
31st March, 1950	1,814,124*	7,727,979*
31st March, 1951	2,514,583*	10,242,562*

* These figures include expenditure totalling £116,419 incurred up to the 31st March, 1951 on Scheme R.7 (work of the Colonial Products Research Council: see Appendix II to Progress Report of the Colonial Research Committee for 1942–43, Cmd. 6486).

Table III

ACTUAL ISSUES IN RESPECT OF RESEARCH SCHEMES, 1940–1951

Financial Year	Issues
	£
1940–41	Nil
1941–42	6,670
1942–43	13,793
1943–44	30,450
1944–45	58,345
1945–46	93,307
1946–47	169,388
1947–48	428,301
1948–49	764,211
1949–50	1,285,348
1950–51	1,406,651
Total	£4,256,464

Colonial Products Research Council Eighth Annual Report (1950-1951)

Ministry of Labour,
80–82 Pall Mall,
London, S.W.1.
30th May, 1951.

SIR,

I have the honour to enclose herewith the Annual Report of the Colonial Products Research Council for the year 1950–51.

I am, Sir,
Your obedient Servant,
(Sgd.) HANKEY.
(Chairman)

The Right Honourable James Griffiths, M.P.,
Secretary of State for the Colonies.

COLONIAL PRODUCTS RESEARCH COUNCIL

Membership

THE RT. HON. LORD HANKEY, G.C.B., G.C.M.G., G.C.V.O., F.R.S. (*Chairman*).

MR. ERIC BARNARD, C.B., D.S.O., M.A., Deputy Secretary, Department of Scientific and Industrial Research.

PROFESSOR H. V. A. BRISCOE, D.Sc., F.R.I.C., Professor of Inorganic Chemistry, Imperial College of Science and Technology, London.

DR. E. E. CHEESMAN, Agricultural Research Council, London.

MR. ANEURIN DAVIES, Co-operative Wholesale Society.

MR. C. G. EASTWOOD, C.M.G., Colonial Office.

PROFESSOR E. L. HIRST, F.R.S., M.A., PH.D., D.Sc., M.Sc., F.R.I.C., F.R.S.E., Professor of Organic Chemistry, University of Edinburgh.

PROFESSOR E. R. H. JONES, D.Sc., F.R.I.C., F.R.S., Professor of Organic Chemistry, University of Manchester.

PROFESSOR SIR JOHN L. SIMONSON, D.Sc., F.R.I.C., F.R.S., Director of Research.

DR. H. G. THORNTON, F.R.S., Rothamsted Experimental Station, Harpenden.

PROFESSOR A. R. TODD, M.A., D.Sc., F.R.I.C., F.R.S., Professor of Organic Chemistry, University of Cambridge.

DR. J. WALKER, Medical Research Council, London.

LT. COL. H. J. HOLMAN, B.Sc., (*Secretary*).

The terms of reference of the Council are:

" To review the field of Colonial production and to advise what Colonial raw materials are likely to be of value to the manufacture of intermediate and other products required by industry; in consultation with the Director, to initiate and supervise researches, both pure and applied, on such products, and generally to consider how by the application of research greater use can be made of them.

In framing their programme the Council will have as their objective the promotion of the welfare and prosperity of Colonial peoples, and will endeavour also to increase the Colonial contribution to the welfare and prosperity of the British Empire and of the world as a whole. The Council will ensure that full use is made of existing research organisations, in particular the Department of Scientific and Industrial Research, the Medical Research Council and the Agricultural Research Council. In formulating its research policy, it will also call into consultation persons with expert knowledge in science, industry, and other related fields."

COLONIAL PRODUCTS RESEARCH COUNCIL
EIGHTH ANNUAL REPORT

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COLONIAL PRODUCTS RESEARCH COUNCIL

EIGHTH ANNUAL REPORT

PART I. GENERAL

During the year the Council has heard with the deepest regret of the death of the Rt. Honourable Oliver Stanley, Secretary of State for the Colonies when the Council was formed. It recalls with pleasure the stimulating address with which he opened their first meeting.

2. The Secretary of State has appointed Dr. E. E. Cheesman, Dr. J. Walker and Professor E. L. Hirst, F.R.S. as members of Council.

3. The Council has heard with satisfaction of the award of the Davy Medal by the Royal Society to Sir John Simonson, the Director of Research, and the proposal of the University of Birmingham to confer on him the honorary degree of Doctor of Science. It has also learnt with pleasure of the award to Professor M. Stacey, F.R.S. by the American Sugar Research Foundation of a five thousand dollar prize. It will be recalled that a similar award was made to Professor L. F. Wiggins some years ago.

4. In March, the Director of Research visited Trinidad to be present at the opening of the new Sugar Technological Laboratory at the Imperial College of Tropical Agriculture. This laboratory, which is being financed jointly by the Council and the West Indies Sugar Association, is the only Research Institute of this kind in the Colonies, being similar to the industrial research associations laboratories which have proved so successful in this country. It is attached to the Imperial College of Tropical Agriculture and the formal opening took place on the occasion of the Charter Jubilee Celebrations of the College.

5. After reading messages from Lord Hankey and Sir Robert Robinson and making a brief speech indicating the functions of the new laboratory, the Director of Research had the privilege of asking His Excellency, Sir Hubert Rance, G.C.M.G., G.B.E., C.B., Governor of Trinidad and Tobago, to open the new laboratory. (See Appendix I.)

6. The laboratory has been admirably designed by Professor Wiggins and there would appear to be little doubt that in due course it will contribute greatly to the economic prosperity of the West Indian islands.

7. During his stay in Trinidad the Director was able to spend much time in the Microbiological Research Institute. As recorded in later paragraphs, the research work being carried out in the Institute is of a high order and reflects the greatest credit on Dr. Thaysen and his colleagues. The grounds of the Institute have been most tastefully laid out and are regularly visited by tourists.

8. During his stay the Director spent a few days in Kingston as the guest of Dr. T. W. J. Taylor, C.B.E., Principal of the West Indies University College. He saw the fine new buildings in the course of erection and met many members of the staff. He was also able to meet Miss Wong, who is supported by the Council, and discussed with her and Professor Hassall the important work upon which they have been engaged. The opportunity was also taken to discuss with Mr. Kirkwood and Mr. Innes of the Jamaica Sugar Research Association, the proposal to manufacture power alcohol in Jamaica. This will be undertaken as soon as the necessary plant is installed. The Council regard this development of importance, since it will bring to Jamaica technical staff who will doubtless develop other industries based on sugar as its raw material.

9. During the past year Dr. A. C. Thaysen and his collaborators have made very considerable advances in the study of the various problems which they are investigating. Full details of the work are given in paras. 94–104. It is only necessary here to direct attention to some of the more important developments.

10. Much attention has been given to the very interesting problem of the fermentation of the cocoa bean. It has now been established that the predominant species of yeast in cocoa beans commercially fermented in the islands of Trinidad and Grenada is *Candida Krusei* (A. Cast.). It is only in the very early stages of the fermentation that other species are in evidence and contrary to statements in the literature *Saccharomyces* species never represent a significant percentage of the total yeast microflora. This observation shows that the formation of acetic acid which accumulates in the sweat boxes cannot be produced exclusively from ethyl alcohol, but results possibly from the action of *Candida Krusei* on the citric acid present in the pulp of the cocoa bean.

11. Reference was made in last year's report (para. 7) to the investigation which had been carried out on the chemical changes by which the precursor of the chocolate flavour is developed in the beans during fermentation. While it has not yet been possible to isolate this precursor, it has been found that micro-organisms are not essential to the change. It must therefore be assumed that this is due to enzymatic action. This is being further studied.

12. A very interesting and important observation has, however, been made that the development of the chocolate flavour results after drying and roasting if aseptic ripe pods are left for some days in dilute solutions of either acetic acid or sodium acetate at 48°. Since this flavour does not develop in solutions of citric or phosphoric acids it would appear that acetate ions are essential for the required change in the beans. The chocolate flavour was assessed by a Panel of the British Food Manufacturers Research Association who found the flavour of beans treated in this manner to be equal in intensity to that of commercially fermented beans. In addition to the scientific importance of this work it may prove of immediate industrial value. If only small quantities of beans of new varieties are available it is not possible to ferment them under normal commercial conditions, whilst treatment in dilute acetic acid under standard conditions can be readily carried out, thus facilitating commercial evaluation.

13. A not inconsiderable portion of the laboratory's activities have been devoted to various aspects of the study and isolation of antibiotics. These investigations have been concerned not only with the isolation of new antibiotics but also with a search for the natural habitats of the micro-organisms which produce them.

14. Particular attention has been given to an antibiotic to which the name "Comirin" has been given. This substance has been examined in the laboratories of the Medical Research Council and has been found to be highly haemolytic and it is therefore unlikely to prove of direct therapeutic value. Attention has now been directed to the possibility of utilising it as a fungicide or in the protection of paper, canvas and paints. It has the valuable property of not being affected by light or the temperature likely to be encountered in the tropics.

15. The value of the Hankey Culture Collection, to which 372 organisms were added during the year, has already been appreciated. Outside requests for 46 cultures were received during the year and a preliminary catalogue was circulated in April, 1950. Miss Morris has been given the title of Curator, Hankey Culture Collection.

16. Amongst the other various activities of the laboratory can be included an investigation of the Red Root disease of West Indian limes and the artificial cultivation of mushrooms, which may prove a useful minor agricultural industry for smallholders.

17. Dr. Thaysen and Dr. Forsyth attended the International Microbiological Congress held at Rio de Janeiro in August. During a visit which Dr. Thaysen paid to British Guiana he was able to advise the authorities on a number of problems of local interest.

18. The Council wishes to express its appreciation of the high quality of the research work being carried out in the Colonial Microbiological Research Institute, the activities of which are likely to prove of increasing value to the Colonies.

19. It is glad to note that the structural defects referred to in last year's report (para. 5) have now been largely overcome, but unfortunately there has been considerable delay in the erection of the building for the pilot plant.

20. Professor C. H. Hassall and Miss Wong have continued their investigation of the antibiotic, monamycin, which results from the culture of Meredith's actinomycete obtained from the Hankey Culture Collection. Whilst this culture corresponds with that studied by Arnstein, Cook and Stacey and discussed by them in their paper entitled "The Inhibition of *Fusarium oxysporum* var. *cubense*, by musarin, an antibiotic produced by Meredith's actinomycete", the antibiotic monamycin is not identical with musarin. Since monamycin up to the present has not been obtained crystalline its homogeneity cannot be regarded as proved but there is little doubt that it is not identical with any antibiotic previously described.

21. Lord Hankey, accompanied by the Director of Research, visited the Chemical Laboratories in the University of Birmingham in November in order to see the work in progress under Professor M. Stacey, F.R.S. Particularly interesting was the blood plasma substitute prepared from sugar, which has now been marketed under the name "Intradex". As the outcome of experiments carried out by Professor Stacey, in collaboration with Professor H. W. Melville, F.R.S., and by an industrial firm a completely new process for the manufacture of this substance is being developed, which involves the use of ultrasonic waves. The Council has recommended that consideration should be given to the desirability of stock piling this substance in the Colonies in view of the fact that it does not require refrigeration for storage.

22. Owing to the departure of Professor L. F. Wiggins and his team from the University of Birmingham there has been a change not only in the direction of the work, which is now under Professor M. Stacey, F.R.S., but also to some extent in the subjects being investigated. More attention is now being paid to the action of bacteria on sugar and other carbohydrates.

23. Dr. C. M. Tatlow has continued her work on the trifluoreacetyl derivatives of sugars, whilst Mr. G. T. Bruce has prepared a number of interesting derivatives of mannitol. In collaboration with Professor Wiggins, Mr. L. Bradford has been engaged in a detailed study of sugar cane wax isolated from the filter muds of all the sugar estates in the West Indies. This is a necessary preliminary to their utilisation as a source of hard wax since it has already been found from previous work that the crude wax contains varying quantities of a soft wax. Mr. Bradford is examining the properties of the latter. Professor Stacey has made the interesting observation that ultrasonic sound waves can degrade the highly polymeric dextran obtained by the action of bacteria on sugar to give the blood plasma substitute previously prepared

by acid hydrolysis. Whilst the value of this substitute is already fully established clinically its fate in the body after transfusion is still imperfectly known. Mr. R. J. Bayly has therefore been examining the nature of the dextran excreted in the urine of rabbits receiving relatively enormous quantities of the plasma.

24. Professor Stacey has been studying the production of cellulose by the action of bacteria on sugar, molasses and sugar containing effluents. A high grade cellulose has been obtained and experiments are now being directed to improving the yield.

25. The removal of Professor Wiggins and his staff from Birmingham to Trinidad, which took place in July, has naturally caused some interruption in their work. A very detailed study has been made of the waxes extracted from the various sugar canes grown on the estates in the West Indies. It has been conclusively proved that these vary greatly in their economic value. A suitable method for the purification of the wax has been developed in the laboratory and this is now being tried out on a pilot plant scale. A pilot plant study is also being made of the method suggested by Sir Norman Haworth and Professor Wiggins some years ago for the manufacture of lactic acid. Whilst sugar was used in these experiments Professor Wiggins has now found that equally good yields can be obtained from molasses. This acid has many industrial uses and it is possible that it may find increasing use in the plastics industry.

26. In a recent review (Advances in Carbohydrate Chemistry, Vol. V, page 222) Professor Wiggins has directed attention to the increased use of hexitol anhydrides in the chemical industry. Perhaps the most important use will be as ingredients of drying oils and their transformation into wetting and emulsifying agents. These developments are of particular interest to the Council since Professor Wiggins himself has been so largely concerned in devising satisfactory methods for the preparation of these sugar derivatives.

27. Mrs. I. Wadja and Miss R. Weston working under Professor Frazer's supervision have completed their examination of the pharmacological action on the nervous system of a number of sugar derivatives, prepared by Professor Wiggins and his collaborators. With one exception it would appear unlikely that any of the 70 pyridazone derivatives screened will be suitable for clinical trial. This work is now being extended by Mr. C. G. Haining to a study of the anti-allergic properties of certain other sugar derivatives.

28. Since the discovery by Professor Sir Norman Haworth and Professor S. Peat of a comparatively simple method for the separation of the starch constituents, amylose and amylopectin, it has become apparent that any economic development of this work would involve a much more accurate knowledge of the formation of starch in the higher plants. The work in Professor Peat's laboratory during the past year has been a further study of the complex system of enzymes involved in starch metabolism but it is at present only of scientific interest.

29. The work carried out on Colonial vegetable oils, more especially on the drying oils, by Professor T. P. Hilditch and his colleagues during the past seven years on behalf of the Council, is likely to influence very greatly their future use and development. It is clear that the chief potential sources of Colonial oilseeds have now been more or less completely surveyed. There is nevertheless ample scope for much further work on particular aspects of the properties and application of fats from the Colonies.

30. The note published recently by Professor Hilditch, (Nature, Vol. **167**, p. 298—" Biosynthesis of Unsaturated Fatty Acids in Ripening seeds ") in which he draws attention to the effect of environment on the properties of vegetable oils, is of outstanding importance. The implication of this work will require very careful consideration in all future proposals to extend vegetable oilseed cultivation in the Colonies and emphasises the need for small scale trial plots with careful examination of the resulting oilseeds prior to larger experiments. The views expressed in this last publication, as well as those expressed in previous ones, have been fully confirmed by the work during the year, details of which are given in para. 75. Of particular interest and importance are the results obtained from the sunflower seeds grown in different areas in Australia where the marked effects of climatic conditions are most noticeable. The Council is glad to have been able to participate in the examination of these oils, which were, in part, received from the Australian Scientific Liaison Officer in London. The desirability of close co-operation in scientific research within the Commonwealth was emphasised at the Commonwealth Scientific Conference in 1946.

31. Messrs. C. Barker and R. V. Crawford have made considerable progress in the study of the complex changes which occur during the thermal polymerisation of drying oils (the production of the " heat-bodied " or " stand oils " of the paint industry). This process has been followed in both linseed and sunflower oils and has resulted in a considerable addition to our knowledge of the changes which occur.

32. Sufficient information has now been obtained from the experimental plots to justify the Director of Agriculture, Nigeria, starting the cultivation on an area of 200 acres of the vine, *Tetracarpidium conophorum*, the oilseeds from which provide the oil known as Conophor oil, to whose potential economic importance previous attention has been directed. This area should, in due course, enable estimates of the yield of oilseeds per acre to be obtained and so determine whether cultivation on a large scale would be economic. The Council is gratified to learn that the Paint Industry regard this experiment of sufficient importance to warrant their offering to make a contribution to its cost. It had been hoped that sufficient oilseeds might have been collected during the year to enable further quantities of the oil to be made available for trials by the industry, but unfortunately the drying plants ordered by the Nigerian Government were not delivered in time for any large scale drying of the seed to be undertaken.

33. The Council has learnt with regret that Professor Hilditch will be retiring at the end of this University session and it desires to place on record its appreciation of the very valuable work which he has carried out on its behalf for a number of years. It is hoped that arrangements may be made for his continued participation in its work.

34. Reference was made in last year's report (para. 24) to the design of a prototype machine for the decortication of Candlenuts (*Aleurites triloba*). This machine has now been given an extended trial and it has been found to separate, in a satisfactory manner, the shells and the kernels. It has not, however, been possible to separate the shells and the kernels without damage to the kernels so that they would not be suitable for export and would have to be processed locally. The Council has been informed that it is improbable the oil will find a market in this country and it is interesting to note that in Fiji, where the oil is already expressed, difficulty has been experienced in the export to their main market, Australia. There is, however, no reason why the oil should not be used locally in the paint industry where superior drying oils are difficult to obtain.

35. It is disappointing to have to record once more that the equipment for the special laboratory at the Forest Products Research Laboratory, Princes Risborough, is still incomplete. Sufficient plant has, however, been available for some preliminary experiments to be carried out for the preparation of hardboard from semi-chemical pulp from Wallaba wood. The economics of this product have not yet been studied but details of the results so far obtained have been communicated to the Colonial Development Corporation, who are interested in timber developments in British Guiana.

36. Recent investigations, more especially those carried out in Professor Erdtman's laboratory in Stockholm, have given rise to a renewed interest in the chemical constituents of various woods. It has been shown by Professor Erdtman that the resistant properties of the heartwood of certain pines is due to the presence of pinosylvin. Professor F. E. King and Mr. M. F. Frundon have now completed their investigation of the phenol present in the West African, *Chlorophora excelsa*. Tests of this material, which have been carried out at the Forest Products Research Laboratory have shown, however, that it has only slight fungistatic properties. Other Colonial timbers are now being examined.

37. Further experiments have shown that the saponin which is present in the wood of *Mora excelsa* is not likely to prove of economic value. Mr. W. G. Campbell and Dr. R. H. Farmer generously presented the material which they have prepared to Dr. D. H. R. Barton of Birkbeck College. The interesting results of his investigations are referred to later in para. 61.

38. In previous reports reference has been made to the importance of studying the very large number of Colonial plants which have been stated either to be of economic value or to possess important pharmacological properties. A considerable number of these are now being investigated in universities and the more important results are discussed in paras. 84–92.

39. In Professor A. R. Todd's laboratory, Dr. A. W. Johnson has continued the supervision of the experimental work on the purification of the germination stimulant for *Striga hermonthica*. The very small quantity of this which can be isolated renders this problem one of great difficulty, but it is interesting to note that the germinating factor of *Orebanche* is similar to that of *Striga* since each will cause stimulation of the other host.

40. In the second report of the Colonial Primary Products Committee (Colonial No. 238, pp. 20–30) the cultivation in the Colonies of various essential oils is discussed in detail. During the year the Director of Research has had the opportunity of discussing this subject with Sir Stewart Gore-Brown of Northern Rhodesia and drawing his attention to the important researches which have been carried out by Mr. Penfold and his colleagues in Australia. Subsequently Sir Stewart Gore-Brown has himself visited Australia and has met Mr. Penfold. The Council welcomes this example of Commonwealth co-operation.

41. The Director of Research has also been informed that Dr. Guenther of Fritzsche Bros. has recently visited Trinidad and discussed with the Agricultural Officers there the cultivation of essential oil plants. It is hoped that this may result in the increased production of essential oils for the American and other markets.

42. A small grant was made last year to the Forest Department of British Honduras to enable them to collect samples of the oleo-resin from *Pinus caribaea* (Slash pine). Samples of this oleo-resin have now been examined in the laboratories of the Colonial Products Advisory Bureau at the Imperial Institute by Mr. Islip and it was found, as was anticipated, that the oil of turpentine

and the resin are both of excellent quality. It is frequently assumed that oil of turpentine is only of industrial importance as a vehicle in the paint industry, but this is far from being the case. It finds an extended application in the fine chemical and plastics industries. There is a large and increasing demand for the rosin. Unfortunately there is not within the Commonwealth a source of oil of turpentine since the oleo-resin obtained from *Pinus longifolia*, whilst yielding an excellent rosin, gives a turpentine having different chemical properties. We are therefore dependent upon French and American sources for turpentine. The development of a " naval stores " industry in British Honduras would therefore be of considerable economic value and this possibility is now being examined by the Forest Department in that Colony. The Council has learned with interest that *Pinus caribaea* has been successfully introduced into Northern Rhodesia and this may provide a future source of the oleo-resin.

43. In an interim report (Colonial No. 217) the Colonial Primary Products Committee directed attention to the desirability of the cultivation of jute or a jute substitute in the Colonies. The fibre is an essential material for the manufacture of bags in which the greater bulk of the world's food supply is moved, and at present it is only grown in India and Pakistan. Agricultural surveys have shown there are a number of possible areas in which such cultivation might be successful in the Colonies, but it is recognised that the harvesting and processing of the jute by the methods now used in India and Pakistan would not be feasible. It has been agreed that so far as possible these should be mechanised and during the year an experimental area of about 200 acres in Nigeria was planted with *Hibiscus cannabinus*. The Council was consulted on the arrangements being made for the mechanical harvesting and processing of this crop, the actual experiments being carried out in co-operation with the Jute Research Association and the National Institute for Agricultural Engineering. As was anticipated, the experimental difficulties were considerable, but much valuable information was obtained. Consideration is now being given to the planning of further experiments. These will no doubt extend over some years and involve a very heavy expenditure, but in view of the great importance of the fibre the Council considers that it is essential for the work to be vigorously pursued.

44. Although the Council is not directly concerned, it has followed with interest the utilisation by the A.S.P. Chemical Co. of Bulstrode of sisal waste as a source of a pectate and a wax. The former product has found a market in the food industry in this country, but so far the wax has not been purified and marketed. A small factory is in course of erection in Kenya and it is understood that it will shortly be in production. The output will be of the order of 250 tons of pectate per annum and it is hoped steps will be taken to collect and purify the wax. Although the pectate production is only on a small scale it should enable an estimate to be made whether the utilisation of the waste is likely to prove economic.

45. Since it has now been established from work which has been carried out in this country and also elsewhere that vegetable proteins can be successfully used in the manufacture of fibres, it has been thought desirable to undertake further research in this field. Mr. J. E. Humpoletz, working in Cambridge under the direction of Dr. P. Johnson, who has made an extensive study of groundnut proteins, has inaugurated an examination of the proteins of sunflower seed. In its initial stages, attention has been directed to the development of a satisfactory method for the preparation of the protein free from other material, and in this work a fair measure of success has been achieved. Unfortunately Mr. Humpoletz has been unable to complete this work, but it is hoped to recommence it later in the year.

PART II. REVIEW OF RESEARCH WORK IN PROGRESS

Clove Oil

46. (33)* Mr. P. Lees, working in Professor G. R. Clemo's laboratory, has continued his investigation of the action of N-bromosuccinimide on eugenol and its derivatives which are referred to in last year's report. During the course of the work, a large number of new compounds has been prepared including some interesting derivatives of tetrahydro*iso*quinoline. The pharmacological properties of some of these substances have been examined in the laboratories of the Medical Research Council, but have not proved of value.

Carbohydrates

47. (35) *Sugar.* Recent investigations in this field are now being directly to the utilisation of cane sugar by various micro-organisms, to cane sugar wax, to derivatives of mannitol and sorbitol and to the trifluoroacetyl derivatives of sugars.

48. Reference has been made in para. 21 to the important discovery of the use of ultrasonic waves for the degradation of highly polymeric dextran. This is being developed on a large scale to give better yields of degraded dextran of the optimal molecular weight and of the right shape for transfusion purposes.

49. From the urine of rabbits receiving relatively large amounts of plasma, Mr. Bayly has isolated a dextran which appears to have passed unchanged through the kidney and a mucoprotein present in normal rabbits' urine. They have been found not to be identical. In the latter, galactose is the main monosaccharide present, whilst in the former glucose, possibly derived from the dextran, predominates. In addition, a mucoprotein of remarkable complexity has been isolated, for the examination of which a new technique will have to be developed.

50. Mr. G. T. Bruce has elucidated the structures of various ethylidene derivatives of D-mannitol. In an elegant investigation he has prepared a triethylidene mannitol and he has shown it to be the 1:3–2:5–4:6–derivative. During this investigation numerous new methyl and acetyl mannitol compounds were prepared. Mr. Bruce has also studied the dextran prepared from starch by the action of *Acetobacter capsulatum* and he is engaged in comparing its structure with that present in the transfusion dextran and also with that obtained by ultrasonic degradation.

51. Mr. D. A. Higgins has continued his study of the high temperature pressure degradation of hexitols in the presence of Raney nickel. Very complex mixtures of products are obtained from mannitol and serbitol. These are at present under examination, but it is already clear that fission of carbon-carbon bonds occurs.

52. In her study of the trifluoroacetyl derivatives of the sugars, Dr. Tatlow has prepared a series of new derivatives. These derived from amino sugars show unusual properties and are now being further investigated.

53. With the object of assisting Professor Wiggins in his pilot plant extraction of sugar cane wax (see below) Mr. Bradford has analysed samples of the filter mud from all the sugar estates in the West Indies. Sugar cane wax is a mixture of hard and soft waxes, the percentage composition varying with the variety

* Figures in parentheses refer to the corresponding paragraph in the 1949–1950 Report.

of cane from which the wax is obtained. Utilising solvent fractionation, Mr. Bradford has separated the hard wax from the soft fatty fraction. This latter fraction, which contains the sterols, is now under examination. In this connection, some work has been done on the production of sterols by the action of micro-organisms on sugar.

54. Sugar cane wax is present in varying amounts in the filter mud obtained in the factories. A number of these muds have been examined and have been found to vary, not only in the quantity of the wax which they contain, but also in its quality. It has been shown that factories in Barbados and the Leeward Islands consistently produce a mud having a high wax content. A comparison between the arithmetical averages of the wax yields obtained from factories in each colony is informative.

Colony	*Average wax yield % dry mud*
The Northern Islands	14·7
Jamaica	11·3
Trinidad	8·8
British Guiana	7·0

Extraction of the wax will clearly only be remunerative in a limited number of factories. Pilot plant investigations are now in progress to develop a satisfactory process for the extraction and purification of the wax.

55. Since their transfer to Trinidad, Professor Wiggins and his staff have devoted a part of their activities to a number of problems of direct factory importance. Of particular interest is that concerned with the possibility of the purification of cane juice using ion exchange resins. This method of purification, which is being vigorously investigated in many laboratories, has obvious advantages, but it will probably be a considerable time before it reaches the stage of practical application. At present the main difficulty apart from the high cost of the resins themselves and the cost of their regeneration, is the fact that loss of sucrose occurs owing to inversion. There is, however, little doubt that the process, if it can be perfected, should increase the yield of crystalline sugar and decrease the yield of molasses.

56. A commencement has been made on the study of the constituents of the cane juice, of which our knowledge is still limited. By paper chromatography it has been found that the juice contains no fewer than twelve amino acids, the percentage of each varying in different juices. Using a similar method, the presence in the juice of five acids has been determined. Parallel with these investigations the cane juice colloids are also being examined.

57. An analysis of the sugar content of the cane at intervals along the stem has been undertaken and will be continued during the whole life of the cane. The present experiments have shown that the sucrose content increases dramatically in the zone where pigmentation commences and that glucose and fructose are present in largest amounts near the green top of the cane. (The cane used was such that the leafy tips only were cut off before analysis. In commercial reaping a little more of the top part of the stem could be discarded). A detailed investigation of the various constituents of bagasse has been commenced. This suggests that it is probable that the result obtained by the normal method used for the factory analysis of sugar lost in bagasse is too low, although the determination was done on dry bagasse and has not yet been carried out on fresh bagasse.

58. For some years Mr. I. Wadja and Miss R. Weston, working under the supervision of Professor Frazer, have been engaged in the examination of a large number of pyridazone derivatives prepared by Professor Wiggins. They have investigated the action on the nervous system of sixty derivatives of pyridazone, eight of pyridazine and four of pyridazinone. This work was desirable in view of the comparatively close structural relationship of pyridazone and pyrazolone, since several derivatives of the latter have proved of pharmacological value. The most active of the pyridazone derivatives examined is as potent as amidopyrin and is somewhat less toxic. This compound is, therefore, likely to be a slight pharmacological advance on the existing analgesic substances. If it can be shown that it is unlikely to produce agranulocytosis it would be worth a clinical trial. Unfortunately, no satisfactory method for testing this property has been found.

59. (36) *Starch.* The main preoccupation in Professor Peat's laboratory has been with the system of enzymes concerned with the metabolism of starch in the higher plants. The function of the R-enzyme, formerly termed γ-amylase, has become much more clearly defined. It is a purely hydrolytic enzyme and unlike the Q-enzyme it has no synthesizing properties. Work has also been continued on the Z-enzyme present in the soya bean. This enzyme does not attack amylopectin but, in conjunction with the β-amylase, hydrolyses amylose to maltose. The important observation has been made that amylose does not consist solely of unbranched chains as had been previously assumed. There is some degree of branching. It is these branches which are attacked by the Z-enzyme and not by the β-amylase. These branches differ from those present in amylopectin and are not improbably β-glycosidic linkages. Although it has been found necessary during the year to modify the original hypothesis for the mechanism of the synthesis of amylopectin there is no doubt that the Q-enzyme is responsible for the synthesis of the 1:6-linkages in this carbohydrate and that an isophosphorylase is not concerned. It is obvious that the presence of so many enzyme systems renders the work in this field one of great complexity and progress must inevitably be slow.

60. The study of the action of ultra-violet irradiation on glucose and other carbohydrates has been continued. It appears likely that this may provide a convenient route for the preparation of many relatively inaccessible simple sugars.

Timber Research

61. (37) *Mora excelsa.* As mentioned in last year's Report the saponin present in *Mora excelsa* yields on hydrolysis a mixture of oleoanolic and morolic acids. Dr. D. H. R. Barton, in collaboration with Messrs. C. J. W. Brooks and N. J. Holness, has been successful in determining the structure of this new triterpenoid acid and has confirmed this by a partial synthesis.

62. *Mora gonggrijpii.* The saponin present in this timber yields oleoanolic acid on hydrolysis and the preparation of a considerable quantity of this acid has been undertaken by Mr. W. G. Campbell and Dr. R. H. Farmer at the request of the Medical Research Council.

Vegetable Oils

63. (38) Professor T. P. Hilditch, F.R.S., has been assisted during the year by Messrs. C. Barker, M.Sc., R. E. Bridge, B.Sc., A. Crossley, M.Sc., and R. Crawford, M.Sc.

Chemical Constitution of Drying Oils

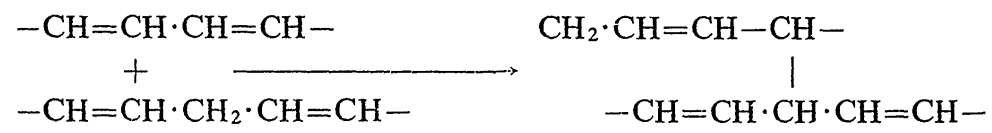
64. *Thermal polymerisation of drying oils* (Messrs. C. Barker and R. V. Crawford). Practically the whole time of the two workers mentioned was occupied during the twelve months with a study of the processes which may occur when a drying oil is maintained at about 300°C. for a prolonged period

(production of " heat-bodied " or " stand " oils). Mr. Barker worked mainly on a series of progressively heat-bodied sunflower seed oils, and Mr. Crawford on a similar group of heat-bodied linseed oils, whilst as the work demanded they co-operated in certain ancillary studies which developed (notably the conversion of β-oleodistearin by thermally induced acyl interchange into an equilibrium mixture of tristearin, oleodistearins, stearodioleins and triolein).

65. In the thermal alteration of linseed oil there are at least three different processes which may go on more or less concurrently; the changes effected by heat in a long-chain acyl group with one pentadiene system (linoleic); and the possibility of glyceride molecules becoming linked together by means of acyl interchanges at the glycerol linkings or, alternatively, by cross-linking between acyl groups attached to different triglyceride molecules. An attempt has been made to isolate each of these in some measure and to study them separately.

66. This has been done by comparing linseed oil heat-bodied to varying stages under plant conditions with a linoleic-rich (sunflower seed) oil heat-bodied similarly but on a laboratory scale. It was originally intended to apply the methods of glyceride structure and of component acid studies now used with the drying oils themselves to the heat-bodied products; but it was found that the glyceride structure problem was far too complicated for attack by the methods available, and that the acids from the heat-bodied oils become progressively more soluble in solvents at low temperatures, so that as much information could be obtained from the mixed acids of the stand oils as by their attempted further resolution by low temperature crystallisation.

67. The conclusions drawn from this work are therefore based upon such characteristics of the stand oils as iodine value, free acidity, viscosity and apparent molecular weight (in *cyclo*hexane), coupled with the composition of the mixed acids as revealed by spectrographic analysis for conjugated diene and triene acids and for unchanged linolenic or linoleic acids. These figures showed that, after allowing for all acids thus recorded, the mean unsaturation of the remaining unsaturated acids was considerably in excess of monoethenoid. The calculated iodine values of these remaining acids was of the order of 103–110 (sunflower) and 135–148 (linseed) instead of 90 (monoethenoid). The explanation offered is that conjugated dienes initially produced from linoleic or linolenic groups may interact rapidly with unaltered linoleic or linolenic groups (so long as these are present in quantity) through migration of a hydrogen atom from a reactive methylene group in the latter:—



68. This reaction is at first predominantly intramolecular. As the linoleic or linolenic content rapidly declines, similar reactions between conjugated diene groups and isolated double bond systems sets in, as indicated by subsequent increase in the proportions of monoethenoid compounds in the products. When unchanged linoleic or linolenic acid has fallen to below 5–10% of the total fatty acids, further changes in the composition of the mixed fatty acids of the stand oils become relatively small. Up to this point the viscosity of the products has not commenced to augment markedly.

69. This sequence of changes can be relatively clearly followed in the linoleic-rich (sunflower) oil. There is close parallelism in the general composition of heat-bodied sunflower and linseed oils, but the presence of both

linolenic and linoleic groups in the latter confuses the interpretation of the analytical results, unless these are taken in conjunction with the simpler case of heat-bodied sunflower seed oil.

70. During the course of these changes the proportion of polyene acyl groups falls, as already indicated, to a very low point, but concurrently there is no marked increase in viscosity. Subsequently however, the viscosity augments rapidly, but with little further marked change in the composition of the acyl groups. It is suggested that, in this third phase of the process, glyceride molecules may be coalesced into glyceride polymers by means of acyl interchange. Such interchange, involving a cross-linked di-acyl chain produced intramolecularly in the earlier phases, would cause two glycerides molecules to be linked through the latter (which is essentially a branched-chain dicarboxylic acid of somewhat complex structure). That acyl interchange in glycerides proceeds (without other catalyst) thermally at 300°C. has been demonstrated in the case of the glyceride oleodistearin, which is transformed in these conditions to the equilibrium mixture of tristearin, oleodistearin, stearodiolein and triolein, in the course of about 10 hours (an account of this latter work has been submitted for publication in the Journal of the Chemical Society).

71. *Stillingia oil* (Mr. A. Crossley). The work on the component acids of various authentic and commercial stillingia oils, summarised in para. 38 (*e*) of last year's Report, has now been published in the Journal of the Science of Food and Agriculture. The study of the component glycerides in an authentic and in a commercial stillingia oil has been completed. Each acid (including decadienoic) was found to be distributed amongst the triglyceride molecules in the generally " evenly-distributed " manner which is followed in nearly all seed oils, and notably in the drying oils. The short-chain decadienoic acid (which only forms about 8 out of every 10^3 mols. of the total acids in the oil) only occurs singly in any triglyceride molecule in which it is present. The chief constituents of stillingia oil are probably linoleodilinolenins (ca. 25%), decadieno-linoleo-linolenins, saturated linoleo-linolenins, and saturated dilinolenins (*ca.* 15% each), oleo-linoleo-linolenins and decadieno-dilinolenins (*ca.* 10% each).

72. Some further studies of deca-2, 4-dienoic acid and its derivatives have led to the following results:—

(*a*) On prolonged treatment with excess of alkali at 180°C., the characteristic broad absorption band of the acid with heat at about 260 m.μ. is replaced by one with a head at 234 m.μ. Examination of the structure of the unsaturated acids produced by this alkali-isomerisation process showed that the conjugated diene group was displaced (mostly as an entity) along the acyl chain *away from* the carboxyl group, leaving however about 15% of unchanged deca-2,4-dienoic acid. The main products were deca-5,7-dienoic and deca-4,6-dienoic acids, amounting in all to about 65% of the original acid, whilst about 20% of the latter appeared to have been converted into non-conjugated decadienoic acids.

(*b*) Deca-2,4-dienol was prepared by reduction of deca-2,4-dienoic acid with lithium aluminium hydride. The action proceeded very smoothly and the fractionally-distilled deca-2,4-dienol (b.p. 67°/0·2mm) had a band head at 231 m.μ. (instead of 260 m.μ. for the acid) with $E^{1\%}_{1cm}$ about 1400. Replacement of the carboxyl group contiguous to the conjugated diene system by the carbinol group led to the appearance of the characteristic absorption band associated with the simple conjugated diene group.

A Diels-Alder condensation between maleic anhydride and deca-2,4-dienoic acid could not be effected somewhat surprisingly, since it is understood that sorbic acid yields a Diels-Alder adduct. The deca-2,4-dienol, in contrast, reacted readily with maleic anhydride to give a liquid adduct which showed very low absorption of a general and almost negligible order in the region between 200 m.μ. and 240 m.μ.

73. *Candlenut, rubberseed and linseed oils* (Mr. A. Crossley). Three further specimens of candlenuts, respectively from Kenya, Uganda and Ceylon have been examined during the year. Since data was last published on candlenut, rubberseed or linseed oils from different sources, a number of isolated observations have gradually been accumulated mainly on candlenuts.

74. Of particular interest was the examination of the oil from nuts growing in the grounds of the Scott Agricultural Laboratories at Nairobi. A separate study of six individual nuts, selected at random, gave the following result:—

	Nuts			Oil		Component acids (%wt.)			
	Wt.	Husk	Kernel	Yield on kernel %	Iodine Value	Satd.	Oleic	Lino-leic	Lino-lenic
	(g)	%	%						
	8·7	75	25	61·5	162·0	16·3	13·5	36·0	34·2
	8·6	73	27	62·9	159·7	14·8	14·0	40·5	30·7
	7·9	75	25	63·4	156·8	17·2	15·3	36·3	31·2
	7·6	73	27	66·8	153·4	16·1	18·8	36·1	29·0
	7·3	74	26	63·4	159·1	15·8	15·2	36·8	32·2
	6·7	72	28	63·0	156·7	17·1	13·3	40·9	28·7
Mean Values:	7·8	74	26	63·4	157·7	16·2	15·0	37·8	31·0

Although the average values for the six nuts differed but little from the results of previous analyses of nuts from various sources, the variation between the oils from individual nuts was more than might have been expected from a single tree. Iodine values ranged from 153·4 to 162·0, linoleic acid content from 36·1 to 40·9%, and linolenic content from 28·7 to 34·2%.

75. *Influence of environment on the composition of sunflower seed oil.* (Messrs. C. Barker, R. E. Bridge and A. Crossley). Following the experimental growth of different varieties of sunflower seed in an English garden in 1949 (last year's Report, para. 38 (*d*)), further trials of two varieties were undertaken in 1950 in order to study (*a*) the composition of the oil at different stages of ripening of the seed, and (*b*) the composition of the oil in mature seeds ripened with full access of light or with fully-reflexed heads not exposed to direct sunlight. The full analytical results are not yet available, but it is doubtful whether materially useful data will result, owing to the very bad conditions in the summer and autumn of 1950, and consequent irregularities and imperfections in the ripening of the seeds.

76. *Sunflower seeds from Australian experimental trials.* A very interesting and well-documented collection of sunflower seeds from widely different regions of Australia (Victoria, New South Wales, Queensland, Northern Territory and Western Australia) has been received through Mr. R. A. Jones

of the Board of Trade and the Australian Scientific Liaison Officer in London. The results for one group of samples from New South Wales and those from Western Australia are not yet completed, but those for the remaining specimens afford a further most striking correlation between the time of ripening of the seeds and the fatty acid composition of their oils, as the following summary shows:—

AUSTRALIAN SUNFLOWER SEED OILS

	Time (days) between flowering and harvesting	Oil Iodine Value	Component fatty acids (%wt.)		
			Linoleic	Oleic	Satd.
VICTORIA					
Bruthen (*Lat.* 37·5°*S*)					
Mannonite	70	130·9	67	18	15
Advance	68	131·0	66	20	14
Cobram (*Lat.* 36°*C.*)					
Mannonite	76	129·3	66	17	17
Mannonite	65	131·2	68	16	16
Sunrise	76	128·9	65	19	16
Sunrise	68	127·6	63	21	16
QUEENSLAND					
Lawes (*Lat.* 27½°*S.*)					
Mannonite	About 40–50	126·9	61	23	16
Sunrise	About 40–50	122·1	56	30	14
Mars	About 40–50	123·3	56	30	14
Pole Star	About 40–50	121·0	55	31	14
Jupiter	About 40–50	122·2	57	27	16
Commercial	About 40–50	122·7	59	24	17
Laidley (*Lat.* 27°*S.*)					
Giant Russian ...	About 60	123·1	58	26	16
Mannonite	About 60	121·3	55	29	16
Sunrise	About 50	117·9	50	37	13
NORTHERN TERRITORY					
Katherine (*Lat.* 14½°*S.*)					
Mannonite	27	105·1	34	53	13
Sunrise	27	105·7	36	51	13
Mars	27	105·5	36	50	14
Pole Star	27	104·1	35	50	15
Sunrise	27	99·9	31	54	15
Jupiter	27	105·8	36	49	15
Commercial	27	103·4	33	53	14

77. *Poppy seed oils* (Mr. R. E. Bridge). Two specimens of poppy seed grown on an experimental farm in Essex in 1947 and 1948 have been examined, the component acids of both oils and the component glycerides of one of them being determined. Concurrently a specimen of Indian grown poppy seed was being studied by an Indian student in the laboratory. Appended is a summary of the results for both the English and the Indian oils.

POPPY SEED OILS

	English 1947	English 1948	Indian
SEEDS			
Weight of 100 seeds	0·05	0·04	?
Oil yield	33·1%	36·4%	44·7%
OILS			
Iodine value	138·8	139·4	137·1
Free fatty acid (as oleic)	3·8%	3·3%	4·3%
Unsaponifiable	1·7%	1·3%	1·1%
COMPONENT ACIDS	% (*wt.*)	% (*wt.*)	% (*wt.*)
Myristic	0·7	—	—
Palmitic	9·5	8·3	11·0
Stearic	1·7	2·7	4·6
Oleic	16·5	16·4	11·4
Linoleic	71·6	72·6	73·0
COMPONENT GLYCERIDES	% (*mol.*)	% (*mol.*)	% (*mol.*)
Categories:			
(i) Mono-unsaturated	1·5	—	1·2
Di-unsaturated	40·3	—	45·9
Tri-unsaturated	58·2	—	52·9
(ii) Mono-linoleo-	7·2	—	10·1
Di-linoleo.	66·1	—	69·2
Trilinolein	26·7	—	20·7
Possible Components:			
Palmitostearolinoleins	1·5	—	1
Saturated-oleo-linoleins	6	—	9
Saturated-dilinoleins	34·5	—	37
Oleodilinoleins	31	—	32
Trilinolein	27	—	21

Both oils are of the " linoleic-rich " type with somewhat over 70% of linoleic acids in the total acids, and with no linolenic acid. Both contain 90% or so of glycerides with either 2 or 3 linoleic groups in their molecules, so that (as indeed the classical artists soon realised) poppy seed oil is an excellent and non-yellowing drying oil. At the same time it should be noted that some workers have recorded little more than 60% of linoleic acid in the total acids, so that poppy seed, like sunflower seed and some other annual seeds which produce linoleic-rich oils, may produce oil of somewhat varying composition under different conditions of growth.

Chemical Constitution of other Fatty Oils

78. *Okra seed oil* (Mr. A. Crossley). A sample of okra seed (*Hibiscus asculentus*) was sent to us from the Sudan, where its bulk cultivation as an oilseed crop is being considered. The small seeds (weighing about 2·4 gm. each) contained 15% of oil with iodine value 94·0, free fatty acid 0·1% and unsaponifiable matter 1·2%. The component acids included palmitic 23·8, stearic 7·4, oleic 27·1 and linoleic 41·7% (wt.). About 40% of the oil consisted of saturated-oleo-linoleins, 25% of triunsaturated glycerides (mainly oleodilinoleins), 10% of saturated dilinoleins and 23% of glycerides with two saturated and either an oleic or a linoleic group. The oil is very closely similar in constitution to cottonseed oil and, providing the harvesting of the seed and its subsequent decortication present no serious difficulties, it should be completely suitable for all uses to which cottonseed oil is put. Okra cultivation is being developed in Louisiana and other Southern States in the U.S.A., and it would appear that it might be a suitable oilseed crop for development in some Colonial regions.

79. *Some annual seed oils grown in England* (Mr. R. E. Bridge). In addition to the poppy seed oil mentioned above, a number of seeds from the experimental farm of Mr. H. Dutton of Wivenhoe, Essex, have been examined during the year. These results are of general interest as a comparison between the types of the respective seed oils produced under English conditions of growth with some of the data which have been accumulated for similar seeds from Colonial or Dominion sources. The English sunflower, linseed and hemp oils, as can now be expected, show general tendency towards the more unsaturated types which are characteristic for species grown in relatively cool climates. The results are summarised below:—

English (Essex) Seeds	Sunflower	Hemp		Linseed	Millet
		I	II*		
SEEDS					
Weight of 100 seeds	4·8	1·9	1·9	0·56	0·68
Oil yield	34·7%	31·4%	32·4%	39·8%	4·3%
OILS					
Iodine value	133·0	163·4	165·3	185·2	138·2
Free fatty acid (as oleic) ...	1·1%	2·4%	2·4%	4·7%	9·5%
Unsaponifiable	1·4%	1·6%	1·4%	1·5%	6·1%
COMPONENT ACIDS (% wt.)					
Myristic	—	0·2	0·6	—	—
Palmitic	6·0	9·5	9·9	8·5	5·3
Stearic	3·9	2·0	2·5	3·9	3·6
as Arachidic	2·3	1·9	1·7	0·4	1·4
Oleic	21·5	7·8	6·5	14·9	22·7
Linoleic	66·3	56·2	55·4	16·8	67·0
Linolenic	—	22·4	23·4	55·5	—

* Hemp grown at Leighton Buzzard, Bedfordshire.

80. *Seed fat of Macadamia ternifolia* (Mr. R. E. Bridge). This interesting fatty oil, sent some years ago from Australia, comes from the seeds of an indigenous tree which belongs to the family Protacoae, and forms one of the typical primitive members of the Australian flora. The oil is remarkable for its content of about 20% of hexadec-9-enoic (palmitoleic) acid, which only occurs in traces in most land seed fats, although it is prominent in the fats of aquatic flora and, indeed, aquatic fauna. The component acids of the oil were found to be myristic 1·6, palmitic 8·0, stearic 3·3, arachidic 2·2, behenic 0·8, hexadec-9-enoic 20·4, oleic 59·3, linoleic 2·2, and an eicosenoic acid 2·2% (wt.).

81. *Castor oils* (Mr. S. S. Gupta and Mr. J. P. Riley). The long-drawn out work on castor oils (mainly on seeds obtained from many diverse sources) has at length been sent for publication. The chief feature of the results is the remarkable general constancy in composition of the oils, the chief acids being 91–94% of ricinoleic, 4–5% linoleic, 1–2% saturated and 0·5% dihydroxystearic acid. Oleic acid is present only in very small traces.

82. *Hippopotamus fat* (Mr. C. Barker). A specimen of fat from a hippopotamus shot in Uganda was received from Sir Frank Engledow. It proved to be a typical " stearic-rich " animal depot fat, although small proportions of highly-unsaturated acids characteristic of aquatic vegetation were present. Its component acids were myristic 2·3, palmitic 27·1, stearic 22·2, arachidic 1·1; hexadecenoic 2·6, oleic 39·3, octadecadienoic 3·6, octadecatrienoic 1·5,

and unsaturated acids of the C_{20} series of 0·4% (wt.). This composition suggests that the greater part of the hippopotamus fat had been synthesised from carbohydrate by the animal, and that relatively little of it was derived by direct assimilation of fats in its diet.

Proteins of Sunflower Seed

83. Mr. J. E. Humpoletz, working with Dr. P. Johnson, has made a preliminary study of the proteins present in sunflower seeds. The seed cake was derived from striped Nigerian seeds remaining after the oil had been solvent extracted and the solvent removed by heating at 100° for some hours. It is possible that some of the difficulties encountered in investigating the protein have been due to the previous treatment of this material. It is probable, therefore, that the information obtained from such meal may not be applicable to the proteins in the untreated seed. Such a meal has now been obtained and will be examined later. The protein preparations have been examined by electro-phoresis and ultracentrifugation. When the protein was isolated by the normal methods it was contaminated with a strong colouring matter which, once formed, could not be removed. An improved product was obtained by extraction in an atmosphere of nitrogen or by the previous extraction of the seed with butanol. Ultracentrifugal examination indicated the presence of three well-defined components, but with electrophoresis boundary spreading only without separation into discrete components was observed. Further work will be concerned with the preparation of the proteins and the separation of the different species present and their examination by different physical methods.

Plants of possible Medicinal and Insecticidal value

84. (39) *Hydrocotyle asiatica* (*Centella asiatica*) (Uganda). Work on the triterpenoid constituents of this plant has been continued under the direction of Dr. B. Lythgoe. The material from Uganda has been shown to contain asiatic acid identical with the aglucone of asiaticoside isolated by French workers from the variety which grows in Madagascar and investigated by Professor E. Lederer and his colleagues in Paris. Work on this interesting substance is being continued under the direction of Dr. D. H. R. Barton, in Birkbeck College.

85. *Thonningea sanguinea* (Gold Coast). A product prepared by aqueous alcoholic extraction of the dried flowers was found to possess slight activity as a vermifuge, some effect being observed against tape worms in mice at a dose rate of 1g/Kg. The amount of material available was too small for further investigation.

86. *Mitragyna alkaloids* (Nigeria and Tanganyika). During the past year the study of the *Mitragyna* alkaloids has been continued under the supervision of Professor J. W. Cook and Dr. J. D. Loudon. The results have been published (G. M. Badger, J. W. Cook and P. A. Ongley, *J. Chem. Soc.*, 1950, 867). Mr. R. M. Gailey has almost completed the extraction with chloroform of about a hundredweight of bark of *Mitragyna rubrostipulaceae* (*Adina rubrostipulata* K. Schumann). The extractable constituents were found to include neutral (wax and steroid), acidic and alkaloidal materials. Quinovic acid, which can be obtained from the acidic fraction, appears not to be present as such, but as an acidic precursor. From the mixture of alkaloids, present to the extent of about 0·5% of the total bark, mitraphylline has been isolated and identified, in agreement with the previous findings of Dr. Ongley. In addition, there were smaller fractions not yet fully investigated, which appear

to contain mitragynine and mitrinermine. In an attempt to identify the base, C_{14} H_{14} ON_2, obtained by Ing and Raison (*J. Chem. Soc.*, 1939, 986) from degradation of mitragynine, Mr. P. McCloskey has synthesised 7-methoxy-1: 2-dimethyl-β-carboline. Although this compound closely resembles the degradation product it is not identical with it.

87. *Brachylaena hutchinsii* (Kenya). Dr. J. C. Smith and Mr. G. Pickering have now completed their study of the essential oil obtained from the wood of *Brachylaena hutchinsii*. The main constitutes of this oil, which is 3·5% of the wood, have been found to be (*a*) a sesquiterpene hydrocarbon *d*-cadinene, (*b*) a closely related sesquiterpene hydrocarbon also yielding cadalene on dehydrogenation, and (*c*) a sesquiterpene alcohol.

88. *Chlorophora excelsa* (Sierra Leone). Professor F. E. King and Mr. M. F. Grundon have now established the structure of the phenol, chlorophorin, present in this wood and a paper embodying the results of this work has been published. Chlorophorin belongs to the limited group of natural products, of which pinosylvin, 2:5-dihydroxystilbene, a constituent of several *Pinus* species, is the simplest representative. It may be noted that Mr. W. G. Campbell and Dr. R. H. Farmer have isolated the calcium salt *dl*-malic acid from a fissure in this wood. The investigation of other resistant hard woods is being continued by Professor F. E. King in collaboration with Mr. J. M. Baker.

89. *Caesalpinia bonducella* (Jamaica). This material has been recorded in the Indian Pharmacopeia as being a useful remedy in the treatment of malaria. The active principle, bonducin, a glycoside, $C_{20}H_{28}O_8$, is now being extracted from 100 lbs. of nuts by Dr. F. B. Kipping and Mr. Alberman.

90. *Phyllanthus engleri* (East Africa). The root bark of this species is used as a criminal poison in East Africa. An extract has been prepared by Dr. F. B. Kipping and Mr. K. B. Alberman in Professor A. R. Todd's laboratory, and has been shown to be fatal to rabbits in a dose of the order of 100 mg./kg. This order of activity is, however, much lower than that previously recorded. The drug is remarkable for the slowness of its action, death usually occurring about four days after administration. A post mortem examination of the animals failed to reveal any abnormality. In addition to the poisonous principle the root bark contains an alcohol of high molecular weight which melts at 233°. The tests on animals with the extract were carried out in conjunction with Mr. P. A. Jewell of the Department of Pharmacology, University of Cambridge.

91. *Canarium schweinfurthii* (Belgian Congo). During the past year Professor F. S. Spring, in collaboration with Drs. R. Bhuvanendram and W. Manson, has completed the investigation of the resin of *Canarium schweinfurthii*. The resin contains a volatile oil, the main constituent of which is (+)-limonene. The acids present consist essentially of elemadienolic and elemadienonic acids. The neutral non-volatile fraction contains, in addition to the α- and β-amyrins, a triterpenoid diol differing from known diols of this series. Work on the properties of this last compound is being continued.

92. *Lupeol.* With the assistance of Dr. G. E. T. Mann, Director of the Rubber Research Institute, Malaya, Professor E. R. H. Jones has been supplied with a quantity of Ge-tah Jelutong for the isolation of lupeol. Professor Jones, in collaboration with Messrs. T. R. Ames and T. G. Halsall and G. S. Davy has thus been able to determine the structure of this triterpenoid alcohol.

Striga Hermonthica

93. (40) Experiments on the germination factor have been actively pursued in the Universities of Leeds and Cambridge. In Cambridge, where the work is being carried out under the supervision of Professor A. R. Todd and Dr. A. W. Johnson, the most active material obtained after chromatography on columns of cellulose has been found to be biologically comparable with that obtained by countercurrent extraction techniques. It is therefore reasonable to assume that each contains an appreciable amount of the natural stimulant, although no concentrates have so far been obtained in the crystalline state. No physical properties have been discovered which are sufficiently characteristic to enable biological testing to be dispensed with. Chemical degradative work is in progress.

Colonial Microbiological Research Institute

94. (43) *Disposal of Rum Distillery Lees.* This investigation has had to be left in abeyance during the year owing to the non-completion of the pilot plant.

The Fermentation of the Cocoa Bean

95. *Microbiological study.* The study of the microflora found on fermenting cocoa beans in Trinidad and Grenada has been continued during the past year. *Candida Krusei* (A. Cast.) has been identified as the predominant species of yeast in commercially fermented cocoa beans in both islands. Only in the very early stages of fermentation have a few other species been in evidence, notably *Torulaspora Rosei* Guillermend, and a species of *Pichia.* Contrary to statements in the literature species of *Sacchromyces* have never represented a significant percentage of the total yeast microflora. Out of a thousand million yeast cells present on one cocoa bean during the first 48 hours of fermentation 65% were represented by *Candida Krusei* while *Saccharomyces* species amounted to only 0·5%. This observation may perhaps imply that the acetic acid formed, and eventually accumulating in the sweat box liquors, is not produced exclusively from ethyl alcohol, the main fermentation produce of *Saccharomyces* species, but may in part be derived from the action of non-alcoholic producing yeasts such as *Candida Krusei,* on the citric acid present in the pulp of the cocoa bean. The actual changes taking place are now being investigated. The Director is indebted to Dr. Johanna Lodder of Delft, Holland, for checking the preliminary identifications of the various yeast types found, and for identifying others. Some of the latter will probably be found to be hitherto unknown species or sub-species.

96. *Cocoa flavours.* The study of the chemical changes by which a precursor of the chocolate flavour is developed in cocoa beans during fermentation has been continued during the year under review. It was again confirmed that micro-organisms are not essential for the desired changes taking place in the beans during fermentation, and their action can be substituted by the use of well defined chemical substances under aseptic conditions. These desirable changes must, therefore, be assumed due to enzymes. In support of this, it may be mentioned that beans extracted aseptically from ripe pods and left for several days at 48°C. in a sterile solution of acetic acid of 1·5% strength, partly neutralised with sodium hydroxide to pH 4·6 yield, after drying and roasting, a chocolate flavour which was assessed by a panel of experts* as of the same intensity as that of commercially fermented beans. Identical beans, kept in water, did not develop any chocolate flavour on roasting, nor

* The assessment of these and all other samples of beans was carried out by the Panel of the British Food Manufacturers' Research Association, dealing with chocolate flavour.

did beans kept at a temperature of 48°C. for several days in a 1·5 solution of citric or phosphoric acid, and partly neutralised with sodium hydroxide to pH 4·6. An immersion at 48°C. of fresh cocoa beans in a sodium acetate solution, on the other hand, gave a product almost equally intense in flavour to that prepared with free acetic acid. This would seem to indicate that acetate ions are essential for the required changes within the beans. The concept that such changes in fermenting cocoa beans are caused not by micro-organisms but by enzymes produced by, and within, the beans, is further strengthened by the observations that beans devitalised by boiling are no longer able to produce a marked chocolate flavour, even in solutions of acetic acid at 48°C., while beans in which the seedling is killed by freezing yield a chocolate flavour equal to that of fresh beans when kept aseptically in an acetic acid solution at 48°C. The investigation of the chemistry of the polyphenolic components of the cocoa beans and of their changes during fermentation has been continued. It has been possible to isolate on a macro-scale the substances previously referred to as pigments (Forsyth, *Nature*, 1949, **164**, 25). The prominence of fractions amongst them with a leuco-cyanidin basis to their structure is striking. Although the work on the isolation of these substances is proceeding satisfactorily, the same cannot be said for the attempts which have been made to isolate the substance, or substances, which on roasting, give rise to a chocolate flavour. This, it is felt, is largely due to the difficulty of assessing the flavour in beans. It is hoped that early discussions which have been arranged with the Cocoa Research Association may lead to a solution of this difficulty.

97. *Panama Disease investigations.* A re-examination of the results reported upon during 1949–50, that the rhizosphere of certain immune banana varieties contain antibiotic producing organisms, whilst non-immune varieties do not harbour such organisms has not so far been confirmed.

98. *Hankey Culture Collection.* A preliminary list of micro-organisms mantained in the Hankey Culture Collection was issued and circulated on the 1st of April, 1950. The number of organisms maintained in the Collection has been increased to 372 by the end of the year. Owing to the absence on long leave of the Curator, the work has been in the nature of maintenance of, rather than of addition to, the collection, although an attempt was made to increase the section of actinomycetes. Previously this section had consisted of but few strains and no attempt had been made to collect species from Trinidad. It is intended to do so in the future. With the collaboration of the Colonial Hospital in Port of Spain, 13 cultures of suspected pathogenic yeasts and fungi were received for indentification. In connection with work on antibiotic substances, several typed pathogens were received from South American collections. Outside requests were received for 46 cultures, (16 yeasts, 20 bacteria, 8 fungi and 2 actinomycetes) a considerable number of the requests coming from the new University College of the West Indies, although cultures of *Torulopsis utilis*, the " food yeast " organism, and various lactic acid bacteria were required by commercial undertakings. The collection is now reaching such proportions that a reduction in the routine subculturing becomes necessary, and various methods of preservation are being tried. Strong sucrose solutions for the yeasts and sand for the bacilli appear suitable. Other methods may be needed for the fungi and actinomycetes.

99. *Red Root Diseases of West Indian Limes.* During the year a request was received from the Agricultural Department of Trinidad and Tobago to assist in exploring the cause of the disastrous disease of West Indian Lime seedlings, usually referred to as Red root disease. Since it is unknown at present whether this disease is cause by fungi or by a virus, it was suggested that the

assistance asked for should concentrate on the possibility of determining the part which might be taken by lower fungi. Microscopic observations of the affected part of the crippled trees give strong support for the belief that fungi may be partly responsible, and cultures made of diseased tissues showed striking numbers of a *Fusarium* belonging to the section elegans, though macroscopically the infection may resemble attack by *Basidiomycetes*. Lime trees imported from Tobago and growing in soil brought over from that island which is known to be free of the disease have been innoculated with the *Fusarium* species isolated and the results of this experiment are awaited. Only two species of *Basidiomycetes* have been found fructifying regularly on diseased lime trees. The most prominent species would appear to be an *Auricularia* while a second species, which has been tentatively identified as *Ganoderma*, has only occasionally been met with. It has been suggested to the Agricultural Department that these apparently secondary infections should also receive attention. Since the disease is apparently soil borne, it would appear of interest to compare the soil microflora on plots where the disease is rampant and compare it with the microflora of soils where the disease has not yet appeared. Such plots can be found in South Trinidad where seedlings are, in some places, crippled beyond saving, while neighbouring plots of the same type of soil appear free from symptoms.

100. *Antibiotics.* Dr. Thaysen and his staff have continued their study of the antibiotic, comirin. Work in a closely related field is being carried out by Professor C. H. Hassall and Miss L. Wong in the University College of the West Indies, where the antibiotic, monamycin, separated from a strain of Meredith's actinomycete, is being studied.

101. *Cultivation of* Volvaria *esculenta, Bresadola, an edible mushroom.* Since there are available in various Colonial territories, including British Guiana, an excess of rice straw which to-day is of but slight commercial value, it was thought worth while ascertaining whether it were possible to devise conditions for the large scale cultivation of *Volvaria esculenta*, an edible mushroom, much appreciated in China and other Far Eastern countries. Preliminary experiments have shown that climatic conditions in Trinidad appear to be satisfactory to outdoor cultivation of *Volvaria*.

102. *Conferences and Overseas Visits.* During the year, members of the staff, (the Director, Mr. Rombouts and Dr. Forsyth) attended the third meeting of the Inter-American Technical Cacao Committee, between November 20th to 25th in Trinidad; and the Director and Dr. Forsyth the Microbiological Congress in Rio de Janeiro. In Rio both Dr. Thaysen and Dr. Forsyth read papers, the titles of which are given in Appendix II.

103. At the invitation of the Agricultural Department, the Medical Association and the British Council of British Guiana, the Director and Mrs. Mackay, the Secretary of the Institute, visited that Colony from the 14th to the 21st of October. The visit was in part to fulfil a promise to lecture before these organisations, in part to study the possibility of recruiting British Guianese technical assistants for the Institute, and in part to explore to what extent local undertakings might be interested in the work of the Institute. During the visit three lectures were given by Dr. Thaysen, one on the nutritional value of food yeast, one on the functions of the Institute, and one on general microbiology. The Secretary of the Institute addressed the students of Queens College, Georgetown, and explained to them the functions of the Microbiological Institute, and the openings offered there for young men and women as technical assistants.

104. Previously members of the British Guianese Legislative Council had visited the Institute and discussed two problems which appeared to be of a microbiological nature, namely the corrosion of cast iron pipes in the soil, and the formation of what was described as " sling mud " in the sea off the coast of British Guiana. During his visit to Georgetown, Dr. Thaysen studied both of these problems. The first, the corrosion of buried pipe lines was apparently of minor practical importance, though it was obvious from an examination of damaged pipes that sulphate reducing bacteria were responsible for the damage caused. The subject of the formation of sling mud was found to be of more serious, though indirect, consequence. Discussions with members of the Public Works Department in Georgetown made it clear that the formation of sling mud is not one in which micro-organisms take a direct part. Analyses of the sling mud have shown that it is composed largely of aluminium and silicon oxides brought down by the rivers of British Guiana to the sea where it forms a heavy colloid which is eventually deposited on the foreshore as a clayey substance. A visit to a part of the shore where sling mud was being actively deposited revealed that here, and presumably throughout the lowlands of British Guiana, sulphate reducing bacteria are extremely active in reducing sulphates to sulphuretted hydrogen, which on combining with dissolved iron in the water phase of the mud forms iron sulphate. Iron sulphide appears to be a normal constituent of the clayey soils of the lowlands. To-day this clay is, and has been for many years past, used in the preparation of clinkers for road construction. To prepare these clinkers clay is fired with wood and thus baked. The clinkers are then used as road fill. The actual burning process was witnessed and the presence of sulphurous acid was unmistakable in the vapours given off. This could only have been brought about by the exidation, during burnings, of the iron sulphide. The clinkers, impregnated with the sulphurous acid, are placed directly on the roads and are here unquestionably responsible for the rapid deterioration of the chassis of motor cars using the roads. The Director was informed by members of the motoring community in Georgetown that, unless the chassis of their cars are repeatedly painted with bitumen or other acid proof paints, the damage caused by the use of the roads in British Guiana is of serious consequence.

APPENDIX I

The official opening of the Sugar Technological Laboratory at the Imperial College of Tropical Agriculture, Trinidad, on the 17th March, 1951

Message from The Rt. Hon. Lord Hankey, G.C.B., G.C.M.G., G.C.V.O., F.R.S.,
Chairman of the Colonial Products Research Council

Realising the importance of sugar to the economy and prosperity of the Colonies, the Colonial Products Research Council on its formation in 1943 decided to make research on the utilisation of sugar as a raw material for the chemical industry its main activity. It was peculiarly well situated to do so since it had as one of its members the late Professor Sir Norman Haworth, the world's leading authority on the chemistry of sugar. The direct supervision of the work in his laboratory at the University of Birmingham was placed under Dr. L. F. Wiggins. It was also realised that it was essential to co-operate as closely as possible with the sugar industry. Advantage was therefore taken of the visit of Sir Robert Robinson and Sir John Simonsen, the Director of Research, to Barbados in 1944 to suggest to the West Indies Sugar Association the desirability of establishing a Sugar Research Association with its own research laboratory. In Great Britain the Department of Scientific and Industrial Research had already proved the value of such Associations, of which there are now forty.

You are able to-day to see the proposal then made, come to fruition and for the new laboratories. financed in part by the Colonial Development and Welfare Act on the recommendation of the Colonial Products Research Council and in part by the Sugar Industry, to be formally opened. I regret that it is not possible for me, as Chairman of the Colonial Products Research Council, to be present in person on this occasion and I am therefore sending this message of goodwill by the Director of Research.

You have been fortunate in obtaining as the Director of this new Research Institute Professor L. F. Wiggins, whose original work on sugar chemistry has already received international recognition. I have no doubt we shall, in due course, see as the outcome of the work of this laboratory new industries in the West Indies utilising sugar as their raw material. We shall, I believe, obtain also a much deeper insight of the nature of sugar cane juice of which, in spite of its long usage, we are still far too ignorant. Based upon fundamental research and upon its application, and given reasonably stable political and economic conditions, we can anticipate an increase to prosperity in the West Indies.

Message from Professor Sir Robert Robinson, O.M., F.R.S.,
Waynefleet Professor of Chemistry, University of Oxford

During the visit which I paid to Trinidad in 1944 the urgent need for a Sugar Technological Laboratory which would concern itself with the development of carbohydrate chemistry in general and the technology of sugar production in particular, was patent and some suggestions relating to the form this development might assume were advanced.

It is a matter for congratulation that the enlightened policy of the Colonial Products Research Council and of the British West Indies Sugar Association has now made this scheme a practical reality. It must have the effect of improving the economics of manufacture, partly directly, and partly by the utilisation of by-products, or even by fostering a chemical industry based on sucrose.

Dr. Wiggins, the Director of Research, is acknowledged to be one of the most distinguished of the late Sir Norman Haworth's pupils. It is fortunate indeed that a man of such originality and drive should be at the helm during the first voyage through seas which we believe to be on the way to a land of discovery. On behalf of the organic chemists of this country I send you warmest felicitations on the inauguration of the Sugar Technological Laboratory.

Address by Sir John Simonsen, F.R.S., Director of Research, Colonial Products Research Council

Your Excellency,

I think that it would not be inappropriate if I were to add a few words on what I regard as the main functions of this new laboratory. The success of the Industrial Research Associations in Great Britain have in large measure been due to the recognition by the industries which they serve that it is no part of their functions to replace the ordinary works laboratory. Whilst always willing to advise it is not for them to undertake the investigation of the day to day *ad hoc* problems which arise in the works. The Associations' laboratory will only investigate major problems of interest to the whole industry. I would venture to suggest that this new laboratory will have two main functions, (*a*) to carry out fundamental research on the utilisation of sugar and the by-products of the sugar industry, and (*b*) when desirable to carry such investigations through the pilot plant stage. If these investigations show that the manufacture is likely to be economic and that a market for the product can be found then it will be for the Sugar Industry itself to undertake large scale production. If the Industry recognises this reponsibility then this new experiment has an assured future.

May I in conclusion wish Professor Wiggins and his staff of the Francis Watts laboratory success? It has been a great pleasure for me to have had the opportunity of seeing this proposal made by the Colonial Products Research Council come to fruition.

I have the honour to ask Your Excellency, the Governor of Trinidad and Tobago, to open the laboratory.

APPENDIX II

List of Publications

Papers Published

The Terpenes, Vol. III. By Sir John Simonsen, D. H. R. Barton and L. N. Owen. *Cambridge University Press.*

Terpene Chemistry. The Past and the Future (Fritzsche Medal Award Address). By Sir John Simonsen. *Chemical and Engineering News*, 1950, **28**, 1458.

Gustav Komppa. Obituary Notice. By Sir John Simonsen and J. Palmen. *Journal of the Chemical Society*, 1950, pp. 2912.

Charles Stanley Gibson. *Obituary Notices of Fellows of the Royal Society*, 1950, **7**, 115. By Sir John Simonsen.

Triterpenes, Part I. By D. H. R. Barton and C. J. W. Brooks. *Journal of the Chemical Society*, 1951, pp. 257.

Triterpenes, Part II. By D. H. R. Barton, C. J. W. Brooks and N. J. Holness. *Journal of the Chemical Society*, 1951, p. 278.

The Chemistry of the Triterpenes. Part VII. An Inter-relationship between the Lupeol and the β-Amyrin Series. Elucidation of the Structure of Lupeol. By T. R. Ames, T. G. Halsall and E. R. H. Jones. *Journal of the Chemical Society*, 1951, pp. 450.

The Configuration of Naturally Occurring Mixed Glycerides. Part VI. The Component Fatty Acids and Glycerides of Stillingia Tallows. By S. S. Gupta and M. L. Meara. *Journal of the Chemical Society*, 1950, pp. 1337.

The Seed Fat of Macadamia ternifolia. By R. E. Bridge and T. P. Hilditch. *Journal of the Chemical Society*, 1950, pp. 2396.

The Component Acids of a Hippopotamus Fat. By C. Barker and T. P. Hilditch. *Journal of the Chemical Society*, 1950, pp. 3141.

African Drying Oils. V. Some Nigerian and Sudanese Drying Oils. By C. Barker, H. C. Dunn and T. P. Hilditch. *Journal of the Society of Chemical Industry*, 1950, **69**, 71–75.

Autoxidation of Oleic (or other Mono-othenoid Long-chain) Esters. By T. P. Hilditch. *Nature*, 1950, **166**, 558.

The Influence of Environment upon the Composition of Sunflower Seed Oils. I. Individual varieties of Sunflowers grown in different parts of Africa. By C. Barker and T. P. Hilditch. *Journal of Science of Food and Agriculture*, 1950, *I*, 118–121.

The Influence of Environment upon the Composition of Sunflower Seed Oils. II. Composition of the Seed Oils of Sunflowers grown in English Gardens from five specimens of different African seeds. By C. Barker and T. P. Hilditch. *Journal of Science of Food and Agriculture*, 1950, *I*, 140–144.

The Component Fatty Acids of Tobacco Seed Oils. By R. V. Crawford and T. P. Hilditch. *Journal of Science of Food and Agriculture*, 1950, *I*, 230–234.

The Component Acids of some Authentic and Commercial Stillingia Oils. By A. Crossley and T. P. Hilditch. *Journal of the Science of Food and Agriculture*, 1950, *I*, 292–300.

The Component Fatty Acids and Glycerides of Groundnut Oil. By R. V. Crawford and T. P. Hilditch. *Journal of Science of Food and Agriculture*, 1950, *I*, 372–379.

The Biosynthesis of Unsaturated Fatty Acids in Ripening Seeds. By T. P. Hilditch. *Nature*, 1951, **167**, 298.

The Fats: 1900–1950. An Essay in Historical Chemistry. Jubilee Memorial Lecture. By T. P. Hilditch. *Chemistry and Industry*, 1951, 154.

The Constitution of Chlorophorin. Part II. Further Oxidation Experiments, and the Completion of the Structural Problems. By F. E. King and M. F. Grundon. *Journal of the Chemical Society*, 1950, pp. 3547.

The Enzymic Synthesis and Degradation of Starch. Part VIII. The Use of Mixtures of P- and Q-Enzymes in the Synthesis of Starch-type Polysaccharides. By S. A. Barker, E. J. Bourne, S. Peat and I. A. Wilkinson. *Journal of the Chemical Society*, 1950, pp. 3022.

The Enzymic Synthesis and Degradation of Starch. Part IX. Methylation and End-group Assay of Some Synthetic Polysaccharides. By S. A. Barker, E. J. Bourne, and I. A. Wilkinson. *Journal of the Chemical Society*, 1950, pp. 3027.

The Enzymic Synthesis and Degradation of Starch. Part X. The Phosphorylase and Q-Enzyme of Broad Bean. The Q-Enzyme of Wrinkled Pea. By P. N. Hobson, W. J. Whelan and S. Peat. *Journal of the Chemical Society*, 1950, pp. 3566.

The Enzymic Synthesis and Degradation of Starch. Part XI. Isophosphorylase. By J. M. Bailey and W. J. Whelan. *Journal of the Chemical Society*, 1950, pp. 3573.

Carbohydrate Primers in the Synthesis of Starch. By J. M. Bailey, W. J. Whelan, and S. Peat. *Journal of the Chemical Society*, 1950, pp. 3692.

Birefringence of Amylose and Amylopectin in Whole Structural Starches. By F. Baker and W. J. Whelan. *Nature*, 1950, **166**, 34.

Mechanism of the β-Amylolysis of Amylose. By E. J. Bourne and W. J. Whelan. *Nature*, 1950, **166**, 258.

Some Morphological Features Accompanying the Aerobic Photo-degradation of Whole Potato Starch. By F. Baker and W. J. Whelan. *Nature*, 1950, **165**, 449.

The Enzymic Synthesis and Degradation of Starch. Part XII. The Mechanism of Synthesis of Amylopectin. By P. N. Hobson, W. J. Whelan and S. Peat. *Journal of the Chemical Society*, 1951, 596.

Alkyl Naphthalenes. Part III. By A. S. Bailey, G. B. Pickering and J. C. Smith. *Journal of the Institute of Petroleum*, February, 1949, 34, 302.

Triterpene Resinols and Related Acids. Part XIX. Isolation of a Triterpene Diol from *Canarium Schweinfurthii* Resin. By Ratnam Bhuvanendram, W. Manson and F. S. Spring. *Journal of the Chemical Society*, 1950, pp. 3472.

Studies of Trifluoro-Acetic Acid. Part II. Preparation and Properties of some Trifluoroacetyl Esters. By E. J. Bourne, (Mrs.) C. E. M. Tatlow and J. C. Tatlow. *Journal of the Chemical Society*, 1950, pp. 1367.

Anhydrides of Polyhydric Alcohols. Part XIV. Observations on the Ring Scission of 1:2-5:6-Diepoxyhexane and 3:4-*iso*Propylidene 1:2-5:6-Dianhydromannitol. By L. F. Wiggins and D. J. C. Wood. *Journal of the Chemical Society*, 1950, pp. 1566.

The *iso*Propylidene Derivatives of D-Altrose and 1:6-Anhydro-β-D-altrose. By F. H. Newth and L. F. Wiggins. *Journal of the Chemical Society*, 1950, pp. 1734.

The Action of Grignard Reagents on Anhydro-sugars of Ethylene Oxide Type. Part I. The behaviour of Derivatives of α-Methyl-2:3-anhydroalloside towards Methylmagnesium Iodine. By F. H. Newth, G. N. Richards and L. F. Wiggins. *Journal of the Chemical Society*, 1950, pp. 2356.

The Composition of the Polysaccharide Synthesised by *Polytomella coeca*. By E. J. Bourne, M. Stacey and I. A. Wilkinson. *Journal of the Chemical Society*, 1950, pp. 2694.

The Conversion of Mannitol and Sorbitol into Dulcitol. By P. Bladon, W. G. Overend, L. N. Owen and L. F. Wiggins. *Journal of the Chemical Society*, 1950, pp. 3000.

The Conversion of Sucrose into Pyridazine Derivatives. Part X. The Properties and Structure of 3-Methyl-6-Pyridazone, 1:3-Dimethyl-6-Pyridazone and some Derivatives of Pyridazine. By W. G. Overend, L. M. Turton and L. F. Wiggins. *Journal of the Chemical Society*, 1950, pp. 3500.

The Conversion of Sucrose into Pyridazine Derivatives. Part XI. The Ultra-violet Absorption Spectra of Substituted 1-Phenyl-6-pyridazones and Related Substances. By W. G. Overend, L. M. Turton and L. F. Wiggins. *Journal of the Chemical Society*, 1950, pp. 3505.

The Conversion of Sucrose into Pyridazine Derivatives. Part XII. The Stability of Tetrahydro-6-ketopyridazine and 6-Pyridazone Derivatives towards Acidic Reagents. By W. G. Overend and L. F. Wiggins. *Journal of the Chemical Society*, 1950, pp. 3508.

The Conversion of Sucrose into Pyridazine Derivatives. Part IX. The Nitration of Pyridazine Derivatives. By S. Dixon and L. F. Wiggins. *Journal of the Chemical Society*, 1950, pp. 3236.

Degradation of Dextran by Ultrasonic Waves. By M. Stacey. *Research*, 1951, *4*, No. 1.

The Formation of a Tetrahydrofuran Derivative from Diallyl. By L. F. Wiggins and D. J. C. Wood. *Nature*, 1949, *164*, 402.

The Anhydrides of the Pentitols and Hexitols. By L. F. Wiggins. *Advances in Carbohydrate Chemistry*, Academic Press Inc., 1950, Vol. V.

Sugar Cane Wax. Part I. By L. F. Wiggins. *Proceedings of B.W.I. Sugar Technological Meeting*, 1949.

The Constituents of Cane Juice. Part I. The Amino Acids. By L. F. Wiggins. *Proceedings of B.W.I. Sugar Technological Meeting*, 1949.

Antibiotics in the Soil. By A. C. Thaysen. *Nature*, 1950, *166*, 93.

The Disposal of Rum Distillery Waste Waters. By A. C. Thaysen. *International Sugar Journal*, 1950, *152*, 14.

The Identification of Antifungal Substances (produced by Fungi by Paper Chromatograph). By W. G. C. Forsyth. *5th International Microbiological Congress*, Rio de Janeiro, 17th–24th August, 1950.

The Colonial Microbiological Research Institute in Trinidad, British West Indies. By Dr. A. C. Thaysen. *5th International Microbioligical Congress*, Rio de Janeiro, 17th–24th August, 1950.

Yeast Growth and Protein Synthesis. By A. C. Thaysen. *Economic Botanist.*

Food Yeast in the British Empire. By A. C. Thaysen. Paper presented before the Committee of the United Nations Scientific Conference on the Conservation and Utilisation of Resources.

Papers in the Press

The Fatty Acids and Glycerides of Okra Seed Oil. By A. Crossley and T. P. Hilditch. *Journal of Science of Food and Agriculture*, 1951.

The Fatty Acids and Glycerides of Castor Oil. By S. S. Gupta, T. P. Hilditch and J. P. Riley. *Journal of Science of Food and Agriculture*, 1951.

Thermal Interchange of Acyl Groups in Triglycerides. By C. Barker, R. V. Crawford and T. P. Hilditch. *Journal of the Chemical Society*, 1951.

Some chemical changes associated with the Thermal Polymerisation of Drying Oils. By C. Barker, R. V. Crawford and T. P. Hilditch. *Journal of the Oil and Colour Chemists' Association.*

The Composition of Poppy Seed Oils. By R. E. Bridge, M. M. Chakrabarty and T. P. Hilditch. *Journal of Science of Food and Agriculture.*

Pyridazone Derivatives with Pharmacological Action on the Nervous system. By M. R. A. Chance, I. Wajda and R. Weston.

The Influence of Environment upon the Composition of Sunflower Seed Oils. III. Oils from Sunflower Seeds grown in Different Regions of Australia. By R. E. Bridge, A. Crossley and T. P. Hilditch. *Journal of Science of Food and Agriculture*

APPENDIX III

Patents Granted

Improvements relating to Levulinic Acid. W. N. Haworth and L. F. Wiggins. B.P. 583,533.

Improvements relating to the manufacture of 5 hydroxymethyl furfural or Levulinic acid. W. N. Haworth and L. F. Wiggins. B.P. 591,858.

Improvements relating to the manufacture of 1:4-3:6-dianhydrides of mannitol and sorbitol. W. N. Haworth and L. F. Wiggins. B.P. 600,870.

Improvements relating to synthetic resins. W. N. Haworth and L. F. Wiggins. B.P. 619,500.

Improvements relating to the manufacture of 5 hydroxymethyl furfural. W. N. Haworth and L. F. Wiggins. B.P. 600,871.

Improvements relating to the manufacture of Alkyl ethers of dianhydrides of hexahydric alcohols. W. N. Haworth and L. F. Wiggins. B.P. 599,048.

Sulphanilamide pyridazones. W. N. Haworth and L. F. Wiggins. B.P. 600,532.

Sulphanilamide thiazoles. W. N. Haworth and L. F. Wiggins. B.P. 619,693.

Patent Applications

Alkyl and Dialkylamine alkyl Pyridazones. W. N. Haworth and L. F. Wiggins. No. 9691.

Manufacture of analgesics from Pyradazine and Pyridazone derivatives. W. N. Haworth and L. F. Wiggins. No. 33482/1948.

Improvement in or relating to apparatus for decorticating nuts with hard shells. H. Curtis and E. F. Mactaggart. No. 3506/1950.

Colonial
Social Science Research Council
Seventh Annual Report
(1950-1951)

London School of Economics and Political Science,
Houghton Street,
W.C.1.
11th June, 1951.

SIR,

I have the honour, on behalf of the Colonial Social Science Research Council, to transmit to you the seventh report of the Council, covering the period from 1st April, 1950, to 31st March, 1951.

I have the honour to be,
Sir,
Your most obedient servant,
(Sgd.) A. M. CARR-SAUNDERS.

The Right Honourable James Griffiths, M.P.,
Secretary of State for the Colonies.

COLONIAL SOCIAL SCIENCE RESEARCH COUNCIL

Membership

SIR ALEXANDER CARR-SAUNDERS, M.A., LL.D., F.B.A., Director, London School of Economics (*Chairman*).

PROFESSOR FRANK DEBENHAM, O.B.E., M.A., Professor of Geography, University of Cambridge.

MR. C. G. EASTWOOD, C.M.G., Assistant Under Secretary, Colonial Office.

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MR. L. FARRER-BROWN, J.P., Secretary, The Nuffield Foundation.

PROFESSOR VINCENT HARLOW, M.A., D.Litt., Beit Professor of Imperial History, University of Oxford.

MR. H. V. HODSON, M.A., Editor of the " Sunday Times ", formerly Reforms Commissioner, Government of India.

PROFESSOR SIR DAVID HUGHES-PARRY, M.A., LL.D., D.C.L., Director of the Institute of Advanced Legal Studies, University of London.

MISS MARGERY PERHAM, C.B.E., M.A., Fellow of Nuffield College, Oxford.

PROFESSOR SIR ARNOLD PLANT, B.Sc. (Econ.) B. Com., SIR ERNEST CASSEL, Professor of Commerce, University of London.

PROFESSOR MARGARET READ, C.B.E., M.A., Ph.D., Professor of Education and Head of the Colonial Department, Institute of Education, University of London.

PROFESSOR R. H. TAWNEY, Litt.D., D. ès L., F.B.A., Professor of Economic History, University of London.

PROFESSOR SIR GODFREY THOMSON, D.Sc., D.C.L., Ph.D., Professor of Education, University of Edinburgh (resigned December, 1950).

PROFESSOR SIR RALPH TURNER, M.C. Litt. D., F.B.A., Director of the School of Oriental and African Studies, University of London.

SIR JOHN WADDINGTON, G.B.E., K.C.M.G., K.C.V.O., Director of the International African Institute.

MRS. E. M. CHILVER (*Secretary*).

The composition of the Standing Committees of the Council is given in Section V of the Report.

Terms of Reference

The terms of reference of the Council are to advise the Secretary of State on matters relating to research in the social sciences, in or for the benefit of, the Colonial Empire.

COLONIAL SOCIAL SCIENCE RESEARCH COUNCIL

CONTENTS

COLONIAL SOCIAL SCIENCE RESEARCH COUNCIL

SEVENTH ANNUAL REPORT

I. INTRODUCTORY

The Council held four meetings during the year 1st April, 1950, to 31st March, 1951. Eight meetings of the Standing Committees of the Council took place.

2. Professor Sir Godfrey Thomson, who had been associated with the work of the Council since 1944 and who had been particularly concerned with the supervision of schemes of research in the field of educational psychology, resigned from the Council at the end of 1950. The Council has placed on record its high appreciation of Sir Godfrey Thomson's work both as a supervisor and as an adviser on research policy.

3. Invitations to be members of the Council from the Secretary of State for the Colonies from 1st January, 1951, for three years were accepted by Sir John Waddington, Chairman of the International African Institute, Professor Sir David Hughes-Parry, Director of the Institute of Advanced Legal Studies, University of London, and Mr. L. Farrer-Brown, Secretary of the Nuffield Foundation.

4. Sir Alexander Carr-Saunders attended the first meeting of the Scientific Council for Africa South of the Sahara, held at Nairobi in November, as a delegate of the United Kingdom. Sir John Waddington and Professor Vincent Harlow visited British Guiana at the end of the year as members of a Commission appointed by the Secretary of State to advise on constitutional reforms.

5. Miss Margery Perham visited the West Indies as a member of a delegation sent by the Inter-University Council for Higher Education in the Colonies to report on the progress made by the University College of the West Indies.

6. The Secretary of the Council attended the first meeting of the Advisory Committee of the East African Institute of Social Research and the Institute's Research and Planning Conference held at Makerere College in December, 1950.

II. GENERAL

7. In view of the pressing need for economy in the use of Colonial Development and Welfare Research funds, the Council in the year under review gave special attention to the assignment of priorities and set up a Working Party to review estimates of expenditure until 31st March, 1956, and to report on possible economies.

8. Another Working Party is now examining possible economies in capital expenditure, salaries and allowances and incidental expenses in the hopes of freeing further funds for social science research. So far as can be estimated at the present time, a little over £100,000 remains available during the next five years for new projects and contingencies out of the total allocation made for social science research in the Colonies.

9. Recruitment of junior research staff continued to show improvement during the year and the field for junior appointments to regional Research Institutes appears to be fairly large. Difficulty is still being experienced in the recruitment of sociologists qualified to undertake the field demographic studies and urban surveys and in finding senior social scientists prepared to accept appointments in the Colonies of two or more years' duration.

10. The scheme initiated in 1948 for the training of sixteen post-graduate students at Univertities in the United Kingdom preparatory to field work in the Colonies is now at an end. Twelve out of sixteen of the students who received awards are now in the field. One has completed his field work and is writing up his material and one is about to leave the United Kingdom or British Guiana. It is hoped that some of these students will find employment after their field projects are at an end in the regional Institutes of Social and Economic Research in East, West and Central Africa and in the West Indies.

11. Three holders of Colonial Research Fellowships in the social sciences working in East Africa have been working in close association with the East African Institute of Social Research. Two have accepted appointments to its staff and will continue to work in the East African field.

12. Of the five American social scientists appointed under the special scheme for training American social scientists at British Universities preparatory to field work in the Colonies, four are now in the field and one has returned to the University of Pennsylvania to write up his field material. All five have been working in Africa.

The role of the Institutes as overseas centres of Study

13. Special efforts have been made to associate the staff of University Colleges in the Colonies with the work of the Institutes of Social and Economic Research, both through association with research projects and attendance at seminars and conferences. Students at these University Colleges have also co-operated in field research projects as field assistants and interrogators.

14. The Institutes have also been able to give hospitality to visiting research workers from British and American Universities and to associate them through conferences, seminars, and the use of Institute facilities, with other work. Among the American visitors are holders of Fulbright awards, and scholars sponsored by the Carnegie Corporation of New York, the Viking Fund, and the Social Science Research Council of New York. The Rhodes-Livingstone Institute has now been accepted as a centre of study to which Fulbright scholars may be attached. By and large, therefore, the regional Institutes are rapidly taking their place among the " overseas centres of study " which the Inter-Departmental Commission of Inquiry on Oriental, Slavonic and African Studies recommended should be set up (Report of the Inter-Departmental Commission of Inquiry on Oriental, Slavonic and African Studies, 1947, paragraph 53).

University Research in the Colonies

15. Reference was made in paragraph 11 of the Sixth Report of this Council to social science research in the colonial field undertaken independently by institutions of higher learning in the United Kingdom. This activity continues. A recent development is the organization by University College, London, of Anthropological investigations in the Jos Plateau and Cross River areas by post-graduate students.

In the Western Pacific area, the Research School of Pacific Studies of the Australian National University is sponsoring two studies. The first is a study of the social structure of an Indian community in Fiji. The second, which Her Majesty the Queen of Tonga has greatly assisted, is a study of the development of social welfare services in Tonga.

The University of Malaya has also been conducting social science research, mainly finances from its own funds. A brief account of it is given in Appendix V to this report. Appendix VI sets out the social science research

projects undertaken by members of the staff of the University College of the Gold Coast. Members of the Staff of the University of Hong Kong have been engaged in historical and geographical research. A history of Hong Kong is being worked on by Mr. G. B. Endacott and the Department of Geography has been engaged in a land utilisation survey of type areas. A series of village surveys, based on geographical survey methods, is projected. A study of Hong Kong's post-war trade with China is being made by Mr. Arthur N. L. Yuan under the supervision of Professor E. S. Kirby. At Appendix VII is a brief account of research undertaken by the Department of Modern History of the University College of the West Indies.

Research sponsored by Colonial Governments or carried out by Officers of Colonial Governments

16. A number of social science research projects have been carried out by officers of Colonial Governments without assistance from Colonial Development and Welfare funds, or have been undertaken by outside experts whose work has been financed from Colonial revenues.

In the *Somaliland Protectorate*, for instance, the Director of Education assisted by one English and two Somali officials has carried out research into the grammar and structure of the Somali language. This research, which is based on the work of Larajasse, Kirk and Barry, has the object of supplying a more up-to-date and accurate grammar covering especially the omissions and insufficiencies of previous works so that the work may be of use to advanced students and to provide exercises and a limited vocabulary for the beginner. The work was largely complete by the end of 1950 and should be available for the publishers in the first half of 1951. In *Kenya* Colony the following reports have been produced by servants of the Kenya Government:—

" Systems of Land Tenure in the Kikuyu Land Unit " by H. E. Lambert, O.B.E. (Published by the University of Capetown School of African Studies.)

" The Problem of Native Law in British Africa " by P. M. Gordon. (So far not published.)

" Notes on Kamba Customary Law in the Machakos District " by D. J. Penwill. (To be published by the East African Literature Bureau.)

" Africans and the Law " by Sir Howard Elphinstone, Bt. (So far not published.)

Three sociologists are employed by the *Tanganyika* Government and have been engaged during the year on the following investigations:—

(*a*) A study of land usage and associated problems in the highland areas of the Northern Province, with particular reference to the difficulties created by the increasing pressure of both human and cattle population on the land and the aversion of mountain people from leaving their highland areas to take up new land in the plains. This study has been undertaken by Mr. H. A. Fosbrooke, Senior Sociologist, and is continuing.

(*b*) Mr. H. Cory has embodied the results of two years intensive study of the Sukuma tribe in a work to be entitled " Sukuma Law and Custom " which it is hoped will be published this year.

(*c*) Mr. W. H. Whiteley has made a study of the hitherto little known tribe of the Makua in the Southern Province. This study is continuing and it is hoped to publish the results later.

In the *High Commission Territories* a report for the World Census of Agriculture was prepared by Mr. A. J. A. Douglas, Administrative Officer, covering land usage and related topics.

The Government of the *Gold Coast* has financed further research by Professor P. Gurrey of the University College of the Gold Coast, into the teaching of English. Research into customary land tenure in the northern territories of the Gold Coast has been carried out by Mr. R. J. H. Pogucki of the Lands Department during the current year. His report is now being cyclostyled for limited distribution but it has been possible to apply the information it contains to the settlement of practical problems.

In *Singapore* collaboration between the Singapore Department of Education, the University of Malaya and scholars from overseas has been most effective in the field of educational research. The results of this collaboration are described in Appendix VIII.

During the year in the *Federation of Malaya* certain studies have been carried out by the Institute for Medical Research into the social and economic considerations which influences food consumed: these have been carried out in conjunction with clinical and dietary investigations into malnutrition. Three socio-economic investigations were made in connection with this project, the first in a peasant community engaged in rice planting, the second in a peasant community engaged in the production of copra, and a third in a fishing village where initiative and resource on the part of the fisherman had produced a good standard of living. A draft report has already been prepared.

Contributions to the study of the material culture of Malaya and the *Borneo* territories have been made by Mr. C. A. Gibson-Hill, one of the Curators of the Raffles Museum, Singapore, in recent numbers of the Journal of the Malayan branch of the Royal Asiatic Society. Tan Soo Chye, Archivist of the Raffles Museum and Library, has contributed to the same journal a study of early legislation in Penang. The Government of Sarawak has financed researches in anthropology, local history, and linguistics including the recording of native literature. Long-term investigations of the inland peoples, particularly the Kelabits, Muruts, Berawans and other small groups with distinctive cultures, are in hand: particular attention is being paid to the early efficient agricultural methods of these people, and to the reasons for their decline in numbers over the past century. Some preliminary results of these works have been published in learned journals. Local history is being studied in close association with linguistics and the recording of native literature. Particular attention is being paid to the history of the State of Brunei and the translation of the Brunei Royal Family traditions. An extensive study is also being made of several coastal groups with particularly interesting histories, such as the now almost extinguished Serus, the settlements of Bugis from the Celebes, and the mixed communities at Santubong and elsewhere near the delta of the Sarawak River. A number of literate Dayaks and other natives are co-operating in recording and translating material of this kind, both in writing and with recording unit. It is hoped to publish a number of special monographs of this character as issues of the Sarawak Museum Journal.

Servants of the *British Guiana* Government have contributed to Amerindian linguistic studies by the publication of papers on Arawak animal, bird and plant names. Further glossaries of plant names of other Amerindian tribes and of the Creoles are projected.

In *Fiji*, Mr. R. S. Adam, Vice-Principal of the Teachers' Training College, Nasinu, has in his spare time done research on the range of the English vocabulary of the Indian, Fijian and other non-European students at the Training College and of pupils at schools.

The Fiji Department of Education is organising a research team to live in Fijian villages to record the social and economic aspects of rural life.

Social Science research undertaken in the Colony and not financed from Colonial Development and Welfare funds include two South Pacific Commission projects:—

(*a*) experiments in community development on Moturiki Island, and

(*b*) a report on technical education in the South Pacific area prepared by Mr. R. A. Derrick, M.B.E., Supervisor of Technical Services.

The South Pacific Commission is sponsoring two other social science projects in the Western Pacific area; these are a survey of linguistic research by Dr. Capell, and a survey of research in social anthropology by Dr. Elkin and Dr. Keesing.

Association with other institutions financing research

17. The Council has in the past year welcomed opportunities to encourage research in the social sciences in the Colonies financed by private organizations such as the Goldsmiths' Company and the Central Research Fund of London University, and proposes, during the coming year to encourage the award of grants by such bodies further by recommending supplementary grants from Colonial Development and Welfare funds on a 50/50 basis. Three grants have been made on this basis already.

III. THE REGIONAL INSTITUTES

18. The Directors of the three regional Institutes and the Rhodes-Livingstone Institute have prepared brief reports which are attached as Appendices to this report. Accordingly they will be dealt with very briefly here.

19. The West Indies Institute, under the direction of Dr. Dudley Huggins, has three projects, two economic and one sociological, in train and has organized a seminar under the direction of Dr. Yates for the study of sampling problems. A fourth member of the staff, Mr. K. H. Straw, has recently been appointed; he is an economist with special interest in the structure and organization of industry.

The Institute hopes that it will be possible in the future to associate with its work more scholars from American universities both under the Fulbright scheme and otherwise. Two independent research workers whose projects are referred to below (Mr. R. T. Smith and Miss Audrey Butt) are being attached to the Institute for study leave and for administrative purposes.

Of the present establishment of the West Indies Institute three out of five are West Indian born.

20. A further interim grant has been made to the University College, Ibadan, to cover the cost of the staff and other expenses of the West African Institute of Social and Economic Research, under the direction of Professor W. Hamilton-Whyte, until a long-term plan can be devised by the Director in consultation with West African Governments. An economist and a human geographer have already been appointed to its staff and further appointments have been advertised. Mr. Robert G. Armstrong, an American anthropologist trained under the scheme referred to in paragraph 12, has been attached to the Institute for administrative purposes. The Institute, so far as its present resources permit, has been acting as a general meeting place for social scientists working in West Africa under the sponsorship of British and American universities.

21. The Rhodes-Livingstone Institute, which is to be transferred to Lusaka from Livingstone, has now put out tenders for buildings to accommodate its staff. Lack of staff accommodation and the difficulties of communication have been handicaps to its work in the past. Two social anthropologists and a historian have been appointed to its staff, but it has not been possible to find a suitably qualified demographer. The Institute has issued several scientific publications during the year and its staff, past and present, has contributed several articles to learned journals.

22. Staff and office accommodation of modest proportions for the East African Institute of Social Research is now under construction and should be complete in the Spring. The Institute's first research conference was attended by nearly all the social scientists working within range, visiting scholars, members of the Makerere College staff, and a member of the Institute des Recherches Scientifiques en Afrique Centrale, and it has been able to offer facilities to several British and American scholars visiting East Africa. Besides supervising studies, the Director, Dr. Audrey Richards, has initiated a study of labour migration on behalf of the Government of Uganda.

A start has been made in linguistic studies by Mr. Eridade Mulira, who is working on a Luganda Grammar.

IV. PROJECTS IN PROGRESS

Africa

Projects undertaken by the International African Institute

23. *Ethnographic Survey of Africa.* The Survey which is being carried out by the International African Institute, and has been extended to the end of 1952, has made considerable progress during the period 1950-51. A number of research assistants, supervised by senior anthropologists, are working under the general direction of Professor Daryll Forde; a committee, of which Professor Radcliffe-Brown is Chairman, is responsible for the programme of work. In addition to material collected in East Africa by Dr. Meinhard, much valuable information has been secured in Northern Nigeria by Mr. Gunn. Four sections of the survey were published during 1950. Two sections on Central Africa (Lunda, Bemba, and Luapula) have appeared in 1951, and sections on the Masai, Kikuyu and Kamba, Ewe, Zande, Nilotic peoples of the Sudan, Teita and Pokoma are being prepared for press.

The French Government is collaborating in the preparation of sections covering French West Africa.

24. *Handbook of African Languages.* Two sections of the projected four-volume survey of the languages of Africa (Berber Languages of North Africa and Languages of West Africa) are now in the press; two others are nearing completion, and several studies of particular languages or groups of languages are in hand.

25. *Survey of the Northern Bantu Linguistic Border.* This linguistic survey organised by the International African Institute, and jointly financed from the Colonial Development and Welfare funds and by the French and Belgian Governments, is nearing completion. The four investigators (one French, one Belgian and two British) have concluded their field studies and are now collating and writing up their material under the supervision of Dr. M. Guthrie and Dr. A. N. Tucker of the School of Oriental and African Studies, with a view to publication during the current year.

26. *African Marriage Survey.* This study organized by the International African Institute and the International Missionary Council, and financed jointly from Colonial Development and Welfare funds and the Carnegie Corporation of New York, will be completed during the current year. The team of three investigators, of which Mr. Arthur Phillips is director, are preparing a joint report dealing with the legal and administrative, the anthropological and the missionary aspects of the survey. The general conduct and programme of the survey is directed by a committee of which Sir John Waddington is Chairman.

Other African Projects

27. *Study of French Administration in North Africa.* Miss S. E. Crowe is writing up the results of her investigations under the supervision of the Colonial Studies Committee of Oxford University and is at present working on the economic aspects of her subject.

28. **Land Tenure in British Africa.* Dr. C. K. Meek has been invited to prepare a comprehensive work on land tenure, including certain aspects of family law, in British African territories. It is hoped that this will prove an indispensable guide to courts and administrative officers, as well as providing students with a valuable work of reference. The project has been undertaken on the initiative of the African Studies Branch of the Colonial Office.

29. **Islamic Law in Africa.* A brief study visit has been paid by Dr. Schacht, Reader in Islamic Law at the University of Oxford, to Northern Nigeria to study the application of Islamic Law there, and a report on certain aspects of the question has been submitted to the Nigerian Government. The publication of sections of the report is under consideration.

Mr. J. N. D. Anderson, Lecturer in Islamic Law in the University of London, has visited East and Central Africa, Aden and Somaliland and is now in West Africa, with a view to preparing a synoptic survey of the present position as regards Islamic Law in the African territories. Both of these projects were proposed by the African Studies Branch of the Colonial Office.

30. **History of African Administration.* Mr. R. E. Robinson, Fellow of St. John's College, Cambridge, is at work on a history of British Administration in Africa from the time of Lord Lugard. Mr. Robinson was at one time a member of the African Studies Branch of the Colonial Office.

31. *Socio-Economic Survey of Zaria, Nigeria.* Mr. M. G. Smith, who has, with his wife's assistance, recently completed a social survey of Hausa and pagan communities in Zaria, has now returned from the field and is preparing his report under the supervision of Professor Daryll Forde.

32. *Socio-Economic Survey of Mba-Ise, Owerri, Nigeria.* Mr. E. W. Ardener will shortly complete his field investigation of Mba-Ise, a federation of five administrative Ibo clans in Owerri Province, and will return to the United Kingdom to complete his report under the supervision of Professor Raymond Firth.

33. *Psychological Testing in Nigeria.* Dr. Geoffrey Tooth's report on test material for Africans seeking technical training has been submitted to the Nigerian Government. Dr. Tooth is now working in the Gold Coast. (See paragraph 41.)

* Items marked with an asterisk are new projects started in the year under review.

34. *Socio-Economic Survey of Oshogbo, Nigeria.* Mr. W. B. Schwab, an American sociologist selected under the scheme referred to in paragraph 12, is now writing up his report at the University of Pennsylvania and is returning to the United Kingdom to complete it under Professor Daryll Forde's supervision. His report should be of particular value to the Nigeria Cocoa Marketing Board which is financing a rural survey in cocoa-producing areas from its own funds.

35. *Delta Trade and Politics in the Nineteenth Century, Nigeria.* Dr. K. O. Dike, who has now been appointed to the staff of the University College, Ibadan, is preparing his historical material for publication.

36. *Economic Position of Women in the Cameroons (Bamenda).* Dr. Phyllis Kaberry's manuscript is now in the hands of the publishers. She has already published a paper in " Africa ".

37. **Field Study of the Nomadic Fulani of Northern Nigeria.* Mr. D. J. Stenning, a post-graduate student of Cambridge University and a recipient of a travelling scholarship awarded by the Goldsmiths' Company, has been awarded a supplementary grant in order to undertake a field study of the Nomadic Fulani of Northern Nigeria. The Government of Nigeria, which is concerned with the settlement of the Nomadic Fulani as sedentary graziers and meat producers, will attach a senior Fulani-speaking Veterinary Officer to Mr. Stenning for a period. This project, which is under the supervision of Professor Fortes, forms part of a larger study to be undertaken by the International African Institute on the Fulani peoples of West Africa.

38. **Ethnographic Study of the Idoma people of Benue Province.* Mr. R. G. Armstrong, an American sociologist selected under the scheme referred to in paragraph 12, has now finished his training at the University of Oxford and is pursuing his investigations in the field. The project is under Professor Evans-Pritchard's supervision, and is administered by the University College, Ibadan.

39. *Socio-Economic Study of the Manya-Krobo, Gold Coast.* Mr. K. D. S. Baldwin's report has been received and publication is under consideration. Mr. Baldwin is now attached to the Nigerian Cocoa Marketing Board project referred to in paragraph 34.

40. **Ethnographic Study of the Lobi, Gold Coast.* Mr. Jack Goody, one of the post-graduate students trained under the scheme referred to in paragraph 10, is undertaking an ethnographic study of the Lobi of the Northern Province of the Gold Coast under the supervision of Professor Fortes.

41. **Psychological Testing, Gold Coast.* Dr. Geoffrey Tooth is now undertaking psychological testing experiments for entrants to the University College of the Gold Coast and for the Junior Civil Service. The project, which is administered by the University College of the Gold Coast, is under the supervision of Professor Sir Godfrey Thomson and Dr. Fraser Roberts.

42. *Social-Economic Survey of rural communities of the Colony Peninsula, Sierra Leone.* Miss E. M. Richardson and Mr. G. C. Collins have completed a survey in one area and have moved to another. The project is supervised by Dr. E. Leach, Dr. K. Little, Mr. Robert Steel, and Mr. W. H. Beckett.

43. *Sociological Research, Gambia.* Dr. D. P. Gamble is continuing his study of rural communities in the Gambia, with special reference to the impact of the work of the Nutrition Field Working Party. His work is supervised by Professor Daryll Forde.

* Items marked with an asterisk are new projects started in the year under review.

44. *Linguistic Research in the Somaliland Protectorate.* Mr. B. Andrzejewski, formerly a holder of a Linguistic studentship, is continuing his research into the Somali language and its dialectal forms. He has now been supplied with a recording apparatus. He is attached to the Somaliland Department of Education. The project is under the supervision of Professor J. R. Firth.

45. *Anthropological Studies of the Kisii (Gusii) Kenya.* Dr. Philip Mayer has now prepared for the press two papers illustrating the practical application of anthropological research at the district level in Kenya. A larger monograph on Gusii law and custom is in preparation, and a report on boys' and girls' initiation ceremonies has been submitted to the Kenya Government, and may be published independently.

46. **Study of the Kikuyu Family, Kenya.* Dr. Jeanne Fisher, a post-graduate student trained under the scheme referred to in paragraph 10, is engaged on a study of the Kikuyu family, with special reference to women's activities. The project is under Dr. Audrey Richards' supervision.

47. **Study of the Teita, Kenya.* The study of the Teita, initiated by Mr. J. H. Prins, who unfortunately broke down in health at an early stage in the investigation, is now being continued by Mr. Alfred Harris and his wife Mrs. Grace Harris. Mr. and Mrs. Harris are two of the American Anthropologists trained under the scheme referred to in paragraph 12, at the Institute of Social Anthropology, Oxford.

48. **Anthropological Study of the Galla of North-Eastern Kenya.* Mr. P. T. W. Baxter, one of the students selected for post-graduate training under the scheme referred to in paragraph 10, has now left for Kenya to undertake a study of the Borana Galla of North-East Kenya, a semi-nomadic cattle people about whom little information exists and who present a difficult administrative problem. The project is under the supervision of Professor E. E. Evans-Pritchard.

49. *Anthropological Study of the Turkana, Kenya, and Jie, Uganda.* Mr. Philip Gulliver has completed his second tour among the Turkana, a semi-nomadic cattle people, and is now engaged on an investigation of the related Jie of the Karamojong district of Uganda. He will probably start his writing-up at the East African Institute of Social Research and complete it at the London School of Economics under Professor Schapera's supervision.

50. *Anthropological Study of the Acholi, Uganda.* Mr. Frank Girling, who has now virtually completed a clan survey of the Acholi people, is at Oxford University preparing a report under Professor Evans-Pritchard's supervision.

51. *Anthropological Study of the Lugbara, Uganda.* Mr. J. F. M. Middleton's investigation, which is being financed in roughly equal proportions from Colonial Development and Welfare funds and by the Goldsmiths' Company, has completed his first tour among the Lugbara and will return to Oxford University to prepare an interim report under Professor Evans-Pritchard's supervision.

52. *Anthropological Study of the Alur and Jonam, Uganda.* Mr. Aidan Southall, a Colonial Research Fellow, who will shortly be joining the staff of the East African Institute of Social Research, is now completing the first part of his investigations. Mr. Southall has, with the permission of the Belgian Congo authorities, worked on both sides of the border. He has thus been able to make his study more complete and to follow up the links between groups claiming common origin.

* Items marked with an asterisk are new projects started in the year under review.

53. *Anthropological Study in the Bwamba-Konjo area, Uganda.* Mr. E. H. Winter, an American anthropologist trained under the scheme referred to in paragraph 12, is at work on a study of a small complex of border peoples much given to sorcery, about whom very little is known. His wife, Mrs. Betty Winter, is making a linguistic analysis of the area. The project is under the supervision of Dr. Audrey Richards.

54. **Anthropological Study of the Toro, Uganda.* Mr. Brian Taylor, a South African graduate trained under the scheme referred to in paragraph 10, is conducting an investigation in the Fort Portal area among the Toro, a sophisticated agricultural people. His work is supervised by Dr. Audrey Richards.

55. *Research into East African Music.* Dr. Klaus Wachmann's researches, which are assisted from Colonial Development and Welfare funds, have resulted in the collection so far of some 600 recordings of songs, cattle-calls, instrumental solos and ensembles for the Uganda Museum, many of great beauty, all of musicological value, and some of great interest from the linguistic point of view. The collection, which will continue, is not being made a moment too soon in view of the decline of many native musical techniques in the face of Western influences.

56. **Study of the Barabaig, Tanganyika.* Mr. Gordon Wilson, a Canadian post-graduate student, has been awarded a Colonial Development and Welfare grant to undertake a study of the Barabaig, a study which will be carried out in association with the Tanganyika Government's establishment of anthropo-ogists, and under the academic supervision of Dr. Audrey Richards.

57. *Legal Studies in Northern Rhodesia.* Mr. Arnold Epstein is continuing his investigation of customary law in the urban areas of Northern Rhodesia under the academic supervision of Mr. Arthur Phillips.

58. *Social Survey of Zanzibar.* The analysis of the material collected by the survey team under the direction of Professor Edmund Batson is almost complete and it is hoped that a preliminary report will issue this year.

59. *Study of Administration by Native Authorities, Nyasaland.* Dr. Lucy Mair's report has been presented to the Colonial Social Science Research Council and forwarded to the Government of Nyasaland. It will form part of a forthcoming book.

60. *Native Land Tenure in Basutoland.* Mr. Vernon Sheddick's report is now complete and is being studied by the Council.

South-East Asia and Pacific

61. *Anthropological Studies in Sarawak.* During the year under review, Dr. Ju K'anj T'ien has presented a comprehensive report on the Chinese community in Sarawak to the Colonial Social Science Research Council, and publication under private auspices is under consideration.

Mr. H. S. Morris, who has been studying a Melanau community primarily engaged in sago production by primitive methods, has returned to the United Kingdom and is now writing his report.

Dr. W. Geddes, who has been studying a Land Dyak community engaged in paddy cultivation, has returned also and is at work on his report.

Mr. J. D. Freeman, who was granted an extension of his period of field work and is studying a traditional Iban community, is due to return to the United Kingdom, in April, 1951.

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* Items marked with an asterisk are new projects started in the year under review.

The project is supervised by Dr. Edmund Leach, and during his absence from the London School of Economics, by Professor Raymond Firth.

62. *Sociological Studies in North Borneo.* Miss Monica Glyn-Jones, a geographer trained under the post-graduate studentship scheme is continuing her study of a rice-growing Dusun community under the supervision of Dr. Leach and Professor Raymond Firth.

63. *Sociological Studies in Singapore.* Mr. Maurice Freedman and Miss Judith Djamour (Mrs. Freedman) have returned from Singapore where they have been studying Chinese family structure and Malay family structure respectively and are now writing up the results of their investigations under Professor Raymond Firth's supervision.

Mr. Alan Elliott, who arrived in Singapore last year, at the end of a period of training under the Colonial Social Science Research studentship scheme, is pursuing his study of various aspects of the relations of the Singapore Chinese with China itself, with special reference to religious associations, under Professor Raymond Firth's supervision.

64. *Linguistic Research in Fiji, Tonga, and the Solomon Islands.* Mr. G. B. Milner has presented his report to the Council and has now returned to teaching duties at the School of Oriental and African Studies. He was able to collect a number of recordings. A Fijian Grammar is in preparation.

65. *Educational Research in Fiji and the Western Pacific.* The building of the Educational Research Institute at Nasinu cannot be started at present because the Fiji Public Works Department is fully occupied with other schemes under the Ten-Year Development Plan.

Caribbean

66. *Psychological Testing in the West Indies.* The two investigations undertaken by Mr. B. J. Bedell and Mr. A. Deans Peggs respectively into the mental abilities of children in Trinidad and Jamaica are now complete, and material has already been submitted for publication in scientific journals. Comprehensive reports are in preparation. Both Mr. Bedell and Mr. Peggs worked under the supervision of Professor Sir Godfrey Thomson and were trained at and worked up their results at Moray House, Edinburgh University.

67. *Social Survey of Jamaica.* The first volume of the social survey of Jamaica carried out under the direction of Miss Edith Clarke is now practically complete. Material collected by other members of the team is also in an advanced state, and it is possible that the University of Liverpool Press will issue a book by Dr. Madeline Kerr on personality conflicts in Jamaica. The reports are being written under the supervision of a committee appointed by the London School of Economics.

68. *Sociological Research in British Guiana.* Mr. R. T. Smith, one of the students awarded a post-graduate social science research studentship under the scheme referred to in paragraph 10, will shortly leave the United Kingdom to undertake a study of Negro coastal communities in British Guiana. His work will be supervised by Professor Fortes and arrangements have been made for him to visit the West Indies Institute of Social and Economic Research on his outward and inward journeys from British Guiana.

An award has also been made to Miss Audrey Butt, a post-graduate student of Oxford University, to assist her in undertaking an investigation of the Arecuna and Akowoio peoples of British Guiana. The balance of the funds necessary will be found from outside sources. Professor Evans-Pritchard is supervising the project.

V. THE STANDING COMMITTEES OF THE COUNCIL

69. Professor E. E. Evans-Pritchard accepted the Secretary of State's invitation to take over the chairmanship of the Committee on Anthropology and Sociology in succession to Professor Sir Godfrey Thomson.

The present composition of the Standing Committee is as follows:—

Committee on Anthropology and Sociology:

Professor E. E. Evans-Pritchard, M.A., University of Oxford (*Chairman*).
Professor Raymond Firth, M.A., Ph.D., University of London.
Professor Daryll Forde, Ph.D., University of London.
G. I. Jones, Esq., M.A., University of Cambridge.
Professor D. V. Glass, B.Sc. (Econ.), Ph.D., University of London.
Professor Margaret Read, C.B.E., M.A., Ph.D., University of London.
K. E. Robinson, Esq., University of Oxford.
R. S. Hudson, Esq., C.M.G., Colonial Office.

Committee on History and Administration:

Professor Vincent Harlow, M.A., D.Litt., University of Oxford, (*Chairman*).
H. V. Hodson, Esq., Editor of the " Sunday Times ".
Miss Margery Perham, C.B.E., M.A., University of Oxford.
Douglas Veale, Esq., The Registrar, Oxford University.
K. E. Robinson, Esq., University of Oxford.
Professor G. Graham, M.A., Ph.D., University of London.
F. J. Pedler, Esq., United Africa Company.

Linguistics Committee:

Professor Sir Ralph Turner, M.C., M.A., Litt.D., F.B.A., University of London (*Chairman*).
Professor J. R. Firth, O.B.E., M.A., University of London.
Dr. M. Guthrie, Ph.D., B.Sc., University of London.
Dr. Edwin Smith.

Law and Land Tenure Committee:

Professor Frank Debenham, O.B.E., M.A., University of Cambridge (*Chairman*).
Professor S. Vesey-Fitzgerald, M.A., LL.D., University of London.
Arthur Phillips, Esq., M.A., University of London.
Professor M. Postan, M.Sc., M.A., University of Cambridge.
Professor Daryll Forde, Ph.D., University of London.
Dr. C. K. Meek, M.A., D.Sc., University of Oxford.
R. S. Hudson, Esq., C.M.G., Colonial Office.

VI. PUBLICATIONS

70. The following publications have already been issued, or are about to be issued by His Majesty's Stationery Office:—

Dr. Geoffrey Tooth; Studies in Mental Illness in the Gold Coast (Colonial Research Publication No. 6) (1950).

Dr. Edmund Leach; Social Research in Sarawak (Colonial Research Studies No. 1) (1950).

Dr. Philip Mayer; Two Studies in Applied Anthropology in Kenya (Colonial Research Studies No. 3).

G. W. B. Huntingford; Nandi Work and Culture (Colonial Reserach Studies No. 4).

African Studies Branch; Bibliography of African Land Tenure (Colonial 258) (1950).

Assistance from Colonial Development and Welfare funds was given towards the publication of the following volumes of the Ethnographic Survey of Africa, which are being published by the International African Institute:

The Akan and Ga-Adangme Peoples of the Gold Coast (1950); Madeline Manoukian.

The Peoples of Sierra Leone (1950); M. McCulloch.

The Southern Lunda and related Peoples (1951); M. McCulloch.

Peoples of the Lake Nyasa Region (1950); Mary Tew.

The Ibo and Ibibio-speaking Peoples of S.E. Nigeria (1950); Daryll Forde and G. I. Jones.

The Yoruba-speaking Peoples of S.W. Nigeria (1951); Daryll Forde.

Volume III of "A Demographic survey of the British Colonial Empire" (Royal Institute of International Affairs and Oxford University Press) based on material prepared by the late Dr. Kuczynski is in active preparation with assistance from Colonial Development and Welfare funds.

71. A number of unpublished duplicated reports, mainly of an interim character, presented by workers whose studies are or were financed from Colonial Development and Welfare funds, have been placed in the Colonial Office Library and may be consulted there, with the Librarian's permission, by bona fide students. These include:—

D. P. Gamble; Contributions to a Socio-Economic Survey of the Gambia (1949).

F. Smithies; Science Teaching in Secondary Schools in West Africa (1950).

Mary Parker; Municipal Government in Kenya (1949).

A. F. Wells; Friendly Societies in the West Indies (1949).

Publication and plans for publication under private auspices are referred to in Section IV of this report, and in Appendixes III and IV.

APPENDIX I

Report on the work of the Institute of Social and Economic Research, University College of the West Indies

The Institute has been established with headquarters in Jamaica in association with the University College of the West Indies. The territories of primary interest are the English-speaking units of the Caribbean: British Honduras, Jamaica, the Leeward Islands, the Windward Islands, Barbados, Trinidad and British Guiana.

At the opening of the year under discussion the Institute's Advisory Board had recently held its first meeting and action was being taken to implement the proposals and recommendations put forward. Those joining in the discussions of the Board were:

Professor Sir Arnold Plant (representing the C.S.S.R.C. and the C.E.R.C.);

Hon. Sydney T. Christian (member of the University College Council);

Mr. H. O. B. Wooding (representative from the Eastern Caribbean);

Miss D. Ibberson (representative of the Development and Welfare Organisation).

Sitting in, during some of the discussions, was Mr. R. W. Hudgens, Director of the American International Association for Economic and Social Development.

2. Research Projects

The Institute has sponsored, or is in association with, the following projects which are either already under way or have been taken well forward in the planning stage.

Labour Productivity—Mr. George Cumper, Economist, has begun a study in this field. It is hoped that the study will extend to different units in the Caribbean and discussions are already under way with British Guiana. Work has thus far been confined to Jamaica. The unpublished returns of a Census of Manufacturers carried out by the Jamaica Central Bureau of Statistics in 1946 were tabulated and an article based on these returns was prepared for publication. It was decided to restrict the study to the two fields for which some statistical background existed, and in which the standard of record-keeping was fairly high—manufacturing industry and the sugar industry. In these fields, too, estimates were made of the differential between Jamaican and foreign productivity, somewhat on the lines of Dr. L. Rostas' study of British and American industry. It soon became clear that field studies in specific industries were necessary and the first, in the sugar industry, was well advanced. The sugar estate selected was particularly interesting in that it drew its labour force in substantial numbers from workers with both urban and rural backgrounds. A pilot study was completed of the connection between variations in the efficiency of different individuals in the same work situation and their social characteristics (e.g., family type, age).

Social Structure—Mr. Lloyd Braithwaite, Sociologist, has started work on a study relating to social structure in Trinidad. The multi-racial character of the population was one of the noteworthy facets of social life in Trinidad.

The various ethnic groups differed markedly in culture and there were differences in geographical distribution, in rate of natural increase of population, in religious beliefs, in family structure, in standard of literacy, to some degree in educational methods and in occupational distribution.

The intention was to make a study of two or three communities. It was hoped then to bring these together in the life of Trinidad's recent historical development with stress on the contribution that the several groups had made to the development of the island.

National Income Estimates—Miss Nora Siffleet, Economist, has collected information in the course of preparation of national income estimates for the Leeward Islands, the Windward Islands and Barbados. Preliminary work was begun in Jamaica—reading of records and extraction of relevant data obtainable in reports. In May Miss Siffleet left Jamaica to begin field work in the Leeward Islands. By coincidence there was in Antigua at the same time, Dr. Simon Rottenberg, Director of the Institute of Labour Relations in the University of Puerto Rico, who had been commissioned by the Social Science Research Council to make a study of voluntary underemployment. He and Miss Siffleet collaborated in an employment and income survey with the co-operation of the Antigua Government which considered that the field study would be useful for administrative purposes. The preliminary results of the study have become available and work on further cross-tabulation of data is proceeding. From the Leeward Islands, Miss Siffleet went to the Windward Islands and to Barbados and at the end of the year under consideration her study was well advanced.

Consumption Patterns—Mr. K. H. Straw has begun work on a project on Consumption Patterns and changes in demand for commodities on which people in a selected community of the Caribbean might be expected to spend extra incomes if the real national income rose. There was likely to be involved a study of past trends in the growth of demand for selected foods of different kinds, for clothing of different kinds, housing, etc., and calculation of the relevant marginal propensities to consume or "Engel" lines. Such a study could have relevance to the planning of industrial production by showing commodities for which demand was likely to grow most rapidly in the reasonably near future.

Industrial Relations—A project with the aim of studying industrial relations in special reference to the teaching of new skills in an industrializing community was started as complementary to Mr. Cumper's labour study (above) and Mrs. Ella Campbell was working on the project.

Economic Activity—During the year in such time as was available for personal participation in research, the Director was concerned with a project on production and seasonal variation in special relation to Jamaica. The intention was to try to secure a picture of the trends in production and economic activity, the implications of such trends as they might effect, for example, the development of secondary industries. Much of the work in collection and compilation of the statistical data was advanced.

Social Anthropological Study of a Guianese Coastal Community—Raymond T. Smith was awarded a colonial studentship to undertake a study of a Negro village community in British Guiana. The project was under the general direction of Professor M. Fortes of Cambridge University.

Social Anthropological Study of two Amerindian Tribes—Miss Audrey J. Butt has been awarded a special grant to undertake a study of the Arecuna and Akowoio under the general direction of Professor Evans Pritchard of Oxford. One of the reasons for this study was the probability of disruption of tribal life owing to increased contact with the coast populations and to government plans covering Amerindian welfare.

Social Psychology—Mr. Deans Peggs, social psychologist, under the general direction of Sir Godfrey Thomson, continued his study relating to intelligence testing. He concluded the field work, returned to the United Kingdom for the final stage of preparing reports, and has now returned to the West Indies.

3. American University Workers in contact with the Institute

Urbanization—Dr. Leonard Broom, Sociologist, Associate Professor of the University of California, Los Angeles, came to the Institute on a Fulbright Award. He was carrying out a study relating to urbanization and social conditions in the British Caribbean.

Family Study—Plans were well advanced for a study to explore the factors underlying family organization in a Jamaica community by Professor M. F. Nimkoff who was awarded a Fulbright Award grant for the purpose.

Patterns of Behaviour—Mr. Yehudi Cohen, a Social Anthropologist, of Yale University, selected the Maidstone community, Jamaica, to study patterns of behaviour in special relation to the attitudes of adults to juveniles of both sexes. Mr. Cohen was accompanied by his wife, also a trained anthropologist, and they worked together as a team.

Social Anthropological Study, Jamaica—Dr. Joseph G. Moore, Social Anthropologist, of North Western University, began research on a project envisaged as a companion to other studies of the Negro in the New World that have been made in Surinam, Brazil, Trinidad, Haiti, Puerto Rico, Cuba, Honduras, etc. It was his purpose to analyse the patterns of culture found among the people of the Morant Bay community in St. Thomas, Jamaica.

Social Change among the Maya Indians—On the initial suggestion of Professor Margaret Read steps have been taken to get under way a study of Maya Indians in the northern area of British Honduras. There the Indians are in a condition of active social change. Professor Robert Redfield of Chicago, and Professor John Rowe of California, have consented to participate in the planning and direction of the study.

Juvenile Delinquency—Plans have been made for a study of the Juvenile delinquency in Jamaica by Mr. Harland Doughty and Professor Elizabeth Hoyt of Iowa State College is interested in the general purposes of the study.

Other studies were under discussion with scholars who it was hoped would be financed, like those mentioned in paragraph 3 above, independently of the Institute.

4. Sampling Seminar Conference

A sampling seminar conference was arranged under the leadership of Dr. Frank Yates, F.R.S. (author of " Sampling Methods for Censuses and Surveys ") and the noted authority in the field. The seminar was attended by representatives from the United States, the Caribbean Commission, Puerto Rico and other Caribbean units. The problem of sampling has so many implications for research in the social sciences that the seminar, although entailing much effort and organization, was thought to have been well worth while.

5. Miscellaneous

The Foundation Stone of the Institute's permanent building was laid on August 21st, 1950, by Professor Margaret Read and the construction work completed in February, 1951. The building, designed by Messrs. Norman and Dawbarn and severely functional in plan, is pleasing in its lines. The permanent building should make a contribution in providing facilities not only for the Institute's staff but for associate studies.

The services of the Institute's library and the main library have been well integrated. The advice and counsel of the Librarian have been sought in regard to policy. The intention was that the Institute should not attempt to build up an independent library but to restrict itself to publications which were of use in the research programme and which could be available for circulation to workers away from base. Special attention was being paid to the cataloguing and indexing of periodicals, a type of service essential for a research group but not always available in main libraries.

Immediately prior to the period under discussion Sir Arnold Plant together with the Director visited the Leeward Islands, the Windward Islands, Barbados, Trinidad, British Guiana. This served a useful purpose and it was possible to discuss, especially with Government and other workers concerned with social and economic problems, the background of the Institute and to attempt to discover possible fields of mutual interest and endeavour.

In May the Director was invited to serve on the Committee on Sociology and Education of the Research Council of the Caribbean Commission. The meetings were held in Trinidad. Opportunity was again taken to meet colleagues in the field, one of whom was in Trinidad and one in Antigua.

The Social Science Group which was brought into existence by the Institute continued to hold meetings and to provide opportunity for discussions and exchange of ideas.

Members of the Institute's staff collaborated in lectures and work of a similar nature on many occasions during the year.

6. Visitors

One of the handicaps from which a group of research workers such as that at the Institute might well suffer was that of remoteness. It often occurred that in a specific study the worker soon became the best informed person in the territory. For that reason it was regarded as fortunate that the Caribbean was strategically placed because the stimulation provided by visitors was of real value. During the year several came, conferred and contributed. Among these might be mentioned: Dr. C. W. de Kiewiet, Professor Margaret Read, Dr. Rita Hinden, Professor Ernest Beaglehole, Professor Ken Galbraith, Mr. F. Scheetz, Mr. Daniel Creamer, Mr. P. F. Vowles, Miss Margery Perham, Miss Dora Ibberson, Dr. Frank Yates, Dr. B. J. Tepping and Dr. M. C. Balfour.

H. DUDLEY HUGGINS,
Director.

APPENDIX II

Reports on the work of the West African Institute of Social and Economic Research

The West African Institute may be said to have begun operations with the arrival of the Director, Professor W. Hamilton Whyte, in Nigeria at the beginning of October, 1950, and his discussions with the Officer Administering the Government, now Sir Hugh Foot.

Before this Mr. D. N. Leich, Administrative Secretary, had achieved some initial liaison work with the Government departments and, during a brief visit, with the Gold Coast authorities. Some assistance had also been rendered to research workers in Nigeria, but this was necessarily of a very restricted nature. In the United Kingdom there had been discussions in various Universities on the general aspects of research in West Africa and some time was spent in the Colonial Office Research Department. Supplementary estimates to Colonial Development and Welfare Scheme R. 326 to cover the first year's programme were submitted and approved.

In October, 1950, the Institute established its headquarters on the permanent site of the University College, Ibadan. There were difficulties to be faced. In the University College itself, owing to its very rapid expansion, resources of housing and accommodation were stretched to their utmost. An earlier offer of four flats to the Institute had to be withdrawn. Nevertheless, the College proved extremely co-operative, particularly in these difficult matters, as the account of Institute buildings will show.

It was originally hoped to hold a full-scale Conference at Ibadan of Government Officers from the Regions and of research workers in Nigeria. This unfortunately proved impracticable at this early stage. In the first place, there was no accommodation available, the few research workers in Nigeria were widely scattered and none of them were of sufficient experience to assist in the preparation of a research programme. Government Officers, though most helpful, proved in early discussions that they had little to add to what was originally said in a Despatch from the Governor to the Secretary of State for the Colonies and were too wrapped up in their own multifarious duties to offer even tentative suggestions at such short notice. The Director therefore decided on a policy of visiting the Regional Secretariats and discussing with all the officers concerned in the various departments priority research topics and the deficiencies of the information available to them in their own fields. From these discussions much material of considerable value was obtained and it was on this basis that the suggested research programme discussed later in this report was eventually drawn up.

2. Institute Buildings

Owing to a change in the layout of the College buildings on the permanent site it was possible to purchase from the College a 200-foot cement building situated between the Department of Agriculture and the Anatomy and Physiology laboratories. This block is admirably suited for the provision of office accommodation along with a small conference room and research library and a recording room. Minor alterations to this building will be necessary at a later stage. In addition, three permanent College houses have been made available to the Institute for the Director, the Administrative Secretary and one Research Fellow. Provision for housing has been made in the African Village in the College and consists of a block of five two-roomed houses each with its own kitchen and bathroom, built of handcrete and suitable for senior clerks and research and field assistants. There is also a further block of four small two-room houses for drivers and junior employees.

The buildings programme for the next six months includes a further house and four chalets suitable for permanent residence by married couples or single people and for the accommodation of visitors. Provision will be made in these for individual catering if desired, the alternative being to take one's meals in the Senior Common Room. This will be most helpful to those whose work will mainly take them outside Ibadan.

It is not generally realised at home that an appointment in West Africa of an expatriate carries with it the necessity of providing accommodation in all save a few cases—for example where an anthropologist spends the majority of his time amongst the community which he is studying. And even he requires accommodation at headquarters for at least part of his study. It is thought necessary, therefore, that a further two chalets should be built during the Academic Year 1951–1952 to give a ratio of two houses and six chalets to twelve research staff and their families of whom at least six will spend most of their time outside Ibadan.

It should be noted that the original estimate for building capital was made in 1949 and that there has been since then a considerable rise in the cost of labour and material particularly cement. Despite this, provision for Institute buildings, for five houses for junior staff, for four chalets and two garages has been made with a saving of approximately £6,000 and this includes one house in excess of the total for which the original estimate was made. Rentals from these houses accrue to the Institute on a basis of 7·7 per cent. of the total salary of the occupants. This large saving is mainly due to the college policy of building by direct labour under the supervision of the Constructional Adviser to the Principal rather than through contractors.

The provision of two further chalets in 1951–52 will still be well within the original estimated capital cost of buildings for the Scheme.

3. Staff

Posts for anthropologists and economists were advertised through the Inter University Council for Higher Education in the Colonies. The response from economists, as had been feared, was on the whole poor, but in the field of anthropology the prospect is much more encouraging and some applications have been received from those who have already had research experience in Nigeria.

Two research appointments have so far been made. P. C. Lloyd, a geographer by training who had had anthropological research experience in the Geography Department of the University College for a year before his appointment, joined the Institute in October, 1950, as an Assistant Research Fellow. D. C. Rowan, an economist from the staff of the University of Birmingham, was appointed Research Fellow in December last.

The Director is proceeding to the United Kingdom on March 1st to interview possible candidates and to discuss the position as it now appears. Subject to adequate financial provision it is hoped that the research staff of the Institute will reach a total of twelve by October, 1953.

Arrangements have been made with the Nigerian Administrative Service to retain the services of Mr. Leich as Administrative Secretary to the Institute for a further period while the Institute is being built up without prejudicing his future prospects when he returns to the Service.

4. **Research**

Two research schemes are at present in operation in the Institute. P. C. Lloyd is continuing his research into the Yoruba which he commenced in 1949 under the University College residing in Iwo in Oyo Province. Before joining the Institute he produced unpublished papers on " Craft Organisation in Iwo, a Yoruba Town in S.W. Nigeria ", and in " Chieftaincy in Iwo and its Relation to the Lineage System ". During his stay in Iwo he outlined the basic feature of the economy and the political, economic and social organization of the town in relation to its historical background and present-day conditions. Lloyd is now continuing this research on a comparative basis in Ado Ekiti. This town, situated in Ekiti division of Onde Province, is in many ways dissimilar to Iwo. In Ekiti, the political units are smaller than in Oyo and there are other significant differences. After a four months' stay in Ado Ekiti Lloyd hopes, with the material thus obtained, to attempt a comprehensive social and economic survey of a single town or village, covering such topics as demographic data, incomes and expenditure, farm sizes and yields, craft industries and market. The result of such a survey should prove most valuable in relation to work already done or on hand on the Yoruba by W. B. Schwab, and American Scholar in receipt of a Colonial Development and Welfare grant, and P. Morton Williams, of University College, London. Lloyd is working in a small scale with, at present, only one research assistant.

The second scheme is an enquiry into the Monetary and Banking System of Nigeria by D. C. Rowan, covering the evolution of the existing monetary and banking system, its operation at present and possible future developments. The technique employed is that of individual research. The project has the support of the Nigerian Government and should be of very considerable value to the Financial Secretary and his staff.

In addition the Institute has offered facilities to Dr. K. O. Dike of the College History Department in connection with his research into the documentary records of Nigeria. This has the active support of the Nigerian Government and they hope it may prove to be the foundation of a Public Records Office.

5. **Research policy**

The history of research in Nigeria vis-à-vis the Nigerian Government has not been entirely happy and the Government feels that it has gained but little information from many schemes both publicly and privately financed whose operation it has facilitated. On the other hand, Government's needs for information on variety of topics are urgent and of vital importance to the future development of the country.

The Director has therefore decided that, so far as possible, a research programme will be drawn up closely related to the needs of Government and enjoying its full support. A definite undertaking has been given that such research will be financed, up to 50 per cent. of the cost, from Nigerian Funds. When this programme has been finally approved by the Colonial Social Science Research Council, schemes will be put forward for the consideration of Government selected on the basis of their comparative urgency and of the availability of Institute staff to undertake them. It should be stressed, however, that fundamental research of a less utilitarian purpose will not be neglected in the Institute's future programme and that every effort will be made to dovetail future schemes into those already in operation under the Colonial Social Science Research Council and other bodies.

Effective co-operation has already been achieved between the Institute and the team employed on the survey of the cocoa producing areas of Nigeria financed by the Nigerian Cocoa Marketing Board under Professor Ashby's Committee. Contact has also been established with most of the individual research workers in Nigeria.

The Institute's aims will be:—

(1) To undertake research, both economic and sociological in subjects of special importance to the West African Governments, so far as possible co-ordinating these schemes with subjects of fundamentally greater academic value.
(2) To establish a centre of research in West Africa and to co-ordinate existing sociological and economic research more effectively than in the past.
(3) To establish closer relation with the other West African territories.

Professor M. Fortes, Professor of Anthropology in Cambridge University, has undertaken to visit the Institute at Ibadan and to advise on research within his own purview. Many of the projects at present under consideration will require the joint service of both an economist and an anthropologist if the best results are to be obtained. How this can best be worked out will naturally depend upon the nature of each individual scheme.

6. Proposed research programme

The duration of this programme will be five years and the estimated research staff of the Institute will, subject to adequate financial provision, rise to twelve in October, 1953. Not all of the following projects can be undertaken within this period.

(1) The socio-economic problems associated with the labour employed by the Cameroons Development Corporation, particularly in relation to the problems of a predominantly male migrant labour force.

(2) Urbanization and its effects on tribal and family responsibility, juvenile delinquency and labour migration.

(3) The development of local secondary industries (see 2).

(4) The effect of the Tin Mining Industry on social and economic conditions of the pagan people on the Jos Plateau.

(5) An economic survey of the palm oil and palm kernel industry in the Eastern Provinces.

(6) An enquiry into the cassava-gari industry, its cultivation, processing and distribution. Gari is unduly subject to market manipulation and its price is an important factor in the rising cost of living.

(7) An enquiry into the native spinning and narrow-loom weaving industry.

(8) The social position of women and the effect of female education.

(9) The changing dietetic habits of the people, with special reference to the use of foodstuffs imported from other areas of Nigeria and from abroad.

(10) The employment of pupils leaving school. A statistical and descriptive survey in a variety of social environments in the four regions of Nigeria. This problem is particularly acute in the Eastern Provinces, and, especially, in Onitsha and Enugu, where an attempt is being made to resettle some of the unemployed on experimental farms; to raise the prestige of farming.

(11) An enquiry into women's organisations in the Eastern Provinces, particularly in Calabar Province.

(12) Moral values in African Society with particular reference to moral values in pagan religion.

(13) Islam in West Africa.

(14) An enquiry into the monetary and banking system of Nigeria.

(15) A survey of a Yoruba community, its economic and political structure: to be related to existing research in this region and to those topics outlined above which bear upon it.

It will be observed that this list is concerned solely with Nigeria and the Cameroons. Whilst every effort will be made to maintain close contact with research in the other British West African Territories and with L'Institut Francais de l'Afrique Noir, the present financial limitations of the Institute necessarily limit its scope to Nigeria during the initial five year period.

7. Constitution

No Advisory Committee has yet been set up for the Institute, though a close liaison is maintained with the College and the Director sits on the Academic Board. It is visualised, however, that an Advisory Committee should be set up from the four British West African Territories and from the College.

W. HAMILTON WHYTE,
Director.

APPENDIX III

Report on the work of the East African Institute of Social Research

1. Work was started at the Institute in May, 1950. After discussions with Government authorities at Nairobi at the end of April, with officials of the Tanganyika Government in Mwanza during July, and with the Administration in Uganda throughout the summer, the Director prepared a budget for the estimated needs of the Institute during the next five years. Treasury approval for the expenditure of £109,450 for the period from 1st July, 1950, to 30th June, 1955, was given in July, 1950 (Scheme R/409); and for £14,398 for a supplementary estimate (Scheme R/409a) in November, 1950, making a total of £136,098 for the five-year period.

2. Plans for the building of office and staff accommodation were immediately taken in hand and a three-roomed office and six four-roomed flats and garages are now in course of construction. It is hoped that they will be ready for occupation by the end of April, 1951. This accommodation should serve the immediate needs of the Institute. The Institute has housed a number of visiting research workers during the year and the need for additional guest rooms is already apparent.

3. Conditions of service for members of the Institute staff have been approved. Salary scales have been fixed in relation to those of the staff of Makerere College, and that of the Rhodes-Livingstone Institute and consist of the following grades: Senior Research Officer equivalent to Readers or Senior Lecturers on Makerere College staff; Senior Research Fellows equivalent to Assistant Lecturers. Local Research Officers, Senior and Junior, will also be appointed, and Bursarships awarded from time to time.

4. An Advisory Committee for the Institute was appointed towards the end of 1950 on the nomination of the Principal of the College, who acts as its Chairman. The following accepted invitations to serve: the Chief Native Commissioner, Kenya; the Member for Local Government, Tanganyika; the Secretary for African Affairs, Uganda; the Director of the Uganda Museum, Dr. Wachsman; Professor Eric Holmes (Makerere College); and Dr. Hugh Trowell. The first meeting of the Committee took place on 14th December, 1950. It was attended on invitation by Mrs. Chilver, Secretary of the Colonial Social Science Research Council.

5. The Institute is building up a collection of Government reports, maps and other documents, and has a small lending library of volumes likely to be in constant use by field workers. By arrangement with the College authorities, major works of reference in the social sciences and periodicals will be centred in the College Library. Since the College is already well supplied with periodicals in the social sciences, the joint collection of books and journals in this field should soon become a valuable one.

The Institute is also compiling a bibliography of East African literature. Periodicals as well as books and reports are being indexed under subject and tribal headings, and Mrs. Lloyd Fallers, who is in charge of this work, hopes to publish a bibliography of Uganda later.

6. Staff already working for the Institute or about to take up their duties are as follows: *Administrative Secretary*, Miss Jean Fortt; *Anthropologists*, Mr. A. W. Southall (April, 1950, after working for two years with a Colonial Research Fellowship); Mr. A. Lloyd Fallers (July, 1951, after working for nine months as a Fulbright Scholar); Mrs. Priscilla Reining (April, 1951); Mr. J. W. Tyler (November, 1950), and Mr. J. Scherer, a Dutch Government Scholar for whom the Institute has provided passages and assistance; Mr. A. B. Mukwaya, Sociological Research Assistant; *Sociologist*, Mr. Cyril Sofer (April, 1950); *Psychologist*, Mr. S. G. Lee (late Summer, 1950); *Linguist*, Mr. E. Mulira (September, 1950).

Working under the supervision of the Institute are the following: *Sociologist*, Mrs. Rhona Sofer (April, 1950, Colonial Research Fellowship); *Anthropologists*, Mr. E. H. Winter (June, 1950, Colonial Development and Welfare grant); Mr. B. Taylor (July, 1950, Colonial Development and Welfare Grant); Mr. G. M. Wilson (February, 1951, Colonial Development and Welfare Grant); Dr. Jeanne Fisher (August, 1950, Colonial Development and Welfare Grant); and Mr. and Mrs. A. Harris (July, 1950, Colonial Development and Welfare Grant); and temporarily attached, Mr. Wilfred Whiteley, Government Anthropologist, Tanganyika.

Work in progress and projected

7. The Institute is engaged on two major surveys.

(a) *Social Survey of Jinja.*—The work in Jinja a centre of the most rapid industrial development in Uganda at the moment, started in June, 1950, under the charge of Mr. and Mrs. Cyril Sofer. A census of the European community was completed in September, 1950, and it was followed by a pilot study of an African estate, Walakuba. A sample survey of all the African settlements in and around Jinja took place between January and March, 1951. The Indian community will be surveyed during April, and Mr. and Mrs. Sofer will then devote themselves to intensive sociological investigations. It is hoped later to appoint a sociologist to make a detailed study of the Indian community.

(b) *Buganda Immigrant Labour Survey.*—This study is being carried out for the Government of Uganda. During April to May, Mr. and Mrs. Sofer made an analysis of the 1948 census figures in order to estimate the numerical proportions of immigrants from Ruanda-Urundi and Tanganyika settled in Buganda. This document is ready for publication. In October, 1950, Mr. Ganafa, a clerk of the Labour Department, Uganda, started to collect data from migrants passing through Kabale camp near the Ruanda-Urundi border under the supervision of the Institute. The results of this work have recently been analysed by Mr. and Mrs. Sofer; and Mr. Ganafa hopes to complete a further sample count of migrants passing through Kyaka ferry camp near the Tanganyika border in March. Studies in four type areas in Buganda are being carried out by the Director, with the help of Miss Jean Fortt, Mr. Mukwaya and occasional help from other members of the staff (Mr. A. W. Southall, Mr. J. W. Tyler and Mr. J. Scherer). Studies of three villages in Busiro, one with a large settlement of immigrants from Ruanda-Urandi and the other with a predominence of immigrants from the West Nile were undertaken in November, January and February. During March, 1950, villages in Kyagwe near a large sugar estate will be studied; and later a suitable district in Buddu. It is hoped that preliminary results of the survey will be completed by July, 1951. A history of the movement of immigrants into Uganda during the last twenty to thirty years is being undertaken by Mr. P. Powesland, an economist on the staff of Makerere College, who began his work in January, 1951, and is co-operating closely with the Institute staff. This survey has not only been used as a training ground for new field-workers without previous field experience, but it has also shown the opportunities a local Institute has of drawing on short time help of research workers on a project that has common interest to all social scientists in the neighbourhood. Mr. A. W. Southall, for instance, was able to interrupt his field study of the Alur in order to make a special study of a small settlement of Alur immigrants in Busiro and it is hoped that Mr. Fallers from Busoga, and Mr. and Mrs. Sofer from Jinja will also provide material. Mr. Middleton, now working among the Lugbara, has also co-operated. It would be impossible to get expert help of this kind for so little cost without a local Institute.

8. *Tribal studies* are being done in the following areas:—*Uganda*—Ganda (A. I. Richards); Alur (A. W. Southall); Soga (A. Lloyd Fallers); Amba-Konjo (E. H. Winter); Toro (B. W. Taylor); Jie (P. Gulliver); Lugbara (J. Middleton); *Kenya*—Kikuyu (J. Fisher); Teita (A. and G. Harris); *Tanganyika*—Zinza (J. W. Tyler); Haya (P. Reining); Ha (J. W. Scherer); Makua (W. Whitely); Mgugwe (R. Gray); Barabaig (G. M. Wilson).

9. *Comparative studies* of particular problems appear to be one of the most important tasks a local Institute can carry out with its special facilities for organising continuous research over a considerable period of years, and by calling on the help of large numbers of research workers. The Institute is at present experimenting in co-ordinating such research by means of periodic conferences which allow workers in different areas to keep in touch, and should give some of the advantages of team work. The first conference of this kind proved very successful. It was held from 17th December till 23rd December and was attended by 22 people including Mrs. Chilver, the Secretary of the Colonial Social Science Research Council.

The problem now selected for comparative study is the present-day working of African political systems in East Africa. The work will include a comparative study of political structure; the intensive investigation of the working of political institutions at the village, county and provincial level; and of political ideologies and attitudes.

A comparative study of race attitudes and of systems of value in general, will probably grow out of this work. While most of the Institute staff will be unable to work on these special problems until their second year of field work, an experiment is being made in the collection of career histories of those in authority in sample provinces or counties.

10. *Linguistics.* It has not been possible to appoint a Senior Linguist this year; but Mr. E. Mulira has been working on Luganda, and the Institute was fortunate in having the advice of Dr. A. N. Tucker of the School of African and Oriental Languages and Cultures from October, 1950, to March, 1951. Dr. Tucker made a comparative study of Lusoga, Luganda, Lunyoro, Lunyankole and Lutoro during October and November, and spent a fortnight with Mr. and Mrs. Winter to help the latter in her study of the complex languages of the Ambo-Konjo area. He spent January and February in Kenya working on Masai and Nandi languages.

Publications

11. Members of the staff have prepared the following for publication during the year: *A. I. Richards*—" Variations in the family system of the Central Bantu " in " African Kinship Systems," edited by Radcliffe Browne and Forde; " Bemba Hut-building " in *Man*, July, 1950; " Puberty Ceremonial and Marriage Rites —A Study of the Cisungu Ceremonies of N.E. Rhodesia," awaiting publication; *A. W. Southall*—" Luo Lineages," to be published as a monograph of the International African Institute; *C.* and *R. Sofer*—" Study of a European Community in East Africa," awaiting publication. The following other publications are projected: *A. N. Tucker*—" Comparative study of the Languages of the Lacustrian Bantu "; *H. Cory*—" Wall Drawings and Figurines in Tanganyika ".

Contacts with other bodies

12. *Makerere College.* Contact has been very close and work is being planned in co-operation with Dr. Kenneth Ingham (History Department) and Mr. Powesland (Social Studies Department). It is hoped to arrange joint work on nutrition with Professor Eric Holmes. Students of the College have co-operated in the social survey of Jinja.

Rhodes-Livingstone Institute. The Institute has been visited by Dr. Elizabeth Colson, Director of the Rhodes-Livingstone Institute, who was able to give much help and advice.

I.R.S.A.C. Dr. Jacques Maquet of the Astride Centre of I.R.S.A.C. attended the Christmas Conference of the Institute and close co-operation has been arranged.

International African Institute. The Institute has financed part of Dr. Meinhard's work in Tanganyika for the Ethnographic Survey and has been in touch with the I.A.I. on many other points.

Governments of East Africa. The Director visited Nairobi and Mwanza during the year and has had visits from Mr. Moffett, the Adviser on Native Courts to the Tanganyika Government, and two of the Government Anthropologists (Mr. Hans Cory and Mr. Wilfred Whitely). Mr. Kenneth Cowley, Adviser on Native Courts to the Kenya Government, also visited the Institute.

The Government of Tanganyika has asked advice on the conduct of a survey of Dar-es-Salaam, and Mr. and Mrs. Sofer are going to advise on this project in March.

A. I. RICHARDS,
Director.

APPENDIX IV

Report on the Work of the Rhodes-Livingstone Institute

Staff

The past year has seen the expansion of the work of the Institute as posts created under the new Colonial Development and Welfare Vote grant have been filled. Early in 1950, the Trustees of the Institute appointed a committee to interview and pass on candidates. The Secretary of the committee was Mrs. E. M. Chilver, Secretary of the Colonial Social Science Research Council. Other members were: R. Hudson, Esq., of the Colonial Office; Professor Daryll Forde, of the University of London; and Professor M. Gluckman, of the University of Manchester. Dr. J. C. Mitchell, a research officer of the Institute then on leave in England, was seconded by the committee to aid in the selection of candidates. In August, the Trustees of the Institute, acting on the advice of the Committee, offered posts to Dr. Marian Pearsall, an American anthropologist trained at the University of California; V. W. Turner, B.A., in anthropology at the University of London and with further training at the University of Manchester; and L. Gann, B.A. History Oxon. Mr. Gann was appointed to do research on the history of Northern Rhodesia and Nyasaland. The other two were appointed as social anthropologists. During the remainder of the year and for the first months of 1951, Mr. Gann worked in England on the documents available there. He sails for Africa in April, 1951, to continue his research in the Central African archives. Mr. Turner reached Northern Rhodesia in September, 1950. He spent several weeks among the Lamba people of Northern Rhodesia as an introduction to field research under the direction of Dr. Mitchell, and then began his investigation of the Lunda of the Balovale and Nwinilunga districts of Northern Rhodesia. Dr. Pearsall was given six months of grace before entering on her contract, and so only sailed for Africa in February of 1951. She will work among the Lakeside Tonga of Nyasaland.

Three posts under the new scheme remain to be filled. It seems improbable that there will be suitable applicants for the post for demographic studies. It is hoped that it will be possible to fill the other two posts in 1951. One post is for an anthropologist to study the Mambwe-Lungu peoples of Northern Rhodesia; the other for a sociologist to assist Dr. Mitchell with the study of urbanization on the Copper Belt of Northern Rhodesia.

2. Work in progress

Work on other schemes financed by the Colonial Development and Welfare Vote grant continued during the year. Dr. Mitchell, who completed his field work among the Yao in 1949, spent the early part of 1950 in England working up his Yao data. In July, 1950, he returned to Northern Rhodesia and began the study of the developing urban society of the Copper Belt and the effects of urban conditions on Africans living in the area. His work has been handicapped by the failure to appoint a second sociologist as his assistant and by the failure to find suitable African research assistants. So far no Senior African assistant and only one Junior African assistant has been appointed. Dr. Mitchell has made preliminary surveys of the African population in one of the towns of the Copper Belt as a background to more detailed work. He has also visited the Lamba and Ushi areas to obtain first-hand information on two of the rural populations contributing elements to the urban areas.

Before his return to Northern Rhodesia, Dr. Mitchell completed a book on the village organization of the Yao of Nyasaland, which was accepted as a D.Phil. thesis at Oxford University. The Institute hopes to be able to publish this work, which is a major contribution to the understanding of local organization in the Central African area. Dr. Mitchell has also written a number of short articles. An article on the social organization of the Yao of the Malemia area, Nyasaland, is to appear in the Nyasaland Journal. A short report on the incidence of literacy in the Lamba area will appear in the Journal of the Institute.

The research on the peoples of the Luapula area of Northern Rhodesia continued. Mr. I. Cunnison, the research officer in charge of this project, spent the early part of 1950 in England working on a preliminary analysis of materials collected during his

first tour. He produced a study of the role of history in the Luapula area, which will appear as a paper of the Institute, and a preliminary account of the social organization of the region which will be circulated as a mimeographed communication from the Institute. He also produced a report on the distinction between tribe and clan in the Luapula area which has been offered to the Northern Rhodesian Journal. Since Mr. Cunnison's return to the Luapula in July, 1950, he has continued his investigations of the general social organization of the area and the role played by the fishing industry. He has written short accounts of the ceremonies that followed the death of the Mwata Kazembe, chief of the area, which will appear in the Northern Rhodesian Journal, and has also produced an article on village rituals which will appear in the Rhodes-Livingstone Journal.

The appointment of the research officer, Miss Marjorie Elliott, who has been collecting material for a study of labour migration in Northern Rhodesia and Nyasaland, was extended by six months to enable her to complete the writing of her final report.

The Institute sponsored further research under grants from the Beit Railway Trust. Dr. J. F. Holleman continued his work among the Shona of Southern Rhodesia, and Mr. A. J. B. Hughes worked among the Ndebele of Southern Rhodesia.

The Director, Dr. Elizabeth Colson, completed her research among the Plateau Tonga of Northern Rhodesia. In September, 1950, she went on overseas leave for a year. She has worked on a revision of an account of marriage and family life among the Plateau Tonga and has also produced a paper on the role of cattle in Tonga life. Both accounts will appear in the publications of the Institute.

During the Director's absence, Miss M. B. Hyam, who was appointed in July as administrative Secretary to replace Mrs. L. Close, has been in charge of all financial and administrative affairs of the Institute. Dr. Mitchell has served as technical research adviser, and therefore has had much to do with the supervision of the research staff and with advising the Trustees on research matters.

3. Conferences

Two conferences were held during the year so that the research officers, who ordinarily are scattered about Central Africa, could meet, discuss field problems, and plan their researches along parallel lines. In July, the staff met in Bulawayo, Southern Rhodesia. Professor I. Schapera, of the University of Cape Town, attended the meetings as a visiting specialist. Dr. H. Ashton, of the Bulawayo Municipal Native Affairs Department, also attended some sessions and was especially helpful in discussions centering on urban research. In February, Dr. Mitchell organized a conference at Kitwe, on the Northern Rhodesian Copper Belt. Professor J. Krige, of Natal University, and Professor Monica Wilson, of Rhodes University, attended as visiting specialists, Mr. A. Epstein, a Colonial Social Science Research Fellow who is studying the work of the urban courts in Northern Rhodesia was also asked to take part in the discussions and to read a paper on his work.

4. Publications

The Institute has continued its programme of publications, though particular items have appeared later than the usual schedule. The Oxford University Press publishes for the Institute. Two journals and two papers have appeared. The papers were:—Dr. Philip Mayer's study of Gusii bridewealth, and Mr. D. U. Peter's report on land usage among the Serenje of Northern Rhodesia. The Institute has accepted two papers for 1951:—Mr. J. Barnes' account of marriage among the Fort Jameson Ngoni, which uses material he collected as a research officer of the Institute, and Mr. I. Cunnison's paper on the role of history in the Luapula area. The Institute is also publishing in book form Dr. Holleman's study of Shona Marriage and Family Law, which the Beit Railway Trust is financing through a subsidy. The book *Seven Tribes of British Central Africa* has been in the hands of the printers for over a year, but continues to be delayed. It has finally reached the page-proof stage under the prodding of Dr. M. Gluckman, one of the editors, who has undertaken to see the book through the press.

5. Buildings

Difficulties with sites and building costs have delayed the building of the new Institute centre at Lusaka. It is hoped now that this will be completed in 1951.

6. Exchange of Information

During the past year the Institute has provided bibliographies for the use of UNESCO. It has loaned manuscripts and given further information to assist the survey into African marriage sponsored by the International African Institute. It has offered the facilities of its growing library, for which it has been commended, to all members of the Institute and to all Government employees in Northern Rhodesia. It exchanges its publications with various institutions, and the interest in its publications has continued to increase. Institute publications circulate in Britain, the United States and various other countries as well as in Africa. In Northern Rhodesia, the Institute has kept a close liaison with the Rhodes-Livingstone Museum, and has helped with the formation of the new Northern Rhodesia Journal.

E. COLSON,
Director.

APPENDIX V

Research conducted under the auspices of The University of Malaya

History Department

In the *History* Department preparations are being made towards writing a History of Malaya in several volumes. The volume likely to be first completed is that dealing with British Malaya from 1867 to 1941, which may be ready in 1952. It is hoped to publish in addition, a volume of Select Documents covering the period 1867 to 1900. This work is being undertaken by Professor C. N. Parkinson. Academic exercises undertaken by students under supervision are now nearing completion on the following topics.

(i) *The Suez Canal and the Singapore Trade.* A study of the period 1859-1879 to illustrate the growth and structure of trade in the period immediately before and immediately after the opening of the Suez Canal.

(ii) A study of *Debt Slavery in Perak* which covers the history of this institution before the British intervention, and of the attempts to abolish it during the early years of intervention culminating in the successful attempt introduced by Sir Hugh Low in 1883.

(iii) *A study on British Relations with Johore* 1855-1869 with the object of discovering news aspects of these relations that have not been treated before or have been treated inadequately.

Department of Geography

2. In the Department of *Geography*, Mr. D. W. Fryer has directed on behalf of the Singapore Improvement Trust the preparation of maps illustrating land use in Singapore by students of the Department of Geography. Mr. Fryer is also collaborating with Mr. R. G. H. Ho in a paper on the Cities of South-east Asia. Professor E. H. G. Dobby has published through the University of London Press, 1950, a geographical study under the title " South-east Asia." He has also published " The Development of Malaya's Uplands " (Institute of Pacific Relations, New York, 1950). He has conducted field work into the problems of environment and peasant methods of dealing with them, which have led to two papers—" The Kelantan Delta " accepted by the Geographical Review, New York, 1951, and " Peasant Pioneering in Kedah " accepted by " Economic Geography," U.S.A. In addition he has edited a series of studies of Malaya published by the Cambridge University Press in which he wrote " Agricultural Problems in Malaya"

Department of Economics

3. In the Department of *Economics*, Ungku Abdul Aziz has been conducting a sample survey of yields on rubber smallholdings in Johore. The information has been derived from actual sales receipts of about 900 randomised small-holdings. The field work is being undertaken with the assistance of the field officers of the Rubber Research Institute of Malaya and of the Department of Agriculture. Samples have to be collected over a period of 12 months and completion is expected in about December, 1952.

Dr. You Poh Seng has completed a short sample study of hawkers in the streets of Singapore, which was published as an appendix to the Report of the Hawker Enquiry Commission in 1950. The field work was conducted under the direction of Dr. You Poh Seng assisted by Mrs. N. Svasti, a member of the Commission, and supervisors from the Department of Social Welfare together with voluntary workers from schools and from the University of Malaya.

Professor T. H. Silcock and Ungku Abdul Aziz prepared jointly a paper on "Nationalism in Malaya" which was presented at the Lucknow Conference in October, 1950. This was based on a study of pre-war and post-war sources including newspaper articles, pamphlets and confidential information which was made available for the purpose by the office of the Secretary for Chinese Affairs. This paper will be published in due course by the Institute of Pacific Relations, New York. Professor Silcock also published in September, 1950, an article on "Accountants, Economists and the Valuation of Fixed Assets" (Economic Journal). This was based on a joint study with an accountant in a local firm on some of the problems arising from inflationary conditions in Singapore after the occupation.

4. No special financial provision has been made for these researches except in the land utilisation survey which was financed in part by the Singapore Improvement Trust.

APPENDIX VI

Research in Social Sciences at the University College of the Gold Coast

1. Institute of Education

The following research projects are being undertaken:—

(a) *The relative merits of English and Twi as media of instruction in the senior primary schools.* The investigation is intended to be a "pilot" character and its future development will be determined in 1952 after the report has been considered by the Conference of Training Colleges.

(b) *Social Function of Language and the teaching of the Mother Tongue.* Preliminary steps have been taken towards working out a project dealing with the social function of language. Information is being collected about (i) changing vocabulary content in Twi and Fanti by borrowing and by semantic change, (ii) special usage of language amongst Fanti fishermen, (iii) pressures on language of small numerical significance by a more powerful language (e.g., Ewe on Akpafu in Togoland).

(c) *Grading and presentation of Arithmetical material for primary schools.* As an exercise in the grading and presentation of number and arithmetic along lines indicated by experience and research elsewhere, a part of the course on the methodology of arithmetic is being devoted to the construction of a set of text books, suitable for West African children and capable of being presented in several vernaculars. A collection of indigenous games and rhymes is being made and these, together with typical local events and customs, will be used as the vehicle for presenting new work.

(d) *Preparation of Intelligence Tests.* Two types of group intelligence tests are being constructed. A verbal test in the vernacular, suitable for Senior Schools has been tentatively constructed. It is being used on a small group of pupils in connection with the language experiment described in (a) above. A group performance test based on the " G " tests used by the R.A.F. is also being prepared. Items (a) and (b) are being conducted by Mr. D. W. Grieve who is assisted by Mr. A. Taylor in the first project. Items (c) and (d) are the responsibility of Mr. A. Taylor.

Mr. A. Taylor has given some assistance to Dr. G. Tooth in connection with the latter's investigations under the auspices of the Colonial Social Science Research Council. Messrs. Lewis, Grieve and Taylor of the Institute are co-operating with Dr. Tooth in the application of aptitude and attainment tests at the school leaving certificate level.

2. History Department

Private research into Gold Coast History is being pursued by members of the History Department within the terms of their appointment to the College Staff.

It is proposed to institute a specific Historical Research Unit at a later date for which a grant may be asked. This would include research into written records and oral tradition.

3. Department of Sociology

The following are details of projects already undertaken or at present in progress in this Department:—

(a) *Mrs. E. Meyerewitz.* "*The Relationship between ancient Egyptian and Near Eastern ritual belief in Akan culture.*" Mrs. Meyerowitz collected material in 1950 as a visiting lecturer of the Department. She worked mainly in Techniman in North Ashanti. She is at present in London writing up her material.

(b) *Mr. David Tait. The Social institutions of the Konkomba.* Mr. Tait is a Lecturer in Anthropology. He has been working among the Konkomba since the beginning of 1950. He hoped to complete his field work in September this year and then proceed to the University of London to write up his work.

(c) *Mr. E. Kurankyi-Taylor. The machinery of justice in the territory of Ashanti, Gold Coast.* An examination into the history and present organisation of the King's Courts and the Native Administration Tribunals in Ashanti, and the relations between them.

Mr. K. Taylor is a research Lecturer in African Studies. He worked in Ashanti from January to August, 1950, and is now at Cambridge writing up his work.

(*d*) Dr. K. A. Busia. *The religious, social and economic aspects of Funeral Customs in the Gold Coast.* This work is still in progress. It is expected that the collection of data will be completed by the end of the year.

4. Department of Geography

The following researches are now in progress:—

(*a*) Mr. E. A. Boateng. *The development of settlement in the Eastern Provinces.*

(*b*) Mr. T. E. Hilton. *The distribution of population in the Gold Coast.*

(*c*) Mr. J. H. Hubbard. *The growth and functions of Accra.*

(*d*) Professor W. J. Varley. *Aspects of land use in the Gold Coast*; in connection with the International Survey of Land Use.

APPENDIX VII

Report on Historical Research in the University College of the West Indies

The following research work has been in progress during the current year in the College's Department of Modern History:—

Miss Elsa Goveia has been engaged on a study of slave society in the British Leeward Islands from 1718 to 1800. The study should be completed in 1952.

Mr. Elvin Wartel who holds an Emerton Travelling Fellowship of Harvard University and is assisted by the Social Science Research Council of Washington, D.C., is engaged on a study of the social history and development of the white population of Jamaica since emancipation. The work should be complete in 1953.

Professor Parry is engaged on a study of the sale of public offices in the Spanish Indies under the Hapsburgs and on a study of the system of Patent Offices in the British West Indies in the 17th and 18th centuries.

APPENDIX VIII

Educational Research in Singapore

1. Matrices Testing

The Medical Department of the University of Malaya and the Education Department, Singapore, are associated in the Singapore Child Guidance Committee. The Committee was formed early in 1950 with a view to exploring the possibilities of testing for Child Guidance in Singapore.

In 1950 a General Survey to discover the need for Testing in Singapore Schools in which the medium of instruction is English, was made by means of a questionnaire addressed to the Principals of the Schools concerned.

This year the Committee have obtained a set of 50 Progressive Matrices (1948 Edition). The Superintendent of the Mental Hospital, Singapore, who has had great experience of Testing has given a series of lectures on the use of the Matrices Test to a group of 250 students at the Teachers' Training College, Singapore. These students are now familiar with the technique and methods of using the Matrices Test, and under supervision will make up the first teams for testing local school children.

The Committee is now considering ways and means of making the Test on a large scale. The Committee hopes that this method of collecting scientific data on the intelligence of the local child population, very largely non English speaking, will provide a much needed scientific basis upon which to study local educational programmes.

2. Teaching Literacy in Romanised Malay

In April 1950, after some limited discussion with the villagers, a class of illiterate women of a fishing village on the South-East coast of Singapore was established under the guidance of Mrs. P. B. Means, wife of an American research scholar working in Singapore.

The material used was a mimeographed primer based on the Laubach key-word method and compiled by Dr. Means and his wife with the assistance of the Inspector of Malay schools. In June, this material was rearranged and unsuitable vocabulary was rejected, and the Department of Education published it in Metro-type under the name of " Kunchi Pelajaran " (The Key to Learning). This was followed by the publication of two follow-up readers.

The average time taken to learn to read the primer was 20 hours, though some managed it in 6 or 8 hours.

Two thousand copies of the primer have been distributed through the neighbouring territories of the Federation of Malaya, Sarawak, North Borneo. The follow-up readers are being distributed through Schools and through the Medical Dispensary and Clinic Service. Experiments are being carried out to test the use of this key-word primer in the Malay Schools.

3. Teaching Literacy in English

In July, 1950, two experimental classes (one for men and one for women) in English were organized by the Department of Education for the illiterate vernacular-speaking members of the staff of a Government Hospital.

The purpose was to test the suitability of the course " Learning the English Language " produced under the guidance of Professor I. A. Richards of the English Language Research Incorporation, Massachussetts, in Singapore.

The experiment has shown that the material is suitable, with certain changes in vocabulary, and has established certain other useful conclusions.

Colonial Medical Research Committee Sixth Annual Report (1950-1951)

Medical Research Council,
38, Old Queen Street,
S.W.1.

20th June, 1951.

SIR,

On behalf of the Colonial Medical Research Committee, I have the honour to transmit to you the Sixth Annual Report of the Committee, covering the period 1st April, 1950, to 31st March, 1951.

I have the honour to be,

Sir,

Your obedient servant,

H. P. HIMSWORTH
(*Chairman*).

The Right Honourable James Griffiths, M.P.,
Secretary of State for the Colonies.

COLONIAL MEDICAL RESEARCH COMMITTEE

Membership

DR. H. P. HIMSWORTH, M.D., F.R.C.P., Secretary, Medical Research Council (*Chairman*).

BRIGADIER J. S. K. BOYD, O.B.E., M.D., F.R.C.P., F.R.S., Director, Wellcome Laboratories of Tropical Medicine.

PROFESSOR P. A. BUXTON, C.M.G., F.R.S., Professor of Medical Entomology, University of London.

SIR ALAN DRURY, C.B.E., M.D., F.R.C.P., F.R.S., Director, Lister Institute of Preventive Medicine.

SIR NEIL HAMILTON FAIRLEY, K.B.E., M.D., D.Sc., F.R.C.P., F.R.S., Senior Physician, Hospital for Tropical Diseases (University College Hospital).

DR. F. HAWKING, D.M., D.T.M., National Institute for Medical Research.

PROFESSOR B. G. MAEGRAITH, M.B., B.S., D.Phil., M.R.C.P., Professor of Tropical Medicine and Dean of Liverpool School of Tropical Medicine.

PROFESSOR B. S. PLATT, C.M.G., M.Sc., Ph.D., M.B., Ch.B., Professor of Nutrition, University of London.

DR. E. D. PRIDIE, C.M.G., D.S.O., O.B.E., M.B., B.S., Chief Medical Officer to the Secretary of State for the Colonies.

MAJOR-GENERAL SIR JOHN TAYLOR, C.I.E., D.S.O., M.D., LL.D., D.P.H., (I.M.S. retd.).

DR. R. LEWTHWAITE, O.B.E., D.M., F.R.C.P.

Joint Secretaries.

Terms of Reference

The terms of reference of the Committee are to advise the Secretary of State for the Colonies and the Medical Research Council on all matters of medical research in and for the benefit of the Colonies.

SUB-COMMITTEES

MALARIA

SIR NEIL HAMILTON FAIRLEY, K.B.E., M.D., D.Sc., F.R.C.P., F.R.S. (*Chairman*).

BRIGADIER J. S. K. BOYD, O.B.E., M.D., F.R.C.P., F.R.S.

PROFESSOR P. A. BUXTON, C.M.G., F.R.S.

MAJOR-GENERAL SIR GORDON COVELL, C.I.E., M.D., Director, Ministry of Health Malaria Laboratory, Horton Hospital.

DR. F. HAWKING, D.M., D.T.M.

DR. R. LEWTHWAITE, O.B.E., D.M., F.R.C.P.

PROFESSOR G. MACDONALD, M.D., M.R.C.P., Professor of Tropical Hygiene, University of London, and Director, Ross Institute of Tropical Hygiene.

PROFESSOR B. G. MAEGRAITH, M.B., B.Sc., D.Phil., M.R.C.P.

DR. E. D. PRIDIE, C.M.G., D.S.O., O.B.E., M.B., B.S.

COLONEL H. E. SHORTT, M.D., Ch.B., F.R.S., Professor of Medical Protozoology, University of London.

MAJOR-GENERAL SIR JOHN TAYLOR, C.I.E., D.S.O., M.D., LL.D., D.P.H., (I.M.S. retd.), (*Secretary*).

HELMINTHIASIS

SIR NEIL HAMILTON FAIRLEY, K.B.E., M.D., D.Sc., F.R.C.P., F.R.S. (*Chairman*).

BRIGADIER J. S. K. BOYD, O.B.E., M.D., F.R.C.P., F.R.S.

PROFESSOR J. J. C. BUCKLEY, D.Sc., Professor of Helminthology, University of London.

PROFESSOR R. M. GORDON, O.B.E., M.D., Sc.D., F.R.C.P., Professor of Entomology and Parasitology, Liverpool School of Tropical Medicine, University of Liverpool.

DR. F. HAWKING, D.M., D.T.M.

DR. R. LEWTHWAITE, O.B.E., D.M., F.R.C.P.

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EAST AFRICAN MEDICAL SURVEY

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COLONIAL MEDICAL RESEARCH COMMITTEE

SIXTH ANNUAL REPORT

CONTENTS

COLONIAL MEDICAL RESEARCH COMMITTEE

SIXTH ANNUAL REPORT

GENERAL

1. Seven meetings of the Committee and its Sub-Committees were held during the year.

2. An innovation in this Report is the inclusion of summaries of investigations in the medical field made by research units or organizations that are wholly supported by the governments of British Colonial Territories or Mandated Territories. For continuity of context some are placed immediately after similar reports from units that are the scientific responsibility of the Committee.

COLONIAL RESEARCH SERVICE

3. The memorandum to the Secretary of State from the Colonial Medical Research Committee on the organization of medical research for the Colonies, referred to in paragraph 4 of last year's report, has been the subject of several discussions with the Colonial Office and, although agreement has been reached on some points of detail, the memorandum as a whole is still under consideration.

WORK OF THE COMMITTEE

General

4. All the main research schemes that were in progress during 1949–50 have been continued. Recruitment of staff is still inadequate quantitatively; but it has been possible to fill seven vacant posts on the establishment of certain of the research units, two of them by former holders of Colonial Medical Research studentships on completion of their specialized training. Designed to bring young graduates into the field of tropical medical research, six of these Studentships are available for selected graduates in medicine and three for graduates in the cognate sciences. Two were awarded during the year. One student is studying the planning and techniques of virus investigation under Professor Sir Macfarlane Burnet, F.R.S., at the Walter and Eliza Hall Institute of Medical Research, Melbourne; the other is taking the D.T.M. & H. course at the London School of Hygiene and Tropical Medicine, prior to concentrating on one particular field of study there. In addition, two students continue their specialized studies for a second year, one under Professor Sir Macfarlane Burnet, the other under Dr. F. Hawking, M.D., at the National Institute for Medical Research.

Development of Research Schemes

5. The Research Schemes under the scientific supervision of the Committee during the year were twenty-one in number. Of these one was new, designed for the investigation of the guinea worm by Dr. S. D. Onabamiro, an African scientist on the staff of the University College of Nigeria. Another, that provided for a three-months' survey by Dr. Muriel Bell and Dr. Lucy Wills of the incidence in Fiji of anaemia and of dental disease in relation to diet, concluded during the year.

Finance

6. The Medical Research Schemes financed from Colonial Development and Welfare funds, which are already approved, would, if operating at full strength, require an expenditure of £595,000 to continue them until the expiry of the Colonial Development and Welfare Acts in 1956. At the end of 1950 it seemed advisable to review the financial provision which could be made from these funds for research, and the Colonial Research Council were asked to determine what sum could be allotted to each field. It was found that only £600,000 were available to cover the cost of the continuance of existing medical research schemes beyond their due date of expiry (if desired), and also the cost of such new schemes as may be considered to be imperative up to 1956. It was accordingly recommended by the Council and subsequently approved by the Secretary of State that this sum be allocated to finance medical research schemes in the Colonies up to 1956.

The Colonial Medical Research Committee, with the assistance of its Sub-Committees, has accordingly reviewed the research schemes in the different fields of medical investigation, and will advise on the future programme in such a way as to make the best use of its resources up to that date. The savings from the budget of any particular scheme will be used for the continuance of that scheme or to assist other schemes in the same field of investigation.

Overseas Visits

7. Many members of the Committee and Sub-Committees made personal contact with medical research units overseas. Dr. H. P. Himsworth visited most of those in West and East Africa. Professor B. G. Maegraith, in the course of an extensive tour as a Nuffield Consultant, saw the field investigations into certain aspects of the control of malaria that are in progress at the Institute for Medical Research in the Federation of Malaya. Professor G. Macdonald and Major-General Sir Gordon Covell attended the malaria congress convened at Kampala by the World Health Organization, and later (together with Dr. Paul Russell) discussed with East African malariologists certain plans for giving effect to its recommendations. Professor H. M. Gordon spent some time with the Loiasis Research Unit at Kumba in the British Mandated Cameroons. Professor B. S. Platt and Dr. F. Hawking worked for some months at the Field Station of the Human Nutrition Research Unit of the Medical Research Council at Fajara in the Gambia, the former on studies of nutrition, the latter on studies of filariasis. Dr. E. D. Pridie was abroad for most of the year, engaged on a series of official inspections. Dr. R. Lewthwaite visited the medical research investigations in progress in West Africa.

8. A desirable development, which the Committee wish to encourage, has been the extending of the facilities of the overseas research units to specialist workers from laboratories in the United Kingdom for the short-term study of specific problems. Dr. D. S. Bertram, Reader in Entomology at the London School of Hygiene and Tropical Medicine, visited East Africa for some months. He spent a considerable time with the Filariasis Research Unit in Tanganyika, and gave valuable assistance in the initiation of its laboratory investigations. Dr. N. A. Barnicot, Reader in Physical Anthropology in the University of London, began specialist studies in the laboratories of the Hot Climate Physiology research station in Nigeria. Dr. F. Hawking made a special field study, complementary to his laboratory studies, on the chemotherapy of filariasis in the Gambia.

REVIEW OF THE WORK IN PROGRESS

East African Medical Survey

9. The aims of the East African Medical Survey are to obtain information on the relative importance of the major medical problems in East Africa and to carry out pilot schemes of control or eradication. Laboratory work will be carried out at Mwanza on Lake Victoria, and field surveys will be made of neighbouring isolated populations. One such survey has begun on Ukara Island on Lake Victoria, this being the first isolated population chosen for detailed study. The field workers find the islanders' diet to be inadequate. They report that intestinal parasites are very common; that malaria is hyper-endemic; that the incidence in the population of certain other diseases is as follows:—filariasis—30 per cent., leprosy—2 per cent., schistosomiasis—30 per cent.

10. A temporary laboratory came into use towards the end of 1950. Its work is at present mainly directed to the testing of techniques; in addition, samples of dejecta and blood from some six hundred consecutive admissions to the local hospital at Mwanza have been examined. Among the findings were that 10 per cent. of blood films showed microfilariae; that 2 per cent. of blood films showed the organism of relapsing fever; that 30 per cent. of patients had anaemia which was often severe; that evidence of schistosomiasis affecting the bladder and large intestine was present in some 30 per cent.; and that among other worm infections the most common was that of hook-worm, which was found in some 40 per cent. of stool specimens. Statistically the worm load of patients bore no relation to the distribution or severity of anaemia.

11. The collection of vital statistics has begun. More than 5,000 maternity histories obtained from native women have been analysed by the East African Statistical Department. The accuracy of the data leaves much to be desired. With this reservation in mind the following conclusions were drawn:—the current gross reproduction-rate is 2·5–2·75 with a net reproduction-rate of 1·3–1·7, which gives a rate of natural increase of between 1 and 2 per cent. annually. There is an infant mortality-rate of 20 per cent.; it is spread over the first twelve months of life, whereas in less primitive communities the deaths occur mainly in the first month.

Publication

LAURIE, W.——(1951) " Annual Report of the East African Medical Survey Unit for 1950 ". East Africa High Commission, Nairobi.

Helminthiasis

(a) *Filariasis*

12. The Research Unit which has been established in East Africa, with headquarters at Mwanza, Tanganyika, has now been fully staffed and has been able to extend its survey of filarial infections in the area, the three forms occurring being bancroftian filariasis, onchocerciasis and dipetalonemiasis. Over 10,000 persons have been examined. A patchy distribution of *Wucheria bancrofti* and *Dipetalonema perstans* has been shown which is related to the breeding and biting habits of the vectors.

13. One object of the investigations is to determine whether or not filariasis is a problem of major importance in the area by ascertaining the number of persons harbouring worms and the effect the parasitizations have on them.

In many individuals the infection appears to have little effect on health and the work, so far, suggests that bancroftian filariasis is not so serious a problem in East Africa as it is in other areas such as Fiji. Part of the explanation may be that the infections, as determined by the level of circulating microfilariae, are not so heavy as in other parts of the world where late complications such as elephantiasis are frequent. In Tanganyika, elephantiasis and hydrocele are found to occur only in a small fraction of individuals showing larval forms in the blood. It has usually been considered that infection with *Dipetalonema perstans* does not harm the human host, but this is a matter which will be further studied.

14. Studies have been continued on the chemotherapy of bancroftian filariasis and it has been confirmed that the African tolerates doses of the piperazine derivative, Hetrazan, much in excess of those used in other parts of the world. The drug causes an immediate marked and prolonged fall in the number of circulating *Mf. bancrofti* but has no effect on *Mf. perstans.* No definite evidence of the effect on the adult worm has been obtained.

15. Another drug tested was protostib, a pentavalant antimony compound, the action of which is on the adult worm and not on the microfilariae. As this drug is expensive and must be given under medical supervision it is unlikely that it could be used in large-scale field work for the purpose of eradicating filariasis. A demonstration of the possibility of obtaining this result by mass treatment is one object of the Unit, and for the purpose Hetrazan may be more suitable. The pentavalent antimonials may, however, be of value in the treatment of advanced bancroftian disease. An effective drug acting on the adult worm, which is of low toxicity and easy of administration, is required in addition to one with microfilaricidal action. Dr. F. Hawking of the National Institute for Medical Research has been carrying out experimental studies on the subject followed by field trials in the Gambia, but the results of the work are not yet available.

Publication

LAURIE, W.——(1951) " Annual Report of the Filariasis Research Unit, Mwanza, Tanganyika, for 1950 ". East Africa High Commission. Nairobi.

16. Other work on filariasis, not financed from Colonial Development and Welfare funds, is being carried out by the Divisions of Entomology and Malariology of the Institute for Medical Research, Kuala Lumpur, Malaya. Studies have been made on the distribution of the infection with *W. malayi*, and on transmission and treatment. It has been found that the quick disappearance of the microfilariae from the peripheral blood after treatment with Hetrazan is usually accompanied by a sharp febrile reaction, but treatment produces little reaction in patients with clinical filariasis without microfilariae detectable in the blood. Microfilariae were absent or at a low level two years after Hetrazan treatment. There was relief from periodic fever in clinical filariasis but little action on long-standing elephantiasis.

17. The pattern of transmission in Malaya is probably complex but is slowly being unravelled. In Kedah, natural infections with young larvae of *W. malayi* have been found in *Mansonia uniformis* and *indiana*, and, for the first time, also in *annulifera*. Dissections in Province Wellesley suggest that *Mansonia indiana* is probably the main vector in that area, with *Anopheles hyrcanus* playing a secondary role. The main breeding places in *kampongs* (villages) of *Mansonia spp.*, little known three years ago, have now been located.

18. An interesting observation comes from the Tampin branch of the Institute where an indigenous *W. bancrofti* infection in a Malacca Malay was found to be transmissible to *Anopheles maculatus*, the main malaria vector of Malaya.

(b) *Loiasis*

19. The investigations on loiasis in the Cameroons were continued during the year and were supplemented by visits of members of the staff of the Department of Entomology and Parasitology of the Liverpool School of Tropical Medicine.

20. Mr. R. B. Griffiths and Dr. F. J. O'Rourke worked in the area during the period March to July, 1950, and visited a number of different centres in addition to Kumba for the purpose of studying the *Chrysops* vector of the disease and the distribution of filarial infections.

21. Professor Gordon visited the Cameroons on behalf of the Committee during July to advise on the administration of the research scheme and on the future lines of work which should be undertaken. Dr. Kershaw again went out to continue his survey on the progress of individual infections with *Loa loa* and on the rate of development of infections in various communities. Further surveys were made in new and different topographical environments in the Cameroons, the whole being linked up with surveys which are regularly made by the permanent members of the team with the assistance of Dr. A. Zahra, whose services have been lent for the purpose by the Director of Medical Services, Nigeria. The distribution of loiasis is being correlated with the topography of the country, the migrations of the population, the distribution of the vectors and the infections in the monkey population. The study of the bionomics of *Chrysops* is recognised to be an important part of the investigation. This has so far been handicapped by the failure to breed the fly in captivity. As a step towards this the trapping of flies in large outdoor insectaries built over the breeding site is being undertaken in the hope that they will mate and breed under the more natural conditions. The breeding of " clean " flies will be necessary for the study of the stages of development of *Loa loa* and for transmission experiments.

22. On the entomological side work has been continued or commenced on the following points:—(1) the density and infection rates with filariae of the known vectors, *Chrysops silacea* and *C. dimidiata* in different localities and at different seasons; (2) the life-cycle of *Chrysops* and the food requirements of their larvae in natural conditions and in the laboratory (in this connection valuable assistance has been given by Dr. Hynes of Liverpool University); (3) the habits of adult flies as regards fertilization, oviposition, range of flight, resting places, etc.

23. Mr. Griffiths and Dr. O'Rourke took the opportunity during their visit to the Cameroons to make some observations on paragonimiasis and schistosomiasis. A high incidence of both diseases was noted in a fishing village on the shore of Barombi Lake above Kumba, and an investigation was made on the possible vectors. Cercariae of *schistosoma* or *paragonimus* were not obtained from snails which were numerous in the area but snails were collected and sent in a preserved state to Liverpool for identification. Dissections of crabs failed to show the presence of metacercariae of *paragonimus*. Although only negative results were obtained during the short period of work, a local problem of importance was shown.

24. The habit of *Chrysops* of haunting the tree-canopy in which several species of monkey live had previously been reported. Further studies have been made on the point by the erection of platforms at canopy level for the purpose of trapping the flies. The possibility of monkeys forming a reservoir of infection is being further studied and of more than 150 monkeys examined, one-third showed filarial infection. It has not so far been possible to distinguish the parasite from *Loa loa* found in man but if " clean " flies can be bred tests will be carried out on the possibility of transmitting the human parasite to monkeys. If this can be carried out successfully it will enable a full study of the development of the parasite to be made in the mammalian host.

Some observations have been made on the use of repellents for *Chrysops*. Dimethyl phthalate applied in pure form was found to give protection against bites for four hours.

25. In the course of their visit Professor Gordon and Dr. Kershaw undertook some investigations on *D. perstans*, infection with which is common in the area, in relation to the possible role of culicoides species as vectors. It is proposed to establish a colony of *Culicoides grahami* at Liverpool for the purpose and the Medical Research Council is being approached for a grant.

The chemotherapeutic aspects of loiasis are being studied at Liverpool.

Publications

GORDON, R. M., KERSHAW, W. E., CREWE, W., and OLDROYD, H.——(1950) " The problem of loiasis in West Africa ". *Trans. R. Soc. trop. Med. Hyg.*, **44**, 11.

KERSHAW, W. E.——(1950) " Studies on the epidemiology of filariasis in West Africa, with special reference to the British Cameroons and the Niger Delta. I. Methods of survey for infections with *Loa loa* and *Acanthocheilonema perstans* ". *Ann. trop. Med. Parasit.*, **44**, 361.

DAVEY, J. T., and and O'ROURKE, F. J.——(1951) " Observations on *Chrysops silacea* and *C. dimidiata* at Benin, Southern Nigeria. Part I ". *Ann. trop. Med. Parasit.*, **45**, 30.——(1951) " Observations on *Chrysops silacea* and *C. dimidiata* at Benin, Southern Nigeria. Part II ". *Ibid*, **45**, 66.

CREWE, W., and O'ROURKE, F. J.——(1951) " The biting habits of *Chrysops silacea* in the forest at Kumba, British Cameroons ". *Ann. trop. Med. Parasit.*, **45**, 38.

(c) *Guinea Worm*

26. Mr. S. D. Onabamiro of University College, Ibadan, has undertaken research on guinea worm in South-West Nigeria. The work has had two aspects, (*a*) the study of the ecology of the local species of *Cyclops* (the Copepod crustacea dwelling in ponds and streams which serve as intermediate hosts to the worm) and (*b*) the survey of the incidence of the infection in the area. The first line of investigation undertaken was to find out which particular species of *Cyclops* serve as the natural host to the guinea-worm and in what conditions these species thrive. The past year has therefore been devoted largely to a study of *Cyclops* and their habitat. It was found that there are some 23 species of *Cyclops* in the ponds and streams of the area under survey (South-West Nigeria). Of these, 17 have already been described by past workers and the remaining 6 are believed to be new. A description of these new species is being prepared for publication.

27. The local species belong to the following Sub-genera of *Cyclops*: –

Sub-genus	*Tropocyclops*	: 5 species	(including 2 new species)
,,	*Thermocyclops*	: 4 species	(,, 2 ,, ,,)
,,	*Microcyclops*	: 3 species	(No new species)
,,	*Afrocyclops*	: 3 species	(,, ,, ,,)
,,	*Eucyclops*	: 2 species	(,, ,, ,,)
,,	*Mesocyclops*	: 2 species	(,, ,, ,,)
,,	*Ectocyclops*	: 2 species	(including 1 new species)
,,	*Macrocyclops*	: 1 species	(Not new)
,,	*Halicyclops*	: 1 species	(a new one)

Certain species like *Eucyclops* and *Ectocyclops* are found only in well-aerated, shallow streams with plenty of green algae. Others like *Mesocyclops* and *Tropocyclops* are found equally abundantly in both streams and stagnant ponds, in water containing green plants and in water devoid of these. Others, like *Thermocyclops* and *Microcyclops*, are chiefly to be found in stagnant ponds, especially those without floating green algae. It is in the last group that are found the two species of Cyclops which serve as the intermediate host to the guinea-worm in South-West Nigeria; these are *Thermocyclops nigerianus*, Kiefer, and *Cryptocyclops* (*Microcyclops*) *jenkinae*, Lowndes.

28. It is found that the incidence of the guinea-worm may be greatest in the dry season (February to May) or in the rainy season (July to October), according to whether the village pond (from which drinking water is obtained) is an all-year-round type, i.e. a large deep pond which contains water all the year round, in which case the intermediate host of the guinea-worm is *Thermocyclops nigerianus*, Kiefer, or the pond is the periodic type, drying up between March and May, in which case the intermediate host is *Cryptocyclops jenkinae*, Lowndes.

29. A series of experiments is being conducted on the comparative infectivity of the *Dracunculus* larvae to various species of *Cyclops* under different conditions, and on the early stages of the worm in experimentally infected dogs. In the course of the past year, what appears to be an unusual variety of guinea worm, differing from the normal type in not having larvae in the uterus, has been found repeatedly, especially in the " out-of-the-season " months. This worm is being further investigated.

Malaria

Malaya

30. Dr. Edeson and Dr. Wilson of the Institute for Medical Research Kuala Lumpur, continued their studies on the chemoprophylaxis and chemo therapy of malaria in Malaya.

31. *Chemoprophylaxis.* Direct supervision of experiments on the chemoprophylaxis of malaria on estates came to an end in 1949. From one estate, however, where proguanil has been given to the labourers for nearly four years, blood-films from all fever cases are still sent to the Institute for examination. The malaria-rate has remained low, but the absence of an untreated control group prevents a proper assessment of the results. The results of chemoprophylaxis with proguanil in a Malay *kampong* (village) are described in a later section.

32. *Chemotherapy.* The appearance of proguanil-resistant strains of *Plasmodium falciparum* in Malaya was mentioned in last year's report. The proportion of patients with *falciparum* infections resistant to full courses of

proguanil (0·3g. daily for 7 days) has risen considerably during 1950. Haphazard and irregular administration of the drug as a suppressive is probably the main cause. Proguanil-resistance with *P. vivax* has not yet been seen, but the number of *vivax* infections treated has been small. Other drugs tested were Camoquin, Chloroquine, and its German prototype Resochin. Single doses of 0·4g. Camoquin and 0·15g. base of Resochin, gave good results in the treatment of both *falciparum* and *vivax* infections.

33. Blood samples from a patient with a proguanil-resistant *falciparum* infection were sent by air to the Horton Malaria Laboratory, where the infection was successfully transmitted to a patient in the Horton Hospital. Unfortunately, however, shortage of suitable patients prevented further experiments with this strain.

34. *Malaria Control in Rural Areas.* An experiment in the control of malaria has been in progress in Malay rural areas in Negri Sembilan since 1949. Four valleys with a relatively high incidence of malaria and with similar topographical features were selected. The vector of malaria is considered to be *Anopheles maculatus.* In one valley all houses are sprayed with DDT and in another valley with BHC (Gammexane); proguanil is distributed weekly to the population of a third valley, and the fourth serves as an untreated comparison area. Three dispensaries have been built to serve these four valleys, and are staffed by resident hospital assistants. The incidence of malaria is estimated by blood-films from all fever cases reporting at the dispensaries, by examination of infant bloods once a fortnight, and by parasite and spleen surveys of the populations twice a year. The insecticides, in the form of wettable powders, are applied with stirrup pumps. The doses aimed at are 200 mg. DDT per square foot, and 40 mg. gamma BHC per square foot. The interval between sprays was originally three months, but has now been lengthened to six months. Proguanil is distributed in a weekly dose of 100 mg. for everyone in the valley concerned, except new-born infants.

35. Taking 1st October, 1949, as the date from which control operations protected the population of the three valleys, the results of the first 12 months work have recently been reviewed. The comparison area has shown a higher incidence of malaria patients attending the dispensary, a higher level of primary malaria infections in infants, and higher parasite and spleen rates, than any of the other valleys since control work started.

The parasite and spleen rates of children 12 years and under examined at the half-yearly surveys are summarised below:—

Valley	Parasite rate per cent.				Spleen rate per cent.			
	Surveys				Surveys			
	1st	2nd	+3rd	4th	1st	2nd	+3rd	4th
DDT	40	33	16	12	66	64	45	36
BHC	32	28	17	12	60	59	45	48
Proguanil ...	37	25	5	3	59	53	34	20
Comparison ...	28	24	17	24	54	54	49	51

+ Control work started about 4 months before 3rd survey.

A quick fall in parasite and spleen rates in the proguanil area was to be expected, as was the slower response to house-spraying. Parasite and spleen rates in sprayed areas tend to be maintained by old infections which take many months to die out, and the results are hence as good as could reasonably be hoped for.

36. *Effect of DDT and BHC on Malayan Mosquitoes.* The Entomologists of the Institute, Mr. Wharton and Mr. Reid, have continued their investigations with window-trap huts and other techniques. In these huts, if 50 per cent. mortality after 48 hours is taken as the lower limit of effectiveness, wettable powders of DDT (200 mg. per square foot) and BHC (40 mg. gamma isomer per square foot) have remained effective against *Anopheles maculatus* for 22–23 weeks, i.e. nearly 6 months. A similar duration of effectiveness is indicated by catches in the houses of the experimental valleys. Although *A. maculatus* does not rest in houses by day, moderate numbers of *A. vagus* and *A. aconitus* can always be found by daytime " knock-down " catches in the unsprayed houses of the comparison valley. Catches in the DDT-treated houses remain negligible up to 25 weeks after spraying, at which time the spraying is repeated. In BHC-treated houses, however, anophelines reappear within 4–6 weeks after spraying, and can be caught resting on sprayed surfaces, but their mortality-rate over the next 48 hours is found to be 70–90 per cent. up to 16 weeks after spraying. It seems, therefore, that although BHC does not have the persistent irritant effect of DDT which keeps houses free of resting anophelines, it continues to kill such species as *A. aconitus* and *A. vagus* for four months or more. The original 3 months interv between spraying in each *kampong* has been lengthened to six months as a result of these findings.

37. Trap-huts have been used to test the same doses of DDT and BHC against other important Malayan species of mosquitoes. The effects of DDT, observed for seven weeks after treatment, vary widely according to species. *Anopheles umbrosus*, and the vectors of filariasis in Malaya (*Mansonia* species), seem susceptible, with death-rates of 70-80 per cent.; *A. barbirostris* and *sundaicus* are readily killed during the first three weeks after treatment, but thereafter the death-rate falls rapidly to 50 per cent. or less. DDT is not very effective against *A. letifer*, and even when fresh kills only 50 per cent. The species of *Culex* have again been shown to be the least susceptible, and negligible numbers are killed although most of them are driven out of the huts and prevented from biting. All mosquitoes are killed by BHC, but this only remains effective against *Culex* for one or two months; the duration against the other species is not yet known.

Publication

WILSON, T., EDESON, J. F. B., REID, J. A., AND WHARTON, R. H.—(1951) " Third interim report to the Colonial Medical Research Committee on prophylactic and therapeutic trials in Malaya of Proguanil (Paludrine), Chloroquine and Mepacrine (Atebrin)." Report No. 16 of the Institute for Medical Research, Kuala Lumpur.

EDESON, J. F. B., AND FIELD, J. W.—(1950) " Proguanil-resistant *falciparum* malaria in Malaya." *Brit. Med. Jl.* I, 147.

38. The following additional malaria investigations, not financed from Colonial Development and Welfare funds, have also been carried out at the Institute.

Mosquito biology. Studies on the behaviour of adult mosquitoes were continued in the Division of Entomology, and precise information on the feeding habits, daytime resting places, and pre-nuptial swarming flight of anopheline and culicine species is slowly being assembled. The technique of collecting anopheline eggs has improved. The eggs of most species are fairly easily identified. A study of specific differences is being made.

Mosquito systematics. A revision of the *A. umbrosus* group of mosquitoes, written by Mr. J. A. Reid in collaboration with Mr. E. P. Hodgkin, was published at the end of the year. From materials and information exchanged with Mr. Colless in Borneo, it now appears that the vector form of *A. leucosphyrus* present in Borneo and elsewhere is not, as was thought, the same as the type form. Both forms are present in Malaya, but the vector form appears to be common only in the Siam border region. A study of the *A. hyrcanus* complex, started in 1940, has now been resumed, and a systematic account of the group will be completed early in 1951.

DDT as a larvicide. Experiments on the use of DDT as a routine larvicide have been continued. Oil solutions can be used on still water, but not on flowing water unless a suitable sprayer becomes available. For flowing water DDT emulsions seem promising and are superior to wettable powders.

North Borneo

39. During the greater part of the past year the weight of the malaria research work has been borne by the Entomologist in the absence on leave of Dr. McArthur. Mr. Colless has continued his systematic entomological research, has carried out experimental work on the repellent effect of DDT on *A. leucosphyrus*, has made the entomological, spleen and parasite surveys for the Tambunan Experiment, and has developed a new mounting medium for larvae. Routine observation has been continued on the habits of, and the transmission of the malaria by, local anopheles; and a number of articles have been written for publication.

40. *Tambunan Experiment.* The Tambunan Experiment, begun two years ago, is designed to determine whether malaria can be controlled by the localised clearing of jungle over *A. leucosphyrus* breeding-places. Clearing was carried out 18 months ago, with a remarkable degree of *A. leucosphyrus* control; and during the present year further surveys have been made to study the state of this control, and to observe any reduction in the degree of malaria. Twelve months after clearing a degree of breeding had reappeared, considered to be due to the creation of a few new breeding places, a little regrowth of shade, but chiefly to the season being wetter than when the clearing was first done. Since the clearing operations, some improvement is noted in the spleen rates, and a remarkable fall has occurred in the parasite rates; but these have occurred also in the untreated comparison area. This generalised reduction in malaria may be due to weather conditions, and no valid estimate can be made of the effect of clearing until conditions become more normal.

41. *Transmission of Malaria.* As *A. leucosphyrus* has been adequately shown to be the chief vector in Labuan and elsewhere, an infected specimen calls for no comment; but during this year the very considerable list of negative dissections of *A. sundaicus* in Borneo has received the further addition of 375, giving weight to the impression that *A. sundaicus* in Borneo is normally not a vector at least of any importance. After a long series of negative dissections, during 1949 for the first time positive gland dissections were recorded from Borneo, although in some cases at least doubts were expressed regarding their validity. As a rule there is no difficulty in recognising sporozoites; but in Borneo bodies have repeatedly been seen in *A. sundaicus* which have given rise to some difficulty. Out of one series of 167 dissections of this species, 8 yielded bodies which at first were taken to be—and could easily be mistaken for—sporozoites, but which closer examination showed to be certainly not viable sporozoites, and possibly not even living organisms. Following this careful examination, it seems doubtful if any of the positive gland dissections recorded of *A. sundaicus* in Borneo are in fact valid, and it must be concluded

that there is still considerable doubt whether this mosquito, which has for long been regarded as one of the chief vectors, is a vector of any importance, if it is a vector at all, in Borneo.

42. *Repellency of DDT* to *A. leucosphyrus.* Following an experiment with 5 per cent. DDT in kerosene, and with kerosene alone, observing the number of *A. leucosphyrus* resting on measured surfaces of walls, to observe any repellant effect, it was concluded that kerosene is markedly repellant to adults of *A. leucosphyrus*, and is quite unsuitable as a solvent for residual insecticides used against this species; and that DDT, deposited from kerosene solution, is in itself repellent to *A. leucosphyrus.* Further experiments are planned to study the mortality with the small degree of contact observed, the effect of other insecticides, and the effect on other species.

43. *Identity of the malaria vector A. leucosphyrus. A. leucosphyrus* is regarded as consisting of a complex of at least six members distributed throughout Asia; and, following a study by Colless and Reid, it has been shown that the form incriminated as a vector in Borneo and elsewhere appears to be *A. leucosphyrus balabacensis*, and that the type form, previously regarded as the vector, appears to be probably a harmless insect of limited distribution in Sumatra and elsewhere.

44. *Mounting Methods.* Mr. Colless has developed a new mounting method for larvae, whereby specimens have the transparency of a mount in Gater's Solution, although without the disadvantages of this method, and with the permanence of specimens mounted in canada balsam.

Jamaica

45. Malaria Research work in Jamaica which was started by Dr. Muirhead-Thomson at the beginning of 1950 has been developed along two main lines; the study of (*a*) the habits and infectivity of suspected malaria vectors, mainly *Anopheles albimanus*, and (*b*) the distribution of anopheline bites among different human age-groups in relation to general problems of malaria transmission and epidemiology.

46. (*a*) *A. albimanus*, the dominant man-biting anopheline over most of Jamaica, can evidently maintain a high degree of malaria with a very low mosquito infection-rate. No gland infections have been found in over 2,500 females dissected. Nevertheless, *A. albimanus* has been responsible within the last year for several local epidemics of *falciparum* malaria. Routine dissection of anophelines from such potential epidemic areas and from comparison endemic areas continues.

47. Experimental *falciparum* infections of mosquitoes have been carried out on an extensive scale in order to throw further light on transmission, the " crescent " carriers being mainly children between the ages of about 7 months and 8 years. *A. albimanus* is very susceptible to infections, gland infections being produced as early as the 9th day after feeding, under Jamaican summer conditions. Noteworthy is the high rate of gland infection which may be produced in batches of *A. albimanus* fed on carriers whose gametocyte count is so low that thick films are liable to be discarded as negative. There is evidently a very low threshold of infection, and information on this point is accumulating.

Numerous attempts to infect *A. albimanus* from quartan gametocyte carriers have met with no success, and the exact mode of transmission of this form of malaria, widespread in Jamaica, is not certain.

Gland infections have also been produced experimentally in *A. grabhamii* from falciparum gametocyte carriers, but this anopheline normally has very little contact with man, and probably plays little part in natural transmission.

48. While *A. albimanus* bites man and animals actively out of doors, a variable proportion enter houses to feed. Attempts have been made to see whether this house-haunting proportion is high enough to justify house treatment with residual insecticides as a control measure. Those that do enter houses have a high degree of contact with the inner walls. Observations in a selected village house, provided with a window trap, have shown that after DDT treatment of the house a high kill of *A. albimanus* is obtained, only a small proportion escaping unharmed. The majority of those killed inside the house have already taken a blood-meal. In areas where mass treatment of houses with DDT has been carried out, outside biting by albimanus is apparently undiminished, but it is still possible that transmission is reduced or interrupted. The very low natural infection rate of *A. albimanus* makes this rather a difficult point to test.

49. (*b*) *A. albimanus*, with two peaks of biting at sundown and at dawn, has proved an ideal subject for studying the distribution of anopheline bites among village family groups covering all ages from infants to adults. Using both Jamaican negroes and East Indians the results show very consistently the scarcity of bites recorded on babies up to the age of about 18 months, compared with the increasing attraction of older children and particularly of adult and adolescent males. The difference between the two extremes is very marked. For each bite the young baby receives, the pre-school child aged approximately 2–5 years will be bitten about 10–20 times; school children and adult women about 30–40 times, and the adult males about 80–100 times. In addition, night-time observations on sleeping children show that of those anophelines which do manage to bite the babies, few are able to follow up the bite with a blood-meal.

These findings, which it is hoped to continue and extend considerably, have two quite different implications. Firstly, the fact that the youngest age-groups are bitten much less than adults affords some degree of freedom from infection, especially with a mosquito like *albimanus* with a very low infection rate. Secondly, our ideas about young children being the main reservoir of malaria infection due to their higher gametocyte-rate may need some revision as it is clear that, other things being equal, the adult gametocyte carrier—particularly the adult male—is a much greater potential danger to the community because of the much greater frequency with which he is bitten, and the comparative ease with which the mosquitoes can take a full blood-meal on him.

50. Observations carried out during a month's visit to Trinidad showed that both malaria vectors there, *A. bellator* and *A. aquasalis*, exhibit the same general trend of biting on family groups, with babies again comparatively free of bites. As this may be a feature common to many anophelines it may eventually prove to be an important factor in malaria epidemiology in other countries besides Jamaica.

Trinidad

51. The investigations on malarial entomology in which Mr. Senior White has been engaged since 1947 have been supplemented in order to expand his work in the study of the bionomics of the local vectors of malaria and particularly *A. aquasalis*, which shows special characteristics and differences for house-haunting species in the Old World. Following on earlier work in

which investigations had been made in different types of terrain new work was planned on (*a*) intensified investigations on outside resting *aquasalis*, (*b*) the relative attraction of various animals for *aquasalis*, (*c*) night activity, (*d*) ecological studies of various types of breeding places. Additional staff was engaged for the purpose and observations have been made over a considerable area.

52. Outdoor resting by *aquasalis* was found to be a general phenomenon and the blood-meals of wild-caught specimens were investigated by use of the precipitin sera prepared at the Lister Institute in connection with a scheme which the Committee has sponsored. So far no human feeding has been found where the man: ox + equine ratio is less than 10 to 1.

53. A weekly survey of breeding in mangrove was carried out and it was noted that where the mangrove had been cleared or had died out the subaqueous plant, *Ruppia maratima*, had taken its place and provided shelter for larvae. A year's survey of the Maracas River showed that local mosquito breeding depends on seasons of low rainfall during which the stream becomes pooled. There was no evidence of mass infiltration with the valley or similar valleys at the season of maximal production on the Caroni Plain as suggested by Shannon. It is considered that there is no malaria transmission in these valleys below the *A. bellator* line.

A season's survey of selected types of rice cultivation was completed. The vast majority of the breeding was found to be *A. albitarsis* and, locally, rice cultivation does not appear to present a malaria hazard.

54. The daily counting of larvae, foot by foot, in a transect, first used by Ribbands to evaluate the natural length of development in *A. minimus* in Assam, has been tried out here on an extended scale. It indicates $8\frac{1}{4}$ days as the length from mid-stage I to mid-pupa. Peaks of adult density occur on an average every 12 days, the difference of $3\frac{3}{4}$ days being apparently consumed in egg development and in mating, and ovarian maturation in the succeeding generation.

55. Observations of swarming and mating have been continued. Females found in the swarms are few, and these do not seem to be the principal locus of fertilization. Females from the swarm invariably have the gut empty. A varying proportion have been captured fertilized, but pairs are probably frequently interrupted in the act by catching. Swarming begins on an average 20 minutes after sunset. Only a few actual light readings were obtained in the one month of the year in which the photometer was not in New York under repair. The maximum light at which a swarm was seen to form was 5 f.c. After the swarm has disappeared or been lost to sight with darkness, both sexes are found at flowers. Chromatography of abdominal smears shows that a large proportion in both sexes is then nectar feeding. Apparently sugar is necessary to regain energy before a blood meal is taken.

56. Some 3,500 precipitin results have been obtained from monthly catches of outdoor resters in three areas. These show wide fluctuations in anthropophilic index. The data still require statistical analysis for significance, but changes of several hundred per cent. between one month and that preceding and following, throw a new light on transmission. The changes are not related to fluctuations in density and their cause is still to seek. It has already been shown that very rapid fluctuations in the amount of multiple feeding during the last meal occur and the trophic habits of *aquasalis* at least are not fixed.

57. The question of local races in *aquasalis* has been examined by maxillary index counts from Rio de Janeiro to Antigua, a distance of 40° of latitude. The data have been statistically analyzed in Professor Buxton's Department at the London School of Hygiene. The species has five " demes " forming two clines, one continental, from 23° S. to 11° N., and one, quite separate, in the Windward-Leeward chain. The two clines appear worthy of subspecific nomenclature. As material from the type locality, Panama, cannot be obtained, settlement of nomenclature is difficult.

A 40′×20′×10′ cage is under construction with Colonial Development and Welfare funds. In this it is hoped to create a cage colony (mating is unobtainable under ordinary laboratory conditions), when experiments on longevity, and perhaps sufficient newly emergeds for flight experiments, may be obtainable.

East African Malaria Unit

58. A grant towards the formation of this Unit was given from research funds in view of the facilities it will provide for developing malaria research in the East African Territories, as well as undertaking practical anti-malaria work. The Unit was established in January, 1950, with headquarters at Muheza, Tanganyika, and later moved to Amani where it took over quarters which had been evacuated by the East African Agricultural and Forestry Organization. Ample housing and laboratory accommodation, with the essential services, will be available and the staff is being built up.

It is recognised that the main obstacle to progress in research and active malaria control work in East Africa is the paucity of trained malariologists; an important part of the work of the Unit will be to train staff of all grades.

59. A major subject for research by the Unit will be the study of the effect of malaria on communities living in areas where malaria is hyperendemic, and the effect that may be produced by different control measures. The necessity for this was emphasized at a recent Conference in Kampala.

Two schemes are under consideration relative to such investigations. One is a scheme for mosquito control in a rural area by the use of residual insecticides which the Colonial Insecticides Committee may sponsor in association with the East African Malaria Unit, and the other scheme for long-term observation of its effect which is before the Colonial Medical Research Committee.

The Unit may be expected to play an important part in expanding malaria work in East Africa, and its formation was overdue.

Publication

WILSON, D. BAGSTER, GARNHAM, P. C. C., AND SWELLENGREBEL, N. H.—(1950) " A Review of Hyperendemic Malaria." *Trop. Dis. Bull.*, **47**, 677.

Nigeria

60. Dr. L. J. Bruce-Chwatt, Director of the Malaria Service, Nigeria, reports that an investigation of the natural history of malaria in African infants was concluded and its preliminary results briefly reported at the W.H.O. Malaria Conference at Kampala. This investigation was carried out in Lagos on 538 parturient women and on their new-born babies. Moreover 138 new-born babies were regularly followed up by periodical examination from birth until the age of 12–18 months. Congenital malaria is extremely rare in African new-born in spite of the fact that 24 per cent. of examined placentae were heavily infected with *P. falciparum*. In Nigerian infants the rate of malarial

infections during the first quarter of life is about 3 per cent. This rate increases to 14 per cent. during the second quarter, and to about 50 per cent. during the third quarter. Nearly all children are infected by the end of the first year.

61. Periodical follow-up of weights of examined infants has revealed that in the average both the infected and the non-infected infants show a steady rise of their weight-curves up to about 5 months of age. From then onwards the weight-curves of both groups of infants flatten out considerably but the downward trend of the curve is more pronounced in the infected group. There is a considerable variation in the shape of individual curves in the infected group. The importance of malaria as the cause of death of African infants was investigated on the basis of critically reviewed post-mortem records of the Lagos General Hospital for the period 1933–1948. This investigation has shown that acute malaria could be incriminated as a cause of death in about 9 per cent. of infants dying at the Hospital. The respective ratio was 13 per cent. in the early childhood, 7·4 per cent. in the first school-age group and 3·6 in the second school-age group.

62. *Chemotherapy.* A method of evaluating the activity of anti-malarial drugs on three " standardized " groups of 245 African school-children naturally infected with *P. falciparum*, *P. malariae* and *P. ovale* was used for comparative field trials of mepacrine, proguanil and chloroquine. This investigation has revealed that all malariometrical indices decreased more rapidly in the chloroquine group than in either mepacrine group or proguanil group. The latter group showed the slowest response, and the relapse rate in this group was higher than in any of the other two.

63. A survey of the incidence of malaria in the non-African population of Nigeria and the relation of this incidence to the prophylactic administration of anti-malarial drugs was carried out by means of a medical and a general questionnaire. This survey has revealed that prophylactic proguanil is used by the non-African population of Nigeria with a considerable degree of success, although occasional failures cannot be denied. The slow therapeutic effect of proguanil and its failure to produce a radical cure of *P. falciparum* infections were confirmed. A report on malaria in Nigeria was presented at the World Health Organization Malaria Conference at Kampala (Uganda), and will be published in the forthcoming Bulletin of the Organization.

64. *Ilaro Eradication Project.* The Ilaro experimental malaria eradication scheme by residual insecticide-spraying continues. Four complete sprayings of the African township of Ilaro in Southern Nigeria were made during the year. The town has 11,500 inhabitants, and is situated within the hyperendemic malaria zone. *A. gambiae* and *A. funestus* are the main vectors of the disease. Benzenehexachloride (Gammexane, P 520) water-dispersable powder is applied to the inside walls of all buildings of this town at a concentration of 10 mgm. of the gamma isomer per square foot. A reduction almost amounting to eradication of the vectors was achieved. The reduction of the malariometrical indices of the indigenous population is slow. The project will continue.

65. Trials on aircraft desinsectisation carried out at the Lagos airport in two types of aircraft used for inter-colonial flights (de Havilland " Dove " and Bristol " Wayfarer "), utilized the new type of Aerosol bomb (" Low pressure Freon propelled aerosol dispenser "), and revealed that the effective use of the formulation must amount to a dose of at least 0·06 gm. pyrethrins per 1,000 cubic feet of aircraft space. The importance of the personal comfort factor during spraying of aircraft in tropical areas was evaluated.

66. Previous work carried out on the ecology of crab-burrows of the Lagos sea-shore was reviewed and related to the ecology of mosquitoes breeding in crab-holes. It was found that there is a definite relationship between the species of crabs and the particular species of mosquitoes breeding in crab-burrows within the three main ecological zones of the West African sea-shore. The successful use of gammexane pellets for control of mosquitoes breeding in crab-holes and tree-holes was described in a report presented at the annual meeting of the American Mosquito Control Association in Chicago in March, 1951.

Publication

BRUCE-CHWATT, L. J.—(1951) " Evaluation of synthetic anti-malarial drugs in children from a hyperendemic area in West Africa." *Trans. R. Soc. trop. Med. Hyg.*, **44**, 563.—(1950) " Recent studies on insect vectors of yellow fever and malaria in British West Africa." *Jl. trop. Med. Hyg.*, **1**, 71.

Idem AND BRUCE-CHWATT, J. M.—(1950) " Anti-malarial Drugs in West Africa, with Particular Reference to Proguanil. Results of a Survey in Nigeria." *Brit. Med. Jl.*, **2**, 7.

Idem AND KEE HOCK OOI—(1950) " Aircraft desinsectisation in West Africa." *Monthly Bull. Min. Hlth. and Publ. Hlth. Service*, **9**, 142.

Virus Diseases

67. The former Rockefeller Yellow Fever Research Laboratories at Lagos, Nigeria, and at Entebbe, Uganda, have completed their first year under their new identities (see last year's Annual Report). The designation of the former is now " The West African Virus Research Institute," and that of the latter " The East African Virus Research Institute." Funds for their maintenance are derived from the Research Allocation provided under the Colonial Development and Welfare Acts, assisted by proportionate contributions from Nigeria, the Gold Coast, Sierra Leone and The Gambia in the case of the former, and from Uganda, Kenya, Tanganyika, Northern Rhodesia, Nyasaland and Zanzibar in the case of the latter. Their purpose is to carry out research on known or suspected virus and rickettsial diseases of medical importance in the territories with which they are associated.

(a) *The West African Virus Research Institute, Lagos, Nigeria*

68. It has unfortunately not yet been possible to secure a suitable Director and adequate scientific staff for this laboratory. For this reason, and because of the absence in America of the two virus workers at the Institute, it has proved impossible to start a programme of work. Dr. W. E. S. Merrett, who had been acting Director during this year of transition, proceeded on leave in February, 1951, and will be returning to another important appointment in Northern Nigeria. He has done valuable work in rehabilitating the facilities at the Institute against the time when an adequate staff becomes available. Dr. F. N. Macnamara is now in acting charge. Dr. R. G. Hahn, a staff member of the International Health Division of the Rockefeller Foundation, and late Director of the Yellow Fever Research Institute, was engaged in rounding off his work until his departure from Nigeria in October. In anticipation of a widening of the scope of the virus work additional equipment has been installed, an aviary has been built for the study of encephalitic viruses in birds, an insectary is under construction, and the mouse colony has been expanded. The possibility of securing grivet monkeys locally or from Sierra Leone is being explored. The testing and distribution of the remaining supplies of Rockefeller yellow fever vaccine have continued. At the end of the year 150,000 doses were in stock.

69. Dr. F. N. Macnamara and Dr. P. B. Stones returned to Nigeria in July, 1950, and February, 1951, respectively, from a period of study leave in the United States of America, during which they had been enabled by the generosity of the Rockefeller Foundation to take a diploma course in public health and to study the planning and techniques of virus research in order to equip them further for their work at the Institute.

70. Dr. Hahn concluded the work on the scratch method of yellow fever vaccination on which he had been engaged for some years. For the preparation of the vaccine, the 17D strain is grown in chick embryos which are emulsified in 0·85 per cent. saline and 5 per cent. gum arabic; the product is then desiccated. Before use it is reconstituted with water. One ml. of the preparation is sufficient for the vaccination of 80 persons. Vaccine from the French neurotropic strain has been similarly prepared. Early in the year a large number of vaccinations with the combined yellow fever and vaccinia vaccine were made by the scratch method in Warri Province by a team of Africans; follow-up studies were made by Dr. S. M. Newstead. Protection tests on post-vaccination sera were made by Dr. Hahn; his publication on the subject is now in the press.

71. On his return from the United States of America, Dr. Macnamara brought with him 15 strains of different neurotropic viruses; and from them has prepared desiccated lots of uniform composition. From school-children from selected areas he has prepared 800 sera, which are being tested for protection against 8 of these viruses. Protective bodies have been found against the following viruses:—Bunyamwera, Bwamba, Semlike Forest (local strain), Uganda S., West Nile, Yellow Fever, and Zika; by far the most commonly found were those against the Bwamba and Zika strains. None were found for Mengo encephalomyocarditis. The investigation continues. Attempts to isolate strains of virus from patients with short-term fevers are being made. One virus has been isolated from the mouth of an adult European with acute gingivo-stomatitis and tonsillitis.

72. The Entomologist, Mr. K. H. Ooi, with a view to work contemplated on the *Ceratopogoninae*, has been making detailed studies of the breeding habits, development and histology of the sub-family *Psychodidae*. The Senior Malariologist, Nigeria, Dr. L. J. Bruce-Chwatt, and Mr. Ooi, have investigated certain new aerosols in aircraft (see para. 65).

Publication

HAHN, RICHARD G.—(1950) "Successful vaccination against yellow fever with the 17D strain of the virus of yellow fever by the 'scratch' technique: procedure for making the vaccine both for yellow fever only, and combined with smallpox vaccine." Report to the Director, Medical Services, Nigeria.

(b) *The East African Virus Research Institute, Entebbe, Uganda*

73. The Directors of Medical Services of the respective territories were invited to state their problems and if possible to give them an order of priority. These include yellow fever, rickettsial infections, alastrim and smallpox and a group of ill-defined pyrexias including possibly encephalitic infections. A long-term programme has been planned to fit in as far as possible with the needs of the territories.

74. *Yellow Fever. Epidemiology.* Uninterrupted researches on the epidemiology of yellow fever have been carried on since 1937 in the field station at Bwamba, W. Uganda, culminating in the identification of *Aëdes* (*Stegomyia*)

africanus Theo. as the host and vector of the virus among the mosquito species captured. From the transience of the appearance of the virus in the peripheral circulation of the wild primates considered to be the main vertebrate hosts, it is thought that the location of survival of virus during periods when the active cycle of transmission is in abeyance is most likely to be in the body of the invertebrate host. Bwamba is an area of heavy rainfall spread throughout most of the year and *A. africanus* occurs continuously in the adult stage. But it by no means follows that the mechanism of transmission is the same in areas with a pronounced dry season, where the adult mosquitoes may disappear for a considerable period with the desiccation of their breeding places. Among other areas in Uganda the Karamoja and West Nile District seemed promising for studies of this kind. In the Karamoja District an immunity survey showed that 2·5 per cent. of human sera were immune. In the West Nile District 4·3 per cent. of 350 human sera were immune and it is interesting to note that all the immunes were amongst adult males, only one male child under 14 being positive. The reason is unknown but the results suggest some occupational factor as hunting. A total of 8 out of 22 monkey sera were immune, all of which were from adults, comprising seven colobus and one grivet monkey.

75. The mosquito survey showed that important vectors habitually breeding in small containers as *A. aegypti* and *A. africanus* were represented at the end of the dry season by a very small adult population biting man in the forest. It seems unlikely in view of the low immunity-rate in man that the usual *A. aegypti*-human cycle is responsible, but the actual mechanism of transmission is quite unknown. In the wet season there seems no reason to believe that the epidemiology of yellow fever differs fundamentally from that in other parts of Uganda.

76. Much accumulated data on immunity to yellow fever amongst monkeys in south and west Uganda was published during 1950. The general immunity-rate in a sample of over 1,000 protection tests on sera from 16 kinds of monkeys was very high—over 40 per cent.—but varied greatly even in contiguous areas, and the reasons for such variation were unknown. Further investigations in the epidemiology of yellow fever are commencing in February, 1951, in (*a*) the coastal belt near Mombasa, where *A. africanus* is absent but the disease is known to occur among the wild primates; (*b*) in the Taveta District, Kenya, selected as a type of Savannah country.

77. Vaccination by scarification with chick-embryo virus of the French neurotropic strain has been practised for several years in the French African territories. While this strain has much to commend it with regard to ease of preparation, it is the present consensus of opinion that in general the reactions are more frequent and severe than after vaccination with 17D vaccine cultivated in chick embryos. As far as is known, there have been no reported studies on vaccination by scarification with the latter vaccine and it was thought desirable to carry out a controlled experiment. Human volunteers were divided into three batches (A) scarified with 17D vaccine, (B) scarified with French neurotropic virus obtained from the Pasteur Institute, Dakar, (C) subcutaneous inoculation with 17D vaccine. All volunteers were bled prior to vaccination and again a month afterwards. The results were:—group A (56 volunteers) 82·7 per cent., group B (52) 98·2 per cent. positive, group C (68) 94·1 per cent. positive. The results of scarification with the 17D vaccine by scarification are very encouraging although the percentage of positives is statistically significantly different from the group vaccinated by the Dakar virus which appears to be a better antigen with this method of vaccination. Further studies are now in progress.

78. On the request of the Directors of Medical Services of Uganda, Kenya and Tanganyika, samples of all batches of vaccine purchased are sent to the Institute for the testing of potency and no vaccine is issued for use before a report of satisfactory potency is obtained. During the year 73 batches were examined.

79. The possibility of the transovarial transmission of yellow fever virus in the mosquito *A.* (*S.*) *africanus* was investigated. It is known that the eggs of this mosquito are semi-drought resistant and a simple explanation of how the virus maintains itself through dry periods is that it passes transovarially from one generation of mosquitoes to the next. Three experiments to test this explanation were carried out commencing with 246 wild-caught *A. africanus* and using inoculated rhesus monkeys as a source of circulating virus. Altogether, 1,892 F_1 adults were produced, 610 of which were from infected parents. All results were negative, and it was concluded that transovarial transmission in this mosquito is most unlikely to occur and is of no importance in the epidemiology of the disease.

Rickettsioses

80. In spite of the accumulation of much clinical and epidemiological data there are still many gaps in present knowledge of this important group of infections in East Africa. During 1950, a long-term programme has been commenced in the Institute with special emphasis laid on tick-typhus. This comprises an examination of the specificity and diagnostic value of the complement fixation test and the attempted isolation of the rickettsias of tick and murine typhus from suspected clinical cases from rodents (trapped in the Entebbe and Kampala areas) and from ticks. The latter were obtained from combing the trapped rodents and from flagging areas in the Entebbe Township. A few points of interest about tick-typhus may be noted:—(1) The low virulence of local strains for guinea-pigs; (2) Positive complement fixation tests (tick-typhus antigen) with a few sera of local rodents; *R. rattus* and *R. coucha ugandae*; (3) Positive complement fixation tests with sera of guinea-pigs inoculated with batches of ticks—larvae and nymphs of *Rhipicephalus sp.*—from Entebbe Township. The entomological studies included the examination of 334 ticks—larvae and nymphs the majority of which were *Amblyomma sp.* 124, and *Rhipicephalus sp.* 198—and some preliminary studies on the microclimate of tick habitats.

81. Amongst other viruses investigated were Uganda S., a hitherto undescribed virus isolated in 1947 from a mixed batch of three *Aëdes* mosquitoes, and Mengo encephalomyelitis virus isolated from rhesus monkeys and from batches of mosquitoes *Taenorhynchus fuscopennatus* and *T. uniformis* caught in the compound of the Institute. Evidence has also been obtained that the sera of certain local rodents such as *R. rattus kyjabius* and *R. coucha ugandae* develop antibodies, but little is as yet known of the epidemiology of Mengo virus or group of viruses.

Publication

DICK, G. W. A.—(1950) " Cultivation of mengo encephalomyelitis virus in the developing chick embryo ". *Proc. Soc. exp. Biol. Med.*, **73**, 77.—(1950) " Persistence of Brunhilde Poliomyelitis virus in rodent brain without evidence of adaptation ". *Proc. Soc. exp. Biol. Med.*, **74**, 3.

Idem, AND HORGAN, E. S.—(1950) " Collection and despatch of material for the diagnosis of virus and rickettsial diseases ".—*E.A. Med. J.*, **27**, 403–6.

HADDOW, A. J.—(1950) " A note on the occurrence of *Aëdes* (*Stegomyia*) *simpsoni* Theobald in the canopy of rain-forest in Bwamba County, Uganda ". *Ann. trop. Med. Parasit.*, **44**, 238–241.

Idem, GILLETT, J. D., MAHAFFY, A. F., AND HIGHTON, R. B.—(1950) " Observations on the biting-habits of some Tabanidae in Uganda, with special reference to arboreal and nocturnal activity ". *Bull. ent. Res.*, **41**, 209–21.

Idem, AND VAN SOMEREN, E. C. C.—(1950) " A new species of *Stegomyia* Theobald from the Ruwenzori Range, Uganda ". *Ann. trop. Med. Parasit.*, **44**, 281–4.

Hot Climate Physiology

82. Work has been continued at the Tropical Physiology Laboratory, Oshodi, Nigeria, on the heat tolerances of indigenous Africans, representative of the local labour force; and further measurements have been made of the metabolic cost of various common African tasks. The Unit has been strengthened by the appointment, for one year only, of a research physiologist, Mr. J. G. Fletcher.

83. Comparison of the reactions of African subjects, exposed for four hours to various climates, with those recorded for fully acclimatized Europeans under similar conditions (McArdle, 1947), confirms the work reported last year, done with short exposures, that Africans are not fully acclimatized, if the standard criteria of sweat-rate and body temperature changes only are considered. As, in some respects, Africans are more tolerant of heat than Europeans, e.g. with severe climates, collapses in the hot room were more frequent among Europeans temporarily resident in Nigeria than among Africans, other criteria of acclimatization are being sought.

84. In two-hour exposures, in climates varying from Effective Temperature 85° F. (29·4° C.) to 95° F. (35·0° C.), serial multiple skin temperature readings have been taken, in addition to other routine observations. In the lower effective temperatures subjects started to sweat with rectal temperatures below 99° F. (37·2° C.) and continued to sweat when body and skin temperatures were falling. Subjects maintained thermal equilibrium, without any initial rise in body temperature, in Effective Temperatures of 90° F. (32·2° C.) when carrying out a routine of mean metabolic cost 100 kg.cal./metre^2/min. As observations on unacclimatized men are more realistic and possibly of more practical value than those on hyper-acclimatized men, these tests were all carried out on Africans maintained in the " unacclimatized " state by suitably spacing the exposures.

85. With the co-operation of the local military authorities the reactions of a group of twelve British soldiers, all volunteers who had been in Nigeria at least six months, have been investigated. The results were compared both with those reported for fully acclimatized Europeans (McArdle, 1947; Ladell, 1945, 1947) and with those obtained in this Laboratory on Africans. Exposures were spaced so as to prevent, if possible, the occurrence of artificial acclimatization. The heat tolerance of these residentially acclimatized Europeans was equivalent to that which could be acquired from 11 to 12 days of artificial acclimatization. But the sweat production was less than that recorded of McArdle's hyperacclimatized subjects in each of the climates in which they were tested, and their mean final rectal temperatures, after four-hour exposures, were about 1° F. higher; thus the residentially acquired acclimatization was not complete.

86. The Europeans sweated more than unacclimatized Africans. But with short exposures they sweated the same man for man, as Africans after 12 days artificial acclimatization, but less per unit area of body surface. With longer

exposures the Europeans sweated more than the acclimatized Africans. In moderate climates after four-hour exposures, mean final rectal temperatures were the same for both Europeans and untrained Africans; but in more severe climates the Europeans had higher temperatures.

When in the United Kingdom Dr. Ladell gave a short communication to the Physiological Institute on the inherent acclimatization of West Africans, and he also addressed the Royal Anthropological Society on the same subject. In August he was an official delegate to the XVIII International Physiological Congress at Copenhagen, and he read a paper on the work of the Unit to the Congress.

87. The facilities of this research station have recently been made available to Dr. N. A. Barnicot, Reader of Physical Anthropology in the University of London, who has commenced a comparative study of the excretion of the 17-ketosteroids in European and African subjects, and also in albino subjects. The study is expected to continue for nine to twelve months.

Publication

LADELL, W. S. S.—(1950) " Inherent acclimatization of indigenous West Africans ". *Jl. Physiology*, **112**.—(1950) " Acquired heat tolerance of temperate climate men living in the Tropics ". *Abstracts of Communications, 18th Physiol. Congress, Copenhagen.*

Physiological Research at Makerere College, Uganda

88. A locally qualified African medical officer was appointed as African Research Scholar for a period of one year. The competence and early promise that he has shown augur well for similar future appointments. Miss Joan Greaves joined the staff to take charge of the Metabolic Ward. Her work has been of the greatest value to the research in progress. The hospitality of the laboratory continued to be extended to Dr. Margaret Thomson who is working with Dr. H. C. Trowell on infant nutrition.

89. A survey of the haematology of a series of 343 Africans attending the surgical out-patient clinic of the hospital, complaining of minor or constitutional surgical conditions, has been completed. This shows that the mean red cell count of this group is 5·3 million per cmm., as compared with 5·95 million per cmm. for the group of Makerere students previously investigated, and who in turn conform to the " world figure " for the altitude of Kampala. Each subject (of the group of out-patients) was questioned as to age, wage, occupation and diet. The results were examined statistically by Mr. F. L. Gee. This examination shows that there are statistically significant differences between the red blood-counts of " Labourers " and " Artisans and others ", in favour of the latter, and also between those who consume animal protein more frequently than twice weekly, and those who do not, in favour of the former. It is felt that these results suggest the desirability of more thorough investigation of the effects of diet and environment. (No more than an indication of this kind was expected to emerge, since the work was primarily planned to investigate haematology, not diet or other environmental conditions).

90. Determinations of serum proteins have been made on the two groups of the series of Africans referred to above. In the first group (150 subjects) the sera were pooled according to blood count; in the second (110) they were examined individually. The results show that:—

(i) The mean values for albumen are low, and those for globulin high compared with values to be found in the literature for Europeans.

(ii) In relation to the red cell count, (*a*) the total protein falls slightly with rising red cell count, while (*b*) the albumen rises, and (*c*) the total globulin falls. (*a*) is of doubtful statistical significance, but (*b*) and (*c*) are undoubtedly significant. The A/G ratio reaches unity only at a value of 5·7 million red blood cells per cmm.

(iii) Only salting out methods for globulin fractionation (albumen and total globulin were determined by the cold emthanol method) were available. These indicate that (1) gamma-globulin is high (nearly 100 per cent. higher than a control series of Europeans resident in Kampala) and changes little with rising red cell count; (2) alpha-globulin is about 50 per cent. higher than in the European series, and is also relatively constant over the red cell count range; while beta-globulin falls with rising red cell count.

91. The institution of the Metabolic Ward has enabled studies to be carried out on anaemic and other subjects on the following lines:—

(i) Nitrogen balances. These show astonishingly large and prolonged apparent retention of nitrogen, confirming previous results in general wards.

(ii) Phosphorus balances.

(iii) Iron balances. The primary object of these is to discover the amount of blood lost in consequence of a given hookworm load.

(iv) Series of haematological investigations with determinations of circulating fluid and extra-cellular fluid spaces.

Publication

HOLMES, E. G., GEE, F. L., ASEA, S. B., *et al.*—(1950) "Red blood-count of East African students". *E. Afr. Med. Jl.*, **27**, 1.

Preparation of precipitin sera

92. Further research on the preparation of specific precipitin sera for the identification of blood-meals of insects was carried out at the Lister Institute by Mr. Bernard Weitz, M.R.C.V.S., at the request of the Committee. Following an earlier visit to East Africa, when the methods of collecting sterile serum from a wide range of animal species were started, the Committee decided that the collection of sera in East Africa should proceed until representative samples of serum from all the possible hosts had been collected. For this purpose a mobile laboratory suitably equipped for the nature of this difficult work was constructed in this country. It is proposed to collect the blood from animals which have been shot for the purpose, to remove the serum, and to sterilize it by filtration in the mobile laboratory. The samples of serum will then be despatched by air in specially constructed containers to the Lister Institute, where a permanent collection of the freeze-dried sera will be kept for investigations relating to the preparation of precipitin antisera.

93. The research has been extended to include a wide range of animals. The investigations are being continued in the light of the results obtained in regard to specificity, which have shown that the antigenic components of serum proteins of mammals apparently contain a common antigen for all species of this class. Studies by means of absorption tests have given encouraging results which are being applied to the routine preparation of specific antisera. Very numerous identification tests have been performed in collaboration with Mr. Senior White in Trinidad which have given considerable help in the study of the bionomics of *A. aquasalis* in relation to malaria. Studies have been continued in Zanzibar on the feeding habits of *Gl. austeni*.

94. In order to determine the time after feeding during which the blood-meals of various arthropods can be identified, investigations were initiated in co-operation with Professor P. A. Buxton at the London School of Hygiene and Tropical Medicine. A number of arthropods including Culex, Aedes, Anopheles, Cimex and Liponyssus were fed in the laboratory and the blood-meals examined after varying periods of time. The periods during which blood-meals can be identified vary considerably with the species of arthropods involved. Similar tests on species of tsetse flies fed on different hosts with the help of the Chief Entomologist, Shinyanga, Tanganyika, have shown that deterioration of blood-meals in these flies varies according to the hosts on which they have fed.

Relapsing Fever

95. The experience and information obtained in the previous year in the course of a survey of tick-borne relapsing fever in the Jombeni Mountains of Kenya was applied by Dr. Walton for the purpose of carrying out a four-month survey in the endemic focus of the South Kikuyu Reserve in the Central Province. A total of 2,035 native huts was examined in order to define the area infested with *Ornithodoros moubata*, the known tick vector of relapsing fever, and to ascertain the influence of the domestic habits of the Kikuyu peoples upon the incidence of the tick. The results have been analysed and a report is being prepared.

For the purpose of determining the presence of infection in the ticks it has been found necessary to establish a colony of rats for experimental transmission. This has been arranged at Dr. Walton's headquarters at Kerugoya and the number of rats has now reached 400.

96. Other surveys were carried out in the Teita Hills in the Coast Province and in the Kwale District between Mombasa and the border of Tanganyika. The Teita Hills, which receive a rainfall of 58 ins. per annum, contain some 4,000 tick-infested huts. Relapsing fever occurs mostly between 4,100 feet and 4,700 feet. Below 3,000 feet the average temperature and humidity of the earth of the floors of the huts was 74·5° F. and 77 per cent., and 7 per cent. of the huts were tick-infested. Between 3,000 feet and 4,200 feet the average readings were 70° F. and 84 per cent., and 30 per cent. of the huts were tick-infested, and above 4,200 feet where 40 per cent. of the huts were infested the average readings were 70° F. and 87 per cent.

Kwale District at the coast receives an annual rainfall of 53 ins.; it contains a small area of some 80 square miles in which 70 per cent. of the houses (about 4,000) are tick-infested. Very few cases of relapsing fever are reported from this area, or from the almost entirely tick-free country surrounding the infested area. The occasional limited outbreaks of fever that do occur are very severe and are attributed to the introduction of ticks from over the Tanganyika border. The ticks indigenous to the Wadigo houses in Kenya are primarily associated with domestic fowls which are kept in the houses and it is provisionally considered that these ticks are not transmitting relapsing fever. They will be tested for infection on rats and domestic fowls, since should they contain spirochaetes these may have to be distinguished from *S. duttoni*.

In relation to the field investigations much work has been done in developing a technique for keeping ticks in bulk for experimental purposes, such as transmission tests, without the necessity to feed them individually on rabbits' ears. The colonies of living ticks are kept in large glass jars and are allowed to burrow into the earth. They are fed by placing in the jar a rat imprisoned in a wire cage.

97. In December, 1950, *Ornithodoros savignyi*, Andouin, 1826, was discovered near Embu in Kenya, considerably further south than hitherto recorded. These ticks are thought to differ slightly from the typical form, but comparison is not possible in the absence of specimens from the usual desert habitat.

Scrub-typhus

98. The field research unit based on the Institute for Medical Research, Malaya, has continued work on the lines indicated in the preceding Reports. An Interim Report has been submitted to the Colonial Medical Research Committee, and whilst on leave in England Dr. Audy addressed the Royal Society of Tropical Medicine and Hygiene on a review of investigations on mite-typhus in Burma and Malaya, from 1945 to 1950. The first and most laborious phase of the work has been completed by a general survey of potential mammalian hosts and trombiculid mites; during 1950 nearly 5,000 more hosts were collected and studied, together with their ectoparasites. Thirty or more of the species of trombiculids sent to Mr. Womersley at the South Australian Museum are being described as new species. Endoparasites are also now being surveyed in collaboration with Dr. A. A. Sandosham of the University of Malaya, while the collections of hosts and mites have been extended into Sarawak in collaboration with Mr. Tom Harrisson, Government Ethnologist and Curator of the Sarawak Museum. Three members of the laboratory staff have made collections around Kuching and during an expedition into the interior of Sarawak.

99. It has been shown that the common giant rats (*R. sabanus*, *R. mülleri*) in the Malayan forest are the proper hosts of the various members of the vector-species group of mites, while the stream- and gulley-infesting species *R. mülleri* is the most prominent host of *Trombicula deliensis* itself in the forest. This may be the chief source of a wild or jungle tsutsugamushi enzootic. Heavy infestations by the vector are, however, found outside the forest on forms of *Rattus rattus*; while it appears that the populations of the rice-field rat, *R. r. argentiventer*, which alone are heavily infested by the vector *T. akamushi*, are the field-dwelling counterparts of the introduced house-rat, *R. r. diardi*, infested by *Xenopsylla cheopis*. *T. deliensis* has been recorded from Hong Kong and Sarawak, while it has also been found infesting tomb-bats from a cave in Angsa Island. This is the first record of the vector from bats and will require further investigation.

100. Experiments on the trapping, marking, and releasing of rats are being steadily extended. They have shown so far that individual rats show marked attachment to their home territories, which may be areas some 50 metres in diameter, but that these territories overlap. Individual species show marked preference for a habitat of one particular kind, and these preferences have now been clearly recognised for seven species. Results have also been accumulated on length of life, rate of growth, and the building up of mite-infestation.

101. A study of the fertility of rats is part of the routine study of the collections; significant differences have been found in the reproduction-rate of the same species in different habitats, such differences being probably directly correlated with the incidence of predation. The most important host of the vector, *R. r. argentiventer*, appears to have an unusually low reproduction-rate and an average life of some four times that of other forms of *Rattus* in town and forest. This species is also unusual in that the males appear to wander afar in search of females. It is, incidentally, the major pest of rice crops.

102. The breeding of mites, the timing of feeding periods, and studies of the acquisition and transmission of infection in collaboration with Dr. S. R. Savoor, have continued. The efficiency of congenital transmission of infection in the vector mites seems to be much lower than has hitherto been supposed. If this is confirmed, then the importance of the animal host as a prime reservoir of infection is correspondingly enhanced.

103. The following summary (para. 104–107) of the investigations made in Malaya during 1950 by the Scrub-Typhus Research Unit of the United States Army Medical and Graduate Research School, with its headquarters at the Institute for Medical Research, Kuala Lumpur, has been contributed by Dr. Joseph E. Smadel, who directs the Unit. Apart from the intrinsic scientific worth of the data recorded, it typifies, as have the corresponding summaries of the two previous years, the great value that accrues from such international collaboration in the elucidation of medical problems.

104. The earlier successes of chloromycetin and aureomycin in the treatment of scrub-typhus have been followed by similar results with terramycin. While all three of these antibiotics are vastly superior to para-aminobenzoic acid as therapeutic agents in this disease, the accumulated observations of three years suggest that the choice among the three is in the order listed above.

105. The problem of protection of the individual exposed to scrub-typhus continued to be investigated along immunological lines. Since inactive vaccines have given consistently discouraging results in field trials in Malaya and elsewhere in the Orient, and since chemoprophylaxis with chloromycetin is expensive to maintain for those at risk for long periods of time, another method of approach was explored. This consisted of inoculating volunteers intradermally with a few infectious doses of an egg adapted-mouse attenuated strain of *Rickettsia tsutsugamushi* and of controlling the induced disease by chemoprophylactic administration of chloromycetin. The trial was successful and the results offer promise of providing a method, although a cumbersome one, of immunizing civilian and military personnel against this once dread disease. All 36 of the volunteers in the test developed at the site of inoculation local lesions which resembled an accelerated or primary reaction to vaccinia. Those who received no chemoprophylaxis showed typical signs and symptoms of scrub-typhus between the eighth and tenth day; all of these recovered promptly when given specific antibiotic therapy. Volunteers who received chemoprophylactic 3·0-gram doses of chloromycetin at four-day intervals from the eighth to sixteenth days were hospitalized on the 20th to 23rd day with scrub-typhus. Those whose prophylactic regimen was extended to 21, 28, or 34 days remained ambulatory during and after the course of drug. The results indicate that chemoprophylaxis continued for three weeks after inoculation was capable of suppressing the infection long enough for the person to develop sufficient immunity so that clinical disease did not develop when the drug was discontinued.

106. Little is known about the duration of immunity in persons who recover from scrub-typhus. Second attacks of the naturally acquired disease are supposed to be relatively common but only two fully authenticated instances have occurred in Malaya. Malayans and Americans who had suffered proved scrub-typhus while serving as volunteers were inoculated intradermally with a few infectious doses of *R. tsutsugamushi*; most of the group was studied at the time the living vaccine-chemoprophylaxis test described above was undertaken. All eight volunteers who recovered from scrub-typhus one to two months previously were completely resistant to re-infection. Eleven of the sixteen who had the disease 11 to 25 months earlier developed a local lesion and typical scrub-typhus which was promptly terminated by specific therapy.

Certain observations suggest that solid immunity continues for at least several years against the homologous strain of *R. tsutsugamushi* but that in most patients such resistance endures for only a few months against heterologous strains of the organism. *R. tsutsugamushi* do persist for many months in the lymph nodes of an occasional patient who recovers from scrub-typhus (one of 12 volunteers tested). The continued presence of such organisms may account for the immunity of certain of the recovered persons who remain resistant for several years to re-infection with a heterologous strain of organism.

107. Since the original observations in the spring of 1948 in Kuala Lumpur that chloromycetin was of great therapeutic value in the treatment of typhoid fever, this drug has been widely used throughout the world in patients with this infection. The general experience has been that little, if any, clinical improvement occurs during the first 36 hours of therapy and that patients do not become afebrile until about the fourth day. This delay in therapeutic response is difficult to explain since previous experience shows that the bacterial organisms are promptly controlled by specific therapy. Indeed, the bacteremia ceases 2–3 days before fever and toxemia subside. However, it seemed reasonable to postulate that the delayed clinical response of typhoid patients to chloromycetin was dependent upon a reaction of the host to the products of bacterial and tissue destruction which existed at the time of institution of therapy. The possibility was considered that the toxemia of typhoid fever might be affected by appropriate doses of cortisone. Accordingly, a group of patients with typhoid fever was given cortisone along with chloromycetin. The febrile period lasted for only 15 hours in those who received 300 mg. of cortisone during the first day. Such observations are of considerable theoretical interest and of enough practical importance to warrant further study.

Nutrition

The Gambia

108. *Field Research Station, Fajara.* The Director reports that in recent months he and other research workers on the station have been able to devote almost all their time to research, whereas in early years much time and effort were given to supervision of building and equipping the station, and to administration. There is now accommodation for forty patients in the research wards, with kitchen, laundry and sewing-room. A surgical theatre, radiological and photographic services, workshops, library and photostat service and six laboratories for biochemistry and pathology are all in good working order, with adequate equipment and stocks of various supplies maintained through the Unit's headquarters in London. There are eight houses and a staff house for 10–12 persons furnished for Europeans, and nearly a third of the 70 members of the African staff are housed. The station has its own electricity, water, and laboratory gas supplies; there is good transport with ample garage and servicing facilities for the vehicles and for the tractor and implements used on the 100 acres of station land. A staff of Africans has been trained in the past three years to maintain all these buildings, equipment and services with the minimum of European assistance.

109. Investigations are being made into the causes of ill-health and inefficiency amongst the rural African population and on the measures likely to alleviate or eradicate them. The staff of the Human Nutrition Research Unit of the Medical Research Council is primarily concerned with problems of under- and mal-nutrition; zymotic diseases, especially malaria, however, contribute to the effects of shortages of foods or nutrients and the various

aspects of these inter-related problems are being examined at the Unit's headquarters at the Medical Research Council's Laboratories at Hampstead, and in rural areas in the Gambia as well as at the Field Research Station. A fuller account than is now given of these activities is being published in the current annual report of the Department of Nutrition of the London School of Hygiene and Tropical Medicine (1950–51).

110. The period for which the vote for the Nutrition Field Working Party at Geneiri was approved ended in the spring of 1950. So many of the facts of this work—social, economic, agronomic, educational and administrative—were emerging that, in June 1949, Professor Platt asked the Colonial Office to consider the future of the Working Party's work and its management. It has recently been decided to continue the work along the lines originally planned, and the Government of the Gambia have assumed complete responsibility for the work as an experiment in development and administration, under the title of Gambia Field Working Party. Arrangements are being made for the medical and nutritional investigations to continue under the direction of Professor Platt. Whilst these arrangements have been under consideration the station at Geneiri has been on a care and maintenance basis. It is of considerable interest that during 1950 the mean weights of the men and women of Geneiri village have fallen from the highest values found in the three years to the same lowest value recorded in the autumn of 1947, when a third of the villagers had nutritional oedema.

111. In his work on nutrition in East Africa before the war, Professor Platt endeavoured to secure the improvement of food supplies—in the Nyasaland work by control of headwaters, and by the introduction of fish and new crops of many kinds. Likewise in the Gambia field work emphasis was placed on the paramount importance of better agriculture. This emphasis is being retained in plans for the future work at Geneiri and in the neighbouring villages. Arrangements are under consideration for continuation of the work of Dr. R. A. Webb, who, as a member of the staff of the Human Nutrition Research Unit, has made important observations on the amounts and interrelationships of nutriments in Gambian soils and their limiting effect on crop production. It has been clear from the work at Geneiri that agricultural science has so far to go in the solution of problems of crop production in parts of the tropics of which the Gambia is more or less typical, that substantial progress in the application of the results of the science of nutrition must be held up for some time to come.

112. Dr. I. A. MacGregor, with the help of Dr. D. A. Smith of the Department of Nutrition of the London School of Hygiene, has continued the medical surveys at Kenaba, West Kiang, and the study of the effects on the health and nutrition of the population of the elimination of insect vectors of disease by spraying with insecticides. New and interesting observations have been made and the results of the spraying are most encouraging. With the co-operation of the Gambia Medical Department the spraying and observations are being extended to other villages.

113. Much of the malnutrition seen in the Gambia is in infants and children, and might be included in the clinical picture frequently called "Kwashiorkor". Drs. Waterlow and Walters have continued to study the pathology of the liver and the clinical course of this condition as seen in the Gambia. Two features are noteworthy—the comparative rarity with which fatty liver occurs, and the early age of occurrence, for many examples of the disease occur in the breast-fed infant. Dr. Waterlow has recently gone to Jamaica under Medical Research Council auspices to continue his work on conditions of this kind in children.

114. Professor Platt has recently made some new observations on the behaviour of breast-milk in the stomachs of the human infant and suckling mammals. The whey proteins of the maternal milk may be of special importance in the nutrition of the young infant; their amount and nature in the milks of Gambian mothers are being investigated in relation to the prevalent infant malnutrition. At the same time, the role and control of the malarial parasite in the infant and mother and its contribution to ill-health are being investigated.

115. Following the thesis that shortage of proteins in the diet or disturbance of protein metabolism in disease may interfere with enzyme systems—as indicated in the work of Dr. Waterlow reported last year on the dependence of the levels of liver and plasma esterase on protein in the diet—Professor Platt has been investigating a possible anabolic function of esterases by determining the body's ability to acetylate sulphonamides. The effects of B-vitamins and of proteins in the diet on this acetylation mechanism are being investigated.

116. The station's ward, laboratory and domestic accommodation was increased soon after plans had been made for setting up the Field Research Station so as to provide facilities for research in fields other than nutrition. Dr. F. Hawking has taken advantage of these facilities recently for investigations of a new filaricidal compound. His work has proceeded smoothly and quickly, and more extensively than he had envisaged, since he has been able to make use of the goodwill of the Gambian towards the station staff and particularly to make good use of the preliminary surveys made by Dr. MacGregor on the prevalence of filariasis in the villagers of Kenaba.

Publications

PLATT, B. S.—(1950) " Enzymes, proteins, and malnutrition ". Leading Article in *Lancet*, **1**, 1002.—(1950) " Report on the work of the London School of Hygiene and Tropical Medicine, 1949–50, Department of Human Nutrition". p. 39.

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WATERLOW, J.—(1950) " Liver choline-esterase in malnourished infants ". *Lancet*, **1**, 908.—(1950) " Enzyme activity in the human liver in relation to malnutrition ". *Proc. XVIIIth International Physiological Congress, Copenhagen.*

Fiji

117. In 1949 Research Scheme No. R. 353 was made for £433, to provide the cost of a three-months' survey by Dr. Muriel Bell and Dr. Lucy Wills, of the incidence and distribution of the anaemias and of dental disease and its relation to diet. A comprehensive and very informative report of these investigations has recently been issued, and is summarised below.

118. The authors investigated as large a cross-section of the Fijian and Indian population as possible, taking in not only the hospitals, ante-natal and health clinics, maternity wards and dispensaries, but also the ordinary population in the coastal zone of towns and villages and certain villages remote from easy access to European foods or sea-fish. The examinations made included 1,000 for haemoglobin, 820 for serum-protein, in addition to a clinical examination of the skin, mouth, teeth, eyes, hair, bones, posture, muscle-tone and thyroid gland.

119. In brief, the clinical and laboratory data obtained indicated that anaemia was not widespread, that when found it was seldom extreme, and that it was usually confined to young Fijian children, Indian infants, or Indian women of child-bearing age. In almost half the children it appeared to be connected with septic infections of the skin. When extreme, the anaemia was associated also with hookworm infestation.

120. Serum protein was found unexpectedly to be high at all ages after 5 years; and further analysis revealed this to be associated with a high gamma-globulin. It was considered possible that some particular form of infection or multiple infections might account for this, and that it was not necessarily due to dietary factors. Further, it was considered that the magnificent physique of the adolescent and adult Fijian belied any suspicion that protein is grossly deficient in the Fijian diet. In contrast, it was considered that the provision of protein food when infants were weaned was inadequate and might predispose to much intercurrent infection that was the immediate cause of a high Fijian infant mortality. Evidence of widespread vitamin deficiencies was largely lacking. Dental defects were common, especially dental caries in the primary dentition, more so in Indian than in Fijian children. Goitre was found to be more widespread than had hitherto been recognised. The authors had perforce to limit their search to one coastal area. It occurred in 80 of 105 Indian girls examined, and in 24 of 31 Indian adults. It was found also in Indian boys and men, but the numbers of these examined were small. In Fijians the incidence was very much lower. Some evidence of hyperthyroidism and cretinism was noted. The authors suggest the desirability of a full survey of the iodine content of the food of the respective races in order to see if this will throw any light on the disparity in racial incidence.

Suggested remedial measures for all the above-mentioned manifestations of ill-health are set out at length; as also are the further investigations considered desirable.

Leprosy

Malaya

121. Dr. F. S. Airey has now established a research laboratory at the Sungei Buloh Leper Settlement near Kuala Lumpur, in the Federation of Malaya. It incorporates all the appropriate equipment and facilities of a research laboratory devoted to the study of leprosy. The proximity of the Institute for Medical Research has proved of great advantage to the investigations in hand, with its many specialist Divisions. The project has been welcomed and given enthusiastic support by the Government of the Federation.

122. In the autumn of 1950, Dr. Airey made a tour in India, visiting leprosy research workers and institutions, as a part of his preparation for the work envisaged. At Chingleput (Madras) he devoted his time to histopathology under Dr. R. G. Cochrane (Honorary Director of the Research Unit at the Government Lady Willingdon Leprosy Sanatorium), who has made a special study of the cutaneous lesions of leprosy. He was able to attend the Third All-India Leprosy Workers' Conference in Madras and so meet most of the Indian leprologists. In Bombay, Dr. V. R. Khanolkar (Director of Laboratories and Research at the Tata Memorial Hospital) explained his recent work on infection of the small cutaneous nerves in leprosy and made valuable suggestions as to the lines which might profitably be followed in continuing these investigations in Malaya. The Leprosy Research Department at the School of Tropical Medicine, Calcutta, directed by Dr. Dharmendra, was visited, and an excursion made to Kalimpong (Bengal) to permit a brief

examination of the racial variation of leprosy amongst the Tibetans, Butanese, Nepalis and others who congregate at the leprosy settlement there. On the outward journey to India, Dr. Airey visited the settlement at Singapore, and on his return journey, Rangoon, Bangkok and Penang. He was able to discuss the leprosy problem of Burma with the Special Leprosy Officer (Dr. Tha Saing) in Rangoon and to study the new proposal for epidemiological research in Thailand. Contacts were made which will be of enduring value, and already advantage is being taken of these connections for the interchange of information.

123. Clinical trials of thiacetazone (para-acetylaminobenzaldehyde thiosemicarbazone) are well advanced, having been started in July, 1950. Plans have been made for studying the possible synergistic effect of thiacetazone and diaminodiphenylsulphone when the two substances are administered together. Tests have commenced. Changes take place in *M. leprae* in response to sulphone therapy, and similar morphological alterations have been observed when thiacetazone is employed as the therapeutic agent. Study of these changes has been facilitated by fluorescence microscopy, a device which is likely to prove of value in tracing latent leprosy in contacts. A simple form of apparatus has been constructed and is now in use in the routine laboratory at the Settlement, so that the medical auxiliaries may carry out fluorescence tests on material which appears to contain few or no bacilli when ordinary staining methods are used.

124. Apart from the continued study of *M. leprae* in relation to fluorescence, most attention is now being directed to the histopathology of the various cutaneous manifestations of leprosy. Carefully documented work has only been possible since the early part of this year, and the period under review has been a time of preparation for the more systematic investigation which is now being undertaken on the skin and its appendages, which, many believe, hold some of the solutions to outstanding problems.

Nigeria

125. The following summary of other work on leprosy, not financed from Colonial Development and Welfare funds, has been contributed by Dr. John Lowe, M.R.C.P., Research Officer at the Uzuakoli Leprosy Settlement, East Nigeria, distinguished for his leprosy investigations in India and now an officer of the Nigeria Leprosy Service.

The Unit at Uzuakoli was formed late in 1947 to continue and extend the work on leprosy treatment already begun by Dr. T. F. Davey. Initiated by the British Empire Leprosy Relief Association, the Unit was taken over by the Nigerian Government, and has concentrated on the treatment of leprosy by modern chemotherapeutic methods. The present report summarises the investigations made during a period of three and a half years, up to April, 1951.

126. The first phase was to study and assess the value of sulphone treatment which had been favourably reported on by some American and British workers, but about which opinion was still very divided. The intensive study made here of this treatment in cases now numbering over six hundred, for periods extending to five years, has, it is believed, contributed materially to the now generally accepted view that sulphone treatment is a great advance. Contrary to the views previously expressed by some workers, it is found to be well tolerated, and to be effective in all stages and clinical forms of the active disease. Studies of different complex proprietary sulphones did not show any one to be definitely superior to the others.

127. The second phase was to attempt to develop a simple, cheap and effective form of sulphone treatment suitable for wide use in countries such as Nigeria, with little medical supervision, and laboratory control often impossible. Pharmacologists in the United States of America had surmised that complex sulphones probably act by liberating in the body the parent substance, diaminodiphenylsulphone (D.A.D.P.S.), but had also reported that D.A.D.P.S. was too toxic for administration to human beings. It had, however, been suggested by a British worker that small doses given by injection might be tolerated and effective. The Unit studied this question very carefully from the pharmacological, biochemical and clinical aspects. Strong evidence was obtained that the complex sulphones liberate D.A.D.P.S. in the body and probably owe their activity to this fact. The idea that D.A.D.P.S. was too toxic to be given to man was found to be quite erroneous, for the therapeutic dose was found to be very small and was well tolerated; moreover it was quite unnecessary to give it by injection, for its absorption after oral administration was almost complete. A method of treatment by the daily oral administration of small doses of D.A.D.P.S. was worked out and applied in 200 cases for eighteen months; certain toxic effects were encountered but were diminished or prevented by a reduction in dose without loss of efficacy. The results were good.

128. The next phase was to make the treatment still simpler, safer, and more widely applicable; this was done by demonstrating the efficacy of less frequent administration, twice a week instead of daily, with a further reduction of dosage, toxic effects and cost. This work led to the mass treatment of leprosy with D.A.D.P.S. now being applied by the Nigeria Leprosy Service; this work has now been proceeding for ten months, and the number of patients has risen to about 20,000. As was inevitable with work on this scale developing so rapidly, and being carried on largely by unqualified staff, teething troubles occurred, but the success of this great experiment now seems assured. The method used is the twice-weekly giving of doses rising from 100 mg. in the first few weeks to 400 mg. in the third month. A very gradual induction of treatment is of paramount importance. The cost of the treatment is about seven shillings a year per patient. Experiments with once-weekly treatment by doses rising to 600 mg. are now in progress.

129. Other sulphones studied in addition to D.A.D.P.S. have included promin, diasone, sulphetrone, hydroxy-ethyl sulphone, and 2196 of I.C.I. None has been found more effective than D.A.D.P.S.; some of them are less effective, and all are more difficult to give, and more costly.

Different methods of giving sulphones have been investigated.

130. Other therapeutic agents studied have included para-aminosalicylate (PAS), streptomycin, and thiacetazone (a thiosemicarbazone). PAS was found of little value; streptomycin appears of value in some cases, but high cost and toxic effects are big drawbacks. Thiacetazone is definitely promising, but toxic effects, including agranulocytosis (seen in one of 65 cases), are troublesome. It apparently cannot be used, as D.A.D.P.S. is used, with little medical and no laboratory supervision. An attempt to give combined D.A.D.P.S.-thiacetazone treatment was abandoned because of toxic effects.

131. Most patients discharged after sulphone treatment come for periodic examination. Observations now cover three years. Out of nearly 100 discharged patients, relapses so far number only four. They are very slight, and respond to resumed treatment. The work of the Unit is described in detail in the following papers already published or now in the press. Further reports are in preparation.

Publications

LOWE, J.—(1950) " Treatment of leprosy with diaminodiphenylsulphone by mouth." *Lancet*, **1**, 145.—(1951) " Diaminodiphenylsulphone in the treatment of leprosy." *Lancet*, **1**, 18.

The East African Bureau of Research in Medicine and Hygiene, Nairobi, Kenya

132. The administration of the East African Bureau of Research in Medicine and Hygiene was greatly facilitated by the occupation in July of a new office situated in the grounds of the Medical Research Laboratory, Nairobi. In March the Director, Dr. K. A. T. Martin, went to London by air for the purpose of discussions at the Colonial Office on revised schemes for the East African Medical Survey and the Filariasis Research Unit. At the same time the opportunity was taken of discussing research problems in East Africa with the Secretary of the Medical Research Council and members of the Colonial Medical Research Committee. In addition to periodic visits to the medical research organisations in East Africa which come under the aegis of the East Africa High Commission, the Director attended the Conference on Malaria sponsored by the World Health Organisation, and also took part in the annual Conference of Directors of Medical Services. Closer liaison has been made with similar research organisations elsewhere in Africa, and information of value has been exchanged on medical research.

133. The medical research organisations in East Africa which are now administered by the East Africa High Commission are, the East African Virus Research Institute at Entebbe; the Filariasis Research Unit at Mwanza in Tanganyika; the East African Malaria Unit at Muheza in Tanganyika; the East African Medical Survey also at Mwanza; a research unit on the bionomics of ticks in Kenya; and that of the Inter-territorial Leprologist. The staff of the first two was at full strength by the end of the year, but, in the case of the Malaria and Medical Survey Units, vacancies still existed. The physical difficulties which were encountered by the integrated Filariasis Unit and the Medical Survey, in regard to housing and laboratory accommodation, are now in sight of being overcome. The proposal to transfer the East African Malaria Unit to the vacated Agricultural Institute at Amani was confirmed at the end of the year, and in many ways will be most valuable. Details of the progress of these organisations will be found in the respective sections. Work of great value in respect of the public health is proceeding; and will widen with the improvement of facilities. Considerable scope still exists for further research bearing on the public health, and several projected investigations have been under consideration. Great importance is attached to the conduct of the Medical Survey on the widest possible basis, from which results may derive of significance and importance in respect not only of evaluation of disease and morbidity, but also in the application of appropriate preventive measures. The extent and scope of medical research problems in East Africa is considerable, and that much remains to be done from which results could be applied with benefit to the general health has been indicated in a detailed report submitted by the Director of the Bureau to the Committee.

Provision of a Medical Library in Fiji

134. In 1947 the Fiji and Western Pacific Research Council endorsed a proposal submitted by the Inspector-General, South Pacific Health Service, for a grant of £3,650 to be made from research funds, provided by the Colonial Development and Welfare Acts, to cover the cost of the establishment of a central medical research library in Suva for Fiji and the Western Pacific High

Commission territories. The recommendation was supported by the Government of Fiji. The Colonial Medical Research Committee recommended that this grant be given, and Research Scheme No. 287 was made for the purpose, on the understanding that, at the end of two years, recurrent expenditure in connection with the library would be wholly met from the funds of the Government of Fiji. This Government now reports that the Medical Research Library was initiated in 1949; that many text and reference books have been purchased, and current medical journals provided; that it has been greatly appreciated both by students in training and officers of the Medical Department; and that the temporary Librarian, who is a Bachelor of Arts, and possesses a Diploma in Education, received three months practical training in medical libraries of the United Kingdom, while on leave.

RESEARCH WORK UNDERTAKEN AND FINANCED BY THE MEDICAL DEPARTMENTS OF COLONIAL TERRITORIES

135. A suggestion was made by the Colonial Office that future reports of the Specialist Advisory Committees should include reference to research being carried out in Colonial Territories in addition to that financed from Colonial Development and Welfare Research funds. The Colonial Governments were advised accordingly and asked to supply any relevant information. A considerable volume of material has been received; it is not possible to include it in full in a necessarily restricted report of this nature. The account which follows is therefore confined to selected items that illustrate the fields of medical investigation that are being explored.

Federation of Malaya

136. The Director of the Institute for Medical Research, Kuala Lumpur, (Dr. J. W. Field), has furnished a brief summary of the activities of the Institute during the year under review. From this summary, excerpts pertaining to filariasis and to malaria (other than the particular malaria control schemes financed from Colonial Development and Welfare funds) have been given earlier in this Report in their appropriate context. Other investigations noted by Dr. Field are as follows:—

Nutrition

137. Dietary and economic surveys of racial and social groups in Malaya have continued in the Division of Nutrition. A report on this important work, already distributed in mimeographed form, is soon to be published. An interesting finding has emerged from feeding experiments in Malacca. An oral syndrome clinically suggesting a deficiency of riboflavin, a member of the B2 vitamin complex, has been recognised in persons whose diet was rich in this vitamin. The explanation of this anomalous finding is not yet clear. Early in the year a start was made with a haematological survey which aims to define the anaemia problem in Malaya. Miss Cheek has examined 1,000 or so persons so far, including Malays, Tamils, and Senoi and Negrito-Senoi aborigines. Contrary to the prevailing view the incidence of macrocytic nutritional anaemia was comparatively low in the groups observed.

Pathology

138. Towards the end of 1949 the scope of the Division of Pathology was extended to include a small section for virus studies. Hospitals are beginning to use the facilities for diagnosis in virus disease which are slowly being developed. A promising laboratory test for smallpox, based on the well-known principle of haemagglutination-inhibition, has been developed. A change in

the technique of preparing canine rabies vaccine, using the Flury strain of virus, is under trial. Work on haemagglutination using tuberculin-sensitised cells has been undertaken with a view to assessing its diagnostic and prognostic value in early and active cases of tuberculosis. Rapid methods of growing tubercle bacilli in culture media and in the chorio-allantoic membrane are under trial at the Perak branch of the Institute.

Bacteriology

139. The use of streptomycin for the destruction of gas-forming anaerobic bacteria in vaccine lymph is under trial. The preliminary results are encouraging The in vitro effects of the antibiotics Chloromycetin and Aureomycin on *Leptospira* are being studied. Chloromycetin inhibited growth at a concentration of 80 micrograms per cc, a level which may be attained in the plasma by oral treatment.

The United States Army Scrub-Typhus Research Unit

140. A third Unit from the Virus and Rickettsial Diseases' Division of the United States Army Medical Department Research and Graduate School, Washington, was attached to the Institute between February and July. Circumstances restricted the ground the team was able to cover in a wide programme of research which included trials of the new antibiotic Terramycin in typhus fever, Aureomycin in amoebic dysentery, combined treatment with Cortisone and Chloromycetin in typhoid fever, the immunity response after induced typhus infection and the recovery of rickettsiae from a variety of forest mites and hosts. This liaison with American workers is a most welcome development in post-war research policy. (For a more detailed summary, see paragraph 103).

Trinidad

141. The Medical Superintendent of the Caribbean Medical Centre, Port of Spain, reports that claims for the success of streptomycin in the treatment of granuloma inguinale were amply confirmed when a series of 77 cases of this disease was treated at the Centre. The patients comprised 41 males and 36 females; each received a total of 20 gm., spread over a period of 15 days. Only in one instance did severe toxic reactions develop; treatment had to be curtailed after the patient had received a total of 8 gm. The table below shows the state of all patients on 31st December, 1950:—

Healed	51
Delinquent	12
Observation as yet less than 1 month after completion of treatment	6
Malignant change	8

The cost of the treatment was $20·20 per patient.

Jamaica

142. From the Faculty of Medicine of the University College of the West Indies it is reported that research work is in progress on the growth of Jamaican children and its relation to nutrition (Professor I. F. S. Mackay and Dr. F. J. Patrick), and on a study of Arawak skeletal remains (Professor W. F. Harper).

Hong Kong

143. From the Faculty of Medicine of the University it is reported that investigations have included the therapeutic use of radioactive cobalt, and studies on leprosy, tuberculosis and hepatic diseases.

Northern Rhodesia

144. From this Territory it is reported that extensive use is being made of diaminodiphenylsulphone in the treatment of leprosy, with results that are encouraging so far.

Kenya

145. From the Division of Insect-Borne Diseases, Dr. R. B. Heisch and Dr. W. E. Grainger report the discovery of numerous *Ornithodoros moubata* in large burrows in three areas of Kenya Colony many hundreds of miles apart. This tick is essentially a human parasite, frequenting native huts, rest-houses and camp-sites for travellers; but earlier reports had recorded that it had been found in the burrows of the wart-hog and in pigsties. A search of these three areas, almost uninhabited, revealed large numbers of adults and nymphs, most of them in the corridors of the burrows, of which porcupines were the usual inhabitants. Examination of the brains of 4 porcupines for *Spirochaeta duttoni* was negative. From small burrows, inhabited by pygmy gerbils (*Dipodillus sp.*), *O. erraticus* was recovered; and from these ticks and the gerbils another type of spirochaete was obtained. Investigations are now proceeding to attempt to establish it under laboratory conditions in *O. moubata*; and, if this is successful, to study any change in pathogenicity that might occur.

Committee for Colonial Agricultural, Animal Health and Forestry Research Sixth Annual Report (1950-1951)

Ministry of Food,
Dean Bradley House,
Horseferry Road,
London, S.W.1.
15*th June*, 1951

SIR,

I have the honour, on behalf of the Committee for Colonial Agriculture, Animal Health and Forestry Research, to transmit to you the Sixth Annual Report of the Committee covering the period 1st April, 1950 to 31st March, 1951.

I have the honour to be,

Sir,

Your most obedient servant,

(Sgd.) NORMAN C. WRIGHT
(Chairman).

The Right Honourable James Griffiths, M.P.,
Secretary of State for the Colonies.

COMMITTEE FOR COLONIAL AGRICULTURAL, ANIMAL HEALTH AND FORESTRY RESEARCH.

Membership

DR. NORMAN C. WRIGHT, M.A., D.Sc., Ph.D., Chief Scientific Adviser to the Ministry of Food (*Chairman*).

SIR EDWARD SALISBURY, C.B.E., D.Sc., Sec. R.S., Director, Royal Botanic Gardens, Kew (*Vice-Chairman*).

DR. G. D. H. BELL, Ph.D., Director, Plant Breeding Station, Cambridge University.

PROFESSOR W. I. B. BEVERIDGE, M.A., D.V.Sc., Professor of Animal Pathology, Cambridge University.

DR. J. CARMICHAEL, C.M.G., D.Sc., M.R.C.V.S., Dip. Bact., Veterinary Research Division, May and Baker, Limited.

PROFESSOR H. G. CHAMPION, C.I.E., D.Sc., Professor of Forestry, Oxford University.

DR. E. E. CHEESMAN, D.Sc., A.R.C.S., Senior Principal Scientific Officer, Agricultural Research Council.

SIR GEOFFREY CLAY, K.C.M.G., O.B.E., M.C., Adviser to the Secretary of State on Agriculture.

MR. F. S. COLLIER, C.B.E., Adviser to the Secretary of State on Forestry.

SIR FRANK ENGLEDOW, C.M.G., M.A., B.Sc., F.R.S., Drapers' Professor of Agriculture, Cambridge University.

DR. W. J. HALL, C.M.G., M.C., D.Sc., Director, Commonwealth Institute of Entomology.

PROFESSOR J. W. MUNRO, C.B.E., D.Sc., Professor of Zoology and Applied Entomology in the University of London.

SIR WILLIAM OGG, M.A., Ph.D., Director, Rothamsted Experimental Station.

SIR RAYMOND PRIESTLEY, M.C., M.A., D.Sc., LL.D., Principal and Vice-Chancellor, Birmingham University.

MR. R. J. SIMMONS, C.B.E., M.R.C.V.S., Adviser to the Secretary of State on Animal Health.

SIR WILLIAM SLATER, K.B.E., D.Sc., F.R.I.C., Secretary, Agricultural Research Council.

SIR JOHN SIMONSEN, D.Sc., F.R.S., Director of Colonial Products Research.

DR. S. P. WILTSHIRE, M.A., D.Sc., Director, Commonwealth Mycological Institute.

DR. G. A. C. HERKLOTS (*Secretary*).

MR. P. J. KITCATT (*Assistant Secretary*).

Terms of Reference

The terms of reference of the Committee are as follows:

(*a*) To determine, in consultation as necessary with the Colonial Advisory Council of Agriculture, Animal Health and Forestry, the matters in these fields of science in which research is required to be carried out in or for the Colonial Empire to assess their relative importance and urgency and to advise on the general policy for such research.

(*b*) To advise on the actual provision required for such research in or for the Colonial Empire, whether in Colonial territories themselves or elsewhere, and on the scope and functions of regional and other research institutions in the Colonial Empire.

(*c*) To keep under review, and comment upon, the course of research in these fields.

(*d*) To keep under review the arrangements for the publication and dissemination of technical and scientific information required for, or arising in the course of, research in these fields, and to make such recommendations as may be appropriate from time to time.

(*e*) To advise, in consultation with the Advisory Council, on the best means of making available the results of research for the development and improvement of agriculture, animal health and forestry in the Colonial Empire.

(*f*) To advise on the recruitment, training and terms of employment of the Government scientific personnel required for agricultural, animal health and forestry research in or for the Colonial Empire in collaboration, so far as may be desirable and necessary, with the Advisory Council and the Colonial Service Department of the Colonial Office.

COMMITTEE FOR COLONIAL AGRICULTURAL, ANIMAL HEALTH AND FORESTRY RESEARCH.

SIXTH ANNUAL REPORT

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COMMITTEE FOR COLONIAL AGRICULTURAL, ANIMAL HEALTH AND FORESTRY RESEARCH

SIXTH ANNUAL REPORT

I. GENERAL

Sir Raymond Priestley, Principal and Vice-Chancellor of the University of Birmingham and Chairman of the Governing Body of the Imperial College of Tropical Agriculture, Trinidad, was appointed a member of the Committee in October, 1950. Mr. W. A. Robertson retired from the post of Forestry Adviser to the Secretary of State and has been succeeded by Mr. F. S. Collier, formerly Chief Conservator of Forests, Nigeria, who took his place on the Committee. The Committee wish to place on record their appreciation of the services rendered by Mr. Robertson, the first holder of the post of Forestry Adviser, who had been a member of the Committee since its inception.

2. During the year 1950–51 the Committee held four meetings. The activities of the Standing Sub-Committees, covering research on cocoa,stored products and soils, are recorded in their separate reports which appear in later sections.

3. The Committee desire to record their appreciation of the valuable advice which has been made available to them by the members of the Sub-Committees and of the various informal consultative panels, which include specialists in a number of fields who are not members of the Committee.

4. Several members of the Committee have paid visits to the different colonial territories during the year. Sir Geoffrey Clay, Sir Raymond Priestley, Mr. Robertson, Mr. Simmons and Sir John Simonsen went to the West Indies and British territories in the Caribbean; Dr. Carmichael, Sir Geoffrey Clay, Mr. Simmons and Dr. Wright visited East Africa; and Sir Geoffrey Clay spent a short time in the Aden Protectorate.

5. Owing to the increasing heavy commitments on the funds which it had been possible to allocate for research from those provided under the Colonial Development and Welfare Acts the Secretary of State decided in October that the balance available (at that time approximately £4,700,000) should be apportioned between the various fields of research. The Colonial Research Council were asked to advise on the apportionments and recommended that £1,300,000 should be allocated for agricultural, animal health and forestry research. The Committee have given preliminary consideration to a list of those research schemes now in being for which additional sums would be required and of new schemes which were considered in principle to be deserving of assistance, with a view to deciding the order of priorities and how the money could be best allocated.

6. The introduction of the Colonial Superannuation Scheme, with effect from the 1st January, 1951, has made it possible for consideration to be given to the transfer of research workers and specialist officers to the Colonial Research Service.

7. Under Marshall Aid technical assistance to the Colonies has taken three forms, namely, (i) missions by United States experts to the Colonies, (ii) missions by Colonial experts to the United States and (iii) engagement of United States technicians and scientists for periods varying between six months to two years for work on selected research and development projects which have an economic end and are susceptible of completion, at least in part, by the date on which Marshall Aid generally is expected to cease. Projects completed or in effective operation under (i) and (ii) have included visits to

East, Central and West Africa by American experts to study in what directions colonial needs could be aided by Economic Co-operation Administration technical assistance, in public health, insecticides, agriculture and livestock and visits by experts from the Colonies to study the processing, production and marketability of tropical timbers. Under (iii), thirteen colonial agricultural, veterinary and forestry projects have been approved by the Economic Co-operation Administration, of which three have been successfully completed, one is in progress, while nine await the recruitment of suitable personnel: further projects are under consideration. A high proportion of these projects have been recommended as a result of the missions referred to under (i) above.

8. One of the more notable events of the year was the holding of a Review Conference in London during June to survey the work of the Commonwealth Agricultural Bureaux Organization. The conference was attended by a large number of delegates from the British Commonwealth and Empire, and included visits to the Commonwealth Institute of Entomology, the Commonwealth Mycological Institute and the various Bureaux. The discussions, in which the colonial delegation took a prominent part, were chiefly concerned with the services which the organization had been able to give to the Commonwealth and Empire during the last five years and with the ways in which those services could be expanded and improved. The delegates were unanimous in their praise of the unique and valuable functions which the organization fulfilled, and it is to be sincerely hoped that the countries contributing financially towards its maintenance will find it possible to provide the funds necessary for its work during the next five-year period 1952–53 to 1956–57, and that all Colonial Governments will avail themselves fully of the facilities which it is able and only too willing to give.

II. REGIONAL AGRICULTURAL RESEARCH

(a) *EAST AFRICA*

The East African Agriculture and Forestry Research Organization

9. The headquarters of the East African Agriculture and Forestry Research Organization have been transferred from Amani to Muguga near Nairobi. The building programme is well advanced, the roads are nearing completion, fifteen European houses have been built and others are nearly finished as are also the library and laboratories. The building of the East African herbarium wing of the Coryndon Memorial Museum was completed in May 1950, and the Amani herbarium of more than 60,000 sheets was transferred there in the autumn; the task of integrating the Coryndon Museum herbarium of some 20,000 sheets with the Amani collection has been begun. Work is proceeding on the laboratories for the Ecology Training Scheme and early in 1951 building commenced on the Animal Husbandry Division, a joint responsibility with the East African Veterinary Research Organization.

10. Tentative conclusions have been reached after three years of fertilizer trials. In seasons of adequate rainfall the lighter soils show satisfactory responses to nitrogenous manures. The heavier soils are more complex in their behaviour and no clear-cut generalizations can be made. On those soils that do show a response to phosphatic manuring, the best economic response is obtained from smaller dressings than those used in the experiments which consisted of triple super 0·96, "soda-phosphate" 2·08 cwt./acre. The evidence tends to support earlier tentative conclusions that the application of phosphates for several years in succession enables a reserve to be built up in the soil which results in marked responses to phosphate fertilizer in contrast to no or little response to these fertilizers in the initial years.

11. An important relation has been shown to exist between calcium and phosphorus in the soil system. The percentage saturation of the base-exchange-capacity of the soil appears to be inversely related both to the phosphate fixing capacity of the soil and to the response of the crop to phosphate manuring. If this clear-cut relation can be shown to hold generally, it is evident that a big step will have been made in an understanding of the manuring of tropical and sub-tropical soils. For maize the importance of a correct nitrogen/phosphate balance in plant growth and yield has been established. Phosphate uptake increases with growth and during maturation of the grain, but the amount taken up is controlled mainly by the concentration of the available phosphorous around the plant roots. The uptake of nitrogen also increases with growth until the grain is set, when the demand rapidly decreases.

12. The breeding of cassava has been continued. Results show that it is justifiable to give increased attention to high-yielding clones that are tolerant to mosaic rather than to clones that are resistant, which has been the aim in the past. It is important to have these clones in case the mosaic-resistant clones which have been bred should break down ultimately. Distribution of selected varieties to the territorial Agricultural Departments is now being increased.

13. It is quite clear that the rosette disease of groundnuts is the most important of the virus diseases of this plant and, therefore, most attention has been given to it. It is known to cause heavy losses in most areas of Africa. In the Urambo area of Tanganyika it has been shown that this virus is carried over the dry season to the next growing season by volunteer plants from missed seeds of the previous harvest. Work with systemic insecticides has been carried out. The experiments showed that virus-carrying aphids, although infecting the systemic-treated plant with rosette disease, were killed by the insecticide. Thus, although initial infection is not prevented, the secondary spread, due to the travel of the colonies developed at the initial centres, no longer takes place.

14. The investigation of the canker disease of Cypresses on Mount Kenya has shown that *Cypressus macrocarpa* is much more susceptible than *C. lusitanica.* There is probably a morphological or histological reason for this difference and experiments are being carried out to determine this. When all infected *C. macrocarpa* trees are removed there is a marked fall in the number of new infections of *C. lusitanica.* This is a strong reason for abandoning the cultivation of *C. macrocarpa.*

15. An important and unexpected relation has emerged between the clove and the coconut crops of Zanzibar. Damage to coconut female flowers caused by a coreid bug is less in areas that adjoin the clove-tree nests of the ant *Oecophylla longinoda* than elsewhere, because the ant is probably a predator of the bug. Should a mass destruction of the ants' nests be carried out, it is clear that some additional action must be taken to protect the coconut crop.

16. The work at Zanzibar on research into the sudden-death disease of the clove trees has continued. It now seems certain that the disease is not the product of a unique cause, but the reasonably uniform symptom-expression of more than one cause. A high proportion of the deaths, in the sudden-death manner, of young clove trees is caused by a new and unpublished species of *Cryptosporella*, this fungus being also responsible for a high proportion of dieback in mature trees. Mature trees dying of sudden-death are found, almost invariably, to be infected with a new and unpublished species of *Valsa* which appears to enter through the roots. This fungus, as a wound parasite, causes some dieback in mature trees. Experimental proof of the pathogenicity of *Cryptosporella* has been obtained and work on *Valsa* is in hand.

The East African Veterinary Research Organization

17. The Committee considered the reports of Mr. Simmons, Dr. Carmichael and Mr. G. A. Atksinson, Colonial Building Liaison Officer, following their visit to East Africa to advise on the capital sum required for the construction and equipment of an Animal Diseases Section and a Biological Production Section for the East African Veterinary Research Organization at Muguga North. On their recommendation a Colonial Development and Welfare Research grant of £263,000 was made available to finance this and it was noted with approval that it was the intention of the East African High Commission that the production of biologicals should revert to the Organization as soon as it was in a position to resume responsibility.

18. It is anticipated that the construction and equipping of the new centre will be completed late in 1952. During the interim period accommodation for the present limited staff is being generously provided by the Kenya Government at the Veterinary Research Laboratory, Kabete. Until the transfer has been made it will not be possible to expand the programme of research. When Muguga North has been established it has been agreed that the Organization will carry out fundamental research on major disease problems common to both East and West Africa. The establishment at Muguga, in close association with the Organization, of an African Bureau of Epizootic Diseases will facilitate this.

19. During the year under review Mr. H. R. Binns was appointed Director. Recruitment towards the agreed establishment has ceased pending the transfer to Muguga North but with the creation in 1951 of a joint Animal Husbandry Division with the East African Agriculture and Forestry Research Organization recruitment in this field will be possible.

20. Research on animal trypanosomiasis and particularly on antrycide has been carried out under the joint East African Tsetse and Trypanosomiasis Research and Reclamation Organization and East African Veterinary Research Organization scheme, the field work being conducted at Mariakani where studies on short interval administration of the drug to cattle exposed to light tsetse infection are being made. The development of drug-fastness by trypanosomes, the pathology of bovine trypanosomiasis and the mechanism of antrycide prophylaxis in laboratory animals have been investigated at the laboratory. Research on East Coast fever was resumed at the beginning of the year and has included a study of the lymphoid tissue changes and blood picture in fatal and non-fatal infections; the collection of tissues at various stages of the disease for investigating pathogenesis and mechanism of recovery; the duration of infectivity for ticks of recovering cattle and a field investigation of the incidence and morbidity of the disease in enzootic areas. Studies on ticks, made partly in conjunction with this East Coast fever research, comprised the establishment of breeding strains of a number of species and an investigation of normal anatomy and histology.

21. Research on lapinized rinderpest virus has been carried on and assistance given to the Kenya Department in the preparation of lapinized virus vaccine, which is being increasingly used with success on the more susceptible types of cattle in East Africa. Investigations, by various serological methods, have been made to develop an *in vitro* test for rinderpest virus—hitherto without real success. This work, which is obviously of great importance to the titration of vaccines, testing immunity and immunological studies of the disease will be unremittingly pursued.

22. Helminthology research has consisted of two main lines. First, the systematics and life-cycle of ruminant paramphistomes and the determination of their freshwater snail intermediate hosts, which work will be extended to the bovine Bilharzias. Secondly, the development and bionomics of the larvae of the common wireworms on pasture under a variety of local conditions, which should throw light on the epidemiology of parasitic gastritis in relation to climate in East Africa; these investigations will later include other Strongyloid larvae. The tuberculosis survey of the Southern Highlands Province of Tanganyika continued, the mobile laboratory and caravan unit working largely in the Iringa district, where nearly 15,000 cattle were tuberculin tested. About fourteen per cent. of adult and young stock in this district reacted to mammalian tuberculin, the rate being as high as forty per cent. in some areas. Observations showed that nearly all reactors would show lesions; that cattle show no clinical manifestations of the disease, while in pigs it is severe; that while the virulence of the organism appears to be low, there is no reason to believe that bovine tuberculosis will not spread in local stock and that the few strains hitherto typed were all bovine.

23. Animal nutrition research has comprised the following. Comparison of the digestibility of several different important grasses and at different stages of maturity; variation of digestibility and nutritive value of pastures throughout the year; nutritive value of fodder legumes and a survey of blood phosphorus of cattle in various areas of Kenya.

(b) *WEST AFRICA*

Appointment of a Secretary for West African Agricultural and Forestry Research

24. It was agreed that in place of appointing a Director of the projected West African Agriculture and Forestry Research Organization, it would be preferable to appoint a Secretary for Agricultural and Forestry Research in the first place with the following terms of reference: to carry out a general survey of the research needs of West Africa in the fields of Agriculture and Forestry; to determine to what extent these needs are being met by the research carried on by commodity research stations, territorial Agricultural and Forestry Departments, University Colleges and other local organizations; to assess in what measure the needs of West African agricultural and forestry research are being, or can be adequately catered for by research in progress elsewhere, e.g., in East Africa; and to make recommendations as to the manner in which those needs which are not covered can best be met and for any co-ordination that appears necessary or desirable. If the survey leads to the conclusion that it is desirable to set up a West African Agriculture and Forestry Research Organization on a regional basis, to formulate detailed proposals for consideration by the West African Governments and the Colonial Office.

Mr. D. Rhind, B.Sc., O.B.E., formerly Director of Agriculture, Ceylon, who had previously held the posts of Principal of the Agricultural College and Research Institute, Mandalay, and Senior Economic Botanist, Burma, was selected for the appointment of Secretary for Agricultural and Forestry Research, and took up his duties in February, 1951, being attached to the Office of the Chief Secretary of the West African Council.

25. With regard to the proposed West African Veterinary Research Organization, it has been decided to postpone its establishment and the appointment of a Director. This decision was made in view of the difficulty of obtaining an adequate supply of qualified veterinary scientists.

Oil Palm Research Station, Benin

26. For three years the station has been financed from a Research grant of £152,160, with concurrent expenditure from Development funds from the Nigerian allocation. In the period January, 1949, to the end of March, 1950, only £42,000 remained of the Research grant and the Nigerian Oil Palm Producers Marketing Board then undertook to continue the finance of the station, voting a sum of £530,608 which it was expected would cover expenditure for a further three years until 1951-52. The pathology and chemistry laboratories have been completed and good progress made with the physiology laboratory; offices and stores are also being built. The total area planted now amounts to 735 acres. The staff position has continued to be most difficult, on the research side only four out of eleven posts have been filled; in these circumstances the station has scarcely been able to function as a research centre.

27. An international conference on oil palm research was held at the station from December 3rd to 14th, 1949—Belgian, French and Dutch delegates participated as well as the station staff and representatives of commercial estates both in Africa and Malaya. Research at the station includes studies of the agronomy of the crop and its fertilizer requirements; a breeding programme with its main objective the elucidation of the genetic relations between *dura*, *tenera*, *pisifera* and their intermediates and crosses; studies of disease, including vascular wilt and cortical root rot of seedlings; and, in co-operation with the Colonial Microbiological Research Institute at Trinidad, the testing of oil palm fungous pathogens with antibiotics.

West African Cacao Research Institute, Tafo

28. The Institute came into being on the 1st April, 1944. In the Gold Coast Legislation, the West African Cacao Research Institute Ordinance, 1947, provides for the legal establishment of the Institute and of a statutory committee to control and administer it. In Nigeria, the Institute and Committee are given status and functions by the West African Cacao Research Institute (Nigerian Status) Ordinance, 1950. The Institute is financed partly from funds set aside by the former West African Cocoa Control Scheme and partly from capital grants provided by the Gold Coast and Nigerian Cocoa Marketing Boards. At Tafo, Gold Coast, where the laboratories are situated, the Institute possesses some nine hundred acres of land and, in addition, five sub-stations totalling one hundred and twenty acres are maintained.

29. The work at the Station includes investigations into the diseases and pests of cacao, the agronomy of the crop, the breeding of improved types and problems of cocoa fermentation. The study of swollen shoot disease is a prominent part of the disease investigations and includes research on the inter-relations and inter-actions of the virus complexes responsible for the disease, on aetiology, chemotherapy and host resistance. In connection with this study, the ecology of the insect vectors and their possible control by insecticidal and biological means are being studied. As a possible means of expediting disease control, the use of arboricides for the destruction of diseased cacao trees and of alternative host plants is under investigation. Other diseases, especially pod diseases, also are being studied. Of the insect pests which receive attention, capsid bugs claim priority. A satisfactory method of control of the pests on young cacao has been devised and the study of possible means of control in mature cacao is continuing.

30. Agronomical and horticultural work includes the elaboration of improved methods of vegetative propagation, in which marked success has been achieved, the study of various methods of establishing young seedling cacao in the

field, determination of the optimum spacing for West African and for introduced cacao types, study of problems of overhead shade, of rehabilitation of derelict cultivations and kindred problems.

31. The fermentation requirements of the various cacao types are being studied in laboratory and large-scale experiments, with the object of improving the quality of West African produce and also of devising techniques which will enable small samples of consistent quality to be prepared for flavour appraisal. Crop improvement is attempted by selection of high yielding types and their progeny and by the study of the performance and quality of introduced types. A long-term programme of plant breeding is now being implemented.

(c) *WEST INDIES*

32. The Imperial College of Tropical Agriculture, Trinidad, celebrated its twenty-fifth anniversary in March, 1951. The development of the College as the regional research centre for agriculture and forestry in the British Caribbean area has received a new impetus following the recommendations made by Sir Geoffrey Clay in a report which he presented on his return from a visit to this region. A major step had already been taken by the establishment there of four British West Indian Research Schemes for bananas, cocoa, soils and sugar technology, to which reference was made in last year's report.

Banana Research

33. The percentage of fertile stems for the period under review has increased from 58 to 74·8 per cent. This is probably due to the fact that all pollinations are now made much earlier in the day than in the past; they are completed before 10 a.m. Evidence shows that the first three or four hands of a bunch are the most efficient seed producers.

34. The study of Panama disease in Jamaica by Dr. J. Rishbeth is proceeding along several lines. A survey is being made of plantations where the Gros Michel variety has been grown continuously for twenty years or more and is still virtually free from the disease, with a view to discovering the factors associated with this condition. Field experiments to investigate the effect on the incidence of Panama disease of adding to the soil various types of organic matter have been set up. Earlier field experiments suggested that addition of inorganic fertilisers to the soil gives little promise of controlling the disease; addition of nitrogen in fact tends to increase susceptibility to it. However, the changes of lime and potash status achieved in these experiments appear to have been too small to provide satisfactory evidence about possible effects on disease resistance, and therefore this line of enquiry has not been abandoned. Trenching after treatment with gas oil retards the spread of the disease and a new treatment for control of the spread of the disease is being tested whereby sheets cut from asphalt drums are used to encircle the diseased tree at a depth of two feet. The resistance of banana roots in different soils to infection by *Fusarium oxysporum cubense* is being tested by inoculation experiments.

Cocoa Research

35. Detailed information on the progress of the work is made public at the successive Cocoa Conferences arranged by the Cocoa, Chocolate and Confectionery Alliance and published in their reports. The 1950 report contained a paper by Dr. H. Evans " Report on Cocoa Investigation in Progress in Trinidad with a Summary of Results Achieved to Date ". Of the published papers the following are of especial interest: " Results of some Experiments on the Preservation of Cacao Seed in Viable Condition " H. Evans—*Tropical*

Agriculture XXVII, 1950, pages 48–55—and " Insect Transmission of Cacao Virus Disease in Trinidad " T. W. Kirkpatrick—*Bulletin of Entomological Research*, 1950, pages 99–117. Work has been proceeding for some time on new techniques for the rooting of stem cuttings and of leaf cuttings. This will shortly be published.

Soils Research

36. One of the lines of investigation is a study of the deterioration of soils on estates in which cacao has been growing over a period of years. This deterioration is partly a result of surface erosion and partly due to soil degradation brought about by diminishing leaf fall and the consequent decrease in organic matter content, and by a leaching and exhaustion by the plants of the soluble mineral constituents. The work suggests that minor element deficiencies, for example of iron, may be of significant importance in the nutrition of the cacao tree.

Sugar Technology

37. The progress in this field is recorded in the report of the Colonial Products Research Council.

III. INDIVIDUAL RESEARCH PROJECTS, UNDERTAKEN WITH ASSISTANCE FROM COLONIAL DEVELOPMENT AND WELFARE RESEARCH FUNDS

(a) *Termites*

38. The immediate objective of the Termite Research Unit is to study the systematics and geographical distribution of the termites of East Africa as a whole, together with the biology of certain selected species. Mr. W. V. Harris, Officer-in-Charge, has been paying particular attention to the termites of Kenya, whilst Miss P. B. Kemp, his first Scientific Officer, has been stationed at Amani in Tanganyika and has been studying the termites of that territory. Housing and laboratory accommodation are being provided at Muguga, and the headquarters of the Unit is being transferred there. Three papers have already been published, including one on the dry-wood termites, and a manual on the termites of East Africa is in preparation.

39. The Forest Products Research Laboratory of the Department of Scientific and Industrial Research, Princes Risborough, have been working on termite problems in relation to timber. Their recently published Bulletin No. 24 entitled " The Protection of Buildings and Timber against Termites " contains a number of references to the Colonies and to indigenous reputedly-resistant timbers.

(b) *Training of Ecologists*

40. Initial provision for this scheme was made early in 1950. Its purpose is the training of a number of suitably qualified men for the undertaking of large-scale ecological surveys in the Colonial territories, with a view to direct application to agricultural and forestry problems. Both primary surveys of whole regions and more detailed surveys of special areas are called for in many territories, and there is at present an acute shortage of personnel for the purpose. Following the recommendation of the Committee last year Mr. C. G. Trapnell has been seconded from the Agricultural Department of Northern Rhodesia as Officer-in-Charge of Ecological Training, and

is now based at the East African Agriculture and Forestry Research Organization's headquarters at Muguga. This centre offers the special advantages of close contact with the Organization's Soil Classification and Survey section and with the Herbarium and library facilities of the Coryndon Museum in Nairobi. Mr. Trapnell arrived at the end of November. Suitable laboratory and drawing-office accommodation is now under construction, as an extension of the Muguga laboratories, and preparatory work for the training surveys has been begun.

41. Students under this scheme will, in the first instance, be young graduates from the universities, who have received a period of special training in England before proceeding to East Africa. The training work carried out from Muguga will take the form of a series of field surveys in various parts of East Africa, with particular reference to areas of potential economic importance. Emphasis in the training course will be placed on large-scale vegetation survey coupled with soil reconnaissance, on air photograph investigation and type-mapping and on the study of land categories in relation to present and potential land usage. Pending the arrival of students a general reconnaissance is being made through the East African territories with a view to selecting areas for the training surveys.

(c) *Pool of Entomologists*

42. Reference was made in last year's report to the creation of a Pool of Entomologists at the Commonwealth Institute of Entomology, for investigation of *ad hoc* problems in the Colonies: unfortunately, owing to the difficulty of obtaining men of the experience and calibre required, it has not yet been possible to recruit the personnel.

(d) *Bio-geochemistry of Aluminium*

43. Dr. E. M. Chenery concluded his investigations at Rothamsted. He completed the survey of the occurrence of aluminium in the plant kingdom and found that very strong accumulators of this element were confined to twenty families and moderately strong accumulators to twenty-eight families. It should be recorded that this survey is the first bio-geochemical investigation to include every family of flowering plant and vascular cryptogam and also a large number of other cryptogams, about 10,000 qualitative tests being performed. Evidence was adduced to show that these families were ancient and/or senescent.

44. Aluminium accumulators are of world-wide distribution but they are concentrated in tropical rain-forests, where they often occur in pure stands, covering vast areas. Their ecological importance conceivably lies in their ability to fix large quantities of otherwise toxic aluminium and manganese. The effect of aluminous vegetation on soil-forming processes was studied in respect to podzolization. Contrary to the claims of Russian workers no effect was found.

45. Some physiological aspects of aluminium in plants were investigated, using the tea-bush as the study-plant. Aluminium accumulation takes place only in the leaves, increasing from about 100 p.p.m. in the flush to 10,000–20,000 p.p.m. in old leaves (oven dry basis). The maximum amount appears to depend on the genetic make-up of the bush and occurs in clones of the *cambodiensis* type. No relation was found between high aluminium content and sulphur "yellows" deficiency symptoms. The mobility of phosphate within the tea-bush was not affected by the presence of large amounts of aluminium. Some indications were obtained that aluminium in the tea-bush might protect the leaf tissue from toxic manganese. The limit of availability of aluminium in the soil was found to occur at the same pH value as the limit for successful tea

cultivation. This suggests that aluminium may be an essential element and that unhealthy tea-bushes growing in soils which are too alkaline, such as kraal, hut, fire and ant-hill sites, might be cheaply cured by spraying with aluminium salts. Dr. Chenery has already initiated aluminium spraying experiments in Uganda where excessive soil alkalinity is a common feature in tea gardens.

46. The interesting correlation between aluminium content and flower colour changes established by Dr. Chenery in his studies of hydrangeas sixteen years ago was advanced by the finding that the Asiatic shrub *Dichroa febrifuga* also produced blue flowers with high aluminium content and pink flowers with low.

(e) *Flora of East Africa*

47. By arrangements with the Royal Botanic Gardens, Kew, and with the co-operation of the East African Agriculture and Forestry Research Organization, additional botanists have been appointed to work at Kew and in Africa on the Flora of East Africa. It is expected that publication will extend over a period of five years; the first part, Ranunculaceae, is now in the press.

(f) *Flora of West Africa*

48. The " Flora of West Tropical Africa " by J. Hutchinson and J. M. Dalziel, published 1927–36, is now out of print. The West African Governments and the Director of the Royal Botanic Gardens, Kew, have been consulted and an arrangement has been made whereby Mr. R. W. J. Keay, Botanist to the Forestry Department, Nigeria, is to be attached for two years to the Royal Botanic Gardens in order to undertake a revision of this work.

(g) *Studentships*

49. With the increase in emphasis that has been put on research, especially at regional centres, there is a need for highly trained junior research workers. An honours graduate straight from university is not qualified to undertake fundamental research until he has had one or two years' further training in research methods under the right leader and in the right environment. It is to provide this specialized training that schemes have been made to meet the cost of six post-graduate studentships for agricultural research and eight for veterinary research.

(h) *Cambridge Botanical Expedition to Nigeria*

50. In 1934–35 Professor Paul Richards organized and led a party which carried out research on the ecology of the tropical rain forests in Nigeria. The main object was to obtain data for a comparison of the vegetation and environment of West Africa and other tropical regions and most of the work done was of the nature of a reconnaissance. As a result of this expedition the need was appreciated for a further expedition to study the nature of the regeneration process in tropical forests and its bearing on the theory of the climatic climax. The expedition took place in 1947–48. It was largely financed by the Royal Society but it received a grant from research funds. A report has been submitted by Professor Paul Richards and the results of the expedition will be published as a series of papers.

(i) *British Honduras: Ecological Land-Use Survey*

51. The Committee have agreed that there is a need for an ecological land-use survey unit to operate in the Caribbean area as a whole for a considerable time. It has been recommended that provision for the establishment of such a unit should be made and that it should be based on the Imperial College of Tropical Agriculture, Trinidad, and commence its activities in British Honduras. Up to the present it has proved impossible to find a suitably qualified leader for this unit.

(j) *Northern Rhodesia: Agricultural Research*

52. On the recommendation of the Committee a scheme has been made providing £214,728 from the Colonial Development and Welfare research allocation to cover 100 per cent of the capital expenditure and 50 per cent of the recurrent costs for five years of inaugurating agricultural research in Northern Rhodesia. This will include provision for the establishment of a Central Research Station at Lusaka and sub-stations at Mumbwa, Mazabuka and Bangweulu. Attention will be paid in particular to the utilization of dambo soils in the Kafue Flats and Bangweulu Basin and the soil problems associated with shifting cultivation in the *Brachystegia* woodlands. Work will also be done on the breeding and selection of sorghums, groundnuts, wheat, maize and pulses; on the pests and diseases of crops; and on pastures.

(k) *Northern Rhodesia: Forestry Research*

53. A scheme has also been made for £20,700 to cover 30 per cent of the total estimated expenditure, over a five-year period, incurred in the establishment of forestry research centres at Choma and Bangweulu. At these centres the ecology of local woodlands will be intensively studied. For hundreds of years the natives have practised a system of shifting cultivation which involves the burning of patches of jungle prior to cultivation followed by a long period of bush fallow. It is these relict forest soils which will be studied. Also plantations will be established where exotic species of pines will be grown and studied statistically over a period of years with a view to determining which are most suited for cultivation on a large scale. This work is of prior importance due to the fact that Northern Rhodesia has no coniferous timbers and few indigenous hardwood trees which grow to a large size.

(l) *Arthropod Fauna of the Soil in East Africa*

54. Very little is known about the fauna of tropical soils, and a research scheme was established in order to allow Dr. George Salt, Lecturer in Zoology at the University of Cambridge, to apply to tropical soil some of the methods he has used in studying the soil fauna in England. A preliminary survey of the fauna of East African pastures showed the arthropod population to be in the order of forty thousand per square yard in the top six inches of soil, of which about half were acarines. This number is small in comparsion with the arthropod population of temperate soils, being less than half the number found in English pastures. The arthropod fauna under elephant grass, however, was much more numerous and included a larger proportion of Collenbola. It was therefore more like the fauna of English pasture, both in number and in composition. The fauna of cultivated soil, both fallow and under coffee or cassava, was extremely scanty.

55. These and other facts raise a number of questions about the influence of the fauna on tropical soil. Arthropods affect the production of humus, both directly by comminuting manure and litter, and indirectly by influencing the balance of fungal and bacterial decomposition. Through their physiological processes, they affect the chemistry of the soil; and by their movements and other activities, aerate the soil and possibly affect soil structure. The relative paucity of arthropods in East African soil may therefore be connected with, if it does not account for, some of its special characteristics. This preliminary survey shows that it will be necessary to take account of the soil fauna in future research on tropical soils.

IV. RESEARCH WORK UNDERTAKEN BY COLONIAL DEPARTMENTS OF AGRICULTURE, FORESTRY AND VETERINARY SERVICES

56. In last year's report there was included a section in which reference was made to research being carried out by the technical departments in the Colonies. In this report this section has been given fuller treatment but it still consists of a number of selected items and must not be interpreted as a summary of all the research work now being undertaken.

BRITISH GUIANA

Rice

57. Twelve of the remaining hybrids bred in 1943 have been selected for final testing in 1951. Introductions of new varieties have been made from Japan, Thailand, Malaya, Indonesia, Hong Kong and Ceylon with the object of evolving a variety suitable for mechanical cultivation by hybridisation with locally bred varieties which were produced for manual cultivation. Thirty-six successful crosses were made and the first generation has been sown. Investigations are continuing with a view to finding a successful crop to be grown in rotation with rice. Work continues to determine the most effective techniques for mechanical cultivation and harvesting of rice and for the control of " volunteer " and red rices. Manurial experiments have commenced and responses have been obtained to nitrogenous fertilizers.

Soils

58. Investigations continue into the causes of loss in fertility of the " pegasse " soils of the North-West District which occurs after three to five years of continuous cropping. Pot experiments have indicated probably acute deficiencies of nitrogen and phosphorus in exhausted " pegasse ". Two manurial experiments have been laid down, one on exhausted and the other on virgin " pegasse ". Laboratory investigations on samples of exhausted " pegasse " have indicated an absence of nitrates and very low nitrifying ability. Attempts are being made to determine whether lime, copper and manganese might restore nitrifying ability or whether a nitrate fertilizer would improve fertility. Investigations into the manuring of rice have indicated that nitrogen applied in the form of sulphate of ammonia to a transplanted crop in two doses each of one hundredweight of 20 per cent N at transplanting and again one month prior to flowering have given positive and economic responses. Laboratory determinations on samples of soil and irrigation water from experimental plots indicate that ammonia nitrogen is the form mainly utilised by rice in rice soils. Leaf analyses indicate that an application of sulphate of ammonia increases the uptake of phosphates. Also, there has been a greater concentration of nitrogen in leaves taken from plants six weeks after transplanting, which subsequently gave positive increases in yield after applications of sulphate of ammonia, when compared with controls.

Sugarcane

59. Importations of sugarcane varieties from the Barbados Cane Breeding Station have continued. Multiplication of these and previous importations have been carried out together with sorting trials. Variety trials with locally bred and imported varieties from Barbados have been continued. A total of sixty-seven varietal experiments were harvested in 1950, of which fourteen contained the new standard cane B.41227, a Barbados importation. Eleven

manurial trials were reaped during 1950 being designed mainly to test response to phosphatic fertilizers with and without heavy dressing of nitrogenous fertilizers. Observations continue on the effect of mechanical tillage. Results in 1950 were undoubtedly affected by the floods early in the year. A long dry season at the end of the year facilitated mechanical cultivation. Preliminary irrigation experiments have been carried out as well as experiments on the use of contact weedicides. Effective control of wild eddoe, *Caladium* sp., has been obtained by the use of weedicides and the pre-emergence control of sugarcane field weeds has been proved feasible but uneconomic. In November, 1950, a new disease of sugarcane provisionally identified as leaf scald disease caused by the bacterium *Xanthomonas albilineans* was reported. Research continues to enable the positive identification of the bacterium and to determine the degree of susceptibility of existing varieties to the disease. A Colony-wide survey of sugarcane areas is being carried out to determine the incidence on estates.

FEDERATION OF MALAYA

Cacao

60. A great deal of interest has been taken in this crop following the report by Dr. Cheesman after his tour in 1948/9 (Colonial No. 230). The Amelonado seed introduced from West Africa at the end of 1949 and planted in Pulau Tekong Isolation Nursery produced seedlings ready for distribution in April. Growth since planting has been generally vigorous. A careful watch has been kept for any sign of disease, insect attack or abnormality of growth. For diagnostic purposes the growth of cacao in nutrient solutions is being studied. One of the observations was that the plants thrive with a very low potash supply and do not tolerate excess of potash.

Oil Palm

61. Selection records have been continued at the Federal Experiment Station, Serdang, on all palms of interest. The dumpy family of palms has had special attention, being more or less uniform at the age of ten and a half years, with a girth of 9 ft. at 3 ft. above the ground and a height of 5ft. 6 ins. to the base of the lowest bunch. It is now considered that the dumpy character is not due to a single recessive factor although the palms are apparently homozygous in that respect. The large variation in yield and other fruiting characters has provided opportunity for further selection and breeding. Cross pollination has continued amongst selected dumpy and tall palms and nearly one hundred pedigree families are awaiting the provision of land for planting in progeny trials. The investigation of *tenera* type palms has been reopened, and selections have been made amongst existing *tenera* and *pisifera* palms for crossing with dumpy and normal tall palms.

Rice

62. The survey and collection of Malayan varieties of paddy has been continued for the purpose of systematic study and identifications. The collections are maintained at three stations in Perak, Malacca and Kelantan. Investigation of the perennial "Penyakit merah", a disease of scattered occurrence causing considerable loss of crop, has confirmed that it is physiological in origin and a resultant of unfavourable soil and water conditions. There has been evidence of varietal susceptibility. In Kelantam very large increases in yield of dry paddy were obtained by application of ammonium phosphate at the time of mechanical cultivation. A depth of ploughing experiment showed significant gains for deep ploughing.

Tea

63. Blister blight of tea caused by *Exobasidium vexans* first appeared in Malaya in February, 1950, and quickly became established on all tea plantations at Cameron Highlands. Experiments were started as quickly as possible to investigate the effect of fungicides, frequency of spraying treatments, the influence of manures and maintenance of vigour and times of pruning. The beneficial effect of spraying pruned bushes with copper fungicides was very pronounced by the end of the year. Mycological studies were made of the fungus and several other fungi associated with it in blisters.

FIJI AND BRITISH SOLOMON ISLANDS PROTECTORATE

Biological Control of Insect Pests

64. The possibility of a new method of control of the serious pest, the banana scab moth, *Nacoleia octasema* Meyr., is provided by the discovery in New Guinea of a tachinid parasite of the moth. This will be introduced for trial in the Colony. Two parasites of the rice armyworm *Cirphis unipuncta*, a serious pest of rice and Para grass, namely the braconid *Apanteles marginiventris* Cresson and the techinid *Eucelatoria armigera* Coq., have been introduced from Hawaii. The indications are that *Apanteles* may prove a major factor in the control of the caterpillar.

65. An attempt is being made to control the bug, *Amblypelta cocophaga* China, which is the cause of nut-fall in the coconut plantations in the British Solomon Islands, by the introduction of tachinid parasite *Trichopoda pennipes* F. Parasites from the original introduction of one hundred puparia from Florida (through the courtesy of Dr. F. J. Simonds of the Commonwealth Institute of Biological Control) have been multiplied and one thousand puparia were produced in the fifth local generation. Of these eight hundred were taken by air to the British Solomon Islands and from these one hundred and sixty adult flies emerged. The main liberation was on Baunani plantation in Malaita. This tachinid attacks various pentatomid and coreid bugs.

Pasture Research

66. At both the Koronivia and Sigatoka Stations work has been proceeding on the introduction of promising species of fodder grasses and legumes, which are being tested for their vigour and ability to persist in competition with weeds, for their ability to produce seed freely, and for their palatability and nutritive value. Certain selections have already been made but it is likely that this work will occupy some years of study.

Veterinary Research

67. Studies of the behaviour of dairy cows in a tropical environment, and also climatic studies on identical twin heifers, the latter in conjunction with the Ruakura Animal Research Station, New Zealand, have been conducted at Sigatoka.

GOLD COAST

Coconut: Cape St. Paul Wilt

68. The coconut palms around Keta are suffering from a wilt disease. Affected palms shed their nuts, the leaves yellow and wilt and hang down and finally the palm dies. The yellowing of the leaves proceeds upwards into the crown the central spike being affected last. Dissection of diseased palms show that the growing point rots before the cabbage is affected. The progress

of the disease is rapid, as diseased palms die six months after nut shedding. No responses have been obtained from mineral injection or from inoculations with fungal and bacterial isolates from diseased palms. A survey has shown that the Rhinoceros beetle, *Oryctes rhinoceros*, is associated with diseased palms when the results were examined by the 2 × 2 contingency table. It is not known whether this association is merely that of a scavenger or whether the beetle is a vector.

Lime Die-back Disease

69. Further work has shown that the mealybug *Ferrisia virgata* Cockerell is a vector of the lime virus but owing to its rarity and immobility is not as important as the aphid, *Aphis citridus* Kirkaldy (*A. taveresi* del Guercio). The aphid vector cannot pick up the virus after a ten-minute feeding time on a source plant, but feeding times of from one hour to twenty-four hours are effective. There are indications that the efficiency of transmission increases with length of feeding time on the source plant. The maize aphid, *Aphis maidis* Fitch, was tested as a vector but did not transmit the virus. The virus has not been transmitted by sap inoculation. The following symptomless alternate hosts of the lime virus have been found:—Rough lemon, Lake and Sampson tangelo, Mediterranean sweet orange, Washington navel orange, tangerine, Marsh grapefruit, Trinidad wild grapefruit, a green orange from Syria, and *Clausena anisata* Oliv. Alternate hosts which show leaf symptoms when inoculated with the virus include citron, Eustice limequat, *Poncirus trifoliata* Linn., *Aeglopsis Chevalieri* Swingle and *Afraegle paniculata* Engl. *Citropsis articulata* (Willd. ex Spring.) Swingle and Kellermann, succumbed to the virus whilst the sour orange was dwarfed and ceased to grow after inoculation, but did not die within twelve months. The virus is not seed transmitted although lime seedlings often show virus-like leaf symptoms, which have not been transmitted by grafting.

Maize Stalk Borer

70. A grass, *Sorghum arundinaceum* has been found to be a major host of the maize stalk borer but several other grasses including elephant grass can also act as host. Experiments on chemical control were carried out on a limited scale; DDT was promising but BHC dust tended to scorch the foliage. Work on the stem borer has shown that there are apparently three species attacking maize and preliminary investigations indicate that these borers, which damage late millet severely as a rule, aestervate as resting-stage larvae and produce a first generation of parasites in early millet which in years when there is any check in growth due to drought, etc., parasitises late millet severely in the second generation.

Plant Breeding

71. *Rice.* Work on rice is confined to *O. sativa* rather than to the local *O. glaberrima* which is commonly grown. It is recognized that the latter may by virtue of its drought resisting qualities be better suited to the local method of cultivation; but it is an inferior type and investigations on *O. sativa* are, therefore, being made in conjunction with the schemes being developed for water control in the valleys.

72. *Sorghum.* In the case of sorghum one of the commonest causes of poor yield is when perfectly normal plants flower but fail to set seed. This appears to be caused by both insufficient and too much rain, depending upon

the varieties. A collection of some fifty to sixty different varieties has been made and is being studied in this connection, since certain types are known as "all weather" varieties. The study of American dwarf sorghums has been continued and more varieties introduced. Hegari, the only variety so far to be grown on a reasonably large scale plot, gave the very encouraging yield of 1,010 lbs. grain per acre in a twelve weeks growing season and has aroused much interest among local people.

Soil Fertility Studies

73. During 1948 and 1949 a series of 113 fertilizer trials on the main annual food crops were laid down. They covered a wide range of climatic and soil conditions. The following general conclusions from these trials have been reached.

74. *Nitrogen.* No appreciable responses have been obtained in forest. In savannah, land which has been left to rest for periods of ten years or more is very short of available nitrogen for the first three years of cropping and large responses have been obtained on all crops. These soils have high C/N ratio values (about 15). On land more frequently cropped, cereals and yams have given moderate responses and groundnuts negative responses. Sulphate of ammonia is best applied about planting time to all crops—except guinea corn and late millet in frequently cropped areas on which applications in August are recommended. 1 cwt. per acre of sulphate of ammonia is likely to be the most profitable rate of application.

75. *Phosphate.* Considerable responses are obtained in forest particularly on frequently cropped granite soils. In the savannah, the Voltaian soils give moderate responses when they are frequently cropped, but have a satisfactory phosphate status when allowed long resting periods. On soils seriously short of nitrogen groundnuts respond to the calcium sulphate in superphosphate which, it is suggested, stimulates the nodules to fix nitrogen. The granite and greenstone soils of the far north show considerable responses to phosphate on all crops. 1 cwt. per acre of superphosphate will be a more profitable rate of application than 2 cwt. per acre. Determination of acid soluble phosphate has been useful in picking out sites disturbed by their being under or near old villages or camps. The adsorbed phosphate values are less useful. There is little correlation between these values of "available" phosphate and the percentage increase in yield given by superphosphates to any of the crops on the undisturbed sites.

76. *Potash.* No good effects have been observed on any crops, and on early millet, groundnuts and yams the yields are decreased. *Lime.* Groundnuts are the only crop which responds to lime. The increases will not pay for the cost of the lime. When lime is applied the bad effect of potash on groundnuts and yams is much reduced. *Mulching.* The treatment of five tons per acre of dry grass or straw has given moderate increases in the yields of all crops, particularly groundnuts. *Dung.* Dung was substituted for mulch in some of the trials in the Northern Territories. It owes its effect primarily to its phosphate content. It was less effective than superphosphate on early maturing crops, but more effective on the late maturing ones.

77. The conclusions are that superphosphates may be used in the main food producing areas in the south; sulphate of ammonia on Voltaian soils recently cleared after a long period in bush; and superphosphates and possibly sulphate of ammonia in the far north.

JAMAICA

Cattle

78. Further work has been carried out on tick dip fluids, both improved arsenical varieties and the newer synthetic types. Work on mineral deficiency conditions and in particular on Manchester wasting disease continues. Livestock work has been mainly concerned with cattle breeding. The Hope Jerseys are now becoming defined as a small number of families with approximately $\frac{3}{8}$—$\frac{1}{8}$ Sahiwal and $\frac{5}{8}$—$\frac{7}{8}$ Jersey blood. They are being line bred and show great promise as a tropically adapted dairy ecotype.

Pastures

79. Apart from introductory work the main emphasis has been on the determination of the yields and composition of various grasses and grass-legume mixtures under various environmental conditions, using plots which are either cut or grazed. Fertilizer and management trials of native and imported grasses are also being carried out.

Publications

80. During the year the Departments of Agriculture and Veterinary Services published nine bulletins: these include detailed accounts of research work on dairy cattle breeding, tick control measures, yields, composition and responses to fertilizers of fodder grasses, citrus orchard analyses and fertilizer experiments on Irish potatoes.

KENYA

Coffee

81. Studies of soil moisture and of the effect of various cultivation treatments on soil structure, which are being undertaken under coffee in the drier areas, are giving results likely to be of wider interest than in connection with this crop alone.

82. By placing calibrated, porous electrical resistance blocks under both bare and mulched surfaces in order to obtain a continuous quantitative record of soil moisture and by taking soil samples down to a depth of ten feet or more at the end of each successive wet or dry season, the use of soil moisture by coffee, the extent of re-charge by each rains and the conservation effects of mulches are being investigated. Radiation, evaporation and windspread are also recorded. Although coffee can reduce soil moisture only to the wilting point (which has been found to vary from about 22 per cent topsoil to over 30 per cent in the subsoil), the sunbaking of bare surface causes further severe losses from the top foot, and measurable losses from the second and third foot, which must be made good from the next rainfall before growth can be resumed. The importance of depth of subsoil, root range and improvement in rainfall penetration is emphasised by the finding that coffee has dried out soil to a depth of eight feet or more in recent successive dry seasons. A well-maintained, 4-inch mulch of grass, sorghum or maize stalks will improve rainfall penetration down to a depth of four and a half feet, and has a very marked effect in reducing soil moisture losses, the conservation of moisture in the surface layers, in particular, giving the coffee roots many extra weeks of feeding. Among the advantages it has been found that mulching gives an improvement in the structure of the surface soil as indicated by the fact that the proportion of water-stable crumbs was twice as great under mulch as under bare soil.

83. Again, in the drier areas a study is being made of various methods of cultivation and weeding, combined with the effect of subsoiling and of application of " boma " manure. Over three seasons, frequent clean weeding has so far given much higher yields than slashing the weeds or removing them only at the end of the rains. The effect of weeds on the crop is mainly due to competition for moisture. The marked decline in soil structure which has occurred under clean weeding has not yet reached the point of decreasing yields, while the improvement in water percolation and root aeration resulting from the growth of weeds during the rains has been obtained at the expense of crop. Mechanical cultivation has given results inferior to those obtained from weeding with a hoe owing to the greater efficiency of the latter in destroying weeds. Deep cultivation has had no beneficial effects and appears to decrease the proportion of the layer soil aggregation.

Plant Breeding

84. Work in progress comprises introduction, selection and hybridisation with wheat, maize, sorghum, barley and oats to produce disease-proof varieties of improved yield and commercial qualities. The greatest attention has been paid to wheat and a number of good varieties, adapted to different altitudes and resistant to disease have been bred and passed into commercial use. Of the diseases, the Black Stem Rust is the most important: its physiologic forms, of which nine are now known to occur in Kenya, have been sorted out and the resistance of all varieties to these forms is studied. A hybrid maize breeding programme, which lapsed during the war, has recently been restarted. Hybrid varieties, imported from a variety of sources, have universally failed under Kenya conditions and it is clear that hybrids must be synthesised locally to be of value. A sorghum breeding programme aiming at the production of varieties suitable for combine harvesting by the combination of the dwarf character of imported varieties with the disease resistance of local strains, has recently been started.

85. Pyrethrum breeding, aiming at the production of varieties adapted to different altitudes and possessing the characteristics of high yield of flowers, high content of pyrethrins, large flowers, erect growth habit and disease resistance, has been in progress since 1946. Varieties giving yields of pyrethrins much above average are already in course of multiplication, but several facts which complicate the process of improvement have come to light. Amongst these are: a tendency for there to be a negative correlation between yield of flowers and pyrethrin content, variation between strains in the effect of stage of maturity of flowers on pyrethrin content, and a tendency for a high pyrethrin content to be correlated with a high rate of deterioration, or loss of pyrethrins in storage or transit.

Soil Fertility

86. In the past three years a large number of fertilizer trials have been conducted over a wide area in the Highlands on wheat, maize and barley. Response to phosphate has been widespread, and very marked over considerable areas. Double superphosphate has usually been appreciably more effective than locally manufactured soda-phosphate. Responses to nitrogen have been common but usually of moderate to low magnitude. Potash has had practically no effect. A smaller number of trials have been carried out on grass. Establishment of grass leys from seed has frequently been greatly improved by the application of nitrogen and phosphate at sowing time. On established grass, increased tonnage has been obtained by applying nitrogen and phosphate, particularly the former which has also increased the crude protein content of the grass.

MAURITIUS

Sugarcane

87. The island of Mauritius, approximately the size of the county of Surrey, is the largest individual cane sugar producer and exporter of all the British Colonial territories. The 1950 crop of sugar from 150,000 acres under cane was 456,000 metric tons. The mounting curve of sugar production owes much to the research carried out at the Sugarcane Research Station of the Department of Agriculture. Not only have high yielding canes been bred on the island but much valuable work has been carried out in assessing the nutritional status of the cane plant, and hence its manurial requirements, by foliar diagnosis, a micro-chemical technique. Research of value has been done on the biological and chemical control of weeds and on the soils of the island. A new building providing laboratories and offices to serve as the headquarters of the Mauritius Sugarcane Research Station was opened early in 1950.

NIGERIA

Fertility placement trials

88. Experience has shown that chemical fertilizers in the hands of the native farmers may do more harm than good, particularly in the case of groundnuts, but superphosphate in the form of pellets has been proved to increase the yield greatly. The application of 60 lbs. per acre results in increases of the order of 200 lbs. to 400 lbs. in the yield of groundnuts. There is also a marked beneficial residual effect, which persists up to four years, whether the crop grown is guinea corn or groundnuts. A scheme for the distribution of large quantities of pellets during the next few years has been approved as it is believed that no other single measure offers such an excellent opportunity for a rapid and substantial economic increase in the productivity of the region.

Cocoa

89. A scheme for a cocoa soil survey has been approved by the Nigerian Cocoa Marketing Board. This is vital to the problem of the regeneration of old cocoa farms and to opening up alternative new land for the crop. The breeding work has produced some interesting results. The progeny of crosses between a Nigerian selection T 38 and Trinidad clones, over a four-year period, has consistently given considerably higher yields than either of the parents.

90. A study of indigenous parasites of the cocoa mealybugs is in progress as a preliminary to assessing the possibility of successful introductions of foreign parasites. Sixty parasites have been collected belonging to the genera *Cheilonurus*, *Leptomastix* and *Anagyrus*.

Entomology

91. Preliminary experiments have been instituted to elucidate the factors which affect the distribution of larvae of the biting fly *Chrysops*—the adult is the vector of loiasis, a helminth infection which causes calabar swellings—on the mud along the banks of the River Okhua near Benin. No key has yet been prepared to aid identification of the larvae of the different flies but large collections of larvae have been made for systematic study in the laboratories at Ibadan. No larvae have been taken from samples of mud under one foot of surface water nor from dry land; 85 per cent were taken in saturated and damp soil and the remainder from mud having less than one inch of surface water. *Chrysops* larvae evidently cannot tolerate any depth of free surface water.

92. The coreid bug, *Leptoglossus membranaceous* causes considerable damage to citrus effecting losses as high as 60 per cent. It has been shown that the bug breeds on alternate host plants of which the most important is *Citrullus vulgaris*, the water-melon. The study of the annual cycle of redboll worm has been completed which shows that if breeding of the moths, which normally emerge in June and July, can be prevented the damage done by the pest to the cotton crop in October and November would be greatly controlled.

Systematic Botany

93. The herbarium maintained by the Forestry Department at Ibadan continues to increase in size and value. Its importance as a centre for the identification of Nigerian plants and the dissemination of accurate botanical information is widely recognized.

NORTHERN RHODESIA

Forestry Research

94. At Ndola a series of plots in dense deciduous woodland of the " Nuyombo " type have been maintained under régimes of fire protection and of late and early burning since 1933. The results of the treatments are very striking and are being critically studied. Species of Mexican pines are being tested: five of the twenty species already planted out show, after fourteen years growth, considerable promise for cultivation on soils of the dense deciduous woodlands of the Congo-Zambesi watershed.

Veterinary Research

95. *Foot and Mouth Disease.* In 1950, in continuance of an investigation carried out in 1948, a vaccine against foot and mouth disease was prepared in the field at Namwala. This vaccine reduced the susceptibility of local cattle to generalized foot and mouth disease from the normal 50 per cent to 2 per cent. This work is to be repeated and pursued in 1951.

96. *Rabies.* Routine laboratory diagnosis, including the biological test, for rabies from brain specimens submitted from the field, has been perfected. In 1949 the manufacture and issue of a field vaccine (Semple type 30 per cent sheep brain in 1 per cent phenol) was undertaken and approximately 10,000 dogs have been vaccinated in the larger towns of the territory and in certain native reserves where the disease is common.

97. *Tuberculosis.* Extensive investigations into the use of tuberculin shows that this agent is not so satisfactory as a diagnostic in Northern Rhodesia as is generally accepted in Europe. An excessive number of reactors which show no lesions of the disease at post mortem examinations have been observed, and investigations are to be continued.

98. *Beef Production.* A long range experiment continues into the comparative values of exotic type cattle and indigenous cattle as beef producers. The indications at this stage are that, under normal ranching conditions as carried out at present in Northern Rhodesia, native or indigenous stock provide, per unit of 100 cows, a greater yield of beef than exotic types, when all factors such as calf mortality, etc., are considered. This experiment also shows that the yield of beef from exotic types is proportional to the standard of animal management practised.

99. *Pasture Research.* A grass drying plant has been obtained and put into operation in order to study the possibilities and economics of grass drying in Northern Rhodesia.

TANGANYIKA

Coffee

100. The main line of work at the Coffee Research and Experimental Station, Lyamungu, continues to be directed towards the improvement of planting material by selection of high-yielding types; and the improvement of growing conditions by various systems of handling coffee trees and of raising or maintaining the fertility of the soil. The investigation of black-tip disease of coffee has continued. The original suspicion of boron deficiency now appears less likely and the investigation has widened to include major and other minor elements. It is being shown that pruning on the multiple stem system is giving considerably higher yields than on the single stem system; that mulching with dried banana leaf or elephant grass (*Pennisetum purpureum*) or application of compost increases yields significantly; that irrigation limits the tendency to biennial bearing and gives higher yields; but that sulphate of ammonia when applied with a mulch depresses yields, though when applied by itself it has significantly improved yields.

101. Progress is being made in the investigations into the most suitable means of propagating coffee by vegetative means, and work on the study and control of coffee pests and diseases continued under the entomologist and plant pathologist resident at Lyamungu.

Cotton

102. The Ukiriguru Experimental Station near Mwanza is the centre for work on the selection and breeding of cotton strains suitable for the Lake Province, and the selection and breeding of such food crops as sorghum, maize, rice and various leguminous crops. Progress has been made in the selection of cotton strains with greater resistance to jassid (*Empoasca* spp.) and blackarm (*Xanthomonas malvacearum*), two of the major factors in reducing cotton yields; and in the selection of strains with higher yield qualities and better ginning outturn. The benefits of manuring, tie-ridging, and early planting have been demonstrated, and a study is being made on the effects of grass rests and artificial fertilizers. Cultivation and rotation trials have also been started on the soil type generally planted to sorghum.

Sisal

103. The Sisal Research Station, Ngomeni, is financed by the Tanganyika Sisal Growers' Association and is staffed by the Department of Agriculture. A large number of long-term experiments is maintained on the station besides several external trials conducted on estates representative of the principal sisal growing areas of the territory. These trials are chiefly concerned with the cultivation, spacing, cutting and manuring of sisal, the interplanting of food crops and the testing of selected agave hybrids. Much attention is being devoted to methods of maintaining soil fertility and the development of rotational system of growing sisal using grass leys. Intensive study is being given to various deficiency diseases and bole rots of sisal not without some success. Means of controlling the sisal weevil are being investigated by members of a private firm who are based on the station.

Soils and Fertilizers

104. Soil work is being expanded to include profile investigations with the idea of gaining a better insight into agronomic problems. A rapid reconnaisance of the soils of the projected tobacco area in the Songea District has been made and the results of the analysis of the profiles collected should be of

value in assessing the prospects of successful high quality tobacco culture in this area. Crocodile flesh has been investigated as a possible fertilizer. It appears, however, to be too fatty.

Veterinary Research

105. Research has been conducted into the interaction of Kenya attenuated goat virus and bovine virus in an attempt to throw light on the " interference phenomenon ". Tests have also been made to estimate more fully the duration of immunity conferred by Mpwapwa inactivated tissue vaccine, and further work has been done towards the evolution of an *in vitro* test for rinderpest virus and anti-body.

106. Research has also been made into the history of rinderpest outbreaks in Tanganyika over the last ten years with a view to linking them with factors such as climate, game movements and rinderpest inoculation campaigns.

TRINIDAD

Cattle

107. The two main cattle breeding projects are based on (*a*) selection from a tropical indigenous breed and (*b*) selection of a new type. With regard to (*a*), pure-bred Sahiwal cattle have been imported from India for the establishment of a herd at the Tobago Stock Farm. Selection is being made for dairy qualities with the intention that either as pure-bred or as grade cattle, the problem of a milk supply for the Colony may be solved. It is considered that a tropical indigenous breed is best suited for care and maintenance under peasant management. With regard to (*b*), after many years of experience with various grades obtained by crossing European and Indian breeds, *Bos taurus—Bos indicus*, it is intended to concentrate on half-breds obtained from crossing Friesian-Holstein bulls on Nelor type cows and by breeding half-bred cows to selected half-bred bulls.

Central Experiment Station

108. A number of investigational plots have been laid down, mainly with cane, citrus, coconuts, rice, fodder, annuals and rotational experiments. Some pasturage has been established, and stock will shortly be introduced. The bulk of the land is still, however, under forest and derelict cacao, and is intended for land utilization projects under the plan for investigation of mixed farming schemes which will form one of the major endeavours of the station. The main buildings to provide office and laboratory accommodation for specialist staff are nearing completion, and sites are being prepared for staff housing, implement sheds, workshops, stock-pens, etc.

Citrus

109. Investigation continues into the cause and control of epidemic die-back in limes. This disease is apparently dissimilar to that caused by a virus in West Africa. Indications are that it is primarily a root disease of seedling trees, and that budded trees are resistant or immune, especially when adequately protected from wind. Investigation of sudden collapse of grapefruit trees on sour orange stocks indicates that the cause is not a virus of the Tristeza type, although reduction of functioning phloem in the stock near the bud-union is a feature. Manurial trials, at varying levels and in varying combinations, with both major and minor elements continue. Striking responses have been obtained from N and Zn. A rootstock trial has been completed and reported on. A new and more comprehensive trial is being prepared to test a number

of stocks for oranges, grapefruit and limes. In this will be incorporated a cultivation trial to compare the effects of tillage, green manures, and permanent cover. A number of leguminous cover-crops have been tested, both annual and perennial. The most promising are *Crotalaria* and Kudzu respectively. A significant increase in crop is obtained from a soil cover of a legume, as compared with the natural cover, predominantly of grasses.

Entomology (Cacao, Citrus, Coconuts, Sugarcane)

110. Dieldrin and aldrin have been proved effective against parasol ants, *Atta* and *Acromyrmex*, on cacao at concentrations down to 40 mg/sq. ft. Dieldrin and aldrin were effective at ¼ per cent in the control of tree ants on citrus. High pressure sprays of oil emulsions at 2 per cent and parathion thiopos at 0·1 per cent were effective on scale insects on coconuts. Investigation of red-ring disease of coconuts continues with the aim of ascertaining the method of infection by the nematode and devising control measures. Studies continue on the life-history, taxonomy, and control of froghoppers on sugarcane. On the commercial scale, complete control is practicable by dusting the gamma BHC and chlordane. Experimental application of dieldrin as a ground spray gave a complete kill of nymphs. Investigations of the sugarcane borers, *Diatraea* and *Castnia*, continue in order to determine the causes of varietal susceptibility and to devise control measures.

Pastures

111. Work is being undertaken at the various stations in grazing grasses which have already given satisfactory results for soiling purposes. These grasses include Guinea grass, *Panicum maximum;* Para grass, *Brachiaria mutica* and Elephant grass (Napier), *Pennisetum purpureum.* The introduction of legumes in stands of these grasses, with a view to improving the protein content of the mixture is also being studied, Kudzu, *Pueraria* spp. and *Indigofera* spp. being used for this purpose.

UGANDA

Cattle (Management Studies)

112. The Serere Zebu herd which was founded in 1939 has been the principal material for these studies and a review of the herd records has provided much useful information not hitherto available. The herd at present numbers approximately 300 head of stock and growth and weight records have shown that under Serere conditions males reach maturity at approximately 66 months and females at 42 months, this latter figure corresponding with the age of first calving down. Calf weights at birth appear to increase up to the third calf born, after which birth weights remain fairly constant until the tenth and subsequent calves which show a marked drop in weight. Calf management studies have provided interesting information on different methods of rearing calves, which indicate that free range methods are preferable from the point of view of live weight gains. Milking records have shown an increase in the average yield per cow from 90 gallons per lactation to 200 gallons over a period of eight years, which is considered to be due almost entirely to management. Individual animals have exceeded 300 gallons in one lactation in addition to feeding their calves whose consumption of milk in the lactation is estimated at 90 to 100 gallons.

113. Experience with the Serere herd has revealed that the production potentialities of Zebu cattle in respect of both milk and beef are dependent primarily upon management practice with the emphasis on feeding and watering. Supplementary feeding of digestible carbohydrate in particular has produced considerable improvements in milk yields and this conclusion is of special

interest and value as the supplementary feeding provided at Serere is well within the means of the average African cattle owner and in fact some enterprising owners have already obtained similar improvements by improved feeding and management on Serere lines.

Cotton

114. Blackarm is the premier disease of cotton in Uganda and is responsible for a considerable loss of crop almost every year. Experimental work on the disease has been in progress for twenty-three years and a review of this work has revealed that main stem infection during the first two months of the life of the plant can be critical for yield. This conclusion has suggested the desirability of avoiding primary infection by fungicidal treatment of the seed prior to planting, and investigations into this aspect of Blackarm control are now proceeding in collaboration with Messrs. Imperial Chemical Industries Limited. Extensive field trials using a copper preparation for seed disinfestation have given promising results and have justified a considerable extension of this method of control to the commercial crop and this is now taking place.

115. In the Eastern and Northern Provinces of Uganda, *Lygus vosseleri*, capsid bug, is the worst pest of cotton and is annually responsible for serious loss of crop. Extensive investigations into its control by the application of insecticidal sprays and dusts are now being conducted and much valuable information is being obtained. Spraying treatments have proved to be more efficacious against this pest than dusting but the necessity of using large quantities of water renders spraying impracticable on scattered peasant-grown cotton plots. Dusting is likely to be more feasible but it has yet to be demonstrated that this method of control is economic as the effect of dusts is less marked and the increased yields obtained may not cover the cost of application. Further experiments have been designed to study this aspect of the problem and to obtain information on the optimum conditions for the use of dusts in relation to the control of the pest and the yield benefits derived therefrom.

116. The Empire Cotton Growing Corporation's new Cotton Research Station in Uganda was formally opened by the Governor on the 9th November. It is situated at Namulonge, sixteen miles north of Kampala. The laboratories have been named after Mr. F. R. Parnell, the first Director of the Station, who was succeeded on his retirement by Dr. J. B. Hutchinson, C.M.G., F.R.S., formerly head of the Genetics Department of the Corporation's Research Station in Trinidad. The total area of the Station amounts to 2,240 acres. Of this some 400 acres are papyrus swamp and 300 acres include the buildings and steep and stony slopes which will be left under permanent cover. It is hoped gradually to bring the remaining 1,500 acres under cultivation on a rotation of three years cropping and three years rest under grass. The basic task is to fit cotton into the environment in which it is to be grown and to increase the yield per acre. The work includes crop husbandry and soil fertility, plant breeding and genetics directed partly towards disease and pest resistance, entomology and plant pathology. A number of demonstration plots will be laid down in the various districts with the co-operation of the Department of Agriculture and the results of research will be illustrated to the growers to their benefit and to that of the cotton industry in the United Kingdom.

Soil Investigations

117. Quantitative and qualitative studies of applications of fertilizers to varying types of soils were developed and interesting results have been obtained, particularly in respect of responses to phosphatic fertilizers on "lunyu" soils which now appear to be soils deficient in phosphates. On such soils both Uganda rock phosphate and double super-phosphate gave marked increases in the

yields of the trial crop and the practical application of these studies on these soils may prove to be of considerable importance. The soil nitrate studies referred to in last year's report have been continued and expanded and the relationship between nitrate formation and soil organic matter content is being studied. Research into the microbiological field will be necessary before full explanations of the phenomena of soil nitrate formation can be obtained and this has now been started.

V. REPORTS OF STANDING SUB-COMMITTEES

(a) *Cocoa Research Sub-Committee*

118. The members of the Sub-Committee are Mr. C. G. Eastwood (Chairman), Dr. E. C. Bate-Smith, Mr. F. C. Bawden, Dr. L. E. Campbell, Dr. E. E. Cheesman, Sir Geoffrey Clay, Mr. F. S. Collier, Sir Frank Engledow, Sir Geoffrey Evans, Dr. G. A. C. Herklots, Mr. W. M. Hood, Professor J. W. Munro, Sir William Ogg, Mr. A. F. Posnette, Sir Edward Salisbury, Mr. E. E. Wells and Dr. S. P. Wiltshire. Mr. Collier became a member on succeeding Mr. W. A. Robertson as Forestry Adviser to the Secretary of State, and Mr. A. F. Posnette and Dr. E. C. Bate-Smith were appointed during the year.

119. The main interest of the Sub-Committee has been the important problems involved in standardizing large-scale fermentation techniques and in developing consistent and satisfactory techniques for small-scale fermentation, involving quantities of beans as small as the contents of a single pod. Members have followed with interest the work being done on various aspects of fermentation at the Colonial Microbiological Research Institute in Trinidad, the Low Temperature Research Station of the Department of Scientific and Industrial Research at Cambridge, the West African Cacao Research Institute and the Department of Agriculture, Trinidad. Dr. Campbell has visited Trinidad and has seen the work on fermentation being carried out at the Microbiological Research Institute and at the Imperial College of Tropical Agriculture.

120. The Sub-Committee have continued to take a close interest in the affairs of the West African Cacao Research Institute. Mr. West, the Director, attended a meeting of the Sub-Committee held in September and members were thus able to amplify at first hand their knowledge of the Institute's work. Research is now being carried out on the use of arboricides, and on the effectiveness of insecticides in the control of capsids and the mealybug vectors of swollen shoot disease. In addition, the team of scientists from Messrs. Pest Control Limited, which is now working at the Institute, has been investigating the use of systemic insecticides in controlling mealybugs. A method of killing them has been evolved, but a good deal of further work remains to be done before the practicability of the method can be established.

121. Another major matter considered by the Sub-Committee has been the policy to be pursued in introducing planting material into Malaya, where efforts are being made to establish cocoa as a crop of economic importance. The Sub-Committee have advised Mr. O. J. Voelcker, the Director of Agriculture in Malaya, on questions relating to the types of cocoa whose cultivation should be attempted, the way in which the crop should be developed and the precautions that should be taken with new introductions.

122. As in previous years, members attended the 1950 Cocoa Conference convened in September by the Cocoa, Chocolate and Confectionery Alliance Limited, at which the cocoa industry, Colonial Departments of Agriculture and research institutions and producer and consumer interests were represented. Among the chief matters considered by the Conference were the swollen shoot

campaign and disease control and rehabilitation measures, and cocoa breeding and propagation. Colonial Governments interested in cocoa production have been sent copies of the report of the Conference.

123. It has not proved necessary during the current year for the advice of the Sub-Committee to be sought on problems of disease control and rehabilitation, but members have been kept informed of the situation through the periodical circulation of progress reports.

124. On the recommendation of the Sub-Committee, the Imperial College of Tropical Agriculture is preparing a leaflet on Witches' Broom disease which will enable officers engaged on cocoa survey work to recognize it.

125. Among other matters considered by the Sub-Committee during the year have been the provision of intermediate quarantine facilities at Kew for planting material in transit between Colonial territories, and proposals for a collecting expedition to South America to be undertaken by members of the staffs of the Imperial College of Tropical Agriculture and the West African Cacao Research Institute.

(b) *Soils Sub-Committee*

126. The members of the Sub-Committee are Sir William Ogg (Chairman), Sir Geoffrey Clay, Dr. E. M. Crowther, Dr. W. Davies, Dr. F. Dixey, Dr. H. Greene, Dr. G. A. C. Herklots, Mr. G. V. Jacks, Mr. C. G. T. Morison, Dr. A. Muir, Professor H. G. Sanders, Dr. A. B. Stewart, Sir Harold Tempany and Dr. F. Yates. The Sub-Committee sustained a severe loss during the year with the death of Professor G. W. Robinson in May. The appointment of Dr. H. Greene as Tropical Soils Adviser at Rothamsted Experimental Station has made it possible for his advice to be sought on matters that would otherwise have had to be referred to the Sub-Committee, and no meeting has been held during the year. Business has been dealt with where necessary by correspondence.

127. At their meeting in January, 1950, the Sub-Committee considered the proposals for soil survey and research contained in the report by the American scientists appointed by the Economic Co-operation Administration to report on the opportunities for American technical assistance to research in the British African Colonial territories. A number of the projects which were finally recommended for implementation were endorsed by the Economic Co-operation Administration as being of international significance. During the course of the year it became evident that it would not be possible for as many of these projects to be implemented as had been hoped, since the Economic Co-operation Administration indicated that it could provide experts for scientific work in the Colonies only if there was some special American knowledge or technique that could be transmitted to British scientists with lasting benefit to British practice during the remaining period of the European Recovery Programme. In the light of these criteria certain projects had to be dropped and others revised. The Economic Co-operation Administration has, however, approved applications for American assistance in soil science research in Nigeria and Nyasaland, but it has not yet been possible to recruit American scientists to carry out these projects. Arrangements have been made for an international mission, led by Dr. L. T. Alexander (America), to visit the British and French Colonial territories in West Africa to study soil laterisation problems. Dr. C. Bloomfield, Rothamsted Experimental Station, will accompany the mission.

128. The response to the advertisement of studentships in soil research was considerably greater than last year, and it proved possible to award studentships to five candidates, who are now undergoing training at research centres in the United Kingdom.

129. Drs. E. M. Crowther, H. Greene and A. B. Stewart attended the Fourth International Congress of Soil Science which was held in Amsterdam at the end of July. Dr. Crowther and Dr. Greene were appointed chairmen of the sections on soil fertility and on tropical and sub-tropical soils respectively.

130. Dr. H. Greene visited East, Central and West Africa from the 22nd March to 9th July. He found that in most territories some progress was being made towards remedying the severe shortage of technical staff for work on soils. In the soil survey team directed by Mr. C. F. Charter in the Gold Coast, African technicians were playing an important part. Dr. Greene also visited the Aden Protectorate as a member of an advisory mission on development in the Abyan Delta.

131. Among the other matters considered by the Sub-Committee during the year have been the study of soil micro-deficiencies in the Gambia by Dr. R. A. Webb, and the results of an extensive series of fertilizer trials which have been undertaken in the Gold Coast by Mr. P. H. Nye of the Department of Agriculture.

(c) *Stored Products Research Sub-Committee*

132. The members of the Sub-Committee are Sir John Simonsen (Chairman), Sir Geoffrey Clay, Mr. J. G. Glover, Mr. W. McAuley Gracie, Mr. G. V. B. Herford, Dr. G. A. C. Herklots. Mr. J. G. Hibbert, Mr. F. W. Irving, Professor J. W. Munro, Professor H. Raistrick (alternate Mr. G. Smith) and Mr. J. J. S. Scouler. One meeting has been held during the year.

133. At this meeting, which took place in October, the main item for consideration was the final report on the work of the West African Pest Infestation Survey. This report showed that the Survey had achieved results of considerable value and importance both to the West African territories and to future work on stored products infestation problems elsewhere. A revised and shortened version will be published in the Colonial Research Publications series.

134. Arrangements had been made for the work of the Survey to be continued by a unit financed by the Governments of Nigeria, Sierra Leone and the Gambia, and members were fortunate in having present at the meeting Mr. A. H. Young, Director of Marketing and Exports, Nigeria, whose department is administratively responsible for the control of the unit. The Sub-Committee accepted the invitation of the West African Governments to continue the scientific direction of the unit and delegated this duty to a Working Party, which has met and considered the programme for future research submitted by Mr. L. A. W. Hayward, the leader of the unit.

135. In view of the difficulty of finding suitably qualified instructors in Colonial territories to carry out the training of local technicians in grain storage, the Sub-Committee recommended that the Colonial Office should approach the Ministry of Agriculture and Fisheries to arrange for Agricultural Officers on leave to attend courses organized by the Ministry's Infestation Control Division. Satisfactory arrangements were made and one course was held during the year.

136. Among the other subjects considered by the Sub-Committee have been reports on laboratory tests of the use of pyrethrum powder against weevils infesting stored grain, and a report on crop storage, transport and infestation submitted by Mr. J. W. Irving to the Overseas Food Corporation.

137. The problem of providing an accurate method of grain moisture content determination suitable for field use in Colonial territories has also been considered. A technical panel, which had already reported briefly on the subject, is giving further consideration to the matter in order to prepare a suitable document for the guidance of Colonial authorities.

138. A technical sub-committee consisting of Dr. J. W. Evans, Dr. R. A. E. Galley and Dr. E. E. Turtle has been convened to draw up a revised Code of Practice governing the use of DDT and BHC with stored products, for the guidance of Colonial Governments.

139. The post of Colonial Liaison Officer at the Pest Infestation Laboratory of the Department of Scientific and Industrial Research, referred to in last year's report, was filled shortly after the close of the year under review.

140. Arrangements have been made for the assignment of Miss K. F. Salmond, the holder of a Colonial Office studentship in stored products entomology, to Nyasaland on completion of her course of study for a higher degree to carry out research into pest infestation of stored products, and the correlation of various storage methods with varying local climatic conditions.

Colonial Insecticides, Fungicides and Herbicides Committee Fourth Annual Report (1950-1951)

Commonwealth Institute of Entomology,
British Museum (Natural History),
Cromwell Road,
London, S.W.7

23rd June, 1951.

SIR,

I have the honour to enclose herewith the Annual Report of the Colonial Insecticides, Fungicides and Herbicides Committee for the year 1950–51.

I am,

Sir,

Your obedient Servant,

(Sgd.) W. J. HALL,

Chairman.

The Right Honourable James Griffiths, M.P.,
Secretary of State for the Colonies.

COLONIAL INSECTICIDES, FUNGICIDES AND HERBICIDES COMMITTEE

Membership

DR. W. J. HALL, C.M.G., M.C., Director, Commonwealth Institute of Entomology (*Chairman*).

PROFESSOR G. E. BLACKMAN, B.A., Department of Agriculture, University of Oxford.

DR. J. CARMICHAEL, late Colonial Veterinary Service.

DR. F. A. DENZ, M.Sc., Medical Research Council.

DR. R. A. E. GALLEY, Secretary, Inter-Departmental Co-ordinating Committee on Insecticides.

DR. P. C. C. GARNHAM, Reader in Parasitology, London School of Hygiene and Tropical Medicine.

DR. D. L. GUNN, Anti-Locust Research Centre.

DR. G. A. C. HERKLOTS, M.Sc., Secretary, Committee for Colonial Agricultural, Animal Health and Forestry Research.

DR. R. LEWTHWAITE, O.B.E., D.M., B.Ch., M.R.C.S., F.R.C.P., Joint Secretary, Colonial Medical Research Committee.

DR. HUBERT MARTIN, Department of Agriculture and Horticulture, University of Bristol.

MR. S. A. MUMFORD, M.Sc., A.R.I.C., Chemical Defence Experimental Establishment, Ministry of Supply.

PROFESSOR J. W. MUNRO, C.B.E., M.A., D.Sc., Imperial College Field Station.

MR. D. L. PEARSON, Secretary, Tsetse Fly and Trypanosomiasis Committee.

PROFESSOR SIR JOHN L. SIMONSEN, D.Sc., F.R.S., Director, Colonial Products Research Council.

DR. S. P. WILTSHIRE, Director, Commonwealth Mycological Institute.

MAJOR-GENERAL T. A. YOUNG, O.B.E., Director of Hygiene, War Office.

Ex-Officio Members

The Secretary of State's Medical, Agricultural, Animal Health and Forestry Advisers.

LT.-COL. H. J. HOLMAN, B.Sc. (*Secretary*).

Officer-in-Charge of Research to the Committee—MR. C. B. SYMES, O.B.E.

The terms of reference of the Committee are:—

(i) to advise the Secretary of State for the Colonies on any problems concerning the use of insecticides, fungicides and herbicides (including arboricides and defoliants) which may be referred to the Committee by him;

(ii) to examine and advise upon research and experimental projects relating to insecticides, fungicides and herbicides which may be referred to it;

(iii) to initiate research in insecticides, fungicides and herbicides, which is approved as desirable by the Secretary of State, and to carry out experimental field work with these materials;

(iv) to co-ordinate agricultural, medical and veterinary interests in the use of insecticides, fungicides and herbicides in the Colonies, and to ensure that the latest scientific information on these materials is available to those concerned with their use in the Colonies.

The work of the Committee is assisted by four sub-committees whose membership is as follows:—

MALARIA SUB-COMMITTEE

DR. P. C. C. GARNHAM, Reader in Parasitology, London School of Hygiene and Tropical Medicine (*Chairman*).

MAJOR-GENERAL SIR GORDON COVELL, C.I.E., Ministry of Health Malaria Research Laboratory, Horton Hospital, Epsom.

DR. W. J. HALL, C.M.G., M.C., Director, Commonwealth Institute of Entomology.

MR. G. H. E. HOPKINS, O.B.E., Zoological Museum, Tring, Herts.

DR. R. LEWTHWAITE, O.B.E., Joint Secretary, Colonial Medical Research Committee.

PROFESSOR G. MACDONALD, Director, Ross Institute of Tropical Hygiene.

DR. E. D. PRIDIE, C.M.G., D.S.O., O.B.E., Chief Medical Officer, Colonial Office.

MR. D. BISHOP, Colonial Office (*Secretary*).

AIRCRAFT TRIALS SUB-COMMITTEE

PROFESSOR D. M. NEWITT, F.R.S., Imperial College of Science and Technology. (*Chairman*).

MR. W. J. BIGG, C.M.G., Colonial Office.

DR. D. R. GUNN, Anti-Locust Research Centre.

DR. A. B. P. PAGE, Imperial College Field Station, Silwood Park.

DR. C. POTTER, Rothamsted Experimental Station.

DR. R. FORD TREDRE, Ross Institute of Tropical Hygiene.

DR. E. K. WOODFORD, University of Oxford.

MR. D. BISHOP, Colonial Office (*Secretary*).

FUNGICIDES SUB-COMMITTEE

DR. S. P. WILTSHIRE, Commonwealth Mycological Institute (*Chairman*).

SIR GEOFFREY CLAY, K.C.M.G., O.B.E., M.C., Agricultural Adviser to the Secretary of State.

DR. R. A. E. GALLEY, Fungicide and Insecticide Research Co-ordination Service.

DR. G. A. C. HERKLOTS, Secretary for Colonial Agricultural Research Committee.

MR. R. LEACH, School of Agriculture, Cambridge.

DR. G. WATTS PADWICK, Imperial Chemical Industries Ltd.

MR. E. F. POSNETTE, East Malling Research Station.

MR. G. SAMUEL, Agricultural Research Council.

MR. D. BISHOP, Colonial Office (*Secretary*).

HERBICIDES AND ARBORICIDES SUB-COMMITTEE

DR. G. A. C. HERKLOTS, Secretary, Colonial Agricultural Research Committee (*Chairman*).

PROFESSOR G. E. BLACKMAN, Department of Agriculture, University of Oxford.

SIR GEOFFREY CLAY, K.C.M.G., O.B.E., M.C., Agriculture Adviser to the Secretary of State.

MR. F. S. COLLIER, C.B.E., Forestry Adviser to the Secretary of State.

DR. R. A. E. GALLEY, Fungicide and Insecticide Research Co-ordination Service.

DR. E. K. WOODFORD, Department of Agriculture, University of Oxford.

MR. D. BISHOP, Colonial Office (*Secretary*).

MR. C. B. SYMES, O.B.E., Officer-in-Charge, Colonial Insecticides Research, and LT.-COL. H. J. HOLMAN, Secretary of the Committee, are ex-officio members of all sub-committees.

COLONIAL INSECTICIDES, FUNGICIDES AND HERBICIDES COMMITTEE

FOURTH ANNUAL REPORT

CONTENTS

PART III—*continued*

COLONIAL INSECTICIDES, FUNGICIDES AND HERBICIDES COMMITTEE

FOURTH ANNUAL REPORT

PART I. GENERAL

An account of the formation of the Committee is given in " Colonial Research, 1947–1948 " (Cmd. 7493).

2. *Membership of the Committee.* Professor P. A. Buxton, C.M.G., F.R.S., Chairman, resigned from the Committee in April, 1950, and was succeeded by Dr. W. J. Hall, C.M.G., M.C., Director of the Commonwealth Institute of Entomology. Professor Buxton's resignation also necessitated his relinquishing his Chairmanship of the Malaria Sub-Committee. The Committee wish to record their appreciation of the valuable services rendered by Professor Buxton and particularly the very great assistance he gave in the work of the Malaria Sub-Committee.

Mr. H. E. Coomber, Colonial Products Advisory Bureau, was appointed by the Secretary of State to the Committee.

3. *Meetings.* The Committee held five meetings during the period under review.

4. *Sub-Committees.* (*a*) The Malaria Sub-Committee held three meetings during the year. Major-General Sir Gordon Covell, C.I.E., M.D., Ministry of Health Malaria Research Laboratory, Horton Hospital, Epsom, Dr. W. J. Hall, C.M.G., M.C., and G. H. Hopkins, Zoological Museum, Tring, were appointed to the Sub-Committee.

(*b*) The Aircraft Trials Sub-Committee met once during the year, and discussed results so far obtained with the aircraft spraying experiments against tsetse fly in Tanganyika, and also the use of helicopters for the dissemination of insecticides.

(*c*) The Fungicides Sub-Committee met on one occasion and the Herbicides and Arboricides Sub-Committee did not meet during the year. It was considered unnecessary to hold meetings until such time as the information sought by both Sub-Committees from Colonial territories had been received and collated in memorandum form. This has now been done and is referred to later in this Report (paras. 19 and 20).

PART II. SUMMARY OF ACTIVITIES

5. An outline of the research work of the Committee from 1947 to 1950, compiled by Mr. C. B. Symes, O.B.E., Officer-in-Charge of Research, is appended to the present Report (Appendix I). This is not intended as a comprehensive and detailed survey, but is designed to give an overall picture of the principal research activities. Details of the various projects described can be found in the annual reports of the Committee and in the appendices thereto.

6. *Colonial Insecticides Research Team, Porton.* The high standard of work of the team has been maintained during the past year. The first part of an important paper by Dr. A. B. Hadaway and Mr. F. Barlow, entitled " Studies of Aqueous Suspensions of Insecticides " has been published in the Bulletin of *Entomological Research* and the second part is in the press. A number of significant factors have been brought to light, and a summary of this investigation and others having a direct bearing on the effectiveness of insecticides is given later in this Report in paras. 22–38. There is no doubt that the work of the Porton team is making a really practical contribution to the development of more efficient insecticides, a matter of no small importance, particularly in view of the present world shortage of insecticide materials.

Another interesting line of research which is being pursued is the production of resin surface coatings incorporating insecticides. This research had been undertaken by Mr. Bracey, who has succeeded, in co-operation with Messrs. British Industrial Plastics Ltd. in producing a number of promising coatings. Some of the resins prepared two years ago are still toxic to insects, and one, containing 20 per cent. D.D.T. has successfully prevented for several months, fouling by barnacles of marine under-water wooden surfaces. This work has been protected by patent application.

7. *Other Fundamental Research on Insecticides in the United Kingdom.* Reference was made in the last Report to arrangements by which fundamental studies of insecticides were to be undertaken at the Imperial College Field Station at Silwood Park and at Rothamsted Experimental Station, under the direction of Professor J. W. Munro and Dr. C. Potter, respectively. At Silwood Park a detailed study is being made of the structure of insects to determine the mode of action of residual deposits. An investigation has also been undertaken to find out the way in which insecticide particles are picked up by insects when moving over treated surfaces.

The knowledge of how insecticide deposits are lost from leaf surfaces is clearly of importance in the control of insect pests, particularly those of agricultural crops. In this connection the fate of crystalline deposits of D.D.T. on glass plates, both plain and coated with layers of wax, has been studied at Rothamsted, the experiments being carried out at temperatures approximating to leaf temperatures in the tropics.

8. *Colonial Insecticide Research Unit, East Africa.* The Unit has now settled into its new Headquarters at Arusha in Tanganyika. This move, together with the absence on leave of several members of the staff, has curtailed activities appreciably.

9. *Insecticide Application by Aircraft against Tsetse Fly.* A large amount of the Unit's work has been concerned with the second series of insecticide application from fixed-wing aircraft against tsetse fly, which was referred to in para. 7 of the last Report. There was some delay in starting these experiments, owing to the time taken to fit the aircraft with the new type of spray equipment which had been designed at the Ministry of Supply Chemical Defence Experimental Establishment at Porton. The experiments are not quite completed, and it is therefore not possible to make a final assessment of the results. The two years' experiments so far have demonstrated, however, that under certain conditions, and against certain species, it is possible to eliminate almost entirely the tsetse population of a given area but the question of whether the method is economically feasible has yet to be proved. The experiments were designed primarily to obtain scientific data on the problem of disseminating chemicals from the air for a variety of purposes, and were not necessarily specific to the control of tsetse fly. The success in reducing tsetse flies which has so far been achieved, suggests, however, that it would be very valuable to carry the experiments a stage further, and link them with a scheme for the experimental reclamation of a large area of tsetse infested bush. In any such trial, aerial application of insecticide might be augmented, where necessary, by ground applications of insecticide. Preliminary plans for an experiment of this type are at present under consideration, and an area of approximately 600 sq. miles has been provisionally selected, and is being photographed from the air, in order to determine its suitability. From the results of the experiment it should be possible to estimate the economic possibilities and limitations of the control of tsetse by aerial application of insecticides.

It was pointed out in para. 7 of the last Report that the aircraft experiments so far conducted had disclosed the need for a greater knowledge of the movements of air and of the micro-climates beneath bush canopy. The Committee have been fortunate in obtaining the services, on secondment from Hong Kong, of Mr. B. W. Thompson, Scientific Officer of the Royal Observatory, Hong Kong, who began work in East Africa in January, 1951. He is making a special study of micro-climates and atmospheric conditions at various levels from the ground to above the bush canopy, with a view to ascertaining the influence of variations in temperatures and humidities and of air movements, upon the behaviour of insecticide particles dropped from aircraft.

10. *Insecticide Application with Ground Equipment against Tsetse.* An interesting example of the use of insecticides by the Colonial Insecticides Research Unit to deal with an urgent practical problem is the application of D.D.T. to vegetation along the tributaries of the Nyando river near Kisumu in Kenya. There has been a serious outbreak of sleeping sickness in this area and the first application of insecticide towards the end of February brought about a striking reduction in the tsetse fly population.

11. *Studies of oil-bound suspensions of D.D.T.* Mr. N. van Tiel, a member of the staff of the Royal Dutch/Shell Research Laboratory, Amsterdam, has been attached to the Colonial Insecticide Unit in East Africa during the last year, to carry out experiments with a special oil-bound D.D.T. suspension against tsetse fly. A brief summary of the experiment was given in para. 57 of last year's Report, and further observations in para. 56 of this Report. Full details of the experiments are shortly to be published.

12. *Control of Simulium Fly (the vector of Onchocerciasis).* At the request of the Director of Medical Services, Uganda, a trial was conducted with the aerial application of D.D.T. oil solution to the vegetation along the banks and islands of five miles of the river Nile at Jinja. The observations on *Simulium* fly reduction are not complete, but the results appear very promising.

13. *Control of Mosquitoes and Malaria in East Africa.* The field experiments in the treatment of human habitations at Kasenje and at Mbale have now been terminated. An assessment of these experiments was made by Dr. P. C. C. Garnham in May, 1950, and his conclusions are in paras. 51-53.

The question of starting an investigation into the use of residual insecticides against malaria in a hyper-endemic rural area in East Africa is under consideration.

The aircraft spraying technique with a D.D.T. high spreading oil solution is being used in experiment against mosquitoes in an extensive swamp breeding area of 4½ square miles near Dar-es-Salaam. The Dar-es-Salaam Municipal Council and the Tanganyika Government are contributing substantially to the cost of this experiment.

14. *Behaviour of Mosquitoes in Huts treated with D.D.T. and B.H.C.* Reference was made in para. 12 of the Report of the Committee for 1948–49 to the work of Dr. Muirhead Thompson on the behaviour of mosquitoes entering huts treated with D.D.T. or B.H.C. and to the conflicting results which had been obtained with the use of these insecticides in various parts of the world. In view of the importance of the problem, the Committee considered it essential that an attempt should be made to clarify the position and, as stated in the last Report, Mr. G. Davidson was appointed to study the problem. He started work with the Colonial Insecticide Research Unit, in East Africa, in February, 1950, and a summary of his conclusions to date is given in para. 55 of this Report.

15. *Malaria Control in Malaya.* The experiment described in the last Report is being continued with satisfactory results and some details of the work are given in para. 62.

16. *Malaria Control in Mauritius.* Three residual sprayings of houses throughout Mauritius have now been completed, and the effect on the reduction of mosquito populations, spleen and parasite rates and the death rate has been most spectacular. Figures are given in paras. 63–66. The treatment has, however, not succeeded in eliminating *Anopheles gambiae* and it has been decided to supplement the spraying technique by anti-larval methods.

17. *Research on Insecticides against Mosquitoes at the University College, Ibadan, Nigeria.* The initiation of the research has been held up for several months owing to delays in the delivery of materials. The laboratory is, however, now completed and affords accommodation for visiting scientists. Preliminary work has consisted of a survey of insects of the site with special attention to those of public health importance. Species recorded include *Anopheles gambiae, Aedes aegypti, Aedes vittatus, Culex spp.* and *Glossina palpalis.*

18. *Application of Insecticides to the Major Agricultural and Animal Pests in Africa.* In the last Annual Report reference was made to a proposal to establish a West African Insecticide Research Unit. Unfortunately, for various reasons, including the difficulty of obtaining a location for the Unit, the Committee has decided that this project must be abandoned for the time being. The need to study means of application of the new insecticides to agriculture and animal husbandry problems in the tropics is, however, very urgent. The losses of crops from insect pests in some areas amount to as much as an average of 50 per cent. of the total crops, and even a small percentage saving would mean enormous increases in food supplies, with possible exportable surpluses. In animal husbandry, the reduction of tsetse and biting flies (other than tsetse) would be reflected in appreciable increases of meat and milk production. As has already been reported, an entomologist has been posted to the Department of Agriculture, Kenya, to assist in studies of the control of some of the major crop pests in that territory, and a field officer is assisting the Senior Entomologist, Uganda, in preliminary trials for the control of *Lygus* on cotton. It is appreciated that this effort is quite inadequate, and the Committee have under consideration the possibility of increasing the scope of this research by the appointment of two more entomologists, a chemist and an engineer, with the necessary ancillary staff. It is intended that these officers shall work in close co-operation with the East African Agricultural Research Organisation and with the local Departments of Agriculture, and shall be posted to those stations where they can best carry out their work. How far it will be possible to implement these proposals will depend principally on how soon the officers in question can be recruited.

19. *Fungicides.* The work of the Fungicides Sub-Committee has been handicapped during the year by the illness of its Chairman, Dr. S. P. Wiltshire, who fortunately has now recovered, and the memorandum which he compiled outlining the major fungicide problems in Colonial territories has been revised and is shortly to be considered in detail by the Committee. At its first meeting the Sub-Committee had drawn attention to the desirability of a bulletin on the Control of Banana Leaf Spot. Dr. Herklots during a visit to Jamaica, discussed this question and as a result an account of Banana Leaf Spot disease control in Jamaica by Messrs. Martyn and McIlvaine was published during the year as Bulletin No. 46 (New Series) of the Department of Agriculture, Jamaica.

20. *Herbicides and Arboricides.* Reference was made in para. 22 of the last Report, to an arrangement with the Agricultural Research Council, whereby the activities of the Council's Unit of Experiment Agronomy should be extended to embrace Colonial problems on the application of herbicides and arboricides. The Unit was formed in August, 1950, and one-fifth of its cost is being met from Colonial Development and Welfare funds. An appreciable number of enquiries from official sources in the Colonies have already been dealt with by Professor G. E. Blackman and his staff. Colonial territories have been circulated and information obtained regarding their problems, and these are being collated into a memorandum from which it is hoped it may be possible to draw conclusions as to those problems which need most urgent attention. A member of the staff of the Unit is at present in East Africa, conducting the first detailed field experiments on defoliation. He is working in co-operation with the Colonial Insecticides Research Unit of East Africa and with the East African Tsetse and Trypanosomiasis Research Organisation. It is hoped to arrange for an officer of the Unit to visit Colonial territories for a few months every year to carry out trials.

Arrangements have been made for abstracts and summaries of papers and reports on herbicides and arboricides to be prepared by the staff of the Unit and issued by the Fungicide and Insecticide Co-ordination Service of the Agricultural Research Council on the lines of the present Insecticide Abstracts.

21. *Helicopters.* It was with deep regret that the Committee learned of the crash of one of the prototype three-rotor Cierva Air Horse Helicopters, involving the death of all three occupants. The aircraft was at the time undergoing developments trials under the aegis of the Ministry of Supply. The Committee were interested in this type of helicopter, as likely to prove suitable as a spraying aircraft. It is understood that the question of proceeding with the development of this type of helicopter is under consideration. The Aircraft Sub-Committee have had an opportunity of discussing with representatives of the Ministry of Supply and of the manufacturers, the performance characteristics of the twin-rotor Bristol 173, and of the smaller single-rotor Bristol 171. The Committee will follow with interest the tropicalisation tests which the Ministry of Supply will be conducting next summer with the Bristol 171 at Khartoum, Bahrein and Nairobi. At the request of the Committee, the Nairobi trials will include flying over difficult terrain in the neighbourhood of sharp escarpments where sudden downdraughts and updraughts may be encountered. It is over this type of country, that any helicopter used for insecticide spraying may have to operate. The performance of the Bristol 171, will serve as a partial guide to the potentialities of the larger Bristol 173.

PART III. REVIEW OF RESEARCH WORK

Colonial Insecticide Research Unit, Porton

Aqueous suspensions of DDT particles in different size ranges

22. (27)* Studies on aqueous suspensions of insecticides have been extended, and dosages of DDT picked up and retained by mosquitoes and tsetse flies have now been determined chemically and correlated with their toxic effects. Results confirm and amplify previous observations. It is clear that several factors are involved in determining the weights of insecticide acting on mosquitos and tsetse flies after short contact periods with deposits from aqueous suspensions of DDT particles. The dosage picked up, the extent to which particles are retained on the insects, and the rate of penetration through the

* Figures in parentheses refer to the corresponding paragraphs in the 1949–50 Report.

cuticle are three of these factors and all are influenced by particle size, the smaller particles having a more rapid and greater toxic effect. Although this work was carried out in connection with the control of adult mosquitoes, the fundamentals involved are of importance in the control of other insect pests.

23. (a) *Dosages picked up.* Aqueous suspensions of DDT particles in different size ranges were sprayed on plaster blocks at a dosage of 25 mg. per sq. ft., and mosquitos (*A. aegypti*) were exposed to the deposits for short contact periods. The weights of DDT picked up during the contact times were determined chemically; kills from similar exposures were determined with a parallel series. Calculated probitlog (weight) regression lines showed that the median lethal dose increased from 0·12 to 0·42 to 2·13 microgrammes DDT per mosquito as the particle size increased from 0–10 to 10–20 to 20–40 microns. Although the weight of 40–60 micron particles picked up was much less than that of 20–40 micron particles it amounted to 1·2 microgrammes per mosquito in a contact time of 16 minutes; yet no kills resulted.

24. (b) *Rate of action.* The rate of action of particles of DDT picked up by mosquitos and tsetse flies increased markedly as the particle size decreased. It is suggested that solubility of DDT in the cuticle waxes, and therefore penetration of the site of action, becomes more rapid as the particle size decreases.

25. (c) *Retention.* The weights of DDT particles retained by mosquitoes after the contact time, until they were obviously showing symptoms of DDT poisoning, were determined. The difference between dosage picked up and dosage retained after a given time may be due to loss from the exterior of the insects by penetration through the cuticle and/or to loss by detachment from the insects during their movements. Results indicate that the difference between dosage picked up and dosage retained can be accounted for largely by penetration into the insect in the case of 0–10 and 10–20 micron DDT particles and largely by detachment from the insect in the case of larger particles.

26. (32) (d) *Availability of deposits on different materials.* Availability of deposits from aqueous suspensions of insecticides is influenced considerably by the type of material to which they are applied. On non-porous materials the wetting agent in solution remains on the surface with the insecticide particles and, on drying, causes them to adhere strongly to the substrate and to be less available for pick-up than on a porous material. For instance, only 0·1 microgrammes DDT per mosquito was picked up in 8 minutes from deposits of 10–20 micron crystals on glass compared with 0·48 microgrammes in 0·5 minutes on plaster.

Particle size and effectiveness of different insecticides

27. (a) *Contact toxicity.* There is an inverse relationship between particle size of insecticides and their initial contact toxicity to mosquitoes. The influence of particle size on effectiveness decreases as the intrinsic toxicity of the insecticide increases. For a given particle size the compounds investigated can be arranged in order of diminishing contact-toxicity to mosquitoes (A. aegypti):—dieldrin, gamma-BHC, aldrin, DDT.

28. (42) (b) *Fumigant action.* There is a similar initial inverse relationship between particle size and fumigant effect because of the relative increase in surface area with decrease in size. The compounds can be arranged in order of diminishing fumigant effect on mosquitoes:—gamma-BHC, aldrin, dieldrin, DDT.

Factors affecting the persistence of volatile insecticides

29. Work on particle size has been extended to include its effect on the persistence of volatile insecticides so that formulations giving both the maximum initial and residual toxic effects can be determined.

30. (a) *Temperature.* The rate of volatilisation increases as the temperature increases and, as would be expected, deposits persist for a longer time at the lower temperatures. For instance, 10–20 micron gamma-BHC crystals at a dosage of 25 mgms. per sq. ft. persisted on plaster blocks for approximately two weeks at 65° F. and for 4–5 days at 78° F.

31. (b) *Particle size.* Again as would be expected, the larger the particle the longer it persists. For any given size, the compound investigated can be arranged in order of diminishing persistence:—DDT, dieldrin, gamma-BHC, aidrin.

32. (c) *Material sprayed.* The persistence of particles of these insecticides is influenced considerably by the type of material to which they are applied. Toxicity is lost completely when deposits disappear from the surface of non-porous materials (e.g. glass, metal) but some materials, e.g. mud, plaster, wall-board, continue to exert a toxic effect long after the surface deposits have disappeared. The most striking results were obtained on mud and these are described below.

Sorption of solid insecticides by dried mud

33. Mud blocks were made from red earth used in the construction of walls of native houses in Uganda. Crystals of all insecticides used, rapidly disappeared from the surface of these blocks when they were kept at 78° F. (25° C), and even those of DDT, which is usually regarded as a contact insecticide with a long residual life, were no longer visible after a few days. At a dosage of 25 mg. per sq. ft., 10–20 micron crystals of gamma-BHC had disappeared from the surface in 3 hours, while similar crystals of DDT were no longer visible after 5 days.

When DDT and dieldrin crystals were no longer visible on the surface, the mud blocks lost their toxicity to mosquitoes (*A. aegypti*) exposed to them for long contact periods. On the other hand, blocks treated with gamma-BHC or with aldrin continued to be effective for a considerable time, after the disappearance of the crystals, against mosquitoes resting on the surface. Results of contact toxicity tests in which mud blocks were sprayed with aqueous suspension of 10–20 micron particles at a dosage of 25 mg. per sq. ft. and then kept at 78° were as follows:—

Insecticide	*Age of deposit*	*Mean percentage kill in 24 hours after exposure of minutes*									
		0·25	*0·5*	*1*	*2*	*4*	*8*	*16*	*32*	*64*	*128*
DDT	1 hour	22	54	85	100						
	1 day	13	35	58	93						
	3 days				0	8	30	64	98		
	1 week							0	0	0	
Dieldrin ...	1 hour	100									
	1 day	45		60	78						
	3 days					0	0	0	3	0	
	1 week								0	0	3

Insecticide	*Age of deposit*	*Mean percentage kill in 24 hours after exposure of minutes*									
		0·25	*0·5*	*1*	*2*	*4*	*8*	*16*	*32*	*64*	*128*
Gamma-BHC ...	1 hour	100									
	1 day			0	8	40	80				
	3 days						13	30	75		
	1 week							8	43	95	
	2 weeks							0	20	60	
	4 weeks								3	40	100
	8 weeks								0	25	78

Chemical tests showed that with 10–20 micron particles of DDT and gamma-BHC, almost the whole of the dosage applied could be recovered from the interior of the block. Almost all the insecticide was sorbed in the top 1/10th inch even at dosages of 200 mgs. per sq. ft.

34. The gamma isomer of BHC and aldrin have, in contrast to DDT and dieldrin, a marked fumigant action against (*A. aegypti*) and there is ample evidence to show that the residual toxicity after the disappearance of crystals from the surface of blocks treated with these insecticides is due to the fumigant effect from the material inside the block. Desorption of the volatile insecticides take several months for completion as compared with a few hours for the sorption process. The rate of disappearance from the surface decreased as the relative humidity of the atmosphere increased. This may be explained by competition between water vapour and the insecticide vapour for the absorbing surface. The same phenomenon occurred when aqueous suspensions of commercial wettable powders and oil-bound suspensions were sprayed on to dried mud from Uganda and when aqueous suspensions of DDT crystals were sprayed on to mud blocks made from soils from Kenya and Jamaica and from Gault and Weald clays from England.

35. The sorption of solid insecticides by dried mud is of obvious practical importance in the control of malaria vectors by spraying the internal surfaces of houses, especially as it occurs on red earths or lateritic soils used in the construction of houses in many tropical countries.

Wide variations in the duration of residual toxicity of an insecticide on different materials may help to explain conflicting reports from field trials with DDT against malaria vectors in various types of houses. The difference in effectiveness of DDT and BHC wettable powders against *A. gambiae* in huts with mud walls may be accounted for partly, at least, by the rapid sorption of both insecticides into the wall resulting in the one case in a complete loss of toxicity and in the other a persistent fumigant effect. Residual effects obtained with DDT wettable powders in houses of this type may be due only to the deposits on the wooden, iron or thatched roof.

36. Sorption of insecticides may be of significance also in treatments against soil insects and in soil fumigation.

Impregnated dusts

37. A study has been made of the contact toxicity to mosquitoes of deposits from aqueous suspensions of inert dusts impregnated with insecticides from other solutions. The effectiveness of deposits from aqueous suspensions of impregnated diatomite increased as the concentration of DDT increased from 5% to 35% when the dosage of insecticides remained constant. There was an inverse relation between the size of the impregnated particles and their effectiveness against mosquitoes exposed to deposits for short contact periods. Differences in effectiveness obtained when different carriers were used can be

accounted for by differences in size of the impregnated particles. For instance, particles of stockalite kaolin were originally smaller than those of slate dust, talc and diatomite, but aggregation occurred to a greater extent during the impregnation process and particles of the impregnated stockalite were larger and less effective than those of the other impregnated dusts.

38. Persistence of the volatile insecticides aldrin and gamma-BHC applied to mud and plaster blocks as aqueous suspensions of impregnated dusts was the same as that when they were applied as aqueous suspensions of wettable powders, (i.e., a mixture of insecticide particles and an inert diluent).

Median lethal doses of DDT and gamma-BHC for tsetse flies

39. A single drop of insecticide solution was applied by means of a micrometer syringe to the dorsal surface of the thorax of each tsetse fly (*G. palpalis*). Solutions used were 0·05% pp' DDT in kerosene, and 0·012% gamma-BHC in kerosene. Mortality counts were made after storage at 25°C. and 70% relative humidity for 24 hours. Calculated median lethal doses were 0·157 microgrammes of DDT per fly and 0·028 microgrammes gamma-BHC per fly. The median lethal dose is contained in a drop of 155 microns diameter when a 10% solution of crude DDT (80% pp' isomer) is used, and in a drop of 160 microns diameter when a 10% solution of crude BHC (13% gamma isomer) is used.

40. (37) *Insecticidal Surface Coatings.* Investigations have continued. The effect of the hardness of the resins after drying on the blooming of insecticidal crystals has been studied. Extreme hardness prevents emergence of crystals. The size of crystals in the ' bloom ' diminishes with (i) increase of hardness (ii) increase in insecticide concentration and (iii) increase in violence of mechanical stimulation.

DDT ' blooms ' at 5% concentration after 3 weeks; aldrin did not crystalize until 40% concentration had been reached; gamma BHC bloomed at 10% concentration and higher. Crystal bloom stimulated by insect activity on treated surfaces varies with the habits of the insects. An active walker like *Musca* provides a heavy ' bloom ' whereas a mosquito like *A. aegypti* does not.

Some of the resins prepared 2 years ago are still toxic to insects. One preparation containing 20% DDT has successfully prevented the fouling by barnacles of marine underwater wooden surfaces for several months.

41. *Insect Flight and Insecticide Pick-up.* Tests in a spray cabinet have shown the importance of flight in influencing pick-up (and lethal dosages) by insects. There is a higher kill of insects flying in a 5% DDT mist than of resting insects in a 20% DDT mist of the equivalent particle size.

Other Fundamental Research on Insecticides in the United Kingdom Imperial College Field Station, Silwood Park

42. Residual deposits of insecticide act primarily upon the tarsi of insects. A detailed study of these structures has been almost completed during the past year, for species of tsetse fly and blowfly. Certain regions of the integument are found to be of special significance as sites of aggregation of toxic material and also of probable penetration to the sensory nerves.

43. Work is proceeding on some factors affecting the rapidity with which particles are picked up by walking insects from lightly treated surfaces. Typically there is a high rate of ' pick-up ' for the first few seconds after which the weight taken up increases more slowly and regularly to a saturation limit.

Particular attention is to be given to the high initial pick-up in view of the behaviour of Tsetse flies and mosquitoes (which do not usually walk about after settling).

44. Analytical procedures for the determination of DDT, suitable for use in experiments designed to measure the " pick-up " by flying insects, of oil-base insecticidal spray particles of various sizes, have been worked out.

Rothamsted Experimental Station

45. The fate of crystalline deposits of DDT on glass plates both plain and coated with layers of wax has been studied, working at temperatures approximating to leaf surface temperatures in the tropics. It has been shown that at 110° F., there is a rapid loss of DDT by volatilization, and that the presence of the wax has little effect on the contact toxity of the plates to *Tribolium castaneum Hbst.*

Methods of testing contact activity which will be applicable to leaf surfaces are being developed, together with a method of applying known, even, deposits of insecticides to leaves. These techniques will be used to follow the decay of insecticidal activity on the leaves of a variety of plants, kept under various conditions of temperature and degrees of insolation. Attempts are being made to find which insecticides penetrate through the wax layer of the leaves into the underlying tissue.

Colonial Insecticide Research Unit, East Africa

Insecticide Applications from Fixed-Wing Aircraft against tsetse flies

46. (56) The two Ansons were fitted with boom and nozzle equipment to give liquid particles of an average diameter of 70–80 microns. This new equipment has been used in an experimental treatment of approximately 15 square miles of bush, including some high acacia woodland, infested with *G. morsitans, G. swynnertoni* and *G. pallidipes.* It was originally intended to do this during the dry season, but owing to delays in equipping the aircraft, the latter part of the treatment was applied after the short rains when considerable new foliage was present. Treatment consisted of five sprayings fortnightly followed by two at 2½ week intervals (owing to weather) with 10% DDT in 50% Power Kerosene and 50% Diesoline at an average overall dosage of ¼ lb. of technical DDT per acre per application Assessments conducted before the applications indicated that though only 10% or so of the volume of liquid emitted from the nozzles could be collected as liquid on magnesium oxide plates, about 60% of the total insecticide came down and was recoverable, and of this five-sixths was in the form of very fine liquid or solid particles that could be collected only on fine wire grids and detected chemically. Immediately after the first three applications made in September and October, before new foliage had flushed, no flies could be found in the block. After the trees had produced new foliage in November, however, the efficiency of the treatment was reduced and a few flies could be found. Total catches of flies in the block up to the end of January 1951 were as follows:—

Weekly	*G. morsitans*	*G. swynnertoni*	*G. pallidipes*
Before spraying (av. of 8)	481	76	170
After spraying ...	*1st Spraying*		
	11	17	2
	21	12	3
	2nd Spraying		
	0	0 ?	0
	12	5	0

Weekly	*G. morsitans*	*G. swynnertoni*	*G. pallidipes*
After spraying— (*contd.*)	*3rd Spraying*		
	0	0	0
	11	2	0
	4th Spraying		
	2	1	0
	1	2	0
	5th Spraying		
	0	1	0
	1	0	0
	3	3	0
	6th Spraying		
	0	1	1
	0	2	0
		1	0
	7th Spraying		
	1	0	0
	4	0	0
	7	5	1

Observations are continuing

47. (55) The block of *Miombo-Acacia-Combretum* treated with BHC exhaust smoke in 1949 is now in full leaf. Flies have recovered sufficiently to warrant an experiment to ascertain the effect of this foliage on small particle applications from the air. This investigation is now being carried out. Preliminary observations indicate that the foliage is filtering out a considerable proportion of droplets of 20 microns and over.

Insecticide applications to vegetation with ground equipment (against tsetse flies)

48. Preliminary tests have been made of a " trailer " fire pump mounted on a launch for application of high volume, low concentration emulsions to peripheral vegetation along the shores of Lake Victoria. Results were not promising owing to the difficulty of getting near enough to the shore line in rocky or shallow areas (though the pump threw a jet of about 100 yards).

49. A serious outbreak of sleeping sickness has been occurring for some time along the tributaries of the Nyando river about 20 miles east of Kisumu in Kenya, where *G. palpalis* is numerous in the narrow riverine bush along these streams. An attempt is being made to treat the bush with a DDT suspension and so reduce the fly and stop the outbreak. The first of four treatments was made along some 16 miles of stream in the 3rd week of February. Reduction of fly was striking after this application. This work is being done in co-operation with the Kenya Tsetse Control Department and the Kenya Medical Department.

50. A small half-square-mile block of bush containing *A. morsitans* and *A. swynnertoni* near Kikore is being retained as a special study area. Fly marking and population observations are going on and when adequate data have been collected it is proposed to conduct an eradication experiment with cattle treated with DDT or BHC, in co-operation with the scientists of the East African Tsetse and Trypanosomiasis Research organisation.

Insecticides for the control of Mosquitoes and Malaria

51. (58) *Field experiments in the treatment of native huts, Kasanje.* The last sprayings were made in February and March, 1950. Samples of mud taken from treated walls were examined chemically for insecticide content in February, 1951. The amounts of insecticide recovered expressed in percentages of the amount applied in February-March, 1950, were as follows:—

	Per cent.
DDT in Diesoline	18
Ditrene W.P.	21
Guesarol W.P.	41
BHC in Diesoline	1
BHC W.P. (P.530)	5

Observations on mosquitoes were continued throughout the year to obtain data on the reduction of efficiency of the treatments. Numbers remained low compared with controls although there was a distinct rise from 3 months after the last application of spray. At the end of 1950, mosquitoes in DDT areas were some 14% of the numbers in controls and in the BHC areas they were about 15% of the controls.

52. Dr. P. C. C. Garnham visited the area in May, 1950, to assess results on malaria. His conclusions were briefly:—

(i) The DDT treatments had little if any permanent effect on malaria after the 4 years experiment.
(ii) BHC treatments had reduced malaria incidence to nearly one-third of its original figure.
(iii) It is suggested therefore that BHC applied at 3-monthly intervals is the best insecticide to use.

53. (59) The experiment in Mbale, designed to ascertain if treatment of all houses in a small township with DDT wettable powder would protect the inhabitants from malaria, has been terminated. Three insecticide applications were made at 6-monthly intervals. These had no significant influence on the malaria parasite rates in children and newly born infants in the township. The minimum amount of residual spraying that is necessary to protect a township is, therefore still to be determined but before this can be done it will be necessary to improve the insecticide formulations considerably.

54. An experiment in the control of mosquitoes and malaria by aircraft applications of larvicides to extensive swamp breeding grounds is being conducted in an area of about 4½ square miles west of Dar-es-Salaam in Tanganyika. The boom and nozzle equipment is being used to apply a 10% DDT high-spreading oil solution at a dosage of 2 oz. DDT per acre at each of eight fortnightly applications. Treatment began early in March.

Special Studies on the reaction of A. gambiae and A. funestus to huts treated with DDT and BHC

55. (60) A new study was started by Mr. G. Davidson at Taveta in February, 1950. His results so far show:—

(i) A definite irritant repellant effect of DDT preparations.
(ii) A lower kill from DDT than from BHC preparations probably as the result of (i).
(iii) The apparent fumigant effect of BHC is confirmed in the field. But a lethal effect on caged mosquitoes suspended in treated huts was obtained with Dieldrin and DDT paste. This might be due partly to fine air-borne particles and this possibility is being investigated. A full analysis of the data obtained in this study will be presented in a special report.

Studies of Oilbound Suspensions of DDT (by a member of the staff of the Royal Dutch/Shell Company attached to the Colonial Insecticides Research Unit in East Africa)

56. (57) *Applications to vegetation against tsetse flies.* It was recorded in the last Report that fly reductions were 78–80% and 70–80% respectively on islands treated with DDT emulsions and oilbound suspension. Further data showed reduction in the oilbound suspension island to be about 97%. Twenty-one weeks after the treatments tsetses had recovered to about 86% of the pre-treatment population on the emulsion-treated island, but only to some 6% of pre-treatment density on the island treated with oilbound suspension.

57. *Application of residual spray to houses for the control of mosquitoes and malaria.* In laboratory and small field trials it was shown that (i) both DDT oilbound suspensions and DDT wettable powder (Guesarol) at dosages of 198, 116 and 104 milligrams per square foot, remained highly toxic to mosquitoes for 3–4 months; (ii) oilbound suspension appeared to be little, if any, more effective against *A. gambiae* and *A. funestus* than Guesarol.

Experiment in the Control of Simulium.

58. During January and February, 1951, seven applications of DDT oil solution were made from aircraft to the vegetation along the banks and on the islands of some 5 miles of the river Nile (at Jinja), in an experiment to control adults of *Simulium damnosum.* The aim was to deposit every 3 days about 20 milligrams of DDT per square foot on vegetation used by adult flies for resting, and to measure the effect on adult density. The deposits assessed from 10 leaf collections averaged 21 milligrams per square foot and the reduction in adult flies is indicated by a drop in average daily catches from 36 before spraying to 2 after the fifth spraying. Observations on the fly populations are continuing. This experiment is being conducted at the request of, and in co-operation with, the Director of Medical Services, Uganda, as a preliminary to a possible treatment of some 40 miles of the Nile northwards from Jinja. Although flying was difficult owing to the steep banks the results appear to be very promising.

Insecticides and Agricultural pests

59. A start has been made in this field by co-operation between the Colonial Insecticide Research Unit and the Senior Entomologist, Kawanda, Uganda, on studies directed to the control of sweet potato caterpillar (*Acraea acerata*), cotton stainers (*Dysdercus spp.*) and cotton capsid (*Lygus vosseleri*) by the application of emulsions, wettable powders and dusts of DDT and BHC. This necessitated a very large amount of chemical analysis, and later the posting of a Field Officer to Kawanda to help in the field work and in designing apparatus. Reports on the experiments will be made by the Senior Entomologist, Kawanda.

60. In January, 1950, an entomologist was provided to work with the Senior Entomologist, Agricultural Department, Kenya, on insecticide control of major agricultural pests in Kenya. The programme of work was agreed upon in discussions with the Director of the East African Agricultural Research Organisation and other East African scientists.

General

61. Co-operation with local authorities has involved a large amount of chemical analysis on behalf of the Veterinary Department, Uganda, The Tsetse Control Department, Uganda, the Agricultural Department, Uganda, the Medical Department, Kenya, and the East African Malaria Unit.

Malaria Control in Malaya

Investigations with Residual DDT and BHC

62. The experiment that was commenced in August, 1949, has continued. This consists of comparing the effect on malaria in three valleys, of residual treatment of houses with DDT and BHC and treatment of the population with Proquanil, a fourth valley being used as control. Parasite and spleen rates of children examined half yearly were as follows:—

	Parasite rate per cent.				*Spleen rate per cent.*			
Surveys ...	1st	2nd	*3rd	4th	1st	2nd	*3rd	4th
DDT	40	33	16	12	66	64	45	36
BHC	32	28	17	12	60	59	45	48
Proquanil ...	37	25	5	3	59	53	34	20
Control ...	28	24	17	24	54	54	49	51

* Treatment started four months before the third survey.

The results to date are as good as can reasonably be expected.

Malaria Eradication Experiment—Mauritius

63. This work has continued and three residual sprayings of houses have now been completed. For the third spraying, DDT only was used over the whole island.

64. An indication of the effects of the treatment may be obtained from the following data:

(i) *Entomological*

Mosquitoes collected in routine catches:—

	No. of houses examined	*A gambiae*	*A funestus*	*A aegypti*
Before spraying ...	7,767	2,486	31,196	1,716
After spraying ...	76,246	703	474	1
Reduction %		97·1	99·9	99·9

(ii) *Malaria parasite and spleen rates in children*

	Children examined	*Spleen rate*	*Parasite rate*
First survey 1948 ...	3,585	34·8	9·5
Second survey 1949 ...	12,105	15·3	2·4
Third survey 1950 ...	14,526	2·8	0·36

(iii) *Malaria parasite rates in infants born since the first spraying*

	Total No. examined	*Parasite rate %*
0–12 months	7,065	0·27

(iv) *Malaria morbidity*

(*a*) Malaria cases notified by hospitals and dispensaries in the period January-June, 1950, show a reduction of 86% on the previous lowest year 1948.

(*b*) In 1,760 Blood slides taken from " fever " cases at dispensaries during the period January to September, 1950, only 53 (3%) were positive for malaria.

(v) *Total annual death rates:—*

Mean rate 1934–48 per 1,000 mid year population	27·2	±	3·37
Range for 1934–48	20·1	—	36·1
Rate for 1949	16·6		

(vi) *Infant Mortality*

Mean rate 1934–48 (per 1,000 live births)	150	±	19·2
Range 1934–48	113·9	—	188
Rate for 1949	91		

(vii) *Malaria deaths during the epidemic first 6 months of year*

Mean rate 1934–48 (per 10,000 population) ...	32·2	±	8·07
Range	21	—	47·1
Rate for 1950 per 10,000	4·9		

(viii) *Total annual death rates for first 6 months of the year*

Mean rate for 1934–48	28·0	±	4·22
Range 1934–40	20·6	—	38·4
Rate for 1950	14·7		

65. The apparent ability of *A. gambiae* to survive the treatment in appreciable numbers makes necessary the introduction of additional measures to deal with it. It has been decided therefore that antilarval measures shall be applied. A re-organisation of staff has been necessary and these additional measures are now being applied in one only of the six districts. They will be extended to other districts when the new organisation and techniques have been proved satisfactory.

66. By arrangement with the French authorities the island of Reunion, about 100 miles west of Mauritius was used as a " control ". The French authorities, however, stimulated by results in Mauritius, have now begun a campaign of DDT residual spraying in Reunion, so that a " control " is no longer available.

APPENDIX I.

Colonial Insecticides Fungicides and Herbicides Committee

Appendix I to the Annual Report of the Colonial Insecticides, Fungicides and Herbicides Committee for 1950–51

COLONIAL INSECTICIDE RESEARCH

Brief History including practical results as far as it is possible to assess them

1. The present organisation has grown from the team of two entomologists who initiated experimental work on malaria control in British Guiana in January, 1945.

2. Before the trials in British Guiana were completed, a request was received (March, 1945) from the Governor of Uganda that staff, materials and money should be provided for field studies on the control of tsetse flies by the use of DDT or BHC. This request was supported by the Tsetse and Trypanosomiasis Committee.

A team of 2 Entomologists, 1 chemist and 3 European assistants was formed and funds were voted for experiments on the lines suggested. At the suggestion of Mr. Symes, however, the team's activities were expanded to embrace experiments on the control of malaria by residual spraying of houses—an extension to Africa of the work started in British Guiana. These two problems seemed worthy of an appreciable effort, not only because in themselves they were two of the major hindrances to colonial development, but also because the studies they demanded would produce data applicable to many other important insect problems. This is particularly true of investigations into the application of chemicals to vegetation for the control of tsetse flies. These investigations were commenced in Uganda at the end of 1945.

3. The Colonial Insecticides Committee was set up in January, 1947. Its terms of reference (see First Annual Report, 1947–48, page 93) are briefly the initiation, stimulation and co-ordination of research in the use of insecticides for the control of pests and disease vectors in public health, agriculture, forestry and animal husbandry. The Committee and its terms of reference were widened in 1949 to include research on fungicides and herbicides (including arboricides and defoliants).

4. *Staff*

(i) An officer-in-charge of research stationed at the Colonial Office whose duties include the co-ordination and supervision of all the research activities carried out under the aegis of the Committee.

(ii) *In United Kingdom at Porton*

2 Entomologists, one chemist and
2 laboratory assistants.

(iii) *In East Africa*

4 Entomologists.
1 Chemist.
1 Physicist.
1 Senior Field Officer.
6 Field Officers.
3 Laboratory Technicians.

One entomologist is working in collaboration with the Senior Entomologist Kenya, on agricultural problems; and one Field Officer is working with the Senior Agricultural Entomologist in Uganda on experiments for the control of certain major pests of cotton. The others are engaged on field and laboratory studies on the control of malaria and on the application of insecticides to vegetation for the control of tsetse flies, and agricultural pests. Much effort is devoted to studies of aircraft spraying.

(iv) *In Mauritius*

1 Research Medical Officer.
1 Chemist.
1 Entomologist (part-time).
(A full-time entomologist is now being provided.)
6 Field Officers and 6 assistant Field Officers.

(v) In addition to the above, basic research is also being undertaken at the Imperial College Field Station, Silwood Park, and at Rothamsted with funds provided by Colonial Development and Welfare Research grants. The staff provided for are:—

Silwood Park: Two research officers and two experimental officers.
Rothamsted: Two research officers and one assistant.

5. It should be emphasised that, although the staff is scattered, all work is closely co-ordinated. All basic research whether in the United Kingdom or overseas is directed to solving problems that have arisen in the field. The activities summarised below are therefore retained under subject rather than geographical headings.

WORK COMPLETED OR IN PROGRESS

Malaria

6.—(*a*) *British Guiana.* Initiation of control by residual spraying with 5% DDT in kerosene has led to the eradication of malaria in the coastal belt. Some 300,000 people have been protected against malaria and the vector *A. darlingi* has virtually disappeared.

(*b*) *Mauritius.* Near elimination of one vector (*A. funestus*) and great reduction of a second (*A. gambiae*) resulting in a reduction in malaria of well over 90% over the whole island. The residue of malaria, presumably being carried by the remaining *A. gambiae*, is now to be attacked by both residual spraying and antilarval measures.

(*c*) *Uganda.* Three field experiments have been conducted.

(i) The first, to determine what kind of insecticide formulation would be suitable for the reduction of malaria in a rural area, was continued over a period of 4 years. Results indicated that of the formulations used, a BHC wettable powder applied every 6 months at a dosage of about 100 milligrams per square foot had reduced infection by over 50%.

(ii) The second was designed to determine the effect, on malaria, of five 6-monthly applications to mud huts of a 4% pp[1] DDT solution in diesolene at a nominal dosage of about 200 milligrams per square foot. The actual dosage as estimated chemically for the last two sprayings was much in excess of this. The cost was about 2s. 6d. per hut per spraying.

Results indicated that though there was a big kill of vector mosquitoes (*A. gambiae*, *A. funestus* and *A. moucheti*) there was no apparent reduction in malaria parasite and spleen rates in children over the whole area. This result was attributed to after-dark movement of the population.

A secondary object of the experiment in its early stages was to measure the effect of this spraying, over about 5 square miles, on malaria incidence on a prisoner-of-war camp situated roughly in the middle of the treated area. Results showed that there was a drop from 91% infection to 24·4% in 18 months presumably as the result of the spraying.

These two experiments and the laboratory investigations that accompanied them indicated amongst many things that solutions and emulsions were not suitable for application to mud walls in East Africa and that wettable powders in suspension were much to be preferred. They also indicated that the areas chosen for the experiments were too small, that much improved technique in the making of spleen and parasite surveys was necessary, and that the spraying equipment available was not very suitable.

(iii) A third experiment was conducted in Uganda over 2 years to ascertain if the inhabitants of a small township could be protected by the residual spraying of houses every 6 months, in the township only, with a suspension of DDT wettable powder (Guesarol) at a nominal dosage of about 100 milligrams per square foot. Results indicated little if any reduction in malaria parasite and spleen rates. Laboratory experiments and estimations showed that, even with deposits of over 600 milligrams of DDT per square foot, the toxicity of this wettable powder was very low and it is suspected that this was due to the masking effect of the large particle diluent dust. This experiment has therefore suggested another " problem " —the proper formulation of wettable powders and suspensions. The protection of a township, or a large part of it, by spraying houses only within its boundaries may still be possible with a suitable insecticide formulation. It is necessary to settle this with more experiments since many authorities in Africa wish to undertake such antimalaria measures in townships.

(*d*) *Uganda.* Special small scale field and laboratory studies in Africa have been a necessary supplement to larger trials. These have shown among other things that:—

(i) Lime plaster interferes seriously with the toxicity of DDT residual deposits.

(ii) Vector mosquitoes enter huts all through the night, with peak entries at dawn and dusk.

(iii) A majority of *A. gambiae* nest on the roofs of huts rather than the walls, and over 70% of all species of mosquitoes entering huts during the night remain for 2 hours or longer.

(iv) Though more specimens of *A. gambiae* escape from huts treated with DDT solutions or wettable powders than from untreated or BHC treated huts, the number that do so are not nearly sufficient to warrant a condemnation of DDT.

(v) Absorption by mud walls (probably combined with adsorption) may account for losses of up to 90% of solutions, up to 70% of the emulsions and up to 30% of the wettable powders.

(vi) Wettable powder formulations despatched by manufacturers often undergo a differential settling out of insecticide and diluent (the one being heavier or bigger in particle size than the other) so that insecticide content varies at different levels of large containers.

(*e*) *United Kingdom.* It became evident that field and laboratory studies in East Africa could not supply answers to many of the problems that arose. The Committee therefore sanctioned a small team of 2 entomologists, one chemist and 2 assistants to work at Porton and to undertake more fundamental work than was possible in Africa. This team started work at the end of 1948. Their researches have produced the following facts amongst many others:—

(i) Availability of insecticides on surfaces depends upon the size, shape, weight and orientation of the crystals, and these are in turn influenced by the surfaces and solvents concerned. Under most conditions small thin needle crystals of 10 to 20 microns, or " plates " of equivalent mass, are more toxic than larger ones, and " oily " small crystals are more toxic than dry ones. The essential requirement is that crystals shall be of such a size, shape and condition that they can be readily carried away on the feet of insects and it may soon be known on what parts of the feet they are best carried.

(ii) In wettable powders it is desirable to have small crystals and not more than 50% of diluent powder of the same particle size as the crystals. Poor toxicities of various wettable powders have been traced to larger crystal sizes or to the large particles of the dust diluent.

(iii) It is possible, under laboratory conditions at least, to produce hard surface coatings of urea formaldehyde resin (similar to hard setting varnish) with DDT, BHC, dieldrin or aldrin incorporated in such a way that the coating remains toxic for many months. (This is part of a search for " residual " formulations, for better class houses, ships, aircraft, etc.)

(iv) BHC (gamma), pure compound 118 (aldrin), chlordane, pure Compound 497 (dieldrin) and toxaphene all have appreciable fumigant action against mosquitoes. BHC and aldrin vapours are particularly toxic, " vapour " from the former killing 100% of mosquitoes exposed to them for 45 minutes. BHC " adsorped " by mud or plastic surfaces so that no surface deposit remains can continue to kill mosquitoes alighting on the surfaces.

(v) The adsorption of DDT on Uganda mud surfaces is much greater than was supposed, and this will account for much of the apparent low toxicity of some DDT formulations to *Anopheles gambiae*.

(f) *Equipment for Malaria control by residual spraying.* Very early in the work in British Guiana and Africa it became clear that the sprayers available for residual spraying were not very suitable and proposals were submitted for new types. This request was dealt with by the Sprayers Sub-Committee of the Research and Development Co-ordinating Committee on Fungicides and Insecticides. Funds voted by the Colonial Office (before the Colonial Insecticides, Herbicides and Fungicides Committee came into being) have facilitated fundamental studies on nozzles and the production of a prototype new sprayer. The best nozzle and the sprayer are about to be tested in the field.

In addition, C.I.C. staff have initiated the production of a new model hand-powered sprayer (the Fortemist), a new stirrup pump assembly, and modifications of the Aerostyle motor sprayer and of Four Oaks Kent knapsack sprayers. The Fortemist and the new stirrup pump assembly, were kindly designed by Dr. H. G. H. Kearns of Long Ashton. All are now being tested under field conditions.

7. *Other activities* in connection with malaria control include:—

(i) Malaya. Financial support for experiments that, so far, appear to be producing valuable results.

(ii) Swaziland. Stimulation of residual spraying with good results.

(iii) Nyasaland. Help in the provision of special stirrup pump equipment.

(iv) Jamaica and Bermuda. Surveys and reports on mosquito conditions.

8. "*Practical*" *Results* of, or developing from, C.I.C. work on mosquito and malaria control.

(i) Eradication of malaria in British Guiana affecting 300,000 people and development of a method suitable for similar conditions elsewhere.

(ii) Near-eradication of malaria in Mauritius (affecting about 350,000 people) and development of a method for dealing with *A. funestus* and *A. gambiae* in an isolated area.

(iii) The adoption of wettable powders and suspensions for residual applications to mud huts in the African region, and probably in part of America and Asia.

(iv) Development and field tests, with the Shell scientists, of a new formulation of BHC and DDT based upon our researches (see para. 6 (*e*) (i)). This is the most toxic suspension now available for residual spraying.

(v) Improvements in other insecticide formulations through close and frequent consultations with Geigy, I.C.I., Shell, Murphy Chemical Company and others.

(vi) Appreciable improvements in equipment, though much remains to be done in this respect.

There is no doubt that our contacts with industry and with authorities in the tropics, and particularly in Africa, both direct and by means of correspondence and reports, have had a very considerable influence on both the production of improved

formulations and on their use in malaria control in many territories both British and foreign. This wide influence probably constitutes our greatest contribution. There is still a great waste of good insecticides and need for a great expansion in their proper use in the colonies.

Application of insecticides to vegetation for the control of tsetse flies (and other pests such as those of crops, ticks, etc.)

9. There are two methods, firstly the application of chemicals in such a way that they remain residual deposits on leaves and stems of vegetation so that insects alighting make lethal contact and, secondly the application of chemicals in such a way that they will remain air-borne and " diffuse " through the vegetation, killing insects whether in flight or stationary that are " hit " by the air-borne particles.

(i) *Residual deposits applied from the ground or from the air*

The first or " residual " method was tried in Uganda during 1946 and 1947 with small knapsack sprayers and in 1948 and 1949 with aircraft. Laboratory studies showed that both DDT and BHC solutions and emulsions applied to leaves at dosages equivalent to ½ lb. or more per acre killed tsetse flies (*G. palpalis*) after a 20-second contact. Field experiments on islands and headlands in Lake Victoria indicated that one application of certain solutions and emulsions to about 5 or 6 per cent. of the total vegetation (in fly concentrations) would reduce flies by 50% or more, and that 4 such applications extended over a period of about 56 days (the minimum duration of the pupal stage) could achieve near and perhaps complete elimination in isolated areas.

Impregnated Screens. A modification of this residual method on leaves is the application of the insecticide to cloth screens distributed in fly concentration areas and patrol routes. After preliminary laboratory studies, three experiments were conducted on islands. The results indicated that with a density of 10 screens per acre treated with DDT in diesoline once a month a reduction of 90% of flies could be obtained. It is concluded that this method, perhaps combined with spraying of vegetation, would reduce flies drastically and economically at infested watering places and river crossings or other places used by people and cattle.

Application of insecticidal sprays from the air. It was considered that more complete kills of flies would be obtained by application of the insecticides in solution to the whole of the infested bush. This is not possible with ground equipment. After trials and studies in England and Africa, aircraft fitted with Porton equipment were used for two island experiments of this kind. A great deal of data was obtained from these experiments. Briefly they showed that whereas in the open some 67% or more of an emulsion (in assessed particle sizes of say 250 to 2,500 microns with a mean mass diameter of 780 microns) could be recovered, in high canopied bush of *G. palpalis* areas only some 5% of this appeared to get to within 6 feet of the ground (except in open glades) the remainder being stopped by the foliage. Thus the initial dosageof 0·25 lbs. of insecticide per acre (DDT or BHC) was reduced to about ·007 lbs. per acre under the dense bush. (It is probable that somewhat more than this got down since the very finest air-borne particles were not picked up by the assessment equipment.) The reduction of flies was negligible on the BHC island and about 10% on that treated with DDT.

A third trial of this method was made against *G. swynnertoni* in light deciduous thorn scrub along a cattle route. In this experiment an average of some 80% of the solution (5% DDT in diesoline) was recorded on and within 6 feet of the ground, but there were many small areas that received no treatment. Kills of flies were estimated at about 60% for each of the seven applications. Since there was little if any breeding in the area, this reduced the flies to nil after the fifth application. The total cost of the operations was about 22 shillings per acre.

Finely divided liquid from aircraft. The exhaust smoke method (see (ii) below) though very promising is somewhat wasteful of material unless considerable improvement in the equipment can be effected. (This is now being attempted with the help of the Porton authorities, and the Lister-Todd Corporation.) It was considered that a finely divided liquid applied from aircraft would diffuse through vegetation and ultimately deposit at the lower levels. Equipment consisting of a boom and nozzle

was therefore fitted to the Ansons (1950) to give a liquid spray of small particle size. This new equipment is now being tried. The first trials, over some 15 square miles of bush containing *G. morsitans* and *G. swynnertoni*, and over 5 miles of the Nile (against *Simulium damnosum*) have been completed. Initial kills of tsetse flies appeared to be satisfactory. Reports of final assessments are awaited.

Laboratory and semi-field studies. These have been conducted in Africa side by side with the earliest of these field experiments. These indicated that there is serious loss by absorption of oil solutions of DDT applied to leaves; the loss of some emulsions is rather less; there is appreciable loss of toxicity of DDT applied to exposed vegetation through the action of the sun's light or heat.

It was concluded from these laboratory and field studies that—

(*a*) the particle size range produced by this Porton aircraft equipment was too high for the penetration of vegetation and particularly in forested areas inhabited by *G. palpalis;*

(*b*) a search must be made for formulations that would not be absorbed by foliage and that would not be seriously affected by sun light;

(*c*) improved means of ground assessment of air-sprays are needed;

(*d*) though the effect on flies in forest areas was poor (owing to the influence of the canopy) the kill in light bush was very promising and warranted much further study.

(ii) *Smokes and ogs: non-residual*

From ground equipment. The application of insecticides in such a form that they " diffuse " through vegetation has received much attention. Insecticidal " smokes " and " fogs " offered the first opportunity for experiments. The first smokes were produced from small ground generators of the canister type. Small trials in which it was shown that both DDT and BHC smokes were toxic to *G. palpalis* led to the treatment of an island of 50 acres with BHC (Gammexane) smoke generated from 1 lb. canisters, in four applications at about fortnightly intervals. Results indicated that there had been a 90% kill of tsetse flies. But even in this small island the distribution of the canisters to ensure complete coverage by the smoke was difficult and inadequate.

Tests were then made with the TIFA fog generator. It was found that the BHC fogs from this gave kills of only about 50% in *palpalis* bush on account of poor penetration; but in light scrub it killed all tsetses up to a range of 600 yards from the generator. Lack of roads makes the use of this machine difficult over wide areas of tsetse bush, but it obviously has its uses in special areas.

From Aircraft. Smokes from aircraft had given appreciable success in South Africa against *G. pallidipes.* Apparatus for generating insecticidal smoke from the exhausts was therefore fitted to the two Anson aircraft used for spraying, and this method was tried on *G. palpalis* bush in 1948–9, and on light deciduous bush against *G. morsitans* and *G. swynnertoni* in 1949–50. The particle size range of this " smoke " was 5 to 250 microns with a mass medium diameter of about 80 microns and a mass number diameter of 10 to 15 microns. It was estimated that 50–60% of the smoke reached the lower six feet of bush in *palpalis* areas. Kills of *G. palpalis* with 8 applications of DDT smoke reached 63% and with the BHC smoke 69%.

In the lighter deciduous bush and over areas of 6 and 9 square miles respectively 8 applications gave kills of 99·5% with DDT smoke and 93% with BHC smoke at a total cost of about £2 per acre. This can be reduced very considerably in routine practice.

These last results were very promising. The trials and their parallel laboratory studies indicated that—

(*a*) flies can be reduced drastically and almost, if not quite, to the point of elimination in a short period by this method;

(*b*) the smokes produced are not true smokes but rather finely divided liquids;

(*c*) there is a certain amount of insecticide lost through exposure to the high temperature in the exhaust. In some assessments this loss has been as high as 16% of DDT and 34% of BHC;

(*d*) the aircraft equipment was not entirely satisfactory;

(*e*) the 10% solutions used were not very suitable in that the insecticide materials caused considerable deposits of sludge in aircraft tanks.

It should be pointed out that the choice of solvents have been confined to those locally available. Solvents such as Toluene for the making of concentrates have not yet been tried since these have to be specially imported.

(iii) *Basic Research in United Kingdom connected with applications to vegetation*

Whilst the field trials have gone on, research staff in England have been employed on questions arising from them. Amongst the data obtained are—

(*a*) a drop of 10% DDT (80% pp.) in 1st grade kerosene of 155 microns diameter and a drop of 10% BHC (13% gamma) of 160 microns diameter will kill a tsetse fly (*G. palpalis*);

(*b*) flies in flight are more than twice as susceptible to airborne particles of about 5–20 microns than flies that are not in flight, presumably because they collect more;

(*c*) the addition of a high boiling point oil to such airborne particles increases their toxicity very considerably;

(*d*) in still air, particles larger than 8 microns settle in 4 minutes or less;

(*e*) the mechanism and rate of " pick-up " of insecticide particles by a walking or alighting insect;

(*f*) the loss (not through absorption or solution in leaf wax) of DDT from deposits on leaves exposed to high atmospheric temperatures.

(iv) " *Practical* " *results or trends of the C.I.C. work on Tsetse bush*

(*a*) Demonstration of ground spraying methods of reducing *G. palpalis* quickly and drastically in dense lake shore bush, and of virtual elimination in isolated areas of such bush, at less than half the cost of bush clearing. This provides a means of dealing rapidly with outbreaks of sleeping sickness in such areas.

(*b*) Demonstration of methods that will protect people and cattle of infested river crossings, watering places and boat landing at low cost.

(*c*) Investigation of insecticidal fogs and smokes has shown them to be very toxic to tsetses and other flying insects in vegetation whether applied from ground equipment or from aircrafts. A virtual elimination of tsetses in a 6 square mile block of bush was achieved with the use of aircraft at about the same cost as bush clearing.

(*d*) Aircraft spraying with fixed wing aircraft even in its present somewhat early stage of development has proved a very promising method for the reduction of tsetses in experimental areas of fairly flat savanna country. The incorporation of our latest knowledge together with the data gathered in the most recent trials, and in the special meteorological studies now going on, should make it a much more effective method for the application of chemicals to vegetation and to other surfaces. It cannot be used in its present form for broken hilly country. For this either pattern " bombing " or the helicopter or both would appear to warrant full investigation.

Both the laboratory and field studies, and particularly the work in the United Kingdom have provided data of great value for application to major agricultural and forestry problems.

Application of insecticides to cattle for the control of tsetse flies (and other pests)

10. A little work was done on this in 1946. After preliminary studies with individual animals in Shinyanga and Uganda a field trial with 350 cattle was conducted by the Tsetse Research Department at Shinyanga (with C.I.C. co-operation). Results showed a reduction of over 80% of *G. pallidipes* in 6 months.

Laboratory studies in Entebbe showed that absorption of oil solution into and through the skin of cattle was appreciable. More recent research at Porton with new formulations has failed to produce one that remains sufficiently toxic on cattle for more than about 8 days. This warrants much further attention; it will be linked with the proposed studies on *Stomoxys*.

Other activities

11. (i) *Hide beetle control.* In 1946–47 the C.I.C. team in Uganda, in co-operation with the Veterinary Department and the Imperial Institute, demonstrated a method of control of hide beetles in raw hides.

(ii) *Protection of timber against termites.* A method of timber treatment for its protection against termites was worked out in co-operation with the Chief Entomologist, Uganda, in 1946.

(iii) *Aircraft Disinfestation.* The C.I.C. team in Uganda initiated and carried out in co-operation with the Senior Parasitologist, Kenya, studies and experiments which indicated that a simple DDT emulsion applied to the internal surfaces of aircrafts in regular passenger service remained toxic to mosquitoes for 4 months. The production of long-lasting insecticidal " varnish " (see paragraph 6 (*e*) (iii) above) is an extension of this early work in Africa.

12. The extension of the work of the Committee to cover the herbicide and fungicide fields is too recent for results to be apparent as yet.

13. *Future work.* This will be directed to continuing the present lines of research and extending them, in the light of the knowledge gained, to cope with new problems as they arise. Greater effort will be made towards a solution of problems directly connected with Colonial agriculture. It will be appreciated, however, that financial stringency makes a rapid extension of the work unlikely.

14. The very real practical results that have been achieved by the Committee have been mentioned above but the work of the Committee may be of even greater importance in some other directions. For instance the fundamental work carried out has had a great influence on the production and application of insecticides during the past three years. It is not possible to assess the value of this to the Colonial Empire and the tropics generally, but it is none the less a very real achievement, that has resulted directly from the work of the Committee.

APPENDIX II

List of publications

Papers Published

Studies on Aqueous Suspensions of Insecticides. By A. B. Hadaway and F. Barlow. *Bulletin of Entomological Research.*

Malaria Eradication Scheme, Mauritius. Annual Report 1950. By M. A. C. Dowling. (Government Printer, Mauritius).

Papers in the Press

Studies on Aqueous Suspensions of Insecticides, Part II, Quantitative determination of dosages picked up and retained. By A. B. Hadaway and F. Barlow.

Comparison of DDT oil-bound suspensions with DDT emulsions for control of tsetse flies in E. Africa. By N. Van Tiel.

Comparison of DDT-BHC oil-bound suspensions with DDT wettable powders for the control of mosquitoes in E. Africa. By H. Van Tiel.

Reports Circulated to the Committee

Gammaxane Experiment: Atta Island, Tanganyika.

Report on a visit to Mauritius. By P. C. C. Garnham.

Properties and Relative Toxicities of a number of Synthetic Insecticides. By A. B. Hadaway and F. Barlow.

Surface Coatings, incorporating DDT, BHC, Aldrin and Dieldrin. By P. Bracey.

Experiments on the effect of the use of Residual Insecticides in houses against *A. gambiae* and *A. funestus.* By G. Davidson.

Aerial Spraying against Tsetse Flies in E. Africa. III. Aerosol applications. By K. Hocking.

Report on the Mosquito Problem in Bermuda. By C. B. Symes.

Report on Malaria in Jamaica. By C. B. Symes.

Factors affecting the action of Residual Deposits on foliage. By A. B. Hadaway and F. Barlow.

Drop Spectra and Recovery Trials with Shell oil-bound suspension. By D. Yeo.

Physical and Chemical Assessments of the Boom Installations of the Experimental Ansons. By D. Yeo.

Report on Drop Spectrum of an Insecticide oil solution when sprayed from an Avro XIX aircraft fitted with modified spraying equipment. Porton Technical Paper No. 198 (25th September, 1950).

Aircraft experiments in E. Africa. Summary of work. November 1948 to December, 1950. By C. B. Symes.

Colonial Economic Research Committee Fourth Annual Report (1950-1951)

London School of Economics and Political Science,
Houghton Street,
Aldwych, W.C.2.
7th July, 1951.

SIR,

I have the honour on behalf of the Colonial Economic Research Committee to transmit to you the fourth report of the Committee covering the period from 1st April, 1950 to 31st March, 1951.

I have the honour to be,
Sir,
Your most obedient servant,
(Sgd.) ARNOLD PLANT.

The Right Honourable James Griffiths, M.P.,
Secretary of State for the Colonies.

COLONIAL ECONOMIC RESEARCH COMMITTEE

FOURTH ANNUAL REPORT

(1950–1951)

Membership

PROFESSOR SIR ARNOLD PLANT, Professor of Commerce, University of London (London School of Economics), *Chairman*.

PROFESSOR A. J. BROWN, D.Phil., Professor of Economics, University of Leeds.

MR. H. CAMPION, C.B., C.B.E., Director of the Central Statistical Office, Offices of the Cabinet.

PROFESSOR S. H. FRANKEL, D.Sc. (Econ.), Professor of Colonial Economic Affairs, University of Oxford.

MR. R. GLENDAY, M.C., Federation of British Industries.

MR. R. L. HALL, C.B., Director of Economic Section, Offices of the Cabinet.

DR. J. R. RAEBURN, Reader in Agricultural Economics, University of London, (London School of Economics).

PROFESSOR E. A. G. ROBINSON, C.M.G., O.B.E., Professor of Economics, University of Cambridge.

MR. K. E. ROBINSON, Fellow of Nuffield College and Reader in Colonial Administration, University of Oxford.

MR. J. STAFFORD, Head of Statistics Division, Board of Trade.

MR. C. S. ROBERTS, Secretary.

There is in addition an Advisory Panel on National Income Studies, the function of which is to assist the Committee when questions of national income research arise. The membership of the Panel includes Professor Sir Arnold Plant (*Chairman*), Professor Brown, Professor Frankel and Professor E. A. G. Robinson, who are members of the Committee, together with Mr. E. Jackson, of the Central Statistical Office, Mr. J. R. N. Stone of the Department of Applied Economics, University of Cambridge, and Mr. R. C. Tress of the London School of Economics.

Terms of Reference

The terms of reference of the Committee are to advise the Secretary of State in connection with economic research and statistics.

COLONIAL ECONOMIC RESEARCH COMMITTEE

CONTENTS

FOURTH ANNUAL REPORT

I. INTRODUCTORY

1. There were three meetings of the Committee during the year. The membership of the Committee remained unchanged during this period.

II. ECONOMIC RESEARCH UNDERTAKEN DURING THE YEAR

2. The study of the national income of Nigeria, which was referred to in paragraph 4 of the previous annual report of the Committee, was initiated during the autumn of 1950. The enquiry which is expected to take up to two years to complete, is being carried out by a team of three operating under the general supervision of a Working Committee convened by the Department of Applied Economics at Cambridge, which consists of Professor E. A. G. Robinson (Chairman), Mr. Richard Stone, Mr. P. T. Bauer, Miss P. M. Deane and Dr. A. R. Prest. In addition a representative of the Colonial Office is associated with the Committee. The members of the investigating team are Dr. A. R. Prest, Lecturer in Economics at Camb dge University, Mr. I. G. Stewart and a Nigerian Research Assistant, whose services have been made available by the local Government. Mr. Stewart is spending the greater part of the period of the enquiry in Nigeria while Dr. Prest, who is in charge of the team, is making periodical visits to the territory. The enquiry, which is being partly financed from Nigerian Government funds, is expected to prove of assistance to the local Government in the formulation of their economic and developmental policy. It is also likely to yield useful results for the planning of national income studies elsewhere in Colonial territories where similar problems arise. In the meantime a number of territories are instituting local studies of their national incomes conducted by the statistical staff a'ready at the disposal of the Governments, or by research workers attached to the local Institutes of Economic and Social Research.

3. A survey of the available data relating to Colonial dependence on imported foods has been completed by Dr. C. Leubuscher. The Committee, after consideration of the report of this enquiry, has recommended that the desirability of further research into the subject should be further explored in consultation with the Governments of those territories where the problems raised appear to have their greatest application.

4. An investigation into the transport economics of Nigeria, in relation to the general economic development of the territory, is being carried out by Professor Gilbert Walker, Professor of Economics at the University of Birmingham. Professor Walker has made two visits to Nigeria, one in July-August 1950, and the other in December 1950–January 1951. His report of the conclusions reached during the enquiry is expected to be available by the summer of 1951. The Government of the Gold Coast also intends to arrange for an enquiry by a suitably qualified economist into the transport economics of their territory, the details of which were still under discussion at the end of the year.

5. Mr. P. T. Bauer, Fellow of Gonville and Caius College, Cambridge, who has been carrying out an investigation into the structure and organization of trade in the British West African territories, returned in October from the second of two visits to West Africa. Mr. Bauer expects to complete the report upon his enquiry in the near future.

6. Another economic research project which was continued during the year was the study of Colonial monetary systems by Dr. Ida Greaves. Dr. Greaves had previously visited the West Indies and West Africa and is now engaged in completing her final report.

7. In March, 1951, arrangements were made for a pilot investigation by the British Export Trade Research Organization on behalf of the Secretary of State, of the value of sample market surveys as an aid to the general policy of promoting industrial development in the Colonial territories. Representatives of the Organization subsequently visited Nigeria in this connection.

III. PLANS FOR FUTURE ECONOMIC RESEARCH

8. Of the subjects for further research listed in paragraph 4 of the previous annual report of the Committee, it is hoped to recruit suitable economists to undertake studies of the retail trade in Tanganyika, Nyasaland and Zanzibar, and of capital investment problems in the Colonial territories generally. In the latter case, the Government of Jamaica have agreed to a suggestion by the Secretary of State that an initial enquiry should be carried out in Jamaica. Detailed plans for these two studies are now being formulated. Of the other proposed projects referred to in the report for 1949–1950 those relating to the economics of the oil palm industries in Nigeria and Sierra Leone, the economics of land use in Jamaica, and a rural economic survey of Malaya are still the subject of correspondence with the Governments concerned. The Committee has further considered the desirability of initiating a study of fiscal policy in relation to Colonial economic development but has recommended that while the subject should be retained on the list of possible projects action to proceed with the study should be deferred. The proposed study of the national income of Mauritius is now to be undertaken by the local Government.

9. Of the total sum of Colonial Development and Welfare Research funds available to provide new money for Colonial Research between now and the date of expiry of the Colonial Development and Welfare Act of 1945 (31st March, 1956), £100,000 has been allocated for the purposes of economic research. The Committee is to consider shortly the planning of the expenditure of this sum, and a detailed list of further schemes for which Colonial Governments have asked is being prepared in the Colonial Office for the Committee's examination and advice.

IV. GENERAL

10. A Conference of Colonial Government Statisticians was held in London in March, 1950, the report of which has been circulated to the members of the Committee for their consideration.

11. The Committee has continued, in collaboration with the Colonial Social Science Research Council, to assist the progress of the various institutes of economic and social research which have been set up in Africa and the West Indies. At the end of the year a special meeting of the Committee was arranged to enable members to meet Professor W. Hamilton Whyte, the Director of the West African Institute of Social and Economic Research, who was on a visit to the United Kingdom, and to discuss with him the problems which he had encountered since taking up his post in September, 1950.

Tsetse Fly and Trypanosomiasis Committee Report for 1950-1951

The Church House,
Great Smith Street,
Westminster, S.W.1
13th June, 1951.

SIR,

I have the honour to transmit to you the Report of the Tsetse Fly and Trypanosomiasis Committee for the year ended 31st March, 1951.

I have the honour to be,
Sir,
Your obedient servant,
(Sgd.) A. B. COHEN,
(Chairman).

The Right Honourable James Griffiths, M.P ,
Secretary of State for the Colonies.

TSETSE FLY AND TRYPANOSOMIASIS COMMITTEE

REPORT FOR 1950–1951

Membership

MR. A. B. COHEN, C.M.G., O.B.E., Assistant Under-Secretary of State, Colonial Office (*Chairman*).

PROFESSOR P. A. BUXTON, C.M.G., F.R.S., Professor of Medical Entomology, University of London.

CAPTAIN K. F. T. CALDWELL, Formerly of the Kenya Game Department.

DR. J. CARMICHAEL, C.M.G., M.R.C.V.S., Formerly of the Colonial Veterinary Service.

PROFESSOR T. H. DAVEY, O.B.E., M.D., D.T.M., Liverpool School of Tropical Medicine.

DR. C. A. HOARE, F.R.S., Of the Wellcome Laboratories of Tropical Medicine.

DR. H. M. O. LESTER, O.B.E., B.Sc., M.R.C.S., L.R.C.P., Director, East African Tsetse and Trypanosomiasis Research and Reclamation Organization.

DR. E. M. LOURIE, M.B., D.P.H., Of the Department of Pharmacology, Oxford University.

DR. L. HARRISON MATTHEWS, M.A., Scientific Director of the Zoological Society of London.

COL. H. W. MULLIGAN, M.D., D.Sc., Director, West African Institute for Trypanosomiasis Research.

SIR COSMO PARKINSON, G.C.M.G., K.C.B., O.B.E., Formerly Permanent Under-Secretary of State, Colonial Office.

MR. D. L. PEARSON, Colonial Office (*Secretary*).

Ex-Officio Members

The Secretary of State's Chief Medical Officer, and Advisers on Agriculture and Animal Health. The Director of Colonial Medical Research. The Secretary of the Colonial Insecticides, Fungicides and Herbicides Committee. A representative of the Secretary of State for Commonwealth Relations. A representative of the Sudan Government.

It is the practice to invite a member of the National Institute for Medical Research and the Central African Scientific Liaison Officer to attend meetings.

Terms of Reference

The terms of reference of the Committee are:—

> " To consider and advise on the co-ordination of action, including research and reclamation, directed against human and animal trypanosomiasis ".

TSETSE FLY AND TRYPANOSOMIASIS COMMITTEE

REPORT FOR 1950–1951

CONTENTS

TSETSE FLY AND TRYPANOSOMIASIS COMMITTEE

REPORT FOR 1950-1951

PART I—INTRODUCTORY

Although notes on the work of the Tsetse Fly and Trypanosomiasis Committee have appeared annually in the publication entitled " Colonial Research " the Committee has not previously submitted a report in the present form. It has been felt desirable, therefore, to preface the report of work carried out in 1950–51 with some notes on the origin and past activities of the Committee.

2. In 1939 there existed in London a Tsetse Committee of the Economic Advisory Council with the duty of considering and reporting on question relating to human and animal trypanosomiasis in the British Colonies and dependencies in Africa. This Committee lapsed on the outbreak of war.

3. In December, 1942, the East and West African Governors' Conferences were invited to review the question of the co-ordination of the agencies in their respective areas engaged in dealing with the tsetse problem. The desirability of obtaining a comprehensive view of tsetse work was also mentioned. When the East and West African Governors considered the matter at their Conferences in 1943 it was apparent that there was a desire for central machinery to guide and assist the efforts of those engaged in tsetse research and control work, and to ensure the exchange of and pooling of information, and the maintenance of contact with scientific workers in imperial and foreign countries. It was accordingly decided to set up in London a Committee in the Colonial Office with representation of other interests, to consider and advise on the co-ordination of action, including research, directed against human and animal trypanosomiasis, and in particular the tsetse fly as the chief vector.

4. When it started work the Committee was aware of the great amount of tsetse and trypanosomiasis research and reclamation that had been carried on in preceding years, but the results were not accessible easily enough to make possible an assessment of their value or to plan future work. The Committee therefore arranged for the compilation of a monograph based on reports and papers published from 1932 to 1944. The most important step taken, however, was the decision to expand an earlier proposal to send fact-finding officers to East and West Africa into a project for the survey of the tsetse and trypanosomiasis problem in East and West Africa and the production of plans for future work.

5. Professor Buxton was the representative chosen by the Committee to go to East Africa. On his return he produced a report upon the trypanosomiasis problem there, which, at the suggestion of the Committee, has been published:* Professor Buxton made recommendations for the future organization of tsetse and trypanosomiasis work, and the Committee was greatly influenced by these when considering proposals for the establishment of the East African Tsetse and Trypanosomiasis Research and Reclamation Organization (E.A.T.T.R.R.O.). This combined under one Director research work on tsetse and trypanosomiasis in East Africa, and also the Inter-territorial Reclamation Pool whose work has included the study of new and experimental methods of control. The unification of the existing experimental services was followed by a recasting of their pro-

* "Trypanosomiasis in Eastern Africa 1947" by P.A. Buxton, C.M.G., F.R.S (H.M.S.O. 3s. net).

grammes which is now beginning to take effect as described in Part II of this report. A further recommendation for the establishment of a Central Trypanosomiasis Research Institute in East Africa has also been accepted, funds have been provided for its construction and a site has been chosen.

6. In West Africa, when the Committee started work, there was already on foot a proposal for the establishment of a centralised research institute, and a tsetse fact-finding survey had been initiated. The Committee made arrangements for Professor T. H. Davey to conduct a supplementary survey in order to cover the whole field of trypanosomiasis in British West Africa. The results of the Tsetse Fact Finding Survey, and of Professor Davey's Survey have been published*.

7. Professor Davey had been asked to make specific recommendations concerning the establishment of an institute. He recognised the essential unity of research on human and animal trypanosomiasis and advised that an interterritorial organization be set up to undertake research on " all aspects of the trypanosomiasis problem, human, animal and entomological ". Considerable sums of money have been made available under the Colonial Development and Welfare Act, and from the resources of the four West African Governments to build and maintain the West African Institute for Trypanosomiasis Research (W.A.I.T.R.), whose official opening took place on the 31st January, 1951.

8. The Committee's main work to date has been to assist in establishing the schemes for trypanosomiasis and tsetse research in East and West Africa described above. This work is not yet complete, but the main outlines have appeared, and the frameworks of the organizations have been created in those areas. The Committee has recorded its great appreciation of the work carried out by Dr. H. M. O. Lester, O.B.E., and Colonel H. W. Mulligan, the Directors of the East African Tsetse and Trypanosomiasis Research and Reclamation Organization, and of the West African Institute for Trypanosomiasis Research.

9. The attention of the Committee was drawn at an early time in its existence to the need for experiments in the use of D.D.T. against tsetse. This led to the consideration of the use of insecticides in general, and in 1945 the Committee advocated the establishment of a team in East Africa to undertake special work in this field. The possible range of application was so large, however, that in 1946 it was recommended that an Insecticides Committee should be set up with a full time scientific secretariat and should take over the work of the T.F.T.C. in relation to insecticides, as well as dealing with other insecticides questions. This has been done, and a report on the work of the Colonial Insecticides, Fungicides and Herbicides Committee appears elsewhere in " Colonial Research ".

10. In the field of Chemotherapy the Committee has taken a part in encouraging the development of and trial with new drugs and has always pressed for very thorough testing in the laboratory before agreeing that any substance should be used for experiments in the field. Liaison is maintained with the Medical Research Council, and a member of the National Institute for Medical Research regularly attends meetings of the Tsetse Fly and Trypanosomiasis Committee. Among the drugs in which the Committee has interested

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* "Tsetse Flies in British West Africa" by T. A. M. Nash, O.B.E., D.Sc., (London), (H.M.S.O. £1 10s. net).
"Trypanosomiasis in British West Africa" by T. H. Davey, O.B.E., M.D., D.T.M., (H.M.S.O. 2s. net).

itself are Dr. Friedheim's antimonial and arsenical compounds for use in human trypanosomiasis, and antrycide and phenanthridinium for use in bovine trypanosomiasis.

11. The Committee has always been conscious of the importance of international co-operation in dealing with the tsetse and trypanosomiasis problem. Members of the Committee attended the Inter-African Conference on Tsetse and Trypanosomiasis held at Brazzaville in February, 1948, the recommendations of which have led to the establishment of a Permanent International Bureau for Tsetse and Trypanosomiasis at Leopoldville in the Belgian Congo, and also the institution of the International Scientific Committee for Trypanosomiasis Research (I.S.C.T.R.). The Bureau is jointly supported by the Governments of France, Belgium, Portugal, the Union of South Africa, Southern Rhodesia and the United Kingdom on behalf of the African Territories for which they are responsible. Its main purposes are the collection and dissemination of information about tsetse and trypanosomiasis research the circulation of a bulletin in English and French containing summaries of published articles, and the publication of notes submitted directly by those engaged in such work. The International Scientific Committee for Trypanosomiasis Research is intended to meet at approximately annual intervals to review research work on tsetse and trypanosomiasis, and to stimulate further research work and discussion, besides promoting co-ordination between research organizations and workers in this field. It shares the Secretariat of the T.F.T.C. Meetings have been held in February, 1949 (London), and June, 1950 (Antwerp). Further details are given in paragraphs 35 and 36.

12. Human and animal trypanosomiasis, and the tsetses, constitute a great range of complex problems, and as a result of a review of its work and functions the Committee was reconstituted early in 1949 so that it now includes representatives of medicine, chemotherapy, veterinary science, agriculture, zoology, protozoology, entomology and game preservation and control. The Directors of E.A.T.T.R.R.O. and W.A.I.T.R. were at the same time invited to join the Committee. In addition the terms of reference were slightly amended and are now as follows:—

> "To consider and advise on the co-ordination of action, including research and reclamation, directed against human and animal trypanosomiasis".

13. The Committee has always had to concern itself with game as the principal food supply of the most widely spread tsetse fly, and as a reservoir of trypanosomes. There are, however, manifestly many other aspects of the game question, and there is the ever present conflict between conservation, and the interests of the African economy, whether pastoral or agricultural. In order that a comprehensive view could be taken the T.F.T.C. invited the Colonial Advisory Council of Agriculture, Animal Health and Forestry early in 1950 to join with it in establishing a joint sub-Committee on Game. In proposing the establishment of such a joint sub-Committee the T.F.T.C. had very much in mind the recommendations which had been made at the Conference on the Fauna of Eastern and Central Africa held in May, 1947, and the African Rinderpest Conference of October, 1948. The work of the Game sub-Committee is described in Part II of this report.

PART II. TSETSE AND TRYPANOSOMIASIS RESEARCH

1950–1951

The East African Tsetse and Trypanosomiasis Research and Reclamation Organization.

14. The East African Tsetse and Trypanosomiasis Research and Reclamation Organization combines the former East African Tsetse Reclamation Department, the Tsetse Research Organization at Shinyanga, and the Trypanosomiasis Research Station at Tinde. The amalgamation, under Dr. H. M. O. Lester, O.B.E., was undertaken in 1948, and the plans for future work which he has produced are aimed at a unified approach to the tsetse and trypanosomiasis problem with the object of producing results which can be of direct assistance in the development of the territories. With this guiding principle in mind new proposals for the internal organization of E.A.T.T.R.R.O. and the future programme of work have been produced. These cover both the continuation of tsetse research at Shinyanga, the continuation of reclamation experimental and advisory work, and also the expansion of trypanosomiasis research by the construction of a Central Trypanosomiasis Research Institute.

15. So far as tsetse research is concerned considerable progress has been made in the study of the relation of tsetse to its environment and new techniques are being developed. These techniques are applicable to tsetse surveys for the purpose of planning development of tsetse infested bush, and for solving problems of human sleeping sickness. They are expected to improve the precision of such surveys and lessen the time needed to obtain information required. The studies have included investigations of the breeding sites and requirements of tsetse, and of the behaviour of the insect both in field and in the laboratory. Studies of the populations of tsetse in their natural surroundings have continued to give valuable results, and here again new techniques have been evolved. The investigation of the long term cycle of fluctuation in tsetse numbers has continued and research into the trypanosome-tsetse relationship has been carried on. Considerable knowledge has been acquired as to the best method of maintaining tsetse in the laboratory for the latter purpose. As a result substantial improvements in methods can be effected. Some of the results suggest that tsetse kept under the most unfavourable conditions show considerably less resistance to infection by the trypanosome than those kept under favourable conditions. The following up of this line may give valuable indications for the study of factors governing the establishment of the trypanosomes in the tsetse fly. In addition to its research work on tsetse and trypanosomiasis the E.A.T.T.R.R.O. is operating a number of schemes of practical reclamation. Two of these are in Tanganyika, three are in Kenya and one is in Uganda. Detailed study of fly distribution has been carried out in order to make possible the determination of the most favourable habitats and consequently to permit the development of methods of control which entail a minimum destruction of vegetation and the lowest possible financial expenditure. Although planned mainly to achieve experimental results, such schemes do of course result in land being cleared and made available for settlement. They are not, however, a substitute for the normal programmes of the territorial reclamation services in East Africa. These services continue their work, and E.A.T.T.R.R.O. assists them by providing an advisory service.

16. Pending the building of the new Central Trypanosomiasis Research Institute at Sukulu, the Trypanosomiasis Research Station at Tinde has been kept on a care and maintenance basis. The *T. rhodesiense* strain, originally

isolated from man in 1934 and maintained continuously at Tinde by means of fly passage, has been kept going. The annual testing of the infectivity of this strain by allowing infected tsetse to bite human volunteers has produced additional evidence of the cyclical changes in infectivity which had been demonstrated previously.

17. The Tsetse Fly and Trypanosomiasis Committee has been principally concerned in 1950–51 with plans for the future work and financing of the E.A.T.T.R.R.O. The period since 1948 has been one of transition. During this time the work of the three separate organizations which were united to constitute the E.A.T.T.R.R.O. has been continued, but new plans for the future have now been prepared, discussed and approved, taking into account the decision to construct the Central Trypanosomiasis Research Institute at Sukulu. Financial provision for the services of the E.A.T.T.R.R.O. during the interim period has been provided as to one-third by the East African Governments, and as to two-thirds by Colonial Development and Welfare Research and Development funds. This arrangement terminated on 31st March, 1951, and on that day a new scheme for the provision of £200,000 to provide for 50 per cent. of the cost of the work of those services as reconstituted for a five-year period, was, on the recommendation of the T.F.T.C., approved. The East African Governments had previously agreed to provide a 50 per cent. contribution to these services for the period in question. During the year also an earlier recommendation of the T.F.T.C. resulted in the provision of a sum of up to £195,000 from Colonial Development and Welfare Research funds to provide the whole capital cost of building and equipping the proposed Central Trypanosomiasis Research Institute at Sukulu, and an additional sum of £85,000 to provide 50 per cent. of the recurrent expenditure during that period. The East African Governments are to provide the other moiety of the recurrent expenditure.

18. Plans are now being formulated for three schemes of experimental/practical reclamation work, one in each of the East African territories. The Tsetse Fly and Trypanosomiasis Committee has discussed these and has recommended the provision of funds from the Colonial Development and Research allocation to cover the research elements in the schemes. All three schemes involve a large amount of clearing work by the E.A.T.T.R.R.O., together with, in the case of Uganda and Kenya, clearing work by the territorial reclamation services. In all cases a considerable amount of work will have to be undertaken by the Governments concerned to ensure suitable use of the land. Detailed schemes are to be worked out in East Africa.

19. It should be mentioned here that in conjunction with the East African Veterinary Research Organization a research scheme financed, on the recommendation of the Tsetse Fly and Trypanosomiasis Committee, from Colonial Development and Welfare Research funds, is being carried out with Antrycide. Interesting interim results have been obtained with a programme of monthly and two-monthly prophylactic injections and a programme of three-monthly injections is now being started. The results are not conclusive, but the Director of the E.A.T.T.R.R.O. considers that it can be said now that the use of monthly injections of Antrycide to allow cattle to be taken into good grazing in certain well-watered tsetse areas during periods of intense drought is safe, and is justified as an emergency measure.

20. Much of what is said above is necessarily in very summary form, but a full report of the work of the E.A.T.T.R.R.O. for the year 1950 has been published by the East Africa High Commission.

West African Institute for Trypanosomiasis Research

21. The necessary funds for the construction of the Institute have been provided as to two-thirds from Colonial Development and Welfare Research funds, and as to one-third by the West African Governments subscribing in agreed proportions. Provision for recurrent expenditure was at first made in the same way. These arrangements, however, came to an end on 31st March, 1951, and have been replaced by an arrangement whereby 50 per cent. of recurrent expenditure for the period 1951–56, up to a maximum of £150,000, will be provided from Colonial Development and Welfare (Research) funds, and the remainder by the West African Governments.

22. Colonel H. W. Mulligan, late of the Indian Medical Service, and formerly Director of the Central Research Institute at Kasauli was appointed Director of the Institute in 1947 and has been responsible for acquiring sites and preparing plans for administrative, laboratory and ancillary buildings, as well as for the other tasks of organization involved in starting an entirely new research institute. The affairs of the Institute are in the hands of a Managing Committee established by an Ordinance of the Government of Nigeria. The Chief Secretary of the West African Council is Chairman and the Director of the Institute is a member of the Managing Committee. The other members are nominated by the West African Governments, whilst the Chairman and Director are nominated by the Secretary of State for the Colonies. As stated in paragraph 7 the official opening of the Institute took place on 31st January, 1951.

23. The Institute is organized in four Sections two of which (Entomology and Epidemiology) have been located at Kaduna, Zaria Province, where both human and animal trypanosomiasis are endemic; the two other Sections (Protozoology and Veterinary trypanosomiasis) have been sited at Vom, Plateau Province, where cyclical transmission of the disease does not occur under natural conditions. The new laboratories at both centres are of simple design, are well equipped, and are readily adaptable to almost any purpose. Ample room has been left for expansion. Provision has been made for a specialized library with microfilm service, a central information bureau, a comprehensive photographic unit, a tsetse rearing centre, an animal breeding centre, spacious insectaries and fly-proofed animal houses. Facilities are, therefore, available for basic studies as well as for field investigations. A noteworthy feature is the provision of laboratory accommodation for visiting scientists in each Section, and already advantage has been taken of these facilities.

24. Living accommodation has been provided for twenty scientific workers and for one hundred technical and other assistants. It has been necessary to recruit expatriate staff for all of the senior scientific posts but all other appointments are being filled by African personnel as suitable candidates become available.

25. The Institute has no direct responsibility for the actual conduct of trypanosomiasis control measures; its primary function is to undertake research, in the laboratories and in the field, on all aspects of human and animal trypanosomiasis. It serves also as a clearing house for information on trypanosomiasis, as an advisory bureau, and as a training centre for expert technical personnel. The inauguration of the research programme has proceeded *pari passu* with the development of the scheme but, owing to the absence of laboratory and living accommodation in the early stages, most of its work

has hitherto been undertaken in the field. A considerable amount of work has already been done on the ecology of the riverine tsetse flies of the savannah zones, *G. palpalis* and *G. tachinoides*, and the results obtained have had practical importance in achieving the elimination of these species in certain areas by the technique of complete or partial clearance of riverine vegetation. Very little is yet known of the tsetse of the high forest areas. Recent survey in such localities, using new survey methods, have revealed that certain species hitherto regarded as uncommon or even extremely rare are, in reality, not only prevalent but possibly widespread. Nothing is as yet known of their economic importance.

26. Researches are in progress, or are projected, on many aspects of tsetse entomology. These include studies on the longevity, dispersal, breeding habits, feeding habits, infectivity, etc., of different species at various seasons. Laboratory experiments designed to supplement and serve as a check on observations made in the field are now being commenced as well as further studies on the systematics and physiology of tsetse and such other biting flies as may be incriminated as vectors. A pre-requisite to these investigations, and especially to the future work of the Protozoology Section, is the availability of large numbers of clean flies and high priority has, therefore, been given to the laboratory rearing of tsetse flies on a vast scale. The Entomology Section is also responsible for investigating the value of arboricides, insecticides and repellants in the control of trypanosomiasis.

27. The study of the epidemiology of human and animal trypanosomiasis is the special responsibility of the Epidemiology Section. It has been possible to trace the origin of the severe and widespread epidemics of sleeping sickness which have occurred in Northern Nigeria during the present century to two endemic foci—one in the vicinity of the Niger-Benue confluence and the other in the Lake Chad basin. It has been shown that these epidemics were precipitated primarily by the dispersal of infected individuals resulting from changing living conditions. There is no evidence that alteration in the prevalence or distribution of insect vectors played any appreciable part in the causation of these epidemics. Two isolated epidemics have recently been subjected to detailed investigation. Future work lies mainly in the elucidation of the intricate complexity of factors which favour or limit the spread of trypanosomiasis under natural conditions and will necessitate the careful study of selected communities, their environment and activities, in relation to the insect vector and the reservoir of infection. In the veterinary sphere it is imperative to ascertain the true extent of the losses from trypanosomiasis which occur among domestic stock; to ascertain how, when and where such infections are acquired; to demarcate the danger zones; to study movements of stock in relation to tsetse; and to consider ways and means of minimizing the losses which occur. This, in turn, involves a careful study of grazing areas; the migrations of nomadic cattle; the movements of trade cattle; and the conditions under which settled stock is maintained. Much more accurate knowledge is required of factors which may influence the severity of trypanosome infections in stock such as heredity, nutritional deficiencies, intercurrent infections, immunizing procedures against other diseases, exposure to adverse environmental conditions, etc.

28. The protozoology of both human and animal trypanosomiasis requires much fuller investigation. Apart from further systematic studies on the trypanosomes, there is an urgent need for improved diagnostic procedures, especially of cryptic infections; for studies on the life history of the trypanosomes in both vertebrate and invertebrate hosts; for immunological researches; and

for ascertaining the factors governing the development, infectivity, transmissibility and pathogenicity of various species and strains of trypanosomes. Facilities are available for using cyclically transmitted strains in experiments of this kind.

29. The chemotherapy and chemoprophylaxis of both human and animal trypanosomiasis are subjects which are currently receiving much attention and which are likely to continue to require constant research work. Experiments carried out during the past year have done much to indicate the circumstances in which Antrycide might be used in the prevention of cattle trypanosomiasis. It is a constant concern of the Institute to devise and test such new measures for the control of trypanosomiasis as may be suggested by the acquisition of fresh knowledge in any of its many and varied spheres of research.

Dr. Friedheim's trypanocidal compounds

30. The Committee has for a considerable period taken a close interest in the trypanocidal compounds discovered by Dr. Friedheim. This interest has been communicated to pharmaceutical manufacturers in the United Kingdom, and as a result supplies of certain drugs are now being made in this country. A group of Tsetse Fly and Trypanosomiasis Committee and Medical Research Council representatives produced recommendations for the T.F.T.C. on the desirability of field trials with certain of the drugs. The important point about the recommendations was the insistence placed by the group upon the necessity for the establishment of standards of toxicity and therapeutic potency before field trials were undertaken. The stage has now been reached where satisfactory data have been furnished about samples of Melarsen and it is hoped that these will make possible the carrying out of trials which will produce sound scientific results. The Committee has recorded its gratitude to the members of the T.F.T.C./M.R.C. group responsible for advising on this matter. The trials will be carried out jointly by the West African Institute for Trypanosomaisis Research, and the Nigerian Sleeping Sickness Service. Dr. McLetchie of the Sleeping Sickness Service has taken a most active interest in these compounds and it is hoped that in addition to Melarsen, Mel/Bal and MSb will also be available for field trials before long.

Antrycide

31. During the year a sub-Committee set up by the Tsetse Fly and Trypanosomiasis Committee to consider the results of experiments with Antrycide carried out a review and submitted a report. Subsequently, at the request of the Committee, it was arranged that this report should be discussed by the sub-Committee and Dr. D. G. Davey, O.B.E. It was agreed that the high incidence of bovine trypanosomiasis in existing herds was the most urgent and immediate practical problem at the moment. It was felt therefore to be of importance to establish optimum dosage schedules for curative treatment. Experimental work and trials with Antrycide including that reported in paragraph 19 above continue, and the Tsetse Fly and Trypanosomiasis Committee has reconstituted the sub-Committee which consists of Dr. Lourie, Dr. Carmichael and Mr. R. J. Simmons, C.B.E. (Adviser on Animal Health to a Secretary of State) to prepare for a further review in September, 1951.

Animal Trypanosomiases in Eastern Africa, 1949

32. After Professor Buxton had completed the visit referred to in paragraph 5 of this report he recommended that a Veterinary expert should make a similar journey with the object of reporting on the loss of domestic animals from trypanosomiasis, and of making recommendations for research and practical measures of control. Dr. H. E. Hornby, O.B.E., sometime Director of

Veterinary Services in Tanganyika, was invited to undertake the task. He brought to it the knowledge gained during 35 years study of the problems of animal trypanosomiases, and a journey of about 10,000 miles carried out in the six months from June to November, 1949, put him in a position to make a comprehensive and up to date survey of the problem in Northern Rhodesia, Nyasaland, Tanganyika, Kenya and Uganda. The result is a report which has been welcomed by the Committee who have recommended that it should be published like the earlier reports of investigations carried out on their recommendations. Arrangements for publication are in hand.

Game Research

33. The Joint Game sub-Committee of the Tsetse Fly and Trypanosomiasis Committee and the Colonial Advisory Council for Agriculture, Animal Health and Forestry, produced recommendations during the year for several projects of Game research. These may be summarised as follows:—

(i) That a qualified Biologist be appointed to the staff of the Game Department in each territory to secure scientific information and to assist in the application of scientific principles to control policy;

(ii) That a research team of four men should be set up to investigate and collect information on game problems in one area—Tanganyika is suggested—to supervise the practical work involved in setting up game fences and to undertake research into game management. The team should consist of (*a*) a Biologist, (*b*) a Veterinary Research Officer, (*c*) a Botanical Ecologist and (*d*) a Game Ranger.

(iii) That there should be a survey to collect, correlate and assess information available in all quarters on all scientific questions relating to the mammalian Fauna of Africa.

The means of implementing the second and third recommendations are under discussion.

The Provision of Funds for Tsetse and Trypanosomiasis Research

34. The provision of funds for future research under the Colonial Development and Welfare Act has been under review, and as a result the Tsetse Fly and Trypanosomiasis Committee has been informed that £425,000 have been allocated to provide for the needs of tsetse and trypanosomiasis research in the years 1951–56. Of this sum £200,000 will be devoted to the future work of the E.A.T.T.R.R.O. under the scheme R. 452 reported in paragraph 17 above. The Committee has also agreed to recommend a maximum of £25,000 as a contribution towards work on Game. It has also agreed to recommend a contribution of up to £70,000 for the research aspects of the pilot schemes referred to at paragraph 18 above. It is also aware of a possible deficit of up to £7,000 on the work of E.A.T.T.R.R.O. up to 31st March, 1951. The sum in hand therefore amounts to from £120,000 to £130,000 which the Committee has agreed to regard for the present as a reserve which will be reviewed at each meeting in the light of the circumstances at the time and any new proposals for research which may come forward.

International Co-operation

35. The International Scientific Committee for Trypanosomiasis Research met at Antwerp in June, 1950. The arrangements were made by Professor Rodhain the retiring Chairman, and the meeting was presided over by M. le Medecin General Inspecteur Vaucel of France. On the recommendation of the T.F.T.C., Professor Buxton, Dr. J. Ford (of the East African Tsetse and

Trypanosomiasis Research and Reclamation Organization), and Dr. K. R. S Morris (Director of Tsetse Control, Gold Coast), were present, but Colonel H. W. Mulligan was unfortunately prevented from attending. The papers and conclusions of the Committee have been published by the Permanent Inter-African Bureau for Tsetse and Trypanosomiasis at Leopoldville in the Belgian Congo.

36. The International Scientific Committee unanimously recommended that Colonel Mulligan should be invited to become Chairman elect for 1950–51 and hence Chairman of the 1951 meeting. Colonel Mulligan has accepted this office and the meeting will be held at Bobo Dioulasso in French West Africa in June 1951. The Committee also decided at its last meeting that it would each year invite a scientist to attend to address it on a specific problem. Mr. W. H. Potts of the East African Tsetse and Trypanosomiasis Research and Reclamation Organization is the first scientist to be honoured in this way. He has been invited to give an account of the distribution of tsetse in Africa with particular reference to the preparation of maps in accordance with a resolution of the Inter-African Conference on Tsetse and Trypanosomiasis held at Brazzaville in 1948. Future meetings of the I.S.C.T.R. will be attended by the honorary co-directors of the Permanent Inter-African Bureau for Tsetse and Trypanosomiasis as observers.

37. The Bureau has now reported that it has completed the preparation of a bibliography of tsetse and trypanosomiasis. It has also published a number of useful bulletins, as well as papers on various subjects connected with tsetse and trypanosomiasis.

Miscellaneous

38. The recommendations of the T.F.T.C. in the past have led to the provision of sums of money from Colonial Development and Welfare (Research) funds for the carrying out of tsetse surveys in Northern Rhodesia and Nyasaland. In the case of the former difficulties in obtaining staff have so far very much limited work, and in Nyasaland the position is little better. These staffing difficulties are being slowly overcome.

39. Other work of interest in Northern Rhodesia has followed the extensive survey of trypanosomiasis carried out in 1945 when it was discovered that infected herds may contain from 16 per cent. to 45 per cent. of infected cattle. Field investigations and experiments showed that under Northern Rhodesia field conditions outbreaks of trypanosomiasis most commonly resulted not from transmission of trypanosomes by tsetse but directly or mechanically from animal to animal within the herds by bites from other vectors. Elimination of carriers was, therefore, essential to control disease in the field, and the advent of the Phenanthridinium compounds for which appropriate dosage and administration technique were evolved provided a most efficacious curative for the sterilization of these carriers. As a consequence a policy of mass inoculation of cattle where trypanosomiasis is a serious problem has been adopted ever since. This has considerably reduced mortality. In addition Antrycide has been used in the field on a small scale to protect cattle imported from Tanganyika territory which had to trek long distances through tsetse infested country.

40. Research by the Department of Tsetse Control in the Gold Coast during 1950 has been concerned with the epidemiology of sleeping sickness, the ecology of *Glossina morsitans*, the ecology of animal trypanosomiases, the

effectiveness of clearings, and traps and insecticides, among other things. Understanding of the epidemiology of sleeping sickness has been advanced by the application of ecological methods in studying the growth, movement and location (or habitats) of West African epidemics. The conclusions drawn are that the exacting conditions required for the development of human trypanosomiasis are represented most completely in the savannah zone, but are hardly represented at all within the forest, which region is, indeed, inhospitable to epidemic sleeping sickness. The practical implication of this is that for both effectiveness and economy a control policy should concentrate first and foremost on the eradication of sleeping sickness in the true epidemic centres, since this may, by cutting off the sources of infection, cause the disease to disappear spontaneously in the subsidiary areas.

Colonial Fisheries Advisory Committee Annual Report on Fisheries Research (1950-1951)

THE CHURCH HOUSE,
GREAT SMITH STREET,
WESTMINSTER, S.W.1
8th June, 1951.

SIR,

I have the honour, on behalf of the Colonial Fisheries Advisory Committee, to transmit to you the Committee's report on Fisheries Research in the Colonial Empire for the year 1950/51. The report includes a retrospect of the Committee's work since its establishment in 1943.

I have the honour to be,
Sir,
Your most obedient Servant,
(Sgd.) J. DUGDALE
(Chairman)

The Rt. Hon. James Griffiths, M.P.
Secretary of State for the Colonies.

COLONIAL FISHERIES ADVISORY COMMITTEE

Membership

THE MINISTER OF STATE FOR COLONIAL AFFAIRS (*Chairman*).

MR. C. G. EASTWOOD, C.M.G., Assistant Under-Secretary, Colonial Office (*Vice-Chairman*).

DR. C. F. HICKLING, C.M.G., Sc.D., Fisheries Adviser to the Secretary of State.

MR. C. N. HOOPER, C.B.E., formerly Clerk of the Fishmongers Company.

MR. J. MORLEY NEALE, of Messrs. Neale & West, Trawler Owners, Cardiff.

DR. C. F. A. PANTIN, Sc.D., F.R.S., Reader in Invertebrate Zoology, Cambridge University.

DR. G. A. REAY, O.B.E., Ph.D., Superintendent, Torry Research Station, Department of Scientific and Industrial Research.

DR. E. S. RUSSELL, O.B.E., D.Sc., formerly Director of Fisheries Investigations, Ministry of Agriculture and Fisheries.

MR. F. S. RUSSELL, D.S.C., D.F.C., F.R.S., Director of the Plymouth Laboratory of the Marine Biological Association.

MR. J. THOMSON, O.B.E., formerly Chief Inspector of Fisheries, Ministry of Agriculture and Fisheries.

DR. ETHELWYN TREWAVAS, D.Sc., Assistant Keeper, Department of Zoology (Fish Section), British Museum (Natural History).

MR. R. S. WIMPENNY, M.Sc., Senior Principal Scientific Officer, Fisheries Laboratory, Ministry of Agriculture and Fisheries.

PROFESSOR C. M. YONGE, D.Sc., Ph.D., F.R.S., Regius Professor of Zoology, Glasgow University.

MR. R. H. BURT, O.B.E. (*Secretary*).

Terms of Reference

The terms of reference of the Committee are to advise the Secretary of State for the Colonies on problems concerning fisheries (marine and freshwater) in the Colonial Empire.

COLONIAL FISHERIES ADVISORY COMMITTEE
ANNUAL REPORT ON FISHERIES RESEARCH FOR 1950–1951

CONTENTS

COLONIAL FISHERIES ADVISORY COMMITTEE
ANNUAL REPORT ON FISHERIES RESEARCH
(1950-1951)

I. INTRODUCTORY

The Colonial Fisheries Advisory Committee was appointed by the Secretary of State for the Colonies in October, 1943. Dr. E. S. Russell, O.B.E., Director of Fisheries Investigations, Ministry of Agriculture and Fisheries, had been appointed earlier in 1943 part-time Fisheries Adviser to the Secretary of State. In May, 1945, Dr. C. F. Hickling was appointed full-time Fisheries Adviser. The membership of the Committee has undergone some changes, and the present membership is as given above.

2. The Fisheries Adviser at once began a series of tours of the Colonial territories in order to study their fisheries at first hand, and draw up a policy for the consideration of the Committee and the Secretary of State, and for recommendation to Colonial Governments. These tours may be summarised as follows:—

1945 October–December	...	West Africa.
1946 May–August ...	...	East and Central Africa; Palestine and Cyprus.
1947 January–August	...	Aden, Somaliland, Ceylon, Malaya, Borneo, Sarawak, Hong Kong, Fiji, Java, South India, and China.
1948 December ...	...	Aden.
1949 January–April	...	West Indies.
1950 June–August ...	...	Central Africa, East Africa, Mauritius, Seychelles, Belgian Congo, and Southern Rhodesia.
1951 February–April	...	Sudan, Somaliland, and Aden.

3. With the permission of the Secretary of State, the Fisheries Adviser is also Honorary Fisheries Adviser to the Sudan Government. He has also advised the Southern Rhodesian Government.

II. THE POLICY OF THE COMMITTEE

4. In the light of the experience of the fishery work done in the Colonies before the war, it has been the policy of the Committee from the outset to separate fisheries development from fisheries research. While there is no hard and fast separation between these arbitrary divisions, the nature of the work and the aptitudes required are somewhat different. Roughly speaking, development is, at present, the gradual improvement of existing fishing techniques in the Colonies towards a higher catch per man-hour, and towards better preservation and marketing of the fish caught. The work involves the trial and application of more effective methods of fishing and preservation, for which the basic information is already available in the skill and experience of more highly-developed countries. Research, on the other hand, involves the discovery of the unknown, namely the productivity of tropical waters, the rates of growth, life histories, and habits of fish of commercial importance, and the physical and chemical properties of fish products. The findings of fishery research will be knitted into the fabric of fishery development.

5. An account of fishery development is not appropriate in a report on Colonial research. It must suffice to say that Colonies will have the full complement of development staff asked for by the Spring of 1952; that there will then be some 50 fishery officers, and some 28 fishing vessels engaged on development work in the Colonial territories.

III. RESEARCH STATIONS

6. Fisheries Research Stations have been planned on a regional basis. Already, before the end of the late war, a research station had been planned for Lake Victoria, on an inter-territorial basis. Since then plans have been adopted for:—

(*a*) a West African research station in Sierra Leone;
(*b*) an East African marine research station in Zanzibar;
(*c*) a Central African freshwater research station in Northern Rhodesia to serve Northern Rhodesia and Nyasaland:
(*d*) a Far Eastern marine research station at Singapore;
(*e*) a Far Eastern fish farming and freshwater research station at Penang;
(*f*) a research station at Hong Kong.

The total number of research stations projected is thus seven, of which two are purely marine, three wholly freshwater, and two (West Africa and Hong Kong) both freshwater and marine.

IV. FINANCE

7. The Committee recommended, and the Secretary of State agreed, that the heavy capital costs of establishing these research stations should be met entirely from Colonial Development and Welfare Central Research Funds, together with half the recurrent costs, the beneficiary Colonial Governments finding the other moiety; and that Colonial Development and Welfare assistance should be given for a period of five years in the first instance. There have been exceptions to this policy: all the capital and recurrent costs of the Lake Victoria research station are to be borne, for the first five years, by Central Research funds, since the scheme for this, the first research station, was drawn up before the adoption of the policy stated above. Secondly, all the capital and recurrent expenses of the Fish Farming Research Institute at Penang will be borne for the first five years by Central Research funds, since fish farming is a novelty in most Colonial territories, and the support of Colonial Governments could hardly be asked for in the case of an unproved technique. The third exception is the research station at Hong Kong, where the Government of that Colony has offered to pay all recurrent expenses.

V. PROGRESS

8. The implementation of this research programme has been most seriously delayed by lack of staff. An expansion of biological research in general, and of fishery research in particular, has occurred simultaneously all over the world, since the end of the war. The result has been an almost complete lack of trained and experienced fishery research workers.

9. To remedy this lack, a scheme was made in 1948 under the Colonial Development and Welfare Act, by which post-graduate students could be trained for fishery work. Five persons have been, or are being trained under this scheme, and the Committee is most grateful to the various research institutes which have assisted with their training.

10. However, as the result of a lecture tour of the Universities by the Fisheries Adviser in the winter of 1949–50, a good field of candidates is now available for fisheries research studentships to be awarded in 1951, and from 1952 onwards the staff situation should be easing.

11. On the other hand, the shortage of experienced men suitable for appointment as Directors is still a serious problem, and it would obviously be risky to place upon a newly-trained and inexperienced officer responsibilities appropriate to a Director. There is however reason to hope that this difficulty also will be surmounted.

12. A small Colonial Development and Welfare scheme has just been made, under which two advanced undergraduates will be assisted in spending a Long Vacation in West Africa and undertaking directed observational work of value to the research station there. It is hoped that the experiences of these men will assist in recruiting; the home Fishery Departments have found that vacation voyages on their research vessels have proved a powerful stimulus in this respect.

VI. INDIVIDUAL COLONIAL RESEARCH STATIONS

(a) *The Inter-territorial Fisheries Research Station at Jinja on Lake Victoria.*

13. The staff consists of a Director (Mr. R. S. A. Beauchamp), who is a hydrologist, an ichthyologist (Miss R. H. Lowe), a botanist-algalogist (Mr. G. R. Fish), and an entomologist (Mr. W. W. MacDonald). There is one vacancy.

14. The main building programme at Jinja, Uganda, is now completed, and besides the laboratory, stores, etc., eight houses have been built. The two motor launches are in good running order. A third dinghy has been purchased made of aluminium, and is principally for use on tours. A number of additions have been made to the laboratory equipment, notably some additional microscopes, mud samplers, photo electric apparatus, and a thermistor thermometer.

15. The East African Scientific Advisory Committee, at its meeting in November, recommended the building of a workshop, an aquarium house, and the purchase of a lorry. The Committee also re-affirmed its earlier recommendation for the development of a sub-station on Lake Tanganyika, and and approval for this scheme has been given by the three Governments.

16. The general policy is to integrate the work of every individual on the staff so that all consider themselves members of a scientific team, and so that new problems as they arise can be investigated from more than one aspect. Already some of the more important discoveries have arisen as a result of joint studies made by two or more members of the staff. As far as possible the work being undertaken is designed to cover the sequence of events which lead from the chemical and physical conditions of the water to the ultimate growth of the various populations of fish.

17. The supply of nutrient salts (phosphates, nitrates, etc.) to the surface waters of a lake is the important factor which ultimately determines its productivity. Most of these salts are produced in the first place as a result of decomposition of the bottom mud. Work done this year on the decomposition of the lake mud has shown the importance of certain bacteria. When anti-biotics were added to cultures of mud the formation of nitrates was inhibited. The importance of these organisms is thus clearly demonstrated.

18. The rate at which nutrients are released is greatly affected by the condition of the water immediately above the mud surface. If the water is deoxygenated the release is relatively rapid; if oxygenated it is slow. This is due to complicated chemical and physical reactions at the mud-water interface, which are

being studied. Once the enriched bottom water is brought to the surface it is utilized by algae and gives rise to an increase in the phyto-plankton. Variations in the density of the phyto-plankton are important as they affect directly the growth rate and breeding of *Tilapia* and other fish.

19. Whether the deeper water in contact with the mud becomes deoxygenated or not depends on quite small variations in the weather which lead to the formation of a warm surface layer overlying the deep water. These two layers remain distinct, on account of their difference in density. Previously it was thought that this condition of stability could not occur in Lake Victoria because there is only a slight temperature difference between surface and bottom water, and because wind and diurnal variations in temperature were supposed to be sufficient to cause mixing from top to bottom. However, quite definite data have been obtained showing that stratification does occur, although only for short periods.

20. An intense study has been started on the growth of the phyto-plankton. In Lake Victoria the surface waters always contain too little phosphate or nitrate in solution to be detectable, yet the phyto-plankton is abundant. This indicates that nutrients utilised by the algae are taken up as fast as they are released. It also follows that nutrients are being liberated continuously at a rate sufficient to allow the phyto-plankton to make up losses arising from death, precipitation and grazing by animal organisms. This very rapid utilization of the nutrient salts has made it necessary to devise some quite new techniques for the study of the phyto-plankton and these have shown *inter alia* that an enormous quantity of plankton is lost by precipitation at the bottom and that grazing by the zoo-plankton is intense. This loss of phyto-plankton is made good by exceptionally rapid growth.

21. The surface layers of the mud contain vast numbers of animal organisms, bacteria, protozoa, molluscs, and insect larvae. All these organisms exert some influence on the overlying water, but probably among the more important are the larvae of the Chironomidae (Lake fly). These larvae live in burrows in the mud and may penetrate to the depth of one or more feet. By eating the mud and digesting the detritus it contains they assist in its break down and decomposition; on the other hand by moving through the surface layers of the mud they tend to carry oxygen below the surface, and this may cause a reduction in the rate at which nutrient salts are released. These insects would in many ways appear to fulfil a role similar to that of earthworms in soil. During the past year some fifty species of Chironomid larvae from Lake Victoria have been identified; many are detritus feeders, but others are predatory and live largely on other species of Chironomid larvae. A study of these insects, their life cycles, and the inter-relationships between the various species is a major undertaking.

22. The amount of oxygen in the deeper waters of the lake may have an important influence on the movements of many species of fish of the genus *Haplochromis* which are present in large numbers in moderately deep water, and some of which appear to feed on mud. It would seem that when the bottom waters of the lake are deoxygenated the *Haplochromis* are driven away from their normal feeding grounds. The practical result of this is shown by trawling experiments.

23. Stomach contents often provide a clue concerning the movements and habits of fish. *Mormyrus*, which may prove to be one of the most abundant fish in the lake, lives almost exclusively on Chironomidae, but certain ripe and running *Mormyrus* were found to contain nympths of a certain species of Mayfly

only found burrowing in wood or in crevices of murram. The breeding habits of the *Mormyrus* are as yet obscure, but it is supposed that they leave the muddy areas of the lake in order to breed, and lay their eggs on or close to rocks. The stomach contents of these breeding fish support this hypothesia.

24. It is already well known that *Tilapia esculenta*, at present the most important economic fish, feeds on phyto-plankton, but a careful examination of the stomach and intestines of this fish has shown that not all the algae eaten are digested. All diatoms are digested, but many green and blue-green algae are not. This is a discovery of importance; without this knowledge one might be led to believe that a certain body of water was suitable for the growth of *Tilapia* because it contained abundant phyto-plankton. However, if this phyto-plankton consisted largely of indigestible species, it could not support a large population of fish. More work will be done on this subject, but it seems likely that it may explain the poor growth of *Tilapia* in many of the smaller lakes.

25. Molluscs form an important element in the food of many fish. A few species such as *Astatoreochromis alluaudi* and *Synondontis spp.* seem to live exclusively on these animals. Some of these fish will undoubtedly be worth introducing into dams where they do not occur and where the incidence of *Bilharzia* is high.

26. Work on the identification and life histories of snails is being carried out, and at the same time studies are being made on their parasites. These parasites include forms which complete their life cycle in man, causing bilharziasis, and other forms which cause liver fluke diseases in cattle. Many other of these closely related parasites complete their life cycles in fish and birds.

27. The work of the laboratory has been mainly concerned with Lake Victoria and investigations have been made in the Kavirondo Gulf, Mwanza area, and the Sese Islands. However, many useful data have also been collected from other lakes, notably Lakes George, Edward and Albert, and from Lake Kioga. Work has also just been started on some Kenya lakes; a report on these investigations will be made next year.

28. Studies on growth rates and breeding of several species of fish are being pursued. *Haplochromis spp.* have been reared in the laboratory, and data concerning *Tilapia* growth collected from various lakes and lagoons. Round the year samples have shown that *Tilapia* may breed at any time of year. Trawling experiments are giving very promising results.

29. A new fishery has been developed on Dagusi Island as a result of findings concerning the abundance of *Mormyrus* in the deeper water. This concern is now well established, and expects to use motor driven dhows, which will enable them to operate over better fishing grounds than at present. A successful start has been made with this enterprise.

(b) *West African Fisheries Research Institute*

30. A Director (Mr. Angus Taylor) has been appointed, who is at present doing the preliminary work for the establishment of the research station. The station is to be set up in the Royal Naval Dockyard at Kissy, near Freetown, Sierra Leone; the war-time administration building is being adapted as a laboratory, workshops and stores are being taken over, and various messes adapted as living quarters for staff. There is a deep-water jetty with water laid on; the fuel oil tanks are adjacent, and there are very convenient stores and offices at the end of the jetty.

31. The major research vessel for this Institute, the "*Cape St. Mary*," was launched from Messrs. Hall Russell's yards at Aberdeen in February, 1951, and this event aroused considerable public interest. The "*Cape St. Mary*" is 105 ft. long overall, a steel diesel-driven trawler type research vessel, equipped with radio, and echo sounders, and a very complete list of gear for fishery research. She should be ready for trials in June, 1951.

32. There are two smaller 30 ft. motor launches, which will undertake research on inshore fisheries and on certain pelagic fishes.

33. Research should begin in August or September, 1951, with a deep-sea trawling survey as the chief line of research. The two smaller boats will start a trapping programme in inshore waters (see paragraph 44) and also research on some important clupeoid fishes, using an echo-sounder to locate shoals of fish and study their vertical movements.

34. Plans have been drawn up for a 40-acre area of mangrove swamp, some three miles from the laboratory, to be bunded off and divided into ponds. These ponds will be used to study fish culture in fresh and brackish water, and problems of acidity and toxicity in reclaimed mangrove swamp. In collaboration with the Sierra Leone Agricultural Department, this research would help in the use of such reclaimed swamp for rice growing in conjunction with fish culture.

(c) *East African Marine Fisheries Research Station*

35. A Director (Dr. J. F. G. Wheeler) and Principal Scientific Officer (Dr. F. D. Ommanney) have been appointed, and are at present in Zanzibar, supervising the buildings and preparing for a research programme. Dr. Ommanney spent some time in Brittany studying the Breton methods of catching the tunnies and other big surface fish. Such fish are the most important in the marine waters of East Africa, and the Breton methods will be used by the research vessel to survey and sample the East African stocks of tunny, kingfish and jacks.

36. The research vessel will be, for the time being, the 70 ft. diesel drifter "*Research*," which has just had a refit following her work on the Mauritius-Seychelles Fisheries Survey (see paragraph 43).

37. It is hoped that this research station may be able to make use of a part or the whole of the Clove Research Laboratory at Zanzibar. Junior staff is available, and research should begin during the summer of 1951.

(d) *The Research Station for Fish Culture at Penang*

38. Work on the station has been delayed by the preoccupation of the Malayan Public Works' Department with emergency work, but it is hoped to resume construction in the autumn of 1951. The site has already been surveyed and some preliminary drainage work done. Dr. C. B. Taylor has been appointed Director of the Station. He is at present on loan to Northern Rhodesia pending the resumption of work on the Penang Station. At this station, the very important technique of fish farming will be studied in its fundamental as well as practical aspects. Not only the breeding and rearing of fish in both freshwater and marine fishponds, but also the stocking of fish in ricefields, will be the objects of research. Although these techniques have been long established in the Far East, little research has been done on the biological basis of fish farming. It is certain that such research will indicate clearly the lines along which greatly improved yields of fish can be obtained.

(e) *The Freshwater Research Station in Northern Rhodesia*

39. It is hoped to begin the construction of the station shortly. As stated above, Dr. Taylor, Director of the Penang Research Station has been loaned to assist in this work. The Station will serve Nyasaland (particularly Lake Nyasa) as well as Northern Rhodesia.

(f) *The Marine Research Station at Singapore*

(g) *The Research Station at Hong Kong*

40. These are still in the planning stage.

VII. OTHER RESEARCH SCHEMES

41. A biologist (Miss R. H. Lowe) was sent to *Lake Nyasa* in 1944 and 1945 to study the fisheries of the Lake. Her report is in typescript and is being revised for publication.

42. A Fisheries Survey of the Gulf of Aden was carried out from 1948 to 1950. The report of the Survey is a valuable one, dealing with fishing methods, the results of experimental fishing, the results of canning and liver-oil experiments, and a taxonomic study of the principal fishes. The report is in preparation for the Press. The team consisted of Messrs. King-Webster and King, Fishing Officers, Mr. Fraser-Brunner, taxonomist, Mr. Bouchier, canning expert, and Mr. Hopkins, vitamin oil expert. Mr. L. Hobson, Political Officer, was lent by the Aden Government to assist in the team's work.

43. A Fisheries Survey of the *Mauritius–Seychelles* area was carried out by Drs. Wheeler and Ommanney during 1948 and 1949. Using a 70 ft. Scottish diesel drifter, the mission covered some 25,000 miles, surveying the fishing potentialities of the Seychelles Plateau and outlying banks, the Aldabra and Amirante Islands, and the Chagos Archipelago, as well as Mauritius, Rodrigues, the St. Brandon Shoals and the vast submerged plateaux of the Nazareth and Saya de Malha Banks. The survey disclosed some rich fishing on these banks, and already there is commercial exploitation of the banks as a result of the survey. The report on the survey is ready for the Press.

44. Mr. E. Banks has completed a joint research and development survey of the fisheries of Sarawak. During the survey successful results were obtained with a modified type of deep-sea fish trap. The Fisheries Adviser has since successfully introduced this type of trap to West Africa and the Gulf of Aden, and in both of these areas excellent catches have been obtained.

VIII. PUBLICATIONS

45. No research scheme is complete unless provision is made for the publication, in a format worthy of serious contributions to scientific knowledge, of the results of research. The sum of £2,000 has been made available from Colonial Development and Welfare Research funds for this purpose, and this will enable a Colonial Fisheries Research series of monographs to be started. The first of these monographs has just beeen published.*

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* " The Food and Feeding relationships of the Fishes of Singapore Straits," by Tham ah Kow, B.Sc. (London), Colonial Office Fishery Publications: Vol. I, No. 1.—H.M.S.O. 1950, 3s. net.

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Report of the Director, Anti-Locust Research Centre, on Locust Research and Control, 1950-1951

Anti-Locust Research Centre,
British Museum
(Natural History),
London, S.W.7
6th June, 1951.

SIR,

As Director of the Anti-Locust Research Centre, I have the honour to transmit to you a Report on Locust Research and Control for the year 1950–51.

I have the honour to be,
Sir,
Your obedient servant,
(sgd.) B. P. UVAROV.

The Right Honourable James Griffiths, M.P.
Secretary of State for the Colonies.

LOCUST RESEARCH AND CONTROL

1950—51

CONTENTS

LOCUST RESEARCH AND CONTROL

1950-1951

INTRODUCTORY

1. Planned anti-locust activities have been steadily developing since 1929 and the general organisation of locust research and control has recently been summarised in a comprehensive report by Dr. B. P. Uvarov, C.M.G., F.R.S., Director of the Anti-Locust Research Centre.* Brief information on anti-locust activities has previously been given in the annual reports of the Colonial Research Council, but their widening scope and increasing importance have made it desirable that they should in future form a special section of the Colonial Research reports.

ANTI-LOCUST RESEARCH CENTRE

General

2. The developments which led to the establishment of the Anti-Locust Research Centre and its activities up to 1950 have been described in Colonial Research Publication No. 10 referred to above. The functions of the Centre when it was established in 1945 were defined as follows:—

(1) It will be the centre for locust information.

(2) It will be the headquarters of such research work as may be sponsored by His Majesty's Government in the United Kingdom with regard to locust problems.

(3) It may be expected to be responsible for the technical direction of anti-locust campaigns, where those are necessary, and of such permanent control schemes as are set up for dealing with the known outbreak areas of locusts in territories where His Majesty's Government in the United Kingdom has interests or responsibilities.

The Centre is guided in its research work by an Advisory Committee, which was appointed in 1946. The membership of the Committee is given in Appendix I.

3. The Centre is accommodated, by agreement with the Trustees of the British Museum (Natural History), in the Museum buildings at South Kensington. Its personnel consisted, during the year, of the Director, a Principal Scientific Officer, a Senior Scientific Officer, one Scientific Officer in charge of Locust Laboratory, two Experimental Officers (one in charge of mapping section, another a bibliographer and librarian), four Assistant Experimental Officers (two for mapping, two in the Laboratory), one Scientific Assistant (in the Laboratory), a Secretary, Assistant Secretary and a typist. Two research workers holding grants are carrying out their investigations at the Centre.

Information service

4. Reports on the locust situation in Africa and south-western Asia are regularly received at the Centre and plotted on large scale maps. During the year over 600 such reports have been received from some 30 countries. Current reports on the present Desert Locust plague (para. 36) are dealt with immediately and *Desert Locust Situation Summaries* accompanied by forecasts, are circulated to all the affected countries.

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* Locust Research and Control. *Colonial Research Publication No. 10.* H.M.S.O. 5s. net.

Advisory activities

5. The major part of the advisory activities of the Centre is connected with regional anti-locust organisations, on the governing bodies of which the Centre is represented in a consultative capacity. These organisations are also regularly provided with advice on current research and control problems and assistance is given to them in establishing contacts with other organisations, persons and industry, as well as in the recruitment of scientific and technical personnel. The Centre is also frequently consulted by foreign organisations and by insecticide and machinery manufacturers.

6. The library of the Centre, which contains the greater part of the published literature on locusts and their control, and is practically complete with regard to recent publications, is regularly consulted by research workers in the United Kingdom and abroad. *Acridological Abstracts* of current literature on all aspects of the locust and grasshopper problem are regularly circulated to all interested organisations and persons. During the year 142 abstracts were issued and their usefulness in keeping scattered workers informed is widely acknowledged.

Conferences, tours and lectures

7. Dr. Uvarov attended meetings of the International Red Locust Control Council and the Provisional International Council for the Control of the African Migratory Locust at Leopoldville in June–July; the Executive Committee of the latter organisation in Paris in December; the Advisory Committee of the Desert Locust Survey and the Executive Committee of the Desert Locust Control at Nairobi in July; the International Conference on Desert Locust Control in Cairo in March, 1951. Dr. Gunn carried out field tests of control methods in British Somaliland in March–April, 1950, and in the Anglo-Egyptian Sudan in September–October (see paras. 25–26); and toured the Red Locust outbreak areas and attended meetings of the Executive Committee of the International Red Locust Control Organisation in May and November. He also visited Copenhagen to discuss Mr. Weis-Fogh's research there (see para. 18) in February, 1951.

8. A special meeting of the Zoology Section of the British Association for the Advancement of Science was devoted to the locust and grasshopper problem, and Dr. Uvarov, Miss Z. Waloff and Dr. P. E. Ellis took part. Lectures on locust research and control were given by Dr. Uvarov to the Royal Institute of International Affairs in London, and by Dr. Gunn to the Royal Scottish Geographical Society in Edinburgh and in various Universities.

Locust laboratory

9. The laboratory at the Centre is run by Mr. P. Hunter-Jones under the charge of Dr. D. L. Gunn. It provides healthy locusts for research, both in the laboratory itself and elsewhere. During the year, over 6,000 adults and about 40,000 newly hatched locusts of two species were supplied for extra-mural research work.

10. Locust outbreaks are the result of successful breeding and survival and they are accompanied by considerable changes in the form and behaviour of the insects, changes which are the subject of Uvarov's phase theory. Mr. P. Hunter-Jones has made substantial progress in investigating phase changes of form and in producing extreme *solitaria* and *gregaria* phases in the laboratory. In addition to the environmental agencies of crowding or isolation, long known to affect phase status, it has been shown that there are inheritable factors affecting the most usual measure of phase status.

11. It has sometimes been supposed that outbreaks of locusts are connected with an increased rate of reproduction in phase *gregaria* as compared with that in phase *solitaria*. Dr. Maud Norris has shown, on the contrary, that in the African Migratory Locust in the laboratory, at any rate, the reproductive rate of *solitaria* is, if anything, higher than that of *gregaria*. She is now studying fecundity in the Desert Locust.

12. A new project has been begun by Miss P. M. Davey on the feeding of the Desert Locust; it is hoped that the results may relieve the difficulty of feeding laboratory locusts, which is now dependent on a daily supply of fresh grass, and also lead to improvements in the bait used in anti-locust campaigns. The work has already led to the rejection of one material put forward for locust bait.

Extra-mural Research

13. The extra-mural researches, which are organised by Dr. Gunn, may mostly be placed in four overlapping groups: those investigations in biochemistry, physiology, or behaviour that refer especially (*a*) to phase phenomena and (*b*) to phenomena of migration; investigations into (*c*) population dynamics which are only just beginning, so that no further reference will be made to them here; and investigations connected with (*d*) the destruction of locusts by means of insecticides and machinery. It is convenient to deal with (*d*) under a separate heading (paras. 23–28), whether it is extra-mural or not.

14. The most obvious differences between locusts of different phases are differences in colour pattern. Dr. T. W. Goodwin, assisted by Dr. Srisukh, in the Biochemistry Department, Liverpool University has, in a series of investigations, estimated the changes in quantities of beta-carotene, astaxanthin, and insectorubin present at all stages of life in both phases of two species of locusts. He has been able to show how far they and certain other pigments contribute to visible colouration. This work now needs to be followed by a study of the enzymatic processes involved in the deposition in phase *gregaria* of that intractable material, melanin.

15. Mr. S. P. Cheu, working in Cambridge, has traced the accumulation and disappearance of fat in adult *Locusta* and has shown that sexual maturation is not closely connected with the presence of an adequate store of fat; indeed, in *gregaria* there is a striking fall in fat present, which occurs before egg laying begins and which cannot be attributed to its transfer to eggs.

16. Some years ago it was noticed that the peculiar massed marching of locust hoppers sometimes occurs in the laboratory. Dr. Peggy Ellis has investigated this behaviour quantitatively and has shown under what conditions it can be produced. Although this kind of migration is most vigorous when there is a lack of food, it cannot be interpreted as essentially a quest for food, because it occurs when good food is readily available. Nor is it an attempt to escape from bad conditions for it lasts longest under conditions, especially of temperature, that are most favourable. Marching appears to be a normal spontaneous activity of *gregaria* hoppers. *Solitaria* hoppers also march, but much less and more slowly.

17. In cool conditions in the field, *gregaria* locusts can often be observed basking in the sunshine, with their bodies parallel to one another and perpendicular to the sun's rays. It has now been shown by Dr. Eleanor Slifer of Iowa State University, working in Dr. Wigglesworth's laboratory in Cambridge with Economic Co-operation Administration assistance, that the thermoreceptors involved are located around the bases of the antennae and that similar receptors occur on the thorax and abdomen.

18. Turning to phenomena of flight, which are of special interest in connection with migration of swarms of locust adults, Mr. T. Weis-Fogh has been working in the laboratory of the late Professor August Krogh, F.M.R.S., in Copenhagen. During the development of methods of getting tethered locusts to fly persistently, he discovered an aerodynamic sense-organ of an entirely new type. The investigations are covering many aspects of flight and migration; among these, it may be mentioned that the energy for flight is obtained mostly from fat and not from carbohydrate, and that stored fat is not generally enough for more than one day's continuous active flight.

19. During flight, locusts can probably take account of wind direction by use of the eyes. In understanding the determination of direction of migration, it is therefore important to know something of the acuity of vision of these insects. Acuity is also probably relevant to formation flying in swarms. Dr. B. Whittington at Sheffield University has been studying this problem of acuity.

Taxonomic research

20. Research on the taxonomy of locusts and grasshoppers was carried out by Dr. V. M. Dirsh, under a research grant. Biometrical work on the extreme solitary and gregarious phases of the Desert Locust has been completed, its main finding being to establish a new and reliable phase criterion, which has been extended also to the African Migratory and the Red Locust. A practical table for distinguishing the sexes in all hopper instars of the African Migratory Locust was prepared and published. General taxonomic work on African grasshoppers made good progress, and the basic locust and grasshopper collection was greatly enlarged by accessions.

Biogeographical research

21. Copious records on breeding and movements of locust swarms is Africa and south-western Asia accumulated at the Centre during the last 20 years are being used for the preparation of generalised schemes of annual cycles, which are published as *Memoirs*. During the year, a *Memoir* on the Desert Locust in North-East Africa and the Middle East has been completed by Mr. D. E. Davies; and another, on the same locust in the Irano-Indian area, is in preparation by Miss J. M. E. Fortescue-Foulkes.

Field research on the behaviour of adult Desert Locusts

22. Field investigations on the behaviour of adult Desert Locusts in swarms, in relation to weather, have been carried out for several seasons as a joint project by the Anti-Locust Research Centre and the Desert Locust Survey. By 1950, however, suitable swarms were absent and the Field Research Party, under Miss Z. Waloff, was transferred to work in Eritrea on the behaviour of solitary locusts, applying quantitative methods and instrumental observations. The work had to be terminated in May because of the disturbed state of the country but some valuable data were obtained and they are being prepared for publication. The Research Party resumed its work in November, this time on swarms which had again appeared in Kenya.

Research on control

23. The researches in this field are co-ordinated by Dr. Gunn, though much of the work is done by experts in other organisations in this country. For example, the Ministry of Supply's establishment at Porton was responsible for the successful development of aircraft spraying methods against settled locusts and for the design of a very effective insecticide solution (20 per cent. dinitro-*ortho*-cresol) for this purpose. Arising from preliminary trials in 1945 of

aerial curtain spraying against swarms in flight, Mr. K. F. Sawyer (Porton) has greatly improved the technique of calculating the best method of laying the curtain while the spraying apparatus has been correspondingly brought up to date. Mr. N. W. Wootten is working at the same laboratory on the amount of spray picked up by a flying locust and the information, which is required for Mr. Sawyer's equations, is expected to be completed in the coming year.

24. During the aircraft trials in 1947, it seemed that sufficiently powerful ground machinery ought to be as effective as aircraft at much lower cost. Dr. H. G. H. Kearns agreed to design and assemble such a machine, which came forward for test in 1950. A team mostly from the National Institute of Agricultural Engineering under Mr. Hoare carried out prolonged trials at Porton and it seemed likely that the " Airflow " machine would be capable of clearing locusts at a rate of several acres per minute, using under a gallon per acre of the same DNOC solution. The machine has now gone to the Rukwa Valley for trials against locusts in the autumn of 1951.

25. In the meantime, there has been a persistent demand from locust control organisations for methods of killing locusts when they will not accept bait or when baiting is impracticable. Accordingly in the spring of 1950 a combined party from the Desert Locust Survey and Messrs. Imperial Chemical Industries Ltd., worked in British Somaliland under Dr. Gunn. The spraying machines then tested were not satisfactory, but the experience gained led Mr. J. Ward to suggest the use of a tall mast to carry the spraying nozzles. The conception was realised by Messrs. Drake and Fletcher in a machine called the " Weardling ", which has since been tested against locusts by Dr. Gunn in the Sudan and tested and improved by the same team from the National Institute of Agricultural Engineering. Mr. Courshee of this Institute has used his experience of this machine and the " Airflow " to discuss the principles involved in wind-drift spraying. This discussion is already of value in assessing the various commercial machines employing airflow and wind-drift methods which are now coming on to the market.

26. The Somaliland experiments also included trials of machine dusting. On the experience then gained, a limited experimental control campaign was recommended, using 40 per cent. benzene hexachloride dust at 13 lb. per acre. The recommendation was not made stronger because of the limited amount of time in each day during which dusting is practicable and because of the inexplicable failures which have been experienced in dusting locusts. As a result of representations made to the United Kingdom Research and Development Co-ordinating Committee on Fungicides and Insecticides, this Committee called together a group of experts on dusts, including a number from engineering and other sciences, to examine the subject of insecticide dusts and their application. That group has met a number of times, at first under the chairmanship of Dr. H. Martin and later of Dr. Gunn, and its recommendations are expected during 1951.

27. While there may be a place in locust control for the use of contact poisons, whether as sprays or dusts, baiting remains the principal method of control because of its simplicity and efficacy and the cheapness of the material. There were indications, however, that improvements could be made: the area dosages used were higher than in the United States, indicating that savings not only of material and labour, but also—and more important—of transport might be possible; water for wetting the bait is often difficult to get in Desert Locust areas, and oiled bait without water had been successful in U.S.A.; hand spreading by local labour is frequently inefficient and may be expensive; and the usual carrier, wheat bran, was already short and getting

dearer. Accordingly, Dr. Gunn investigated baiting methods, both in Somaliland in the spring, and in the Sudan in the autumn. It was shown that bran bait can be successfully used against the Desert Locust entirely without water or oil; that the dosage of dry bait can be reduced to about 25 lbs. per acre; that dry bait can be spread by an ordinary dusting machine at a rate of about ½ acre per minute; and that the most effective method, line baiting against marching locusts, can be carried out with a large funnel made from petrol tins, tied to the back of a vehicle moving at 10 m.p.h. or more. There was insufficient time to investigate bran substitutes properly, though some recommendations were made. Subsequently Mr. V. Joyce, Government Entomologist of the Sudan, showed that certain fractions of sorghum millet (*dura*), a local product which is plentiful and cheap in some years, were if anything better than wheat bran for locust baiting. As insecticides, both sodium arsenite and benzene hexa-chloride were found to be effective, each having merits in particular directions.

28. During the year some tests of newer insecticides have been made against locusts, but none has been recommended for general use. The mode of action of certain insecticides applied directly to the central nervous system of locusts was being studied by Miss Paula Cook in the Zoology Department of Glasgow University.

REGIONAL ORGANISATIONS

International Red Locust Control Organisation

29. The International Red Locust Control Organisation, maintained under a convention between the Governments of the United Kingdom, Belgium, Southern Rhodesia, the Union of South Africa, and Portugal, has its headquarters at Abercorn, Northern Rhodesia. The personnel of the Control Service consists of a Director (Mr. H. Bredo), one Senior Scientific Officer (Mr. D. Vesey-Fitzgerald, M.B.E.), and two Scientific Officers, in addition to the technical and administrative staff. The Service was faced in 1950–51 by a serious outbreak of the Red Locust in the Rukwa Valley, and extraordinary control measures had to be taken to prevent the formation and escape of swarms. These measures were successful.

30. The research work of the Service is still in its initial stages and is liable to disturbance by control requirements, but good progress has been made in ecological studies on locust populations in relation to vegetation (Mr. D. Vesey-Fitzgerald and Dr. H. Backlund), and on the flora of the outbreak areas (Mr. A. A. Bullock, taxonomic botanist, temporarily seconded from the Royal Botanic Gardens, Kew).

Provisional International Council for the Control of the African Migratory Locust

31. Pending the conclusion of an international convention to establish permanent international control of the outbreak area of the African Migratory Locust on the River Niger in the French Sudan, a French service is being financed jointly by France, Belgium and the United Kingdom, and administered by a Provisional International Council. The United Kingdom share of the cost is apportioned between those British territories in Africa which are liable to invasion by the African Migratory Locust. The activities of this service are at present restricted to supervision and control of outbreaks. During the year there was a sudden increase in the locust activity, several thousands of hopper bands and swarms were destroyed, and it was hoped that escapes would be prevented. In the absence of a permanent research officer on the

staff, M. G. Rémaudière of the Institut Pasteur, Paris, was sent on a mission to study the ecology and life-cycle of the solitary locusts in the outbreak area; the mission was planned to last two years, but had to be restricted to one, and its results are being prepared for publication.

Desert Locust Survey

32. The Desert Locust Survey came into being at the end of 1948. It is an organisation administered by the East Africa High Commission and has its headquarters at Nairobi. The cost of the Survey is met by a grant from Colonial Development and Welfare funds, and by contributions from the East African and a number of other territories. The task of the Survey is to watch the known outbreak areas of the Desert Locust and to investigate other areas which are suspected to be a source of outbreaks, as well as to carry out research on the Desert Locust in general. Its Director is Mr. P. R. Stephenson, O.B.E., and the Senior Research Officer is Dr. R. C. Rainey. The Survey maintains field bases at Asmara, Hargeisa, Jedda and Aden, while its mobile teams have been carrying out investigations also in Ethiopia, Yemen, Hadhramaut, Oman, Persia and Tripolitania.

33. The development of the Survey and its research activities were considerably affected when the new plague of the Desert Locust developed and the young organisation became involved in locust control operations, although it was neither intended nor adequate to deal with a large scale emergency. The latter required a large, special, temporary organisation, the Desert Locust Control (para. 36), to which the Director of the Survey provides technical advice on the planning and execution of operations. The establishment of the Desert Locust Control has preserved the Survey as a more permanent research and advisory organisation and the view accepted by the authorities in East Africa and at home that research work should be intensified rather than reduced in the face of an emergency, deserves to be put on record as unique in the history of anti-locust work.

34. Research by the Survey staff includes extensive studies in the biometrics of locust populations from different areas (Dr. R. C. Rainey); analysis of swarm movements in relation to synoptic meteorology (Dr. Rainey and Miss Z. Waloff of the Anti-Locust Research Centre); and hopper behaviour in relation to ecological conditions, population density and hopper colouration (Mr. W. J. Stower, in Eritrea). The last named research involved the need for an expert microclimatologist and Mr. J. F. Griffiths has been appointed for this work. Investigations of suspected locust outbreak areas are being pursued in Arabia, particularly in Oman and on the southern confines of the Rub al Khali desert, and in Ethiopia. Research projects of the Survey executed jointly with the Anti-Locust Research Centre are reported in paras. 22 and 25.

Moroccan Locust research team, Cyprus

35. Research on the causes of swarming of the Moroccan Locust in Cyprus were due to start in 1950, but no definitive appointments could be made in time and a temporary team consisting of Mr. A. R. Waterston (Entomological Adviser, British Middle East Office), Dr. N. Waloff (Imperial College of Science) and Mrs. E. Chapman was engaged in preliminary investigations. A survey of the distribution of the locust was made and areas for intensive study selected; different methods of estimating locust densities in relation to vegetation cover were tested; colour variation in hoppers in relation to densities, colour changes in adults in relation to maturation, oviposition habits and biometrics of adults

were studied. Although most of the results are only preliminary, they are of great value to the definitive team which was appointed in October and consists of Mr. F. Merton (plant ecologist) and Mr. S. J. Curry (entomologist). Preliminary studies by members of the team were carried out during the winter in London and were greatly assisted by the staff of the Imperial College of Science and of the Kew Herbarium. Since January, 1951, the team has been working in Cyprus.

DESERT LOCUST CONTROL

36. The development of a new plague of the Desert Locust (para. 33) made it necessary to create a temporary organisation for directing the vast anti-locust operations, mainly for the protection of East Africa. A Desert Locust Control Executive Committee was established by the East Africa High Commission at Nairobi, and a Chief Locust Officer (Brigadier E. Gamble) was appointed, together with a large field staff of locust officers. A sum of £1,222,000 has been provided by contributions from the United Kingdom, East African colonies and the Anglo-Egyptian Sudan, Eritrea and Tripolitania towards the annual cost of the campaign; close liaison was established with the Italian Trusteeship Administration in Somalia, and with the Governments of Egypt, Ethiopia, Saudi Arabia, Yemen and Oman, while co-operation was maintained with the Governments of India, Iran and Pakistan. General planning of the campaign was in the hands of the Desert Locust Survey Advisory Committee and experts of the Survey provided technical advice.

37. Operations against swarms have been conducted from a number of field bases in Eastern Africa and Arabia, and the general outcome has been eminently satisfactory. East Africa, where the occurrence of a severe invasion at the end of the year was anticipated, has been visited only by a few swarms owing to the successful control of hoppers in British Somaliland, Somalia and the Ogaden province of Ethiopia. By the end of 1950 and in the early months of 1951, active operations were mostly confined to Saudi Arabia where some swarm escapes may be expected, owing mainly to the difficulty of making available sufficient transport for the operation of control teams. The situation, however, remains very serious in Iran, Pakistan and India, while there are swarms also in West and North Africa. These countries are outside the field of operation of the Desert Locust Control, having organisations of their own.

APPENDIX I

ADVISORY COMMITTEE ON ANTI-LOCUST RESEARCH

Membership

SIR GEOFFREY EVANS, C.I.E., M.A., Royal Botanic Gardens, Kew, Surrey, (*Chairman*).

MR. G. A. BULL, B.Sc., Meteorological Office, Air Ministry.

PROFESSOR G. R. CAMERON, D.Sc., M.B., B.S., F.R.S., Professor of Morbid Anatomy, University College Hospital Medical School, University of London.

SIR GEOFFREY CLAY, K.C.M.G., O.B.E., M.C., Agricultural Adviser to the Secretary of State for the Colonies.

AIR-COMMODORE K. D. G. COLLIER, C.B.E., Ministry of Supply, D.Arm., R.D. (Air).

DR. D. L. GUNN, Principal Scientific Officer, Anti-Locust Research Centre.

DR. W. J. HALL, C.M.G., M.C., Director, Commonwealth Institute of Entomology.

LT.-COL. H. J. HOLMAN, B.Sc., A.R.C.S., D.I.C., Colonial Office.

MR. S. T. A. MIRRLEES, M.A., Meteorological Office, Air Ministry.

MR. S. A. MUMFORD, M.Sc., Chemical Defence Experimental Establishment, Ministry of Supply.

DR. O. W. RICHARDS, M.A., Reader in Entomology, Imperial College of Science and Technology.

MR. N. D. RILEY, Keeper of Entomology, British Museum (Natural History).

DR. B. P. UVAROV, C.M.G., F.R.S., Director, Anti-Locust Research Centre.

PROFESSOR G. C. VARLEY, M.A., Ph.D., Hope Professor of Zoology (Entomology), University of Oxford.

DR. V. B. WIGGLESWORTH, C.B.E., M.A., F.R.S., Director, Agricultural Research Council Unit of Insect Physiology. Reader in Entomology, University of Cambridge.

DR. C. B. WILLIAMS, M.A., Chief Entomologist, Rothamsted Experimental Station.

MR. A. T. THOMPSON, Secretary, Anti-Locust Research Centre. (*Secretary*).

APPENDIX II

List of publications

ANTI-LOCUST BULLETIN

ELLIS, P. E., 1951. The marching behaviour of hoppers of the African Migratory Locust (*Locusta migratoria migratorioides* R. & F.) in the laboratory.—*Anti-Locust Bull.*, London, No. 7: 48 pp.

COLONIAL RESEARCH PUBLICATION No. 10

UVAROV, B. P., 1951. Locust Research and Control, 1929–1950.—H.M.S.O., London. 67 pp.

JOURNAL PAPERS, written by members of the staff, sponsored or otherwise assisted by the Centre

DIRSH, V. M., 1950. Two new African injurious grasshoppers.—*Bull. ent. Res.*, London, *41* : 317–320, 16 figs.

DIRSH, V. M., 1950. A practical table for the determination of sexes of nymphs of *Locusta migratoria migratorioides* (R. & F.).—*Proc. R. ent. Soc. Lond.*, *19* : 136–138, 2 figs.

DIRSH, V. M., 1951. A new biometrical phase character in locusts.—*Nature*, London *167* : 281–282, 3 figs.

DIRSH, V. M., 1951. A new injurious Indian grasshopper (Orthoptera, Acrididae).—*Bull. ent. Res.*, London, *41* : 599–601, 7 figs.

ELLIS, P. E., 1950. Marching in locust hoppers of the solitary phase.—*Nature*, London, *166* : 151, 1 fig.

GOODWIN, T. W., 1950. Biochemistry of Locusts. 4. Insectorubin metabolism in the desert locust (*Schistocerca gregaria* Forsk.) and the African migratory locust (*Locusta migratoria migratorioides* R. & F.)—*Biochem. J.*, London, *47* : 554–562, 2 figs.

GOODWIN, T. W. and SRISUKH, S., 1950. A biochemical description of locust coloration.—*Biochem. J.*, London, *46* : xvii.

GOODWIN, T. W. and SRISUKH, S., 1950. Biochemistry of locusts. 3. Insectorubin: the redox pigment present in the integument and eyes of the desert locust (*Schistocerca gregaria* Forsk.), the African migratory locust (*Locusta migratoria migratorioides* R. & F.) and other insects.—*Biochem. J.*, London,*47*: 549–554, 5 figs.

GOODWIN, T. W. and SRISUKH, S., 1951. Biochemistry of locusts. 5. The green pigment of the haemolymph and integument of solitary locusts (*Locusta migratoria migratorioides*, R. & F., and *Schistocerca gregaria*, Forsk.)—*Biochem. J.*, London, *48* : 199–203, 3 figs.

HAMILTON, A. G., 1950. Further studies on the relation of humidity and temperature to the development of two species of African locusts—*Locusta migratoria migratorioides* (R. & F.) and *Schistocerca gregaria* (Forsk.).—*Trans. R. ent. Soc. Lond.*, *101* : 1–58, 34 figs.

LEVENBOOK, L. and CLARK, A. M., 1950. The physiology of carbon dioxide transport in insect blood. Part ii. The effect of insect blood on the rate of hydration of CO_2.—*J. exp. Biol.*, Cambridge, *27* : 175–183, 6 figs.

SAWYER, K. F., 1950. Aerial curtain spraying for locust control: a theoretical treatment of some of the factors involved.—*Bull. ent. Res.*, London, *41* : 439–457, 16 figs.

UVAROV, B. P., 1950. Recent progress in locust and grasshopper research.—*Proc. 8th int. Congr. Ent. Stockholm*, 1948: 693–694.

UVAROV, B. P., 1950. Locust and grasshoppers.—*Nature*, London, **166** : 625–626.

WEBLEY, D. P., 1951. Blood-cell counts in the African migratory locust (*Locusta migratoria migratorioides* Reiche and Fairmaire).—*Proc. R. ent. Soc. Lond.* (A) *26* : 25–37, 6 figs.

WEIS-FOGH, T., 1950. An aerodynamic sense organ in locusts.—*Proc. 8th int. Congr. Ent. Stockholm*, 1948: 584–588, 3 figs.

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