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COLONIAL OFFICE

# COLONIAL RESEARCH

## 1959-1960

### REPORTS OF THE

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

Research Matters not covered by the above Reports  
of the Specialist Advisory Bodies

*Presented to Parliament by the Secretary of State for the Colonies  
by Command of Her Majesty  
December 1960*

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## ANNUAL REPORT OF COLONIAL RESEARCH FOR 1959-1960

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

Agricultural, Animal Health and Forestry.

Economic.

Fisheries.

Medical.

Pesticides.

Road Research.

Social Science.

Tsetse and Trypanosomiasis.

Locust Research and Control.

Research matters not covered by the reports of the Specialist Advisory Bodies.

**COLONIAL RESEARCH**  
**ANNUAL REPORT**  
**1959-1960**

**INTRODUCTORY**

*Colonial Research Council*

The Colonial Research Council was dissolved in August, 1959, and its functions taken over by the Overseas Research Council. In its first Progress Report, that for 1942-43, the Colonial Research Committee stated its intention to present annual reports. This intention was honoured until and including the year 1947-48. In 1948 the Committee was reorganised and renamed the Colonial Research Council, which has followed the practice of its predecessor and published its report annually. The first Progress Report consisted of twenty-six pages including appendices. The Report has grown a good deal since then, partly because the reports of the various Committees set up from time to time have been annexed to it, but mainly because of the steady growth over the years of research carried out in and on behalf of the Colonial territories. Since the Colonial Research Committee was created, research in these territories has come to be organised on an inter-territorial and a territorial basis. In the West Indies and East and West Africa, fundamental research of interest common to the territories composing each of the three regions is organised and financed on an inter-territorial basis and carried out under the auspices of inter-territorial Research Councils on which there are scientific representatives from the United Kingdom who attend the meetings of the Councils and visit the research units in the regions. Territorial research has also increased, and is in the main financed from local funds. Colonial Development and Welfare funds are used to help in financing some of this research (particularly in the smaller territories or territories in which research in a particular field is being started), as well as research conducted on an inter-territorial basis.

2. Good progress in the development and organisation of Colonial research has been made over the years within the limits of the finance and scientific man-power available, and the Council could, at its dissolution, look back on its work with satisfaction, while recognising that much still needs to be done. An adequate supply of scientific man-power for work overseas is probably more important than financial assistance, and the problem of the retention and recruitment of scientific staff is under continuing consideration by the Overseas Research Council.

*Colonial Research Advisory Bodies*

*Colonial Products Council*

3. As was noted in "Colonial Research, 1958-59", the Colonial Products Council was disbanded on the 1st April, 1959, when responsibility for the Tropical Products Institute was transferred to the Department of Scientific

and Industrial Research. The affairs of the Institute are in the hands of the Tropical Products Institute Committee, on which there is a representative of the Colonial Secretary. A report on the work done by the Institute on behalf of Colonial territories will be found in section XI.

*Colonial Medical Research Committee*

*Colonial Road Research Committee*

4. Although they occurred after the close of the year 1959-60, it is convenient to refer here to changes made with respect to the above Committees. In July, 1960, it was announced that the Medical Research Council had set up a Tropical Medicine Research Board. It was necessary, in view of the increasing number of countries evolving from colonial to independent status, to ensure that help and advice should continue to be available from the United Kingdom to countries that still wished to receive it. The new Tropical Medicine Research Board will be in a position to do this and one of its functions will be to advise the Colonial Secretary, through the Medical Research Council, on all medical research in and for the Colonies financed from Colonial Development and Welfare Funds. The new Board has absorbed the functions of the Colonial Medical Research Committee, which has been dissolved.

5. For reasons similar to those obtaining for medical research, the Colonial Road Research Committee was dissolved after its annual meeting in June, 1960. Its functions have been absorbed by the new Committee on Overseas Road Research which will advise the Road Research Board of the Department of Scientific and Industrial Research on matters of research concerned with problems of roads and road transport overseas. The new Committee has taken over the function of advising the Colonial Secretary on Colonial road research and the Tropical Section of the Road Research Laboratory will, of course, continue to work on behalf of the Colonial territories.

*Overseas Research Council*

6. In July, 1959, the Lord President announced the establishment of the Overseas Research Council with the following terms of reference:—

“ To advise the Privy Council Committee on Overseas Research :—

- (1) on the formulation of U.K. policy in respect
  - (a) of scientific research undertaken in or for overseas territories both within and outside the Commonwealth.
  - (b) of methods of making the results of research available in these territories, and
  - (c) of assistance to the scientific services of those territories :
- (2) on the co-ordination of the activities of United Kingdom Government organisations in the development of science in the civil sphere in overseas territories ; and
- (3) on co-operation within the Commonwealth, with other countries and with international agencies in promoting such development ”

The membership of the Council is:—

Sir Robert Aitken (*Chairman*).  
Sir Jock Campbell.  
Dr. E. G. Cox, F.R.S.  
Sir Charles Dodds, M.V.O., F.R.S.  
Sir Harold Himsworth, K.C.B., F.R.S.  
Sir Joseph Hutchinson, C.M.G.  
Dr. R. Lewthwaite, C.M.G., O.B.E.  
Professor J. McMichael, F.R.S.  
Sir Harry Melville, K.C.B., F.R.S.  
Sir Geoffrey Nye, C.M.G., O.B.E.  
Sir Arnold Plant.  
Sir William Slater, K.B.E., F.R.S.  
Sir Henry Thornton, F.R.S.  
Sir Solly Zuckerman, C.B., F.R.S.

7. As explained above, the Overseas Research Council has taken over the functions of the former Colonial Research Council. While the various Colonial Research Advisory Committees will continue to advise the Secretary of State for the Colonies on research within their respective fields and on the expenditure of Colonial Development and Welfare Funds within these fields, they will keep the Overseas Research Council informed of their activities, and their annual reports will be made available to the Council. The Overseas Research Council is, of course, able to call on existing research organisations, including in this context the Colonial Research Advisory Committees, for advice, and to make suggestions relating to research overseas. Similarly the Colonial Research Advisory Committees will be able to seek the advice of the Overseas Research Council on any general questions which may arise in connection with Colonial research.

8. The various changes described above have already been made in the titles and organisation of certain of the Colonial Research Advisory Committees in order to meet changing needs, and the possible necessity for further changes is being kept in mind.

### GENERAL

9. This report deals with certain research matters not covered by the reports of the specialist advisory research committees. The subjects comprised in the latter are Agriculture, Animal Health and Forestry; Economic; Fisheries; Pesticides; Anti-Locust Research and Locust Control; Medical; Road Research; Social Science, and Tsetse and Trypanosomiasis Research. Other research matters not covered by the reports of these Committees, are discussed in report number XI in this volume.

10. As in previous years, visits were made to various territories by members of the Colonial Research Council and the Research Advisory Committees. Members attended meetings in East Africa, West Africa and the West Indies of the Research Advisory bodies for those regions. These and other visits by scientists from the United Kingdom are referred to in more detail in the reports of the individual committees.

11. Under the Act of 1959, an additional sum of £95 million was provided for Colonial Development and Welfare. £7·526m. was allocated to Colonial Research. This amount includes a balance of £3·026m. unspent in the period ended the 31st March, 1959. The allocation takes account of the fact that certain territories have or will become independent during the new period and therefore be outside the scope of the Colonial Development and Welfare Acts.

12. Expenditure during the year under review was £1,483,192 as compared with £1,224,000 in 1958-59.

*Colonial Development and Welfare Research Schemes made in 1959-60 and their Cost*

13. A list of the schemes made during the year and the grant allotted to each from Colonial Development and Welfare funds is given in Table I of the Appendix. 134 new schemes and 82 supplementary schemes were made, involving grants totalling £2,370,261. These compare with 71 new schemes and 63 supplementary schemes made during the previous year entailing grants totalling £798,974. It will be appreciated, however, that each year many of the schemes shown as new schemes are in fact continuations of earlier schemes. As will be seen from Table II, these grants bring the total sum allocated to Colonial Development and Welfare Research schemes since 1940 to £21,864,193. The net commitment, after allowing for revision of schemes and unspent balances was, on the 31st March, 1960, about £19m. of which some £18·8m. is chargeable against the funds provided under the 1945, 1950, 1955 and 1959 Colonial Development Welfare Acts. The financing of many of these schemes is assisted by Colonial Governments from their own resources. Table II shows the actual disbursements made each year since 1940-41 which now total nearly £16·2m.

14. About 42·6 per cent of the gross allocation of Colonial Development and Welfare Research funds amounting to £2,370,261 has been for agricultural, animal health and forestry schemes, 15·8 per cent. for medical research, 2·6 per cent. for fisheries research, 1·9 per cent. for tsetse and trypanosomiasis research, 2·1 per cent. for social science and economic research, 23·7 per cent. for pesticides research, 2·4 per cent. for products research, 7·1 per cent. for anti-locust research, and 1·8 per cent. for miscellaneous schemes including building and road research. Approximately 33·5 per cent. of the gross allocation has been for schemes to benefit the East African territories, 7 per cent. for the West African group, 15·5 per cent. for South-East Asian territories and Hong Kong, 12·5 per cent. for the West Indian colonies, British Guiana and British Honduras, 1 per cent. for the Central African territories (Northern Rhodesia and Nyasaland) and 30·5 per cent. for other territories and for schemes for general interest.

15. These percentages are of course in respect of the first year of the new quinquennium 1959-1964. Some of the allocations have been put to use more rapidly than others, and the percentages should not be taken as likely to be constant.

16. New projects during the year include:—in the United Kingdom, research on the preservation of malarian parasites and studies of genetics of *Aedes aegypti* and on tick-borne diseases at the London School of Hygiene and Tropical Medicine, a preparation of botanical monographs by the



Imperial Forestry Institute, Oxford, a Colonial Pool of Pesticides Chemists based at the Tropical Products Institute, London, the appointment of an analytical chemist for stored products work at the Pest Infestation Laboratory, Slough, and investigation on glossitis and the *buccal mucosa* in relation to malnutrition by the Medical Research Council; Biochemical research and research on swamp ecology at Makerere College, Uganda; research on fauna, coffee berry disease and cereals in Kenya and a contribution towards the recurrent cost of the The Wellcome Institute for Research on Foot and Mouth Disease; research on social organisation of an Arab tribe in the Aden Protectorate; a socio-anthropological survey in Seychelles; agriculture research services and the establishment of agricultural research stations in North Borneo; the improvement and extension of agricultural facilities and the establishment of a new Herbarium in Sarawak; arrowroot research in St. Vincent; and in British Honduras, termite research and a study of dermal leishmaniasis.

*Research Branch of Her Majesty's Overseas Civil Service*

17. Twenty-four new appointments were made on Research Branch terms during the year. Seven officers retired, 24 resigned and 1 died. The total complement in March, 1960, was 199 officers compared with 207 in March, 1959. Two Research Fellows, one studying human trypanosomiasis at the West African Institute for Trypanosomiasis Research and the other investigating arterial hypertension in Jamaica at the University College of The West Indies completed their investigations during the year; a third Fellow studying the effect of diet on the levels of various cofactors and enzymes concerned with carbohydrate and fat metabolism at the University College of The West Indies was released from his Research Fellowship to undertake other research work. A report on his work during the tenure of his fellowship was received. Two further Research Fellowships were awarded during the year, one to undertake a plankton survey of Western Indian Ocean based at the East Africa Marine Fisheries Research Organisation, Zanzibar and the other based at the East Africa Fisheries Research Organisation, Uganda to study the freshwater algae of Lake Victoria and other lakes in the region. In addition six research studentships were awarded for the training of candidates for research appointments overseas; one in medicine and five in agriculture.

*Scientific Council for Africa South of the Sahara (C.S.A.)*

18. Under the auspices of the Council meetings of specialists on Basic Psychological Structures of African Populations, Hydrology and Forestry were held at various centres in Africa. Meetings of the CCTA/CSA Committees on Soils and Social Sciences, and symposia on Helminthiasis, Tropical Vegetation in relation to the Soil and Soil Stabilisation were also held during the year.

*Co-operation between the Colonial Office, Colonial Governments and the United Kingdom Research Councils.*

19. A high level of co-operation was maintained throughout the year, much valuable information and advice being provided by the various laboratories of the United Kingdom Research Councils. Notes on the Tropical Products Institute, building and water pollution research are included in report No. XI.

*Colonial Research Publications*

20. The following reports have been published by Her Majesty's Stationery Office:—

## Colonial Research Studies

No. 27 Traffic and Transport in Nigeria by Gilbert Walker (£3 15s.)

No. 28 An Investigation into Storage Problems on Rice in Sierra Leone by P. F. Prevett, B.Sc., A.R.C.S., D.I.C., F.R.E.S. (16s.)

## Colonial Research Publications

No. 24 Land in British Honduras. Report of the British Honduras Land Use Survey Team A. C. Wright, D. H. Romney, R. H. Arbuckle, V. E. Vial. Edited by D. H. Romney (55s.)

## Colonial Fishery Publications

No. 12 The Hydrography of the British East African Coastal Waters Part II by B. S. Newell, M.Sc. (5s. 6d.)



## APPENDIX

TABLE I

LIST OF SCHEMES APPROVED FOR RESEARCH GRANTS UNDER THE COLONIAL DEVELOPMENT AND WELFARE ACTS DURING THE PERIOD 1ST APRIL, 1959 TO 31ST MARCH, 1960

Scheme No. (Prefix "R")	Benefiting Territory	Description of Scheme	Amount
368A	General ... ..	Visit to East Africa and Mauritius of expert to assess results of residual spraying trials. (Supplementary provision.)	£ 27
628C	do. ... ..	Research on the metabolism of pathogenic trypanosomes. (Supplementary provision.)	65
669B	do. ... ..	Leprosy research at Oxford University. (Supplementary provision.)	2,500
685A	do. ... ..	Research on Colonial paint problems. (Supplementary provision.)	665
685B			7,600
700A	do. ... ..	Visits by members of the Committee for Colonial Agricultural, Animal Health and Forestry Research. (Supplementary provision.)	2,800
702B	do. ... ..	Secretariat of the Committee for Colonial Agricultural, Animal Health and Forestry Research. (Supplementary provision.)	810
714A	do. ... ..	Colonial Agricultural and Allied Research Studentships. (Supplementary provision.)	3,000
716C	do. ... ..	Secretariat of the Colonial Medical Research Committee. (Supplementary provision.)	575
726A	do. ... ..	Termite research at the Commonwealth Institute of Entomology. (Supplementary provision.)	480
791C	do. ... ..	Leprosy research at Strangeways Research Laboratory. (Supplementary provision.)	260
800A	do. ... ..	Training of malacologists for schistosomiasis research. (Supplementary provision.)	4,500
800B			516
874H	do. ... ..	Fish Culture Research Institute, Malacca. (Supplementary provision.)	17,174
899A	do. ... ..	Visits to Colonial Territories by members of the Colonial Fisheries Advisory Committee. (Supplementary provision.)	2,000
917A	do. ... ..	Visits abroad by members of the Tsetse Fly and Trypanosomiasis Committee and Chemotherapy Panel. (Supplementary provision.)	50
951A	do. ... ..	Continued research into the deposition of <i>trypanosome rhodesiense</i> in the human host. (Supplementary provision.)	4,211

## COLONIAL RESEARCH

Scheme No. (Prefix "R")	Benefiting Territory	Description of Scheme	Amount
954A	General— <i>cont.</i> ...	Research on virology at London School of Hygiene and Tropical Medicine. (Supplementary provision.)	£
954B			4,250
962A	do. ...	Morphological studies in the United Kingdom. (Supplementary provision.)	8,290
965A	do. ...	British Commonwealth Scientific Office—Common Services Section, 1959–60. (Supplementary provision.)	1,470
994	do. ...	Anti-Locust Research Centre and its extra-mural activities, 1959–60.	87
1000	do. ...	Tropical Products Institute: provision of salaries and expenses.	71,760
1001	do. ...	Tropical Products Institute: provision for extra-mural contracts.	20,500
1002	do. ...	Visit by member of the Medical Research Council to Northern Nigeria to study the fly <i>Simulium damnosum</i> .	16,500
1005	do. ...	Colonial Spraying Machine Centre: erection of new building.	400
1005A			1,025
1011	do. ...	Visit to East Africa by the Lecturer in Medicine at the Post-Graduate Medical School for research on diabetes.	65
1011A			500
1011B			130
1012	do. ...	Drug trials against leprosy at Sungbi Buloh Leper Settlement.	40
1013	do. ...	Research on preservation of malaria parasites at London School of Hygiene and Tropical Medicine.	1,900
1019	do. ...	Visit of Leprosy experts to Northern Nigeria	1,540
1033	do. ...	Investigation on onchocerciasis ...	550
1034	do. ...	Visit by member of the National Institute for Medical Research to East Africa for a study of the genetical aspect of sickle-cell disease.	620
1036	do. ...	Colonial Pesticides Information Service, 1959–60.	625
1052	do. ...	Trials with anti-typhoid vaccines ...	7,259
1052A			1,000
1053	do. ...	Colonial Pool of Pesticides Chemists ...	37,250
1057	do. ...	Study of genetics of <i>Aedes aegypti</i> at London School of Hygiene and Tropical Medicine.	2,600
1061	do. ...	Studies on tick-borne diseases at London School of Hygiene and Tropical Medicine.	6,305
			2,122

Scheme No. (Prefix "R")	Benefiting Territory	Description of Scheme	Amount
1062	General— <i>cont.</i> ...	Appointment of analytical chemist for stored products work.	£ 5,055
1063	do. ...	Sickle-cell work at University College, London.	500
1066	do. ...	Secretariat of the Committee for Colonial Agricultural, Animal Health and Forestry Research.	21,200
1067	do. ...	Contribution towards the cost of maintaining the Common Services Section of the British Commonwealth Scientific Office, 1960-61.	699
1071	do. ...	Preparation of botanical monographs by the Imperial Forestry Institute.	4,500
1074	do. ...	Employment of Assistant on tuberculosis and leprosy research at Guy's Hospital Medical School.	1,702
1075	do. ...	Study of phlebotomines in Kenya and the <i>Simulium neaveri</i> in Nyasaland.	525
1076	do. ...	Visits by members of the Colonial Medical Research Committee, 1959-60.	15,500
1078 1078A	do. ...	Economic research on the effects of falls in commodity prices.	150 15
1080	do. ...	Secretariat of the Colonial Medical Research Committee, 1960-64.	22,859
1081	do. ...	Overseas Research Fellowships, 1960-64 ...	16,500
1082	do. ...	Visit of a member of the Hannah Dairy Research Institute to East and Central Africa to study tropical environment conditions.	570
1084	do. ...	Investigation of Prophylaxis of Leprosy in Northern Nigeria.	1,375
1087	do. ...	Laboratory investigations on glossitis and the <i>buccal mucosa</i> in relation to malnutrition.	4,070
1088	do. ...	Visit of a member of the National Institute of Medical Research staff to East African Virus Research Institute to advise on the use of new virological techniques.	450
1089	do. ...	Colonial Medical Research Studentships, 1960-64.	15,000
1092	do. ...	Leprosy research at Strangeways Research Laboratory.	3,150
1093	do. ...	Assistance for sickle-cell research and work on abnormal haemoglobins.	3,850

Scheme No. (Prefix "R")	Benefiting Territory	Description of Scheme	Amount
1094	General—cont. ...	Colonial Pool of Pesticides Chemists, 1960-64.	£ 10,380
1098	do. ...	Visit to British Guiana of an expert on anti typhoid vaccine.	500
1102	do. ...	Fundamental research on insecticides at Rothamsted Experimental Station.	10,875
1103	do. ...	Research on spraying techniques and trace element deficiencies at Long Ashton.	18,503
1105	do. ...	Assistance by Rothamsted Experimental Station on statistical matters for the years 1960-64.	9,000
1107	do. ...	Termite Research Unit at the Commonwealth Institute of Entomology.	11,070
1108	do. ...	Central expenses of the Colonial Social Science Research Council and Colonial Economic Research Committee.	4,000
1110	do. ...	Studentship for a study on the mechanism of action of trypanocidal drugs.	1,150
1111	do. ...	Colonial Pesticides Information Service, 1960-64.	27,882
1112	do. ...	Appointment of the Tropical Liaison Officer and staff at the Pest Infestation Laboratory, 1960-64.	25,075
1115	do. ...	Tropical Soils Adviser at Rothamsted Experimental Station, 1960-64.	11,377
1116	do. ...	Employment of two assistants at the Liverpool School of Tropical Medicine.	3,150
1122	do. ...	Contribution towards recurrent cost of the Agriculture Research Council's Unit of Experimental Agronomy and Weed Research Organisation, Oxford, 1960-61.	7,480
1123	do. ...	Colonial Pesticides Research Unit, Porton, 1960-63.	51,009
1126	do. ...	Trachoma Research in London and in the Gambia.	42,968
1127	do. ...	Anti-Locust Research Centre and its extramural activities, 1960-61.	69,500
871A	Africa General ...	Fact finding survey of Literature on African fauna. (Supplementary provision.)	770
1003 1003A	do. ...	Demographic research on British Colonial Africa.	3,565 172

Scheme No. (Prefix "R")	Benefiting Territory	Description of Scheme	Amount
1038	Africa—cont. General—cont. ...	Contribution towards the cost of the transfer of the headquarters of the Commission for Technical Co-operation in Africa South of the Sahara and the Scientific Council for Africa South of the Sahara.	£ 861
1043	do. ...	Study of development of African trypanosomes in the human host.	50
1073	do. ...	Study in Africa of Volutin Granules in relation to the severity of epidemic and sporadic Rhodesiense—Sleeping Sickness.	1,370
1079	do. ...	Study of mealybugs in Africa South of the Sahara.	10,311
222C	East Africa General ...	Study of arthropod fauna of tropical soils. (Supplementary provision.)	16
233B	do. ...	Research into African music. (Supplementary provision.)	130
642D	do. ...	Employment of assistant for the care and utilisation of post mortem material at Makerere College. (Supplementary provision.)	800
850B	do. ...	East African tuberculosis therapy trials. (Supplementary provision.)	1,335
864B	do. ...	Colonial Pesticides Research Unit, Arusha. (Supplementary provision.)	91
909A	do. ...	Weather forecasting research in East Africa. (Supplementary provision.)	2,863
936B 936C	do. ...	Colonial Pesticides Research Unit, Arusha, Tanganyika. (Supplementary provision.)	57,139 500
953A	do. ...	Control of malaria by therapeutic measures at Taveta/Pare. (Supplementary provision.)	2,260
1021	do. ...	Office of East African Agricultural and Fisheries Research Council, 1959-60.	363
1022	do. ...	East African Agriculture and Forestry Research Organisation, 1959-60.	47,892
1023	do. ...	East African Veterinary Research Organisation, 1959-60.	33,283
1024	do. ...	East Africa Trypanosomiasis Research Organisation, 1959-60.	33,504
1025	do. ...	East African Fisheries Research Organisation, 1959-60.	7,311
1026	do. ...	East African Marine Fisheries Research Organisation, 1959-60.	8,059

Scheme No. (Prefix "R")	Benefiting Territory	Description of Scheme	Amount
1027 1027A	East Africa—cont. General—cont. ...	Office of the East African Council for Medical Research, 1959-60.	£ 2,123 462
1028	do. ...	East African Institute for Medical Research, 1959-60.	13,266
1029	do. ...	Continuation of the services of the East African Institute of Malaria and vector borne diseases.	5,160
1030	do. ...	East African Virus Research Institute, 1959-60.	15,126
1031	do. ...	East African Malaria Control Scheme, 1959-60.	1,087
1032	do. ...	Desert Locust Survey (1959-60) ...	25,920
1035	do. ...	Provision of equipment for research on nutritional ophthalmology.	750
1040	do. ...	Aerial spraying experiment at Arusha, Tanganyika.	2,700
1041	do. ...	Visit to East Africa by two members of the Medical Research Council's staff in connection with Tuberculosis drug trials.	840
1046	do. ...	Schistosomiasis research, East Africa ...	3,685
1058	do. ...	Research on African forest crab ...	2,900
1059	do. ...	Sterilization of tsetse flies by irradiation ...	2,220
1072	do. ...	Purchase of new aircraft for Colonial Pesticides Research Unit, Tanganyika.	6,800
1077	do. ...	Research study of water requirements of crops.	465
1086	do. ...	Equipment for physiological studies at Makerere College.	650
1096	do. ...	Biochemical research at Makerere College	13,150
1907	do. ...	Research on swamp ecology at Makerere College.	9,750
1100	do. ...	East African Institute of Social Research ...	9,773
1104	do. ...	Investigations into the serological relationships between certain trypanosomes.	440
1120	do. ...	Visit of scientist to the East African Agriculture and Forestry Research Organisation for fundamental research.	550
1125	do. ...	Colonial Pesticides Research Unit, Arusha, 1960-63.	313,032
684B 684C	Kenya ...	Research on the biology of sand flies. (Supplementary provision.)	1,240 4,326



Scheme No. (Prefix "R")	Benefiting Territory	Description of Scheme	Amount
894A	East Africa—cont. Kenya—cont. ...	Social study of the Sanbura tribe. (Supplementary provision.)	£ 200
983A	do. ...	Research into farm production costs. (Supplementary provision.)	16,607
993	do. ...	Fauna research ...	8,425
996	do. ...	Research on coffee berry disease to 31st March, 1960.	9,414
998 998A	do. ...	Cereals research ...	25,690 13,960
1007	do. ...	Expansion of fisheries research ...	3,000
1042	do. ...	Contribution towards the recurrent cost of the Wellcome Institute for Research on Foot and Mouth disease.	55,506
1056	do. ...	Publication of technical reports on soils and land use.	1,000
1070	do. ...	Publication of research on coffee ...	900
1119	do. ...	Research on coffee berry disease, 1960-62	21,235
1047	Tanganyika ...	Extension of the Medical Department Laboratory.	1,400
946A	Uganda ...	Anthropological study of Karomojong. (Supplementary provision.)	9
1018	do. ...	Inquiry into human factors affecting productivity.	2,250
1065	do. ...	Study of local markets and produce movements.	1,600
698C	Central Africa General ...	Rhodes Livingstone Institute. (Supplementary provision.)	413
817B	Nyasaland ...	Cotton pest research. (Supplementary provision.)	20,153
967A	do. ...	Investigations into fusarium disease of coffee. (Supplementary provision.)	3,797
806A	West Africa General ...	West African Council for Medical Research. (Supplementary provision.)	22,939
1014	do. ...	West African Maize Research Unit maintenance during 1958-59.	6,141
1015	do. ...	West African Maize Research Unit maintenance during 1959-60.	13,862
1017	do. ...	West African Timber Borer Research Unit maintenance during 1959-60.	4,996

Scheme No. (Prefix "R")	Benefiting Territory	Description of Scheme	Amount
1044	<b>West Africa—cont.</b> <b>General—cont.</b> ...	Visit to West Africa of the Head of the Entomology Section of the Forest Products Research Unit.	£ 300
1090	do. ...	West African Rice Research Station, Rokupr.	57,295
1099	do. ...	Preparation of scientific work on mammals	250
1106	do. ...	West African Rice Research Station, Rokupr (1960-61).	20,558
645B	<b>Gambia</b> ...	Sociological research. (Supplementary provision.)	8
883A	<b>Nigeria</b> ...	Nigerian Institute of Social and Economic Research. (Supplementary provision.)	6,416
999	do. ...	Drug trials against trypanosomiasis in Northern Nigeria.	1,000
1060	do. ...	New building for the Nigerian Institute of Social and Economic research.	5,625
1109	do. ...	Inquiry into human factors affecting productivity.	1,195
1121	do. ...	Tsetse survey, Northern Nigeria ...	1,100
1069	<b>Sierra Leone</b> ...	Visit to Dakar by the Sierra Leone Government Archivist.	105
1095	do. ...	Linguistic research ...	1,600
1114	do. ...	Assistance towards the Joint Fisheries Department and Research Unit for 1960-61 and 1961-62.	22,938
	<b>High Commission Territories</b>		
495A	<b>Basutoland</b> ...	Soils research. (Supplementary provision.)	1
	<b>Middle East</b>		
853B 853C	<b>Aden</b> ...	Preparation of a history of Aden. (Supplementary provision.)	1,090 280
1039	do. ...	Research on social organisation of an Arab tribe.	3,050
	<b>Indian Ocean</b>		
966A 966B	<b>Seychelles</b> ...	Pest control. (Supplementary provision.)	250 1,313
975A 975B	do. ...	Coconut research. (Supplementary provision.)	600 9,577
1064	do. ...	Investigation of anaemia ...	1,550
1068	do. ...	Socio-anthropological survey ...	3,070
1016 1016A	<b>Mauritius</b> ...	Research on trade since 1764 ...	314 941
1045	do. ...	Research into sea-wave energy ...	800

Scheme No. (Prefix "R")	Benefiting Territory	Description of Scheme	Amount
943A	Far East Hong Kong ...	Research at Hong Kong University on toxæmia of pregnancy. (Supplementary provision.)	£ 4,433
1051	do. ...	Visit to Hong Kong of Lecturer in Midwifery at the University of Aberdeen.	800
995	South East Asia General ...	Contribution towards the cost of preparation of a <i>Flora Malaysiana</i> .	1,000
1009	North Borneo ...	Economic study of transport development	1,710
1020	do. ...	Agricultural research services ...	181,000
1113	do. ...	Appointment of a Forest Botanist ...	7,386
1118	do. ...	Establishment of agricultural research stations.	73,625
848B	Sarawak ...	Establishment of soils laboratory. (Supplementary provision.)	2,917
1004	do. ...	Improvement and extension of agricultural facilities.	77,911
1006 1006A	do. ...	Silvicultural and mensuration research ...	1,370 7,247
1037	do. ...	Establishment of new herbarium ...	4,783
987A	Singapore ...	Fisheries Research Institute (Supplementary provision.)	1,160
927A	Western Pacific British Solomon Islands Pre- tecture	Soil survey. (Supplementary provision.) ...	4,000
1010 1010A	do. ...	Coconut research ...	3,174 4,088
956A	Fiji ...	Investigation of banana seal moth and small coconut leaf moth. (Supplementary provision.)	4,110
984A	do. ...	Cocoa Research Station. (Supplementary provision.)	12,455
1008	do. ...	Geographic study of land and population...	920
914B	New Hebrides ...	Economic survey. (Supplementary provision.)	130
960A	do. ...	Sociological study of Aoba. (Supplementary provision.)	762
673B	The West Indies General ...	Histochemical nutritional research at University College of The West Indies. (Supplementary provision.)	4,350

Scheme No. (Prefix "R")	Benefiting Territory	Description of Scheme	Amount
	<b>The West Indies—</b>		
	cont.		
742F	<b>General—cont. ...</b>	Colonial Microbiological Research Institute Trinidad. (Supplementary provision.)	9,808
742G			7,757
742H			2,724
812B	do. ... ..	Secretariat of the Standing Advisory Committee for Medical Research in the British Caribbean. (Supplementary provision.)	4,808
893A	do. ... ..	Investigation at the University College of The West Indies of incidence and distribution of abnormal haemoglobins. (Supplementary provision.)	3,250
925C	do. ... ..	Tropical Metabolism Research Unit, Jamaica. (Supplementary provision.)	1,580
925D			590
1054	do. ... ..	Regional Research Centre, Imperial College of Tropical Agriculture, Trinidad.	124,755
1055	do. ... ..	Herbicides research at the Imperial College of Tropical Agriculture.	47,459
1083	do. ... ..	West Indies Meteorological Service hurricane research project.	2,105
1085	do. ... ..	Grant to the Standing Advisory Committee for medical research in the British Caribbean.	5,000
981A	<b>Jamaica ... ..</b>	Study of factors affecting blood pressure in a Jamaican population. (Supplementary provisions.)	5,550
1050	do. ... ..	Studies on atherosclerosis ... ..	3,200
1101	do. ... ..	Visit to British Honduras of Stored Products Entomologist, Jamaica.	125
1117	do. ... ..	Survey of chest abnormalities ... ..	1,100
	<b>Leeward Islands and Windward Islands.</b>		
1124	<b>St. Vincent ... ..</b>	Arrowroot research ... ..	12,805
675C	<b>Trinidad ... ..</b>	Regional Virus Research Laboratory. (Supplementary provision.)	2,832
675D			5,664
675E			2,832
	<b>Other Caribbean Territories.</b>		
997	<b>British Guiana ... ..</b>	Oxford University Expedition to British Guiana.	250
1091	do. ... ..	Care and maintenance of the Fisheries Research Vessel, Cape St. Mary.	2,218
1048	<b>British Honduras</b>	Termite research ... ..	11,775
1049	do. ... ..	Study of dermal leishmaniasis ... ..	32,750
1049A			600

## COLONIAL RESEARCH 1959-60

TABLE II  
ALLOCATION FOR RESEARCH UNDER THE COLONIAL DEVELOPMENT AND  
WELFARE ACTS, 1940, 1945, 1950, 1955 AND 1959

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 ... ..	606,776*	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 ... ..	2,514,536*	10,242,515*
31st March, 1952 ... ..	879,902*	11,122,417*
31st March, 1953 ... ..	1,096,904*	12,218,821*
31st March, 1954 ... ..	738,065*	12,945,194*
31st March, 1955 ... ..	533,548*	13,478,742*
31st March, 1956 ... ..	1,889,486*	15,368,228*
31st March, 1957 ... ..	2,202,880*	17,571,108*
31st March, 1958 ... ..	1,123,850*	18,694,958*
31st March, 1959 ... ..	798,974	19,493,932*
31st March, 1960 ... ..	2,370,261	21,864,193*

\*These figures include expenditure (totalling £137,376 up to the 31st March, 1957) incurred 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, 1940-1960

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 ... ..	1,411,352
1951-52 ... ..	1,233,262
1952-53 ... ..	1,268,562
1953-54 ... ..	1,289,840
1954-55 ... ..	1,176,317
1955-56 ... ..	1,374,323
1956-57 ... ..	1,534,746
1957-58 ... ..	1,319,145
1958-59 ... ..	1,224,000
1959-60 ... ..	1,483,192
	£16,164,552

Committee for Colonial Agricultural,  
Animal Health and Forestry Research  
1959-1960

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Rothamsted Experimental Station,  
(Lawes Agricultural Trust),  
Harpenden, Herts.  
August, 1960.

SIR,

I have the honour, now that Sir William Slater has ceased to be the Chairman of the Committee for Colonial Agricultural, Animal Health and Forestry Research, to submit to you the Fifteenth Annual Report of the Committee covering the period 1st April, 1959, to 31st March, 1960.

I have the honour to be,

Sir,

Your most obedient servant,

F. C. BAWDEN,  
*Chairman.*

The Rt. Hon. Iain Macleod, M.P.,  
Secretary of State for the Colonies.

COMMITTEE FOR COLONIAL AGRICULTURAL, ANIMAL HEALTH  
AND FORESTRY RESEARCH

**Membership**

- SIR WILLIAM SLATER, K.B.E., D.Sc., F.R.S., F.R.I.C., Secretary, Agricultural Research Council (*Chairman*).
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- DR. G. D. H. BELL, Ph.D., Director, Plant Breeding Institute, Cambridge.
- PROFESSOR W. I. B. BEVERIDGE, D.V.Sc., M.A., Professor of Animal Pathology, Cambridge University.
- DR. J. CARMICHAEL, C.M.G., D.Sc., M.R.C.V.S., Dip. Bact., formerly Colonial Veterinary Service. (*Until January, 1960.*)
- SIR FRANK ENGLEDDOW, C.M.G., M.A., F.R.S.
- DR. R. A. E. GALLEY, Ph.D., A.R.C.S., D.I.C., F.R.I.C., Director, Tropical Products Institute and Officer-in-Charge, Colonial Pest and Diseases Research.
- DR. W. J. HALL, C.M.G., M.C., D.Sc. (*Until November, 1959.*)
- MR. G. V. B. HERFORD, C.B.E., M.Sc., Director, Pest Infestation Laboratory, Agricultural Research Council.
- DR. J. C. F. HOPKINS, D.Sc., A.I.C.T.A., M.I.Biol., Director, Commonwealth Mycological Institute.
- PROFESSOR SIR JOSEPH B. HUTCHINSON, C.M.G., Sc.D., F.R.S., Professor of Agriculture, Cambridge University.
- PROFESSOR M. V. LAURIE, O.B.E., M.A., Professor of Forestry, Imperial Forestry Institute, Oxford.
- MR. R. S. MARSHALL, C.B.E., M.R.C.V.S., D.V.S.M., Dip. Bact., Adviser on Animal Health to the Secretary of State.
- PROFESSOR J. W. MUNRO, C.B.E., D.Sc., M.A., Professor Emeritus of Zoology and Applied Entomology, University of London.
- SIR GEOFFREY W. NYE, K.C.M.G., O.B.E., Adviser on Agriculture to the Secretary of State.
- PROFESSOR J. E. NICHOLS, M.Sc., Ph.D., F.R.S.E., Professor of Agriculture, University College of Wales.
- MR. E. O. PEARSON, M.A., Director, Commonwealth Institute of Entomology.
- DR. A. B. STEWART, M.A., B.Sc., Ph.D., F.R.I.C., F.R.S.E., Director, Macaulay Institute of Soil Research.
- MR. C. SWABEY, Adviser on Forestry to the Secretary of State.
- DR. G. TAYLOR, D.Sc., F.R.S.E., F.L.S., Director, Royal Botanic Gardens, Kew.
- MR. D. RHIND, O.B.E., B.Sc., F.L.S. (*Secretary*).
- MR. R. MOWFORTH (*Assistant Secretary*).

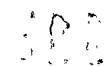
## STORED PRODUCTS RESEARCH SUB-COMMITTEE

- MR. G. V. B. HERFORD, C.B.E., M.Sc., Director, Pest Infestation Laboratory  
(*Chairman*).
- MR. W. L. BLOOMFIELD, Nigerian Produce Marketing Company Ltd.
- MR. H. W. CASHMORE, C.B.E., National Institute of Agricultural Engineering,  
Silsoe.
- MR. H. A. DADE, A.R.C.S., Assistant Director, Commonwealth Mycological  
Institute.
- MR. M. B. TUCKER, The United Africa Company Limited.
- DR. J. A. FREEMAN, Ph.D., A.R.C.S., Infestation Control Division, Ministry  
of Agriculture, Fisheries and Food.
- DR. W. F. JEPSON, O.B.E., Ph.D., A.R.C.S., Imperial College of Science and  
Technology.
- DR. D. W. HALL, B.Sc., Ph.D, Tropical Liaison Officer, Pest Infestation  
Laboratory, Agricultural Research Council, Slough.
- MR. T. A. OXLEY, B.Sc., A.R.C.S., Tropical Products Institute, D.S.I.R.
- MR. L. W. PHILLIPS, C.B.E., Chairman, National Federation of Corn Trade  
Associations.
- MR. D. RHIND, O.B.E., B.Sc., F.L.S., Secretary for Colonial Agricultural  
Research.
- MR. G. M. RODDAN, C.M.G., Deputy Agricultural Adviser to the Secretary of  
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- DR. E. E. TURTLE, M.B.E., M.Sc., Ph.D., F.R.I.C., Infestation Control  
Division, Ministry of Agriculture, Fisheries and Food.
- MR. J. YOUNG, Rowntree and Company Limited.
- MR. R. MOWFORTH (*Secretary*).

## CROP PROTECTION SUB-COMMITTEE

- DR. R. A. E. GALLEY, Ph.D., A.R.C.S., D.I.C., F.R.I.C., Director, Tropical  
Products Institute and Officer-in-Charge of Colonial Pesticides Research.
- DR. W. J. HALL, C.M.G., M.C., D.Sc. (*until November, 1959*).
- MR. G. V. B. HERFORD, C.B.E., M.Sc., Director, Pest Infestation Laboratory.
- DR. J. C. F. HOPKINS, D.Sc., A.I.C.T.A., M.I.Biol., Director, Commonwealth  
Mycological Institute.
- PROFESSOR J. W. MUNRO, C.B.E., D.Sc., M.A., Professor Emeritus of Zoology  
and Applied Entomology in the University of London.
- SIR GEOFFREY W. NYE, K.C.M.G., O.B.E., Adviser on Agriculture to the  
Secretary of State.
- MR. D. RHIND, O.B.E., B.Sc., F.L.S., Secretary for Colonial Agricultural  
Research.
- MR. G. W. THOM, O.B.E. (*Secretary*).





COMMITTEE FOR COLONIAL AGRICULTURAL, ANIMAL  
HEALTH AND FORESTRY RESEARCH  
FIFTEENTH ANNUAL REPORT

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# COMMITTEE FOR COLONIAL AGRICULTURAL, ANIMAL HEALTH AND FORESTRY RESEARCH

## FIFTEENTH ANNUAL REPORT

### I. INTRODUCTION

The Committee held five meetings during the year. Membership was unchanged except for the resignations of Dr. W. J. Hall and Dr. Carmichael.

2. Members of the Committee made a number of overseas visits. The Chairman attended the 13th meeting of the East African Agriculture and Fisheries Research Council in Nairobi and subsequently visited Tanganyika, Uganda and Southern Rhodesia. Mr. Marshall also attended the 13th Research Council meeting as well as visiting Malta, Kenya, Tanganyika, Zanzibar, Uganda and Cyprus. Mr. Marshall attended the 16th International Veterinary Congress in Madrid, and served on an Economic Mission to Mauritius. In view of the importance of the business to be discussed at the East African Agriculture and Fisheries Research Council, a third representative, Sir Geoffrey Nye, who was at that time visiting East African territories, attended the meeting of the Council. At the 12th meeting of the Council, held in 1959, the Committee was represented by Dr. Taylor and Dr. Stewart who took the opportunity to visit various research stations in Kenya and Uganda. Mr. Swabey, Forestry Adviser, visited Kenya, Zanzibar, Seychelles, Somaliland Protectorate, Aden, Mauritius and Nyasaland. He also attended the conference on Open Forests in Tropical Africa held in Northern Rhodesia. Mr. Roddan visited the West Indies and Mauritius. Sir Frank Engledow visited research stations and agricultural development schemes in Kenya, Tanganyika and Uganda. Mr. Pearson visited Nyasaland and Southern Rhodesia in connection with cotton pest research. The Secretary and Mr. Bawden attended the first meeting of the new Regional Research Committee of the West Indies held in Trinidad. The Secretary visited Barbados, St. Vincent and Antigua in the West Indies. He also visited Bermuda, Aden, Sierra Leone and the West African Research Office in Ghana. He led the United Kingdom delegation to the F.A.O. Coconut Study Group which met in Colombo and attended the meeting of the U.N.E.S.C.O. Humid Tropics Advisory Committee meeting in Abidjan (Ivory Coast).

3. The Committee is confident that there is great benefit from overseas visits to research workers, not only from the personal contacts and exchange of information, but also in the general field of organisation of research, particularly when this is on an interterritorial basis.

4. The Committee considered applications from a number of territories for research aid and recommended grants amounting to £1,010,374. This sum includes continuation grants for research schemes already in existence as well as for new schemes. The Committee had discussions on certain general principles of research organisation, particularly in relation to research in territories with a federal structure. Sir Frank Engledow was engaged, at the request of the Government of Nigeria, in a study and report on research in that country.

5. Following discussions at meetings of the East African Agriculture and Fisheries Research Council, at which the Committee was represented,

the Committee feels bound to record its uneasiness at the state of inter-territorial research in East Africa. A great deal of money has been expended in building up centralised research in different subjects with two large organisations, Agriculture and Veterinary, with which this committee is directly concerned. Financial difficulties in East Africa have led to a limitation in funds provided by the East African territories to £300,000 a year maximum for all research services under the guidance of the Research Council. These include Trypanosomiasis, Marine Fisheries and Inland Fisheries in addition to Agriculture and Veterinary research. The East African Agriculture and Forestry Research Organisation (see paragraphs 15 to 66), which is generally acknowledged to be of great value to the region, has had to curtail research. The Committee can only view this with misgiving as a retrograde step unhelpful to the territories whose successful development depends so much on research.

6. In the West Indies the reorganisation of regional research under the Federal Government has resulted in the setting up of a Regional Research Committee which is advisory to the Natural Resources Council of Ministers. This committee held its first meeting in 1959, attended by Mr. Bawden and the Secretary as your representatives. The work of this regional committee, which dealt largely with the Regional Research Centre, showed that some changes in the character of regional research may be necessary in order to meet the needs of unit territories. Your Committee, while welcoming the agreed arrangements for continuing the work of the Regional Research Centre after the merger of the Imperial College of Tropical Agriculture with the University College of the West Indies, hopes there will be increased collaboration with the Agricultural Departments of unit territories.

7. In West Africa interterritorial research was well maintained under the aegis of the West African Research Office in Accra. The future administration of this research, which includes the large research institutes dealing with cocoa and oil palms as well as several smaller units, depends on there being an efficient administrative body to handle the complexities which unavoidably arise when separate territories are concerned. Your Committee earnestly hopes that the future maintenance of such an administration can be agreed.

8. In the Federation of Rhodesia and Nyasaland the Federal Government has set up an Agricultural Research Council of Rhodesia and Nyasaland, the opening of which the Chairman was privileged to attend. This Research Council has been set up with the object of co-ordinating research in the Federation. Your Committee welcomes this move and notes with satisfaction that the Director of the East African Agriculture and Forestry Research Organisation has been appointed a Member of the Council, thus ensuring a link with similar research in the East African region.

9. Visits to the larger research centres by experts is one way of improving overseas research which your Committee considers should be fostered. It is noted that such visits took place last year to the East African Agriculture and Forestry Research Organisation (two workers) and to the East African Veterinary Research Organisation (four workers) and records its appreciation of the various authorities whose co-operation made such visits possible at small cost to the research organisations.

10. The provision of further funds for research during the five years 1959 to 1964 by the passing of the new Colonial Development and Welfare Act in 1959, is viewed with satisfaction tempered with misgivings about the amounts which it is possible to assign to the subjects of agriculture, animal health and forestry on which many territories depend.

11. Previous reports of this Committee attempted to record briefly research in each organisation, major institute and territory separately. The growth of research over the past fifteen years has resulted in this report expanding from 3 pages in 1945-46 to 175 pages in 1958-59, and it has become unwieldy. In this year's report it has been attempted to summarise research under subject headings, apart from the work of the larger organisations and United Kingdom institutions. It is hoped that this will make a more readable account though it has the unavoidable effect of scattering the work of any one territory amongst different subject sections. Though the report is shorter there has, in fact, been more research done.

12. Your Committee wishes to record its thanks to the many research organisations and their staffs in the United Kingdom which have freely given their services to help colonial research. Such help has taken many forms, such as housing units engaged on colonial research, lending staff for overseas work, carrying out analyses and identifications of plants, pests and pathogens, and in advice and training to overseas staff. All this adds up to a great deal and colonial research would be badly hampered without it.

## II. REGIONAL RESEARCH ORGANISATIONS

### **The East African Agriculture and Fisheries Research Council**

13. Research on an interterritorial basis in East Africa is co-ordinated by the East African Agriculture and Fisheries Research Council at ministerial level, with a number of regional and specialist committees. The Council, acting under the East African High Commission, must approve the allocation to the various research organisations of the funds made available by territorial contributions and C. D. & W. research grants.

14. Financial stringency in East Africa has resulted in the territories placing a ceiling of £300,000 a year on their joint contributions to interterritorial research, this limitation being the maximum they are to provide in any one year, with no carry-over of any savings from year to year. The C. D. & W. research grant applicable to the subjects of agriculture, animal health and forestry is limited to an amount equivalent to 30 per cent. of the total. Some curtailment of the research expenditure has therefore been unavoidable. The Council, on which the Secretary of State is represented by two members, has sought to effect economies in the ways thought least harmful to the research programmes as a whole, though naturally reduction in the research effort is to be regretted.

### **East African Agriculture and Forestry Research Organisation**

15. The year 1959 has seen a reduction in the scope of problems which this Organisation can work on, consequent upon the decision of the Research Council to reduce the establishment of research officers from 28 to 23. In consequence it has been agreed to reduce very considerably the work

dealing with soil fertility because the territorial Departments of Agriculture all have a number of soil chemists on their establishment. The decision also means that for the next few years several research divisions will only have one research officer, and experience is showing that on the whole it is much more difficult for these divisions than for the larger ones to play their full role in co-operative interterritorial research.

16. A reduction also has had to be made in the number of scientific assistants from 20 to 14, and this reduction has already begun to limit the amount of co-operative work this Organisation can undertake with the Territorial Departments. It is particularly unfortunate it has had to come at the present time, just as so many co-operative projects are getting under way. Every opportunity will be taken to reorganise the staffing of the Divisions to minimise the effects of these reductions in establishment in those fields of work in which the Territories are most anxious for co-operation. It will have the consequence, however, that it may become increasingly difficult for the staff to carry out even essential scientific research if it does not have a fairly immediate bearing on urgent practical problems.

17. Although the staffing of the Organisation must be at a lower level than planned, it is very gratifying to report that visiting research workers from other countries spent several months working in these research divisions, and it is hoped that the quality of the work being done there, and the facilities available, will continue to attract such visiting workers.

18. It is also very gratifying to report very generous help from the Rockefeller Foundation. They gave Mr. H. Doggett (sorghum breeding research unit) a fellowship to visit the principal sorghum breeding laboratories in the United States, in which spectacular improvements in the sorghums have recently been made, and in Mexico, where the agricultural conditions are fairly similar to those in East Africa. The Foundation has also made a grant of up to £3,000 for eight new glasshouses and a potting shed, mainly for the use of the Nematology Division. This is a new Division, but no moneys are available in East Africa for these essential requirements. When these glasshouses are erected it is hoped that the nematologist will be able to develop much more rapidly than would otherwise have been possible his work on methods for controlling the damage plant parasitic nematodes are doing to various crops in East Africa.

19. The Nuffield Foundation has also expressed their willingness to finance two additional lines of work at E.A.A.F.R.O., closely related to work already in hand, namely further research on the physiology of drought resistance in crops, and on the possibilities of raising the nitrogen status of tropical soils by suitable use of indigenous tropical legumes.

20. The Organisation is in close touch with research and related bodies in Africa. The Director is a member of the East Africa Agricultural, Animal Industry, and Forestry Research, Co-ordinating Committees, and Chairman of the Soil Fertility and the Pasture Research Specialist Committees. He is a member of the Kenya Agricultural and Veterinary Research Advisory Committee, the Kenya Pasture Research Committee, the Chairman of the Research Committee of the Tanganyika Coffee Growers Association, a member of the Governing Body of the Tea Research Institute of East Africa and Chairman of its Research Committee, and a member of the Namulonge

Advisory Board of the Empire Cotton Growing Corporation. He is a member of the Scientific Council for Africa South of the Sahara (C.S.A.), and attended the 10th Meeting in Kampala, and he was Chairman of the C.S.A. Meeting of Specialists in Hydrology held in Yaounde. He is also a member of the Agricultural Research Council recently set up in the Federation of Rhodesia and Nyasaland. In co-operation with the Provincial Agricultural Officer, Rift Valley Province, he helped to organise and was Chairman of a Working Party on methods of research for improving African grazing lands, held in Baringo, and in co-operation with the Chief Research Officer, Uganda Department of Agriculture, helped to organise and was Chairman of a conference on the classification of East African soils held at Kawanda. Senior members of the staff serve on a number of similar Boards and Committees.

### *Physics Division*

#### *Catchment Area Research*

21. This has been the first priority task for the whole Division. Useful progress has been made, in co-operation with officers of the many Territorial Departments involved, in all four of the main experiments in land-use hydrology.

22. In Uganda the basic study of the improvement of the severe flash-flooding behaviour of overgrazed Karamoja thorn-scrub country has given important but rather alarming observations. Livestock trampling has so effectively reduced the penetration of rainfall into soil that it rarely wets the soil to a depth of one foot in spite of an annual rainfall exceeding 25 inches. Thus a striking impoverishment of the vegetation due to this induced drought is added to the effects of soil erosion and severe overgrazing.

23. An extensive detailed study of the vegetation by Mr. Kerfoot has provided data on the volume of fuel and building timber and the numerical composition of the scanty surviving herbage. While carrying out a detailed topographical survey, Mr. Simmons joined Mr. Wagg of the Uganda Water Development Department in the calibration of the torrent spates through the massive standing-wave flumes. The effects of the very heavy deposition of sand and gravel bedload have now been measured and allowed for, since they cannot be prevented. Quantitative water measurements are now being obtained.

24. Excellent progress has been made on the study of the conversion of tall rain forest to tea gardens. A substantial contribution from the Kenya Ministry of Agriculture, Animal Husbandry and Water Resources in the provision of funds and technical knowledge made it possible for Messrs. Brooke Bond (E.A.) Ltd., to build, to the designs of the Chief Soil Conservation Engineer, masonry flumes through which surface runoff from critical areas is recorded autographically. Soil moisture sampling and energy-balance calculations have combined to give detailed and satisfactory accounts of the hydrological balance of both the valley under development and the adjacent forest control valley. The co-operation of the African Highlands Produce Company is providing water yield information on a nearby forested catchment of some 30 square miles, which are confirming very satisfactorily the results obtained in the two test valleys.

25. In the Aberdare Mountains the study of the large-scale change of land usage from bamboo forest to softwood plantations in the main catchment area of Nairobi City's water supplies, has now yielded two full "water years" of good and consistent data. One important result is that the energy-balance approach developed by Penman at Rothamsted applies well in this high cool tropical forest area, particularly when the main component, the incoming solar radiation, is measured directly with the Gunn-Bellani integrator, an instrument whose use for this work has been developed by this Division.

26. A second result is becoming clear as this year's data from the high altitude catchments are compared with those from the comparison of water use of bamboo and softwoods which has been conducted jointly with the Kenya Forest Department since 1950. In the high wet zones of the mountain forests the well-distributed annual rainfall is approximately twice the annual evaporation. Under this local climate no large soil moisture deficits are built up, and the water use of the continuous canopies of trees and bamboo appears to be independent of their size and root-range. At the lower altitudes, annual evaporation not only equals or exceeds annual rainfall, but the distribution of the latter into wet and dry seasons is strongly marked. Here very large soil moisture deficits, amounting to as much as 14 inches, have been found under the larger and older trees, whose root development exceeds that of the bamboo. These water deficits must be made good from subsequent rainfall before percolating rainfall can contribute to streamflow.

27. In Tanganyika, the Mbeya Range catchment studies have already shown that the steep hillside cultivation, characteristic of much of the Southern Highlands Province, causes losses of soil far greater than is apparent by inspection. Even the fairly clear dry weather streamflow is carrying 12 times as much mineral soil from the cultivated valley as from the forested valley, while the heavy soil wash from the former valley during storms has repeatedly filled the large concrete silt-traps. Unfortunately there is not yet any satisfactory device available for automatically collecting sediment-load samples from flood-peak levels, though a pilot model of a possible suitable device has recently been designed and built at E.A.A.F.R.O., and it is hoped to test it in the next rainy season with the co-operation of the Tanganyika Water Development and Irrigation Department.

#### *Irrigation*

28. Preliminary work in investigation into crop water use at the Mbarali Irrigation Scheme has been completed. Soil profiles of the most important soil types have been calibrated for water holding capacity. A rough check on water use by systematic soil moisture sampling is in progress and plots have been selected and delineated for a more detailed study. Similar soil calibration work has been carried out at Ulu where lucerne is being grown on heavy black clay soils under sprinkler irrigation. Soil moisture sampling to check calculations of irrigation needed for Kenya's arabica coffee plantations was continued at Ruiru, and a new set of irrigation control measurements was begun in the Rift Valley, in a new soil type and local climate. Progress on this work, and of other sites in Kenya and Uganda, has been held up by the restriction of E.A.A.F.R.O. funds.

*Agricultural Meteorology*

29. This section is responsible for processing the substantial volume of climatological measurements which are being taken on a large number of experiments throughout East Africa. The principal objective is the estimation of rainfall and evaporation. Dr. Dagg's soil physics work also includes the analysis of a considerable number of Dines autographic rainfall records taken from the catchment and irrigation experiments, and this is allowing us to build up a detailed picture of the storm patterns and of the violence of the impact of the rainfall on the soil surface in these areas.

30. Dr. Pereira presented to a meeting of engineers at Lusaka a preliminary report on the standardisation of evaporation pans, which he made at the request of the East and Central African hydrologists, and jointly with Dr. McCulloch presented a summary of their measurements of the heat flow to the atmosphere from the surface of bare soils and from the canopies of forests, crops and pasture to the Munitalp-WMO Symposium on Tropical Meteorology held in Nairobi in December.

*The Effect of Shade Trees in Tea Plantations*

31. The planting and maintaining of shade trees in East African tea plantations is common field practice, yet very little is known about the advantages or disadvantages of this practice. An experiment was started two years ago jointly between the Physics Division, E.A.A.F.R.O., the Tea Research Institute, Kericho and Messrs. Brooke Bond (East Africa) Ltd., to find the effect of *Grevillia robusta* shade on mature tea under two contrasting systems of pruning. This experiment is under way, yields are being taken from bushes with various degrees of shading and detailed measurements are being taken on the micro-climate around the tea bushes.

*Plant Physiology*

*The effect of drought on maize and groundnuts*

32. One of the principal lines of work is the study of the effects of drought on the growth of the more important crops of East Africa. In previous years it was proved that maize leaves are more easily damaged by drought than are sorghum leaves. This year it was found that groundnut leaves behave like sorghum leaves, that is they can withstand a severe wilt without being permanently damaged. The principal way drought affects groundnut yields is through it causing the plant to shed flowers or pegs when it is wilted. Thus the effect of drought on the yield of groundnuts depends largely on the length of the flowering season, particularly as it is affected by the rains which break the drought.

33. Studies on the behaviour of maize leaves will be continued next year because we have been able to obtain seed of four very drought-resistant maizes, which have been developed in Mexico, through the kind offices of the Rockefeller Foundation. The preliminary studies have shown that these maizes appear to be very drought-resistant at Muguga, so that it is worth while investigating how far their leaves can withstand much more serious wilting than the normal East African maizes.

*The effect of age of forage plants on their composition*

34. Two lines of work are in progress. The first is in co-operation with the pasture chemist of the Grassland Research Station, Kenya, on the



relation between the total and digestible carbohydrates in lucerne and several grasses and their content of nitrogen or digestible crude protein, phosphorus and sulphur, over a period of several contrasting seasons. This work is nearing completion and will soon be written up.

35. The second line of work is an examination of the relation between the yield of a number of perennial forage crops grown for 12 to 14 years at Kabete and the rainfall and the age of the crop. Most of the crops were grasses, but there were plots of cannas and sweet potatoes as well as annual crops of maize. We are grateful to Mr. W. R. Birch of the Grassland Research Station, Mo'lo, for supplying us with this data. The principal point that has come out of this work is that, for crops of a given age, the annual yield is proportional to the annual rainfall, but that as the crop ages its yield falls off very rapidly during the first few years and then much slower. This loss of yield appears to be due to the over-crowding of the plants and not to any loss of fertility in the soil.

### Chemistry Division

#### *Decomposition of organic matter in tropical soils*

36. Dr. Birch has continued his work on the factors which influence the rate at which organic matter or humus oxidises in tropical soils. He has shown over the last few years that the principal factor which affects this rate of oxidation is the number of times the soil is dried and re-wetted, and he has not yet been able to give satisfactory explanations of the cause of this phenomenon. The practical importance of this work is that it is only during the decomposition of humus that nitrates can be produced in the soil, and these are essential for good crop growth. But since the nitrates can easily be washed out by rain, the crop must be managed in such a way that it can use these nitrates as soon as possible.

37. This year he has been studying the effect of the length of the dry season, or of keeping the soil dry before it is moistened, on the production of nitrates, and he has shown that the nitrates produced increase quite considerably with the length of time the soil is kept dry up to about six weeks, after which the effect of a longer dry period is not so marked. He has also been trying to identify the fractions of the soil organic matter which decompose so readily after the dry soil is re-wetted. There appear to be two separate fractions involved, one of which is water soluble, but there are still many puzzling features about the decomposition of this fraction. He has found it difficult to study the non-soluble fraction, so he has commenced work on the effect of drying and wetting of soils at different times after green manures of varying nitrogen contents have been added to them. The results show that alternate wetting and drying of such a soil results in a more rapid decomposition of the green manures, and the more rapid release of part of the nitrogen they contain as nitrates, than if it had been kept continuously moist.

#### *Soil Phosphorus*

38. With the development of Dr. Birch's work on the effect of wetting and drying soils on the release of nitrates from the humus, work has started

to see how far the release of phosphates during these flushes of decomposition of the soil organic matter could be an important source of phosphate for the crop. The results suggest that the phosphate released in these flushes of decomposition does in fact form an important source of available phosphate in many East African soils.

#### *Vegetation and Soil Surveys*

39. One of the primary problems facing the ecologists in East Africa is recognising areas that were ecologically similar under natural conditions, that is the areas carrying the same types of plants, but in which the natural vegetation has been so altered by the agency of man that it has become very difficult to deduce what the original vegetation was from the small remnants that are left. The importance of this work is that one would expect the same crops to grow equally well, or the same weeds and bush to encroach on grazings, and to be controlled by similar methods on areas which, under natural conditions, were ecologically similar.

40. The principal work of the ecologist has been the planning and the commencement of a detailed vegetation survey of Southern Kenya, which is being carried out in collaboration with the Directorate of Overseas Surveys, London, and the Kenya Department of Agriculture. The Survey covers an area of 40,000 square miles, and is being carried out partly in the field and partly with the aid of air photographs. The data which will be put on print lay-downs will subsequently be transferred on to maps at the scale of 1:¼ million by the Directorate of Overseas Surveys, and these should be completed some time in 1961. As a result of this work it is hoped to be able to obtain far closer correlations between the possible land uses of the various ecological zones, and also a much clearer picture of the way the ecology of each area is affected by meteorological and other factors.

#### *Plant Breeding*

41. Much of the plant breeding work undertaken by this Organisation has been concentrated on trying to produce new varieties of a particular crop that are resistant to important specific diseases. The work has largely fallen into two parts: research into the possibility of obtaining resistance to a disease, and the genetics of this resistance. The two principal lines of work in progress concern the possibility of breeding maize resistant to Streak disease, and a general research scheme for improving the resistance of sorghums to disease.

#### *Streak Disease of Maize*

42. Streak Disease is a virus of maize carried from plant to plant by a leaf sucking insect *Cicadulina mbila* and some varieties of maize originating in Peru are resistant or immune to it. One part of last year's work was concerned with the genetics of this resistance. All East African maize varieties are susceptible. The first crosses between the resistant lines and the East African maizes have given progeny all of which are susceptible. In the next generation a wide range of reactions, from high resistance to high susceptibility has been found, and a genetic analysis of these progenies, in so far as it concerns Streak resistance, is now in progress. The preliminary results suggest that the genes for susceptibility are dominant

which means that we can only get high resistance by removing all these dominants from the genetic make-up. If this turns out to be a correct conclusion this will not complicate the breeding of maizes resistant to Streak very much, but it will mean that the resistant varieties will lose part of their value in African areas unless one can replace all the existing maize by new seed in one season.

43. An essential preliminary to genetic studies has been an attempt to assess the resistance of a maize plant to Streak from the early behaviour of infected seedlings. It is being found in the Muguga greenhouses that plants may show moderate or slight symptoms of the disease when young but grow away from the disease later on in life. It is now important to test the behaviour of these plants in the field in areas where Streak is usually prevalent, and arrangements are in hand for this to be done in Southern Tanganyika next year.

44. Another problem which is being looked at is whether there are a number of different strains of the Streak virus in East Africa or not. This investigation is expected to progress slowly, because it involves collecting the virus from a number of parts of East Africa, or from a number of different plants, and testing if they all have the same virulence against a range of maize lines. The results to date are consistent with there being only one virus strain in East Africa, though it is possible that there is a different strain in one part of Tanganyika which can cause mild symptoms in plants highly resistant to the wide-spread strain of Streak.

#### *Sorghum Breeding Research*

45. This work is being done at the Serere Agricultural Experiment Station, Uganda, through the co-operation of the Director of Agriculture. The object of the work is to study how far the yields of East African sorghums can be increased by incorporating into them characters which will confer resistance to a number of important pests and diseases.

46. A second line of work is the production of tetraploid sorghums having as many desirable characters as possible. The first object is to test the possibility that a suitable tetraploid can be as high yielding as a true "hybrid" sorghum, for the latter have given yields 20 to 25 per cent. above normal varieties in the U.S.A. Hybrid seed production, and ensuring that it will be properly used, will be difficult in East Africa, but high yielding tetraploid varieties may be expected to show a relatively slow loss of yield as hybrid vigour declines, necessitating relatively infrequent issues of new seed. If a useful tetraploid variety can be produced, it can be distributed to African cultivators, and they can grow it along with their local sorghums without any fear that the seed they produce will have been affected by cross-pollination with the local varieties. Provided only one tetraploid variety is issued in each district, its seed should remain pure for a long time.

#### *Plant Pathology*

##### *Stem Pitting condition in Coffee*

47. This is a disorganisation of the xylem cells usually near the base of the stems of Arabica coffee: it may cause the base to become bottle shaped, and the wood to become fluted in outline and to show pits and furrows when

the bark is peeled away. It has now been found that this condition is widespread in Arabica coffee. The present position is as follows: Dr. Sheffield has confirmed the observation that there are no micro-organisms present in the stem which could cause this condition. She is testing the possibility that the cause is a virus by making a large number of suitable grafts of material from stem-pitted bushes on to what should be clean seedlings. The results of these experiments are still negative, but if the condition can be transmitted in this way it is likely the grafted plants may have to grow several years before the condition can be seen. Owing to the restricted glasshouse space at Muguga the larger plants have been moved to the Irrigation Research Station of Mwea Tebere where they are being cared for by officers of the Department of Agriculture, Kenya, and are isolated from other coffee showing the condition.

48. Work is also in progress both at Muguga and in the Coffee Research Stations to test whether other factors such as mulching could induce this condition, but again it may be necessary to wait a considerable time before definite conclusions can be drawn. Work is in progress to determine if this condition affects the health of the tree.

49. Examination of the results of a Survey made by the Senior Research Officer at Lyamungu in 1958 have shown that for two varieties in which there were a considerable number of deaths among young bushes, the same proportion of dead bushes as of living bushes had visible symptoms of stem pitting. From this it can be concluded that at least for these varieties at Lyamungu stem-pitting does not render the bushes more liable to die.

#### *Ratoon Stunting of Sugar Cane*

50. This is a virus disease which causes sugar cane ratoons to grow much more weakly than they should, so causing a rapid decrease in sugar cane yields; and this in turn involves the re-planting of the fields with new canes at much too short intervals. The great hindrance to research on this disease is the difficulty of diagnosing if a plant is infected or not, for so far no reliable symptoms of the disease in the plant have been recognised.

51. Dr. Sheffield has been searching for reliable diagnostic symptoms for the presence of this disease. She has inoculated a number of well-known virus test plants and other monocotyledonous plants and examined them for external symptoms and also microscopically for any cell abnormalities that might have been induced by the virus. Unfortunately so far no symptoms have been observed in any of the inoculated plants.

#### *Plant Nematode Diseases*

52. Mr. Whitehead has completed a survey of the incidence of these diseases on the more important crops in East Africa, and has been able to show a certain number of the more important root knot nematodes are common inhabitants of East African forests. Hence crops susceptible to these nematodes are likely to carry a large population of them on their roots if planted on land recently in forest or excised from forest.

53. His work on the identification of the various nematodes attacking East African crops is going much more slowly than expected because of the very great difficulty of separating the various species present from each other. It is essential that this be done before any control of nematode

diseases by such methods as crop rotations and suitable methods of cultivation can be investigated. This separation in species is being found extremely difficult because the study of the East African populations has thrown great doubt on the validity of the classifications adopted in the temperate regions. It was to help in this study that Mr. Whitehead spent six months this year working in the British Museum (Natural History) and other laboratories in England and Holland.

54. Mr. Whitehead's work on the effect of different crops on the nematodes in the soil has been very severely restricted by lack of glass-house accommodation. Fortunately towards the end of this year the Rockefeller Foundation have very generously given E.A.A.F.R.O. a grant for another range of glasshouses, largely for the use of the nematology work. This will enable research on field methods of nematode control to go forward very much more quickly and reliably than has yet been possible.

#### *Animal Husbandry Division*

55. The Animal Husbandry Division is primarily concerned with problems of the nutrition of farm animals, but its programme includes general problems of animal management, particularly as these affect the efficiency of food utilisation.

#### *The Nutrition and Management of Pigs*

56. Work on the nutrition of the pig is very largely a part of a co-ordinated pig research programme conducted at three experiment stations of the Kenya Department of Agriculture, one experiment station of the Kenya Veterinary Department and Muguga. One group of problems are concerned with the evaluation of the Pig Industry Board's protein and mineral supplements, the type of cereal mixtures that it can be used with, the effect of restricting such rations on the production of quality carcasses, and how far it can replace skimmed milk as a protein supplement on farms where the supply of skim is intermittent. Much of this work arose out of the request made by the Pig Industry Board to this Organisation for a cheaper protein supplement than the one they had been using. This Division was able to suggest a much cheaper and probably more effective supplement than had been used in the past, but it has been necessary to test its effectiveness by experiments.

57. Four additional studies have been undertaken. The first concerns the effect of temperature on the piglets' nutritional demand for iron, for there is a strong suggestion that low night temperatures increase the incidence and severity of piglet anaemia. The second concerns the effect of synthetic oestrogens and of restricted feeding, by increasing the fibre content of the ration, on the carcass quality of bacon pigs. The third is a comparison of four different protein and mineral supplements to high maize content rations, one of which is our recommended protein supplement and the others being similar mixes but in which varying amounts of cotton seed meal have been used. Cotton seed meal is the cheapest form of protein obtainable in East Africa, but too high a percentage in the feed may have undesirable consequences. And the fourth is an investigation on the effect of varying the percentage of individual amino-acids in the protein supplement on the productivity and carcass characteristics of the pig. During 1959 the amino-acids tryptophan and lysine have been under trial, but no

results are yet available from these experiments. In addition there have been a few experiments on the effect of farrowing equipment and the micro-climate in the farrowing pen on piglet mortality. We have been able to show that mortality due to sows lying on their piglets is very much reduced if artificial heat is supplied in a suitably designed farrowing house.

#### *Nutrition and Management of Beef Cattle, Sheep and Goats*

58. The first problem being undertaken is a study of the relative efficiency of the Boran and the Shorthorn Zebu in converting feed into beef, both under conditions of high nutrition at Muguga and of low nutrition on a ranch in the Kedong. Unfortunately, quarantine restriction at Isiolo has prevented the importation of the Boran cattle. A co-operative trial with the Department of Veterinary Services, Tanganyika, to be conducted at the Northern Province Stock Farm, Ngare Nairobi, has been planned on the water requirements and productivity of indigenous cattle when subjected to frequent and infrequent watering with long daily treks. The livestock for this experiment, ten sets of Zebu-type identical twins, have been selected from the identical twin herd being collected at Muguga. Small-scale preliminary studies have been undertaken in conjunction with the Kenya Agricultural Department on some sheep of temperate breeds which have shown unusually high respiration rates, for these could account in part for the unthriftiness of some British and New Zealand breeds of sheep at high altitudes.

#### *Beef Carcase Evaluation*

59. Discussions with research workers in the United Kingdom when he visited them during his leave did not reveal to Mr. Ledger the need to alter the system of analysis which the Organisation has developed, but they did emphasise the necessity for finding a reliable and simple method for estimating the total fat in the living animal. During the year 71 Zebu carcasses have been analysed. In addition some co-operative work has been carried out with the Tanganyika Veterinary Department on the possibility of evaluating the carcase by analysing a small sample joint, which has about the same proportion of lean, fat and bone as the carcase as a whole. The problem is to show that such a sample joint can be found, and that its composition is representative of the carcase as a whole for the range of carcasses likely to be met with in practice.

#### *The Silvicultural Division*

60. The field work of this Division falls into four main classes, namely, research into methods for raising better plants from seed in the nursery; the best practices for lifting the plants from the nursery and planting them out in the forest, so that they have the maximum chance of making rapid growth; comparisons of the growth rates, habits of growth and liability to disease of different exotic tree species for selecting any that are likely to be of commercial or practical use in East Africa; and research on problems of managing trees in the forest, such as the effect of different intensities and times of pruning. In addition, some work was done on the problem of the development and testing of methods of grafting on to local root stock from living shoots taken from outstanding trees either from within or from outside East Africa. At the present, this work is confined to two species of pine, *radiata* and *patula*.

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61. There has been a most encouraging confirmation this year of the value of the methods developed at Muguga for the raising and planting out of seedlings in the forest. 1959 has been a most difficult year for planting out, because of prolonged drought. The preliminary results of this year's experiments have given an almost complete stand of young saplings, which could grow away as soon as the November short rains came.

#### *Forest Entomology*

62. The Forest Entomology Division has recommenced work this year with the appointment of two Entomologists to the staff. Mr. Jones will be mainly concerned with insect pests of established plantations and particularly with borers in living trees, whilst Mr. Wilkinson will be mainly concerned with insect pests of afforestation and particularly with those species of termites which attack young plantations.

63. The East African Forest Insect Survey which was initiated by J. C. M. Gardner several years ago when he was forest entomologist at E.A.A.F.R.O. has now been resuscitated. Due to the two years interregnum, there has been a tremendous backlog in the sorting and naming of the insect collections which have been coming in, and the two entomologists have spent much of their time on this work. The Division also distributes duplicate identified specimens to Territorial Departments, and a collection of 1,600 named specimens has been passed over to the Kenya Forest Entomologist to form the nucleus of his Territorial reference collection.

64. Mr. Jones has made a preliminary survey of the relative importance of the major insect pests in established forests. His principal work will be concerned with the biology of the more important insect borers which attack living trees, namely *Oemida* and the *Androeme* in Kenya and Tanganyika and the *Paranari* borer and Ambrosia beetles in Uganda. The present work is on the feeding habits and the minimum food requirements of the larvae of the *Oemida* borer, for it is the larval stages which do the damage in wood. Preliminary investigations are also in hand for developing a reliable non-destructive method for determining if borer larvae are living inside individual trees. This work is likely to involve such advanced physical techniques as those based on ultra-sonic pulses. It will have to be done in conjunction with research laboratories in the United Kingdom.

#### *The East African Herbarium*

65. The principal work of the Herbarium staff is the naming of plant collections sent in mostly by members of the Natural Resources Departments in East Africa, and this usually involves mounting and naming specimens for the Herbarium collection itself. This year 11,400 specimens have been received from various sources, many connected with the various ecological surveys at present being undertaken by a number of Territorial Departments. In all a total of 15,000 new sheets have been added to our collections. There is also constant interchange of duplicate specimens with other Herbaria, many of them specialised Departmental Herbaria in East Africa, and in all 12,000 specimens have been loaned or distributed to them.

66. In addition, much time must be spent in answering the many enquiries which come in, many of them concerned with medicinal or poisonous plants.

Dr. Verdcourt has finished a revision of his monograph on the Convolvulaceae for the Flora of East Tropical Africa, and Miss Napper has continued her studies of East African grasses.

#### *Publications*

BIRCH, H. F.—“Further aspects of humus decomposition.” *Nature, Lond.*, **182** (1958), 1172.

BIRCH, H. F.—“The relationship between the digestibility and decomposibility of some animal feeds.” *J. agric. Sci.* **51** (1958), 337–379.

BIRCH, H. F.—“Further observations on humus decomposition and nitrification.” *Plant and Soil*, **11** (1959), 262–286.

BIRCH, H. F.—“Simultaneous decomposition processes in soils.” *Nature, Lond.*, **183** (1959), 1415.

BOCK, K. R., ROBINSON, J. B. D., and CHAMBERLAIN, G. T.—“Zinc deficiency induced by mercury in *Coffea arabica*.” *Nature, Lond.*, **182** (1958), 1607–1608.

CHAMBERLAIN, G. T.—“Trace elements in some East African soils and plants. I. Cobalt, beryllium, lead, nickel and zinc.” *E. Afr. agric. J.*, **25** (1959), 121–125.

FRIEND, M. T.—“Shade measurement by a chemical radiation meter.” *E. Afr. agric. J.*, **25** (1959), 110–112.

GLOVER, J. and DUTHIE, D. W.—“The apparent digestibility of crude protein by non-ruminants and ruminants.” *J. agric. Sci.*, **51** (1958), 289, 293.

GRIFFITH, A. L.—“A list of *Eucalyptus* species known to be attacked by the snout beetle *Gonipterus scutellatus* (Curculionidae).” *E.A.A.F.R.O. For. Tech. Note No. 9* and *Emp. For. Rev.*, **38** (1958), 200–201.

GRIFFITH, A. L.—“The stock mapping to quality classes of an even aged forest.” *E.A.A.F.R.O. For. Tech. Note 10* and *Emp. For. Rev.*, **38** (1958), 301–303.

GRIFFITH, A. L.—“Forestry courses in East Africa.” *Emp. For. Rev.* **38** (1959), 7–8.

GRIFFITH, A. L.—“The second Inter African Forestry conference, Pointe Noire.” *Emp. For. Rev.*, **38** (1959), 139–140.

LAMPKIN, G. H., QUARTERMAN, J., and KIDNER, M.—“Observations on the grazing habits of grade and Zebu steers in a high altitude temperate climate.” *J. agric. Sci.*, **50** (1958), 211–218.

LEDGER, H. P.—“How to decide live weight of steers: the economy of producing heavy versus light beef carcasses under existing K.M.C. regulations.” *E. Afr. Fld. Farm.*, **24** (256) (1959), 19–21.

LEDGER, H. P.—“A possible explanation for part of the difference in heat tolerance exhibited by *Bos taurus* and *Bos indicus* beef cattle.” *Nature, Lond.*, **184** (1959), 1405–1406.

MAY, W. B.—“In your garden.” *E. Afr. Fld. Farm.*, **24** (1959), April–December.

MCCULLOCK, J. S. G.—“Soil temperatures near Nairobi, 1954–1955.” *Quart. J. roy. met. Soc.*, **85** (1959), 51–56.



MILLBANK, J. W.—“The physiology of nitrification in Kenya highland soil.” *Plant and Soil*, **11** (1959), 293-311.

PAYNE, W. J. A.—“A possible vitamin E deficiency occurring in a herd of pigs fed standard rations in the tropics.” *Nature, Lond.*, **183** (1959), 828-829.

PAYNE, W. J. A.—“Identical cattle twins for animal husbandry experimental work in East Africa.” *E. Afr. Fld. Farm.*, **24** (1959), 18.

PEREIRA, H. C.—“Lessons gained from grazing trials at Makavete, Kenya.” *E. Afr. agric. J.*, **25** (1959), 59-62.

PEREIRA, H. C.—“Physical basis for land use policy in tropical catchment areas.” *Nature, Lond.*, **184** (1959), 1768-1771.

PEREIRA, H. C.—“Practical field instruments for estimation of radiation and of evaporation.” *Quart. J. roy. met. Soc.*, **85** (1959), 253-261.

PEREIRA, H. C.—“Tea gardens or tall forests?” *Corona*, **11** (1959), 209-213.

SHEFFIELD, F. M. L.—“Stem-pitting condition in coffee.” *Kenya Coffee*, July (1959).

SHEFFIELD, F. M. L.—“Sugar cane importation.” *E. Afr. agric. J.*, **25** (1959), 16-17.

STOREY, H. H. and HOWLAND, A. K.—“Resistance in maize to the tropical American rust fungus, *Puccinia polysora*. Part 2. Linkage of genes Rpp<sub>1</sub> and Rpp<sub>2</sub>.” *Heredity*, **13** (1959), 61-65.

TRAPNELL, C. G.—“Ecological results of woodland burning experiments in Northern Rhodesia.” *J. Ecol.*, **47**, 129-168.

VERDCOURT, B.—“The cowries of the East African coasts.” *J.E. Afr. nat. Hist. Soc.*, **23** (1959), 130-134.

VERDCOURT, B.—“Moringa—a correction.” *Kew. Bull.*, **1958** (1959), 384-386.

VERDCOURT, B.—“Scorpion shells.” *J.E. Afr. nat. Hist. Soc.*, **23** (1959), 146.

WHITEHEAD, A. G.—“*Rotylenchoides brevis* n.g., n.sp. (Rotylenchoidinae n.subfam.: Tylenchida).” *Nematologica*, **3** (1958), 327-331.

WHITEHEAD, A. G.—“*Hoplolaimus angustalatus* n.sp. (Hoplolaiminae: Tylenchida).” *Nematologica*, **3** (1959), 99-105.

WHITEHEAD, A. G.—“*Nothanguina cecidoplastes* n.comb. (syn. *Anguina cecidoplastes* (Goodey, 1934) Filipjev, 1936) Nothptylenchinae: Tylenchida.” *Nematologica*, **3** (1959), 70-75.

WHITEHEAD, A. G.—“*Scutellonema clathricaudatum* n.sp. (Hoplolaiminae: Tylenchida), a suspected ecto-parasite of the roots of the cotton plant (*Gossypium hirsutum* L. var. Uk. 51).” *Nematologica*, **4** (1959), 56-59.

WILKINSON, W.—“Two new species of *Kaloterme*s Hagen from West Africa (Isoptera: Kalotermitidae).” *Proc. roy. ent. Soc., Lond., B*, **27** (1958), 109-115.

WILKINSON, W.—“Four new species of Kalotermitidae from East Africa (Isoptera).” *Proc. roy. ent. Soc., Lond., B*, **28** (1959), 61-72.

**East African Veterinary Research Organisation**

67. The year 1959-60 has again been one of consolidation rather than expansion, and good progress has been made in various lines of research.

68. The estimates for the forthcoming quinquennium were prepared during the year under review. The detailed financial forecast made in connection with these estimates enable provision to be made for some of the scientific and technical posts which had to be placed in abeyance in 1959-60, and the limitations in staff due to financial stringency which were anticipated last year will not be as drastic as had been thought. On the other hand there is a possibility that staffing may be affected by the constitutional changes occurring generally throughout Africa, and by the need to recruit in the face of keen competition for scientists who are everywhere in great demand and to whom interesting and lucrative posts are available in the United Kingdom, the older Commonwealth countries, the U.S.A. and elsewhere. This problem is likely to affect all the research organisations.

*The Scientific Work of E.A.V.R.O.*

69. The following notes outline briefly the research and allied activities carried out by the several Divisions of the organisation and by visiting scientists.

70. The Division of Virus Diseases has again concentrated mainly on rinderpest, and interesting and important results were achieved. Investigations undertaken by Dr. G. R. Scott in collaboration with the Uganda Department of Veterinary Services confirmed the presence of rinderpest in goats in the Karamoja district. This is the first detection of the disease in this species in East Africa, and its existence will complicate future eradication from this region. Research on this condition is being expanded and serological surveys are being made to determine the incidence in goats in Uganda and Kenya. Similar studies have been continued on rinderpest in game in Tanganyika and Kenya Masailand, so as to elucidate their rôle in epizootiology and significance in control; this work is being done in collaboration with Mr. and Mrs. L. M. Talbot, who are undertaking a wild-life research project under the ægis of the National Research Council of America.

71. Co-operative research by Dr. Scott and Dr. D. E. DeTray of the United States Department of Agriculture team of virologists, involving an extensive series of experiments, has shown that pigs of European origin are fully susceptible to rinderpest by inoculation or feeding of infected meat, and that the disease spreads readily from such artificially infected pigs to susceptible in-contact pigs or cattle. The disease in pigs is clinically inapparent. It has been known for a considerable time that Asiatic pigs are susceptible to the disease but critical research has been needed on the status of European pigs; this has now been thoroughly and successfully completed. Other co-operative studies by Mr. G. White of E.A.V.R.O. and Dr. K. M. Cowan of the American team have thrown new light on the nature of rinderpest virus by the use of special equipment supplied from the U.S.A. They showed by column chromatography and ultra-centrifugation studies that a soluble antigen distinct from infective particles occurs in rinderpest virus. Dr. Cowan has made substantial progress in the development of a complement fixation test for rinderpest.

72. Mr. W. Plowright and Mr. R. D. Ferris have carried on their important researches on the cultivation of various African viruses in the Tissue Culture Section of the Division. The immunity produced by the new rinderpest tissue culture vaccine mentioned last year has been shown to be solid after two years, and studies on duration are continuing. The investigations on rinderpest-like diseases, whose significance will increase in the final stages of eradication, have comprised the completion of the work on bovine papular stomatitis and considerable advances in research on bovine malignant catarrh, including the first successful growth and passage of the virus in tissue culture. Mr. Ferris made good progress in the cultivation of this virus after Mr. Plowright went on leave in May, and Dr. Scott and he studied the nature and pathogenicity of malignant catarrh in experimental cattle at Muguga.

73. Mr. Plowright was awarded a travel grant by the Rockefeller Foundation and spent about six months visiting scientific institutions in the U.S.A. and Canada, studying research methods and recent advances in virology and pathology applicable to the problems in these subjects being investigated by E.A.V.R.O. He attended the XVIth International Veterinary Congress held in Madrid in May and presented a paper on his research on rinderpest virus in tissue culture.

74. The Division produces all rinderpest vaccine used in East Africa and in several other territories. During 1959 4,440,590 doses of K.A.G. (caprinised) rinderpest virus vaccine, and 312,190 doses of lapinised rinderpest virus vaccine, produced by Mr. S. A. Evans and Mr. C. S. Rampton, were sold by E.A.V.R.O. The fall in issues of lapinised vaccine compared with last year was due to decreased demand from the Sudan. Production was combined with research on improvements in these vaccines, particularly keeping qualities.

75. The research on African swine fever carried out by Dr. D. E. DeTray, Dr. W. A. Malmquist and Dr. K. M. Cowan, the U.S. Department of Agriculture team of virologists at Muguga, has made further good progress. The hæmadsorption inhibition test developed in 1958 by Dr. Malmquist has been successfully used in the typing of viruses. He has achieved attenuation of the virus by growth in kidney cells in tissue culture, and this virus induced resistance in inoculated pigs. This is the first indication that it may be possible to develop a method of immunisation against the disease; evidence of plurality of viruses is being obtained and the problem is therefore likely to be complex. Promising results have been obtained by Dr. Cowan in the development of a complement fixation test for the disease. Dr. DeTray continued his epizootiological studies and collected further data on the rôle of wild pig as carriers; in one instance virus was isolated from five out of nine wart hog shot in one area, which stresses the need for care in importing these animals into Zoos.

76. The Division of Bacterial Diseases has suffered from shortages of research staff, which have hindered the programme of work on contagious bovine pleuropneumonia. Mainly due to the problems encountered in the use in the field of avianized vaccine, both failure to protect against the acute virulent type of disease and also severe reactions, research has been started by Mr. C. R. Newing and Mr. G. J. Knight on a freeze-dried culture vaccine using the V5 strain of the organism which has given good results in

Australia. A culture vaccine prepared at Muguga from this strain was shown by laboratory experiments to produce an immunity about equal to E.A.V.R.O. T2/32 vaccine, and avianized vaccine of intermediate virulence. An extensive series of experiments was carried out, comprising bacteriological studies and of vaccination of cattle, on the relative efficacy of various suspending agents in the freeze-drying of Australian-type V5 culture vaccine. Agar, soluble starch, skimmed milk plus lactose, and alumina gel were investigated by Mr. Knight; only alumina gel gave promising results. An experimental adjuvant vaccine prepared by a modification of Mandes' technique, using formalin and aluminium hydroxide, proved disappointing.

77. Immunological studies have been undertaken by Dr. Cowan and Mr. Knight on the pleuropneumonia organism, with a view to elucidating its antigenic composition and isolating the fraction which produces immunity. The gel diffusion precipitin test for pleuropneumonia, developed by Mr. White and described previously, has continued to give very satisfactory results in the diagnosis of the disease, especially outbreaks in remote areas.

78. The Division of Protozoal and Arthropod-borne Diseases has continued long-term research on East Coast fever and allied theileriasis. The disease in buffaloes transmissible to cattle has been studied further by Dr. S. F. Barnett and Mr. D. W. Brocklesby at the laboratory, and the results have produced further evidence that *T. lawrencei* infection as it occurs in Kenya is very similar to and probably an aberrant form of E.C.F. Mr. Brocklesby and Miss B. O. Vidler are continuing laboratory studies on the differentiation of the two parasites. The field investigations on this disease in an infected area of the Ol Arabel forest were completed. A number of strains of *Theileria* isolated from the field have been studied at Muguga, including a most interesting mild strain of *T. parva* in which about 85 per cent. of infected cattle recover; this is the first occasion on which a naturally occurring mild strain has been obtained for investigation.

79. The method of immunization against E.C.F. by the use of Aurofac developed by Dr. Barnett and Mr. K. P. Bailey is now being applied at the territorial laboratories at Mpwapwa and Entebbe, using infected ticks bred and issued from Muguga. Field strains of *T. parva* are being obtained from Uganda and Tanganyika and cross-immunity studies carried out at Muguga to ensure that the standard E.A.V.R.O. strain of *T. parva* will protect against those existing in the territories.

80. Mr. Bailey is attempting to develop a serological test for the theileriasis, and his experiments are showing some promise. He is obtaining most valuable advice and guidance from Dr. Cowan, whose considerable experience of immunology and serological methods is benefiting many aspects of the research of E.A.V.R.O.

81. Professor H. M. Martin, Chairman of the Department of Parasitology in the University of Pennsylvania, who spent about nine months in E.A.V.R.O. in 1955 on a Fulbright fellowship studying the cycle of *T. parva* in the tick vector, has obtained a grant from the U.S. National Institutes of Health and will continue this research for a further two years here at Muguga.

82. Miss J. B. Walker's long-term research on East African ticks, particularly the taxonomy and life-cycles of the vectors of disease have again made

good progress. She has continued to give valuable assistance and advice to officers in the Veterinary Departments on the identification of ticks, especially the differentiation of the rarer species.

83. Miss Walker was awarded the M.Sc. of Liverpool University for her thesis "A Comparative Study of the Larvae and Nymphae of Ticks belonging to the genus *Rhipicephalus* in East Africa". She has also been awarded a grant by the United States National Institutes of Health in order to attend a six weeks course in 1960 and seminars on vectors of human and animal disease at the Institute of Acarology of the University of Maryland, and a Rockefeller Foundation Travel Grant to enable her to visit other laboratories in the U.S.A. and Canada where research is being done on ticks and other arthropod vectors.

84. The activities of the Division of Helminth Diseases have again comprised the studies of Dr. J. A. and Mrs. N. N. Dinnik on the trematodes of livestock and their snail vectors, and the research of Dr. G. M. Urquhart on the epizootiology of bovine cysticercosis or "beef measles".

85. The research on the morphology of three species of liver fluke occurring in East Africa, *Fasciola gigantica*, *F. hepatica* and *F. nyanzae* has been completed by Dr. Dinnik and is being published. *Lymnaea natalensis* and *L. truncatula* have been shown to be snail vectors of *F. gigantica*, the common fluke of Africa, and the studies of Mrs. Dinnik on the relationship of temperature to the development of this parasite in the snail host have been completed. Their research carried out over a number of years on the systematics and life-cycles of the paramphistomes or stomach flukes has now been rounded off and publication of recent work will complete the series of scientific papers on this subject, most of which have appeared in *Parasitology*. Research on bilharzia of livestock and field studies on the incidence of trematodes, particularly in the Lake Province of Tanganyika, will be intensified in future.

86. Dr. Urquhart continued his experiments at Muguga on the epizootiology of bovine cysticercosis, and also undertook field investigations on beef ranches and in African cattle. His work has thrown valuable light on this condition in cattle in East Africa, including the age of infection, the resulting resistance of calves and of adult cattle, and the longevity of cysts of *C. bovis*.

87. A Training Course in Laboratory Techniques in Helminthology, jointly organised by E.A.V.R.O., C.C.T.A. and W.H.O., was held from the 27th July to the 8th August in the E.A.V.R.O. laboratories at Muguga. The instruction was given by four distinguished helminthologists from the United Kingdom and France—Professor J. C. C. Buckley, Professor A. Galliard, Professor J. A. Euzeby, and Dr. F. H. Jarrett, and by Dr. and Mrs. Dinnik and Dr. Urquhart. These three E.A.V.R.O. officers did a great deal of valuable work for many weeks before the Course, preparing teaching material, assembling equipment and making other preliminary arrangements which did much to ensure its success, as well as taking a significant share of the teaching and practical demonstrations. The Course was attended by 27 veterinary and medical scientists from 15 different countries in Africa. Several of the participants who were particularly interested in the transmission of trematodes of animals and man spent all the time which they

could spare from the formal teaching, studying the breeding and maintenance of snails in Dr. and Mrs. Dinnik's laboratory, and the valuable additional experience which they thus gained was much appreciated.

88. The Division of Metabolic Diseases has made sound progress following its establishment last year, and the staff will soon be increased by the appointment of a Laboratory Technician. Dr. D. Horrocks has completed balance studies in African zebu and exotic cattle in respect of Na, K, P, Ca and Mg, and has made interesting observations on the levels of these five elements in the contents of eight different sites in the stomachs and intestines of these cattle. He is doing a long-term investigation at Muguga on sodium metabolism in zebu and exotic cattle, in order to attempt to produce a sodium deficiency by elimination of salt in food and water, and to determine whether sodium is a limiting factor in food and water intake, and in weight gain, under poor nutritional conditions.

89. The Animal Production Division has continued the good progress described in 1958, and done valuable work in various lines of research which will be extended following the filling of the establishment of four Research Officers and three Laboratory Technicians.

90. The Director, Mr. H. R. Binns, obtained a grant of \$20,000 from the Rockefeller Foundation at the end of 1959 towards the cost of establishing a Climatic Laboratory at Muguga for research on the environmental physiology of livestock, particularly African zebu cattle. This grant is for the purchase of air conditioning plant and of control and recording instruments, to be installed in the psychrometric building being constructed with funds provided by E.A.V.R.O. The laboratory aspects of co-operative research with territorial stations on bioclimatology and environmental physiology will be carried out in this unit. It is the first of its kind to be established in tropical Africa, and will be a most valuable addition to the research facilities of the Physiology Section of the Division.

91. Mr. G. D. Phillips completed the experiment described last year on the comparison of the digestive physiology of zebu and exotic types of cattle, before going on leave in July. The results of this work, and also of earlier research on ruminant digestion done at Muguga with Professor R. E. Hungate, Chairman of the Department of Bacteriology of the University of California, are being published in the *Journal of Agricultural Science*. Professor Hungate hopes to return to continue these lines of research in 1962, when he has sabbatical leave, and there is good reason to anticipate that he may then be able to work in E.A.V.R.O. for longer than the four months he spent at Muguga on a grant from the Rockefeller Foundation in 1957.

92. Mr. Phillips, spent a month during his vacation leave studying research techniques in ruminant physiology at the National Institute for Research in Dairying near Reading, and made shorter visits to research centres in Germany and Holland working on physiological problems similar to those being studied at Muguga.

93. Dr. A. Rogerson has undertaken a very full programme of research throughout the year on the utilisation of food and energy requirements

of cattle, by the use of the respiration calorimeter built last year by the E.A.V.R.O. workshops for the Metabolism Section of the Division. Mrs. M. Lamb is doing most of the chemical estimations and gas analyses involved in these aspects of the work, and her appointment in September to deal with these aspects of the work resulted in a significant increase in the amount of research achieved. In a study of the effect of diet and of environmental conditions on the energy balance of zebu and exotic cattle, the heat production and energy balance of animals fed rations ranging from near starvation to super maintenance are being measured, and the influence of varying temperatures and humidity is being investigated. The effect of restricted water intake is also being studied. Valuable and interesting results have been achieved which form the basis for a considerable expansion of this field of research by E.A.V.R.O. in the future, and much credit is due to Dr. Rogerson who designed and operated the first respiration calorimeter for cattle to be established in Africa, and to Mr. C. A. May who built the chamber and plant.

94. Mr. G. H. Lampkin and Dr. K. Lampkin have continued the long-term research described last year of the Genetics Sections of the Division, on the growth and production of beef-type indigenous zebu cattle originating from the Northern Frontier Province of Kenya. They are obtaining valuable information on the relative significance of breeding and management in the improvement of beef characteristics and quality, by the use of sire progeny groups. This important investigation is planned to last ten years and to comprise some 40 progeny groups each containing about 14 cattle; it is now in the fifth year, and 20 groups have been formed or are being established. The female progeny are being studied during two lactations and the steers until ready for slaughter. The severe drought of 1959 caused retardation of growth and weight gains in the genetics herd which is maintained solely on grass at Muguga.

95. Mr. and Mrs. Lampkin are carrying out various ancillary studies on the genetics herd. An investigation of the effect of milk yield of the dam on the growth of suckled calves was completed. This comprised 164 calves, which received an average of 2,486 lbs. of milk from birth to weaning at 36 weeks of age, which resulted in average weights at weaning of 408 lbs. for males and 370 lbs. for females. From a correlation analysis, it was concluded that calf growth could be increased more effectively by improvement of grazing than by selection of high milk yield in the cow.

96. Mr. Binns was appointed a Consultant on animal science in tropical Africa to the United States National Academy of Sciences and visited a number of African countries in March and April as a member of the survey undertaken by the Academy of needs and problems in science, technology and scientific education in Africa south of the Sahara. The purpose of this survey was to advise the U.S. Government on ways in which technical and financial assistance might be made available to those countries. He then took part in the Conference held near New York, which comprised eleven American and four British Consultants under the Chairmanship of Dr. J. G. Harrar, Vice-President of the Rockefeller Foundation, and which considered these problems and made recommendations regarding future developments and assistance.

*Publications*

BAILEY, K. P.—“Note on the rearing of *Rhipicephalus appendiculatus* and their infection with *Theileria parva* for experimental transmission.” *Bull. epiz. Dis. Afr.* (in press).

BARNETT, S. F. and BROCKLESBY, D. W.—“*Theileria lawrencei* in Kenya.” *Bull. epiz. Dis. Afr.*, **7**, 345–346 (1960).

BARNETT, S. F., BROCKLESBY, D. W. and BRENDA O. VIDLER.—“A note on the susceptibility of East African cattle to infection with *Theileria annulata*.” *Bull. epiz. Dis. Afr.* (submitted).

BROCKLESBY, D. W.—“Buffaloes, East Coast fever and Corridor disease.” *E. A. Veld*, **6**, 16–17 (1960).

BROCKLESBY, D. W.—“Eperythrozoonosis in swine.” *E.A. agric. J.* (in press).

DINNIK, J. A.—“Some facts and problems concerning the epizootiology of Fascioliasis in Africa South of the Sahara.” *Bull. epiz. Dis. Afr.* (in press).

DINNIK, J. A. and DINNIK, N. N.—“Observations on the longevity of *Haemonchus contortus* larvae on pasture herbage in the Kenya Highlands.” *Bull. epiz. Dis. Afr.* (in press).

DINNIK, J. A. and DINNIK, N. N.—“Effect of the seasonal variations of temperature on the development of *Fasciola gigantica* eggs in the Kenya Highlands.” *Bull. epiz. Dis. Afr.*, **7**, 357–368 (1960).

DINNIK, J. A., and DINNIK, N. N.—“On the morphology and the life history of *Fasciola nyanzae* Leiper 1910 from the hippopotamus.” *J. Helminth.* (submitted).

DINNIK, J. A. and DINNIK, N. N.—“Development of *Carmyerius exoporus* Maplestone (*Trematoda: Gastrothylacidae*) in a snail host. *Parasitology* (submitted).

HUNGATE, R. E., PHILLIPS, G. D., HUNGATE, D. P. and MACGREGOR, A.—“A comparison of the rumen fermentation in European and Zebu cattle.” *J. agric. Sci.* (in press).

HUNGATE, R. E., PHILLIPS, G. D., MACGREGOR, A., HUNGATE, D. P. and BUECHNER, H. K.—“Microbial fermentation in certain mammals.” *Science*, **130**, 1192–1194 (1959).

KNIGHT, G. J.—“Studies with avianized strains of the organism of contagious bovine pleuropneumonia. VII. Self-contained experiments.” *Bull. epiz. Dis. Afr.*, **7**, 227–233 (1959).

KNIGHT, G. J.—“Studies with avianized strains of the organisms of contagious bovine pleuropneumonia. VIII. Experiments with avianized vaccines tagious bovine pleuropneumonia. VII. Self-contained experiments.” *Bull. epiz. Dis. Afr.* (in press).

LAMPKIN, K. and LAMPKIN, G. H.—“Studies on the production of beef from Zebu cattle in East Africa. Part I. A description of the Muguga herd. Part II. Milk Production in suckled cows and its effect on calf growth.” *J. agric. Sci.* (submitted).

LIBEAU, J. and SCOTT, G. R.—“Rinderpest in Eastern Africa today.” *Bull. epiz. Dis. Afr.* (in press).



PHILLIPS, G. D.—“Relationship between water and food intakes of European and Zebu type steers.” *J. agric. Sci.* (in press).

PHILLIPS, G. D., HUNGATE, R. E., MACGREGOR, A. and HUNGATE, D. P.—“Experiments on rumen retention time, fermentation rate and dry matter digestibility in Zebu and European-type cattle on a grass hay ration.” *J. agric. Sci.* (in press).

PLOWRIGHT, W.—“Studies with rinderpest virus in monolayer tissue cultures.” *Proc. XVIth International Veterinary Congress, Madrid*. May, 1959.

PLOWRIGHT, W. and FERRIS, R. D.—“Papular stomatitis of cattle. II. Reproduction of the disease with culture-passaged virus.” *Vet. Rec.*, **71**, 828-832 (1959).

POLDING, J. B., SIMPSON, RUTH M. and SCOTT, G. R.—“Links between canine distemper and rinderpest.” *Vet. Rec.*, **71**, 643-645 (1959).

ROGERSON, A.—“The effect of environmental temperature on the energy metabolism of cattle.” *J. agric. Sci.* (submitted).

SCOTT, G. R.—“Heat inactivation of rinderpest-infected bovine tissues.” *Nature*, **184**, 1948-1949 (1959).

SCOTT, G. R., DETRAY, D. E. and WHITE, G.—“A preliminary note on the susceptibility of pigs of European origin to rinderpest.” *Bull. Off. int. Epiz.*, **51**, 694-698 (1959).

SCOTT, G. R. and HEISCH, R. B.—“Rift Valley fever and Rift Valley rodents.” *E. A. med. J.* **36**, 665-667 (1959).

URQUHART, G. M.—“Diethylcarbamazine therapy in bovine cysticercosis.” *J. Parasitol.* (in press).

URQUHART, G. M. and HAY, D.—“Warble larvae in Grant's gazelle.” *Vet. Rec.*, **72**, 256 (1960).

URQUHART, G. M. and HAY, D.—“The numbers of *Crossocephalus zebrae* (*Nematoda: Atractidae*) in the zebra (*Equus burchellii* Böhm). *J. Parasitol.* (submitted).

URQUHART, G. M., HAY, D., ZAPHIRO, D. R. P. and SPINAGE, C. A.—“Some internal parasites of game animals in Kenya.” *E. A. Agric. J.* (submitted).

WHITE, G. and SCOTT, G. R.—“An indirect gel diffusion precipitation test for the detection of rinderpest antibody in convalescent cattle.” *Res. vet. Sci.* (submitted).

### Imperial College of Tropical Agriculture

#### Herbicides

97. Herbicide trials on several crops were continued and the main results can be summarised as follows:—

- (a) Only groundnuts and maize showed any appreciable tolerance to pre-emergence applications of 2,4-DB, groundnuts being very tolerant.
- (b) Up to 2 lb./acre MCPB can be safely applied to groundnuts three days after sowing, but larger doses caused severe damage if rain

fell soon after sowing. Weed control with 1 lb./acre MCPB was not so good as with 10 lb./acre Dinoseb, but costs and handling problems were reduced.

- (c) Simazin at 1 lb./acre active ingredient was outstandingly good in maize.
- (d) Pre-emergence applications of MCPB caused severe damage to soya beans if rain fell soon after spraying.
- (e) The most satisfactory herbicide for yams was 4 lb./acre amine 2,4-D applied 12 days after planting, with no apparent damage to the yams.

#### *Animal Husbandry*

98. A continuation of the grazing studies reported in 1958-59 has confirmed the importance of good night pastures in increasing the night grazing by animals which results in a reduction of day grazing and therefore reduces the heat burden on the animals.

99. Studies on water requirements of the cross-bred Zebu-Holstein herd was continued in collaboration with the Trinidad Department of Agriculture. The latest results bear out the earlier finding that the total water consumed and also the total dry matter intake is greatest during the dry season when grass quality and palatability are low. This accords with the observation of the animal nutrition chemist that there is a direct connection between the dry matter percentage of herbage and the dry matter intake of the sheep.

100. Digestibility trials were carried out on nine local grasses and forages, using sheep. In general it was found that the digestibility of the crude protein fraction was high in the case of high protein grasses and that as the protein fraction decreased so did its digestibility, as is common in the tropics. In general, the digestibility of the crude fibre fraction of the grass was higher than that of the nitrogen-free extractions. This indicates that the high levels of crude fibre commonly found in tropical forages are not particularly disadvantageous from the nutritional standpoint.

101. In Trinidad weaning weights of piglets are generally low and anaemia is common due to depletion of iron reserves and insufficient milk intake. A repetition of work carried out elsewhere on intramuscular injection of iron as an inorganic suspension resulted in significantly higher levels of haemoglobin and higher weaning weights at six weeks.

#### **West Indies Regional Research Centre**

102. With the creation of the West Indies Federation research became a Federal responsibility. To ensure good co-ordination of research and to guide it in ways thought most helpful to the Region, the Federal Government set up Councils and Committees to advise the Ministries concerned. In the subjects of Agriculture, Animal Health and Forestry a Regional Research Committee under the Chairmanship of the Federal Agricultural Adviser met for the first time in 1959. The membership of this Committee includes two representatives of the Secretary of State, who were Mr. F. C. Bawden and Mr. D. Rhind at this meeting. The duties of the Committee, which is

advisory to the Regional National Resources Council at Ministerial level, include consideration of the programme of work of the Regional Research Centre.

103. The pattern of research at the Regional Research Centre has resulted largely from the historical fact that the Centre was formed by amalgamation of three separate research schemes for cocoa, bananas and soil survey. The work has tended to become compartmentalised and the staff has tended to work in comparative isolation from each other. This has channelled research into restricted lines to the exclusion of problems of pressing importance within the Region.

104. The Regional Research Committee, at its First Meeting in 1959, felt that in some respects the work had become out of balance with the needs of the region. Consequently certain recommendations were made with the hope that research staff "would break away from the restricted attitude of working in watertight compartments on single crops to develop the team approach to the problems of the Region".

105. Your Committee share these views and have expressed the hope that in future the programme of the Regional Research Centre will be arranged so as to meet the needs of the West Indian territories to the fullest possible extent.

#### *Banana Research*

106. Research on the genetics and breeding of bananas has hitherto been divided between the Imperial College of Tropical Agriculture in Trinidad and the Department of Agriculture in Jamaica. Work in Trinidad has been on the basic cytogenetics of the Musaceae, the assembly of breeding stocks and the breeding of more parents for use in the hybridisation programme in Jamaica. This work has so far advanced that it has been decided to transfer the whole of the work to Jamaica along with the collection of wild and cultivated bananas. The hybridisation programme will then continue with a reduced amount of work on the cytological side. Arrangements for this transfer are well advanced, but final arrangements have been delayed for various reasons. The physical transfer of the breeding stock, involving about 150 clones, has not yet taken place. Duplicates will be maintained in Trinidad until it is certain this valuable collection, the work of many years, has become safely established in Jamaica.

107. The chief handicap in banana breeding has been the very low seed production when using parthenocarpic parents which is unavoidable in commercial banana production. Studies on parthenocarpy now suggest that it is caused by a dual chemical stimulus of which one component (perhaps of the auxin type) is also partly responsible for seed sterility. If this hormone effect could be negated by means of an applied antagonist, then seed fertility in otherwise infertile edible bananas might be increased with great practical benefit in banana breeding. So far, two out of five antagonists trials have shown anti-parthenocarpy effects but only one gave any indication of increase in fertility, and that was sporadic.

108. An examination of seeded and non-seeded bananas has shown that  $\beta$ -indolyl acetic acid is common to both varieties, but with the difference

that it is only detectable as free auxin in the non-seeded varieties while incomplete ovules are present. Once the ovules abort, some two weeks from receptivity and when edible pulp formation is taking place, free auxin is no longer detectable. In the seeded varieties, however, free auxin can be found in the fertilized ovules until maturity of the seeds. This suggests that free auxin is dependent on ovule development although evidence has been found that IAA is still present in non-seeded varieties in a bound complex from which it can be separated by acid hydrolysis.

109. In male parent breeding, crosses of the wild Samoan introductions with edible diploids have continued to yield a proportion of outstanding seedlings. The general quality of these families is undoubtedly aided by the fact that the Samoan plants, though apparently truly wild and normally very seedy, themselves exhibit a low degree of parthenocarpy.

110. Other families now in the breeding programme introduce variability from a hitherto unused wild source, a Pahang strain of *M. acuminata* which bears larger than average fruits for a Malayan form of that species. No large-fruited hybrid plants have yet been isolated, but advantage is expected from increasing the diversity of breeding stocks.

111. The blackening of bananas is a process of obvious economic importance, but the mechanism of the process is largely unknown. It has been shown that the compound giving rise to the black pigmentation is 3:4 dihydroxyphenyl ethylamine and that an active polyphenoloxidase system capable of rapidly oxidising this compound is present in the pulp and skin of the fruit.

#### *Cocoa Research*

112. The yields of the six Trinitario X Scavina hybrids continued to rise but it is clear that a yield plateau is approaching. The most prolific cross was again ICS 6 X SCA 6 which gave a crop at the rate of 2,781 lb. dry cocoa per acre from 154 bearing seedlings, or 3.25 lb. per tree. Small-scale fermentations on these crosses did not receive encouraging reports for flavour, all being ranked inferior to ICS 1. The fermentations may, however, have been below the optimum and will be repeated.

113. Studies on the genetics of the "crinkled dwarf" character and of pigmentation were continued. In order to determine the mode of inheritance of resistance to Witches' Broom disease, progeny of the cross ICS 8 X SCA 6 were subjected to artificial inoculation with spores of *Marasmius perniciosus*. Inter-specific crosses in the genus *Theobroma* have been extended and back-crosses of F<sub>1</sub> material to species parents have been made.

114. Cytological work on compatibility was not resumed. A sound working knowledge of the mechanism, inheritance and effects of incompatibility has been obtained.

115. The trial of stock-scion relations planted in 1951 has shown that a poor clone will give a higher yield on a good stock and, conversely, yields of a good clone are reduced on a poor stock. This supports the policy of using cuttings on their own roots rather than on unproven seedling stocks. No combination gave significantly higher yields than the best clone on its own roots. Interaction between stock and scion is negligible, differences between yields of scions being the same irrespective of rootstock.

116. A considerable amount of work has been done on the endogenous auxins of cherelles and their bearing on cherelle wilt. Using the oat curvature test, it was shown that there is a quantitative inverse relationship between total endogenous auxin and the incidence of cherelle wilt. This may explain the partial control of wilt by spray applications of 2, 4-D.

117. Preliminary work has shown that the abnormal growth resulting from *M. perniciosus* infection is not due to auxins of the indole type nor are substances of the gibberellin type present.

118. Reported increases in yield of cocoa by low volume spraying with copper oxide formulations are being investigated in experimental trials at River Estate. Perenox (cuprous oxide) with and without other trace elements is being used as the source of the copper ion. These experiments are being conducted on a randomised block design but without information on yields from previous years. Owing to the startling and possibly far reaching consequences of the effect of copper sprays on cocoa, 1,344 trees in another field are being recorded for the next two years in order to superimpose trace element sprays at a later date.

119. The development of chocolate flavour in fermenting beans in relation to their chemical and physical environment is receiving detailed study. Earlier investigations having indicated that optimal flavour development was dependent upon the presence of acetic acid, attention has been given to the factors controlling acetic acid formation in the cocoa fermentary. A method was initially developed for the estimation of acetic acid in raw cocoa giving a recovery of ninety-seven per cent. It has been shown that acetic acid formation is highest in the superficial layers of the fermenting mass, values of up to 1.75 g acetic acid/100 g bean having been recorded. Formation in the centre and bottom of the box is low but the rate is considerably increased on "turning" due to increased aeration of the mass and redistribution of the microbial population. A correlation has been noted between the rate of heat production in the box and the rate of acetic acid formation suggesting that the *Acetobacter* are the organisms primarily responsible for the thermal changes characteristic of fermenting cocoa.

120. Acetic acid formation in tray fermentations was also investigated and it was shown that under these conditions very high acetic acid levels were recorded; values up to 130 per cent. in excess of those found in box fermentations are being frequently found. This increase is undoubtedly due to the higher degree of aeration obtaining in thin layers and explains the origin of the acidic flavour character of tray-fermented cocoa, reported by manufacturers' tasting panels. It has been found, however, that under appropriate conditions of drying much of the excess acetic acid can be eliminated before shipping. Experiments are proceeding on the application of this technique to the preparation of small batches of cocoa on the estate; a satisfactory estate method for small batch fermentation has not previously been developed. Preliminary results indicate that, with quantities between forty and two hundred pounds, the tray method gives a product superior to that produced by heaping the beans in the traditional Trinidad boxes. With quantities greater than two hundred pounds, however, the product from the boxes is superior to that prepared in the trays.

121. A comparative study of the polyphenols of a range of species and clones of *Theobroma* has been completed. It was shown that 1-*epi*-catechin

and the leuco-anthocyanins L<sub>1</sub>, L<sub>2</sub> and L<sub>3</sub> were present in most species of *Theobroma* and all clones of *T. cacao* examined. A new leuco-anthocyanin, L<sub>4</sub> was also detected and the presence of other hitherto unreported polyphenols are described. It is of interest that the major bean polyphenols of *T. cacao* were found to be present in a wide range of related species which are not used for cocoa manufacture. Chromatic study of the polyphenolic bean constituents of the clones has indicated that although considerable variation in the anthocyanin content of fresh beans of differing clones occurs, other major bean polyphenols, including 1-*epi*-catechin and the leuco-anthocyanins, do not show marked variation.

122. Pathology was concentrated on the problem of *Ceratostomella* wilt. This disease, which was reported as new to Trinidad cocoa in the last annual report, continued to spread at River Estate and now occurs in almost all the fields. Field observations and exploratory experiments have been continued with particular reference to transmission, to the effect of environmental factors on the incidence of disease and to resistance.

123. Evidence is accumulating to indicate that beetles of the *Xyleborus* spp. are worthy of special study in investigating the problems of transmission of this disease. These insects possibly are directly involved in the transmission of the disease organism on and in their bodies, and also indirectly by extruding from their tunnels frass which contains numerous spores and which becomes air-borne. The faeces of these insects have been found to contain chlamydospores of *Ceratostomella fimbriata*, but the small sizes of the insects and consequently the small amounts of unadulterated faeces which it is possible to collect present difficulties in determining the importance of this method of spore dispersal.

124. Experiments designed to establish infection by caging live insects on the host plants have been unsuccessful because of the trapping of these minute insects by water films which arise from condensation on the internal surface of the cages. Small scale inoculation experiments using pulverised insects as inoculum have shown no positive results. Inoculation experiments using the frass as inoculum are being conducted.

125. In order to elucidate the life cycle of these insects attempts have been made to rear them from the larval to the adult stage on pure cultures of *C. fimbriata* and on *Fusarium* spp. isolated from diseased cocoa wood. These attempts have not been very successful. It is evident, however, that the insects are highly susceptible to dessication.

126. No sporulation has been observed on natural surfaces of diseased trees in the field, but cut wood surfaces have been found to produce heavy sporulation. Pure cultures from such spore masses bear both asexual and sexual spore forms which, when inoculated into greenhouse cuttings, will produce the disease. Perithecia are formed externally on these artificially inoculated hosts and chlamydospores are produced internally. These perithecia are similar but apparently not identical with perithecia which are commonly to be found on the surface of wilted cherelles on healthy trees in the field. The possibility of plurality of strains of *C. fimbriata* is therefore being investigated while efforts are being made to determine the connection between the infected cherelles on otherwise healthy trees and the lethal disease of the cocoa trunk.

127. Considerable differences in growth rate and pathogenicity of *C. fimbriata* can be obtained on different culture media and methods for standardising inoculum are under investigation with a view to testing host material for resistance. With this aim in mind inoculation techniques are also being tested and it would appear that low infection percentages obtained in earlier inoculation experiments could be attributed to faulty inoculation technique and unsuitable culture medium.

128. Inoculation experiments have also indicated that the wilt disease caused by *C. fimbriata* is not enhanced in virulence by the presence of the *Fusarium* sp. which is commonly associated with the active pathogen.

129. Detailed records of the incidence of disease at River Estate have been kept and correlations sought between this and rainfall, soil types, cultural operations, manurial treatments, shade, spacing and genetical constitution. Clear evidence has been obtained for the high susceptibility of ICS 45 and of crosses with ICS 45, ICS 54 or ICS 101 as parents.

130. The concept that drought weakens the tree and thereby renders it prone to this disease might afford a partial explanation of the seasonal trends of the epidemic, but the disease incidence recorded over the past year at River Estate indicates the possibility of a complex of factors determining these seasonal trends.

131. Disease incidence tends to be higher in shade and in close-spaced plantings, but no clear evidence has so far been obtained for the effects of different cultural operations, manurial treatments or soil types.

#### *Sweet potatoes*

132. From the results so far obtained it is obvious that only a small percentage of the collected cultivars will be retained because of their yield. Records of observation plots indicate that four seedlings, or almost three per cent., raised experimentally are likely to be good yielding. Two of these seedlings are derived from 20/56, "Red Nut", a comparatively high yielding cultivar from Trinidad, and one from 07/56, "B.34", which shows a marked resistance to *Megastes* attack. Because of these results it has been decided to commence full time breeding work on sweet potatoes and a polycross plot has been laid down.

#### *Pigeon peas*

133. Preliminary studies on the time taken from sowing to pod production have shown that this period varies greatly, not only with the variety but also with the season of planting. The "Farm" pigeon pea is one of the highest yielding but suffers from the disadvantage of taking, in the June sowing, twenty-six weeks to reach podding, and fifty-four weeks when sown in October. In contrast 56/57/1 and 01/58 take twelve to fourteen weeks to podding whether sown in June or October.

#### *Yams*

134. The results of a survey of *Dioscorea alata* cultivars have been submitted for publication. A suspected virus infection exists in the cultivar "Coconut Lisbon". Investigations on the variability of *D. cayenensis*, *D. rotundata* and *D. trifida* are in progress. The collection of *D. esculenta*

cultivars now includes four additional ones from the Pacific region. It is unfortunate that the yams of this species, so far examined, store rather badly and are not generally liked by the local population. They are high yielding with tubers of good shape which are developed in the upper layers of the soil.

#### *Aroids*

135. The first yield trial of *Xanthosoma* cultivars has been harvested. The results are very encouraging, the highest yielding cultivar was 22/57 "Barbados", which produced 13.8 tons/acre of marketable tubers from planting pieces derived from the main rhizome and 10.9 tons/acre from planting tubers. The best storing and eating quality tannia was 13/56 "Chackelle"; this cultivar yielded 9.5 tons/acre. It is interesting to note that the greatest revenue received from any individual root-crop was from the *Xanthosoma* cultivars, a crop which is rarely grown as a pure stand of commercial type production in Trinidad.

136. A *Colocasia esculenta* cultivar "Mumu" from Fiji again exceeded the yield of the "Trinidad Purple" or "Common" dasheen. It gave 6.84 tons/acre compared to 5.70 tons/acre from the "Trinidad Purple", but its cooking quality is not as good.

#### **Soils Research and Survey**

137. The routine laboratory continued to function satisfactorily and dealt with about 19,000 plant analyses and 1,300 soil analyses. Plant analyses which had reached very large numbers, due to the crop logging programme on cocoa were considerably reduced so that further examination of the accumulated data could be made. Correlation between the levels of N and  $P_2O_5$  in the leaf and yield have been calculated and it has been shown that the N/ $P_2O_5$  ratio has a highly positive correlation with yield in unshaded plots but the correlation is negative in shaded plots. The "guard" plots, used for studying rates and times of application showed the advantage of applying fertiliser in split doses for N and P, and to a lesser extent K. In view of this the fertiliser application to the "experimental" plots has been split, half the dressing being applied in September and half in May.

138. At River Estate the trial with four different species of shade trees has shown that Immortelle (*Erythrina poeppigiana*) is the best and Pink Poui (*Tabebuia pentaphylla*) the worst, the yields of cocoa under the former being between three and four times those of the latter. When some soil samples were taken from plots under different shade treatments and used for pot trials with lettuce and tomatoes both crops showed considerably better growth on the soil from the Immortelle shaded plots.

139. In a pilot trial on chemical weed control in cocoa carried out at River Estate weekly observations were made of the effect of weed killers on the weeds and also on the cocoa and bananas. Sodium arsenite and pentachlorophenol showed no effect on cocoa at all levels used, while they gave good weed control. The sodium salt of dichloropropionic acid at a sufficient level to affect weeds is detrimental to cocoa.

140. The trace element levels in some samples of cocoa beans have been determined. Particular attention has been paid to copper since the



activities of the polyphenol oxidases are known to be related to copper levels. During the course of this investigation high levels of boron were noted and values of up to 95 p.p.m. B in dried fermented beans were obtained.

141. Investigations of the values of K, Ca and Mg in the solution phase of three different soils have shown that the  $pK-\frac{1}{2}p(Ca + Mg)$  value is constant over the entire moisture range only in the case of the Montserrat series. For the River Estate Fine Sandy Loam and Princes Town Marl series it was found that there was a significantly large increase in the values of  $pK-\frac{1}{2}p(Ca + Mg)$  with increasing dilution. The effect of increasing the ionic strength on River Estate series was investigated by equilibrating soil with 0.002 M, 0.005 M, 0.02 M and 0.1 M calcium chloride solutions. It was shown that the values of  $pK-\frac{1}{2}p(Ca + Mg)$  decreased rapidly with increasing ionic strength over the lower concentration range. This is possibly due to the potassium ions being brought into a more readily exchangeable condition.

142. The formula of Thornthwaite has been used to draw up maps of "irrigation needs" for various parts of the West Indies. The maps show the amount of irrigation needed to bring the soil moisture up to field capacity. Each month of the dry season (in some cases of the whole year) is shown separately. In addition an attempt has been made to draw isonoms showing the chances (i.e. number of years in ten) that irrigation will not be needed at all. Similarly isonoms have also been produced for the chances that 2 inches or 4 inches of water applied will be theoretically sufficient to supply plant water needs. Maps for Trinidad and Jamaica have been completed and those for Barbados, Antigua, Montserrat and St. Kitts-Nevis are in hand.

143. Following the initial soil and land-use surveys it was noted that some soils of the West Indies suffered from certain trace element deficiencies, one of these being molybdenum. It has been shown that molybdenum deficiency can occur on soils which are highly leached and siliceous or on those which have a low pH which renders the Mo unavailable. Deficiency can also occur over laterites and a response to Mo application was obtained on a soil which as a bulked sample gave 3 p.p.m. Mo.

144. Investigations on the trace element status of British Guiana soils have shown that values for extractable zinc were below 5 p.p.m. for soils in the Ebini area. Pot tests showed a yield response from zinc, and zinc deficiency symptoms of citrus have been observed. It is possible that the zinc levels are sufficiently low to affect the development of the livestock in the area.

145. In an investigation on the behaviour of trace elements in soils during the weathering cycle, it was found that certain elements followed a similar pattern. The soils examined were volcanic in origin and as the age of the soil increased the levels of Sr, Ba and Cr dropped rapidly at first, tending to become asymptotic to a given value. Ni and Co showed similar trends but the initial decline was less steep. In the case of Zn and Cu the levels rose with increasing age.

146. With the proposed legislation by the U.K. Ministry of Health that lead levels in citrus juice should not exceed 1 p.p.m., lead determinations in samples of Trinidad grapefruit juice were carried out. All

of the samples had values below 1 p.p.m. Trace elements have been determined in sugar-cane leaves from the South African Sugar Association.

147. Soil survey proceeded at a steady rate in spite of staff changes. In Jamaica work continued in the parishes of Westmoreland and St. Elizabeth. Reports and maps were published for St. Vincent, St. Andrew and Clarendon (Jamaica), Bartica, Mahdia, etc. and the Rupununi and Intermediate savannahs (British Guiana). Reports were prepared and one in the press for the following: St. James (Jamaica), St. Mary (Jamaica) and Grenada.

#### Statistics

148. The scheme for the improvement of agricultural statistics in British Caribbean Territories continued under the technical direction of the Regional Research Centre. During the two years from September, 1956, the Agricultural Survey Officer appointed under Colonial Development and Welfare Scheme D.2878, carried out the field work consisting of complete enumerations of farmers and agricultural sample surveys in the Leeward and Windward Islands. The analysis and reporting of these surveys has been carried out during the past year, so that the first phase of this scheme is now complete.

149. A full account of the scope and methods of the surveys was prepared together with reports on the surveys in Montserrat and Grenada. The subsequent reports on the other individual surveys have followed the same pattern. These reports have been published as separate bulletins by the Federal Ministry of Natural Resources and Agriculture. The computation of the estimates and sampling errors for both Montserrat and Grenada were carried out at the Regional Research Centre while the remainder of the analyses were supervised in the Federal Ministry of Natural Resources and Agriculture. Investigations of the efficiency of the sample design used in the 1956-58 surveys are being carried out at the Regional Research Centre.

150. Considerable experience for planning future surveys and agricultural information of immediate value have been obtained. This experience is being constantly used in the planning of the 1961 Agricultural Census. One achievement of fundamental importance has been the production of a list of farms classified by size groups for each island. The position has now been reached when sample surveys may be readily conducted both for the regular collection of agricultural statistics and for *ad hoc* purposes of a more technical nature; for example, on farming practices or the incidence of disease.

151. The Statistician visited Barbados to advise the Ministry of Agriculture and Fisheries on plans for an agricultural sample survey to be carried out later in the year. Pilot investigations were initiated. Assistance was also given to members of the Department of Agriculture on other statistical problems including plans for a sugar-cane borer survey investigation. A visit was made to Jamaica to discuss and advise on statistical problems concerned with sample surveys and experimental designs in that territory.

152. Close co-operation has been maintained with the various departments in the College. Assistance has been given with the design and analysis of experiments and with the interpretation of results. A limited computing service was maintained and accumulated results of experiments on the spacing

effect on yields of dwarf beans, egg plant and groundnuts have been analysed. The advantage of much closer spacings than those commonly used for these crops has been clearly demonstrated.

153. Assistance has also been given on a variety of matters to Agricultural or Statistical Officers not only within the region (Trinidad, Barbados, British Guiana, St. Vincent) but also in Africa (Ghana, Kenya, Nyasaland, Tanganyika and Northern Rhodesia). Work for institutions outside the region has been on an increased scale this year.

### STORED PRODUCTS

154. Work on the infestibility of paddy by *Sitophilus sasakii* Tak., and *Rhyzopertha dominica* Fab., and on the ability of *Oryzaephilus* spp. to breed in unrefined sugars was completed and the accounts prepared for publication. The work on paddy showed that, as far as Caribbean grown rice varieties are concerned, the mature paddy grain with an intact husk is not infestible by *S. sasakii* and is probably almost as immune to infestation by *R. dominica*. However, husk defects render the grain infestible by both species and especially by *R. dominica*, the larvæ of which can exploit much smaller cracks than can adults of *S. sasakii*. The degree of husk damage in harvested paddy may be related to the method of harvesting and threshing and is most severe in combine-harvested grain.

#### Publications

ROSHER, P. H.—“The spacing of Swamp Rice in Trinidad.” *Emp. J. exp. Agric.*, **27**, 223-234 (1959).

ROSHER, P. H., and SHELDRIK, R. D. “The effect on Groundnuts of Pre-emergence Applications of MCPB.” *Trop. Agric. Trin.*, **36**, 118-129 (1959).

ROSHER, P. H., and SHELDRIK, R. D. “The Effect of Pre-emergence Applications of MCPB on Groundnuts.” *Trop. Agric. Trin.*, **36**, 211-217 (1959).

WILSON, P. N. “The Effect of Plane of Nutrition on the Growth and Development of the East African Dwarf Goat.” Part III. “The Effect of Plane of Nutrition and Sex on the Carcass Composition of the Kid at Two Stages of Growth, 16 lbs. Liveweight and 30 lbs. Liveweight.” *J. agric. Sci.*, **52**, 287-319 (1959).

PURSEGLOVE, J. W. “Notes on Orchid Cultivation for Trinidad Conditions.” *Bull. Amer. Orchid Soc.*, **28**, 81-86 (1959).

RICHARDSON, W. D. “Preliminary Investigations on the Utilisation of Marine Algae in the Caribbean.” *Abstracts of the Third International Seaweed Symposium*. 49-50 (1958).

RICHARDSON, W. D., and DEWAR, E. T. “Third International Seaweed Symposium.” *Nature, Lond.*, **182**, 1779-1781 (1958).

BENNETT, M. C., and COPE, F. W. “Nuclear Fusion and Non-fusion in *Theobroma cacao* L.” *Nature, Lond.*, **183**, 1540 (1959).

BREESE, M. H., and WISE, T. E. “The Biology of *Nausibius clavicornis* (Kug) (Col. Cucujidae).” *Bull. ent. Res.*, **50**, 237-258 (1959).

CONSTABLE, D. H., and HODNETT, G. E. “The Responses of *Hevea Brasiliensis* to Fertilisers in Ceylon.” *Emp. J. exp. Agric.*, **27**, 150-157 (1959).

COPE, F. W.—“Incompatibility of *Theobroma cacao*.” *Nature, Lond.*, **181**, 279 (1958).

GOODING, H. J. “West Indian ‘*Dioscorea alata*’ Cultivars.” *Trop. Agric., Trin.*, **37**, 11–30 (1959).

GRIFFITHS, L. A. “Detection and Identification of the Polyphenoloxidase Substrate of the Banana.” *Nature, Lond.*, **184**, 58–59 (1959).

GRIFFITHS, L. A. “Recent Advances in Cocoa Fermentation.” *J. Agric. Soc. Trin. Tob.*, **59**, 414–420 (1959).

HODNETT, G. E., and NANTON, W. R. E. “The 1956–58 Surveys: Scope and Method.” *Agricultural Statistics Series, 1, No. 1.* (Ministry of Natural Resources and Agriculture, The West Indies) (1959).

HODNETT, G. E., and NANTON, W. R. E. “The 1956–58 Surveys: The Survey of Montserrat.” *Agricultural Statistics Series 1, No. 2.* (Ministry of Natural Resources and Agriculture, The West Indies) (1959).

HODNETT, G. E., and NANTON, W. R. E. “The 1956–58 Surveys: The Survey in Grenada.” *Agricultural Statistics Series 1, No. 4.* (Ministry of Natural Resources and Agriculture, The West Indies) (1959).

HODNETT, G. E., and NANTON, W. R. E. “The 1956–58 Surveys: The Survey of St. Vincent.” *Agricultural Statistics Series 1, No. 5.* (Ministry of Natural Resources and Agriculture, The West Indies) (1959).

HODNETT, G. E., and NANTON, W. R. E. “Definitions of a Farm and a Farmer in Agricultural Statistics in the West Indies.” *Social & Economic Studies*, **8**, 190–196 (1959). (Institute of Social & Economic Research, University College of the West Indies, Jamaica.)

JONES, T. A., and MALIPHANT, G. K. “Yield Variations in Tree Crop Experiments with Specific Reference to Cacao.” *Nature, Lond.*, **182**, 1613–1614 (1958).

JONES, T. A. “Land-use in the Caribbean; Advances During the Last Twenty-Five Years Towards a Scientific Policy.” *Emp. J. exp. Agric.*, **26**, 293–297 (1958).

MURRAY, D. B. “Response of Cacao to Fertilisers.” *Nature, Lond.*, **182**, 1613 (1958).

MURRAY, D. B. “Deficiency Symptoms of the Major Elements in the Banana.” *Trop. Agric., Trin.*, **36**, 100–107 (1959).

MURRAY, D. B., FRAMPTON, A. DEK., *et alia*. “Report and Recommendations for the Development of St. Vincent.” pp. 125 (1959). (Advocate Co. Ltd., Barbados.)

NICHOLS, R., and DUDMAN, W. F. “Absence of Gibberellin-like Substances in Filtrates of *Marasmius perniciosus* Stahel (Witches’ Broom Disease of Cacao).” *Nature, Lond.*, **183**, 899 (1959).

SHEPHERD, K. Two New Basic Chromosome Numbers in the Musaceae. *Nature, Lond.*, **183**, 1539 (1959).

SIMMONDS, N. W. “Bananas,” pp. 446 (illus.). Longmans, Green, London. 45s.)

SIMMONDS, N. W. “Experiments on the Germination of Banana Seeds.” *Trop. Agriculture, Trin.*, **36**, 259–273 (1959).

SMITH, G. W. "The Determination of Soil Moisture under a Permanent Grass Cover." *J. geophys. Res.*, **64**, 477-483 (1959).

WATSON, J. P., SPECTOR, J., and JONES, T. A. "Soil and Land-use Surveys No. 3, St. Vincent," pp. 70 (with maps). (I.C.T.A., Trinidad, W.I. 25s.)

VERNON, K. C., and JONES, T. A. "Soil and Land-use Surveys No. 4, Parish of St. Andrew, Jamaica," pp. 28 (with maps). (I.C.T.A., Trinidad, W.I. 12s. 6d.)

STARK, J., RUTHERFORD, G. K., SPECTOR, J., and JONES, T. A. "Soil and Land-use Surveys No. 5, British Guiana," pp. 34 (with maps). (I.C.T.A., Trinidad, W.I. 14s.)

STARK, J., RUTHERFORD, G. K., SPECTOR, J., and JONES, T. A. "Soil and Land-use Surveys No. 6, British Guiana," pp. 24 (with maps). (I.C.T.A., Trinidad, W.I. 15s.)

FINCH, T. F., and JONES, T. A. "Soil and Land-use Surveys No. 7, Parish of Clarendon, Jamaica," pp. 33 (with maps). (I.C.T.A., Trinidad, W.I. 20s.)

### West African Cocoa Research Institute

155. The promising results obtained in 1958-59 in the control of mealybugs, *Pseudococcus njalensis*, by the destruction of the attendant ants have been followed by a steep rise in the incidence of some of the minor pests; in particular wood-boring insects. A new trial has been started in which attempts are being made to control the attendant ants by limiting the spray to a band on the lower trunks of the trees, in the hope that the spray will have a less disturbing effect on the predatory and parasitic insect population.

156. Field tests have been commenced using a series of systemic insecticides for the direct control of mealybugs on the trees. The two most promising appear to be Rogor 40 and Metasystox.

157. Field trials on capsid control which have been carried out for two seasons, using Endrin, Dieldrin, Aldrin, Gammalin and Malathion, have shown that Dieldrin is unsuitable, particularly because of its effect on *Marmara* and other minor pests, and Malathion gives unsatisfactory capsid control. Endrin, Gammalin and Aldrin all give satisfactory capsid control. Endrin is significantly better than Gammalin; Aldrin is less effective than Gammalin, but the differences between the two are barely significant.

158. The first field-scale trials of cocoa varieties bred specifically for resistance and tolerance to infection with swollen shoot virus have been planted. There are a number of types that have shown considerable resistance to infection when tested in glass-house tests, and others have been found to be almost completely tolerant. Detailed observations on the WACRI clonal collections of cocoa have shown that some Trinitario clones have considerable field resistance to black-pod infection. Hand-pollinations have been made between resistant and susceptible types to study the inheritance of resistance to infection.

159. A gall-forming disease of cocoa that occurs rarely in Ghana and other West African territories, appears to be similar to "cushion gall" or "buba" disease that is causing serious damage in Costa Rica and other

cocoa producing countries of Central America. The cause of the American disease is still unknown, but that in Ghana has been transmitted experimentally to seedlings by inoculating dissected cocoa beans; the pathogen is a bacterium similar to or identical with *Agrobacterium tumefaciens*.

160. The shade and fertiliser experiments continue to give large crops and to yield interesting results. One experiment in which Amazon cocoa has been established with only temporary shade yielded up to 2,000 lbs. of dry cocoa per acre in its third year after planting, the first season in which it had been completely de-shaded.

### West African Institute for Oil Palm Research

#### *Agronomy Division*

161. The main practical problems of how to raise nursery seedlings and how to transplant to the field have now been solved, but the improved nursery techniques have themselves given rise to other problems. One-year-old seedlings are now rather too large to be handled conveniently at transplanting and when planted at the previous standard distance of 2 ft. × 2 ft. they tend to be drawn-up and etiolated. In addition, plants so closely spaced are more subject to *Cercospora* leaf spot. Trials have now shown that spacing at 2½ ft. provides much stockier seedlings and disease is more easily controlled.

162. Mulching and irrigation experiments in the nursery have continued and the value of a bunch refuse mulch applied throughout the season has been confirmed; roofing felt has also been shown to be a satisfactory mulch while grass and palm fronds have not been so satisfactory. Irrigation needs throughout the dry season have been studied by the use of tensiometers and although this work is not yet complete it has been shown that irrigation water applied at the rate of 2 inches per week maintains the soil at near field capacity while under only 1 inch of irrigation water per week the soil dries out considerably between applications.

163. Work on the establishment of dry-season nurseries has now reached the stage where they can be recommended in most parts of West Africa. With the introduction of two nurseries per year it is now possible to accumulate seed for only 5 to 7 months instead of 12 months as previously. Loss of viability is therefore reduced and the production of much larger numbers of seedlings from a given quantity of seed is possible. Control of Blast in the dry-season nursery has been obtained by shading the individual plants.

164. A general review of the work carried out in recent years on transplanting methods was published in the Institute's Journal. Present work is confined to investigations of methods of nitrogen manuring shortly after transplanting, of methods of root pruning and of dealing with very large seedlings. It has been shown that root pruning is as desirable with seedlings from the dry-season nursery as with those from the main nursery.

165. Field experiments on pruning, manuring, spacing, inter-cropping and the combining of planting palms with annual crop rotations are continuing. The results obtained so far from manurial experiments have recently been reviewed and a new fertilizer experiment programme, which takes account of the work recently done in the Soil Chemistry and Plant

Nutrition Divisions, has been started. This programme allows for different rates of application so that optimum rates under various soil conditions may be determined. Particular attention is being given to magnesium and phosphorus, and provision is made in the experiments for the testing of other elements at a future date. For the first time in West Africa a really substantial response to phosphorus has been obtained, a 50 per cent. increase in yield due to phosphorus appearing in an experiment at Aiyimasi in Ghana in its first year. This increase was again significant in the second bearing year although it was slightly less pronounced. There are also indications that phosphorus is going to be required in other parts of West Africa.

#### *Engineering Division*

166. The main lines of work being carried out in this Division concern (1) Hand processing methods, (2) Bleachability, and (3) Improvement of the Pioneer mill. A systematic investigation of all the factors likely to influence bleachability is being undertaken and it has already been shown that there are marked progeny differences and that extraction methods and extraction rates influence the bleachability of the resulting oil. Good progress has been made with the testing and adapting of a handpress obtained from a Dutch firm. For large scale milling the problem of continuous clarification is still being pursued and sterilisation techniques are under investigation.

#### *Plant Breeding Division*

167. The new breeding programme started last year and based mainly on *tenera* selfings and crosses has been continued and trials of a large number of promising progenies both from within Nigeria and from abroad are in course of being planted. At the same time considerable attention is being given in the breeding programme to Deli parents and during the 1959 and 1960 planting seasons 29 Deli  $\times$  Deli, 10 Deli  $\times$  *tenera* and 5 Deli  $\times$  *pisifera* progenies have been planted. The Deli  $\times$  *pisifera* cross is regarded as a particularly promising source of *tenera* palms for the production of both oil and kernels.

168. Seed production for distribution is now limited to the *dura* or Deli *dura*  $\times$  *pisifera* cross giving only *tenera* progenies, and seed being issued by the Institute is divided into three grades, the first grade being produced entirely from parents proved by their progenies.

169. Attention is being given to a number of genetical problems of which the most important is that concerning the connection between shell thickness and the fertility of the *pisifera* parent.

#### *Plant Nutrition Division*

170. In the leaf analysis laboratory work on analysis techniques is now complete and a study is about to be undertaken of the most satisfactory sampling procedure for leaf analysis. Although leaf analysis has been used in several parts of the world as a basis for fertilizer recommendations no proper sampling technique has anywhere been worked out for the oil palm. It is considered that this fundamental information should be obtained before any other analysis work is undertaken.

171. In pot culture work further progress has been made in determining the deficiency symptoms of the micronutrients. Symptoms of boron and manganese deficiency have now been confirmed but attempts to induce symptoms of copper and zinc deficiency have so far failed.

*Plant Pathology Division*

172. Details of the mycological work carried out in the diagnosis of Blast disease have now been published. The disease has been shown to be due to co-infection by *Rhizoctonia lamellifera* and a *Pythium* species. Field experiments have now confirmed that the application of irrigation water in August and September reduces the incidence of Blast during the following dry season.

173. Freckle (*Cercospora elaeidis*) has been increasing in nurseries and in fields of young palms in recent years and, although certain organic fungicides have exercised partial control, means of completely controlling the disease have not been obtained and further work is required.

174. A review has been undertaken of the literature on Little Leaf disease and it has been shown that two distinct diseases in fact exist. Experiments have shown that in Little Leaf with a spear rot the original infection takes place well up the spear leaf and not in the bud; if the spear is cut off below the seat of infection "little leaves" do not subsequently develop. The initial cause of the rot in the spear has not yet been determined, however.

175. During 1959 a new disease of young palms just coming into bearing was reported from an estate and has been shown to be due to *Ceratocystis paradoxa*. The disease causes a dry rot at the base of the stem. Careful surveys are being carried out in the diseased area and a watch is being kept for the possible appearance of cases elsewhere. It has been shown that recovery can take place even from quite severely attacked palms. The disease has been named Dry Basal Rot.

*Plant Physiology Division*

176. Further work on temperature effects on the germination of oil palm seed has shown that it is not necessary for the seed to be moist during the high-temperature period of 80 days at 39.5°C. A high germination percentage can be obtained when air-dried seed which has been subjected to this high temperature is subsequently maintained at ambient temperature at the optimum moisture content for germination. This discovery may have considerable influence on future methods of seed distribution. The germination of seed in polythene bags is proving very satisfactory.

177. A full scale seed storage experiment designed to determine the optimum conditions of moisture and temperature for storage is now under way. The methods of preparation of seed for storage is also under examination following some rather poor germination results from one of the Institute's seed producing stations.

178. The work on stomatal movement in the oil palm is shortly to be published in full. Growth analysis of nursery seedlings has been in progress.

*Soil Chemistry Division*

179. In previous work on the acid sand soil the exchangeable potassium<sup>2</sup>/total exchangeable bases was found to be the most useful factor

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in determining deficiency levels for potassium while it was believed that the controlling factor in magnesium deficiency was the exchangeable magnesium/potassium ratio. More detailed work is however now being carried out on cation activity ratios since it is believed that the controlling factor for potassium may be the ratio  $(\text{activity of potassium})/\sqrt{(\text{activity of calcium plus magnesium})}$ . The rôle of calcium is being investigated further, in conjunction with the Plant Nutrition Division, in pot work with soils. A start has been made on testing analysis methods for phosphorus. Work on soil nitrogen in Sierra Leone was discontinued in December.

#### *Statistics Division*

180. A paper on the two uniformity trials at the Institute's Main Station has now been completed for publication. Two years planting has been undertaken in the Calibration Trial which is designed to enable comparisons to be made of palms of different ages independently of climatic variations and will make possible the determination of the effect of climate independently of age.

181. Considerable progress has been made in the collection of meteorological data and this will be of value in the growth analysis studies carried out in the Plant Physiology Division. In particular, much more extensive data is being collected on soil temperature, evapotranspiration and solar radiation.

#### *Publications*

BULL, R. A., and ROBERTSON, J. S.—(1959). "The problems of 'Little Leaf' of oil palms—A Review." *J.W. Afric. Inst. for Oil Palm Res.* **2**, 331.

CROMBIE, W. M.—(1959). "Seed metabolism in the West African Oil Palm (*Elaeis Guineensis*): Part IV. Respiration in the developing seed." *J.W. Afric. Inst. for Oil Palm Res.* **3**, 96.

HUSSEY, G.—(1959). "The germination of oil palm seed: experiments with *tenera* nuts and kernels." *J.W. Afric. Inst. for Oil Palm Res.* **2**, 331.

KOWAL, J. M. L., and TINKER, P. B. H.—(1959). "Soil changes under a plantation established from high secondary forest." *J.W. Afric. Inst. for Oil Palm Res.* **2**, 376.

REES, A. R.—(1959). "The germination of oil palm seed: the cooling effect" *J.W. Afric. Inst. for Oil Palm Res.* **3**, 76.

REES, A. R.—(1959). "The germination of oil palm seed: large scale germination." *J.W. Afric. Inst. for Oil Palm Res.* **3**, 83.

ROBERTSON, J. S.—(1959). "Blast disease of the oil palm: its cause, incidence and control in Nigeria." *J.W. Afric. Inst. for Oil Palm Res.* **2**, 310.

ROBERTSON, J. S.—(1959). "Co-infection by a species of *Pythium* and *Rhizoctonia lamellifera* Small in Blast disease of oil palm seedlings." *Trans. Brit. Myc. Soc.* **42**, 401.

SPARNAAIJ, L. D., and GUNN, J. S.—(1959). "The development of transplanting techniques for the oil palm in West Africa." *J.W. Afric. Inst. for Oil Palm Res.* **2**, 281.

TINKER, P. B. H.—(1959). "Soil heterogeneity and sampling procedure under oil palms." *J.W.Afric. Inst. for Oil Palm Res.* **3**, 7.

TINKER, P. B. H.—(1959). "The rapid determination of exchangeable calcium and magnesium in highly leached soils." *Analyst*, **84**, 743.

TINKER, P. B. H., and ZIBOH, C. O.—(1959). "Soil Analyses and fertilizer responses." *J.W.Afric. Inst. for Oil Palm Res.* **3**, 52.

TINKER, P. B. H., and ZIBOH, C. O.—(1959). "A study of some typical soils supporting oil palms in Southern Nigeria." *J.W.Afric. Inst. for Oil Palm Res.* **3**, 16.

### III. RESEARCH BASED IN THE UNITED KINGDOM

#### *Commonwealth Mycological Institute*

182. Over 1,600 identifications have been made this year of material sent from the following territories: Bechuanaland Protectorate, British Guiana, British Solomon Islands Protectorate, Cyprus, Fiji, Gambia, Hong Kong, Jamaica, Kenya, Mauritius, Nigeria, North Borneo, Rhodesia and Nyasaland, Sarawak, Seychelles, Sierra Leone, Southern Cameroons, Tanganyika, Trinidad, Uganda, and Zanzibar. This is an increase of 700 over last year.

183. Important records include *Chloridium musae* and *Piricularia musae* on banana in the Cameroons; *Ramichloridium musae* on banana in Sierra Leone and the British Solomon Islands Protectorate; *Cladosporium colocasiae* on *Colocasia esculenta* in North Borneo, Sarawak and Mauritius; *Mycosphaerella alocasiae*, which seems to be quite common, *Cercospora fuliginea* causing brown leaf mould of tomato, *Elsinoe fawcettii* on Citrus, *Cercospora koepkei*, *Leptosphaeria michotii*, and *Glomerella tucumanensis* on sugarcane in the British Solomon Islands Protectorate; *Mycosphaerella musicola* on banana in Mauritius; *Fusarium oxysporum* on banana in Kenya; *Pseudoplea trifolii* prevalent in Northern Nigeria and numerous new records of the same fungus from Nyasaland, Sarawak, etc.; *Glomerella vanillae* again in the Seychelles.

184. Mr. Deighton has continued his studies of West African fungi with special reference to *Cercospora* and allied genera and has assisted in the compilation of a list of plant diseases in Sierra Leone.

185. A revised list of plant diseases in Tanganyika by E. A. Riley, published as *Mycological Paper* No. 75 of this Institute, contains numerous records of organisms identified or checked at the Commonwealth Mycological Institute. Specimens from different colonial territories are retained in the herbarium for reference. A new bacteriology Department has been started and bacteria as well as pathogenic fungi are now being identified.

186. A detailed investigation, initiated in Trinidad by Dr. A. C. Hayward, the bacteriologist, of *Pseudomonas solanacearum* has been continued. A sudanophilic substance, poly- $\beta$ -hydroxybutyric acid, found only infrequently in pseudomonads, is present in all authentic cultures of the bacterium examined by him and is easily detected by a simple staining method. It

is thought that this may provide a new and rapid technique for the identification of this common and serious tropical pathogen.

187. Assistance is being given to Mauritius in the differentiation of strains of *Xanthomonas vasculorum*, the cause of gumming disease in sugarcane.

188. Numerous plant pathologists from colonial territories visited the Institute, but none worked for any appreciable length of time as in the past.

189. Mr. R. W. Rayner, under a C. D. & W. scheme, spent the year writing up the results of his researches on coffee in Kenya in a series of papers for publication.

#### *Pool of Plant Pathologists*

190. Mr. Holliday has continued his work on *Phytophthora* foot-rot of pepper (*Piper nigrum*) in Sarawak. Two of the introduced Indonesian varieties have shown considerably more resistance than the local varieties, with Indian introductions intermediate. Field trials have shown that young pepper vines are as susceptible as mature ones and that spread of the disease can be checked by the application of cuprous oxide drenches.

191. The suspected virus disease of pepper recorded last year has been shown to be due to that cause and named Pepper Stunt Virus disease. The results of transmission experiments were published in *Phytopathological News*, 5 (1959) 49-52.

192. Dr. Wheeler has confirmed that wither tip (*Gloeosporium limeticola*) of limes in Zanzibar can be economically controlled by spraying with 3 lb. : 100 gals. water of kramsol (phenyl mercury nitrate), provided the applications are correctly timed. Captan was also effective but too expensive. Seven other fungicides tested were ineffective. Owing to the poisonous nature of mercury salts, investigation of spray residue has been kindly undertaken by Professor H. G. H. Kearns of Bristol University. Fertiliser trials have shown an increase in shoot growth due to nitrogen and a reduction due to potassium, but no direct response in disease severity. Investigations on the spread of the disease in a plantation are continuing.

#### *Commonwealth Institute of Entomology*

193. The Institute continues to remain in close touch with entomologists working in the Colonial territories, a number of whom worked for short periods in the library or, under the aegis of the Institute, on taxonomic problems at the British Museum (Natural History). The identification service constitutes an especially important link with Colonial territories, on behalf of which, in 1959-60, over 18,000 specimens were received and some 2,700 identifications sent out. The taxonomic papers published by members of the staff included an important study of the mealybugs of the Solomon Islands. *The Bulletin of Entomological Research*, Vol. 50 (1959) published a total of 36 papers dealing with work carried out in the Colonial territories, and continues to provide a useful medium for the publication of the longer and more important accounts of such research.

#### *Pool of Entomologists*

194. Mr. E. S. Brown remained on secondment to the Foreign Office for work, under the Economic Aid Agreement of the Central Treaty

Organisation, on the sunn pest complex (*Eurygaster* and *Aelia*) in the Middle East. The three principal papers describing the results of his work on the immature nutfall of coconuts in the Solomon Islands were published in the *Bulletin of Entomological Research* during 1959.

195. Mr. C. R. Wallace returned from St. Helena in December, 1959, and has since been occupied at the Institute in working over the considerable amount of insect and other material amassed during his survey of the Island's pests, and in writing the report on the latter.

196. Dr. I. W. B. Nye completed his report on the insect pests of graminaceous crops in East Africa, which is now in the press, and was posted to the Seychelles for approximately one year to assess the results of the extension campaign against *Melittomma insulare* on coconuts that resulted from Mr. F. S. Brown's earlier investigation. He has initiated an improved method of treating infested palms, using a creosote/coal-tar mixture, which has been applied to the whole palm population on Praslin Island and is now being extended to the main island, Mahé.

#### *Termite Research Unit*

197. This small Unit of three research officers is based on the British Museum (Natural History). During the past year one officer continued to work at Samaru in Northern Nigeria on a survey of the termites of that region. This work in Nigeria ended in March, 1960. The work at the British Museum is mainly basic taxonomic study which is an essential background to an understanding of the problems of termite control, but the Unit also deals with a large number of enquiries about protection from termite attack. A feature of special note is the growing interest in universities and research institutes.

198. The Unit is receiving many enquiries relating to termite protection of a great variety of materials and structures, many related to United Kingdom exports.

199. The number of identifications made during the year, excluding specimens collected by the Unit, was 89, involving the examination of 218 tubes of specimens. They originated in East Africa, Northern Rhodesia, West Africa, Ethiopia, Sudan, St. Helena, Ascension Islands, Saudi Arabia, Persia, India, Malaya, Singapore, Indonesia, Dutch New Guinea, Costa Rica and Surinam. Among the large collections were those from the Forest Entomologist, Uganda; Forest Entomologist and Rubber Research Institute, Malaya; Division of Entomology, Pretoria; and Dr. L. G. E. Kalshoven, Holland.

200. New and unusual records include a new species of *Eremotermes* from maize roots in the Sudan, *Nasutitermes nigriceps* attacking sugarcane in Costa Rica, *Cryptotermes cynocephalus* in timber at Amsterdam, *Coptotermes formosanus* (dead) in cotton goods arriving in the U.K. from the Far East.

201. Dr. W. G. H. Coaton worked in the Museum during May as part of an overseas tour under the auspices of the Nuffield Foundation. In return for specimens from the Unit's African collection, he arranged the exchange of valuable material from Pretoria. This includes a number of Fuller's co-types and a general collection from Northern Rhodesia.

202. Mr. Sands, stationed at Samaru, made an extensive tour of Ghana over a period of two months, in order to compare the termite fauna and problems with those of Nigeria. Field observations on agricultural problems in termite control in Nigeria have been supplemented by replies received to a questionnaire sent to provincial agricultural officers, mainly in those areas which it has not proved possible to visit. Suggestions for control measures have been made.

203. Research on termite control in eucalyptus plantations has continued. Field trials carried out in co-operation with the Forest Department on the Jos Plateau have been supplemented by work at Samaru on the persistence of insecticides in soil exposed to weathering, on tests of the toxicity of treated potting soils, and by investigation of colony variation in the susceptibility of *Trinervitermes* to low doseages of dieldrin. The results obtained so far in preventing termite damage in the field have led to similar methods being adopted by the sponsors of a large mines reclamation scheme on the Jos Plateau. Further studies have been made on the biology of *Trinervitermes ebenerianus*, the termite which is being used for assay work on toxicity in soils.

204. Mr. Harris visited Nyasaland in February. The timing of the visit was unfortunate in view of the local preoccupation with political matters. It is hoped that, in due course, the Unit may be of practical assistance to the Forest Department with their problem of establishing eucalyptus plantations. There is a considerable amount of damage done to public and private buildings by subterranean termites.

205. Information and advice was sought by Industry on a variety of economic aspects of termite biology. More queries come from manufacturers of products which it was an advantage to have considered "termite proof", than from consumers or the makers of insecticides. For example, we were asked by a manufacturer of prefabricated wooden buildings for assistance in convincing a Government Department that such buildings could be made termite proof. Other points raised included the question of facilities for laboratory and field testing, and measures for termite proofing of composite boards, kitchen cabinets, leather belting, and butyl rubber sealing compound. Two cases where imported cotton goods arrived in the U.K. in a damaged condition were shown to be due to termite attack in the country of origin. Information was also supplied on insecticides suitable for soil treatment in Malaya, control of termites in buildings in Bermuda and the Middle East, and sources of live termites in Europe. Two film units interested in photographing damage to buildings and to crops were advised. Suggestions for control measures in buildings overseas were given to the Ministry of Works. Colonies of living termites have been maintained. *Zootermopsis* cultures have been supplied to a number of Universities.

206. An investigation into the effects of methyl bromide fumigation on termites has been started at our request by the Pest Infestation Laboratory. For the initial series of tests we supplied *Kaloterme jouteli*, *Zootermopsis angusticollis* and *Reticulitermes lucifugus*. The results obtained so far have been used in making recommendations for the fumigation of buildings in Singapore.

207. Lectures on the prevention of termite damage to buildings were given by Mr. Harris at the Building Research Station course for overseas architects and civil engineers, and in the Tropical Department of the Architects Association School of Architecture. A talk was given in the World of Science series of the B.B.C. Overseas Service to Asia, and this was later repeated to the Caribbean. Specimens illustrative of termite damage to materials was lent for an exhibition organised by the Ministry of Supply, packaging branch. Mr. Harris represented the Commonwealth Institute of Entomology at a meeting of a British Standards Institution committee on the testing of wood preservatives against insect attack.

208. Arrangements have been made for a study of termites damaging Pitch Pine in British Honduras and Mr. R. M. C. Williams left the U.K. in March. It is anticipated that Mr. Williams will spend three years in the field in Central America studying the biology of *Coptotermes niger* in natural forests and in plantations, and collecting information on termites generally.

#### *Publications*

WILKINSON, W.—“Four new species of Kalotermitidae from East Africa.” *Proc. R. Ent. Soc. Lond.*, (B) **28**, 61–72.

HARRIS, W. V.—“Notes on Termites injurious to Forestry in British Honduras.” *Emp. For. Rev.* **38**, 181–185.

SANDS, W. A.—“Revision of the Termites of the genus *Amitermes* from the Ethiopian Region.” *Bull. B. M. (N.H.) Ent.* **8**, 129–156.

WILLIAMS, R. M. C.—“Flight and colony foundation in two *Cubitermes* species.” *Insectes Sociaux.* **6**, 203–218.

WILLIAMS, R. M. C.—“Colony development in *Cubitermes ugandensis*.” *Insectes Sociaux.* **6**, 291–304.

HARRIS, W. V.—“Further records of East African Termites, III.” *Proc. R. Ent. Soc. (B).* **29** (1959), 17–21.

#### *Commonwealth Institute of Biological Control*

209. Work on problems of importance to Colonial Territories has been carried out in 1959–60 at Californian, Indian and West Indian Stations for Barbados, Bermuda, Dominica, Jamaica, Mauritius and Seychelles. Visits were paid by the Director to Barbados, Bermuda, Fiji and Trinidad, and by Mr. F. D. Bennett to Barbados, Bermuda and Jamaica.

210. In Barbados, in connection with the control of *Diatraea saccharalis*, emphasis is now being shifted from the mass-releases of *Trichogramma minutum* to the establishment of larval parasites, and promising recoveries have been made of *Lixophaga diatraeae*, of which several “strains” are being investigated and tried.

211. In Bermuda additional predators have been tried against the two scales *Pseudaulacaspis pentagona* and *Pulvinaria psidii*. An additional serious pest has now appeared in Bermuda attacking Casuarinas and our West Indian Station is investigating the possibilities of biological control. The nymphal parasite *Carbunia myersi* is being liberated and research for additional parasites carried out.

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212. At the European Station investigations have been made to find suitable biological agents to control fennel, *Foeniculum vulgare*, in Bermuda, where it is becoming increasingly abundant.

213. Parasites and predators of the mealy-bug, *Pseudococcus adonidum* have been sent to the Seychelles from the Californian Station.

214. From this Station also a survey of natural enemies of *Aenolamia* spp. has been made in Mexico. Unfortunately no species of interest either to Trinidad or British Guiana were obtained.

215. Further investigations of the coffee leaf-miner, *Perileucoptera coffeella*, have been made on behalf of Dominica, and some parasites obtained from East Africa. This work is hampered by the danger of introduction of the coffee leaf-rust, *Hemileia vastatrix*. Additional shipments of predators of the banana borer, *Cosmopolites sordidus*, have been made both to Dominica and to Mauritius.

216. From the West Indian Station investigations have been carried out in Jamaica on the natural enemies of the West Indian cane-fly, *Saccharosydne saccharivora*. Further work has been done in the West Indies for Mauritius on the natural enemies of pod-borers of the pigeon-pea, *Cajanus cajan*.

217. At the Indian Station investigations of parasites of sugar-cane borers have resulted in the shipment to Mauritius for trial against *Proceras sacchariphagus* of the parasites: *Tatrastichus israeli*, *Elasmus zehntneri*, *Glyptomorpha (Stenobracon) deesae*, *G. nicevillei*, *Mibrobracon chinensis*, *Xanthopimpla* sp., and also egg-parasites, *Telenomus* spp.

218. Most recent reports from Nevis indicate that *Cactoblastis cactorum* has given excellent control of *Opuntia* spp. in some areas, and that its effect is becoming more widespread. Other neighbouring islands are now interested in the introduction of *Cactoblastis*.

219. In Fiji *Tetraeuaesta obscuriventris*, introduced from Trinidad against tobacco weed, *Elephantopus mollis*, is now extremely abundant and it is hoped that an assessment can soon be made of its effect on the weed.

#### *Pest Infestation Laboratory, Tropical Liaison Section*

220. During the year the Pest Infestation Laboratory was transferred from the Department of Scientific and Industrial Research to the Agricultural Research Council. The Committee is grateful for the help received in the past from the D.S.I.R. and from the Director and staff of the Laboratory. The Colonial Liaison Officer, who is housed at the Laboratory, has found that his work continues to widen and that assistance continues to be sought from territories which have become independent. The Laboratory, on its side, has felt the need to extend its work overseas where many infestation troubles have their origin. The former colonial section has, therefore, been re-named the "Tropical Liaison Section" and has been so organised that its work can embrace territories not under the Colonial Office. The aims of the Tropical Liaison Section are to be knowledgeable about post-harvest problems in the tropics, particularly in British Colonies, to promote improvements in the handling and storage of produce in the Colonies and to disseminate information on the subject overseas; to keep abreast of relevant research on the subject; to encourage

investigation of overseas problems in the United Kingdom or elsewhere and to carry out appropriate *ad hoc* investigations in the Laboratory or elsewhere.

221. Progress has been made in the achievement of these aims by visits to overseas territories, maintaining personal contact with the administrative and technical people concerned, by discussions in the U.K. with commercial organisations and through the active collaboration of the scientists in U.K. organisations involved in investigations of many aspects of post harvest problems. It is encouraging to be able to record an increase in the number of visits paid by members of the staff of the Laboratory to overseas territories.

222. It has been found desirable to strengthen the liaison with the Colonial Office and the Tropical Products Institute. This now requires the full-time attention of the Tropical Stored Products Liaison Officer during two days a week. The Tropical Products Institute has an increased interest in stored products problems.

223. Certain aspects of post-harvest problems are of interest to the Building Research Station (D.S.I.R.) and the National Institute of Agricultural Engineering and their advice is sought on problems concerning the handling and drying of produce. The staff of the Tropical Liaison Section has been increased by the appointment of a chemist at the Tropical Products Institute to carry out analyses of insecticidal residues in produce from overseas territories.

224. Special courses of instruction in the United Kingdom of up to six months duration, were arranged with the collaboration of several Government departments for nine officers representing Antigua (1), Cyprus (3), Ghana (1), Nigeria (1), Sierra Leone (1), Jamaica (1), and Trinidad (1). Two Colonial Food Storage Courses on insect and rodent problems, held at the Ministry of Agriculture, Fisheries and Food, were attended by nine officers from Cyprus, Fiji, Ghana, Kenya, Mauritius and Nigeria.

225. During the year there have been reports from a number of territories about experimentation in the use of insecticides and fumigants. The stored product workers in Jamaica, Uganda, Kenya, Southern Rhodesia, Ghana and Nigeria have been particularly active in this field of work. Malathion applied as a water-dispersible powder on stacks of bagged produce is proving successful against *Tribolium* spp., *Oryzaephilus* spp. and certain moths. Useful information is being accumulated on its lasting toxicity under tropical conditions. Lindane is still widely used and continues to be a very useful insecticide. Pyrethrum applied either as a dust or as an oil-based spray continues to be used for special problems and field testing work is being carried out in West Africa, particularly in Ghana. Methyl bromide continues to be the fumigant most often used but in some territories the chlorinated hydrocarbons (ethylene dichloride and carbon tetrachloride) are being considered more than in the past. Phostoxin is used to a limited extent.

226. Insecticidal dusts are used either admixed with the produce (e.g., pulses or cereals) or on the outside of each layer of bags as a stack of bagged produce is being built. The latter type of treatment is carried out at present by a variety of locally improvised methods because standard dusting machines tend to disperse a considerable amount of dust into the



atmosphere. A prototype duster designed to minimise this problem has been designed in the Laboratory and is being tested. Many people have expressed their willingness to use it once experience has been gained in practice.

227. With an increase in the use of malathion in overseas territories the Colonial Office Stored Products Sub-Committee has prepared a "Code of Practice" on the use of malathion on stored foodstuffs in Colonial Territories for the guidance of overseas workers. During 1958 recommendations were made on the form which legislation might take in Colonial territories to control the use of methyl bromide and hydrogen cyanide and local action on the suggestions made is being undertaken in Kenya, Nigeria, Northern Rhodesia, Nyasaland, Uganda, and The West Indies.

228. Problems on the suitability of different types of gas-proof sheeting for use in overseas territories continue to arise and on the basis of the work of the Fumigant Section of the Pest Infestation Laboratory the Colonial Office Stored Products Sub-Committee has drawn up Specifications for Fumigant Sheets. These specifications are intended to help users to obtain a standard article which, in the present state of knowledge, appears to be suitable for the purpose. Manufacture has been arranged of the thermal conductivity meter by which concentrations of methyl bromide and other fumigants in the air can be estimated. The commercial availability of this instrument should encourage workers to investigate in some detail the efficiency of distribution of a fumigant under local conditions during practical fumigations.

229. Much thought has been given in the past to the design and construction of bulk stores in comparison with buildings for storage of produce in bags. Requests for advice on the latter aspect continue to be received by the United Kingdom organisations concerned and the Tropical Building Section of the D.S.I.R. has prepared a useful paper on "Buildings for the Storage of Crops in Warm Climates".

230. Increasing attention in overseas territories to the quality of produce inevitably emphasises problems of moisture content and of drying. Advice on the suitability of different methods of measuring moisture content continues to be sought, especially on the efficiency of field methods, with a wide range of produce. The modified type moisture meter for use with copra has been developed further. The suitability of this meter under field conditions in a number of territories will be tested in collaboration with the Tropical Products Institute.

231. If produce is to store well it must be dry and therefore methods of drying produce in overseas territories are very important and there are many territories where artificial drying is necessary. A considerable quantity of produce is grown on small farms for which existing driers are too large and expensive. The need for small, robust, efficient and cheap, batch driers has been brought to the attention of commercial organisations. Prototype models are under trial which will be capable of dealing with approximately one ton per day and preferably making use of such products as coconut shell and paddy husk to provide part of the heat requirements. This development is now being pursued in collaboration with the Commonwealth Liaison Officer at the National Institute of Agricultural Engineering.

232. Advice has been sought in relation to condensation problems which have been encountered in bulk stores and in bagged stacks in overseas territories. This is usually caused by convection currents within the produce and the translocation of moisture to the surface where condensation takes place. The possibility of insulating the surface of bulks of produce has been suggested.

233. Assessment of infestation and tolerance levels of infestation for different types of produce are problems on which it is difficult to make satisfactory recommendations because of local factors and different trade practices and standards. It is only possible at present to advise on the methods of inspection in use, to draw attention to the limitations of each of these and to attempt to encourage the examination of produce by methods which give a reasonably clear picture of the actual infestation and of the quality of the produce. Suggestions have been made on the basis of "sequential sampling" and it is hoped that more territories will examine produce in as critical a manner as possible.

234. Problems of the infestation of cocoa by insects and moulds which affect the cocoa trade have continued to demand considerable attention. Assistance has been given to the Ghana Cocoa Marketing Board in experimental work.

235. Mould problems with groundnuts from the Gambia have been investigated jointly by the Pest Infestation Laboratory, the Tropical Products Institute, and the Commonwealth Mycological Institute, and some rather unusual problems arising out of the storage of palm kernels in Sierra Leone have been investigated jointly with the Tropical Products Institute.

236. The World Health Organisation has been aided in their survey of problems of infestation of dried fish and also with regard to the practical problems of fish drying.

237. The correct identification of species found overseas is important and many specimens have been received and named during the year. The result of the recent Japanese investigations on *Sitophilus* spp. have been brought to the attention of a number of overseas workers. Information on rice and paddy problems was collated by the Pool staff and aspects on which research is required were put before the Stored Products Sub-committee.

238. The Literature Survey Officer has compiled a considerable amount of scientific information received in correspondence in an easily accessible reference cabinet and has collated information following requests in correspondence. During the year, the first number of "*Tropical Stored Products Information*" (TSPI) appeared.

#### *Experimental Work*

239. Advice on overseas problems has to be based on research results and, since many of the current problems are new, a considerable amount of experimental work has to be carried out.

240. The behaviour of local strains of insects to chemicals is important in designing control measures. Living material has been obtained from a number of territories to enable a survey to be made of the differences in

resistance to fumigants between different infestations of the same species. In the past experimental results from Laboratory tests have been accumulated but little information is available on how these compare with results under tropical field conditions.

*Tests on paper and other sack linings*

241. These tests are now complete. Eighteen materials and nine species of stored product insects were investigated. None of the materials tested was resistant to penetration by all species of insect. Five-ply kraft paper each ply 37 lb. D.C. was resistant to *Sitophilus oryzae* and *Tribolium castaneum*. Polyethylene-terephthalate (terylene film) was resistant to *Lasioderma serricorne*. Difficulties arise in using such materials under field conditions, particularly the problem of sealing sacks effectively against insect penetration. This is now being investigated in collaboration with a commercial organisation.

*Maize Meal and Wheat Flour*

242. An investigation into the condition of these cereal products as at present marketed in East Africa in regard to "filth contamination" was carried out. Maize has in the past been milled in hammer mills, but during the last six years a number of roller mills have been brought into operation. Maize meal produced on a roller mill contains less fibre than meal from a hammer mill because in the former the husk is removed from the endosperm. The insect fragment count of meal taken from mills showed a reasonably low degree of contamination when the mill was in clean premises, but very high contamination when the premises were dirty (15 as compared to 250 insect fragments for 25 gm.). Wheat flour produced in a modern mill was found to contain up to 1,150 insect fragments in 25 grams. These are high contaminations compared with that which is average in flour milled in the U.K.: about one fragment in 25 grams.

*Biology of Araecerus fasciculatus DeG., a pest of cocoa*

243. Certain aspects of the biology of the cocoa bean weevil have been investigated, particularly in relation to the longevity of the adults and to the effect of relative humidity on rate of development. Adults lived more than twice as long at 90 per cent. R.H. as at 70 per cent. (65 days against 25 days, average figures). The time taken for development from egg to adult was much less at 90 than at 70 per cent. R.H. (64 days against 136, average figures). These results confirm and explain the prevalent opinion that *Araecerus* is mainly a pest of damp cocoa.

*Fumigation of cocoa beans infested with Lasioderma serricorne*

244. *Lasioderma serricorne* is a serious pest of cocoa beans against which it may be necessary to fumigate before export or on arrival in this country. Methyl bromide is the usual fumigant. *Lasioderma* is among the more resistant stored product species, especially at the low temperatures which obtain during fumigations in this country during winter. In such circumstances, a concentration time product of 200 mg/h/1 is recommended for general use and this includes infestations of *Lasioderma*.

*Lindane dusted paddy stored in Trinidad and resistance of Sitophilus sasakii*

245. Four varieties of paddy were mixed with lindane dust and stored in Trinidad for up to twelve months with monthly sampling. Analysis and

examination of the paddy, rice and husk/dust samples showed that the lindane dust had been mixed unevenly. On milling most of the lindane was removed with the husk/dust fraction and very little was left in the rice fraction. Living *Sitophilus* sp. were present in samples of paddy containing 18 p.p.m. of gamma-BHC. Experimental work has shown that the Trinidad strain of *Sitophilus sasakii* survived dosages of 8 and 16 p.p.m. gamma-BHC on paddy at 30°C and 70 per cent. R.H. At the 16 p.p.m. level there was 4 per cent. survival, but at levels of 32 and 64 p.p.m. there were no survivals.

*Maize cobs dusted with lindane in Ghana*

246. In Ghana, over 28,000 four ounce packets of a gamma-BHC dust were sold between September and November, 1958, for dusting maize cobs stored in cribs. The rate of application recommended by the Ministry of Agriculture was equivalent to 12 p.p.m. and it was felt essential to know how much gamma-BHC remained after a few weeks' storage, as the farmer may sell at any time if the price is favourable.

247. Samples of dusted cobs taken after 5, 6, and 7 weeks' storage were found on arrival in the U.K. to contain dead emerging *Sitophilus oryzae* adults. Samples of undusted cobs, on the other hand, had many living weevils. It was clear therefore that eggs had been laid in the cob maize before dusting and that the treatment had been successful in killing the emerging adults.

248. Analysis of the gamma-BHC content indicated that the initial dusting of the cobs had been uneven. Shelled and winnowed grain contained negligible quantities of gamma-BHC.

*Lindane dusted sorghum stored in Northern Nigeria.*

249. In Northern Nigeria guinea corn or sorghum is stored on the stalk in small containers made of mud. The grain becomes badly infested with the moth *Sitotroga cerealella* and an experiment has been started by the Northern Nigeria Department of Agriculture to determine if a low concentration (to give 2 p.p.m.) of gamma-BHC would protect the grain from this moth.

250. The samples of threshed grain examined in England showed about 0.1 p.p.m. gamma-BHC present. Despite this low level, the insecticide appeared to be having some effect on reducing the number of *Sitotroga* adults which emerged, at least during the first few months of storage.

*Publications.*

—Water storage proofing of concrete surfaces for food storage premises. *Crown Agents Rev.*, **24** (1959), 18.

DAVEY, P. M. *et al.*—"The effect of insect infestation on the quality of decorticated groundnuts." *Trop. Sci.*, **1** (1959), 296.

GREEN, A. A.—"The control of insects infesting groundnuts after harvest in the Gambia. 1. A study of the groundnut borer, *Caryedon gouagra* P., under field conditions." *Trop. Sci.*, **1** (1959), 200.

GREEN, A. A. and KEENE, J.—"A comparison of lindane, DDT and malathion for the protection of bagged groundnuts from infestation." *Trop. Sci.*, **1** (1959), 290.

HALL, D. W.—“Storage of produce in the Gambia. *Trop. Sci.*, 1 (1959), 193.

PARKIN, E. A. and SCOTT, E. I.—“The germination of food crop seeds stored in contact with lindane and DDT dusts.” *Trop. Sci.*, 1 (1959), 206.

PREVETT, P. F.—“A study of rice storage under Tropical conditions.” *J. Agric. Enging. Res.*, 4 (1959), 243.

PREVETT, P. F.—“The oviposition and duration of life of a small strain of the rice weevil, *Calandra oryzae* L. in Sierra Leone. *Bull. ent. Res.*, 50 (1960), 697.

PREVETT, P. F.—“An investigation into the storage problems of rice storage in Sierra Leone.” *Col. Res. Study*. No. 28 (1959).

WHISTON, A., HAY, R. J. and RAYMOND, W. D.—“The effect of storage for different periods of time in Nigeria and the quality of groundnuts with special reference to their value for the manufacture of protein fibres.” *Trop. Sci.*, 1 (1959), 149.

#### *Floras*

251. Work on a number of Floras was continued and the Committee was able to assist this basic botanical study in several ways. There were further additions to the working herbarium of the *Bechuanaland* Department of Agriculture. In *Bermuda* a collection was made of endemic flowering plants and ferns, some of which appear to be on the point of extinction. In *British Guiana* a botanist from Kew undertook a survey of the flora of the Intermediate Savannahs, where toxic plants have been suspected of causing liver cirrhosis in cattle. Attention was also given to the Georgetown herbarium. The publication of the “Check List of the Forest Flora of Northern Rhodesia” was well advanced. The herbarium of the Federal Forest Department in *Nigeria* has been rehoused in the new building of the Department, which also provides laboratories for plant physiology and forest soils studies. The post of Forest Botanist in *North Borneo* was filled during the year and work on the Dipterocarps resumed. The herbarium now contains over 15,000 specimens. Work on the heavy-wooded species of *Shorea* and *Hopea* was directed towards finding a more satisfactory classification than the rough system now in use for timber. Further progress was made on the description of the North Borneo Dipterocarpaceae, of which between two and three hundred species occur in the Colony. A grant was made to the Government of *Sarawak* for rehousing the herbarium collections which contain many valuable species, including types. Pending transfer of collections to the new building, work was continued on re-mounting old specimens and in building up material by exchanges for a study of the Dipterocarpaceae. A catalogue of the flora of the peat swamps of *Sarawak* and *Brunei* was completed. The work of the *East African Herbarium* is referred to in paras. 65 and 66 but the existence of three separate herbaria in *Uganda* may be mentioned here. These three herbaria serve different departments, agriculture, forests and Makerere College, each emphasising different aspects of the flora. The Committee discussed the advisability of combining these for economy and efficiency and hoped that this could be effected. Work on other floras, including those of *Swaziland*, *Trinidad* and *Jamaica* was continued. The

major floras, to which C. D. & W. contributions are made are separately reported below.

#### *Flora Zambesiaca*

252. The first part of Vol. I of this Flora was published in January 1960. Work is well advanced on further parts, Part 2 of Vol. I being in the press. Further collections were made in the area covered by this flora and much assistance was received from the Governments of Portugal and Southern Rhodesia.

#### *Flora of Tropical East Africa*

253. The preparation of the Flora has continued satisfactorily during the year, and the number of families published at the end totals 25. The largest and most important part yet published is the "Leguminosae: Mimosoideae", prepared by Mr. J. P. M. Brenan, containing some important genera of timber trees together with the account of *Acacia* (a tree so characteristic of much of East Africa) in which 63 species are described and their differences contrasted in an excellent key. Co-operation with the British Museum (Natural History) has resulted in the appearance of the "Droseraceae" by Mr. J. R. Launden.

254. The preparation of the MS. of "Convolvulaceae" by Dr. B. Verdcourt, of "Araliaceae" by Mr. J. R. Tennant and "Aizoaceae" by Mr. C. Jeffrey was completed during the year, whilst Miss S. Carter has written the accounts of several small families in the Monocotyledons. Messrs. Brenan and Gillett have made good progress with the remaining sections of the "Leguminosae" and Dr. G. P. DeWolf has almost completed his account of "Capparidaceae", Dr. E. Launert (of the Flora Zambesiaca team) the "Malpighiaceae" and "Zygophyllaceae", Professor G. Cufodontis (of Vienna) the "Pittosporaceae", and Mr. J. H. Hemsley (of the Nature Conservancy) the "Sapotaceae". Mr. Jeffrey was, at the end of the year, finishing his researches on Cucurbitaceae, whilst Mr. P. R. O. Bally, assisted by Miss Carter, carried out some preliminary work on the succulent species of Euphorbiaceae, and Mr. V. S. Summerhayes started on the Orchidaceae. Mr. P. Raylor, continuing his researches on African *Utricularia*, visited both the Paris and Geneva Herbaria in October.

#### *Flora of West Tropical Africa*

255. Work on the revised edition of the Flora of West Tropical Africa made considerable progress during 1959. Attention was centred on Volume 2 which will conclude the Dicotyledons; the final volume (Vol. 3) will deal exclusively with Monocotyledons. This will mean that the Revised Edition when completed will consist of three volumes (Vol. 1 with 2 parts), compared with the 2 volumes (of 2 parts each) in the first edition.

256. "The Ferns and Fern-Allies of West Tropical Africa" by the late Mr. A. H. G. Alston was published in October, 1959. This is a supplement to the Flora itself and is the first complete account of the ferns for the whole region of West Africa.

#### *Flora of Cyprus*

257. Circumstances have called for a departure from the usual programme and instead of completing the Violaceae and Cisteraceae and other

early families of *Polypetalae*, as intended, a revision of the Convolvulaceae was prepared, the final drafts of which are now almost complete.

*Statistics, Rothamsted Experiment Station*

258. By arrangement with the Director and Head of the Statistics Department, facilities are made available to colonial territories for the handling of statistical problems, processing of difficult or bulky data and for training. A great variety of problems are handled in this way which it would be impossible to cope with overseas and it is thereby made possible to improve standards of experimentation and to derive the maximum amount of information from data collected.

259. Throughout the year A. J. Vernon continued to be primarily responsible for this work, again in consultation with other members of the Department on specific problems, in particular with H. D. Patterson (rotation and other long-term experiments), B. M. Church (surveys and sampling problems) and H. R. Simpson (work involving insect populations).

260. The total time given by members of the Department to this work was appreciably higher than in the past year because in addition to a somewhat increased number of requests for advice and no decline in the amount of data accepted for analysis, for much of the year colonial probationers and officers on leave were present as temporary workers in the Department, making heavy demands on staff time for advice and tuition.

261. The major items of work were as follows :—

1. *Maize variety trials in West Africa*

The Department continued to process on the electronic computer all the routine variety trial data of the West African Maize Research Unit. Mr. van Eijnatten stayed as a temporary worker from 9th November to 18th December and made extensive use of the computing facilities in working on several problems. He also commenced, in collaboration with Mr. Vernon, a review of the results of all the maize variety trials in West Africa during the last ten years.

2. *Department of Agriculture, Uganda*

W. R. Mills of the Uganda Department of Agriculture visited Rothamsted from 21st March to 14th April and, in consultation with Patterson, worked on the following subjects :—

- (a) The analysis and interpretation of the Serere Rotation Experiment.
- (b) The future design of this experiment.
- (c) A series of experiments on the effect of *Lygus* and bollworm on cotton and the control of these pests by spraying. (Data processed on electronic computer.)
- (d) The sources or error in a cattle weighing experiment.

3. *Rust disease of coffee in Kenya*

A tremendous mass of data, the accumulation of some ten years intensive study of the foliation of coffee and incidence of rust and

other leaf-spotting diseases in a number of fungicide spraying experiments and observation plots, is now being reviewed by Mr. A. W. Rayner, until recently botanist in the Kenya Department of Agriculture. During the year Rayner had frequent consultations with Patterson and Vernon on the analysis and interpretation of the data, and Vernon co-operated with Rayner on the analysis of some of the experiments.

4. Another major item of work in the Colonies was done by direct arrangement with a commercial firm, Church visiting Kenya for two months to study the sampling of pyrethrum for Mitchell Cotts Ltd. In the course of this visit he met several of the staff of the Kenya Department of Agriculture and of E.A.A.F.R.O. for discussion of their problems. Also on behalf of a semi-commercial organisation, the analysis of a lengthy series of experiments on tobacco and other crops was undertaken for the South Highlands Non-Native Tobacco Board of Kenya.

262. Advice and help in the design and analysis of a variety of experiments were given to the Gambia, Nigeria, Kenya, Tanganyika, Northern Rhodesia, Malaya, Seychelles, Malta, Fiji, Borneo and the Empire Cotton Growing Corporation (for Sudan). In four cases processing of data required the use of the electronic computer.

#### IV. RESEARCH BY COLONIAL DEPARTMENTS OF AGRICULTURE, FORESTRY AND ANIMAL HEALTH

##### PLANT BREEDING

263. The improvement of crops by selection and breeding has for long been one of the main tasks of colonial agricultural departments and the fruits of this work are numerous and widespread. That there have been great and lasting benefits from it accruing to the farmers there can be no doubt, though it is impossible to assess these benefits in money. Improvements in yields and in quality, in resistance to pests and diseases, and in adaptation to local conditions of climate and soil have been achieved in many crops and in many places. The following reports of research in this subject only mention part of the work which is progressing at the present time, as an indication of the kind of investigations now current.

##### *Arrowroot*

264. In *St. Vincent* this crop is important. Work on the genetics and breeding of arrowroot was continued with the help of a research grant. Selection for yield and starch content within the varieties "Banana" and "Creole" has given promising results. A preliminary survey of pollen fertility has been made and it appears that selection for pollen fertility may prove useful before attempting hybridisation. Cytological study showed variable chromosome numbers in root-tips. In "Creole" counts of  $2n = 48, 52$  and  $53$  have been obtained. Such variation has not been found in "Banana" ( $2n = 48$ ) but the number of samples was small.

##### *Bananas*

265. Hitherto the banana breeding work has been divided between the West Indies Regional Research Centre and Jamaica (see paras. 106 to 111).



Following the decision to transfer the Trinidad work to Jamaica, all breeding work will now be concentrated in one place. In *Jamaica* it has been decided to expand the Research Department of the Jamaican Banana Board and that organisation will in future assume almost complete responsibility for all banana research. The breeding programme was continued in 1959 with the incorporation of new improved male parents. One promising tetraploid seedling has passed the first tests for resistance to Panama Disease and is being increased for full trials. Twenty-eight other seedlings were under test for disease resistance.

#### *Barley*

266. Only Cyprus and Kenya are concerned with this crop. In *Cyprus* the new variety B.55-22, derived from a cross between the local varieties Athenais and Cyprus Blade, has done well and is for release to farmers in 1960. In *Kenya* selection for resistance to net blotch disease continued, but introduced varieties gave poor results against this disease and against yellow rust.

#### *Beans and Peas*

267. Peas and beans of many kinds are widely grown, but little genetical work is done on them apart from selection and variety testing. In *Basutoland*, where the crop is important, variety trials were continued on beans, cowpeas and peas, considerable quantities of seed of selected varieties being sold to farmers. Amongst beans the variety Small White Haricot is recommended for early sowing and Pink Wachter for late season. Amongst cowpeas tests are inconclusive though the variety Iron Grey seems promising. In mountain areas Basuto Yellow peas have so far proved the best yielding variety, though many farmers crops still suffer price reductions due to mixing. In *Bechuanaland* selection amongst local mixtures of Jugo beans (*Voandea subterranea*) has produced one of superior yield. Cowpea improvement has so far produced no variety better than Blackeye. In *British Guiana* variety trials were conducted with Pigeon Pea, Mung Bean (*P. radiatus*) and cowpeas. In *Nigeria* cowpea selection at the University College farm revealed 12 varieties giving high yields. In the Western Region selection and breeding material with *Phaseolus lunatus*, pigeon peas and cowpeas continued. Many varieties of groundnut were under test. In *Tanganyika* the soya bean breeding programme is proving highly successful. Varieties with higher yields, improved plant habit for mechanised harvesting and less liability to shattering have been produced. The increased yield over the current variety is estimated as 50 per cent.

#### *Cassava*

268. The principal interest in cassava is in evolving varieties resistant to virus diseases of the mosaic type and having high yields of good storage and eating quality. With the suspension of the work on interspecific hybrids by E.A.A.F.R.O. the responsibility for further breeding and for local testing has devolved on the East African Departments of Agriculture. This is being pursued in *Kenya*, *Tanganyika*, *Uganda* and *Zanzibar*. In *Nigeria* the Federal Department of Agricultural Research has added twenty-two local varieties and two triploid Japanese varieties to the breeding collection. Interspecific hybrids in the first stage of multiplication showed high resistance to

mosaic virus. Variety 58308 has remained free from mosaic symptoms after three years' exposure to infection in the field and for one year at three other stations. Performance at Ibadan has been found to be an unreliable indication of behaviour elsewhere so that district trials have had to be undertaken. Comparison of varieties of low, high and intermediate branching habit showed that, though variety differences in yield were significant, there were no reliable effects of spacing nor any spacing x variety interaction.

*Castor*

269. Though nowhere a large crop in colonial territories, it is occasionally useful on poor soils. Attempts at improvement of varieties have not so far been very successful. *Tanganyika* has had a large programme of selection and breeding but insect pests and harvesting problems remain intractable. *Uganda* tried four of the *Tanganyika* types, including two dwarfs. These dwarf types proved susceptible to bacterial leaf spot and failed. The tall Kilosa Giant variety, while growing well, was ravaged by insects and attacked by *Sclerotinia ricini*. Trials in *Kenya* were also disappointing, mainly because of insect pests.

*Cocoa*

270. The principal breeding work was done at the West Indies Regional Research Centre and the West African Cocoa Research Institute (paras. 112 to 131 ; 155 to 160). Material distributed from these two centres was under trial in a number of territories including islands in the Caribbean, British Guiana, British Honduras, Nigeria, Camerouns, Sierra Leone, North Borneo, Sarawak, Nyasaland, Uganda and Zanzibar. In addition there were breeding and selection programmes in Trinidad, Jamaica and Fiji. There has been a good deal of new material introduced into the Pacific area in recent years from West Africa and the Amazon basin, and this may usefully widen the selection possibilities which appear to have been rather restricted in the past in that region because of limited gene sources. In *Fiji* production of hybrid seed is progressing and the first should be available for distribution in 1963 or 1964. It is hoped to combine the vigour and early bearing of Amazon clones with the large bean size and high yields of Fijian material, and Trinidad clones. The West African Amelonado (ex Malaya) is growing well in isolation and shows no sign of serious disease. It may well prove superior to local varieties. In *Western Nigeria* there were a number of district variety trials with open and controlled pollinated F<sub>2</sub> Amazons and various Amazon x Amelonado and Amazon x Trinitario crosses. In *North Borneo* cocoa continued to grow extremely well at the Quoin Hill Station. The yield from the first one-acre plot of 524 trees of Amelonado planted on Quoin Hill soil in baskets on 17th May, 1959, was 7,426 pods, at less than one year in the field. A number of introduced clones from Trinidad, Upper Amazon (via Malaya), Indonesia, West Africa, New Guinea and Samoa have been budded onto Amelonado stocks. A pruning trial has been laid down. A further trial plot of two acres has been laid down on the Apas soil series. The trial on the ultra-basic soils at Ranau is useless, the poor growth being now known to be due to chromium and nickel toxicity. In *Jamaica* comparison trials between I.C.S. clones and local selections continued. Yield results are still in favour of I.C.S. Nos. 95 and 60. In the light of results in *Trinidad* with hybrid seedling cocoa from crosses between Amazonian and I.C.S. clones, there has been a change of emphasis in the

Cacao Expansion Scheme towards this material in preference to clonal rooted cuttings. Large quantities of hybrid seed have been imported from the Trinidad Department of Agriculture, together with the Amazon parents for establishing seed gardens in Jamaica.

### *Coffee*

271. While variety trials were done in a number of territories, the main work of selection and breeding was centred at the Coffee Research Station in *Kenya*. This is confined to *arabica* coffee. As yield data are assembled from different parts of *Kenya*, the adaptability of S.L.14, S.L.28 and S.L.34 becomes more evident. K.7 remains the selection most resistant to rust (Race II) although S.L.6 is more consistently immune to this race. N.100 has yielded well in several trials and has shown signs of some resistance to Coffee Berry Disease. Blue Mountain and selections from this type have given disappointing yields though partially resistant to Coffee Berry Disease. In 1959 a new series of variety trials was started in African areas and rust exposure tests in several places. Exploratory trials with *Coffea excelsa* were planted below 3,500 ft. in Embu district. The first crop has been picked from the Indian varieties S.288, S.333 and S.795 planted in 1956. All these have continued to show immunity to rust Races I and II. If yields and liquoring quality are good they should prove invaluable in the Race I endemic areas of Nyanza and Central Provinces. Performance of different varieties has been very much affected by locality. For example, the best variety at Kisii, S.L.28, averaged 5.81 cwt. in the year 1953-58, but gave 16.81 cwt. at Meru, the two stations being at nearly the same altitude (5,500-5,600 ft.) The experimental plot of *C. excelsa* planted in 1957 at Ishiara gave a first small crop in 1959, quality being satisfactory. In *Jamaica* first results of a variety trial to compare Bourbon and Typica varieties and imported varieties have shown that Bourbon and Villa Lobos compare favourably with Typica in quality, but the beans are less bold and considerably smaller than those of Typica. A number of imported varieties are under trial in different localities in comparison with Typica, and of the sun-hedge and Brazilian methods of culture against local standard practices.

### *Cotton*

272. In all the chief cotton-growing territories cotton breeding and the provision of nucleus stocks of improved seed is undertaken by the Empire Cotton Growing Corporation with assistance from the territories. In *Aden* selection for yield improvement and resistance to Abyan Root Rot continued. Wilds Early showed considerable resistance to Root Rot and is being used as a source of resistance in breeding. In *Bechuanaland* good yields of up to 944 lb./acre were given by varieties from Uganda and South Africa, the best being A.7215 from South Africa. There was little insect attack except some limited red bollworm damage. In *British Guiana* work on cotton has been discontinued, mainly because of interference by rain at picking time and insect pests. In *Kenya* trials at the Coast gave yields of over 1,000 lb./acre from U.K.51 and U.K.58, the latter being a promising new variety from Tanganyika. In another trial at Galote mean yields of 1,300 lb./acre were obtained from I.58 and U.K.51. At the Central Research Station in *Northern Rhodesia* yields in variety trials in some cases exceeded 2,000 lb./acre of seed cotton, the leading strain being Albar 637

from Nyasaland, which yielded up to 2,600 lb./acre. This variety also did well in three provincial trials, and is to replace the variety 9L34 which has hitherto been the stock variety in Northern Rhodesia. *Nyasaland* trials demonstrated the general superiority of the Albar 637 strain both in yield and spinning quality and this variety is being multiplied for distribution to all areas. A low ginning out-turn has been a disturbing feature and some varieties from Uganda have been better in this respect than local strains, but even so, the ginning out-turn has been considerably lower when they were grown in Nyasaland than when grown in Uganda. In *Tanganyika* three breeding programmes have been amalgamated. From the wide range of material available, commercial varieties, highly resistant to bacterial blight, with the quality required by the industry and higher yielding than the current issues, will be produced for Lake Province. As a result of earlier planting and the successful conclusion of the insect control programme, it is clear that bacterial blight is of more importance in Eastern Province than was previously thought. An increased effort is therefore being made to breed blight resistant varieties at Ilonga. In *Uganda*, where the principal research station of the Empire Cotton Growing Corporation is situated, a very large programme of cotton breeding and genetical studies is in progress and no attempt is made to summarise its work. Extensive trials with new strains were conducted at a number of places within Uganda, the variety N.C.58 being one of the most successful. Improvement of the *Northern Nigerian* cotton crop continued with the distribution of the new strain Samaru 26 J throughout the Region. A series of experiments at Samaru have resulted in yields of 2,000 lb/a. of seed cotton for three years in succession.

273. Sea Island cotton, confined to the West Indies, was under a breeding programme centred on *Antigua*. Three main types, M.S.1, V.H.8 and V.H.10 were used in yield trials and seed distributed for bulking to other islands. Similar yield trials were continued in *St. Kitts—Nevis* and in *St. Vincent*.

#### *Groundnuts*

274. Every country where groundnuts are important is doing trials with different varieties. These trials are extensive in *Nigeria*, *Gambia*, *Tanganyika* and *Nyasaland*. Hybridisation is little attempted though some work is in progress in Nigeria and Tanganyika. The variety Mwitunde, resistant to rosette disease, has become one of the leading varieties in many areas liable to this disease though, apart from this advantage, it does not seem to outyield other established varieties. The variety Marie Pintar has shown promise in *Northern Rhodesia*, out-yielding other selections. A self-coloured red selection has been extracted which has a more attractive appearance than the common striped selection.

#### *Maize*

275. While many territories carried on trials with different varieties of maize, those which had major maize breeding programmes were only four: West Africa, Kenya, Uganda and Nyasaland. The tropical American maize rust-disease (*P. polysora*) which ten years ago threatened to become disastrously destructive in the humid and warm parts of Africa, pointed to the importance of maize breeding programmes in both East and West

Africa. The intensity of the attacks by this disease appear to have declined recently, but it has left a legacy of maize improvement effort. Nothing stimulates research on a crop better than the advent of a really destructive pest or disease.

276. In *West Africa* the primary breeding programme has been entrusted to the West African Maize Research Unit supported by Ghana, Nigeria, Sierra Leone and with C. D. & W. Funds. The Unit continued its programme of assessment of the general combining ability of inbred lines derived from a number of Central American maize varieties, with a view to the development of synthetic varieties and, ultimately, of high yielding hybrids. Two tentative synthetics were composed of eight first-stage inbred lines each. These are being tested under a wide range of environmental conditions. Inbred lines are now available with a homogene for low susceptibility to *P. polysora*. They are derived from Mexican SLP. 24-A. Assessments of damage by *P. polysora* and various leaf blights emphasised the importance of *Cochliobolus heterostrophus* in reducing effective leaf-area.

277. Difficulties in drying maize in the cob led to a search for varieties having a relatively low moisture retention at harvest and to a study of correlations between plant characters, such as number of husk leaves and moisture in the grain at harvest.

278. In *Uganda* the major part of the maize breeding programme has reached a stage of assessing the progress already made before proceeding to further work. Up to the present two first synthetics have been made from local varieties by recurrent selection and one second synthetic. This second synthetic is earlier than the others, but this has been achieved at the expense of yield, being no better than its parent. It will be abandoned. One first synthetic has yielded well in variety trials and should be useful where early maturity is important. The best progenies from two crosses (Murata x K8 hybrid and K8 x Murata hybrid) have been bulked and multiplied, and will be included in variety trials in 1960. In order to produce rust-resistant varieties a number of crosses were made using AFRO-24 and AFRO-29 to provide resistance genes. Five crosses, all homozygous for resistance to Race EA1, have been selected and the best progenies have been multiplied for district trials in 1960. One progeny has been tested already; it is earlier than the local parent and yields well when conditions are good, but not as well as the local parent when conditions are unfavourable.

279. In *Kenya* the grant of C. D. & W. Research funds has made it possible to expand the maize breeding programme. The existing policy of breeding hybrids and synthetics is to be continued, but on a bigger scale with a co-ordinated programme to cover all maize-growing areas, European and African, West of the Rift. Under the new scheme breeding will be increased at Kitale and Njoro, and new work will be started at Kakamega and Endebess. Kitale has intermediate conditions for maize and will be the main station. Njoro serves the higher, cooler areas and Kakamega serves lower, hotter and wetter areas where *P. polysora* rust can be serious. The Enderbess station will be for areas of higher soil fertility.

280. Maize breeding has made very satisfactory progress at Kitale and Machakos. The Kitale Synthetic II was multiplied on five acres and gave the highest general level of yield in six trials. The maize breeder was able to visit the U.S.A. and Central America this year. His programme aims at producing both hybrids and synthetics with special emphasis on improved resistance to white blight and rust. Synthetic II shows signs of some achievement in this direction already. At Machakos the work was directed at earliness as the best means of combating drought conditions which are frequent in Southern Province. The early variety Taboran is now being grown by many African farmers and 10 tons of seed were sold.

281. Another season of success can be reported with the new maize stock resistant to tropical rust. There are now over 1,000 bags of seed for distribution in 1960 in the Coast Province.

282. In *Nyasaland* work over the past seven years has reached the stage where the first double hybrid is being multiplied for distribution. This hybrid not only has the highest yield in all variety trials but also has good storage qualities. The parents of this cross were a local selection and a Mexican variety. Synthetic varieties, though not as high-yielding as the hybrid, are being grown in some areas.

283. *Jamaica* continued a programme of crossing local varieties. Introductions from Mexico through the Rockefeller Foundation showed no marked superiority over the local variety J.S.Y.

284. A number of territories where maize is important are carrying on variety trials, particularly in *Eastern Nigeria*, the *Cameroons*, *Basutoland* and *Bechuanaland*. In most cases they derive their test varieties from territories where larger breeding programmes are in progress.

#### *Potatoes*

285. Variety trials and breeding are largely directed towards resistance to Late Blight together with general agricultural suitability. In *Kenya* a programme of hybridisation has produced clones which are promising, particularly C.52. In *Mauritius* the standard variety is now King George, but difficulties have arisen in the supply of adequate quantities of certified seed. As a result efforts have been intensified to find alternative varieties. In the *Cameroons* variety trials, particularly for Late Blight resistance were continued. In *Jamaica*, out of six imported varieties tested against the established varieties Sebago and Arran Consul, one German variety gave the outstanding return of 17:1.

#### *Pyrethrum*

286. This work is centred in *Kenya*. Selections under trial numbered 667. New crosses were produced in 31 isolated plots and the "sugar beet" breeding systems were continued in 12 isolation fields. Seed production fields were planted with nine varieties and seven others were maintained. Improved seed amounting to 5,234 lb. was delivered to the Pyrethrum Board for issue to farmers. Seven of the recent hybrids have shown promise and their parent clones are being bulked up. Altogether 22 field trials in various parts of the pyrethrum-growing area were maintained.

287. In the *Cameroons* trials with pyrethrum were started at the Experiment Stations at Bambui in the Bamenda Highlands, which was re-opened in late 1958.

### *Rice*

288. At the *West African Rice Research Station* studies continued on hybridisation of rice. A new series of crosses was made in an attempt to produce high-yielding varieties of seven months' duration. In another series of crosses the aim is to produce high-yielding short duration (3-4 months) types. A diallel series of crosses involving four parents in all combinations were studied in  $F_1$  in 1959, but owing to the large variations between individuals in pure lines of rice, it was found that the crop is not very suitable for diallel analysis unless a method can be found of producing  $F_1$  seed in large quantities.

289. Investigations into response to fertilisers were made on 450 varieties and large differences were found which could form a basis for a breeding programme for high fertility conditions.

290. Comparison of growth rates and survival ability amongst floating (deep water) rices showed a marked difference between floaters of the two species *O. sativa* and *O. glaberrima*. The most important factor was the age of the plant when flooding began.

291. Interspecific crosses between *O. sativa* and *O. glaberrima* yielded a number of  $F_1$  plants all of which had completely sterile spikelets. A further series of crosses has been made and attempts at producing amphidiploids will be made.

292. Studies on dormancy of rice seed has shown that the inhibition of germination involves two components: the most important is due to the husk but some dormancy is also exhibited by the caryopsis. Treatments which remove husk dormancy do not necessarily remove the caryopsis dormancy. The presence of germination inhibitors has not been demonstrated. There is evidence that treatments which accelerate the breaking of dormancy are concerned with terminal oxidation in respiration.

293. The initial work on viability of cereal grains has shown that the period of viability of a number of temperate cereals can be predicted from a knowledge of moisture content and storage temperature. Incomplete experiments on rice suggest that rice behaves in a similar way but with constants somewhat different from those which apply to other cereals.

294. In the *Seychelles* rice trials continued on Mahé island, yields of about a ton an acre being given by the variety Radin Siak II. Damage by the Cardinal Weaver Bird (*Foudia madagascariensis* L.) was severe.

295. In *Fiji* a wide range of experiments on rice were in progress at the Koronivia Agricultural Station. Progeny of the FAO *indica* x *japonica* hybrids were grown, 38 on wet land and 36 on dry land. Other experiments included methods of drill sowing compared with transplanting, and of irrigation.

296. In *North Borneo* some introduced varieties have given very high yields in small plots compared to local varieties but there has been great variation in behaviour with locality and season. Short duration second crop

trials showed that with irrigation double cropping is possible if bird damage can be controlled. Trials continue with *indica* x *japonica* hybrids.

297. The *British Guiana* rice breeding programme produced a number of varieties which were non-shattering and did not lodge. Unfortunately other defects such as difficult threshing in combines, poor cooking quality and low yield have eliminated many cultures. A further series of hybrids is under trial which it is hoped includes types with acceptable characters.

298. In *Kenya*, on the Mwea irrigation scheme, varietal trials continued. New introductions were under test from U.S.A., Nigeria, Japan, India, Austria and Surinam.

299. The *Nigerian* Federal Rice Research station tests of *O. glaberrima* showed most varieties to be tolerant of flooding up to 5½ ft. and suitably adapted white-grained varieties are now being released for distribution. Few of the 40 floating varieties were found sufficiently early to compete with indigenous varieties. Marked differences in milling performance of varieties have emphasised the importance of taking this character into account in selection programmes.

#### *Sesamum*

300. Though widely distributed, sesamum is not an important crop in most colonial territories and interest in it is largely confined to *Nigeria* and *Tanganyika*. Hybridisation work in *Northern Nigeria* is producing lines greatly superior to local types and trials are being made in efforts to expand the crop. The variety Yandev 55 continues to be distributed but it is hoped to replace it soon with some of the new hybrids. In *Tanganyika* a comprehensive breeding programme is in progress based on local selections and varieties introduced from Venezuela and the U.S.A. It is proving difficult to introduce the indehiscent character from Palmetto and Rio into good varieties free from undesirable linked characters and a series of backcrosses will be necessary. A new non-shattering variety with "papershell" capsule walls has been obtained from the U.S.A.

#### *Sisal*

301. Research on sisal is confined to *Kenya* and *Tanganyika*. The hybridisation programme has concentrated mainly on crosses between *Agave amaniensis* and *A. angustifolia*, and some clones from this combination are very promising. One clone has been released for commercial testing on plantations. Selections from the common clone mixture have shown little improvement over sisal and those which have given better yields have had undesirable characters such as spines, short leaves or susceptibility to insect attack.

#### *Sorghum*

302. In spite of the great importance of this cereal, little is being done to improve it generally except in East Africa. There the East African Agriculture and Forestry Research Organization have established a sorghum breeding centre at Serere with the co-operation of the Uganda Department of Agriculture (paras. 45 and 46).

303. In *Somaliland* trials of different varieties on terraced land with flash irrigation in basins on a silt soil showed that the local variety (*Elmi Jama*)



outyielded all others, but with normal irrigation Double Dwarf Yellow Sooner was superior. In *Basutoland* variety trials were repeated, but hail destroyed them, as it frequently does in that country. In *Bechuanaland* trials showed that the variety *Radar* from South Africa was one of the best, and because it has shown resistance to witchweed (*Striga* spp.) to a varying degree dependent on soil fertility, it has been multiplied and distributed to farmers. In *Northern Nigeria* extensive selection and breeding trials are in progress and some improved varieties are ready for issue to farmers. In *Northern Rhodesia* selections for high yield are beginning to show results, the best showing yields up to 3,000 lb./acre. Crossing to combine malting quality and resistance to bird damage has apparently given the desired combination within a small  $F_2$  generation.

### *Sugarcane*

304. Breeding programmes for sugarcane are confined to the British West Indies Central Sugar Cane Breeding Station in *Barbados* and the Mauritius Sugar Industry Research Institute. Trials of varieties evolved at these and other stations outside the colonies are carried on in many territories where the crop is important, often with seedlings raised locally from fuzzi provided by the main research stations.

305. In *Barbados* there was a prolonged and severe drought in 1959 which was useful for an appraisal of drought resistance in the breeding stock. New importations to add to the collection of breeding varieties included four original noble cane (*S. officinarum*) varieties from the New Guinea series, several commercial varieties from Australia, India and Hawaii, a *barberi* form and a *spontaneum* form from the Indian collection. Five varieties developed in Jamaica from Barbados nursery material were also received for testing and use as parents. About half the breeding programme was accomplished by the solution technique, to which improvements were made in respect of the preparation and lasting qualities of the solution. Several polycrosses were made with material from Jamaica and British Guiana, and a number of area-crosses using several female varieties with a single high-class male in each case. The inbreeding programme was continued with some selfings in the fifth generation. Top crosses to standard female parents and inter-line inbred crosses were also made to test combining ability and to assess some of the inbreds for their value as parents. While remarkable stability of vegetative characters has been achieved in some inbred lines, others exhibit considerable segregation, even into the fourth and fifth inbred generations. Cytological investigations have revealed that due to irregular meiosis resulting from the aneuploid state of many of the clones, chromosome losses occur on selfing to a variable extent in different lines. Consequently comparable degrees of homozygosis are reached by successive selfing more rapidly in some lines than in others.

306. There was some indication of a correlation between selectable variation in tillering at the pot stage and performance in the first year trial. Such a correlation, though far from absolute, would be a useful indication when reduction in numbers becomes necessary between potting and field stages for reasons of space and might be preferable to natural selection by the "bunch" planting method. Further investigations on the "bunch" method have cast doubt on its value under Barbados conditions.

307. Since the Station's facilities now include seedling nurseries in Barbados, Jamaica, British Guiana and the Dominican Republic, the opportunity has been taken to obtain a statistical measure of genotype-environment interaction. Co-operative experiments using a common set of families were begun, scoring for commercial characters at each stage of selection. Characters showing similar scoring in all nurseries and all crosses will be reliable criteria when selecting for diverse conditions in one nursery. While the behaviour of Barbados-selected varieties in Jamaica, British Guiana, British Honduras and further afield has shown that this view is not universally true, it is desirable to ascertain to what extent added precision is in fact secured by location of nurseries in different environmental conditions.

308. Data on resistance of Barbados seedlings to mosaic disease in Jamaica and to leaf scald disease in British Guiana have been received, and is invaluable in planning crosses because neither of these diseases occurs in Barbados. As a result of this work all varieties grown on a commercial scale in Jamaica are now resistant to mosaic disease and in British Guiana good progress has been made in substituting varieties resistant to leaf scald.

309. Arising out of the observation that heat treatment used against ratoon stunt virus can result in increased flowering in some varieties, an undesirable permanent physiological change not thought to be related to the disease, crosses have been made between treated and untreated B.37101 and B.41211 in all combinations. A similar observation in Mauritius was recorded for Co.419 but M.134/32 was unaffected.

310. The *Mauritius* station has had more difficulty in making crosses than Barbados, altitude being important. Little success has come from the solution technique. The possibility that a high Brix might be cytoplasmically inherited was not borne out in crosses between Ebene 1/37 and B.37172 but it was found that environment had a large influence on Brix readings. A large number of pre-release trials were carried out in different climatic zones, including varieties from Barbados and Natal.

311. Variety trials were reported from *Antigua, British Honduras, British Guiana* and *St. Kitts-Nevis* and *Anguilla*. In British Honduras it is curious that Barbados varieties, so successful in many countries, have not consistently yielded any better than the old Java P.O.J.2878. In British Guiana the industry is overwhelmingly dependent on B.41227 and B.37161. Trials of new Barbados varieties in St. Kitts have not revealed any which can replace the present standard varieties.

#### *Sweet Potatoes*

312. This widespread crop has had relatively little attention given to its breeding. In *British Guiana* some variety trials are being done. In *Barbados* similar trials are continuing.

#### *Tea*

313. The establishment and testing of clones of tea has mainly been carried on at the East African Tea Research Institute, the Tea Research Station in Nyasaland and in Mauritius. In *Kenya* interest centred on the performance of clones in respect of rooting ability and growth rates under different watering practices, and clear differences in relative growth rates were noted between clones. Differences in net assimilation rates were also

observed between clones. In *Nyasaland* staff shortages compelled suspension of selection work. In *Mauritius* there are 140 clones under study and tests for quality on individual bushes have begun.

#### *Tobacco*

314. Trials in *Jamaica* of Virginia-type tobacco showed that only limited areas were capable of producing crops of acceptable quality, particularly of burning quality. Variety trials all suffered from Black Shank disease except the American variety No. 711, which showed considerable resistance. American varieties resistant to this disease were also found in trials in *Mauritius*, including the local strain of Yellow Mammoth. *North Borneo* has not been so fortunate in its trials of imported varieties, all proving more susceptible to pests and diseases than the local varieties. Likewise in *Nyasaland* variety trials showed that local dark fired selections were better than imported varieties. In *Tanganyika* a new sub-station has been opened for research on fire-cured tobacco.

#### *Vegetables*

315. Vegetable production in tropical countries is more often a problem of marketing and distribution, and a battle against pests and diseases than one of selection and breeding. Nevertheless, a good deal of the testing of varieties introduced from tropical and sub-tropical countries was carried out in colonial territories, often with success. Work of this kind has been reported from *Cyprus*, *Bahamas*, *Jamaica* and *North Borneo* but is by no means confined to these territories. Supplies of seed, locally produced or imported by Government for sale to growers, have been on an expanding scale, and these activities, unspectacular from the research point of view, have greatly improved vegetable supplies.

#### *Wheat*

316. This is a crop important in certain East and Central African territories, particularly *Kenya*. There, a long-sustained breeding programme for resistance to stem rust was expanded with the help of a grant from C. D. & W. Research funds. The effect of this has not yet had time to appear. The season of 1959 was unusually dry and stem rust attacks were reduced. The rust which did occur was mainly Kenya race K 18 (=International Race 40). This race and K 19 (International Race 189) seem able to attack most varieties in commercial use and contribute a severe threat to the wheat crops. They caused heavy damage at Njoro. The nurseries of International and F.A.O. varieties were as badly attacked as ever, with the result that the number of varieties extracted was correspondingly smaller. The crosses dating from 1955 yielded a number of promising selections which are now going for multiplication. The large backcross programme started in 1958 ran into trouble in that rust levels (K 18) in all 940 of the backcrosses were uniformly high in the second season of 1959 so that selection of resistant plants was virtually impossible. Multiplications of newer varieties have been more successful. A range of high altitude varieties was released in 1959 (under the names of Kenya Curlew, Eagle, Hawk, Buzzard, Dove, Plover and Quail). They have yielded well and two of them have better baking quality than usual for high altitude varieties, especially Plover. Four varieties at pedigree stage had a successful season and should be ready

for release in 1960. In *Northern Rhodesia* the hybrid Kentana 51B showed promise of resistance to *Helminthosporium* blight which is a major restraint on summer wheat yields. Irrigated wheat at Mt. Makulu gave about a ton an acre but the better selections coming forward show greater promise.

317. Varietal testing of wheat continued in *Cyprus* and in *Northern Nigeria* a start has been made in variety testing with the object of expanding wheat production under irrigation.

318. In *Tanganyika* tests of a wide range of varieties failed to find one sufficiently resistant to stem rust.

319. In *Basutoland* variety trials, now continued for three years, showed four varieties to be fairly consistent good yielders and these have been passed for multiplication. Promising varieties, mainly from the Union of South Africa, appeared in preliminary variety trials. Amongst winter wheats a number have consistently outyielded local varieties. For sowing before mid-May the varieties Scheepers, Red Victory and Red Spitzkop appear best, while White Spitzkop, Talberg and Maluti are best to plant after that date.

#### *Yams*

320. Work at the West Indies Regional Research Centre has been referred to in paragraphs 134 to 136. In addition to this *Eastern Nigeria* has instituted a survey and collection of varieties which is nearly complete. The work of identifying, cataloguing and describing is proceeding. This collection will be used for selection and breeding work. The Nigerian Federal Department of Agricultural Research also have in hand a classification of yam varieties. It appears that flowering in *Dioscorea* is controlled genetically and little affected by environment or photoperiod.

#### *Miscellaneous*

321. In *Antigua* aloes (*Aloe* sp.) is of local interest and trials have been done to improve yield of the drug. While the juice quality was good, the first harvest yields were disappointing. Bullrush millet (*Pennisetum typhoideum*) was under trial in *Bechuanaland* where six synthetic poly-cross varieties yielded up to 1,500 lb./acre. A further 77 uniform lines of this millet were grown and selection for uniformity and for heavily awned heads to give protection against bird damage were made. In *Northern Rhodesia* the awned varieties escaped bird damage when naked types were present and the bird population, mainly *Quelea* spp., was low.

322. Finger Millet (*Eleusine coracana*) in *Northern Rhodesia* was not improved in yield by introductions from India and Ceylon.

323. Experimentation with Jute in *British Guiana* was discontinued on account of disappointing results. Yield of fibre was low and too short.

324. Selection of coconuts was carried on in a number of territories, including *British Guiana*, *Seychelles*, *Sarawak*, *Zanzibar* and *Jamaica*. In the last attention was concentrated on dwarf varieties for resistance to Lethal Yellowing or "Unknown Disease". For these tests there were six trials including the dwarf Fiji and St. Lucia types. The disease appeared in the St. Lucia plots but has not yet done so in the Fiji plots.

325. Comparison of *patchouli* of Malay and Seychelles origin revealed no quality differences when the two types were grown in the Seychelles, indicating that the difference between Seychelles and Singapore oil is due to environment.

326. In Somaliland comparison of about 100 varieties of *dates* in trials over the last ten years have shown that the most suitable for Somaliland conditions are three from the Hasa coast of Saudi Arabia and two from the Hadramout.

327. Watermelons have been the subject of variety trials in the *Bahamas*, attention being given to size, flavour and yield. Differences in behaviour towards Blossom End Rot were observed. Varieties of Canteloup developed from the variety Georgia 47 were under test and two are recommended to growers. A collection of pineapples is maintained at the Experiment Station where plants produced from the cross Eleuthera x Jamaica Sugar Loaf made good growth. The aim is to produce a pineapple with a tougher skin suitable for shipping. Differences in flowering time have been a hindrance to other crosses.

#### ENTOMOLOGY AND ZOOLOGY

328. Studies on insect pests and their control, as well as other animal pests such as mites, birds, rats and nematodes, fall partly within the field of this committee but are partly the concern of other committees. Certain groups of insects, such as locusts and tsetse flies, are the subject of the committees specially set up to deal with them. Pesticides as a subject is primarily the concern of the Colonial Pesticides Research Committee, but it is impossible to exclude them from a review of the research falling fairly under the agricultural heading. It is therefore necessary to read a number of reports in order to gain a full appreciation of the research effort being put into pest control. Within this report reference should be made to Section III for accounts of work on stored products pests and termites and to Section II for pests studied by the larger research organisations. References to insects affecting animals will be found in those sections (447 to 499) dealing with Veterinary Research. In this Section pests are dealt with first under the crops affected and under subject headings where necessary. For nematodes see paragraphs 52 to 54. Insect vectors are dealt with under Plant Pathology.

#### *Bananas*

329. Banana Scab Moth (*Nacoleia octusema*) is a serious pest in *Fiji* and other territories in the Pacific. Attempts to find effective parasites of the moth have been made and are continuing. A special officer visited Malaya, Sumatra, Java, Celebes and the Marianas chain of islands extending from Java to Timor searching for suitable parasites. His investigations show that parasites which attack the Scab Moth on *Nipa* and *Pandanus* usually do not attack it on banana plants. However, one parasite was found attacking Scab Moth on banana in Timor and the first consignment of these insects reached Fiji in the early part of 1960. Some of these are being studied in the laboratory and a small number have been released in a carefully selected locality. Meanwhile trials with DDT dusts to control the pest in Fiji are continuing.

330. Spraying with dieldrin against banana weevil in *Kenya* did not give such increases in yield as from mulching the crop.

331. *Mauritius* introduced two parasites against the weevil (*Cosmopolitus sordidus*), *Leionota quadridentata* and *Plaesius javanus*, but their effect is not yet known.

332. Nematodes injurious to *Musa* spp. have received a good deal of attention recently. In *Jamaica* a study of those species associated with bananas has been started with support from the United States. In *North Borneo* investigations on abaca (*Musa textilis*) plantations, following reports of declining yields, showed the presence of several species of parasite eelworms, including *Pratylenchus* sp., *Tricodorus* sp. (both probably undescribed) and *Helicotylenchus nannus*. In another sampling *Tylenchus semipenetrans*, *Pratylenchus coffeae* and the *Trichodorus* n. sp. were found, *P. coffeae* being present in sufficient abundance to cause damage. There was no apparent correlation between vigour of the abaca and the numbers of nematodes recovered in samples.

#### Barley

333. Barley Fly in *Kenya* was found to be controllable with seed dressings of dieldrin, heptachlor or aldrin. Dieldrin at 3½ oz. a. i. per 100 lb. seed was fully effective.

#### Citrus

334. Good control of Citrus Midge (*Contarinia citri*) attacking lemons in *Cyprus* was obtained with sprays of parathion. The citrus fruit Moth Borers in *Jamaica* (*Gonodonta*=*Athysania* sp.) have been incriminated for this form of damage, but as there are at least seven species widely distributed in the island the problem of identifying the real culprit is difficult. There may also be other species of Noctuid moths not of the genus *Gonodonta* concerned. Fiddler Beetles (*Propodes* and *Pachnaeus* spp.) were controlled with dieldrin at 1 to 1.5 lb. a. i. per 100 citrus mounds. It was observed that a single treatment on this basis given in 1954 appeared to be still exercising some amount of control five years later. A severe outbreak of citrus Black Fly (*Aleurocanthus weglumi*) which occurred in one area in 1959 was eventually controlled by three cycles of spraying with a mixture of malathion (6 pints) and Shell White Oil (6 galls.) in 30 galls. water.

335. In *Kenya* a parasite of citrus Black Fly, *Eretmorcerus serius*, was introduced into the coastal area where Black Fly is a serious pest. The introduction was from the Seychelles and the parasite seems to have established itself in *Kenya*. In *Mauritius* spraying the trunks of citrus with dieldrin was found effective against the black ant and Dimecron gave excellent control of the aphid, *Toxoptera citricidus* Kirk., scale insects and lepidopterus pests.

336. The Rust Mite (*Phyllocoptruta oleivora* Ashri.) attacking citrus in *Trinidad* was well controlled by Trithion in both high and low volume sprays. The same insecticide gave control of the scales *Chrysomphalus aonidum* and *Lepidosaphos beckii*.

#### Cocoa

337. In addition to the major work done in cocoa pests by the West African Cocoa Research Institute and the West Indies Regional Research Centre, there was attention to cocoa pests in other territories, As in the rest

of West Africa, capsids are a pest of cocoa in *Sierra Leone*, particularly *Sahlbergella singularis* Hag. Trials were initiated with insecticides on similar lines to those at W.A.C.R.I. with special attention to times of application. Aldrin 40 per cent. and Gamelin 20 emulsifiable powders are the principal insecticides under trial. Endrin is also included in the trials.

In *Trinidad* the shot-hole borer which is associated with *Ceratostomella* disease has been identified as *Xyleborus ruscotus* Eich. Low volume monthly sprays of Toxaphene reduced the disease to one third.

#### Coconuts

338. The most damaging pests on coconuts which have been receiving attention are the two mirid bugs causing premature nutfall in the British Solomon Islands Protectorate and Zanzibar, Rhinoceros Beetle which has invaded some of the islands in the Pacific, the *Melitoma* beetle in the Seychelles and various leaf-eating insects.

339. Work on the Solomon Islands pest, *Amblypelta cocophaga*, has unfortunately had to be suspended for want of an entomologist. For an account of work on the Zanzibar mirid, *Pseudotheraptus wayi*, reference should be made to the Colonial Pesticides Research Committee Report. The Rhinoceros Beetle has received much attention from the *South Pacific Commission* and also in *Fiji* where it has become a major pest in some areas. There has been a theory that in areas newly invaded by this pest it has been relieved of its usual controlling parasites and predators so allowing it to multiply more than is the case in South-east Asia. Attempts have therefore been made to recruit parasites and predators from wherever the beetle or allied species are endemic. Searches have been made in West Africa, Asia, Madagascar and other places. *Scolia* wasps have been imported from Zanzibar into the Pacific but seem to exert only limited control. *Mauritius* has sent shipments of the Histerid parasite *Leionota quadridentata* to Diego Garcia island where Rhinoceros Beetle is damaging, and the Carabid Beetle *Scaritas madragascariensis*, is being collected in Madagascar, also for trial in Diego Garcia. In *Mauritius* itself, the mite, *Raoiella indica* Hirst., which causes considerable damage to coconuts in all stages of growth, can be controlled with various sprays (such as Rogor and Metasystox). In *North Borneo* the leaf eating *Satora nitens* is damaging in some areas and control through its parasite *Chaetexorista javana* is being attempted. Rearing of this species in quantity has not been possible because of heavy mortality, and the best method is still the rearing of pupae of *Satora* collected in the field and the release of emerged parasites in affected areas. By this means surveys have shown that parasitism has been increased from 7.6 to 18 per cent. The *Melitoma* problem in *Seychelles* has received further attention following the posting of a Pool Entomologist in the islands. A survey of the infestation by *Melitoma insulare* showed a situation not very satisfactory and trials have led to a more efficient treatment of infested palms using a creosote/tar mixture instead of paradichlorobenzene. Attempts are being made to introduce the *Scolia* wasp from North Island to Praslin and La Digue islands where Rhinoceros beetle is prevalent.

340. In *Trinidad* investigations of the Red Ring disease caused by the nematode, *Aphelenchoides cocophilus*, were continued.

#### Coffee

341. The main lines of entomological work on coffee in *Kenya* in 1959 were on the biology and control of Tip Stem Borer (*Eucosma nereidopa*

Meyr.), Leaf Miners (*Leucoptera* spp.) and the Antestia Bug (*Antestiopsis lineaticollis* Stal.). Using flower buds and small green berries as food a successful technique for the laboratory rearing of *Eucosma* was developed. Spraying of shade tree trunks with 2 per cent. DDT caused large reductions in moth population but it is not certain if this will give adequate control. Many leaf miner specimens were examined from both East and West Rift coffee areas and 18 species of parasitic Hymenoptera were recovered. There are probably few now undiscovered. The dominant species recovered from caterpillars of *L. meyricki* Ghes. was an undescribed species of *Cirrospilus*. A surprising observation was that the shade-loving *L. coffeina* Washb. was absent from the West Rift despite the fact that much of the coffee there is shaded. Field observations confirm the finding of the Pyrethrum Board laboratory that pyrethrum is ovicidal at spray concentrations as low as 0.001 per cent. pyrethrins. Leaf miner eggs are also killed by parathion, methyl parathion and diazinon at concentrations used for killing caterpillars in the mines. A two-phase method of Antestia control was devised for African farms and small plantations. Trees are sprayed with 0.006 per cent. pyrethrins and the stump is dusted with 5 per cent. DDT. A Tachinid parasite, probably *Epineura rubens*, Vill., was bred from adult Antestia. It proved fairly simple to maintain in laboratory culture and it should be possible to release it in the main East Rift coffee areas in 1960. Small scale investigations were carried out on other pests, including taxonomic work on the Green Scale of Coffee. This insect has had a confused history but a survey of green scales on coffee in Kenya, Tanganyika, Uganda and other areas in Africa has revealed four new species hitherto confused with the common scale, *Coccus africanus*. The work is important in relation to biological control of these pests.

342. Shot Hole Borers do considerable damage to coffee in *Sierra Leone*. The common species is *Xyleborus morstatti* Hag. A pilot trial using 0.5 per cent. dieldrin spray at 1 to 1½ lb./a. gave good control though it lacked persistency.

343. Locally severe outbreaks of Lacebug (*Habrochila* spp.) in *Uganda* called for investigation. At least two species of *Habrochila* occur in Uganda with possibly montane races of one species. *H. placida* Horv. is confined to robusta coffee and does little damage. *H. ghesquierei* Sch. is found almost exclusively on arabica coffee and is responsible for much damage. It is in this species that montane races are thought to exist. The main difference between the Kawanda and Mount Elgon races is in egg structure. The breakdown of the control recommendation which was made on the basis of experience in Kenya (two malathion sprays at 20 days interval) is thought to lie in the difference in the incubation period resulting in a considerable proportion of the eggs hatching after the end of the spray period.

#### Cotton

344. Cotton is probably more beset by pests than any other tropical crop so that cotton growing can hardly survive without some attention to their control, if only by legislating for a close season for the host plant. A great deal of investigation of cotton pests is going on, in British territories largely by the Empire Cotton Growing Corporation and Departments of Agriculture. The account of special work given here does not by any means indicate the amount of entomological attention given to the cotton crop. The main pests reported on are grouped according to the kind of damage they do.

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345. *The Bollworms.* Species of *Diparopsis* in Africa are in places serious threats to the crop. In *Aden* they are usually of minor importance, but seem to fluctuate in successive years according to the area of land watered in relation to the cotton acreage of the preceding year. Thus there is a high incidence on cotton situated in or surrounding unwatered land cropped with cotton the previous year, and conversely a lower incidence in cotton growing on large areas uncropped the previous year. The emergence of moths over the two months following watering (in *Aden* only one flood watering is given) consequent on a reduction of soil temperatures occurs in large part before the crop is suitable for breeding. The interception of the main moth flight after watering by stand-over cotton or cotton sown very early has been shown to result in locally high incidence of Red Bollworm. Weekly applications of 0.125 per cent. endrin emulsion at high volume kept the crop virtually free of this pest.

346. In *Antigua* Pink Bollworm required control and trials with insecticides were made. In *Kenya* American Bollworm (*Heliothis armigera*) causes considerable damage but insecticide sprays can give good control. Full insect control at Msababa Cotton Research Station gave a 75 per cent. increase in crop value, which was less than in former years due to a lower pest incidence. In *Northern Nigeria* it is estimated that sprays can increase the crop by 80 per cent. over unsprayed. In *Northern Rhodesia*, in a year of generally light insect attack, insecticide sprays gave an average yield increase of only 25 per cent., American Bollworm being the principal pest.

347. A special Cotton Pest Research team, with C.D. & W. help, is based on Nyasaland for studies on *Diparopsis* and stainers. A detailed study of the life history of *Diparopsis castanea* has been made in Nyasaland and Southern Rhodesia (Gatooma Station) and its habits observed throughout the day and night. These have revealed, amongst other things, that egg mortality is generally high, about a third being carried off by ants, a third unaccountably lost and only a third hatching. The first instar larvae suffered about a 30 per cent. mortality, many dying for no apparent cause before penetrating the cotton plant. Fifth instars, on leaving the boll, suffered about 6 per cent. loss before reaching pupation sites. The mortality from the time of larval penetration of the plant to moth emergence averaged 98 per cent., ants accounting for a large share. The Pentatomids *Macrorrhaphis* sp. and *Agonoscelis versicolor* Fabr. were also recorded as predators. Despite this heavy mortality Red Bollworm contrives to remain a most serious cause of loss of cotton crop in many parts of Africa.

348. Studies were continued on overwintering pupae and moth emergence as influenced by depth of pupation and temperature. Studies on chemical control failed to find any insecticide which prevented development of the egg. First instar larvae can be killed as they eat their way out of the egg, Sevin being particularly potent against *Diparopsis*, but against *Heliothis* DDT was more effective. In field trials it was found that D2 Hollow Cone Disc jets gave better coverage than Conejet Y6 tips. Endrin gave good control of *Diparopsis* but did not effectively control *Heliothis*, which was more susceptible to DDT.

349. In *Uganda* a detailed study was started on the biology of the Spiny Bollworm (*Earias* spp.). Analysis of previous work leaves no doubt that bollworms, of which *Earias* is the most important, are by far the major pest

of cotton in Uganda. Results at Kawanda show that *Earias* has two main peaks of emergence corresponding to the June/July planting season and the October/November period of boll-setting. Practically every wild Malvaceous plant is an acceptable alternate host. Spraying experiments at Serere combined with dates of planting confirmed the benefits from early planting but showed there was no benefit from starting spraying earlier than First Flower. The insecticide was DDT at 1 lb./a, four applications at 10 days interval being best. The Pink Bollworm, *Platyedra gossypiella*, was recorded for the first time in Southern Rhodesia on cotton and *Hibiscus dongolensis*. It had been previously recorded in Nyasaland but had not been seen since 1943.

#### Stainers

350. The principal work on stainers (*Dysdercus* spp.) was done by the Cotton Pest Research team in Nyasaland. There were, however, many straightforward spraying trials in other territories in which stainer control played a part. In *Nyasaland* a long-term experiment on the effect of removing the principal pre-rains alternate host of *Dysdercus* was continued on 50,000 acres using 40 small observation plots for stainer population observations. These observation plots were in concentric circles within the trial area. In the early part of the season *Dysdercus* populations were highest near the periferæ, but later became highest near the centre, probably due to movement from the outer cotton fields inwards. The stainer population was generally low and yields were fairly high. Aboricide trials for killing the alternate host, *Sterculia africana*, were made but none of the non-toxic materials were quicker than ring-barking the trees, 1½ in. deep at breast height, which kills the tree in about two years. Studies on biotic control of *Dysdercus* were handicapped by generally low populations of the pest. No difficulty was encountered in breeding considerable numbers of the predator, *Phonoctonus nigrofasciatus*, since this was fed mainly on *Odontopus* spp. Natural control of *Dysdercus* due almost entirely to predator activity occurred in a number of instances.

#### Mites

351. In Uganda Red Spider Mite (of the *Tetranychus telarius* complex) was more than usually prevalent but this did not seem to be related to the spraying programme. One of the worst attacks was in an area where no spraying had ever been done. It appears to be related to senescence in many cases, and because sprayed cotton matures earlier than unsprayed, it tends to receive an early build-up of the mite population. Where sprayed cotton is attacked, any unsprayed cotton in the vicinity will show attack within a week or two. Nevertheless, it is apparent that the present spray recommendation is finely balanced in respect of red spider. The Tea Mite (*Hemitarsonemus latus*) does not at present seem to be a serious pest of cotton in Uganda, and DDT controls it.

#### White Flies

352. Work on species of *Bemisia*, some of which include cotton in their host range, was carried out by the Federal Department of Agricultural Research in *Nigeria*. Experiments to determine the host selection mechanism of adults showed little olfactory sense but a reaction to light of wavelength below 0.35 microns and to yellow. A collection of Aleyrodidae made near Ibadan included many species and some genera not previously reported from

Nigeria. The parasite *Prospatella* sp. has not been found to parasitise *B. tabaci* in the field even when it is active in *Bemisia*-infected cassava nearby.

#### *Cowpeas*

353. Nigeria has reported attacks on cowpeas by a beetle of the Family Buprestidae, a type of damage which has not been seen mentioned previously in the literature.

#### *Groundnuts*

354. Seed dressing of groundnuts in the Gambia has hitherto been done with an organo-mercurial dust. Attempts to find a less toxic material have shown that preparations containing thiram appear superior to organo-mercurials.

#### *Maize*

355. A number of stem borers are everywhere found damaging this crop and in many territories where they are serious trials continue with insecticides, generally as dusts, to control them. Few of these trials are reported in any detail, though they are known to be widely carried out. The Colonial Pesticides Research Unit in Tanganyika have also studied this problem (see C.P.R.C. Report). In *Basutoland* liquid formulations were found preferable to dusts. Aerial applications at 5½ galls/acre from a Piper aircraft applied at a constant cost rate and compared to similar doseages by ground application showed that the latter was preferable. Both DDT and endrin were effective.

356. In parts of *Kenya* (Trans Nzoia) there were severe attacks by chafer grubs (*Selizonycha* spp.) which did not yield satisfactorily to sprays of dieldrin nor chlordane.

#### *Pigeon Pea (Cajanus cajan)*

357. Some success has been obtained in *Mauritius* with biological control of pigeon pea pod borers, damage falling to 5 per cent. in some areas and not over 15 per cent. in others. The parasite *Bracon cajani* Mues. and *Eiphosoma annulatum* Cress have thrived well while *Phanerotoma bennetti* has not been recovered from the field. *Heterospilus etiellae* has lately been introduced and released.

#### *Rice*

358. *British Guiana* reported bad attacks of Rice Water Weevil (*Lissorhoptrus simplex*), particularly in late broadcast rice, resulting in much yield loss over 10,000 acres. Drainage difficulties hindered control. Damage by the caterpillar *Laphygma frugiperda* was controlled with dieldrin. In *Fiji* Rice Leaf-hopper, a possible vector of Rice Yellow, was under study.

#### *Sorghum*

359. Stem borer attacks on sorghum are everywhere prevalent. The aerial spraying trial already mentioned under Maize in *Basutoland* included sorghum plots. In *Bechuanaland* aphid attack treated with a systemic insecticide gave increased yields. Studies on the sorghum midge (*Contarinia* spp.) were continued by the Federal Department of Agricultural Research in *Nigeria*. Midges reared from *Andropogon gayanus* were morphologically indistinguishable from the sorghum midge, *C. sorghicola*. If biological tests

show that they are identical then *A. gyanus* must be classed as an important alternate host of the pest. Matings between midges from both hosts have been observed but no evidence of the viability of these matings has been obtained.

360. By classing sorghum stems according to generations of borer (*Busseola fusca*) it was found that stems bored by the first generation produced the lowest yield. By the third generation most of the stems had been attacked, but had little effect on yield. Two unrecorded parasites of stem borers were reared, one a Tachinid and the other a Chalcid. A parasite, *Syzeuctus* sp. (Ichneumonidae), was found diapausing in larvae of *Coniesta ignefusalis*. A new record for Nigeria is the stem borer *Manga basilinea* Bowden, found in millet.

361. In *Northern Rhodesia* one of the chief pests of sorghum is birds, from which sorghum suffers damage almost everywhere. The breeding programme seeks, amongst other characters, resistance to bird damage, but the resistance may only be relative. Bird damage has been most severe on dwarf, early-maturing varieties which have been sown early in the season. Though potential yield may be higher with early sowings, the concentration of birds on the first available grain vitiates the general recommendation to plant early unless it is possible to give effect to it over wide areas simultaneously.

#### *Sugarcane*

362. In *Barbados* the mass liberation of *Trichogramma minatum* has been the standard method of control of the moth borer, *Diatrea saccharalis*, for 30 years, but it is ineffective. Liberations did not reduce *Diatrea* potential (the number of eggs hatching per cane), and were often greatly outnumbered by the natural parasite population. The campaign to introduce the larval parasite, *Lixophaga diatraeae*, was continued and four strains were obtained from different islands and crosses made between them. The results so far, though not spectacular, are quite promising. Varietal resistance between canes to borer attack are being followed up. Root borer, *Diaprepes abbreviatus*, against which insecticide trials were laid down in 1957, has been shown to be controllable with dieldrin, which is now recommended. Endrin gave good control of cane root mealybug (*Rhizoecus* sp.) but better cultivation and a shorter ratoon is recommended. The Jumping Borer, *Elasmopalpus lignosellus*, was recorded in Barbados for the first time in 1959. It was associated with fields of cane which had not been mulched.

362. One of the periodical outbreaks of rats occurred in *British Guiana* and much damage was done to sugarcane and rice for a time. Arrangements were made for a specialist officer on rodent control from England to visit the colony. He was able to carry out a study of the problem and to devise control measures based on poison pellets containing endrin and zinc phosphide. In *St. Kitts* treatment of setts to control mealy bugs with lime water and insecticide dips showed that an insecticide is necessary in the soaking water to give some measure of control. In *Trinidad* an attempt is being made to control frog-hopper by dissemination of spores of *Metarrhizium anisopliae*.

363. A study of the nematodes of sugarcane fields was continued in *Mauritius*. A reference collection is being built up. A number of phytophagous nematodes have been recorded in and around cane roots, sometimes in large numbers. The species encountered which are possibly harmful include the root-knot eelworms (*Meloidogyne* spp.), lesion nematodes of the genus *Pratylenchus*, the burrowing species *Radopholus similis* as well as others. Damage to cane in *Mauritius* does not appear to be generally severe except on an area of sandy coral soil. Soil disinfection with ethylene dibromide showed improved growth and yield of cane but the cost was prohibitive. Work on the stalk borer, *Proceras sacchariphagus*, included the introduction of parasites from the Indian station of the Commonwealth Institute of Biological Control and observations on differences in varietal susceptibility. Estimates of the damage to cane by loss of sugar from attacks by the scale insect, *Anacaspis tegalensis*, varied from 30 to 46 per cent., damage being most severe in droughty areas. The introduced parasite, *Tytthus mundulus*, of the leafhopper, *Perkinsiella saccharicida*, appears to be well established.

#### Tea

364. As in the case of sugarcane, the tea producing industry is largely responsible for research on the crop. In *Mauritius* the aphids *Toxoptera auranti* B.d.F. and *Macrosiphum (Sitobion) africana* H.R.L. have been causing severe curling of young tea leaves. Though Dimecron and Rogor 40 will control these pests, it is necessary to investigate possible taint. The soft brown scale, *Coccus hesperidum* L. has been found to damage young tea plants considerably.

#### Tobacco

365. Tobacco Leaf Miner, *Gnorimoschema opercuella* Zell., and the aphid *Aphis gossypii* Glov., were well controlled in *Mauritius* with Dimecron, which also controlled budworm. A new species of mite was found damaging tobacco seed beds.

366. In *Mauritius* the fruit fly, *Pordalaspis cyanescens* Bezzi, which was found attacking tomatoes in the northwest of the island in 1958, has now spread widely. Dipterex sprays have given good control and at the same time have suppressed American Bollworm which also damages tomato. A new acarine pest, *Vasates lycopersicae* Masee, has been discovered. It, and also *Tetranychus marianae*, can be controlled with several acaricides.

#### Wheat

367. In *Cyprus* further investigations were made into the biology of the leaf miner, *Syringopais temperatella*, and into the influence of rotation practices on the insect, but exceptionally light infestations hindered the work. In *Kenya* serious damage to wheat by *Nematocerus* weevils has necessitated undertaking a high priority investigation of the pest.

#### Yams

368. The yam beetles, mostly *Heteroligus claudius*, continue to call for study in *Nigeria*, where they can be very destructive. The Federal Agricultural Research Department found that earlier planting increased beetle

damage but, on the other hand, late planting reduced yields. The method of cultivation, on mounds, ridges or on the flat, appeared to influence the degree of attack. Egg development in relation to moisture showed that hatching was prevented under dry conditions. Insecticidal dusts containing BHC or aldrin applied to setts controlled larval attack by *Eulepida reichei* and aldrin reduced adult attack. It was possible to get fairly good control of yam beetle by treating early planted yams in the planting hole with BHC and aldrin, but it was uneconomic to do so. In the *Eastern Region* of Nigeria it has been decided to give up the use of BHC for yam beetle control and to substitute aldrin.

#### *Ornamentals*

369. *Bermuda*, whose tourist industry is of great importance, has suffered badly in appearance by the destruction of the endemic cedar trees and by damage to oleanders. Recently the casuarinas, planted to replace the dead cedars, have been infested by spittle bugs, *Clastoptera undulata*. It is a fairly common pest of *Casuarina* spp. in some West Indian islands and in Southern Florida but had not been seen in Bermuda before 1958. While *Clastoptera undulata* is not considered a serious pest of casuarinas in the Caribbean, it is impossible to foresee its behaviour in Bermuda where it may be free of natural enemies. Detailed studies of its life history have been started and insecticide trials have shown promise. The nymphal and adult stages can be controlled with both malathion and dieldrin, the latter being capable of killing newly hatched nymphs for a month or more. The Commonwealth Institute of Biological Control is undertaking studies on the natural enemies of the pest. Small shipments of an encyrtid parasite, *Carabunia myersi*, from Puerto Rico have been received and arrangements made to receive more.

370. Studies on the juniper scale *Carulaspis minima* Targ., suggest that it is not spreading so rapidly as it was eight to ten years ago. Cedars remaining alive, and those putting out new growth, may have some resistance or there may be a loss of virulence on the part of the scale insect.

371. Both oleander scale (*Pseudaulacaspis pentagona*) and green shield scale (*Pulvinaria psidii*) continued as pests of importance on oleander. Shipments of parasites and predators were received at various times during the year through the Commonwealth Institute of Biological Control. Beneficial species liberated for the first time in Bermuda included the coccinellids *Cryptolaemus affinis*, released against the green shield scale, and *Chilocorus circumdata*, a predator of the oleander scale.

#### *Snails.*

372. Two species of predaceous snails were introduced into *Bermuda* in the hope of reducing the numbers of the phytophagous snail *Otala lactea*. Three shipments of *Euglandina rosea* and one of *Gonaxis kibweziensis* were received from Hawaii. The former species now seems established in several parts of Bermuda.

373. In *Mauritius* the introduced predator, *Lamprophorus tenebrosus*, of the Giant African snail appears to have failed and has not been recovered in the field. *Euglandina rosea* is being bred up in the laboratory prior to

release. Snail baits based on meta have been effective against both the Giant African Snail (*Achatina fulica*) and against *Helix aspersa*. (See also Report of the Colonial Pesticides Research Committee.)

### Birds

374. Observations have been made by the University College of Nigeria on the bird pests of millet in the Northern Region. The major pests are *Ploceus cucullatus*, *Quelea quelea*, *Euplectes orix* and *Spermastes cucullatus*, *Quelea* being regarded as the worst menace to millet. A large number of other birds were noted as causing damage, mostly other species of Ploccidae and including *Q. erythropis*. Little is known of this bird, which may turn out to be a major pest of rice. A survey of *Quelea* is being made and its breeding habits studied.

### General

375. A survey was made of insect pests of *St. Helena* by a member of the Colonial Pool of Entomologists. The work was largely concerned with biological control measures against the eucalyptus snout beetle, *Gonipterus scutellatus* Gyll., and control of various miscellaneous garden pests. A full survey of insect pests of the island was made.

376. The taxonomic study of the mealybugs of East Africa was continued. A monograph on the genus *Ceroplastes* from Africa was carried further. Several new species of coccids were isolated and the nomenclature sorted out. A grant was made in aid of the publication of "Agricultural Insects of East Africa", 1908-1956 by Dr. Le Pelley.

### Publications

DE LOTTO, G.—"Further notes on the Ethiopian species of the genus *Coccus* (Homoptera: Coccoidea: Coccidae)." *J. ent. Soc. S. Africa*, **22** (1959) 150.

DE LOTTO, G.—"Two new Margarodidae (Homopt: Coccidea) from Kenya." *J. ent. Soc. S. Africa*, **22** (1959) 385.

BROWN, S. W. and DE LOTTO, G.—"Cytology and Sex ratios of an African species of armored scale insect." *Amer. Nat.*, **93** No. 873.

LE PELLEY, R.—"Agricultural Insects of East Africa, 1908-1956."

HARRIS, K. M.—"Notes on gall midges (*Cecidoemyiidae*) on Nigerian crops with a description of a new species of *Thomasiella* Rubsaamen." *Bull. ent. Res.*, **50** (1960) 661.

WILLIAMS, C. N. and CASWELL, G. H.—"Insect attacking *Striga*." *Nature, Lond.*, **184** (1959) 1668.

CASWELL, G. H.—"The reference collection of insects in the Faculty of Agriculture, University College, Ibadan, 1959 (Mimeo)."

### PLANT PATHOLOGY

377. In this section work on plant pathological problems is reported where it was not done by the major research institutions whose reports will be found in Sections II and III. A good deal of routine work on plant

disease control is carried on in addition to that mentioned in this section, which only refers to instances specifically reported during 1959-60. Breeding for disease resistance is included under Plant Breeding.

*Abaca. (Manila Hemp)*

378. In *North Borneo* the Bunchy Top disease of abaca which has menaced the industry in the past has been kept under control. Studies on the disease, which could not be maintained for experimental purposes on commercial estates, have been hindered by difficulties in establishing abaca at the Experiment Station at Tuaran. Virus transmission studies were impossible because no plants developed bunchy top symptoms. Corms from infected mats transferred to Tuaran failed to produce symptoms, as did corms of edible bananas and wild species. The pathogen of Stem Rot, *Helminthosporium torulosum*, was isolated from abaca sheaths.

*Bananas*

379. Considerable research continued on Leaf Spot disease in the West Indies. This was carried out mainly by the All-Island Banana Growers Association in *Jamaica* and by commercial concerns. For the first time Leaf Spot, *Mycosphaerella musicola* Leach, was recorded in *Mauritius* on the dwarf banana, the most important local variety. Two other leaf spots caused by *Cordana musae* (Zimm.) von Hohn and *Deightoniella torulosa* (Syd.) M. B. Ellis, were also recorded in the island for the first time. In *Trinidad* the Moko Disease or Bacterial Wilt (*Pseudomonas solanacearum*) was most active in soils in the pH range 7.4 to 7.6, which is the most favourable range for bananas.

*Barley*

380. Seed dressings of 20 to 40 p.p.m. of Hg gave good control in *Kenya* of seed-borne infections of *Pyrenophora teres*, *Cochliobolus sativus* and *Rhynchosporium secalis*.

*Cassava*

381. Apart from Cassava hybridisation work for resistance to mosaic virus little work has been done on the virus itself. In *Nigeria* successful graft transmissions of mosaic virus have been made, but masking of leaf symptoms in the insectary due to high temperatures has prevented the identification of cassava mosaic virus strains. Transmissions are also being carried out to determine the vector of vein banding, a suspected virus disease distinct from mosaic.

*Citrus*

382. In the Western Region of *Nigeria* studies were made of citrus fruit blemishes and on the tristeza virus in citrus. Bordeaux mixture successfully eliminated lichens on citrus trees.

383. A disease of grapefruit in *Trinidad* with symptoms somewhat like those caused by tristeza virus could not be transmitted. Neither could a Lime Dieback disease which has symptoms suggesting a virus cause. Withertip of Limes in Zanzibar was the subject of a special study by a member of the Pool of Plant Pathologists (paragraph 192).



*Cocoa*

384. Most of the research on diseases of cocoa is carried out by the West African Cocoa Research Institute and the West Indies Regional Research Centre. (Paragraphs 113, 117, 158, 159.) In *North Borneo*, where there has been considerable interest in developing cocoa production on basaltic soils, records of expected diseases on cocoa have been made. Pod rots due to *Phytophthora* sp. (probably *P. palmivora*) were recorded on Old Criollo cocoa and Amelonado. Amongst new plantings Brown Pod Rot (*Botryodiplodia theobroma* Pat.) has appeared following capsid and borer damage to pods. Damage was not severe. A *Fusarium* was also isolated from pods damaged by pests. Other records include Pink Disease (*Corticium salmonicolor*) and a white thread blight, neither serious.

385. The presence of Cushion Gall is confirmed in the Western Region of *Nigeria*, from at least three localities and a detailed survey is being made. It appears to be of minor importance in *Nigeria*. Fungicidal treatments of seedling wilt caused by *Ph. palmivora* gave varying degrees of control in cocoa nurseries.

386. It has been confirmed that there are at least two viruses of cocoa in *Sierra Leone*, although not commonly, and there may be a third. A cocoa virus survey unit has been formed and a reconnaissance survey is in progress. Trials of fungicides against Black Pod were designed to explore the possibility of lengthening the interval between applications and to test the efficiency of various sprayers and formulations. The most satisfactory control was obtained with carbide Bordeaux mixture applied every three to four weeks with a Mysto No. 155 sprayer. A Black Pod control campaign is being organised through co-operatives.

387. In *Trinidad* the borer-transmitted disease caused by *Cerastomella* was partly controlled by toxaphene sprays against the vector. There is some indication of susceptibility differences between I.C.S. clones, but whether this is a resistance towards the fungus or a differential preference on the part of the insect is not known.

*Coconuts*

388. Mysterious diseases afflict coconut in different parts of the world, being often attributed to viruses in default of any obvious parasite. In *Jamaica* work was continued on the Lethal Yellowing disease, but without much progress. Assessment of resistance amongst dwarf varieties showed that St. Lucia dwarfs were not immune because two trees died of the disease, but they may be highly resistant. Fiji dwarfs have not so far succumbed. Examination of possible nematode vectors of a virus, in collaboration with the Florida State Plant Board, who are interested in the disease since its appearance in Key West, showed that a species of *Rotylenchus* was frequently associated with the disease, but this cannot be claimed as more than a coincidence.

*Coffee*

389. The principal research on coffee diseases was done in East and Central Africa. A lot of work was done on coffee rust (*Hemileia vastatrix*) in *Kenya*. Fungicide trials were aimed at detection of damage to the coffee from commonly-used copper fungicides, captan and mineral oil. No adverse

effects were seen, nor was there any scorch from copper sulphate sprays at 0.1 per cent. Higher concentrations are now being tried. The main work on coffee rust was transferred to the team working on Coffee Berry Disease since fungicides used against one disease influence the other. The C.B.D. team found that copper formulations were generally better than captan, but time of application was critical for best results, being February–March for most districts, but in some districts (Mweiga and the West Rift) a second application in June–July is necessary. A detailed investigation has been undertaken of the relationship between meteorological conditions and disease incidence with the object of predicting attacks of rust. Though captan applications have given excellent results when applied over the period February–April, it has been found that copper sprays in the period October–November remain effective over two or more epidemic cycles, whereas captan is effective for only one. Spore dispersal studies have shown that wind is not the main agent of dispersal in these areas.

390. In *Nyasaland* the disease caused by *Fusarium lateritum* continued to invade plantations a few years after establishment and is causing anxiety. A pathologist has now been appointed to work on the disease under a C. D. & W. research scheme.

391. A large programme of work on coffee diseases was continued in *Uganda*. Epidemiological studies on rust confirmed the Kenya observation on spore dispersal by the low number of uredospore captures in the First Spore Trap. A sampling method being used to measure the intensity of rust attack in the field has proved more sensitive than earlier techniques. The selection of host varieties for the differentiation of the races of *H. vastatrix* is in progress, after first evolving methods for the culture of the rust on seedlings and detached leaves as multiple, discrete and individually identifiable infections. Coffee Berry Disease (*Glomerella cingulata*) was found in *Uganda* for the first time in a trial of Arabica varieties at 6,200 ft. in North Bugisu. The variety “French Mission” was most severely attacked. The whole trial was uprooted on this discovery and the “French Mission” variety has been removed from other trials in Bugisu.

392. On Robusta coffee an undescribed fungal disease has been causing concern since 1953. Spread is slow but the foci of infection are numerous and widespread. Starting as red blisters on the green berries, severe infection causes heavy abscission and a total loss of crop.

#### *Cotton*

393. Like most research on cotton, the work is nearly all in the hands of the Empire Cotton Growing Corporation, though application of control measures, where practicable, falls to the territorial departments of Agriculture. In *Aden* a type of root rot continues to give concern, but whether it is primarily due to a pathogen or to a soil condition is still uncertain. Isolates have been made of a number of possible weak pathogens none of which appear likely to be primary causes of the disease. The variety “Wilds Early” has shown high resistance to the disease, but this may be due to a difference in root habit.

394. In the Eastern Province of *Tanganyika* it has been found that bacterial blight is more damaging than had been thought previously and

another officer has been posted to Ilonga to breed resistant varieties. In Uganda a large 15-acre trial of different seed dressings to control bacterial blight showed no significant differences.

#### *Cowpea*

395. Research at the Federal Department of Agricultural Research, Nigeria, on Yellow Mosaic virus of cowpea has failed to find any alternate host. Transmission between cowpeas is readily effected by the Galerid beetle, *Ootheca mutabilis*, which is easily controlled by insecticides and virus spread much reduced thereby. Roguing does not check the spread when the beetle population is high.

#### *Loquat*

396. Loquat scab (*Spilocaea eriobotryae*) in Cyprus called for attention and trials gave good control with lime sulphur and cupravit at 3 per cent. and 0.625 per cent. respectively. Two applications were made before the opening of flowers and four after fruit set at 15 day intervals.

#### *Maize*

397. Rust disease research is reported under the West African Maize Research Unit (paras. 275 to 276). Maize bred in 1958 from stocks resistant to *Puccinia polysora* and released to the Shimba Hills Settlement Scheme in Kenya appears to be well suited to the area. In Mauritius both *P. polysora* and *P. sorghi* were found controllable with zineb. The leaf spot, *Ascochyta zaeae* Stout., was recorded for the first time in the island. In Northern Rhodesia a widespread yellowing of leaves following heavy rain may be a zinc deficiency. Maize streak virus was again widespread.

#### *Pears*

398. Satisfactory control of Pear Rust (*Gymnosporangium sabinae*) in Cyprus was obtained with copper sprays applied from early June onwards at 12 day intervals.

#### *Pepper*

399. A Pool Plant Pathologist continued work on root rot of Pepper in Sarawak. Only 12 outbreaks of the disease were reported in 1959, but it must still be regarded as dangerous. The method of spread in the soil can now be predicted with considerable certainty and measures to prevent the ingress of the disease into gardens have been devised, such as fencing and the sterilisation of tools and feet before entering a garden. The absence of the disease in vines under two years old remains characteristic and is explained on the theory of escape due to the time required to build up a heavy infection and some chance avoidance. A suspected virus affecting young and mature vines and causing stunting and reduction of crop was reported.

#### *Potatoes*

400. Selection and breeding for resistance to Late Blight (*Phytophthora infestans*) was continued in Kenya where 34 varieties were imported from seven sources for evaluation of performance and resistance. A colony-wide survey of bacterial wilt was started and many examples of the disease were collected from all areas but specially from the Embu district; Jamaica and Mauritius concentrated on Late Blight control by fungicides where several

formulations were found satisfactory, with copper compounds best. *Northern Rhodesia* tested numerous varieties for resistance to Late Blight.

#### *Pimento*

401. Rust disease (*Puccinia psidii*) was found controllable in *Jamaica* with Dithane Z-78 at 3 lb./100 galls. as a low volume mist spray.

#### *Rice*

402. Blast disease (*Piricularia oryzae*) caused losses in several territories and called for attention. *British Guiana* found that spraying with an organo-mercuric compound (Verdasan) at 1 lb./acre in three pre-flowering applications gave good control. *British Honduras* recorded the virus disease "Hoja blanca" which was damaging in restricted areas and a search for resistant varieties is necessary. In *North Borneo* there were records of several diseases of rice, including *Piricularia oryzae*, *Cochliobolus miyzeanus*, *Trichoconis padwickii*, *Nigrospora* sp. and *Curvularia* sp. All were controlled with a copper fungicide.

#### *Sorghum*

403. The only fungus disease of this crop attracting attention was the Grain Smut, *Sphacelotheca sorghi*. Seed disinfection with various fungicides was tried in a number of territories and in some, campaigns for seed treatment are under way. Research on the Witch Weed parasite, *Striga* spp., was done in *Nigeria* (University College) and included investigations of the effects of mineral nutrition and soil factors on the host/parasite relationship. Studies are being made on the effects of endogenous and environmental factors on the germination and growth of *Striga* seedlings. Fundamental work on this parasite is also going on in the United Kingdom.

#### *Tobacco*

404. Leaf spotting diseases were everywhere present to a greater or lesser extent on tobacco. *Mauritius* gave attention to Brown Spot (*Alternaria longipes*) which was most severe during hot, wet months. Early harvest of mature leaves is urged as a partial control. A search for alternate hosts of the Frog Eye Spot (*Cercospora nicotianae*) revealed senile tomato leaves as one host. The same disease is important in *North Borneo*. There was a high incidence on smallholders fields where even young nursery plants were attacked. Copper spraying of nurseries and removal of diseased leaves was tried. Areas in *Keningau* were infected with bacterial wilt (*P. solonacearum*) necessitating lengthy crop rotations and removal of alternative hosts. Frog Eye and Anthracnose were reported as prevalent and damaging in *Northern Rhodesia*, as well as virus diseases.

#### *Tomato*

405. In *Mauritius*, *Stemphylium solani* Weber was isolated for the first time and its pathogenicity proved. It caused yellowing and drying of tomato leaves.

#### *Vanilla*

406. Cases of diseased vanilla vines on Mahé and Praslin islands in the *Seychelles* were found to be due to *Glomerella vanillae*, the fungus which was believed to have wiped out the vanilla industry in the islands at the beginning

of this century. Fearing a resurgence of the disease, sanitation precautions, including burning of infected vines, were adopted, and adjacent healthy vines sprayed with Bordeaux. These precautions appear to have checked the disease.

#### Survey

407. In the British Solomon Islands Protectorate a survey of plant diseases was carried out with the assistance of F.A.O. The diseases recorded were those pan-tropical ones which would be expected.

#### Publications:

FELIX, S.—“A List of *Cercospora* occurring in Mauritius, with short notes on the newly recorded species of some economic importance.” *Rev. agric. Maurice* (1960), 39.

CHANT, S. R.—“Note on the inactivation of mosaic virus in cassava (*Manihot utilissima* Pohl.) by heat treatment.” *Emp. J. exp. Agric.*, 27 (1959), 55.

CHANT, S. R.—“Investigations on a seedling dieback of *Theobroma cacao* L. in Nigeria. I. Description of the disease and its spread in the nursery.” *Trop. Agric. (Trin.)*, 36 (1959), 138.

CHANT, S. R.—“Viruses of cowpea, *Vigna unguiculata* L. (Walp.) in Nigeria.” *Ann. appl. Biol.*, 47 (1959), 565.

CHANT, S. R. and BECK, B. D. A.—“Effect of cassava mosaic virus on the anatomy of cassava leaves.” *Trop. Agric. (Trin.)*, 36 (1959), 231.

CHANT, S. R. and HALL, T. R. H.—“Investigations on a seedling dieback of *Theobroma cacao* L. in Nigeria. II. Factors affecting the incidence of the disease and its control.” *Trop. Agric. (Trin.)*, 36 (1959), 145.

THOROLD, C. A.—“Methods of controlling black-pod disease (caused by *Phytophthora palmivora*) of *Theobroma cacao* in Nigeria.” *Ann. appl. Biol.*, 47 (1959), 705.

#### PASTURES AND ANIMAL HUSBANDRY

408. While it is known that a lot of work is progressing on pastures and animal husbandry, the gathering of information has proved a little difficult so that this section of the Committee's report does not give a complete account of what is going on. Additional information from the large research organisations will be found in Section II.

409. The Nelthropp herd in *Antigua*, which is maintained for beef, was further increased and sires made available to peasants throughout the island. A certain amount of destocking has become necessary in the Greencastle area. Pastures of Pangola and Bermuda grasses continued to spread.

410. In *Bechuanaland* the eight long-term grazing trials to determine the optimum carrying capacity of natural pastures under different systems of management was continued. The one-herd two-paddock split season mid-summer to mid-winter system again gave the highest percentage seasonal liveweight increase of 34.8 per cent. Steers weighing 711 lb. at the end of October, 1958, weighed 959 lb. a year later, having reached a mean liveweight of 1,005 lb. in mid-August 1959. Results in 1959 of a cattle and goat grazing trial are that where goats have been grazed in addition to steers,

both the goat and cattle liveweights are less than where goats have been replaced by large stock animal units even though the goat is mainly a browser. The indications are that the availability of fodder for steers is decreased by the presence of goats and that their competition only becomes apparent from the beginning of the dry season. The goats pruned all the trees and shrubs up to their browsing height. Further comparative data are becoming available on maturity, liveweight increases and carcass grading of the indigenous Tswana cattle as compared to Afrikander and Afrikander x Hereford crossbred animals. Observations were made on a collection of 60 introduced grasses and fodder plants. Seed production pastures of the Witbank strain of *Eragrostis curvula* and of *Panicum maximum* were maintained.

411. The Committee has from time to time recommended substantial grants towards research in *British Guiana* on pasture improvement and animal husbandry on the Intermediate Savannahs. At the Ebini Livestock Station satisfactory progress was made and the herd now numbers about 1,000 head. Grading up is being done with Santa Gertrudis, Sahiwal and Brahman bulls. The progeny, particularly those from the Santa Gertrudis, show much promise and the Station is now able to supply good quality bulls to ranchers. Over 1,000 acres of improved pastures have been established, mainly with Pangola grass (*Digitaria decumbens*), and the carrying capacity thereby raised from one animal to about 60 acres to one animal per acre. On these poor, sandy soils it is necessary to apply NPK dressings in pasture establishment. Two-year old steers fed on improved pastures and given a minimum amount of trace-elemented bone flour have given liveweight increases of over a pound a day on average. At slaughter they have given carcass weight of 468 lb. average with excellent quality meat. The pastures are grazed rotationally at 3½ day intervals. Indications are that zinc and copper are likely deficiencies in the soils and herbage. Investigations on liver cirrhosis include examination of liver biopsy material at the Department of Pathology of the University College of the West Indies. A botanical survey by a botanist, kindly loaned from Kew, identified three species of *Crotalaria* (*C. retusa*, *C. maypurensis* and *C. stipularia*) in small quantities at Waranama, and poisoning by *C. maypurensis* is a possible factor involved in cirrhotic livers. Feeding trials with this species have been started, but the plant is scarce and difficult to obtain in adequate quantities. At the St. Ignatius Livestock Station in the Rupununi Savannahs similar attempts are being made to upgrade stock and improve the pastures but progress is handicapped by the long dry season. At the Central Agricultural Station on the coast trials of grazing grasses have again shown the value of Pangola and Coastal Bermuda grasses which, with dressings of sulphate of ammonia, give herbage with 10 to 12 per cent. crude protein on DM. On the deep peat soils at Horosoro Para grass (*brachiaria mutica*) and Locuntu grass (*Ischaemum timorense*) have done exceptionally well.

412. In *British Honduras* pasture trials were continued particularly on the effects of nitrogen dressing. These were found to confer only temporary benefits up to six weeks after application, even with large dressings of as much as 370 lb./ acre.

413. Two promising introductions into *Fiji* were Pangola grass and Buffet grass (*Pennisetum ciliare*). There appear to be two distinct strains of Pangola grass, one from Australia and one from Hawaii. The latter seems the

best suited to the wet areas of the island. There is need for grasses to develop the poor *talasiga* soils of Fiji. At present the two dominant species are Mission grass (*Pennisetum polystachyum*) and Wire grass (*Sporobolus indicus*), neither of which are much value as fodder. A series of trials in management of these soils and of grass establishment were started. Most of the preliminary troubles with zero grazing trials have been overcome and it is possible to keep cattle indoors for the whole year, but yields of the indoor cows are much below those of the outdoor animals, due largely to shorter lactations indoors. Santa Gertrudis heifers were imported from U.S.A. in 1959. The crossbreeding programme with Red Polls and Herefords continued and both the crossbreds are doing well and are heavier than the pure breeds, age for age.

414. In *Hong Kong* the experimental cross-breeding work using Middle White and Berkshire boars on local native sows was completed. The resultant crosses were very satisfactory animals well accepted on the local market. Litter size and development were good and a killing percentage of between 82 and 85 per cent. was obtained. The Middle White × Native cross was slightly superior in litter size and final pork production, but the Berkshire × Native cross tended to give a larger type of animal.

415. In *Jamaica* work was continued on pasture improvement particularly on management of Pangola grass pastures using irrigation and various fertilisers, and trials of introduced legumes and grasses, singly and in mixtures. Livestock breeding continued in efforts to raise productivity in beef and dairy cattle involving extensive culling of dairy cattle. Selection work on private farms was facilitated through appraisals with the objective of upgrading the national herd of cattle to the four tropically adapted breeds, Jamaica Hope, Jamaica Brahman, Jamaica Black and Jamaica Red. Research on nutrition designed to cheapen animal production was expanded. Successful trials were undertaken on the use of milk replacer in calf rearing. Chemical investigations were started on some industrial and agricultural by-products with a view to using them in animal feeds.

416. Grassland research in *Kenya* is a major feature of the agricultural research programme. At the Kitale Grassland Research Station there were 196 new introductions of clovers, grasses and other fodder plants. Some of the new strains of Red Clover showed up well in nursery plots. Other species which did well included a perennial variety of *Dolichos lablab*, *Glycine javanica*, *Vicia villosa*, *Paspalum commersonii* from Southern Rhodesia and *Panicum maximum* from Nyasaland. In preliminary grazing trials over four years, the best results with perennials were obtained with "Louisiana White Clover" (*Trifolium repens*), *Desmodium uncinatum* and "Hairy Peruvian" lucerne. The best annuals were "Dwalganup" subterranean clover and the less aggressive varieties of *Trifolium rueppellianum*. An interesting phenomenon has been the observation that certain wild bees transfer pollen of some species of grasses, which does not seem to occur in temperate countries. In the herbage agronomy work, further evidence was obtained on the merits of grass-legume mixtures compared with grass alone. The results confirm earlier experience that legume mixtures may be expected to yield more than grass alone, given correct management and fertilisers. Kenya White Clover, Louisiana White Clover and Lucerne are

the most important legumes for general purpose leys at Kitale. In comparisons of grasses under both clipping and grazing, Molasses Grass, the Chepararia, Mbarara, Mpwapwa and Endeless strains of Rhodes Grass and the newly introduced Coloured Guinea Grass (*Panicum coloratum*) were the best yielders.

417. Work continued on dry (late) season pastures. Evidence from three completed experiments shows that sowing of certain legumes, such as *Glycine javanica*, may be advantageous in dry season mixtures with such grasses as *Panicum maximum*. The "Gold Coast" and "Cameroons" varieties of elephant grass are the best for dry season grazing at Kitale.

418. Investigations of fertilisers continued. Indications of a magnesium shortage in the soil have received further confirmation, both with Lucerne and Kenya white clover. Earlier responses to gypsum have been confirmed this year by a response to pure sulphur by lucerne. Significant responses to potassium were obtained on *Trifolium rueppellianum* and a Rhodes grass to which a basal application had been given of triple superphosphate, magnesium and sulphur. The trend of the year's results is to provide further evidence of sulphur, boron and magnesium shortages and also evidence of potassium deficiency in addition to the well established deficiencies of nitrogen and phosphorus. Work now needs to be done to find what proportion of those elements to use in order to obtain the maximum economic crop production.

419. After several years' work first results are now beginning to show from evaluation of species or treatments by meat and milk production. A grass-clover ley was evaluated with and without the use of fertiliser over three years by means of beef production. In 1959 plots with fertiliser produced 473 lb. L.W.I. per acre compared to 284 lb. from control plots. The economic value of the increase is not very convincing yet and it took two years to pay for the fertiliser applied. In view of the work on soil deficiencies it may be that the NPS mixture was not the best to use. In another experiment in which milk production was compared from leys of grass-clover and grass alone, using pairs of identical twin heifers, the grass-clover ley produced significantly more milk.

420. There are now 85 acres under seed production on the Station and mother seed for the seed certification scheme is being produced for eight grasses and two clovers.

421. At the Molo Grassland Sub-Station previous findings that calcium and phosphorus are the main deficiencies were confirmed, but a significant response to magnesium was also obtained. Selection work with *Trifolium burchellianum* var. *johnstonii* has produced some promising plants for use in leys and there are some good varieties of *Phalaris tuberosa* in the collection which seem better than commercially available types.

422. At the Katumani Sub-Station dry weather showed the lack of persistence of Rhodes grass and work was concentrated on *Cenchrus ciliaris* which now seems to be the most generally useful ley for dry areas. Work on silage crops showed that in a dry season of only 7½ in. of rain, maize will still give as good a yield of dry matter as any other crop, though Bullrush millet is equally good and has the advantage of a higher protein content.



423. During 1959 the work of the Kamasia Pasture Research Sub-Station was centred on the rehabilitation and management of the semi-arid grasslands of the Rift Valley Province, with particular reference to the African areas. Trials on the technique of reseeding denuded grasslands are following lines suggested by earlier trials completed in 1959. Work on bush control has been widened to include a more critical evaluation of the Holt IXa bush clearing machine. Machines of this type have a negligible killing effect on the bush species of the *Tarchonanthus-Acacia* complex, and current work is concerned with the application of associated treatments aimed at arresting regeneration.

424. At Sotik Experiment Station useful residual responses to phosphate followed increases in the initial application to sown leys but no fertilisers have shown any economic improvement to natural grassland.

425. Kikuyu grass responded significantly to F.Y.M., phosphate and nitrogen at Kanja and the enclosure of cattle on the grass at night resulted in a 300 per cent. increase in grazing-days. Cattle feeding trials at Eldoret and Kitale showed that calves weaned off milk to a special meal at three weeks of age achieved only slightly slower liveweight gains than calves reared by conventional methods. The early weaned calves grew more evenly and there was a saving of labour and feeding-stuffs. A trial was attempted to compare the first crosses of Hereford, Aberdeen Angus and Red Poll on Boran for beef production and to compare yard-finishing with finishing on grazing. Results were inconclusive, but there appeared to be no advantage in yard-finishing. Work at Eldoret on pigs was concentrated on the correction of deficiencies in the protein complex found in a standard maize and meat meal ration. With direction from the East African Agriculture and Forestry Research Organisation, it was found that the addition of nicotinic acid cured the prevalent dermatitis, but alone was not sufficient to restore normal growth. Conversion ratios improved considerably with the addition of blood meal to the ration. It appears that local meat, notwithstanding its high protein content, may be deficient in certain essential amino-acids and should not be used as the sole source of protein for pigs.

426. Another attempt was made to produce Highland Mutton at the Eldoret Station. Corriedales again made very poor gains on both Rhodes grass and rape. Work on sheep is now being increased at a number of stations in the Colony.

427. Feeding trials on pigs by the Veterinary Department included a trial in which pigs were fed 78.5 per cent. of maize to 120 lb. liveweight and then 92.5 per cent. maize to bacon weight with a protein supplement and nicotinic acid and compared to pigs on a normal ration. The high maize fed pigs finished more quickly and showed better conversion efficiency, but were over fat and gave lower returns. Limiting the quantities fed did not improve matters. Supplements of chlorotetracycline and copper sulphate and a combination of both all improved growth rate and conversion efficiency of pigs to bacon weight.

428. The programme of producing improved stock of known economic value for issue to African areas was continued. While grading up to pure Sahiwal forms the major part of this work, selective breeding within the East African Zebu has received constant attention. A gradual rise in milk

production is being recorded for the Sahiwal with higher gradings and resistance to disease is improving comparable to that exhibited by the indigenous strains of Zebu. The demand for these improved animals is now far exceeding the supply from Veterinary Department farms and A.I. is being used more extensively in African areas.

429. *Mauritius* made many introductions of grasses and legumes which are to be tried in various ecological zones of Mauritius and Rodrigues. Several grasses have shown promise, particularly Pangola grass from Trinidad and *Digitaria pentzii* from South Africa, which appears to be identical with Pangola grass. In a preliminary rotational grazing trial it has proved possible to graze dairy cattle, which are normally stall fed and confined throughout their lives, during the night. Animals seem to be able to consume their requirements of roughage during this period and thus save the cost of hand feeding. Grazing during the daylight is impossible because of attacks by *Stomoxys* flies.

430. At the *Nigerian Federal Department of Veterinary Research* animal husbandry work included further observations on the Freisian × Zebu milking herd in which many of the animals are now entering their fourth lactation. New importations were made into the Large White pig herd and extensive culling of the old herd has been done. In the *Northern Region* the Agricultural Department has carried out digestibility trials with sheep and goats on 30 local fodders and four concentrates. The results provide a measure of the exceedingly low nutritive value of unimproved pastures which give less than maintenance requirements from October to May. Grasses are deficient in protein, providing less than 3.5 per cent. digestible crude protein, which is the minimum requirement for maintenance, between September and May. Silages are low in energy and protein and haymaking has proved a more efficient method of conservation. It is recognised that the only practical methods of rangeland management in Northern Nigeria are by control of burning and of the grazing animal. Investigations have shown that removal of bush growth improves the carrying capacity and that the bush layer can be reduced by preventing fire until the end of the dry season so as to give a hot burn.

431. A long-term programme of pasture research sponsored by the Federal Government was started in 1959 at the University College, Ibadan. An area of 12 acres has been laid out for grazing and species trials and for study of the changes in pasture composition under different treatments. An additional area of 25 acres in 5 acre paddocks has been prepared for comparison of various grass-legume mixtures. A group of 11 N'dama steers grazed continuously on Stargrass-Centrosema pasture increased in live-weight at 0.68 lb. a day from June to November, 1959. The root distribution of certain tropical pasture species is being examined and a study is in progress on seed production in tropical grasses with an attempt to select free seeding strains. Observations on the dairy herd of White Fulani cattle kept under conditions of moderate exposure to infection by trypanosomes have continued. The herd was established in 1950 and is housed in byres about 500 yards from a stream where *Glossina palpalis* is found. The animals have at various times shown trypanosome infection by *T. vivax* or *T. congolense* or both. Only two cows have so far received treatment for trypanosomiasis, the remainder, after showing various degrees of mild to fairly acute symptoms,

appearing to recover. This recovery may be due to the development of tolerance or a premunition to trypanosomiasis as a result of an adequate plane of nutrition and good management. Young draft bulls, on the other hand, broke down with trypanosomiasis, but could stand heavy work after prophylactic treatment with antrycide.

432. A programme of rotation crossing of closely inbred lines of Large White and Tamworth pigs has been started. Research is in progress on the value of certain local feeds for pigs, current work being on the value of dried cassava.

433. Studies continue on the performance of poultry under intensive, semi-intensive and extensive systems of management. Work on broiler production has started. Current experiments are to compare various breeds and crosses and also different mashes for broilers. A number of mashes have been tested for egg production and to determine the effect of thyroprotein supplements in the diet of second and third year layers.

434. In the *Western Region* pasture management investigations included the influence of height and interval of cut on yields and persistence of Gamba grass (*Andropogon tectorum*) and Giant Star grass, grazing trials with Giant Star and Guinea grasses alone and in mixtures and the production and consumption of six grasses in all mixtures with four legumes under bi-monthly harvestings. All legumes yielded more and made up a greater percentage of the stand at the second harvest. All grasses declined in percentage of stand except Pangola grass (*Digitaria decumbens*), which increased moderately, and Elephant grass (*Pennisetum purpureum*). The grasses used can be grouped in three classes: the two sod forms, Giant Star and Pangola, are the lowest yielders, but the most palatable; the three bunch grasses, Molasses, Guinea and Gamba, are intermediate in both respects; the Elephant grass is the outstanding yielder, but the least preferred.

435. In *North Borneo* the Keningau Livestock Station was extended and facilities improved. Grazing management of a herd of about 65 animals has involved very rapid rotation round 135 acre paddocks allowing one day in each with considerable improvement to the grazing. The grass, if not bitten down, is highalang (*Imperata cylindrica*). On Kubata Estate an outbreak of ticks had to be controlled by the installation of a dip. It is accepted that grazing under coconuts increases the yield of copra.

436. In *Northern Rhodesia* research on pastures and animal husbandry were transferred to the Department of Agriculture from the Veterinary Department. Work on the climatic adaptation of African cattle showed little difference in skin thickness between cattle indigenous to the tropics and those of the temperate zone, but the structure and, in particular, the sweat glands show considerable differences. The superior heat tolerance of the Zebu seems to be largely due to their possession of very large sweat glands. In the course of these investigations it appeared that accepted methods of defining heat tolerance in cattle are not reliable indications of the ability of cattle to withstand continuous high temperatures. Study of the growth and nutrition of indigenous cattle has revealed a faculty which they have for the virtual cessation of skeletal growth during periods of adverse nutrition, which enables them to withstand hard conditions without undue strain. It has also been found that indigenous cattle have a greater intake of food and a more rapid passage of food through the gut than

exotic cattle, and this may help to explain their observed ability to extract their requirements from large quantities of material of low nutritive value. The digestive juices of these cattle appear to be more saline than those of exotic cattle, and exotic breeds kept in Northern Rhodesia appear to have a higher salt content in the gut than the same breeds in temperate regions. It is suggested that the beneficial effect of a dry season salt supplement might be the maintenance of suitable conditions in the rumen for the digestion of materials high in cellulose. Supplementation studies indicate that a protein or carbohydrate supplement (1½ lb. groundnut meal or 1 lb. of maize meal per head per day through the dry season) produced no effect alone, but in combination they produced a substantial liveweight gain and a still greater gain with the addition of 1 oz. of salt a day. The addition of an iron and copper supplement produced a further gain, and analysis of the blood minerals of the cattle in July and October indicated that while all essential elements were present in adequate amounts in July, the October figure showed iron deficient and copper, sodium and chlorine barely adequate.

437. An attempt was made to assess the reproductive rate of cattle in African areas by examination of statistics in each province. Indications are that most cows in African areas calve only in alternate years and there is a high calf mortality. Poor nutrition is suggested as the main cause, aggravated by lack of control over breeding which results in many calves being born in the dry season when there is insufficient keep to ensure a good milk flow from the dam.

438. Grassland is not yet an important feature of African farming in *Nyasaland* but investigations are continuing on pastures. In one experiment *Setaria sphacelata* and *Panicum coloratum* produced more dry matter than Rhodes Grass. A carrying capacity trial was done using Rhodes Grass fertilised, unfertilised and interplanted with Pigeon Pea. This produced encouraging results in that the animals gained weight for eight or nine months of the year and showed that a reduced area of grass was sufficient when it was fertilised or interplanted with a legume.

439. Although tree crops have the greatest potentiality under high rainfall conditions in *Sarawak*, there have been trials with a number of grasses and legumes for pastures. *Brachiaria brizantha* in mixture with *Stylosanthes gracilis* and *Ischaemum timorense* show promise for grazing, while *Tripsacum laxum* and *Pennisetum purpureum* are best for cut fodder.

440. In the *Somaliland Protectorate* work on contour-ploughed land showed that Sudan Grass could be successful with only 12 inches of rain between May and October. The local grain/fodder sorghum was better adapted than any introduced varieties under terraced conditions and under flash irrigation.

441. Long-term cattle breeding was continued in *Tanganyika* with particular attention to the crossbred Indo-African Zebu for dual purpose production, and the breeding of Boran and the European × Zebu crosses for coastal dairying. An experimental Boran beef unit was built up and a number of managerial and physiological trials carried out on these breeds. The Boer goat gave good results when crossed with local goats.

442. Work on pastures, leys and animal husbandry in *Uganda* is carried on by the Agriculture and Veterinary departments, by the Empire Cotton

Growing Corporation as part of the rotation which includes cotton, and by the Agricultural Faculty of the University College of East Africa at Makerere. The part which grasses can play in the maintenance of soil structure and fertility has long been a major interest of the Department of Agriculture.

443. A detailed elephant grass experimental programme has been started to see if further improvements can be made in the management practices for this grass. Fields resting under elephant grass at Kawanda now produce the bulk of the farm's grazing, and the carrying capacity now approaches two beasts per acre. Early cuts have given up to 15 tons green material per acre, but subsequent yields show a marked decline. Elephant grass has given considerably more grazing days than short grasses. The presence of lucerne in leys of Rhodes Grass can stimulate the growth of the grass. Lucerne grows vigorously under Kawanda conditions and yields of from 17 to 27 tons per acre have been harvested. Pangola grass (*Digitaria decumbens*) recently introduced, grows well and appears to form a good mixture with short-growing legumes such as Kenya white clover. At Serere research on temporary leys was confined to Rhodes Grass, Guinea Grass and *Hyparrhenia rufa* in conjunction with *Stylosanthes gracilis* and *Centrosema pubescens*. The superiority of *H. rufa* in palatability to cattle was confirmed. *Stylosanthes* in mixture with grass gave greater total herbage production, better ground cover and apparently better liveweight gains per acre, than grass alone. On Serere soils *Stylosanthes* is very aggressive in competition with grass. This is due to its relatively low palatability during the wet season and to prolific seeding. Varietal selections and management practices may effect improvements. A fertiliser experiment suggests that nitrogen helps the grass in competition with *Stylosanthes*, but P and S without N increase the growth and vigour of *Stylosanthes* at the expense of the grass in the second year of establishment. The Veterinary Department investigated in detail the value of elephant grass cut and fed to housed cattle. Studies were continued on the effects of cutting and burning indigenous *Themeda* pasture. Further results became available on the effects on the pasture of a reduction of hippopotami in the Queen Elizabeth National Park. Studies were begun on the pasture weed *Cymbopogon afronadus*, and the principle of study of individual plants, their method of growth and spread, has also been applied to *Acacia hockii* with a view to its control.

444. The Agricultural Department continued to seek good cows for use in the Jersey × N'ganda crossing programme at Kawanda, using A.I. for N'gandas. Milk yields continued to improve and out of 40 cows all but three exceeded 100 gallons per lactation in addition to what the calves took. For comparison, in 1947 under good short grass management, only four cows out of 25 exceeded this figure. In 1958 the best lactation was 229 galls. (416 galls. if 45 per cent. is added for the calf) in 305 days. At Serere heavy selection for beef characters has been practised. The qualifying weight for bulls was 700 lb. at three years. Three bulls exceeded this weight, one reaching 932 lb. by 3½ years. The progeny test data from two bulls tested in previous years justified their return to use as proven sires. There was an attempt to introduce E.C.F. susceptible improved Boran stock to Serere. This involved the use of previously untried techniques such as antibiotic additions to feeds to protect animals while they picked up tick-borne infections during normal grazing. The first attempt was disastrous

(70 per cent. mortality), but subsequent introductions show much more promise (seven per cent. mortality in six months). The herd, which now comprises 27 heifers and four bulls, has shown a promising growth rate of 0.63 lb. per day for heifers compared to 0.31 lb. per day for local Zebu heifers of comparable age.

445. The Veterinary Department continued to develop the N'ganda herd at the Livestock Experimental Station, Entebbe, and cross breeding of Kenana with Shorthorn Zebu cattle was started. Twelve of the highest yielding N'ganda cows, all with recorded lactations exceeding 400 gallons, were inseminated with imported semen for the production of half-breed sires for a Jersey/N'ganda breeding programme which is to be undertaken. Comparative productivity studies on Ankole Longhorn and Zebu Shorthorn cattle were continued at the Mbarara Stock Farm and cross breeding of Boran and Ankole Longhorn was started. Preliminary results indicate that the beef quality and the conformation of the cows bred will be superior to the Ankole animals. Stocks and herds of indigenous sheep and goats were maintained for the collection of production data and cross breeding work has started using Dorset Horn and Toggenburg breeds.

446. Comparison of Boran crosses with local Zebu animals under ranching conditions in *Zanzibar* showed no significant differences in weights up to nine months of age. At ten months the Borans were significantly heavier than local animals and this difference persisted. At 18 months the Zebus were only three-quarters the weight of the Boran crosses. Implantation of hexostrol in 30 local or Boran/local cross Zebu cattle of about four years of age under ranching conditions resulted in significant increases in weight of the treated animals three months after implantation.

#### Publications

ANSLOW, R. C.—“Fodder production from Hedges of Acacia (*Leucaena glauca*).” *Rev. agric. Maurice*, 1959, **38**, 99.

ANSLOW, R. C., and BELCOURT, M. S.—“The use of Maize for Ensilage.” *Rev. agric. Maurice*, 1959, **38**, 174.

OYENUGA, V. A.—“Effect of frequency of cutting on the Yield and Composition of some Fodder Grasses in Nigeria. (*Pennisetum purpureum*).” *J. agric. Sci.*, 1959, **53**, 25.

OYENUGA, V. A.—“Nigeria's Feeding-Stuffs. Their Composition and Nutritive Value.” 2nd Ed. Ibadan Univ. Press, 1959.

OYENUGA, V. A.—“Effect of Stage of Growth and Frequency of Cutting on the Yield and Composition of some Nigerian Fodder Grasses. (*Andropogon tectorum* Sehian.)” *West Afr. J. biol. chem.*, 1959, **3**, 43.

#### ANIMAL DISEASES

447. Research on animal diseases tends to develop in the larger territories which have large and valuable animal industries. Smaller colonies generally maintain veterinary services with diagnostic facilities necessary for disease control. The larger territories maintain close contact with veterinary research organisations in the United Kingdom and in some cases Australia. Work on trypanosomiasis is separately reported by the Tsetse Fly and Trypanosomiasis Committee.

448. In the *Bahamas* a survey of animal parasites was continued and new records of *Monezia expansa* in sheep and goats were made. A survey of animal diseases in the *British Solomon Islands Protectorate* showed the main diseases were tuberculosis in cattle, in the Russell Islands only; brucellosis on Guadalcanal and Kidney Worm almost ubiquitous in village pigs.

449. In the preparation of anthrax vaccine in *Cyprus*, using the avirulent strain 34F, work carried out on media indicated the desirability of standardising batches of Casein Digest on the basis of their total nitrogen content. There were also indications that Casein Digest produced by rapid alkaline digestion with trypsin could be incorporated into a satisfactory medium and was less subject to variation than Digest prepared by the routine method involving 16 days incubation. Results from the use of Crystal Violet vaccine against Swine Fever lead to failures in immunisation except in self-contained areas. Under local conditions where sanitary control measures are imperfect, the vaccine is not always reliable and consideration is being given to the use of a live vaccine. Swine Erysipelas was diagnosed for the first time and the organism isolated from adult pigs dying of the septicaemic forms during cold weather. It is thought the disease may have been introduced by feeding unboiled swill containing foreign pork or bacon. The behaviour of the disease has been atypical in that no septicaemic cases were observed in young pigs during hot weather. It is believed that a batch of Sardinian sheep introduced Sarcoptic Mange in 1957. The diagnosis was first made when the 1958-59 lamb crop was affected. The parasite has become established amongst the local fat-tailed flocks, though this breed appears more resistant than the Sardinian. Dipping alone did not afford satisfactory control and hand treatment was found necessary as well. Work was continued on caprine verminous pneumonia. Over a period of three years routine treatments have been given with cyanethyrazide orally, and later by injection. This has been associated with a progressive fall in larval counts. During the autumn of 1959 weather conditions were very favourable for the parasite, but for the first time no losses were reported from this disease. It is believed that Virus Abortion in Goats has been present for some years, but diagnosis has been hindered because foetal membranes are rarely available for examination. Elementary bodies were recognised in smears from foetal stomach contents and the virus was established without difficulty in eggs by yoke sack inoculation. Antigen prepared from infected membranes was used for complement fixation tests which yielded supporting evidence when serum titres were compared with clinical histories. The organism showed a definite resemblance to the virus reported in 1950 by Stamp and McEwan from Scotland, amongst sheep. Samples of positive sera and antigen for this virus were obtained through Dr. S. E. Piercy of the Wellcome Research Laboratories, Beckenham, and subjected to comparative complement fixation tests. Both Beckenham and Cyprus sera gave almost identical titres with either antigen. The result at least indicated that the two viruses belonged to the same group. For various administrative reasons it was not possible to obtain suitable young pregnant goats for transmission tests and the final confirmation of this disease has yet to be effected. It is of interest to record that stained smears and titration on eggs indicated an appreciably higher concentration of virus in whole yolk than in thoroughly washed yolk sac membranes. In view of the much larger volume of the yolk this feature might well find a useful application in vaccine production.

450. In *Hong Kong* a type of Ephemeral Fever encountered in cattle was successfully transmitted to healthy local brown cattle by subcutaneous injection of infected blood samples and typical symptoms were produced.

451. A number of surveys have been started in *Jamaica* on various conditions affecting livestock, including a search for virus pneumonia in pigs (for which no evidence was found), a tick survey, a survey of brucellosis amongst pigs, sheep and goats (incidence 0.5 per cent.) and a survey of the blowflies causing myiasis. Trials to determine the effect of the parasite burden on weight gains of fattening steers and dairy calves were started. Various types of Newcastle Disease vaccines introduced into the island were screened.

452. Important research on animal diseases was continued by the Department of Veterinary Services in *Kenya*. For research covering the whole East African region reference should also be made to paras. 67 to 96 (E.A.V.R.O.).

453. Recruitment to staff vacancies at the Kabete and Naivasha laboratories was very satisfactory and by the end of the year both were up to full establishment with 15 professional officers and 22 technologists. The building of the Wellcome Institute for Research in Foot-and-Mouth Disease was completed and work was in progress within it by February, 1960.

454. A total of 88,662 samples and specimens was examined or analysed. There was an increase in the number of specimens for diagnoses from every species and those of ovine origin trebled compared with the previous year.

455. In routine helminthological diagnoses an unusual finding was *Fasciola hepatica* in sheep and a search revealed the snail host *Lymnaea truncatula*. A very severe outbreak of lung infestation by *Dictyocaulus* spp. occurred in sheep on one farm.

456. The number of complement fixation tests for contagious bovine pleuro-pneumonia was 16,692; an increase of 7,715 compared with 1958, largely in connection with disease control work in Masai. Antigen for the tests was made throughout at Kabete, but extraordinary difficulty was experienced in its production.

457. Survey of incidence of Johne's disease continued: 2,987 serum samples were examined by the complement fixation test of which 137 were positive.

458. Breeding stock and immature cattle from the Northern Frontier Province were all tested for leptospirosis by the agglutination test before movement; of 3,843 only 38 were positive, but autopsy findings were correlated satisfactorily with test results.

459. Work was carried out on the application of the agar gel double diffusion technique to the diagnosis of enterotoxaemia in sheep. Interpretation of results was difficult but positive findings enabled appropriate control measures to be applied effectively in some cases.

460. Bacteriological work on contagious pleuro-pneumonia of the goat in the Northern Frontier Province showed that the condition was not caused by *Borrelomyces* spp. Attempts to reproduce the condition were only partly successful and work on the identity of the infective agent continued.

461. In addition to routine chemical analyses of carcass products special investigations included bacteriological studies of organisms associated with



excessive slime on green bacon at the Uplands Factory and bacterial checks during the development of a dried meat powder at field abattoirs.

462. In a survey of foot lameness true footrot in sheep was not confirmed. Conditions found included foot abscess, scald and infections by foot-and-mouth disease and contagious pustular dermatitis viruses.

463. In the chemical section a large proportion of working time was spent in analysis of mixtures of BHC and DDT in dipping fluids; DDT was analysed by a supplementary colorimetric method. Organo-phosphorus compounds came into use for dipping and spraying and their estimation by oxidation to orthophosphate and colorimetric estimation as the molybdo-vanadate complex was found to be satisfactory.

464. Analytical methods for foodstuffs analysis were critically examined preparatory to introduction of controlling legislation in the Colony. The mineral survey continued with analysis of 100 pasture samples and 1,800 bloods.

465. Research on beef measles showed a very high incidence of natural infection and resistance to artificial oral infection in calves at 2-3 months of age, but localised infection by subcutaneous or intramuscular injection of oncospheres was achieved in calves and adults irrespective of previous infection; it was inferred that an intestinal phase of immunity could be by-passed.

466. Chemotherapeutic trials were commenced and much work done on seriological tests including the application of haemagglutination, complement fixation and intradermal sensitivity techniques.

467. Survey on diseases affecting hides and skins extended on a district basis; mechanical damage was also noted. Demodicosis was the most serious disease problem. A study of the skins of game animals was included and these were remarkably free from disease.

468. A recently isolated strain of *S. gallinarum* was selected into its variants and these were passaged independently on McConkey agar at 42°C. After 23 transfers the smooth variant could be inoculated safely into chicks and conferred a high degree of immunity against subsequent challenge by virulent *S. gallinarum*. Experimental batches of the vaccine were used in the field in outbreaks of fowl typhoid with satisfactory results.

469. Prophylaxis by Nicarbazine failed to prevent outbreaks of intestinal and caecal coccidiosis in several poultry flocks; peracute and acute caecal coccidiosis caused by *E. tenella* continued to occur and oocysts of *E. ascervulina* and *E. maxima* were identified in excreta of some birds under prophylaxis.

470. More than 12,000 birds were tested for pullorum disease and an outbreak of the disease was confirmed at Kitale in which four farms were involved following movement of infected stock.

471. The number of samples submitted for diagnosis of bovine trichomoniasis and vibriosis decreased for the first time since the inception of a full diagnostic service; the incidence of these conditions has probably decreased due to application of appropriate control measures. Samples from 43 herds were positive for *V. fetus*, 18 for *T. foetus* and 17 for *Br. abortus*; eleven of these herds had mixed infections.

472. Contagious pustular dermatitis again occurred in the Rift Valley and 9,500 doses of glycerinated scab vaccine were issued as vaccine to combat the infection. Work commenced on the use of a strain of virus adapted to tissue culture and lyophilised.

473. Epizootiological studies on foot-and-mouth disease continued and the World Reference Laboratory reported that out of 233 samples submitted 51.9 per cent. were type O, 15.9 per cent. type A, 1.8 per cent. SAT II and 30.3 per cent. failed to give a result. The percentage figures for 1958 and 1959 were remarkably similar.

474. Co-operative experiments were conducted between the Veterinary Departments of Kenya and Tanganyika and the Research Institute (Animal Virus Diseases) at Pirbright on an experimental SAT II vaccine strain attenuated at Pirbright; the work was carried out at Mpwapwa. Further collaboration between Kenya and Pirbright included work on an attenuated type A strain at Kabete, and another trial with SAT II vaccine at Kirumun, after which animals were challenged at the Wellcome Institute in Nairobi. Both vaccine showed considerable promise as immunising agents.

475. In research on lumpy skin disease it was found that "Allerton" virus could be re-isolated easily and without fail from experimental lesions produced by this agent, whereas only "Neethling" type virus continued to be isolated from field cases.

476. Experiments confirmed that a known strain of sheep pox virus administered to cattle by the intradermal, intramuscular or subcutaneous routes immunised them against subsequent intradermal challenge by virulent Neethling type virus. The 50 per cent. protective dose of sheep pox virus propagated in tissue culture was assessed in cattle and a standard vaccine inoculum arranged to contain approximately 20,000 of such doses. Safety trials were carried out in which 1,000 head of cattle were given single or multiple standard inocula subcutaneously; a very low proportion of transient local swellings were the only adverse sequel noted and sheep placed in very close contact with vaccinated calves did not contract sheep pox. Ninety-thousand doses of vaccine in lyophilised form were issued to the field. At the end of the year no case of the natural disease had occurred in vaccinated cattle and throughout the Colony only one farm was in quarantine.

477. The inactivated Newcastle disease vaccine previously described was continued and 70,000 doses were issued in the frozen state and used for prophylaxis. The immunity conferred by one dose of this product against intramuscular challenge was shown to be waning five months after vaccination; but a duration of 12 months complete protection against contact infection was apparent in one experiment at Kabete and in two instances in the field.

478. Addition of a suspension of aluminium hydroxide ("Alhydrogel") as adjuvant was found greatly to increase the immunising potency of the product and its duration of viability on storage at 4°C. and at ambient temperature; the presence of adjuvant caused an undesirable myositis on intramuscular injection but it was innocuous when administered subcutaneously. Fluid containing a four-fold dilution of inactivated antigenic

material in a 25 per cent. v/v suspension of adjuvant ultimately replaced the previous vaccine; it is issued in the liquid state for administration subcutaneously in the neck.

479. In further tests on "F" strain Newcastle disease vaccine 98 per cent. protection against intramuscular challenge was conferred in 10 week old birds by the intranasal instillation of reconstituted allantoic fluids. The lyophilised product of standardised egg infectivity was held ready for issue but was not used within Kenya; keeping properties at  $-20^{\circ}\text{C}$ . were found to be excellent.

480. Nairobi sheep disease (N.S.D.) virus at the 25th and 35th mouse brain passage levels was found to be too virulent for use as vaccine in sheep. Material at the 42nd level conferred some but not absolute immunity against challenge by a heterologous strain; the immunising dose for sheep approximated the infecting titre for infant mice. A newly isolated (Ngong) strain of N.S.D. caused severe reaction or death in sheep previously immunised with the attenuated strain at the 42nd level; however, the vaccine protected against later sheep passage levels of the Ngong strain and the phenomenon is under investigation.

481. The passage stage of Rift Valley fever vaccine issued was reduced to the 104th mouse brain level and the product lyophilised. In field safety trials vaccinated lambs remained healthy and inoculation had no significant effect on breeding performance of ewes before and at different stages during pregnancy. Serological responses to vaccination were studied.

482. Other virology work included a comparison of bovine inoculation, agar gel precipitin and complement fixation tests for the diagnosis of rinderpest. Two combined distemper and infectious canine hepatitis vaccines were compared in their effects on antibody production in a police dog unit.

483. Three strains of sheep pox virus were isolated in tissue culture from field cases of the disease and tissue culture propagated virus was used as vaccine to control one outbreak.

484. Studies on bovine petechial fever continued and three fresh strains were isolated, passaged and ultimately lost when experimental cattle proved to be resistant. No way has yet been found to preserve the infective agent or maintain it in any culture system or in any host other than bovine. One experiment indicated that oxytetracycline had a deleterious action on the agent *in vitro* although treatment with the drug had no effect during the course of the disease reaction in cattle.

485. During the course of the work infection by *Rickettsiae* morphologically resembling *R. phagocytophila* occurred and was studied by transmission to cattle and sheep.

486. Experimental work on the immunisation of goats in *Malta* against brucellosis has continued. A field trial using Elberg's living attenuated vaccine was commenced during the summer of 1959. A total of 333 kids were vaccinated in 60 herds in private ownership. At the end of March, 1960, the results of these vaccinations were being investigated. A small experiment was started to determine whether or not it is safe to mate young goats immediately after vaccination with the living vaccine, because farmers do not always obey the instruction to allow one month or more to elapse

between vaccination and mating. Because of certain difficulties that have come to light in the field application of the living vaccine, an extensive experiment was begun in July, 1959, to compare the efficacy of the living attenuated vaccine and a killed vaccine in water and oil emulsion. The killed vaccine would, if it produced a satisfactory immunity, be more easy to apply on a large scale in the field. One group of young goats was vaccinated with the living vaccine and another similar group with the killed vaccine, after mating the two groups were exposed to natural infection along with a group of uninoculated controls. The results of this experiment will be available in June, 1960.

487. In *Mauritius* an attempt was made to produce a crystal violet vaccine for swine fever with encouraging results and a successful distemper vaccine was made. A polyvalent vaccine to control bovine mastitis from local strains of *Streptococcus agalactiae* was prepared and production started.

488. *The Federal Department of Veterinary Research, Nigeria*, continued work on Avianised Rinderpest vaccine and a research officer proceeded to Tokyo on F.A.O. Fellowship for four months to work with Dr. Nakamura. Further development of this strain for use as a field vaccine was commenced. Studies with Nakamura's Complement Fixation Test for Rinderpest were continued. Work was commenced on the use of tissue culture using bovine kidney cells. Tissue culture was found useful in diagnosis, serum neutralisation tests and the virus strain obtained from the East African Veterinary Research Organisation showed distinct possibilities for use as a field vaccine. Small scale field studies with different breeds were in progress at the end of the year as a preliminary to field trials.

489. Routine production of a desiccated vaccine for contagious bovine pleuro-pneumonia was started and over 400,000 doses were used in the field, especially in Bornu. The dried product has overcome the difficulty of getting the normal culture vaccine to remote areas within the restricted time limit during which the latter may be used. In addition, it became possible for Provincial Field Officers to hold emergency stocks as required.

490. A Research Officer was allocated on a full time basis to carry out studies on Cutaneous Streptothricosis. The studies have so far been on the fundamental bacteriology of the organism although some new methods of treatment have been tried with varying success. The work is in the early stages but a good start has been made.

491. Work has been carried out to study the possibilities of preparing an effective vaccine against *Haemonchus contortus* using X-irradiated larval suspensions. This work has been made possible through the co-operation of Glasgow University. Tests for measuring serological responses to parasitism were studied. Whilst the Complement Fixation Test was only capable of detecting antibodies in high concentration the Passive Haemagglutination test proved much more sensitive and work is in progress on developing this latter test. Epidemiological studies of Parasitism were considerably extended. Work on Fascioliasis was commenced in the latter half of the year as an extension of studies carried out at Cambridge University by an officer completing his Ph.D. thesis.

492. Work on genetical resistance to parasitism was continued. The effect of subcutaneous inoculation of contagious bovine pleuro-pneumonia cultures in different lines of mice was studied in co-operation with a bacteriological project which utilised the mouse in an attempt to assess virulence of various strains of the organism.

493. Additional studies were carried out on the normal values of blood constituents in healthy cattle. Detailed studies of the phosphorus levels were made and, as a result, analyses of native salt licks from an extensive area followed. These did not reveal a great deal other than that sodium and potassium were the most important elements. Studies were made on the intraerythrocytic sodium and potassium levels. Results showed the levels to be of use as genetic markers but that they were not related to haemoglobin phenotypes. A beginning was made on studying the metabolism of *Asterococcus mycoides* in collaboration in a bacteriological project.

494. *North Borneo* is a territory where cattle play a small part in the economy apart from draft animals. Veterinary services are concerned with diagnosis and disease control. Information is assembled on the incidence of diseases. The two most important developments in 1959 were the identification of *Mycobacterium johnei* and an investigation into a skin disease of cattle in the Tawau area. In this skin condition the presence of large numbers of the larvae of a nematode of either the genus *Setaria* or *Onchocerca* was demonstrated by Dr. Shoho in Japan. The condition appears to respond to arsenical dips.

495. A snail survey of the Kafue Pilot Polder in *Northern Rhodesia* was started and five important species were found but none contained schistosome cercariae. The polder had been free of livestock since its construction and had been heavily flooded. Before a herd of 50 steers was introduced, they were given intensive antihelminthic treatment. A helminth survey of stock was carried out in the Mumbwa area. Young stock carried a heavy load of nematodes, which was relatively light in mature animals. Studies were continued on ticks using *R. evertsi* as a type species in studies of the microclimate in three habitats, short grass (*Sporobolus marginatus*), intermediate (*Chloris gayana*) and tall grass (*Hyperrhenia rufa*). Engorged females enclosed in mosquito netting bags were placed individually in favourable sites on or below ground level. The inimical effects, previously observed, of high temperatures and low humidities on survival, ovipositing and eclosion were confirmed. An unidentified rodent is believed to have eaten more than half the ticks placed in test bags. Rhipicephalid larvae have been observed to remain on vegetation for periods of up to 120 days. In an attempt to discover whether long exposure to climatic influences impairs ability to attack and feed, larvae at 75 days old were transferred from the grass to the ear of a sheep. All failed to attack. In further tests laboratory-reared larvae also failed to attack. It was noted that in short grass areas larval clusters were regularly found down wind from the site of eclosion.

496. Investigations of outbreaks of rinderpest and rinderpest-like diseases in game in *Tanganyika* showed that in some cases the disease was rinderpest, but in others no definite diagnosis could be made, though rinderpest could not be excluded. In the course of immunising cattle against East

Coast Fever for issue to stock owners, difficulty was encountered from the susceptibility of such animals to Heartwater. Surveys of the distribution of E.C.F. in the former enzootic area which had been freed of the disease by the Iringa Dipping Scheme, showed re-invasion by *R. appendiculatus* to be slow. An intensive survey of the distribution of the disease in an epizootic area in Lake Province showed a very close relationship between its distribution and the ecology of this tick. Two large-scale Foot and Mouth Disease vaccine trials were staged in conjunction with the Animal Virus Disease Research Institute, Pirbright (see para. 474). Out of 80 samples sent to Pirbright, 50 were diagnosed Type O, 8 Type A and 9 Type SAT II. In a co-operative trial with E.A.V.R.O. on the diagnosis of Contagious Bovine Pleuro-pneumonia, it was found that the rapid slide agglutination test was of very limited value. A Division of Helminthology Research was opened during 1959 and surveys carried out to gain information on the distribution and seasonal incidence of species.

497. Research into the causes of calf mortality was continued in *Uganda* during the year. In collaboration with the Virus Research Institute, Entebbe, work was completed on the mouse adapted vaccine against Nairobi Sheep Disease. Immunisation of imported Boran cattle against East Coast Fever was undertaken using the Aurolac technique; during this work the opportunity was taken to study methods of determining the immune responses to East Coast Fever (para. 79). Considerable laboratory work was undertaken on the use of the agar gel diffusion test applied to local diseases. An investigation was made into the use of Stuart's transport medium for preserving pathogenic organisms with a view to aiding field diagnosis; it was found that this technique offered good possibilities for ensuring diagnosis after delays of up to twelve weeks' storage at room temperature. A comparative trial was undertaken of the protection afforded against fowl typhoid by one living, two killed and human T.A.B. vaccines; the results obtained with the living vaccine (*S. gallinarum 9R*) were the most promising. Studies were continued on the cattle liver fluke (*F. gigantica*); particular attention was paid to the infection rate of snails under different conditions in relation to the liver fluke infection in the cattle population. Investigation of the poisoning of cattle at the Livestock Experimental Station, Entebbe, showed that the local shrub *Bersama abyssinica* was the cause; subsequent investigations showed that the leaves of this shrub contained a toxic principle which caused paralysis and death in cattle, rabbits and mice. During the course of diagnostic work *Salmonella dublin* and avian tuberculosis were identified for the first time in Uganda. *Br. melitensis* was again isolated from bovine material and an interesting outbreak of streptococcal septicaemia was identified in a group of 100 monkeys awaiting export; the cause of the outbreak appeared to be a Group A beta haemolytic streptococcus of unknown type.

498. A detailed assessment of previous digestibility trials was undertaken; further studies were made on East African hays, and chaffed fresh elephant grass was also used for digestibility investigations. This latter material appeared to have a much greater digestibility coefficient than any of the East African hays previously studied. Special studies of the chemical composition of grasses, particularly in the pastoral areas of north-east Uganda, were made in conjunction with the Department of Agriculture.

499. Physiological work was concentrated on obtaining an improvement in the conception rates obtained through artificial insemination in a variety of conditions. Semen issues were made thrice weekly and good conception rates were consistent at all four stations by the end of the year. Semen collection has been continued using the electro-ejaculation technique and, although collections with the artificial vagina have been made, this method is not normally used. Semen from N'ganda bulls has been frozen for long term storage and a bank of deep frozen semen is now maintained which can provide semen from N'ganda, Jersey or Guernsey breeds. Studies were completed upon the absorption of globulins by new born calves.

#### *Publications*

AYRE-SMITH, R. A.—“Use of tranquillisers prior to the transport of slaughter cattle.” *E. Afr. agric. J.*, 1959, **25**, 73.

CAPSTICK, P. B., PRYDIE, J., COACKLEY, W., and BURDIN, M. L.—“Protection of cattle against the ‘Neethling’ type virus of lumpy skin disease.” *Vet. Rec.*, 1959, **71**, 422.

FROYD, G.—“Cysticercosis and hydatid disease of cattle in Kenya.” *J. Parasit.* (In press).

FROYD, G.—“The incidence of liver-fluke and hydatid cysts in Kenya cattle.” *J. Parasit.* (In press).

FROYD, G. and ROUND, M. C.—“The artificial infection of adult cattle with *Cysticercus bovis*.” *Res. vet. Sci.* (In press).

FROYD, G. and ROUND, M. C.—“Infection of cattle with *Cysticercus bovis* by the injection of encospheres.” *Nature (Lond.)* 1959, **184**, 1511.

GLOVER, P. E., TRUMP, E. C. and WILLIAMS, R.—“Note on mechanical bush-clearing.” *E. Afr. agric. J.* 1959, **25**, 18.

GREEN, H. F.—“Some hide and skin curiosities.” *J. Soc. Leath, Tr. Chem.* (In press).

MANN, I.—“Animal industries in underdeveloped tropical countries.” Madrid. XVIth International Veterinary Congress, 1959. II, 1017-9.

MANN, I.—“Meat handling in underdeveloped tropical territories.” Rome. F.A.O. (In press).

MANN, I.—“Rural tanning techniques.” Rome. F.A.O. (In press).

PARKER, Alison M.—“Contagious bovine pleuro-pneumonia: Production of complement fixing antigen and some observations on its use.” *Bull. epiz. Dis. Afr.* (In press).

SAPIRO, M. L.—“Notes on veterinary toxocological analysis.” *E. Afr. agric. J.*, 1959, **25**, 126.

SCOTT, G. R.—“Effect of caprinised rinderpest virus in rabbits.” *J. comp. Path.*, 1959, **69**, 423.

SCOTT, G. R.—“Heat inactivation of rinderpest infected bovine tissue.” *Nature. (Lond.)* 1959, **184**, 1948.

SCOTT, G. R.—“Mortality of rabbits inoculated with lapinized rinderpest virus.” *J. comp. Path.*, 1959, **69**, 148.

SCOTT, G. R. and WINMILL, A. J.—“Newcastle disease in the grey parrot.” *J. comp. Path.* (In press).

SHIRLAW, J. F.—“Observations on calf disease in Kenya.” Part 2. Calf scours: Coli bacillosis of calves, with special reference to vaccination.” *Brit. vet. J.* (In press).

WINMILL, A. J.—“Some vitamin deficiencies of poultry.” *E. Afr. med. J.* (In press).

BURDIN, M. L.—“Redwater and anaplasmosis.” (Revision of the original published in *E. Afr. agric. J.* 1939, 4, 297.) *E. Afr. agric. J.*, 1959, 25, 10.

WILEY, A. J.—“Piroplasmosis and anaplasmosis of animals other than cattle, and trypanosomiasis of domestic animals.” (Revision of the paper published in *E. Afr. agric. J.*, 1939, 4, 463 and 1947, 12, 220). *E. Afr. agric. J.*, 1960, 25, 147.

BURDIN, M. L.—“Rinderpest.” (Revision of the paper published in the same journal, 1939, 5, 57 and 1947, 13, 29). *E. Afr. agric. J.*, 1960, 25, 153.

MACAULAY, J. W.—“Diseases caused by Worms.” Nairobi, Government Printer (In press. Reprint with amendments by J. W. Macaulay of the section formerly published in two parts in *E. Afr. agric. J.*, 1944, 9, 177, and 240, and 1948, 14, 18 and 105.)

WILEY, A. J.—“Common ticks of livestock in Kenya.” Nairobi, Government Printer, 1959. (Reprint, with amendments by A. J. Wiley of the paper originally published in *E. Afr. agric. J.*, 1953, 19, 5.)

BREDON, R. M. and MARSHALL, B.—“Notes on the Composition of Cattle for Slaughter and the Availability of Meat in Uganda.” *Trop. Agric. (Trin.)* 1959, 36, 309-320.

GOURLAY, R. N.—“Some Observations on the Haematology of Zebu Cattle in Uganda.” *Brit. Vet. J.*, 1959, 115, No. 8. 1-4.

GOURLAY, R. N., NUNN, W. R. and COYLE, T. J.—“Deliberate Asphyxiation of Cattle in a Primitive Area in Uganda.” *Vet. Rec.* Vol. 1959, 71, 743-745.

GUILBRIDE, P. D. L., BARBER, L. and KALIKWANI, A.—“Bovine Infectious Keratitis Suspected Moth-Borne in Uganda.” *Bull. epiz. Dis. Afr.* 1959, 7, 149-154.

HARKER, K. W.—“An acacia Weed of Uganda Grasslands.” *Trop. Agric. (Trin.)*. 1959, 36, 45-51.

ROLLINSON, D. H. L. and LOMAX, G. D.—“Paper Electrophoresis—Hippopotamus Haemoglobin.” *Nature, Lond.*, 1959, 184, 1653-1654.

HILL, D. H.—“Visceral schistosomiasis in the domestic pig.” *Brit. Vet. J.* (In press).

MARKHAM, A. E. G.—“Orientation of food production programmes: Animal production FAO/WHO Seminar report.” (In press).

ARNOLD, R. M.—“Epizootology of Rinderpest in Game in Tanganyika Territory.” *Bull. Epiz. Dis.* (In press).

ARNOLD, R. M.—“History of Rinderpest in Game in Tanganyika since 1921.” *Bull. epiz. Dis. Afr.* (In press).

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E



## SOIL AND LAND USE SURVEYS

500. The work of soil survey and land capability survey is now widely distributed and has become a major feature of colonial agricultural development. The Committee has, however, emphasised on a number of occasions the importance of following up formal soil surveys of a descriptive kind with field assessment of the performance and agricultural characters of the soils, and for supporting such surveys with agronomic trials wherever land development is anticipated.

501. In the *West Indies* work at the Regional Research Centre is separately reported (para. 147), but additional information, where available, is included here. In *British Guiana* surveys in the Cane Grove and Vergenoegen Land Settlement Schemes were chiefly to demarcate boundaries of soils on which rice yields would be very low, because of high sulphuric acid and aluminium. The maps will be used in fixing rentals on a productivity basis and for fertiliser recommendations. In the Tapacuma area on the Essequibo coast drainage and irrigation work will make 30,000 acres of land available for cropping, mainly with rice, and a soil survey of this area is in progress. The survey of the Amerindian Reserve in the North-West District was completed, and land use planning of the Mara Land Settlement.

502. In the *British Solomon Islands Protectorate* a soil surveyor from the Pool has started work on the Guadalcanal Plains, a potential rice-growing area, and on Malaita island where areas suitable for cocoa has been found. In *Hong Kong* the soil survey was completed and the report is to be published soon. In *Kenya*, with help from the International Co-operations Administration, the survey of soils was continued. An area of 130,000 acres in the Kano Plains was written up and the Directorate of Overseas Surveys has undertaken to produce the maps without cost to Kenya. Field work on the survey of South Nyanza has been completed on nearly 100,000 acres, written up and maps delineating soils drawn, as well as maps showing areas suitable for sugarcane. About 21,000 acres were found suitable for sugarcane and another 45,000 acres for other crops. The genesis and classification of the soil types have been studied and described. In connection with the investigation of the hydrology of the northern Vaso Nyiro and with the formulation of proposals for the utilisation of the waters of this river, reconnaissance surveys were made of these soils in those parts of the watershed where physical studies had suggested possibilities for irrigation. Quite extensive tracts of suitable land were found and demarcated. A reconnaissance in the Meru District confirmed the suitability of soils at Michimikuru for tea and was followed immediately by a major investigation of the area. Some 20,000 acres in the Sotik District were surveyed for soil classification, and the survey of the Nakuru is well under way. A full range of soil analyses was undertaken in support of these surveys including Webb-Hewitt and *Aspergillus niger* tests of selected soils. Apart from the usual widespread nitrogen and phosphorus deficiencies, a prevalence of sulphur deficiency on Grumosols is becoming apparent. Instances of the low boron status have been noted though confirmatory tests on crops were inconclusive except for tomatoes. Completion of the land use investigation and laboratory tests was followed by further fertiliser trials in the field.

503. In *Northern Nigeria* soil survey teams have covered an area of about 8,000 sq. miles in reconnaissance surveys and 14 detailed surveys have been

made of areas from 500 to 50,000 acres. Work is concentrated in development areas such as North Borneo where irrigation possibilities exist. In *Eastern Nigeria* there has been little progress, but staff have been recruited and aerial photographs provided. In *Western Nigeria* the reconnaissance survey of the main cocoa areas, scheduled for completion in 1959-60, was delayed because staff were transferred for work on newly-formed Farm Settlements and Farm Institutes. Over 750 sq. miles were, however, surveyed. Over 25 sq. miles of semi-detailed soil and vegetation mapping was carried out in the cocoa swollen shoot *cordon sanitaire* area.

504. Important areas of fertile soil have been discovered in *North Borneo*. The survey of the Semporna Peninsula has been completed and about a million acres covered. Maps of the soil types are complete. About half the area is considered suitable for agriculture. Until further field trials can be done it is only possible to assess the cropping possibilities by reference to areas already developed. Rough indications are that the Peninsula contains land suitable for cocoa on 48,000 acres, coconuts on 14,000 acres and rubber on 160,000 acres. An area of 9,000 acres has been demarcated for cocoa. On the West Coast the Sook Plain and areas to the south and east of Trus Madi have been found disappointing agriculturally. Surveys were therefore extended to the east where basaltic soils are known to exist. At least 30 sq. miles of basaltic soils, the analysis of which is similar to that of the Jerangan soils of Quoin Hill, were found. These soils appear good and suitable for cocoa though perhaps not as good as the exceptionally rich soils of Quoin Hill. There are indications that there may be up to 120 sq. miles of such soils. Detailed surveys in the lower reaches of the Labak River showed that there were stretches of alluvium which would be suitable for rice and, as they are surrounded by land suitable for rubber and perhaps cocoa, they would make ideal smallholder settlements. The surveys were supported by analyses. Tests for chromium toxicity in certain soils demonstrated its presence in near toxic quantities in serpentine soils.

505. In the Eastern Province of *Northern Rhodesia* an area of 315 sq. miles was mapped in detail on a scale of 1:20,000. A successful attempt was made to relate the information gathered in the course of soil survey to the vegetation and to local agricultural practices and to relate the soil to the relief within the group of Plateau soils. The results so far confirm Trapnell's hypothesis that the major soil groups are determined by geomorphology and age, and the vegetation not only corresponds with the major soil types, but where there are differences due to variations in the parent material, they are reflected in the vegetation. There is a close similarity between the soil and vegetation maps.

506. In *Sarawak* staff shortages restricted work, but reports were made on 12 areas where development schemes were proposed. It has now been possible to describe the major soil types occurring in Sarawak. These include yellow latosols on the hills where most of the hill rice is grown and the riverine alluvium soils where swamp rice is important. Most areas are of low fertility.

507. In *Sierra Leone* work was resumed by a soil surveyor from the Pool on the inland Boli-lands and is expected to be complete in 1960. Surveys were also done on areas being considered for rubber and oil palm development.

508. The soil survey of the Lower Usutu Basin in *Swaziland* was completed and mapped on a scale of 1:50,000, showing soils and irrigation classes. The soil analyses were done at Rothamsted. Soils were also mapped in the Malkerns Valley on 10,000 acres of an irrigation scheme showing about 45 per cent. as suitable land. In the Kopoyi Block out of 18,000 acres reconnaissance surveyed, only about 3 per cent. was found suitable for intensive cropping, the remainder being only useful for cattle ranching. Several other areas were similarly surveyed and mapped for development purposes. The total area surveyed in Swaziland since 1955 is now about 280,000 acres or 7 per cent. of the whole area.

509. The soil survey of *Trinidad*, started many years ago by Hardy and continued by Chenery, is now almost complete. Some 120 soil series have been described.

510. Combined soil and vegetation surveys in *Uganda* were completed so far as field work and reports largely written up. They will be issued as research memoirs with accompanying soil maps on a scale of 1:500,000. The surveys are therefore on a reconnaissance scale. Particular attention has been paid to surfaces worn nearly level at successive geological times, it being presumed that surfaces that have long been exposed to weathering will have become impoverished whereas surfaces only recently exposed are likely to retain more plant nutrients and to be more fertile. The soil survey is well supported by analysis and by long-continued agricultural experimentation.

511. In support of soil surveys overseas the soil survey of England and Wales, based at Rothamsted Experiment Station, have kindly continued to carry out laboratory investigations which could not be done in the territories. These included further study of Nyasaland soils and those of the Ukiriguru area of Tanganyika. A large number of soils from Borneo, Swaziland and Basutoland were analysed, including, besides the usual routine measurements, both clay mineral and trace element determinations. Two soils from the Pangani Basin in Tanganyika were found to contain montmorillonite in moderate to dominant amounts. One forest soil from Tanganyika (Kawatire) was found to contain unusually large amounts of beryllium. The determination of clay minerals in some Uganda soils helped to explain their chemical properties.

#### AGRONOMY

512. In all Agricultural Departments a great deal of work goes on on the husbandry of crops, the use of fertilisers in many formulations, trials of sowing dates and methods, spacing and intercultivation treatments and the like. Much of this work is of a "look-see" kind, useful and often leading to important improvements in local practices but of limited applicability. Likewise the use of fertilisers is governed by a complex of soil, climate and cultural conditions at each locality. Nevertheless, this kind of work is some of the most important and frequently yields results of immediate use. Conversely, it sometimes reveals problems and puzzles of a quite fundamental kind. No attempt is made in this section to include all the work reported of this type, but to be selective, though showing how widespread

the problems are and giving some indication of the volume of work in hand. The arrangement is by territories, alphabetically.

*ADEN*

513. Studies on the cotton root rot problem (393) included different irrigation regimes and last year a heavy pre-sowing irrigation in a replicated trial was associated with a lower incidence of root rot.

514. The water-table in the saline-alkaline area of Abyan was shown to fluctuate with the annual volume of irrigation water applied. Two years of low irrigation supply resulted in a lowered water table and was associated with increased average yields. Field experiments have shown that a commercial cotton crop can be matured with a single irrigation of 30 cm. Estimates of the reduction in soil moisture content during the growth of the cotton crop approximated to 30 cm.

*ANTIGUA*

515. Sugarcane trials involving planting dates, varieties, bagasse mulch and fertilisers were carried out by the Antigua Sugar Cane Investigation Committee.

*BAHAMAS*

516. Studies were made on the keeping qualities of onions and on cultural practices to improve bulb production of the local variety, Red Creole C 5, which is far the best keeper. High costs of hand weeding lead to trials with herbicides, particularly in nurseries of some orange stocks. It was found that citrus stocks were damaged by herbicides which would kill grasses. Simazine at 3 lb./acre in the wet season killed all weeds except *Cynodon dactylon* and *Argemone mexicana*. At 6 lb./acre it controlled *Cynodon* but damaged citrus seedlings. In the dry season it failed to control *Cynodon* but did not damage citrus seedlings. Diazon at 3 lb./acre gave about 80 per cent. weed control but *Argemone* was tolerant. At 6 lb./acre it damaged citrus seedlings.

*BARBADOS*

517. In a series of trials on sugarcane with nitrogen dressing (kind, time, variety, spacing) two varieties (B. 41211 and B. 45151) have shown an ability to utilise higher doses of nitrogen than B. 49119 and B. 4744. This interesting result is being further studied. Problems of irrigation of sugarcane are in progress with the aim of understanding the soil changes following water applications. Stations to study evapo-transpiration control of irrigation are being set up in co-operation with the Bellairs Institute (McGill University). Fluctuations of soil moisture with depth in irrigated fields have been followed through the growing cycle of sugarcane. The Soil Physicist at the Regional Research Centre has been asked to help in this work and in certain drainage and cultivation treatments of irrigated land.

518. A programme of investigations of chemical weed control has been drawn up. First trials show that Simazine gives the largest period of protection when used as a pre-emergence spray.

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E 3

*BASUTOLAND*

519. Population pressure on the land, widespread soil erosion and declining fertility make it imperative to improve the agronomy. The main research work was done at the Central Experiment Station, Maseru and on six sub-stations covering the main soil types and ecological zones. There was a series of 58 precise experiments including NPK fertiliser trials with and without trace element additions, kinds and quantities of N, Ca, P and FYM, on maize, wheat and other crops. The black soils of the mountains are very fertile but there is evidence that P may be necessary under continuous cropping. Changes in cultivation practices are required in these areas to control wild oats. Nitrogen applied to maize gave large responses on all soils and P likewise except on some alluvial soils. Potash showed no responses. Lime gave responses on heavy lowland soils but not on light soils. There was some evidence of response to sulphur, in one case to magnesium, definite responses to molybdenum on some soils and to iodine on lowland soils growing wheat and peas. This last is an unusual observation. The doses of iodine (as KI) are not reported. It is known that K is ineffective. There were no responses to iodine by beans or maize but quite marked responses by wheat and peas. Uptake of iodine by the crops is not reported. Goitre is very prevalent in Basutoland and it is evident that this investigation should continue.

*BECHUANALAND*

520. The experiment station at Lobatsi has been closed, but a new sub-station has been opened at Gaborones. The new fertiliser trials were started, one to test residual effects of kraal manure and the other to evaluate the effects of kraal manure applied every second or third year. The use of organic manures is becoming more widespread amongst African farmers. A bare fallow trial to determine whether moisture could be stored in one year for cropping in alternate years showed such small yield increases as to be uneconomic. Results of a four-year grass ley gave no significant increases in the first indicator crop of maize, but yields in the second crop after ploughing were definitely higher and this continued in the third crop after the ley. In a bean-maize-sorghum rotation experiment there were no yield increases in the rotation compared to continuous cropping.

*BRITISH GUIANA*

521. Experiments with jute were abandoned in 1959 following disappointing results. Yield of fibre was low and the plants did not reach a satisfactory height. Trials with cotton were also discontinued, mainly because of difficulties of pest control and irregularities of weather.

522. Field trials on sugarcane cultivation practices showed equally good results from simple cultivation techniques, but flood fallowing has a more lasting effect on tilth than mechanical cultivation. Cultivation, over and above flood fallowing alone, gives about 10 per cent. increase in plant crop but shows no effect beyond the first crop. Experiments indicate that the dominant factor in sugarcane yield is the supply of water and of soil aeration at all times. In periods of drought and soil moisture deficit and, in many areas, accompanying salinity, moisture is limiting, whereas in excessively wet periods lack of soil aeration is limiting. Manurial trials were chiefly concerned with forms of nitrogen and phosphorus. Ammonium sulphate appeared

to have a small advantage over urea and, where Ca is low, superphosphate (single) had an advantage over forms not containing sulphur.

523. The use of fertilisers on rice is extending slowly but responses are not large generally. Trials on farmers' fields showed responses to N and P, of which a 10:20 mixture is recommended.

#### *BRITISH HONDURAS*

524. Top dressing of sugarcane in August with N, following a basic NP dressing in May, results in a 7-ton increase in yield. Foliar analysis of citrus shows adequate levels of Mn and near-limiting levels of K and P. A high rate of nitrogenous manuring is necessary, probably about 0.3 lb. N per box of fruit. Fruit drop is being caused by boron deficiency.

#### *BRITISH SOLOMON ISLANDS PROTECTORATE*

525. A joint scheme of coconut agronomy has been arranged between the Agricultural Department and Messrs. Levers Pacific Plantations Pty. Ltd. The work includes replanting and manurial trials in the Russell Islands and has been continuing since 1952. Investigations on copra storage at initial moisture contents of 4, 6 and 8 per cent. during three months' storage showed that the actual loss of oil during storage was 6 per cent. for copra at a moisture content of 8 per cent. at the time of storage, but was only 1 per cent. for copra of 6 per cent. moisture content. Thus the loss of 5 per cent. of oil can be saved by proper drying. The 8 per cent. moisture copra also produced more dust and had a higher f.f.a. than that at 6 per cent. The differences between copra at 6 and 4 per cent. moisture were slight.

#### *CYPRUS*

526. Tests of citrus rootstocks resistant to tristeza are proceeding. Sour orange stocks at the two major citrus-growing areas have been budded with nucellar virus-free strains of Washington and Carter navel oranges. Field trials on the growing of deciduous crops of apples, plums and peaches on the plains were continued. Further plantings were made of peach varieties which appear to have low chilling requirements. A collection of late flowering almonds was established for observation. Preharvest sprays on apples with 20 p.p.m. of  $\alpha$ -naphthylacetic acid reduced drop by 15 per cent.

#### *FIJI*

527. Investigations on the drilling of rice in comparison with transplanting and broadcasting were continued, and also trials on spacing, NPK dressings and green manure, rotation of rice with grass and forage crops, nursery seed rates and age of seedlings, herbicide trials (Na salt of MCPA at 1 lb./acre best) and irrigation trials. Trials on bananas show that if fertilisers are used the usual spacing of 11 × 11 ft. can be reduced to 11 × 6 ft. with considerable advantage. Responses were obtained to N and K (sulphate) and a series of trials on private land are beginning to give valuable information on fertiliser requirements on different soils.

528. Good progress has been made in the production of hybrid seed of cocoa and it is hoped the first seed will be available in 1963 or 1964. A series of fertiliser trials are still in the early, non-bearing stage but already

interesting effects are apparent. There are responses to N and P but NPK does not appear to have much effect. There are shade and no shade comparisons included. Fertiliser trials on maize emphasised the importance of plant populations in gaining the full benefits.

### GAMBIA

529. A considerable amount of work was done in the *Gambia* on fertilisers for groundnuts and rice. The fertiliser recommended for groundnuts as a result of trials is an NPK mixture of 8 : 11 : 8. On 54 scattered farmers' plots this gave an average increase of 38 per cent. (546 lb./acre). Various mixtures of NPK which it was thought might be better than that recommended were tried, but though the proportions varied widely there were none which were better. All significantly outyielded the controls by a range of 25.9 per cent. though the control yield was itself high at 1,780 lb./acre unshelled nuts on average. The 1959 factorial trials (S/A at 0,25,50 ; single super and muriate of potash each at 0, 50, 100), unlike those of previous years, showed a much greater response to P than to K. PK interactions are clearly important. No significant responses were found to N either at sowing or six weeks later, nor did N affect nodulation. Nodulation was stimulated by P (as super) but depressed by K. Residual effects of a dry grass mulch applied in 1957 were still considerable in 1959.

530. Foliar analysis of limes showed prevalent N and P deficiencies as well as serious Zn deficiency in some places.

531. On rice there were general significant responses to N and P but none to K nor Mg. Sulphate of ammonia and urea were better than ammonium chloride and ammonium nitrate. No responses were seen to Zn, Cu or Mn at 5 and 10 lb./acre.

532. Maize and finger millet gave large responses to N and P but not to K. Soya bean responded to neither N, P nor K.

533. Bexone as a pre-emergence weedkiller depressed germination considerably but as a post-emergence weedkiller, it and Agroxone gave good control of broad-leaved weeds and sedges. Dalapon gave complete control of wild rice and grasses at 5 and 10 lb./acre when grasses were about nine inches high.

### HONG KONG

534. Fertiliser trials on a range of farmers' fields generally confirmed earlier results that N is everywhere effective, but responses to P and K are variable. Information was collected about methods of growing vegetables on high lands at around 2,000 ft. altitude, the object being to work out techniques which will enable these lands to be brought under cultivation and to extend the growing period for temperate zone vegetables.

### JAMAICA

535. Fertiliser responses by a moribund citrus grove reported to be unresponsive to treatments was spectacular a year after fertiliser dressings (NPK factorially combined). Trials with hormone sprays on barren pimento trees had little or no success. It was found that branches from bearing trees

could be grafted on to barren trees and these continued to bear though the proportion of successful grafts is still low. Further trials of tobacco on "Terra Rossa" soil again produced unsatisfactory leaf. There appear to be about 1,000 acres of land in Jamaica which is capable of producing good quality Virginia-type tobacco. The results of three years' trials with cotton show that, though there is a fair prospect of yields in the region of 800 lb./acre of lint there is considerable hazard from pests. To be economic, there would have to be mechanisation which is only possible on level lands already occupied by remunerative crops.

536. A Drainage and Irrigation Section of the Ministry of Agriculture and Lands was set up in 1959. Preliminary studies were made on water consumption by sugarcane and pangola grass pastures and evapotranspiration units were installed. Studies on frequencies and systems of water distribution in cane fields were started.

537. Spectro-chemical investigations were carried out on trace element components of citrus, maize and coconuts on a range of soil types.

#### KENYA

538. A great amount of investigation was carried out by the Kenya Department of Agriculture, only very little of which can be mentioned here. Maize trials in Kakamega and Mtwapa confirmed that a 3 × 1 ft. spacing is the best for these areas. Potatoes did well at Dundori, Kanja and Eldoret. There were storage problems at Kakamega. At Mau Narok whole seed produced better crops than cut seed. Yields of castor were disappointing except in drier areas where pests are less troublesome. New tea trials were established at Kakamega and Kagochi. Trials with new cassava varieties gave good yields up to 13·8 tons/acre on the coast and six varieties showed complete resistance to mosaic.

539. Very encouraging results were obtained in vegetative propagation of coffee using the N.I.A.E. Burgess type intermittent mist propagator. After two months in the propagator rooting was as high as 97 per cent. using capped single nodal cuttings. Rooting was very satisfactory without the use of hormone preparations. Experiments on the best method of hardening off of cuttings are in progress. Cuttings have been successfully transplanted from the propagator into nursery beds and if all goes well, it should be possible to produce plants ready for the field in a year. In comparing different composts, the best was a mixture of vermiculite, coffee hulls and coarse sand in proportions of 1:1:2 by volume. Excellent results were also given by equal volumes of coffee hulls and coarse sand.

540. Yields from field trials in 1959 were notable for consistency of the responses to mulch and nitrogen dressings. Grass mulches between alternate rows of coffee raised yields between 20 and 30 per cent. Rather lower increases were obtained (22 to 28 per cent.) from mulch between every row. Data on quality over the past 10 years show no loss of quality accompanying high yields from mulching and nitrogen dressings. Important increases in average bean size have been recorded on mulched fields and there are indications that magnesium dressings improve the raw and roasted appearance of the coffee.



541. In picking trials on pyrethrum it has been found that stripping down to and including buds causes a loss in pyrethrins while there is little difference in the intervals between pickings. In the rotation trial, which has completed 13 seasons, yields from continuous pyrethrum plots have so far shown no significant decline in yield compared to pyrethrum rotated with grass and/or cereals. Inter-plantation of one year lupins or grass between pyrethrum plantings had no effect on succeeding yields. There is further evidence of the benefits of phosphorus at high altitudes on reddish soils but no difference between kinds of phosphate.

542. In sisal nursery trials responses to sisal waste and nitrogen were good. Irrigation only gave benefits in the third nursery cycle and requires further study. Spacing and cutting trials have proved the possibility of growing 2,000 plants per acre in all localities. An even higher plant population may be possible. The double versus single row trial demonstrates clearly the more rapid growth of the double rows, resulting in earlier fibre yield. The first fertiliser trial planted in 1950 was cut out in 1959. No significant responses were given by lime, phosphate or potash. Applications of sisal waste caused no difference in leaf numbers per plant although fibre yield was increased, due to more rapid growth and larger leaves. Nitrogen increased both leaf number and plant and fibre yield. Results of applications of sisal waste show that less than 50 tons per acre should not be contemplated and also that nitrogen applications must be repeated, possibly twice a year, for the first 3-4 years. Work continues on herbicides.

543. Investigations were continued in connection with the proposed citrus juice industry. Commercial assessments of samples of lime and lemon were favourable. Citrus trees planted in 1951 at Jacaranda are showing symptoms of decline which appears to be related to poor root penetration and Kikuyu red soils cannot be recommended for planting. In a trial on blight (*P. infestans*) control on tomatoes sprays containing copper, vineb and captan all increased yields greatly. The second harvest of asparagus at Thika produced a high proportion of unsaleable spears and until the cause of the trouble is known and controlled, growers in this climatic zone cannot be advised to grow the crop. At Molo spacing and harvesting trials indicate an economic life of the crop of not more than four years.

544. Strawberry culture suffered from a fall in local prices which might have been avoided if a larger proportion of the crop had been of export quality. Trials indicate an economic life of not more than three years at Molo. The commercial pineapples at Thika planted in 1956 completed their plant crop and gave an average yield of 11½ tons/acre. Pineapples are found not to respond to late applications of fertilisers and these low yields were due to low soil fertility.

545. The wheat quality investigations concentrated on the development of zone electrophoresis for the fractionation of gluten proteins. Sponge rubber has been found promising for this purpose and with it differences between the composition pattern of gluten of varying strengths have been found. Agronomy investigations continue to be inconclusive, none of the soil management treatments having any effect on strength.

546. Work on rice included fertiliser trials, spacing and irrigation comparisons. Applications of 1 cwt./acre of double superphosphate and ammonium sulphate gave large responses, but larger applications added little to yield.

Crop investigations on the Tana Irrigation Scheme continue, including land reclamation and fertiliser studies. The 1959 programme extended to fish farming on the heavier soils which occur in the drainage ways in the desert hinterland. Very good cotton yields (2,000 lb./acre seed cotton) were obtained on large plots using short term 5½ month varieties. Water penetration and distribution has been a special investigation and improvements were achieved. Foliar abnormalities suggest deficiencies of Fe, Mg and Mn, the last having been confirmed in laboratory tests.

547. On the Perkerra Scheme a clear policy has been decided on which includes food and cash crops. Earlier investigational work on this scheme was not well provided for but now the policy is determined it is possible to intensify work on the crops which have been given a place in the cropping programme. Work is being concentrated on improving yields of maize and beans, on onion production, a very promising cash crop; on maintenance and management of pastures; on tree crops such as citrus, bananas and dates and on animal husbandry.

548. Agricultural machinery trials included tests of the prototype Newage Hibiscus ribboner, tried at Mwea, which performed well. The Hibiscus decorticator was tried but there was insufficient suitable material to complete tests. A plot seeder was constructed to give accurate sowing and easy cleaning for seed dressing trials. The mechanism seemed satisfactory, but mounted on a two-wheel tractor it was unmanageable. Comparative trials of three different machines for the construction of terraces and cut-off ditches showed, for the construction of V terraces, there was little to choose between a Motor Grader, crawler tractor and trailed terracer, or a four-wheel-drive tractor and small trailed terracer. For broad-based terraces and cut-off ditches the small tractor cost about 50 per cent. more than the larger machines.

549. A study was made of the operations involved in cutting and transport of sisal leaf and showed that a cutter spends between 57 and 67 per cent. of his time cutting, 18 to 31 per cent. bundling leaves and 12 to 15 per cent. carrying bundles to the end of the row. Savings seem possible in cutting labour. Work is in progress in field decorticators for estate use, a hand decorticator for African areas, equipment for de-suckering and control of grass between rows, on drains and on alternative systems of leaf transport.

550. Trials with a cascade type of coffee drier have shown that a layer of coffee one bean thick can be made to flow down a perforated tray with a slope of 10° when air is blown through the tray with a velocity of 800 to 1,200 F.P.M., according to the type of perforations. An experimental drier constructed on this principle having wire trays measuring 3 × 1 ft. had a throughput of 650 lb. of coffee per hour drying fully wet to skin dry.

551. The East African Tractor and Implement Testing Unit based at Nakuru continued to operate during 1959. The Farm Tractor trial on machines owned and operated on farms (3 in Kenya and one each in Tanganyika and Uganda) was concluded and reports prepared for the National Institute of Agricultural Engineering. The manufacturer has requested that the trials run for a further year to get more information on wear. One further altitude investigation was concluded and reported on. The manufacturer has issued instructions for altitude adjustments for this machine. Trials with four different tractors at Serere (Uganda) were not completed. The Special Development Section of the Uganda Government

co-operated with the Unit on Farm Trials and on fuel filtration problems, which resulted in requests for tests on fuel/water separation systems by two United Kingdom manufacturers. A specially modified tractor has now completed 18 months very satisfactory work and the Uganda Department of Agriculture have modified several more tractors in a similar manner. Assistance given to one manufacturer in 1958 in solving overheating problems has led to an investigation into cooling characteristics of tractor engines in East Africa. The survey in 1958 covering tractors in East Africa has been studied in the U.K. and has led to a request for a comprehensive survey to be carried out in co-operation with the N.I.A.E. Tractors for small African holdings is a subject which is assuming considerable importance. Work is in hand on several aspects of this formidable problem. Work with a conventional tractor in the African areas is in progress and five two-wheeled tractors or motor cultivators will be tried after their implements have been tested.

552. Work continued on various machines for light bush clearing, pasture topping and grassland improvement. The work now includes the use of chemicals. Tests were completed on a prototype groundnut harvester, experimental cultivation equipment and tie-ridging equipment. The last two implements are now being tried in Tanganyika in conjunction with E.A.A.F.R.O. to assess agronomic suitability. Requests for tests at the end of 1959 were so numerous that the Unit has been forced to refuse or delay applications.

#### NIGERIA

553. The Federal Department of Agricultural Research in *Nigeria* carried out studies on the effect of the length of growing period on cassava over 21 months. At nine months an early maturing variety gave a significantly greater yield than any other, but at the end of the experiment there was no reliable difference between the yields of any varieties in the trial. The mean numbers of tubers per plant remained constant after the first six months growth and subsequent increases in yield were by additions to existing tubers rather than by formation of new ones.

554. Sand and water culture methods are being used to investigate deficiency symptoms of the major food crops, and in conjunction with leaf analysis to determine the nutrient status of the plant under varying levels of nutrient supply. Loss of water and leaching of plant nutrients from soils is being investigated using evapotranspirometers and lysimeters. Early investigations have shown the value of mulch covers.

555. In the *Eastern Region of Nigeria* sub-stations for research on rubber, citrus and coffee are proposed under the Development Plan. Control of weeds in rice with chemicals is under study using a logarithmic sprayer fitted to a Ferguson tractor. A fertiliser trial on rice on mangrove swamp in Calabar gave a large response to nitrogen. On derived savannah soils there was marked response to phosphates by groundnuts. A preliminary trial of fertilisers and trace elements on citrus gave very striking results, particularly in fruit quality.

556. Recent work in the *Northern Region of Nigeria* has shown that substantial increases in crop yields can be obtained by the use of fertilisers. Although in the case of groundnuts and sorghum the economics of the applications are marginal, fertilisers are likely to be needed to maintain the long-term fertility of the land. Substantial economic returns can be obtained by using fertilisers on yams and rice. The volume of the work handled by

the Agronomy Division has increased considerably and all experiments from the districts are analysed and summarised at the Central Experiment Station, Samaru.

557. The nitrate levels in bare and bush fallow soils have been studied over two years. Under bare fallow there is an accumulation of nitrate during the dry season, whilst the levels are low throughout the year under bush fallow. The increase in the bare plot illustrates the advantage of early clearing of the land before planting.

558. The occurrence of blind nuts in groundnuts can be overcome by adding calcium as gypsum or lime. Calcium levels in soils producing blind nuts have been found to be less than 0.2 m.e. of Ca per 100 g. and there is a positive correlation between soil Ca and shelling percentage up to this level.

559. In the *Western Region* there were eight fertiliser trials on arable crops, mostly in derived savannah areas where the need for a balanced NPK fertiliser has been proved. The optimum yields of maize have been from a 6:3:2 or 3:2:1 mixture, and for yams either a 2:1:1 or 6:3:2 mixture, depending on the site. An experiment in progress since 1956 on rates, kinds, methods and times of applications of nitrogen has shown that generally there is no difference between ammonium sulphate, ammonium nitrate and urea as the N carrier, that placement is superior to surface application and mixing with the surface soil, and that a single dose gives higher yields than split applications. Experiments have continued with N, P and K on soils of clayey sand texture derived from sedimentary rocks in the Rain Forest Zone. Maize, yams and cassava gave small positive responses to N and K. Maize showed a small positive response to P, but yields of yams and cassava were reduced by P.

560. Cultural experiments on maize revealed a linear relationship between  $\log_{10} Y$  and  $Y/D$  where Y is the yield per acre and D the number of days between onset of the rains and the time of planting. This relationship is being further studied. The interaction of varieties and plant populations in one maize experiment indicated that varieties should be compared at optimum densities and that for some varieties a correlation exists between height at six weeks and yield per plant at different levels of competition.

561. Yields of legumes (Pigeon pea, cowpea and groundnut) appeared to be unaffected whether planting is on the flat or on ridges. Plant populations of 5,000–8,000 per acre in 4 to 6 ft. rows appear to give the best yields.

562. An irrigation trial on citrus, the first of its kind in the Western Region, was started and it is intended to irrigate up to 70 acres.

563. In the *Southern Cameroons* the programme of field experimentation has been expanded, particularly for cocoa agronomy and pasture studies. In the southern forest zone work on cocoa and coffee was increased, as well as on maize and groundnuts. In the Bamenda Highlands the emphasis has been on pastures, potatoes, maize and pyrethrum. At Barombi Kang a cocoa rehabilitation trial is giving good results; plots coppiced in 1956 for chupon regeneration produced in 1959 as much cocoa as old, untreated cocoa. Experimental plantings of Upper Amazon varieties showed great promise and they are being extensively planted in the Cameroons.

564. In the Agricultural Faculty of the University of Nigeria studies were continued on fertility of soils under grass/legume covers, on the effect of burning vegetation, on nitrogen fixation and on lime-induced chlorosis. Over a five year period it was found that *Centrosema* contributed 102 lb. of nitrogen per acre to a Star Grass-*Centrosema* pasture. In the field of agricultural economics work was undertaken on the general economy of Nigerian agriculture, marketing, farm management in relation to cropping systems, and a special study of the production and marketing of rubber.

#### NORTH BORNEO

565. Your Committee recommended that a research station should be set up at Tuaran to deal with the problems of the rapidly expanding agricultural production of the colony and substantial grants were made for this purpose. Provision was also made for sub-stations on the East Coast for studies on cocoa and oil palms, though development of the oil palm sub-station has been postponed as a result of further soil surveys which indicate that oil palm development may occur on soils different from those of the site originally selected for the sub-station.

566. Investigations were continued into methods of early budding of rubber with the object of producing stumped buddings on a large scale and so reduce the dependence on Malaya for clonal seed, on which increasing export duties are imposed. The investigations are showing promise.

567. Fertiliser trials on rice again showed only small increases in yield from nitrogen and phosphate dressings, which were uneconomic. Double cropping was found possible with irrigation, but on a small scale bird damage to the off-season crop was naturally heavy.

568. Cocoa continued to do extremely well in experimental plantings at the cocoa sub-station at Quoin Hill, where 109 acres are now planted. The yield from the first one-acre plot of Amelonado planted in baskets in 1959 was 7,426 pods. Clones from Trinidad, West Africa, Indonesia (via Malaya), New Guinea and Samoa (Lafi 7) have been budded onto Amelonado stocks. Four spacings are being used in 10-acre blocks. It is hoped that a duplicate pruning trial of four methods, named Urquhart, Voelcker, Bridge and Control, will provide data for discussion and eventual decision. Trials have been laid down on soils of different series. On the ultra-basic soils at Ranau cocoa is useless due to chromium toxicity.

#### NORTHERN RHODESIA

569. Comparison of maize yields on two different soil types at Mt. Makulu gave 5,600 lb./acre on one soil but 4,600 lb./acre on another, both with optimum fertiliser treatments. The lower-yielding red clay soil is generally considered to be the best arable soil in the district, but in these trials a shallow soil of sandy clay loam overlying sandstone yielded better. The limited area of arable on the station, hitherto confined to the supposedly better red soil, is being expanded to take in other soil types.

570. Fertiliser trials on groundnuts have given inconclusive results. Cultivation methods and plant populations showed little effect on yields in 1959 though insufficient weeding showed spectacular decreases in outturn. The

phenomenon of empty pods is widespread but its cause is still unexplained. There are indications that trace element deficiency or imbalance is related to the problem.

571. A start was made on a long-term fertility trial intended to give data on the effects of fertilisers and organic manures, rotations and leys. This trial is to be repeated in the provinces. In its first year maize gave the expected response to nitrogen, the unfertilised yield of 13·7 bags/acre being raised to 20·4 bags by the addition of 50 lb./acre of nitrogen. Farm-yard manure at 5 tons/acre gave about the same response. Maize responded in a linear manner to nitrogen as ammonium sulphate up to 100 lb./acre of nitrogen (500 lb. Am. sulphate) but showed no response to superphosphate. Nitrogen at 100 lb./acre also doubled the yield of crude protein in maize taken as silage.

572. Specialist officers of the Agricultural Department continued to co-operate with the staff of the Kafue Pilot Polder. Summer crops on the polder in 1958-59 were not successful and the reasons for the failure are being investigated. Wheat under irrigation was successful as a winter crop though yields and quality were not commensurate with the costs of development. Indications are that surface irrigation with careful levelling may be superior to sprinkler irrigation, but much is to be learnt about soil management. A Rhodes grass pasture, irrigated and dressed with 400 lb./acre of sulphate of ammonia carried 30 head of cattle on 20 acres, but even this stocking could not cope with the heavy growth and cutting had to be resorted to. Four model farms, two irrigated by flooding and two by sprinklers, were set up to study the problems likely to be encountered by African farmers under these conditions.

#### *NYASALAND*

573. In most areas dressings of nitrogen on maize are generally economic and as a result of a wide series of district trials it is now possible to determine, within limits, the optimum rate of application for all areas in Nyasaland. They have also demonstrated the importance of having the optimum plant stand (13-14,000/acre) and of early weeding. Groundnuts have suffered from a widespread sulphur deficiency in the Northern Province, with marked yield increases following gypsum applications. An investigation into the occurrence of empty pods showed that it was correlated with a high K : Ca ratio. Fertiliser trials on tobacco emphasised the improvement in quality and yield by N and P dressings. There were extensive cultivation trials on the best levels at which to top and prime plants. The trade has shown a preference for "coloury" Burley leaf and trials showed that the proportion of such leaf can be influenced to some extent by changes in spacing and the amount of nitrogen applied.

574. On tea soil moisture studies have been of great value in explaining various aspects of tea culture. The pruning of tea is now usually done earlier in the year than was formerly the practice. This has led to a better recovery from prune and some conservation of moisture which has meant a lower water strain on the plants in the dry season. The root systems of tea have been worked out down to a depth of 17½ feet and the rooting depth at different ages measured. Pruning experiments have demonstrated an interaction between the frequency of pruning and nitrogen applications. With

high nitrogen applications the superiority of the 3-yearly prune over the annual prune has been clearly shown. An experiment on the effect of permanent shade on the yield of tea has so far shown that no shade or *Grevillea* have given higher yields than shades of *Albizzia* or *Glyricidia*. The differences are not entirely due to the differences in water consumption by the shade trees and the experiments will have to be continued.

575. Work on the biochemistry of the fermentation is being done by the Department of Biochemistry, Cambridge University, and is financed by the Tea Association. Methods were developed for the measurement of (a) the rate of fermentation, (b) polyphenol oxidase activity, (c) total polyphenol concentration and (d) concentration of total chlorophyll pigments. It was shown that the main cause of slow fermentation is low polyphenol oxidase activity. Polyphenol content appeared to be less important, but it may influence the brightness of liquor.

576. Rotation experiments were continued at all stations. In one experiment on planting maize after Rhodes grass pasture, the highest yields of maize were on plots which had received the lowest fertiliser applications. The cause probably does not lie in the amount of nutrients taken from the soil by the larger grass crop, but in the larger amount of organic matter left in the soil in an undecomposed form and a consequent greater fixation of nitrogen in the subsequent year. A series of rotation trials without fertilisers showed that lower total production was achieved when maize followed a resting period and also demonstrated the value of groundnuts in any rotation.

#### ST. HELENA

577. It is not possible to carry out research proper in St. Helena but the Agricultural Staff have conducted trials on various crops. These include cultural trials on flax (*Phormium tenax*) (laid down but are not yet harvested), on grass leys and on coffee culture.

#### ST. KITTS—NEVIS—ANGUILLA

578. Field trials essential to the Nevis Agricultural Development Scheme involve fertiliser and cultivation trials on normal food crops, possible new crops, pasture trials and experiments on sugarcane and cotton. Sugarcane showed response to 1 cwt./acre of superphosphate in some localities, but no additional response to double dressings. Growing crops other than cotton during the close season reduced the incidence of weeds in the following cotton crop and lowered the cost of cultivation. Mulch on the close season crop with mulch continuing on the cotton crop showed substantial increases in yield particularly when fertiliser was also applied. Some responses were obtained in St. Kitts to applications of sulphate of ammonia although it was accompanied by increased seed weight and thus a reduction in ginning percentage.

579. A series of trials on tomatoes were conducted using the minimum of cultivation but with systematic spraying against insects and fungi. Good growth was obtained and reasonable yields, but none reached the goal of 25 tons per acre which is the minimum yield necessary for an economic return for processing.

*SARAWAK*

580. Grants were made to expand the research branch of the Agricultural Department, including the construction of a laboratory for entomology and buildings at sub-stations in the Districts.

581. Fertiliser trials on hill and swamp rice in a number of places gave responses to N and P. Nutritional disturbances were revealed in fertiliser trials on pepper. The processing of pepper received attention and it is clear that the smoking of black pepper can improve the product and that proper drying is of great importance.

*SEYCHELLES*

582. Plans have been made to convert the Grand Anse Farm into a research station in 1960. Fertiliser trials on coconuts were started on the madreporic island of Denis and Daros. Two coconut nurseries are to be established in 1960 to produce selected seedlings on Mahé and Praslin islands. Trial shipments were made of fine-grade cinnamon quills to the United Kingdom in 1959 in an endeavour to establish this on the spice market. A shipment was also made of long (3 foot) quills suitable for the American market. Studies are being made to find out the differences which affect the quality disparity between Ceylon and Seychelles cinnamon bark and oil.

583. A coffee trial plot at Grand Anse yielded well and demonstrated the possibility of coffee growing on lateritic hills of granite islands.

*SIERRA LEONE*

584. At the West African Rice Research Station an investigation into differential responses of rice to fertilisers amongst 450 varieties was made. Large differences indicated that a breeding programme for highly fertile conditions would be useful. A short investigation into growth rates and survival under inundation of floating rices showed an appreciable difference in growth rate between *O. sativa* and *O. glaberrima*. The most important factor in survival was found to be the age at time of flooding.

585. Work on the dormancy of rice seed was continued. It has been shown that the inhibition of germination involves two components: the most important is due to the husk, but some dormancy is also exhibited by the caryopsis. Treatments which remove the husk dormancy do not necessarily remove the other type of dormancy. It has not been possible to demonstrate the presence of germination inhibitors. Experiments suggest that methods which accelerate the breaking of dormancy are concerned with terminal oxidation in respiration.

586. The initial work on the viability of cereal grains has been completed. It was shown that the period of viability of a number of temperate cereals can be predicted by a knowledge of the moisture content and temperature of storage. Experiments on rice, which are not yet completed, suggest that rice behaves in a similar way to these other cereals. The constants for the prediction of rice viability have not yet been calculated, but the results so far suggest that their values will be somewhat different from those which apply to other cereals.



587. Preliminary work on some aspects of the water relations of the rice plant suggest that there are similarities between upland types and swamp types which are reputedly salt tolerant: both are capable of withstanding a relatively high water stress brought about by growing the plants in a balanced culture solution of high osmotic pressure.

588. An investigation was carried out into the palatability of rice varieties. An experiment involving a tasting panel gave some highly significant results which indicated that two new varieties which have been released for distribution are at least as acceptable as the standard varieties which are already distributed and widely grown. This investigation also included a comparison of the results of the tasting panel with various chemical and physical methods of assessing rice palatability used by other countries.

589. Studies of tidal mangrove soils have continued, from both chemical and microbiological angles.

590. Work in previous years has been mainly concerned with obtaining a general picture of the sulphur-oxidation processes which may occur in empoldered saline mangrove soils. These investigations have been carried out using soil from Rokupr Rice Farm. Recent experiments have been directed towards applying the knowledge gained to an assessment of the suitability of other soils for empoldering. It has been found that accurate and rapid information on the type of sulphur compounds available for oxidation can be obtained by measuring the oxygen uptake of the soil under standard conditions and interpreting the results on the basis of the behaviour of the various sulphur compounds in Rokupr soil. This method enables a number of soil samples to be examined simultaneously and should be also useful in giving more fundamental information on the process of acid-formation in tidal soils.

591. Investigations have been started to attempt to assess the importance of nitrogen-fixation in maintaining the fertility of paddy soils.

592. The studies of the mode and rate of humus decomposition in mangrove muds was continued. The principal aim of this year's work was to assess the probable effect upon the organic matter status of the muds when proposed reclamation schemes are put into practice. This aspect of the investigation was virtually completed and the results will be published in the near future. The main stages of proposed reclamation schemes are firstly clearing the mangrove vegetation, secondly empoldering the land to exclude salt water which results in the third stage of drying the top soil during the dry season and finally leaching the muds by rainwater during the rains with or without treatment with lime. All these stages have been shown to affect the humus content of the mud.

593. Removing the mangroves not unnaturally causes a reduction in the amounts of readily decomposable organic matter and empoldering the land results in increased humus decomposition at the onset of the rainy season. Leaching with rainwater also increases humus decomposition, mainly by removing soluble salts and rendering certain fractions of the organic matter more soluble. If the muds are limed before leaching however, the rates of decomposition are lowered.

594. Leaching without previously liming leads to destruction of the physical structure of the muds and impeded drainage.

595. An investigation was made into analytical methods of assessing the fertility of waterlogged soils as opposed to those in common use for upland soils. Information so far obtained should lead to a satisfactory method for assessing nitrogen levels. The importance of iron in submerged soils has been shown by laboratory work on degree of reduction.

596. Work has continued on the soils of inland swamps and ten field fertiliser experiments using a high replication and 1/300 acre plots were laid down. Nine of these were successfully harvested to give statistically reliable results. The experiments tested levels of application of phosphate, lime and nitrogen, the possible benefits of adding organic matter and iron-rich soil and also, certain interactions of the various treatments.

#### *SOMALILAND PROTECTORATE*

597. Trials to find the optimum frequency of irrigation of dates for the establishment of off-shoots on sand, salt and clay soils were inconclusive. Indications are that on silt or clay twice weekly watering is enough but on sand daily watering is necessary. Sorghum on terraced fields gave responses in grain yield of up to 50 per cent. with farmyard manure, and mechanical ploughing gave yields 20 per cent. better than when the local bar-point plough was used.

#### *SWAZILAND*

598. Grants have been made for the establishment of research stations in Swaziland where agricultural development is taking place on a large scale. Effort has been largely on soil surveys and on getting the new station and sub-stations going.

599. Fertiliser trials on annual crops show general responses to N and P but no response anywhere to K. At Malkerns maize showed a response to molybdenum.

#### *TANGANYIKA*

600. New laboratories at the Southern and Western Regional Research Centres, built with C. D. & W. Research grants, were completed in 1959. In view of the high value of cashew an agronomist has been appointed to work solely on this crop. Although intercropping of maize and groundnuts is more productive than pure stands, it has been found that for some combinations of crops intercropping can result in very poor yields of one crop in the combination. Maize drastically reduced the yield and quality of sweet potatoes. Cassava and castor late planted in groundnuts produced little, but maize and groundnuts combined well.

601. The application of fertiliser to late planted crops does not increase yields to a level approaching those of the early planted crops. It is thought that different factors for the various crops affected may be responsible; low humidity suppresses flowering and causes death of the meristematic tissues of the gynophore of groundnuts, whilst for maize low minimum temperatures occurring after April do not reduce leaf area but do appear to affect grain production.

602. Useful results continue to accrue from the permanent fertiliser trials laid down in the past three years. There are appreciable residual effects from farmyard manure and phosphates. Farmyard manure and its ash plus an equivalent amount of nitrogen to that lost on burning have given comparable yield responses. A series of Trial Management Farms have been started to test the value of experimental results in a farming system which could be adopted by African farmers.

603. Forest glade soils on Kilimanjaro have been compared with adjacent forested soils in connection with pyrethrum development and reafforestation. The glade soils are practically identical with forest soils in composition except for a marked reduction in exchangeable calcium, probably brought about by grazing and burning.

604. Dieback of pines in the Southern Highlands has been confirmed as boron deficiency and the large-scale treatment of pine plantations is now in hand. Copper toxicity in coffee on Kilimanjaro, perhaps due to copper sprays, has been detected. With it was found sub-normal levels of N, P, K, S and Mn. Isolated boron deficiency has been detected on coffee on Kilimanjaro. Unthrifty robusta coffee at Bukoba has shown low N and B levels and excessive uptake of P on a soil low in P. This high P uptake is probably due to B shortage. Little further work has been done on coffee at Mbozi but there are field indications of a response to lime. Mbozi coffee is known to be short of Ca, Mg, B and Zn. Boron deficient maize has been found in this area.

605. Boron deficiency, K and P shortage and Mn and Al toxicity has been shown in the Southern Highlands by pyrethrum, lupins and oats. Pyrethrum has responded well to lime.

### *TRINIDAD*

606. Fertiliser trials on citrus gave no results because of losses of crop by theft, an experimental error statistically unrecoverable. Attempts to remedy rind discoloration of grapefruit by trace element sprays have been started. Experiments are in hand on plant form and habit of plantains, and on cultural and fertiliser requirements of yams, dasheens and maize. The practice of ploughing out and replanting sugarcane after the second ratoon is now a matter of concern. It appears that the physical condition of the soil is the principal factor contributing to the uneconomic yields of later ratoons and cultural methods to improve the aeration within the rooting zone have been undertaken. Results indicate that chiselling after harvest followed by sprinkler irrigation will maintain yields above 30 tons an acre on second ratoon cane.

607. A programme of foliar analysis was started with the intention of using it as a guide to fertilizer requirements. Citrus has been given most attention, but work has also been done on bananas and sugarcane.

### *UGANDA*

608. Studies on the phenomenon of nitrate accumulation were resumed with a new field experiment designed to throw light on the possible upward movement of nitrate ions. From pot experiments young robusta coffee

appeared to prefer nitrate to the ammonium form of nitrogen, though urea seemed as effective as nitrate. Extensive analyses of coffee leaf samples were made spectrographically. Leaf nitrate contents were shown to correlate closely with nitrogen treatments. It seems that an important effect of a sweet potato cover is to compete with coffee for available soil nitrogen. There were a number of fertilizer experiments on coffee (including growth substance sprays) and responses to nitrogen have been economic at Kituza. Permanent factorial experiments on annual crops were started at 14 places in Buganda and Western Province to study effects of N, P, K, S, Mg and farmyard manure under rotations and continuous cropping. Early responses have been small and nitrogen may be the main requirement.

609. Results from fertilizer trials at Serere have shown small effects in most localities though some responses have been larger. Residual effects on finger millet were observed on plots dressed with sulphate of ammonia with indications that this was mainly due to the sulphate. With a directly applied fertilizer to the finger millet a basic yield of 1,800 lb/acre of grain was almost doubled by heavy rates of phosphate, nitrogen and sulphur, the last two nutrients being the more important. A new trial on cotton demonstrated the importance of N and S and a yield of 760 lb/acre was increased to 980 lb/acre by heavy NS dressings. But, as often happens with cotton, this increase was not economic. On the other hand, dressings of 28 lb/acre of sulphate of ammonia to farmers' crops of finger millet gave very worthwhile responses. In Teso District 107 trials gave an average increase of 340 lb/acre; in Bukedi 96 trials averaged 500 lb/acre increase and in North Busoga 52 trials gave an average of 690 lb/acre, all profitable returns. Groundnut responses to an NPK=10:10:5 mixture were just economic but very variable, and more work on this crop is needed. Cotton likewise gave erratic responses.

610. New plantings of African-grown cocoa amounted to 100 acres, all Trinitario from old trees planted 40 years ago. In 1959 seed of Amelonado types were imported from the Belgian Congo. Upper Amazon selections obtained from Ghana have produced their first crop, some promising selections giving up to 40 pods per tree.

611. At Serere work in collaboration with the National Institute of Agricultural Engineering on a prototype groundnut harvester and the "Hawkins" tie-ridging equipment showed that at present neither machine can satisfactorily work under Serere district conditions.

612. Studies on farm costings were greatly expanded and included both arable farms and animal husbandry units.

### ZANZIBAR

613. Experiments with coffee (liberica) using banana trash mulch and NPK fertilizers showed very high responses to mulch over five years, the increase in 1959 being nearly 29 cwt. of fresh cherry per acre. Results of cropping rice land with other crops during the interval between rice crops over five years have shown that fallow cropping gave higher rice yields than the customary natural grass fallow in moist conditions and results in a greater total crop production. Sweet potatoes with FYM were best under moist conditions and pulses planted on the flat under drier conditions. Trials on cassava again showed insignificant responses to artificials, but

very large yield increases with farmyard manure. Coir dust applied to pineapples gave large increases in fruit, both by number and size, yields from mulched plots over two years averaging 7.1 tons/acre of fruit of 6.1 lb weight compared to unmulched plots average of 3.9 tons/acre of 4.8 lb weight.

#### Publications

WILLIAMS, C. N.—“Resistance of *Sorghum* to Witchweed.” *Nature, Lond.*, 1959, **189**, 1511.

WILLIAMS, C. N.—“Action of Inhibitor- $\beta$  on the growth of *Striga* seedlings.” *Nature, Lond.*, 1959, **184**, 1577.

DENNISON, E. B.—“The maintenance of soil fertility in the Southern Guinea Zone of Northern Nigeria, Tiv country.” *Trop. Agric. (Trinidad)*, 1959, **36**, 171.

KING, H. E.—“Quality of cotton seed and the size of the cotton crop of Northern Nigeria.” *Emp. Cott. Gr. Rev.*, 1959, **36**, 21.

MIDDLETON, K. R.—“The use of the Orange I Method for determining soil nitration and a comparison with the phenolsulphonic acid method for certain soils of Northern Nigeria.” *J. Sci. Food Agric.*, 1959, **10**, 218.

GISBORNE, J. H.—“The Northern Region Agricultural Programme. Ministry of Agriculture, Kaduna, 1959.”

WATSON, K. A.—“Herbicide trials on *Cynodon dactylon*.” *Pest. Abs. News Sum.*, C 5, 1959, 148.

WATSON, K. A.—“Herbicide trials on *Imperata cylindrica*.” *Pest. Abs. News Sum.*, C 5, 1959, 144.

MOORE, A. W.—“Mineralization of organic phosphorus in wet meadow soils.” *Agron. J.*, 1959, **51**, 59.

MOORE, A. W. and ABAELU, J. N.—“Non-symbiotic nitrogen fixation in a soil of the Nigerian rain forest zone.” *Nature, Lond.*, 1959, **184**, 75.

MOORE, A. W. Symbiotic nitrogen fixation in a grazed tropical grass-legume pasture.” *Nature, Lond.*, 1960, **185**, 638.

MOORE, S. W.—“The use of nitrifiable nitrogen as an index of nitrogen availability in a tropical soil.” *West. Afr. J. Biol. Chem.*, 1960, **3**.

HART, M. G. R.—“Sulphur oxidation in tidal mangrove soils of Sierra Leone.” *Plant and Soil*, 1959, **11**, 215.

ROBERTS, E. H.—“Geotropic and Morphological alterations in Rice Seedlings caused by Plant Growth Regulators.” *Nature, Lond.*, 1959, **183**, 1197.

HARDCASTLE, J. E. Y.—“Development of Rice Production and Research in the Federation of Nigeria.” *Trop. Agric. (Trinidad)*, 1959, **36**, 79.

#### FORESTRY

614. Research on different branches of forestry is progressing in most territories but naturally tends to be more time-consuming than in agriculture or animal health. Many Forestry Departments are engaged in taxonomic work by reason of their need to know what species they harvest from a mixed vegetation naturally occurring, in contradistinction to agriculturalists

who have little difficulty in knowing the crops they handle and whose interest in the general flora seldom extends beyond weeds of cultivated land. Work on floras is referred to in paras. 251 to 257

### *Tropical Conifers*

615. Considerable interest has developed in tropical conifers which are now under trial in many territories. In *British Guiana* an additional 16 acres of pine plantations (*P. caribaea* and *P. elliottii*) were established on white sand soils, bringing the total to 77 acres with ages up to six years. Germination of *P. elliottii* was poorer than *P. caribaea* but survival in the field was better and recovery after fire was good (90 per cent.).

616. Work on pines in *British Honduras* was concentrated on the study of *P. caribaea*. Many sample plots were analysed and new ones laid out. Attempts were made to correlate growth with various site preparations such as drainage, fertilizers and weeding treatments. Soil surveys and root profile analysis carried out on typical pine sites indicate a more cautious estimate of yields to be anticipated for both pulpwood and timber production within the rotation laid down in Working Plans. Experiments are in progress to find out the effects of various intensities of thinning and whether adverse site conditions can be offset by cultural treatments. Many of these test plots of pine have been in existence for some time, but it is only recently that staff have been available to bring the work up to date. Experiments are progressing on natural regeneration of pine on savannahs and pine ridge soils where much of the future production is anticipated. The first stages of genetic studies of *P. caribaea* were attempted by examining selected stands in natural forest for elite trees, but distinct varieties have not so far been identified. Most areas carry overmature stands, often damaged by fire and termites, from which the best stems have been removed. On one small plantation on a fertile soil marked varieties occur in the form and growth of several individuals, and efforts are being made to propagate clones vegetatively. Controlled pollinations are also being made.

617. In *Cyprus* work continued on reforestation of burnt areas under *Pinus brutia* and initial assessments were made of survival and growth of seedlings. A start was made in the selection of elite trees of *P. brutia* and 362 trees were given preliminary selection on desirable morphological characters and growth. Progeny trials are to follow. Some success was obtained in grafting trials and crosses were made between *P. brutia* and *P. canariensis*.

618. In *Fiji* nursery techniques in raising pine seedlings showed that best results were obtained with mixtures of Forest soil, gravel, compost and an NPK fertilizer. Addition of "pine soil" for mycorrhizal inoculation did not appear to be needed.

619. Amongst a species trial in the *Gambia*, *P. caribaea* attained a height of 8 ft. in a year (best specimen) and will be watched with interest.

620. The introduction of *P. caribaea* and *P. elliottii* into *Jamaica* has now been successful and the apparent need for mycorrhizal inoculation overcome. Of the two species *P. caribaea* has been the more suitable, but good results on a small scale have been obtained with *P. merkussi* from *Indonesia*.

621. Experiments to determine effects of varying degrees of thinning and pruning on volume in *Cupressus* spp. have continued in Kenya. Data have been collected for the compilation of volume and yield tables for cypress, and preliminary volume tables have been produced. The study of progeny of selected *P. patula* trees continues. A further selection of 60 plus trees of *P. patula*, 48 of *Cupressus lusitanica* and 3 of *C. benthami* have been prepared for planting.

622. In Northern Nigeria *P. patula* and *P. oocarpa* were doing well in the arboreta at Vom and Naraguta, particularly the latter, but other species were less vigorous. In North Borneo it was found that *P. caribaea* did not do well unless given large doses of phosphate in the early stages. Northern Rhodesia continued work on conifers with many species under trial, and a large variety of silvicultural treatments.

623. Considerable interest in conifers in Nyasaland continued and a large number of trials were in progress. The effect of foliar application of nutrient sprays on unthrifty *P. patula* was being tried in an area where foliar analysis suggested nutrient deficiencies. In another area fertilizer trials with N, P and Mg were initiated. Preparations were made near Dedza for the establishment of a series of pine trial plots to investigate the suitability of an area of some 10,000 acres for afforestation with pines. On Zomba plateau an experiment is being done to determine the difference in yields of logs from first thinnings of *P. patula* at 7 and 9 years of age. On Nyika plateau the permanent sample plots in the 1953 trial and in the 1959 plantations were enumerated in 1959. There were marked differences in growth and vigour of different species, *P. patula* and *P. radiata* showing the best growth and *P. pinaster* the least promise. Plantings made in 1958 of *P. patula* by deep planting and contour-trench planting in Nchisi Forest on an exposed hillside where establishment had hitherto proved very difficult, gave very satisfactory establishment and growth. On Zomba Mountain a trial plot of *P. leiophylla* from Mexico from seed of an alleged straight form (R.50) has given stems even more crooked than usual. Seed of elite strains of *P. elliotii* and *P. taeda* from Queensland and of *P. patula* from New Zealand were planted and seed of one specially promising tree of *P. patula* collected at Dedza.

624. Conifers are not important in Sarawak forests but specimens of *Podocarpus*, *Agathis* and *Dacrydium* were collected for anatomical study. Research on *P. caribaea* in Sierra Leone has shown some promise on alluvial sands, but growth was poor on lateritic gravels.

625. In Tanganyika a die-back condition of pines in the Southern Highlands has been found to be due to boron deficiency and it has been shown that lack of boron can retard growth of young pines even when it is not severe enough to cause die-back. Ground applications of boron alleviate the symptoms. Studies were continued on the properties of early thinnings from plantations of *P. caribaea* and *P. radiata*.

626. Comparison of different thinning intensities were started in Trinidad on 7 year old plantations of *P. caribaea*. Selection of trees of *P. caribaea* were made for seed and vegetative propagation and the timber qualities of parent trees are concurrently being tested at the Imperial Forest Institute, Oxford. An introduction of *Araucaria cunninghamii* was made from New Guinea.

627. In *Uganda* misgivings arose about the strength properties of *P. patula*, which forms the major part of the annual timber plant, and tests were put in hand. Strength tests were completed on *Cupressus lusitanica*.

628. In the *Solomon Islands* first measurements of sample plots of kauri pine (*Agathis macrophylla*) were analysed at the Imperial Forestry Institute. A rate of growth of a foot in girth in ten to twelve years can be tentatively assessed for large numbers of trees in the exploited areas. Such trees are mainly from three to nine feet in girth and which were below exploitable size at the time of felling. Further confirmatory measurements are desirable because the present data are from trees initially suppressed and they may not indicate the full potential of the species.

#### *Hardwoods*

629. The tropical mixed forests form the basis of the timber trade in the colonies and its exploitation, management and preservation is the main work of Forest Departments. Consequently it absorbs the largest part of their energies, but it is an intractable subject for research because of its unlimited variation.

630. The Greenheart Forests of *British Guiana* which have been exploited, call for regenerative treatment to ensure further yield of valuable timber. In two centres work started in 1954 and 1957 was continued on natural regeneration with encouraging results.

631. Sample plots of mahogany were maintained in *British Honduras*. The results of sample plot analysis of teak have been impressive. In order to get information for a larger planting programme various methods of treatment of seed for direct sowing as against stump planting were tried. There is little or no volume data in the natural forest in this territory, so volume measurement plots have been laid out in a representative block of high forest containing various girth class distributions of the more important economic species.

632. In the *British Solomon Islands Protectorate* preliminary data on the growth rate of *Pometia pinnata* indicate that girth increments of up to four inches a year may be obtained. Promising results were obtained in experiments on natural regeneration of this species, but an unidentified shoot borer caused trouble. Plots of *Cedrela* spp. have been promising in many cases but shoot borers have been troublesome and better seed strains are required of some species. Logs of common Solomon Islands timbers have been tested for their suitability for plywood manufacture in the C.S.I.R.O. Forest Products Laboratory.

633. In *Fiji* investigations into the natural regeneration of lowland rain forests show that most of the regeneration consists of either indeterminate species or of timber species whose rotations are too long to merit silvicultural tending. There is some evidence that more intensive exploitation favours colonisation of the felled areas by the light-demanding *Endospermum macrophyllum*. Work on the natural regeneration of *Fagraea gracilipes*, one of the colony's most durable hardwoods, has shown that height increment responds to an increase of light following opening of the canopy. Cold storage (35–40°F) of seed of *Swietenia macrophylla* gave much improved viability after a year compared to seed at room temperature. Trials with hormone arboricides (2,4,5-T and 2,4-D) compared with sodium arsenite applied



in various ways suggested that after four months arsenite given in frill girdles was the most effective and economical.

634. A large number of exotics were under trial in the *Gambia*. The local bamboo, *Oxytenanthera abyssinica* (?) has not responded well to block planting, but stumps may have been too roughly handled. An introduced species has responded better.

635. The importance of flood prevention and conservation of water supplies in *Jamaica* had led to the setting up of a section of the Forest Department to prepare plans showing the vegetation cover on each important catchment. These plans will form the basis for future improvement in land use, and it is intended to establish an Island Watershed Authority. The total areas of plantations is about 10,000 acres. It has been found that local species will not grow uniformly on the poor soils now available for planting and present practice is to use species of *Eucalyptus* and *Pinus*, species yielding good cabinet woods being limited to the better soils.

636. In the *Northern Region of Nigeria* emphasis was on the development of suitable techniques for the establishment of *Eucalyptus* on the High Plateau and elsewhere. Much work was done on nursery techniques. The Eucalypts are showing great promise. In the riverain high forest cleaning and poisoning treatments are assisting regeneration of the economic species, but sample plot measurements indicate that *Khaya grandifoliola* cannot be expected to reach exploitable size under 100 years. The influence of fire protection and cultivation on plantations of *Cassia siamea* was a marked improvement. The same treatments in adjacent Derived Savannah combined with sowing and planting have shown very promising results. The early growth of teak was particularly promising. Work has begun on underplanting the pioneer plantations of *Gmelina arborea* with more valuable timber species and indications are that the method may be of value around the edge of riverain forests, outliers for reclamation of degraded savannah, the rehabilitation of which is a major problem in Northern Nigeria.

637. Similar work on the growing of economic species in association with *Gmelina* is proceeding in the *Eastern Region of Nigeria*, where other work includes the silviculture of *Chlorophora* and *Borassus* palm, regeneration of *Mitragyna*, *Gossweilerodendron* and *Borassus*, the operation of the Tropical Shelter Woods system in rain forests and the performance of various economic species line planted in rain forest. The response of *Khaya grandifoliola* to canopy opening is under trial and the effect of gibberellic acid on *Chlorophora excelsa* in the nursery.

638. A large programme of forestry investigation is in progress in *North Borneo*, where dipterocarps are a major asset to the country. The influence of shade intensity on young dipterocarps is under trial and results show that shade is very beneficial for establishment but that nearly full light is required afterwards. After the fruiting of *Parashorea malaanonan* in 1958, plots were assessed for seedlings in 1959. Apparently fruit set was poor since an increase of only 1,400 seedlings per acre was recorded. In another forest a similar assessment showed a recruitment of 33,000 dipterocarp seedlings per acre. In all cases height growth was negligible in virgin forest. Comparison of trees on two soil types on the East Coast, one of them a basalt soil, showed that on basalt soils a large proportion of the basal area is in the commercial size classes though the total wood volume per

acre is probably no higher than on other soil types. In a trial on the timing of regeneration operations following logging it was seen that growth in untreated plots was generally not so rapid as where treatments were given; there appeared to be sufficient stocking of commercial species. Final analysis of arboricide trials showed that the use of a wetting agent combined with sodium arsenite had a small but insignificant beneficial effect. Arsenic pentoxide was found very effective and could replace sodium arsenite, but is equally toxic. Tests on mixtures of butyl esters of hormones were made to try and cheapen these, since it is largely on account of the cost of buying and transporting diesolene to the forest. An experiment designed to measure the response of advance growth of commercial species to logging and various degrees of girdling was continued. The results will decide whether advance growth of pole size and above should be left in girdling operations. A large plot was laid down to measure the increment of advance growth before logging and to carry out increment assessments for some years after logging. Trees of *Eucalyptus alba* have reached a height of 32 feet and 9.8 in. girth in two years, with averages of 18 ft. and 5.4 in. respectively. Good growth has been shown by *Maesopsis eminii* and *Melaleuca leucadendron* and in an old plot (1932) of *Morea* from British Guiana the best tree has reached 70 ft. in height with a girth of 57 in. A small test was made of stratified random sampling. No difficulties were encountered and routine instructions were prepared for its use in standard regeneration sampling. Height/girth relationships in young dipterocarps appear to be very variable. Experiments in the use of relascopes showed these were very useful instruments and even where visibility is limiting, simple measurements of girth and distance show which trees are to be counted. The structure of lowland dipterocarp forests was investigated by the method of Richards in an attempt to determine whether the structure of rain forest varied with soil type, but the data are not completely analysed. A table giving basal areas in square feet for all girths up to 10 ft. 1 in. by 0.1 in. intervals and thereafter to 20 ft. girth by 1 in. intervals was constructed. Such a table did not appear to be available in the literature. Further work on crown/diameter relationships indicated that sufficiently exact measurement of the crown/diameter cannot be made in air photographs of a scale of 1:25,000 for a reliable estimate of volume to be made. Precise identification of species of individual trees from air photographs does not appear to be possible, though certain groups of species can usually be identified.

639. In *Northern Rhodesia* ecological work was continued particularly in vegetation typing for forest surveys. Much work was done on check lists of trees, their identification and silvicultural requirements. The Utilisation Division collected timbers for durability trials. A satisfactory and cheap method of preserving fence posts by sap replacement was evolved using Tanalith as the preservative. Experiments were started to find the minimum preservative treatment required for mining timber and a graveyard was established in Nkoma mine by courtesy of the Rhokana Corporation. A series of tests on pressure impregnation treatment of squared and round mining timber showed good absorption by indigenous species in the round, but very unsatisfactory and irregular absorption by baulks of the same species. Further advances in the classification of sites for exotics were made and studies were continued on soil moisture relationships which appear to be correlated with parent material regardless of the depth of soil formed.

Some 24,000 acres were covered by intensive soil-vegetation surveys as a basis for plantation planning. Work continued on species trials with emphasis on pines and eucalypts from Northern Australia, on land preparation methods and costs, on weeding techniques, on firebreak problems and enrichment of indigenous woodlands by exotics.

640. In *Nyasaland* it was found that coppice regrowth of eucalypts could be prevented satisfactorily with "Finopal", an operation necessary after thinning. Improvements to nursery techniques were tried including root-pruning of polythene-tubed and open-rooted stock, watering methods and transport to the planting site. Further opening of the canopy over the dense natural regeneration of *Newtonia buchananii* was done but further drastic thinning will be necessary. Baton-planting trials with *Pterocarpus angolensis* were not successful in the Muia-Livulezi Forest, in striking contrast to success in forests with higher rainfall. A plot of the endemic *Burttavya nyasica* planted in 1956 is making remarkable growth and now averages 22.8 ft. in height and 3.5 in D.B.H. Eucalypt planting trials have demonstrated that the growth of the different species in plots in the open is much superior to that of the same species under the shade of *Brachystegia*. All plots, however, show very good growth, especially *E. saligna*. A number of new species of eucalypts were introduced from Australia and one (*E. microtheca*) from the Sudan. Work on the dry zone indigenous woodlands under less than 40 in. rainfall was combined with the object of obtaining more information on the management and silviculture of the widespread *Brachystegia-Isobertinia-Uapaca* stands that make up most of the dry woodland in Nyasaland. Special studies were carried out on the silvics of *Pterocarpus angolensis* and other species, and attention is being given to type classification of the dry woodlands.

641. A catalogue of the flora of the peat swamp forests of *Sarawak* and *Brunei* was completed. The palynologist of the Brunei Shell Petroleum Co. completed the pollen analysis of a core 13 metres in depth of a highly developed raised bog formation in the Marndi area. Preliminary results indicate that the peat developed over mangrove, and the succession of the forest types, similar to the horizontal succession across a raised bog, can be interpreted. Results of radiocarbon dating from the same core show that peat accumulates at an average rate of one foot in 50 years, though with increasing depth and the development of the raised bog formation the rate of accumulation probably decreases. The age of the peat at the base of the core was  $4,270 \pm 70$  years. The study of the *kerangas* forests continued. The collection of 4,500 botanical specimens and correlated timber samples were arranged but critical determinations could not be completed. About 900 woody species are represented in this collection. As part of the project to investigate the factors which control the flowering and fruiting of dipterocarps a meteorological station was set up in the Semengok Agricultural Station near the Arboretum, with a second station inside the Arboretum around a large *Shorea* tree with thermo-hydrographs at five levels up to 107 ft. which will give data on the microclimate from the forest floor to near the top of the tree. Timber specimens, authenticated by herbarium material, now number 1,630. A study has been made of 51 timbers of the most important peat-swamp forest trees and a punch card index prepared. A study of the timber anatomy of *Dactylocladus stenostachys* was completed at Oxford. The results indicate that the characteristic flecks in this

timber are caused by axial strands of included phloem of two types: the "foraminate" type which commonly occurs in the Melastomaceae, and a second type, not previously recorded in this family, in which the included phloem forms radial strands. A grant towards the employment of a silviculturist was made from the Central Research allocation.

642. In *Sierra Leone* the newly found large timber tree, *Didelotia sp.*, was collected. It is known by the unsatisfactory name of African pine in Liberia. It forms about 10 per cent. of the marketable timber in some forests. The wood is coarse-grained but strong and suitable for buildings. On rocky lateritic hills great promise is shown by *Cordia alliodora* from Trinidad and it is an excellent furniture wood. Improvements were made in the technique of mass production of prefabricated wooden buildings, both houses and schools. These incorporated hard, heavy durable timbers otherwise unsaleable except for special purposes or railway sleepers.

643. Enumeration surveys have been started in *Somaliland Protectorate* in *Acacia ethaica* woodland and in *Juniperus procera* forest, and local volume tables have been prepared.

644. In *Tanganyika* planting of *Chlorophora excelsa* in the form of widely spaced "nests" in a matrix of fast-growing utility hardwoods continued to show promise and was tried in conjunction with licensed cultivators to reduce costs. Research on camphorwood (*Ocotea usambarensis*) is now concentrated on a study of increment in relation to spacing as a basis for thinning prescriptions in pole stands of regeneration from root suckers. Work by the Utilisation Division on *Cephalosphaera* was directly responsible for the sudden widespread interest in this timber which is still new to the trade.

645. Few *Uganda* forests have failed to produce natural regeneration and emphasis was further changed to studies on established crops. For these the four or eight leading desirables in each of two thousand chain-square quadrats are measured annually, performance then being analysed with respect to species, treatment, climate, size, age, crowding and exposure. It is now becoming possible to predict the probable effect of various treatments and to deduce performance from present silvicultural condition. So far no partial canopy opening has significantly accelerated the growth of impeded juveniles. Spectacular improvements have resulted only from total opening, though unfortunately confined to poles and saplings. Adolescents over four feet girth have usually failed to respond. Among the smaller juveniles "natural" annual girth increments around half an inch have been easily doubled and others quadrupled. Other studies suggest that such rates are likely to persist to eight feet girth and more, provided the trees remain illuminated and the stands limited. Thus rotations of 40 to 80 years are in sight and by extending the argument, annual acre yields from 30 to 60 cu. ft. of valuable hardwoods for little cost. Research has been started in 500 acres of factorial experiments on problems of early maintenance in felled and refined forest. This is the notorious climber-tangle problem of Benin and pre-war Malaya. The already considerable series of species trials was extended into several new reserves. Several very satisfactory quantitative results were achieved with eucalypts: local volume tables were constructed, a regression equation for yield over tree-space was worked out, the effect of storing young plants in polythene and the discovery of annual acre yields from 600 to 840 cubic

feet. Further use was made of the revolutionary "Pudden Clinal Plot" in design of thinning experiments. From ten to sixteen thinning regimes can be validly compared and replicated within an area of five to eight acres. Because apparently excessive stocking is found in many Uganda crops much attention was given to basal area. All plot measurements now follow a computing procedure allowing thinning to be ruled by basal area. The same routine was extended to the field and a local sample-plot code is now in operation for permanent crop inventory.

#### FOREST ENTOMOLOGY

646. *The West African Timber Borer Research Unit*, which is based at Kumasi in Ghana, was short of staff until in early 1960, Mr. F. G. Browne took over as Officer-in-Charge. During the year the Unit buildings, staff and equipment have been more than doubled.

647. In the research programme attention has been concentrated on ambrosia beetle, *Trachyostus ghanaensis*, that attacks only growing trees of *Triplochiton scleroxylon* (Wawa). This "borer of Wawa" is confined in its distribution to Wawa growing west of the River Volta in Ghana. The insect is known to occur in Ghana and the Ivory Coast and will probably also be found in parts of Liberia and Guinea; it is absent from Togo, Dahomy, Nigeria and the Southern Cameroons. Trees are first attacked at about 2-3 ft. girth and attack can continue throughout their life but is most intense on trees of 5-7 ft. girth. Where present, attack is never very heavy, only affecting about 20 per cent. of the trees, with normally not more than one or two holes being found per tree. Those trees that are attacked are attacked steadily throughout the year and in all probability vigour of the tree is the dominant factor in determining whether the insect will penetrate into the trunk. However, all trees at some time in their life are attacked and each tree appears to go through a phase when its condition may attract the borer: the flowering phase, which occurs once every three years may be important in this cycle of attack. Economically this pest is of great importance to the quality of the Wawa lumber produced in Ghana and the Ivory Coast, largely because stains are able to penetrate the heart of the growing tree along the galleries made by the borer and then spread into the surrounding wood. The best possibilities of control will be found in silvicultural practices and by the encouragement of the spread of natural parasites and predators.

648. A borer commonly attacking growing *Terminalia superba* (Ofram) has been identified as *Doliopygus dubulis*, an ambrosia beetle. Unlike the borer of Wawa this beetle has been recorded from a number of tree species where the felled tree is usually attacked. Attack begins early in the life of the tree. The insect occurs throughout the forest areas of both Ghana and Nigeria.

649. A study is being made of the size of ambrosia beetle populations in areas where extensive poisoning of weed trees has been carried out. Results obtained so far suggest that poisoning may permit the build up of the population with the subsequent danger of invasion of growing trees by the beetles when their numbers reach epidemic size.

650. A paint formulation of BHC has proved very successful in preventing the attack of ambrosia beetles on floating logs. It gave 96 per cent. protection to Wawa over a 12 week exposure period. Aldrin, next to BHC, was most useful as a control. Malathion gave negligible protection against attack. Grease formulations were greatly inferior to the paint.

651. A survey of the powder-post beetles of Nigeria has revealed the species of importance and the timbers that are particularly susceptible and consequently in need of chemical treatment for protection. These insects are major pests of lumber in Southern Nigeria.

652. Examination of the monthly change in the starch content of standing Wawa trees has shown that a marked drop in starch occurs in May in Ghana prior to the appearance of new leaves. A second fall occurs in October—November in some trees which may be associated with flowering. In felled trees with the bark still on high starch values were still obtained after 9 months exposure in the forest.

653. In *British Honduras* experiments with systemic poisons are being done to control shoot-borer (*Hypsipyla* sp.) attacks on young mahogany trees. Planting of Teak-Mahogany and Balsa-Mahogany mixtures have been attempted as further shoot-borer control methods.

654. A similar borer (*Hypsipyla* sp.) attacked species of *Swietenia* and *Cedrela* in the *British Solomon Islands Protectorate*, where it was noted that *Cedrela mexicana* and *C. odorata* adjacent to severely attacked *C. australis* remained free from attack.

655. In *Cyprus* the incidence of attack by *Myelophilus* sp. in summer-thinned *Pinus brutia*, the relation of fire injury of *P. brutia* to borer attack in burnt areas and the life cycle of *Thanmetopoea wilkinsoni* were items of study.

656. The main problem in *Kenya* was the Cerambycid borer, *Oemida gahani*, attacking cypress plantations. Research was concentrated on practical measures of reducing damage through the application of results obtained from the investigations of flight and oviposition preferences in the beetles and the comparative susceptibility of indigenous stumps and logs to attack. Sampling of indigenous stumps in plantations revealed that at least 75 species act as hosts of the pest, 10 of the commonest species being frequently attacked. Proof was thus obtained of the necessity for greatly improved plantation hygiene preparatory to planting cypress after clearing natural forest. Comparatively low incidence of *Oemida* was found in predominantly bamboo areas and this characteristic, combined with greater ease of effective clearing for planting, showed their suitability for cypress. A possible method of attracting attack away from select final crop trees, in plantations where old stumps are common, was tried experimentally. Wounds were made on trees due to be removed at the next thinning to attract ovipositing female beetles. Some success was obtained and the method shows promise of reducing the beetles in older plantations, by concentrating eggs so that they may be easily destroyed. The danger of spread of attack from natural forest to cypress plantations was shown by flight tests, in which female beetles flew up to 120 yards. An investigation of the effectiveness of strips cleared of

stumps and logs, between natural forest and plantations, in checking spread has been started. An alternative method of planting non-susceptible pines in belts is also being tried.

657. In *Uganda* serious and sometimes fatal attacks by platypodids are reported on adolescent *Albizzia* suddenly exposed in felling areas. The cause was apparently partly sunscorch, but damage was only severe in areas where arboricides had been widely used and where, therefore, the platypodid population was high. Attention is being given to prevention by silvicultural methods. Considerable progress was made with control of *Chlorophora* gall with systemics and an economic technique may be achieved. Work on termites was greatly hampered by failure of attack in the expected and occurrence in the unexpected places.

#### BEEKEEPING

658. The only territory carrying out research on beekeeping is *Tanganyika*, where honey and beeswax are useful forest byproducts. Studies on pollen and nectar formation have led to the general conclusion that rainfall is the main factor limiting production and that there is a critical rainfall, provisionally set at 40 inches, below which economic beekeeping involving capital investment becomes a very dubious proposition. With less than 35 inches even peasant beekeeping is considered doubtfully economic. Research on bee biology and behaviour was continued and a new type of hive intended for commercial bee-farming was designed for African bees.

Colonial  
Economic Research Committee  
Thirteenth Annual Report  
(1959-1960)

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London School of Economics,  
and Political Science,  
Houghton Street,  
Aldwych,  
London, W.C.2.

26th September, 1960.

SIR,

I have the honour, on behalf of the Colonial Economic Research Committee, to transmit to you the Thirteenth Report of the Committee covering the period from 1st April, 1959 to 31st March, 1960.

I have the honour to be,

Sir,

Your obedient Servant,

ARNOLD PLANT,

*Chairman.*

The Right Honourable Iain Macleod, M.P.,  
Secretary of State for the Colonies.



## COLONIAL ECONOMIC RESEARCH COMMITTEE

### Membership

PROFESSOR SIR ARNOLD PLANT, B.Sc. (Econ.), B.Com., Sir Ernest Cassell Professor of Commerce, University of London (*Chairman*).

PROFESSOR S. H. FRANKEL, D.Sc. (Econ.), Professor of Colonial Economic Affairs, University of Oxford.

PROFESSOR A. T. PEACOCK, D.S.C., M.A., Professor of Economic Science, University of Edinburgh.

PROFESSOR J. R. RAEBURN, B.Sc., M.S., Ph.D., M.A., Department of Agriculture, Marischal College, Aberdeen.

PROFESSOR E. A. G. ROBINSON, C.M.G., O.B.E., M.A., F.B.A., Professor of Economics, University of Cambridge.

PROFESSOR K. E. ROBINSON, M.A., Director of the Institute of Commonwealth Studies, University of London.

PROFESSOR R. C. TRESS, B.Sc. (Econ.), Professor of Political Economy, University of Bristol.

MR. A. J. PECKHAM (*Secretary*) to December, 1959.

MR. R. C. H. GREIG (*Secretary*) from January, 1960.

### *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

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## COLONIAL ECONOMIC RESEARCH COMMITTEE

### 13th Annual Report and Bibliography

#### I. INTRODUCTION

1. Two meetings of the Committee were held during the year.

#### II. GENERAL

2. Issues from the Economic Research allocation for the year ended 31st March, 1960, amounted to £8,846.

3. One of the proposals for future research put forward by the Committee was a study of the problem of coffee producers in colonial territories with reference to the world market situation. Mr. J. W. F. Rowe, a Fellow of Pembroke College, Cambridge, who already had a considerable knowledge of coffee problems, has agreed to undertake this study.

4. Included in other projects under consideration was the need for a study of the economics of forestry both in respect of the exploitation of natural forest products and of the afforestation of new areas.

5. The annual reports of the regional Institutes of Social and Economic Research, which appear as appendices to the Annual Report of the Colonial Social Science Research Council, contain an account of economic research undertaken by them. A social and economic history of the Cameroons was included in the programme of work undertaken by the Nigerian Institute of Social and Economic Research. Plans were proposed for members of the teaching staff of Makerere College to be associated with the Institute's research work on economic and other subjects.

#### III. PUBLICATION OF RESEARCH FINDINGS

6. Professor Gilbert Walker's book "Transport in Nigeria" was published as Colonial Research Study No. 27.

7. Mr. J. W. F. Rowe's report "The Economy of the Seychelles and its Future Development" was published by the Government of the Seychelles.

8. During the year under review, Mr. J. R. Sargent made an investigation into the transport needs of North Borneo and his report, "Transport Requirements in the Light of Economic Development in North Borneo", was published by the North Borneo Government.

9. Two reports "Social Aspects of Maltese Agriculture" and "Social Aspects of Maltese Migration" were published by the Royal University of Malta as a result of work carried out by a team of members of the University of Durham in collaboration with the Royal University of Malta.

10. Mr. E. K. Hawkins completed his study of the economics of road development in Uganda and his report will be published in the Colonial Research Studies Series.

**IV. RESEARCH IN PROGRESS**

11. Professor J. S. G. Wilson continued work on the Economic Survey of the New Hebrides.

12. The Government of Mauritius applied for and was given a grant towards research into the trade of Mauritius since records were first kept in 1764. The aim is to produce a selection of statistical data to serve as a basis for further investigation and Dr. Toussaint, the Chief Archivist to the Mauritius Government, was appointed to carry out the work.

13. Mr. D. N. McMaster completed his geographical study of subsistence crops of Uganda and submitted his final report to the Committee.

**V. NEW PROJECTS**

14. A small grant was made to assist the Department of Political Economy at Edinburgh University to study the effects of commodity price falls on the development plans and sterling balances of selected British Colonies, with implications for improved viability in the future.

15. Towards the end of the year under review the Committee considered and approved a grant towards the cost of two pilot schemes undertaken by the National Institute of Economic and Social Research into long-term trends in exports of primary products from the overseas sterling area.

16. An application from the Uganda Government for a grant towards the cost of a fact-finding study of African local markets and produce movements, excluding coffee and cotton, was approved.

**VI. PUBLICATIONS BY WORKERS ASSISTED FROM COLONIAL DEVELOPMENT AND WELFARE FUNDS**

17. Publications by workers assisted from Colonial Development and Welfare funds (new publications in the year under review and additions to the list of publications noted in the Twelfth Annual Report) are:

Adu, S. A.—“Statistics in a Developing Economy with Special Reference to Nigeria.” *Nigerian Journal of Economics and Social Studies*, Vol. I. No. 1.

Cirillo, Professor R.—“Social Aspects of Maltese Agriculture,” published by the Royal University of Malta. July, 1959.

“Social Aspects of Maltese Migration,” published by the Royal University of Malta. November, 1959.

Hawkins, E. K.—“Capital Formation in Nigeria and Ghana, 1946-55.” *Oxford Institute of Statistics Bulletin*, Vol. 21. No. 1.

O’Loughlin, C.—“The Economy of British Guiana, 1952-1956: A National Accounts Study.” *Social and Economic Studies*, Vol. 8, No. 1, March, 1959.

“The Economy of Montserrat,” *Social and Economic Studies*, Vol. 8, No. 2, June, 1959.

“The Economy of Antigua.” *Social and Economic Studies*, Vol. 8, No. 3, September, 1959.

- "The Economy of St. Kitts, Nevis, Anguilla." *Social and Economic Studies*, Vol. 8, No. 4, December, 1959.
- Ord, H. W.—"The Employment of Capital in East Africa," E.A.I.S.R. Conference Paper, December, 1959.
- Prothero, R. M.—"Migrant Labour from Sokoto Province, Northern Nigeria." Government Printer, Northern Region Nigeria.
- Rowe, J. W. F.—"Report on the Economy of the Seychelles and Its Future Development," published by the Government of Seychelles, October, 1959.
- Sargent, J. R.—"Report on Transport Requirements in the Light of Economic Development in North Borneo," published by the Government of North Borneo, 1960.
- Van Velsen, J.—"Labor Migration as a Positive Factor in Continuity of Tonga Tribal Society." *Economic Development and Cultural Change*, Vol. VIII, No. 3, April, 1960.
- Walker, G.—"Traffic and Transport in Nigeria." Colonial Research Studies No. 27, published by Her Majesty's Stationery Office, 1959.
- Warmington, W. A.—"A West African Trade Union," published by O.U.P. 1960.
- "C.D.C. and the Cameroons." *West Africa*, No. 2233, 19th March, 1960.

Colonial Fisheries Advisory  
Committee Annual Report on  
Fisheries Research  
(1959-1960)

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Colonial Office,  
The Church House,  
Great Smith Street,  
S.W.1.

10th August, 1960.

SIR,

I have the honour to transmit herewith the report of the Colonial Fisheries Advisory Committee for the year ended 31st March, 1960.

I have the honour to be,

Sir,

Your obedient Servant,

PERTH,

*Chairman.*

The Rt. Hon. Iain Macleod, M.P.,  
Secretary of State for the Colonies.

## COLONIAL FISHERIES ADVISORY COMMITTEE

**Membership**

- THE MINISTER OF STATE FOR COLONIAL AFFAIRS (*Chairman*).
- MR. W. B. L. MONSON, C.M.G. (*Vice-Chairman* up to the 4th August, 1959).
- MR. TRAFFORD SMITH, C.M.G. (*Vice-Chairman* from the 12th October, 1959).
- DR. H. A. COLE, D.Sc.
- DR. G. E. R. DEACON, C.B.E., D.Sc., F.R.S.
- DR. C. F. HICKLING, C.M.G., Sc.D. (Fisheries Adviser to the Secretary of State).
- MR. T. S. LEACH, C.M.G., M.C.
- PROFESSOR C. F. A. PANTIN, Sc.D., F.R.S.
- DR. G. A. REAY, C.B.E., Ph.D., F.R.I.C.
- DR. F. S. RUSSELL, C.B.E., D.S.C., D.F.C., LL.D., F.R.S.
- DR. E. TREWAVAS, D.Sc.
- MR. R. S. WIMPENNY, O.B.E., M.Sc.
- PROFESSOR C. M. YONGE, C.B.E., D.Sc., Ph.D., F.R.S.
- MR. W. F. DAWSON, M.B.E. (Secretary up to the 2nd November, 1959).
- MR. E. W. A. SCARLETT, O.B.E. (Secretary from the 5th November, 1959).

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**Terms of Reference**

The Committee was appointed by the Secretary of State for the Colonies in October, 1943, to advise him on problems concerning fisheries (marine and freshwater) in the Colonial Empire.

COLONIAL FISHERIES ADVISORY COMMITTEE  
REPORT FOR 1959-1960

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## COLONIAL FISHERIES ADVISORY COMMITTEE

### ANNUAL REPORT ON FISHERIES RESEARCH, 1959-60

#### I. GENERAL

1. Three meetings of the Committee were held during the year. Dr. H. A. Cole, successor to Mr. R. S. Wimpenny as Director of Fisheries Research, Ministry of Agriculture, Fisheries and Food, joined the Committee in May, 1959. Mr. W. B. L. Monson relinquished the Vice-Chairmanship on the 4th August, 1959, and was succeeded by Mr. Trafford Smith. Mr. E. W. A. Scarlett took over from Mr. Dawson as Secretary in November, 1959.

2. The Fisheries Adviser, Dr. Hickling, returned to the United Kingdom in April, 1959, after acting as Director of the Malacca Institute. His place there was taken for nearly six months by Mr. J. E. Shelbourne of the Lowestoft Laboratory of the Ministry of Agriculture, Fisheries and Food, by kind permission of the Director of Fisheries Research. Dr. G. A. Prowse was appointed Director of the Institute in September, 1959.

3. Dr. H. D. Slack of the Department of Zoology, Glasgow University, who is in charge of the University's freshwater biological research station on Loch Lomond, continued his work at the Malacca Institute, financed by Colonial Development and Welfare funds, on the spawning of the Chinese Grass Carp and made some progress in this difficult problem. The Committee are very appreciative of the University's co-operation in making available Dr. Slack's experience.

4. In April, 1959, the Fisheries Adviser visited North Borneo, Sarawak and Brunei, and in November and December, 1959, he visited Sierra Leone and the Federation of Nigeria.

5. Dr. J. Evans of the Royal Holloway College was awarded a Colonial Research Fellowship to enable him to undertake a study of the freshwater algae of Lake Victoria and other lakes in the region.

#### II. FINANCE

6. Expenditure up to the 31st March, 1960, against the allocation of £840,000 from Colonial Development and Welfare money for fisheries research over the five-year period that ended on that date was estimated at £588,487.

#### III. REPORTS ON INDIVIDUAL COLONIAL FISHERIES RESEARCH STATIONS

##### *Sierra Leone Fisheries Research and Development Unit*

7. In connection with the extension of trawl fishing in Sierra Leone waters, considerable time has been spent by the Research Unit on the effect of trawl meshes of different sizes on the size of fish caught. Consistent selection coefficients have been determined for the most important fishes, with nets made of different materials. Should advice be needed by the Sierra Leone Government on mesh regulations, the data are now to hand.

8. In the course of this work, much information has been got on the distribution and life history of the most important species.

9. Extensive marking experiments have now shown that there is practically no interchange of the bottom-living fish species between the Sierra Leone Estuary and the open sea.

10. Marking experiments are being continued with the pelagic fish "Bonga". Recaptured fish show a movement out of the Sierra Leone Estuary in a northerly direction. A return movement has not yet been proved. A survey is being made of the spawning times and places of this important fish.

11. A start has been made with research on fish preservation, and in particular the rate of uptake of salt.

*East African Fisheries Research Organisation, Jinja*

12. A survey of the *Tilapia* stocks of Lake Victoria continues. The first effect of removing restrictions on the size of mesh allowable in gillnets resulted, as expected, in a temporary increase in yield, but now the yield is declining and may reach a new low level.

13. In this connection, much work has been done on the selective action of gillnets, in particular in relation to body-girth, a factor hitherto unconsidered: and it is now possible to make more accurate estimates of the size composition of the stocks of fish, as selected by the gillnets of the commercial fishery. Indeed, by experimental fishings with gillnets of small mesh, some estimates are being made of the size of the stocks of fish before they are of a size to enter the exploited stocks.

14. A special study is being made of *Tilapia variabilis*, which has assumed greater importance now that *T. esculenta* is declining and now that smaller meshes are in use. Its rate of growth appears to be even slower than that of *T. esculenta*, and it seems unlikely that *T. variabilis* can compensate for the decline in *T. esculenta*.

15. Laboratory studies on the growth of fish under controlled conditions are being continued. These have resolved some uncertainties about the growth-rate of small *Tilapia*, and the type of food they require. They have also given indications of the growth rate which could be achieved under ideal conditions, and on the effect of temperature on growth rate and on the onset of maturity.

16. Records have been kept on the occurrence of fish parasites. The young stages of an important freshwater mussel, *Mutela*, have been found to be parasitic on the fish *Barbus*. As the run of *Barbus* up the Victoria Nile into Lake Victoria is now stopped by the Owen Falls dam, the population of the mussel may be adversely affected, to the disadvantage of another important food fish, *Protopterus*, which feeds on mussels.

17. Work on the Nile Perch has begun on Lakes Albert and Kioga. Preliminary surveys have shown that a suitable base at the southern end of Lake Albert will be needed. Some of these fish are under observation in a dam to see what they feed on and how fast they grow.

*East African Marine Fisheries Organisation, Zanzibar*

18. Exploratory work with the tuna longline continues. A standard set of about  $7\frac{1}{2}$  miles of line has been adopted. Tuna are most likely to be

caught during the south-east monsoon, while swordfish, sailfish and especially the marlins are most likely to be caught during the north-east monsoon.

19. Although the tuna are the more valuable per pound, the swordfish, sailfish and marlin give the greatest weight because of the large size of the individual fish and the numbers caught. The indications are of a fishery which will yield a catch of high commercial value throughout the year.

20. The exploration of the North Kenya fishing banks also continues. The sea bottom has a complex formation; there are a number of rough areas suitable for snapper fishing, as well as two or three areas smooth enough for trawling.

21. On these banks it appears that there are two periods of relative abundance of fish, these coinciding with the changes of the Monsoons. These may be due to the concentration of the fish preparatory to spawning.

22. Work on prawns has been handicapped by mishaps to the research launch; but the work has reached the point where the species of prawns most likely to form the basis of a commercial fishery have been determined.

#### *Northern Rhodesia-Nyasaland Joint Fisheries Research Organisation*

23. During the year, research has continued on Lake Bangweulu and the new Kariba Lake. The Bangweulu work has reached the point where the results of the swamp survey can be written up for publication. Arising out of this more general survey, a more detailed survey of a swamp lagoon is being made.

24. Visits to the Kariba Lake have shown that the multiplication of the fish in the new lake is going well.

25. Meanwhile, a monograph on the ecology of the fish in the Zambesi before inundation has been prepared for publication. This will make a valuable comparison with the fish population which will become established in the new lake.

26. Work has now started at the southern end of Lake Tanganyika. There is a group of fishes, predators based on the freshwater sardines, which live in the open water and have little connection with the shore. On the shores is a group of fishes which are either specialised to rocky or sandy shores, or which run up rivers to spawn.

27. In connection with the off-shore fishery, trials are being made with a simple net based on the "chilimila" of Lake Nyasa, used in conjunction with a light to attract the fish.

28. This net shows promise and some successful hauls have been made with it. The conventional type net, with its small-meshed central portion made of cotton, was found to be not strong enough to hold the larger fish, such as Nile Perch; so trials are being made of a net with this vulnerable centre portion made of Nylon.

29. At the sub-station at Nkata Bay on Lake Nyasa, work has continued on the *Haplochromis* species, commercially fished as "Utaka", and on the small pelagic fish *Engraulicypris*.

#### *Tropical Fish Culture Research Institute, Malacca*

30. Trials with fertilisers were continued in the "Latin Square" of 36 one-acre ponds.

31. Trials of phosphate and potash, singly and together and in unlimed ponds and ponds limed at two different levels, gave the definite result that 20 cwt. limestone and 20 lbs.  $P_2O_5$  per acre as triple superphosphate gave the best yield of fish—an average of some 688 lbs. per acre and per annum. Potash alone gave no improvement over untreated ponds, potash with phosphate gave less fish than phosphate alone. Phosphate with 36 cwt. of limestone gave less fish than phosphate with 20 cwt. limestone.

32. The next trials tested 40 lbs.  $P_2O_5$  against  $P_2O_5$  and nitrogen (given as calcium nitrate) together ; and against several tons of cow-dung per acre. 40 lb.  $P_2O_5$  by itself gave a better result than the organic manure or than any other combination of inorganic fertiliser. The paramount importance of phosphate as a fertiliser is thus confirmed.

33. A series of experiments to test slaked lime against limestone as a means of neutralising acid soil and water is nearing completion.

34. Observations on the Chinese Grass Carp have shown that these fish may reach a weight of 6.5 to 7.3 kg. in 460 days from fingerlings. In July, towards the end of their natural spawning season in rivers, the ovaries of the females ripened, but they regressed a month later without spawning. The males ripened earlier and regressed later. Though it has been shown that the Grass Carp will mature in ponds, actual spawning has not yet been accomplished.

35. Injections and implantations of hypophyses of Tilapia did not accelerate maturation, and Grass Carp kept in tanks showed a stress reaction inhibiting ripening.

36. A modified pond now allows subjection of Grass Carp to flowing water, and this treatment is being applied. The fish quickly respond by shoaling and circling in the region of the inflow.

37. The collection of routine plankton and hydrological data continues.

#### *The Fisheries Research Unit of the University of Hong Kong*

38. The research trawler "Cape St. Mary", on the completion of her survey of the British Guiana shelf, was assigned to Hong Kong and has begun investigations of the trawlable grounds within a wide radius of Hong Kong.

39. Papers on the biology of the Golden Thread (*Nemipterus virgatus*) and the Yellow Croaker Fishery are being published.

40. Oyster research continues with the construction of new test rafts at Tolo Harbour. A thesis on prawns of commercial value has been based on research at the Unit.

41. Routine oceanographic surveys were continued so far as possible, both at two fixed stations and on the line Lantau Island-Macao.

42. A report is being prepared on the trawling survey carried out by the "Alister Hardy".

43. Fertiliser trials have been started in the freshwater fishponds.

11

Colonial  
Medical Research Committee  
Fifteenth Annual Report  
1959-1960

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Medical Research Council,  
38, Old Queen Street,  
London, S.W.1.  
18th August, 1960.

SIR,

On behalf of the Colonial Medical Research Committee, I have the honour to transmit to you the Fifteenth Annual Report of the Committee, covering the period 1st April, 1959, to 31st March, 1960.

I have the honour to be,

Sir,

Your obedient Servant,

H. P. HMSWORTH,

*Chairman.*

The Rt. Hon. Iain Macleod, P.C., M.P.,  
Secretary of State for the Colonies.

## COLONIAL MEDICAL RESEARCH COMMITTEE

### Membership

- SIR HAROLD HIMSWORTH, K.C.B., M.D., F.R.C.P., F.R.S., Secretary, Medical Research Council (*Chairman*).
- BRIGADIER SIR JOHN BOYD, O.B.E., M.D., D.P.H., D.T.M. & H., F.R.C.P., F.R.S. (late R.A.M.C.), formerly Director, Wellcome Laboratories of Tropical Medicine.
- MAJOR-GENERAL SIR GORDON COVELL, C.I.E., M.D., D.P.H., D.T.M. & H., Director, Ministry of Health Malaria Laboratory, Horton Hospital.
- SIR NEIL HAMILTON FAIRLEY, K.B.E., M.D., D.Sc., F.R.C.P., F.R.S., Consulting Physician, Hospital for Tropical Diseases, University College Hospital, London.
- PROFESSOR A. C. FRAZER, M.D., D.Sc., Ph.D., F.R.C.P., Professor of Medical Biochemistry and Pharmacology, University of Birmingham.
- PROFESSOR P. C. C. GARNHAM, M.D., D.Sc., D.P.H., Professor of Medical Protozoology, University of London.
- PROFESSOR R. M. GORDON, O.B.E., M.D., Sc.D., F.R.C.P., D.P.H., D.T.M. (late Professor of Entomology and Parasitology, Liverpool School of Tropical Medicine, University of Liverpool).
- DR. F. HAWKING, D.M., M.R.C.P., D.T.M., National Institute for Medical Research.
- PROFESSOR W. E. KERSHAW, V.R.D., M.D., D.Sc., D.T.M. & H., Professor of Entomology and Parasitology, Liverpool School of Tropical Medicine, University of Liverpool.
- PROFESSOR G. MACDONALD, C.M.G., M.D., F.R.C.P., D.P.H., D.T.M., Professor of Tropical Hygiene, University of London, and Director, Ross Institute of Tropical Hygiene.
- PROFESSOR B. G. MAEGRAITH, M.B., B.Sc., D.Phil., F.R.C.P., Professor of Tropical Medicine, University of Liverpool.
- PROFESSOR B. S. PLATT, C.M.G., M.Sc., Ph.D., M.B., Professor of Human Nutrition, University of London.
- SIR ALEXANDER WILSON RAE, K.C.M.G., M.D., Chief Medical Officer to the Secretary of State for the Colonies.
- SIR LANDSBOROUGH THOMSON, C.B., O.B.E., D.Sc., Medical Research Council.
- PROFESSOR A. W. WOODRUFF, M.D., Ph.D., F.R.C.P., D.T.M. & H., Professor of Clinical Tropical Medicine, The Hospital for Tropical Diseases, University College Hospital, London.
- DR. R. LEWTHWAITE, C.M.G., O.B.E., D.M., F.R.C.I., Colonial Office (Secretary).

### 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, and, in particular, regarding:—

- (a) medical research in the Colonies financed from Colonial Development and Welfare funds ;

- (b) the promotion of such basic and long-term work as is required to be based on the United Kingdom and the supervision of workers engaged for this purpose;
- (c) the promotion of work in, and for, the Colonies by workers in home universities and research organisations.

In addition the Committee will serve as a focus and clearing house of information.

### SUB-COMMITTEES

#### MALARIA

- BRIGADIER SIR JOHN BOYD, O.B.E., M.D., F.R.C.P., F.R.S. (*Chairman*).
- MAJOR-GENERAL SIR GORDON COVELL, C.I.E., M.D., D.P.H., D.T.M. & H.
- SIR NEIL HAMILTON FAIRLEY, K.B.E., M.D., D.Sc., F.R.C.P., F.R.S.
- PROFESSOR P. C. C. GARNHAM, M.D., D.Sc., D.P.H.
- DR. R. LEWTHWAITE, C.M.G., O.B.E., D.M., F.R.C.P.
- PROFESSOR G. MACDONALD, C.M.G., M.D., F.R.C.P., D.P.H., D.T.M.
- PROFESSOR B. G. MAEGRAITH, M.B., B.Sc., D.Phil., F.R.C.P.
- SIR ALEXANDER WILSON RAE, K.C.M.G., M.D.
- DR. F. HAWKING, D.M., M.R.C.P., D.T.M. (*Secretary*).

#### HELMINTHIASIS

- PROFESSOR W. E. KERSHAW, V.R.D., M.D., D.Sc., D.T.M. & H. (*Chairman*).
- BRIGADIER SIR JOHN 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.
- SIR NEIL HAMILTON FAIRLEY, K.B.E., M.D., D.Sc., F.R.C.P., F.R.S.
- PROFESSOR R. M. GORDON, O.B.E., M.D., Sc.D., F.R.C.P., D.P.H., D.T.M.
- DR. F. HAWKING, D.M., M.R.C.P., D.T.M.
- DR. R. LEWTHWAITE, C.M.G., O.B.E., D.M., F.R.C.P.
- DR. J. NEWSOME, M.D., D.T.M. & H., Director, Medical Research Council Group for Research on Bilharzia Disease, St. Albans.
- SIR ALEXANDER WILSON RAE, K.C.M.G., M.D.
- DR. J. WALKER, D.Sc., Ph.D., D.Phil., National Institute for Medical Research.
- DR. T. WILSON, C.B.E., M.D., D.P.H., D.T.M. & H., Senior Lecturer in Tropical Hygiene, University of Liverpool (*Secretary*).

#### LEPROSY

- BRIGADIER SIR JOHN BOYD, O.B.E., M.D., F.R.C.P., F.R.S. (*Chairman*).
- DR. A. R. D. ADAMS, M.D., F.R.C.P., Senior Lecturer in Tropical Medicine, Liverpool School of Tropical Medicine, University of Liverpool.
- DR. E. M. BRIEGER, M.D., Honorary Pathologist, Papworth Hospital, Cambridge, Member of the Strangeways Research Laboratory, Cambridge.
- DR. S. R. M. BUSHBY, Ph.D., Wellcome Research Laboratories.
- PROFESSOR G. A. H. BUTTLE, O.B.E., M.R.C.S., L.R.C.P., Wellcome Professor of Pharmacology, School of Pharmacy, University of London.



- DR. R. G. COCHRANE, M.D., F.R.C.P., Technical Medical Adviser, American Medical Missions.
- DR. T. F. DAVEY, C.B.E., M.D., M.Sc., Medical Secretary, Methodist Missionary Society, London.
- DR. P. M. D'ARCY HART, C.B.E., M.D., F.R.C.P., National Institute for Medical Research.
- SIR NEIL HAMILTON FAIRLEY, K.B.E., M.D., D.Sc., F.R.C.P., F.R.S.
- DR. F. HAWKING, D.M., M.R.C.P., D.T.M.
- DR. G. R. F. HILSON, M.D., Reader in Bacteriology, St. George's Hospital Medical School, University of London.
- DR. D. G. JAMISON, B.M., B.Ch., Senior Research Fellow, Corpus Christi College, Oxford.
- DR. E. MUIR, C.M.G., C.I.E., M.D., F.R.C.S.E., LL.D., Hon. Medical Adviser, British Leprosy Relief Association.
- SIR ALEXANDER WILSON RAE, K.C.M.G., M.D.
- DR. R. J. W. REES, B.Sc., M.B., National Institute for Medical Research.
- DR. D. S. RIDLEY, B.Sc., M.B., Pathologist, Hospital for Tropical Diseases, University College Hospital.
- PROFESSOR J. M. ROBSON, M.D., D.Sc., F.R.S.E., Professor of Bacteriology and Immunology, University of London.
- DR. J. ROSS INNES, M.D., D.T.M., Medical Secretary, British Leprosy Relief Association.
- PROFESSOR E. T. C. SPOONER, M.D., Professor of Bacteriology and Immunology, University of London.
- DR. I. SUTHERLAND, D.Phil., Statistical Research Unit, London School of Hygiene and Tropical Medicine.
- DR. A. G. MCD. WEDDELL, M.D., D.Sc., Reader in Human Anatomy, University of Oxford.
- DR. R. LEWTHWAITE, C.M.G., O.B.E., D.M., F.R.C.P. (*Secretary*).

#### MOLLUSC-BORNE DISEASES

- PROFESSOR G. MACDONALD, C.M.G., M.D., F.R.C.P., D.P.H., D.T.M. (*Chairman*).
- PROFESSOR J. J. C. BUCKLEY, D.Sc.
- PROFESSOR R. M. GORDON, O.B.E., M.D., Sc.D., F.R.C.P., D.P.H., D.T.M.
- PROFESSOR A. GRAHAM, B.Sc., D.Sc., Professor of Zoology, University of Reading.
- DR. P. L. LEROUX, D.Sc., M.R.C.V.S., Reader in Medical Parasitology, University of London.
- PROFESSOR W. E. KERSHAW, V.R.D., M.D., D.T.M. & H.
- PROFESSOR B. G. MAEGRAITH, M.B., B.Sc., D.Phil., F.R.C.P.
- DR. O. D. STANDEN, D.Sc., Wellcome Laboratories of Tropical Medicine, London.
- DR. E. L. TAYLOR, C.B.E., D.V.Sc., D.V.H., N.D.A., N.D.D., Central Veterinary Laboratory, Weybridge.

DR. C. A. WRIGHT, B.Sc., A.R.C.S., Ph.D., D.I.C., British Museum (Natural History), London.

DR. J. NEWSOME, M.D., D.T.M. & H. (*Secretary*).

PERSONNEL

PROFESSOR G. MACDONALD, C.M.G., M.D., F.R.C.P., D.P.H., D.T.M. (*Chairman*).

MR. J. G. DUNCAN, M.A., LL.B., Principal Administrative Officer, Medical Research Council.

SIR ALEXANDER WILSON RAE, K.C.M.G., M.D.

DR. R. LEWTHWAITE, C.M.G., O.B.E., D.M., F.R.C.P. (*Secretary*).

ADVISORY WORKING-PARTY ON THE SICKLE-CELL TRAIT AND  
SICKLE-CELL ANAEMIA

PROFESSOR A. W. WOODRUFF, M.D., Ph.D., F.R.C.P., D.T.M. & H. (*Chairman*).

DR. A. C. ALLISON, D.Phil., B.M., National Institute for Medical Research, London.

PROFESSOR P. C. C. GARNHAM, M.D., D.P.H.

DR. H. LEHMANN, M.D., Sc.D., Ph.D., M.R.C.P., F.R.I.C., St. Bartholomew's Hospital, London.

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

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

DR. A. E. MOURANT, D.M., D.Phil., F.R.C.P., Blood Group Reference Laboratory, Lister Institute of Preventive Medicine, London.

DR. A. B. RAPER, B.Sc., M.D., M.R.C.P., D.T.M. & H., Department of Pathology, Bristol Royal Infirmary, Bristol.

DR. J. A. FRASER ROBERTS, M.D., D.Sc., F.R.C.P., Clinical Genetics Research Unit, Institute of Child Health, Hospital for Sick Children, Great Ormond Street, London.

DR. J. C. WHITE, M.B., Department of Pathology (Haematology), Postgraduate Medical School, London.

DR. G. H. BEAVEN, M.Sc., Ph.D., Medical Research Council Laboratories, Hampstead, London (*Secretary*).

COLONIAL MEDICAL RESEARCH COMMITTEE  
FIFTEENTH ANNUAL REPORT

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## COLONIAL MEDICAL RESEARCH COMMITTEE

### WORK OF THE COMMITTEE

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

#### *Development of Research Schemes*

2. Fifty research projects are in varying degree under the scientific aegis of the Committee. They range from large units, independent and self-contained or attached to existing research organisations and Colonial universities, to projects providing fully or in part for single investigators in the field or in the laboratory. In addition, many grants were made for home-based scientists to visit overseas units, for the rapid transport of research material, for the purchase of apparatus, and for the support of projects within departments of universities in Britain or Colonial territories that are undertaking basic research relevant to the problems of tropical medicine.

New projects include two of particular interest, the first a field assay of two anti-typhoid vaccines in British Guiana, the second a field study designed to define the aetiology and epidemiology of dermal leishmaniasis in British Honduras.

#### *Personnel*

3. The Personnel Sub-Committee has continued to advise on all medical appointments to the Research Branch of Her Majesty's Overseas Civil Service, and to scrutinise annually the emoluments of all members of that Service. During the year eight new overseas postings were made, three of them former Colonial Research Students. Three Students are under training in Britain prior to posting overseas. Three officers resigned, two on completion of their short-term projects.

#### *Finance*

4. The apportionment of funds allocated to medical research under the Colonial Development and Welfare Acts necessitated assiduous consideration by the Committee, having due regard to existing research projects, the claims of new proposals, the need to retain an emergency reserve, and the varying financial participation of the Governments of Colonial territories. The valued collaboration of the Government of Ghana, in finance, personnel and other research facilities, has continued in the existing and projected medical research activities sponsored by the West African Council for Medical Research.

#### *Oversea Visits*

5. Nine members of the Committee and two members of the Sub-Committees visited various research units in the field.

#### *Tropical Medicine Research Board*

6. This Fifteenth Annual Report of the Committee will be the last in the series. For in the autumn of 1960 the existing arrangements for supporting medical research in tropical countries will be adjusted to meet those political and administrative developments in Colonial territories whereby, during the last few years, some territories have become independent and are therefore

no longer eligible to receive disbursements from Colonial Development and Welfare funds; similar changes are imminent in other Colonial territories.

7. Consequent on these developments, consultations have been held between the Medical Research Council, the Colonial Office and the Commonwealth Relations Office, and have led to the decision that the Medical Research Council should set up a Tropical Medicine Research Board to advise:

- (a) The Secretary of State for the Colonies through the Medical Research Council on all medical research in or for the Colonies financed from Colonial Development and Welfare funds;
- (b) the Medical Research Council on all medical research in or for the independent Commonwealth financed from the United Kingdom exchequer;
- (c) the Medical Research Council on all medical research in or for tropical or subtropical countries financed from their own budget.

8. This Board will take over the work of the existing Colonial Medical Research Committee, including the promotion of visits abroad by experts and by home research workers who have a problem that could be developed with advantage overseas. Its functions will pertain mainly to policy. The existing Sub-Committees of the Colonial Medical Research Committee will continue as Advisory Committees of the Medical Research Council, so that their functions of dealing with detailed scientific matters will continue without interruption.

#### REGIONAL ORGANISATIONS FOR MEDICAL RESEARCH IN THE COLONIAL TERRITORIES

##### *East African Council for Medical Research*

9. This Council held its sixth meeting in Entebbe in February, 1960, which was preceded by a meeting in January at Dar-es-Salaam of its Scientific Advisory Committee and by a three-day Scientific Conference on "The origin and effects of malnutrition in East Africa." The Conference was opened by His Excellency the Governor of Tanganyika, and its President was Professor B. S. Platt, Professor of Human Nutrition, University of London; some 50 scientists attended each day.

Professor G. Macdonald and Professor A. W. Woodruff participated in all meetings and visited each medical research unit in the region.

##### *West African Council for Medical Research*

10. The fifth meeting of this Council was held in Bathurst, Gambia, in February, 1960, being preceded by a meeting of its Standing Scientific Committee. Professor B. G. Maegraith and Professor P. C. C. Garnham participated in both meetings as delegates of the Committee and visited the medical research units in the region. Sir Landsborough Thomson also attended the two meetings.

##### *Standing Advisory Committee for Medical Research in the British Caribbean*

11. This Committee held its fifth meeting in April, 1960, in Kingston, Jamaica. It was preceded by a three-day Scientific Conference on "The

application of the laboratory to the problems of clinical medicine," which was formally opened by His Excellency the Governor of Jamaica and was attended by some 70 scientists from the various island territories and from British Guiana and British Honduras. Professor A. C. Frazer and Professor E. T. C. Spooner, as delegates of the Committee, participated in all meetings and visited the various medical research units in the region.

### REVIEW OF THE WORK IN PROGRESS

12. In addition to the reports from the research units under the scientific aegis of the Committee, summaries are included of projects by research units supported by the Governments of British Colonial Territories or Trust Territories or by research organisations based in Britain. For continuity of context, they are placed in apposition.

#### *Helminthiasis*

##### (a) *Loiasis in the Cameroons and Nigeria*

13. *Entomological aspects.* At Kumba the Helminthiasis Research Unit under Dr. B. O. L. Duke have continued tests to compare the susceptibility of late instar larvae of *Chrysops* to Dieldrin, D.D.T., gamma B.H.C., and Aldrin. Complementary field tests showed that control of the known breeding-sites should be possible with much lower concentrations than was previously thought; thus breeding-sites sprayed with Dieldrin at a concentration of four pints of 0.2 per cent. emulsion to 100 square feet are still clear of all larvae seven months after spraying. This may be due to the greater susceptibility of young *Chrysops* larvae, or to the longer exposure of the larvae to the insecticide in the field tests. The chemical analysis of samples of mud sprayed with various insecticides is as yet incomplete. Thus, so far, on grounds of toxicity to larvae and persistence in the field, Dieldrin appears to be the best insecticide to use in Kumba against *Chrysops* larvae. At the above concentration the cost would be about £5 per acre for the insecticide alone, and it remains to be seen whether this is a justifiable expenditure for spraying which may have to be carried out annually. Work continued on the routine collections of adult and larval *Chrysops* in the Kumba area, designed to produce the basic information against which to measure the effect of any control scheme. It is hoped to start spraying all the known breeding-sites for a distance of three miles around Kumba, as a large scale field experiment in *Chrysops* control, at the beginning of the rains in April, 1960.

Observations on the biting-cycles of parous and nulliparous *Chrysops* suggest that the behaviour of the two populations is not strikingly different; but more work is needed to determine whether this factor is of importance in the epidemiology of loiasis. The study is continuing of the effects of infective and uninfected *Chrysops* bites on sensitised individuals, and in particular of the origin of the small papules which sometimes appear several days after an infective bite.

14. *Parasitological aspects.* Detailed information has been obtained on the development of larvae of *Loa* in bred *Chrysops silacea* kept at constant temperature. There are now for the first time accurate drawings and descriptions of all stages of developing larvae, which will be the yardstick against which development in other species of flies can be accurately measured.

Investigations are in progress to compare development of human and monkey *Loa* in as many species of bred flies as possible.

15. In the testing of various possible prophylactic drugs in monkeys and a few human volunteers, Banocide has so far been the most effective. The trial continues of Banocide in the control of loiasis transmission at Sapele. Almost all the people in the area who showed microfilaraemia were cleared of microfilariae with Banocide treatment, but the effect on the infection-rate in the population of *Chrysops* was small. This was disappointing, but the follow-up surveys will continue for some time before a thorough analysis is made.

(b) *Onchocerciasis*

16. *Drug trials.* The two year follow-up of ten patients treated with TWSb has shown that the drug has a microfilaricidal effect and that it produces a temporary interference with the fecundity of the females; the microfilarial build-up in the first year after treatment is slower than in the second year. In one case the microfilariae were still absent after two years, and nodules are being examined histologically to reveal whether the parasites have been killed by the drug or merely sterilised.

*Survey work.* Assistance was given to Dr. F. H. Budden in his survey of onchocerciasis in villages in the Cameroons rain-forest. All the generally accepted eye lesions were encountered, but they were seldom severe enough to cause blindness. Considerable progress has been made towards the development of a standard survey method for large-scale onchocercal surveys designed to elicit the maximum amount of parasitological data.

*Publications*

DUKE, B. O. L.—(1959) “Studies on the biting habits of *Chrysops*. VI: a comparison of the biting habits, monthly biting-densities and infection-rates of *C. silacea* and *C. dimidiata* (Bombe form) in the rain-forest at Kumba, Southern Cameroons, U.U.K.A.” *Ann trop. Med. Parasit.*, **53**, 203.

CREWE, W., and GORDON, R. M.—(1959) “The immediate reaction of the mammalian host to the bite of uninfected *Chrysops* and of *Chrysops* infected with human and monkey *Loa*.” *Ibid.*, **53**, 334.

WILLIAMS, P.—(1959) “The effect of atmospheric pressure on *Aedes aegypti* exposed to *Dirofilaria immitis* and on *Glossina morsitans* exposed to *Trypanosoma rhodesiense* or *T. congolense*. *Ibid.*, **53**, 451.

(c) *Filariasis in East Africa*

17. Dr. P. Jordan and Mr. K. D. Goatly of the East African Institute for Medical Research (Director: Dr. E. G. Holmes), report on investigations on the vector-parasite relationship in bancroftian filariasis at Kilwa, a coastal village in Southern Tanganyika. *Culex fatigans* were fed on volunteers who had microfilaraemia. The following findings were recorded:

- (i) the weight of blood ingested was directly related to the unfed weight of the mosquito.
- (ii) If the weight of the blood-meal and the concentration of microfilariae in it are taken into account, the number of microfilariae which a mosquito can be expected to ingest at a meal can be calculated. It was found that the number of mosquitoes ingesting

more microfilariae than expected significantly exceeded those ingesting fewer.

- (iii) Considerable loss of microfilariae occurred during their development to infective larvae, and the percentage loss was greater when mosquitoes were fed on carriers with a high density microfilaraemia than on those with lower microfilarial densities.
- (iv) No microfilariae were present in the dejecta passed by mosquitoes while feeding, but many were passed in the dejecta 2-3 days after an infected blood-meal.
- (v) There was a higher mosquito mortality following feeds on carriers with high density microfilaraemia than on those with fewer microfilariae in their blood.
- (vi) No consistent increase was found in the infectivity rate of mosquitoes feeding on bloods of increasing microfilarial densities.

In view of a report by Chinese workers of a 93·4 per cent. immediate cure-rate by a single dose of 1 gram of Hetrazan, this dose was given to 23 persons with microfilaraemia. Of these, 15 were examined four days later; 13 still had microfilaraemia; but the mean microfilarial count of the 15 was reduced from 68 per 20 c.c.m. of blood before treatment to 14 after treatment. All but one of the 15 subjects complained of fever, vomiting and abdominal or joint pains.

#### *Publications*

JORDAN, P.—(1959) “The treatment of bancroftian elephantiasis and observations on hyaluronidase.” *J. trop. Med. Hyg.*, **62**, 286.—(1960) “Effect of prednisolone in bancroftian elephantiasis.” *Brit. med. J.*, **1**, 1020.

#### (d) *Guinea-worm*

18. Dr. S. D. Onabamiro, Senior Research Fellow, University College, Ibadan, continued his investigation on frogs, *Camallanus* larvae and guinea-worm larvae. Laboratory results suggested that it might be practicable to utilise *Xenopus* frogs infected with *Camallanus* worms to reduce the incidence of guinea-worm infection in rural areas. Field tests were therefore begun in ponds supplying drinking water to six villages: two in Agbor in the Mid-West, and the rest in Shaki, Ipaja, Ado Ekiti and Ikorodu, which were small enough for records of villagers' public health to be taken fortnightly; their populations were 136, 84, 70, 91, 65 and 112 respectively, excluding children under one year. The incidence of the infection in the six villages prior to the experiments was respectively 50, 22, 30, 45, 25 and 62 per cent.

19. Frogs infected with *Camallanus* worms in the laboratory were introduced into the village ponds during October and November, 1959, since the villagers usually acquire their infection at the height of the dry season, viz. January-March. By mid-January, 1960, many *Cyclops* taken from four of the six ponds harboured the larvae of both *Camallanus lacustris* and *Dracunculus medinensis*. Infected *Cyclops* from the other two ponds harboured only guinea-worm larvae, but the frogs appeared to have died off. Data of the infection among the villagers are being collected fortnightly, and by November, 1960, should indicate the outcome of this first field experiment.



20. Observations continued on the use of an anti-guinea-worm brass sieve by the 100 families selected for this test in Ijebu Province, Western Nigeria. After one year it was found that, of the 860 people who had promised to use the sieve regularly, only 534 had done so. Of these, only 8 developed guinea-worm infection, i.e. 1.5 per cent. Of the remaining 326 people who had either not used the sieve at all or made irregular use of it, 34 developed the infection, i.e. 11 per cent. During the previous three years the incidence had been 27.7 per cent., 22.4 per cent. and 35.4 per cent. respectively among the same people.

The villagers are now convinced of the value of this simple apparatus in preventing dracontiasis. There remains the difficulty of the cost of the sieve relative to the income of the villagers. Proposals to solve this difficulty are under consideration.

(e) *Schistosomiasis*

21. At the East African Institute for Medical Research at Mwanza, a group of three scientists, one of them seconded by the Ministry of Health, Tanganyika, is studying three aspects of schistosomiasis, viz. clinical and parasitological, snail taxonomy and vector-parasite relationships, and snail ecology and molluscicides. They maintain an effective liaison with another group of workers under Professor L. C. Beadle of Makerere College, Uganda.

22. To obtain data on the quantitative aspect of infection with *Schistosoma haematobium*, and in particular to find whether the output of ova can be used as an index of the intensity of infection, the numbers of ova excreted at different periods of the day, when the patient is either at rest or active, are being ascertained. Preliminary findings suggest that there is a maximum hourly output between noon and 16.00 hours, and a minimum output during the midnight hours.

To find if pathological tissue change may affect the output of ova and the value of ova counts as a measure of the intensity of infection, standard amounts of bladder, rectum, liver and lung, taken from post-mortem material, are digested, ova counts made from the digest, and correlated with any macroscopic and microscopic tissue change.

23. An epidemiological study has been made at Usagara near Mwanza. A house-to-house collection of stools and urines revealed only a few cases of *S. mansoni*, but many of *S. haematobium*. The infection-rate with the latter exceeded 70 per cent. in school-children and 50 per cent. in adults over 50 years of age; the numbers of ova excreted by individuals were fewer in the adults.

24. In field and laboratory studies on snails, of 600 *Bulinus (Physopsis) nasutus* collected and examined 3 were found to be shedding mammalian type schistosome cercariae, so few in number that mice had to be exposed to them repeatedly to ensure infection; 8 out of 18 mice developed bisexual infections. Eggs were found in the intestines and livers of 3 of them, and the parasite was identified as *S. haematobium*. In corroboration, *B. nasutus* has been infected in the laboratory with *S. haematobium*.

In 2,000 *Biomphalaria* collected and examined *S. mansoni* infections were regularly found. The infection-rate among snails varied from 0-40 per cent. at different times. In the course of collecting *B. nasutus* and *Biomphalaria*, other species of snails were encountered. These included *Lymnaea natalensis*,

*B. forskalii* (which together formed the majority), and also *B. ugandae*, and small planorbids. Schistosome cercariae were never recovered from these, but many other cercariae were seen. Schistosome cercariae with eye spots, or of larger size than the mammalian type, were several times found in *B. nasutus*. Bovine schistosomes have not yet been identified round Mwanza. Dr. Dinnik, of the East African Veterinary Research Organisation, Muguga, found schistosomes in the mesenteric veins of a number of cattle slaughtered in the local abattoir; the cattle, however, were not all local stock.

25. In investigations of host-parasite relationships, laboratory-infected *B. nasutus* often produced 100 to 2,500 cercariae per day, numbers much greater than those found in the naturally infected snails, and higher than those reported from West Africa, and also than those reported for *Australorbis glabratus* injected with *S. mansoni*. The numbers were low at first, and reached the peak after the first 2 weeks. Production continued for some 9 weeks until the death of the snails. Those which began to produce cercariae 30-40 days after exposure to miracidia produced more than those in which the latent period was 40-89 days. In studies to determine the number of miracidia actually penetrating the snails, some evidence suggests that mature cercariae may remain in the snail until conditions are favourable for their emission. *Biomphalaria* exposed individually to single miracidia shed up to 2,400 cercariae daily at their peak of production, and 4 snails produced 1,000 or more on only the fourth day after shedding began. A batch of 100 *Biomphalaria* were exposed individually to 10 miracidia each; 54 became infected, and the length of infection was determined in 45; 14 died within 3 weeks, 27 remained infected for 3 to 5 weeks, 2 remained infected longer, and 2 others ceased to shed and were regarded as having achieved spontaneous cure.

In three baboons from an area where human *S. haematobium* infection is common, no evidence of schistosome infection was seen in sections of liver, intestine and bladder.

26. Studies on vector snail population, age, distribution and infection-rates, largely by weekly examinations of selected tracts of water, are designed to determine why particular species prefer some habitats to others, which involves study of their probable food supply, the chemical characteristics of the water, and related factors. Particular attention is paid to seasonal fluctuations in snail population, age and infection-rate. The ultimate objective is to discover where and when people become infected with *S. haematobium* and *S. mansoni*.

A trial of a new molluscicide, Bayer 73, in the laboratory and in the field indicated that it is very effective against snails and their eggs at much lower concentrations than are other molluscicides.

#### Publications

WEBBE, G.—(1960) "Observations on the seasonal fluctuations of snail-population densities in the Northern Province of Tanganyika". *Ann. trop. Med. Parasit.*, **54**, 54.

27. The Bilharzia Research Unit of the Medical Research Council has begun work on chemotherapy in Kenya where Dr. A. Davis, working from the Medical Research Laboratory in Nairobi, is investigating the suppressive effect of monthly injections of antimony dimercaptosuccinate. Such a regime

has, elsewhere, been successful on a small scale in preventing patients infected with *S. haematobium* from passing eggs, and it is proposed to study carefully the effects in these infections and in infections with *S. mansoni*. Early results have not been discouraging. Dr. Davis is also working with lucanthone, and has had some success in reducing the unpleasant side effects. He will also begin trials soon of new schistosomicides which are emerging from the experimental stage.

28. In England the Unit is studying schistosome physiology and drug action. Dr. D. L. H. Robinson has found that *S. mansoni* can be persuaded to lay eggs *in vitro* in a serum medium. The flukes produce 50 to 60 eggs per day, but they need to be in copula and supplied with sufficient oxygen. The protein metabolism of *S. mansoni* is being studied in normal flukes and in those subjected to the effects of drugs. The work is still in the early stage of testing suitable methods. Mr. G. A. T. Targett, B.Sc., is finishing an investigation of the amino-acid content of haemoglobin and haemocyanin from species of snails which are susceptible or refractory to schistosome infection. The constitution of the globins varies little from one species to another.

There has been some interest in the suggestion that diaminodibenzylalkanes interfere with carbohydrate uptake and may be able to potentiate the action of small doses of antimony. They have been given, by intramuscular injection, to baboons but have proved to be active only by mouth. It is hoped to test the activity of a suitable compound with and without half the normal dosage of antimony. A method of estimation of these diamines in the blood has been investigated, and some improvements in the usual method of lucanthone estimation have proved valuable.

The Unit is also interested in the reaction of the reticuloendothelial system to dead and dying flukes and work has begun on the phagocytic response to flukes during the time drugs are acting upon them.

#### *Publications*

DAVIS, A.—(1960) "Antimony dimercaptosuccinate in intestinal bilharziasis". *Lancet*, **1**, 604.

ROBINSON, D. L. H.—(1960) "Egg laying by *Schistosoma mansoni* *in vitro*". *Ann. trop. Med. Parasit.*, **54**, 112.

#### *Malaria*

##### *East Africa*

29. From the East African Institute of Malaria and Vector-borne Diseases at Amani, Tanganyika, the Director reports that in June, 1959, the Pare-Taveta Malaria Scheme came to an end, save for a small continuing project. The Scheme has shown that malaria transmission can be reduced to a very low level by four years of residual spraying of houses with Dieldrin in an area of hyperendemic malaria. Anthropometric and certain clinical observations revealed little or no change as a result of the interruption of malaria transmission; but there was an apparent reduction in the deaths of infants and an increase in the fertility rates. The serum protein pattern changed towards what is regarded as the normal, and haemoglobin levels rose most significantly in the youngest age groups. Chemical

investigations included the development of a method of urinalysis to assist in measuring the baseline of exposure to, and excretion of, Dieldrin among the spraying personnel.

30. By August, 1959, an organisation for the detection and treatment of clinical malaria in the previously protected zone was in being, and in November the periodic examination of population samples was initiated. Throughout the period now, over one year, since spraying ceased, malaria transmission has remained low and fresh cases have been mild. Anopheline density has risen substantially since December, 1959; nevertheless the age composition of the indoor mosquito population remains relatively low. There is as yet no sign that *Anopheles funestus* is re-invading the area.

31. In the Muheza area, the dispersion and activity of *A. gambiae* has been studied by the release of adult mosquitoes labelled with the radio-isotopes P32 and S35. Of some 62,000 released, 450 were eventually recovered, mostly at a range of one-half to three-quarters of a mile from the point of release. The average age at recapture was 6-7 days, and small numbers of females were caught 21-23 days after release. Males, unexpectedly, survived nearly as long as females but showed less tendency to disperse. The mortality in nature among marked mosquitoes was estimated at about 15 per cent. daily, the rate remaining independent of age.

The techniques of age-grouping of wild caught *Anopheles*, including *A. funestus*, were further studied, and progress has been made towards the development of a simplified method. An investigation began into the part played by secondary, and exophilic, vectors in the transmission of malaria near the coast.

Trials have been undertaken to compare larvicides containing BHC with those containing DDT. Provided due allowance is made for their relative efficiencies, BHC can be accepted as an economical substitute for DDT in East Africa.

32. Observation continued of the ecological conditions that may foster or deter the breeding of bilharziasis-carrying snails in ponds at Korogwe. Colonies of potential snail vectors are maintained in the Institute. Of these *Biomphalaria globosus* has proved to be an efficient laboratory vector of *Schistosoma haematobium* as well as a vector in nature. The role of *B. nasutus* is obscure, as it has hitherto proved refractory to infection by miricidia from human urine.

33. The results of a year's counts of domestic flies made in Zanzibar by the Scudder Grill method indicated that this method is not suited to local conditions. Preliminary tests of a trap, in which an adhesive is combined with an attractant, promise to provide a more objective method of assessing fly densities.

34. The engineering section of the Institute has increasingly assisted urban authorities in the design and planning of the drainage of storm water and of anti-malarial drainage. Attention has also been given to the problem of snail and mosquito breeding in dams, and plans have been prepared of feasible modifications in dam construction and maintenance on an experimental basis, which should minimise certain hazards to health.

Training activities continued, and a number of World Health Organisation Overseas Fellows visited the Institute for varying periods.

*Publications*

SMITH, A.—(1959) "Results of screening *A. gambiae* for resistance to Dieldrin." *Bull. Wld. Hlth. Org.*, **21**, 239.—(1959) "Susceptibility to Dieldrin of *Pulex irritans* and *Pediculus humanus corporis*." *Ibid.*, **21**, 240.

*Idem* and DRAPER, C. C.—(1959) "Malaria in the Taveta area of Kenya and Tanganyika. II. Results after three and a half years' treatment of huts with Dieldrin." *E.A. med. J.*, **36**, 633.

*Idem* and VAIL, J. W.—(1959) "Relationship between salinity and breeding of *A. gambiae* in North-Eastern Tanganyika." *Nature*, **183**, 1203.

*Idem* and WEITZ, B.—(1960) "Feeding habits of *A. gambiae* with particular reference to subsidiary hosts." *Ann. trop. Med. Parasit.*, **53**, 414.

HILL, G.—(1959) "Methods of water flow measurement applicable to *Simulium* control." *Bull. Wld. Hlth. Org.*, **21**, 201.

MSANGI, A. S.—(1959) "The value of a spreading agent in larvicidal formulations containing DDT." *Ibid.*, **21**, 773.

*Trinidad*

35. The Government Malariologist, Trinidad, Dr. F. R. S. Kellett, reports further progress in curbing the incidence of malaria due to *Anopheles bellator* and *A. aquasalis*. The incidence has progressively fallen from 640 cases in 1957, 376 in 1958, 96 in 1959, to only 9 cases in the first quarter of 1960. This decline has been effected by the judicious use of chemoprophylactic and chemotherapeutic drugs combined with the spraying of houses and the increased penetration of the spraying of cocoa and forest land with copper sulphate which has been attained by the adoption of many of the recommendations made by Professor Colin Pittendrigh, whose advisory visit three years ago was sponsored by the Committee.

A notable achievement by the Malaria Division in the campaign against yellow fever has been the apparently complete eradication of *Aedes aegypti* from Trinidad and Tobago.

*Nigeria*

36. Mr. R. Elliott, the Entomologist in charge of the Federal Malaria Service, reports that the studies made in connection with unsuccessful trials of insecticidal fogging for mosquito control in the Ikoyi residential area showed that a source of malaria vectors (*A. gambiae* type and var. *melas*) was Victoria Island, between Lagos and the sea. This area has a population of 5,000; the villages were sprayed twice in 1959 with a DDT/BHC mixture at a rate of 1.5 gm/m<sup>2</sup> DDT plus 0.15 gm/m<sup>2</sup> gamma BHC. Reductions in malaria parasite-rates were obtained in all age groups, and were highly significant in children. Such reductions have not before been obtained at so early a stage in any other programme of the kind in Nigeria. The very encouraging result of this small trial is stressed, as it is felt that the combination of long-lasting but slow-acting DDT with the stronger but shorter-lived activity of BHC may hold some promise for breaking the present deadlock in West African malaria eradication.

37. In the laboratory, studies of mixtures of insecticides have shown that both compatible and incompatible pairs of insecticides can be detected.

Development of a field method for estimation of chloroquine in body fluids has been undertaken ; further studies on the effect of exposure time as a variable in insecticide-susceptibility tests in larvae have been made ; also studies on the effects of different fractions of blood on maturation of eggs by mosquitoes.

### Gambia

38. At the Medical Research Council's Laboratories in the Gambia studies on the ecology of *A. gambiae melas* and *A. gambiae gambiae* have continued, especially the movement of adult populations between breeding places and villages. These populations were sampled daily to determine age-composition, state of feeding and degree of gonotrophic development in questing, house-resting and outside resting members. Studies on host determination by precipitin tests (with Mr. B. Weitz) and the relationship between wind and "drift" direction and mosquito movement are also in hand.

The age-composition of *A. gambiae melas* populations has been shown to vary cyclically with the tides, peak population being due to an influx of nulliparae after which older individuals become progressively more abundant until the next cycle commences. Hence, in analysis of true population level, age-structure and mortality in a cyclical species such as *A. gambiae melas*, each cycle must be treated as a unit ; both smaller and larger sampling periods will be biased by periodicity. True population levels are being studied and it has been detected that published equations used in the calculations of mortality rates are rendered inaccurate by several factors.

39. In work on the gonotrophic cycle in *A. gambiae melas* and *A. gambiae gambiae* it has proved possible, on the relationship of yolk to ovum nucleus, to split Macan's Stage 2 m. of ovarian development into two stages which are of value in investigating the unfed questing mosquito population. Christopher's Stage 5 has been further divided into early and late stages on the basis of the degree of development of the floats and platform. This subdivision is of value when investigating house-leaving populations. Results indicate the existence of gonotrophic cycles of three different durations, 72, 48 and 36 hours, in mosquitoes of the *A. gambiae* complex at different seasons of the year. Ecologically and epidemiologically the latter two appear to be the most important. In conjunction with Mr. Weitz, the degree of positivity of the precipitin reaction at intervals after feeding has been determined.

40. Polovodova's technique for ageing mosquitoes has been applied to mosquitoes captured by a variety of methods, and over 26,000 dissections have been made on a variety of *Anophelines*. Results indicate that the technique cannot be used to determine the precise age of mosquitoes of the *A. gambiae melas* complex ; of the *Anopheline* mosquitoes studied to date, only in *A. constani ziemanni* does it seem promising.

In studies on the structure and function of the female genital system in *A. gambiae* the morphology of the ovariole has been described, including a new structure, the Funicular Rosette or Sphincter.

41. Professor B. G. Maegraith and Mr. M. V. Riley, B.A., have contributed the following summary of their studies at the Liverpool School of Tropical Medicine on tissue enzymes in malarial infection.

In the previous report a biochemical lesion in the livers of animals infected with *P. berghei* malaria was described. This work has been elaborated, using both a variant of the *P. berghei* originally used, and also *P. knowlesi* infections. Full details of the earlier work have been published in the *Biochemical Journal*, volume 76.

42. It has been found that the liver damage evident in the terminal stages of a short-term (5 days) fatal infection of *P. berghei* in mice is similar to that already described for the long-term infection (18 days). The changes in the livers of monkeys succumbing to *P. knowlesi* in about seven days are not so marked, but appear to be of the same type. The defect in each case is of a progressive nature, concerning not so much a specific reaction as a general structural disorganisation of the mitochondria which becomes more severe as the disease progresses leading to complete cessation of energy production and the death of the liver cell. This is probably not a primary lesion, and investigations are being made into the effects of bile and blood from infected animals upon the mitochondrial metabolism, and the changes produced by the conditions of anaemia and anorexia that accompany the malarial infection.

#### *Virus Diseases*

##### (a) *The West African Council for Medical Research Laboratories, Lagos, Nigeria*

43. *Yellow fever epidemiology.* A few cases of yellow fever occurred in April and May in Tema in Ghana. A serological survey was made and indicated that in the old fishing village, since demolished, around which the new port is being developed, there had been a heavy wave of infection. Neutralisation and complement fixing tests suggested that other group B "arbor" viruses had also been endemic in the village. Although the infection-rate with yellow fever had been high, clinical cases were few. Owing to the better conditions in the new town the spread of the infection thither was not noticeable.

Other serological surveys have been made. Of notable import were those in Lagos and the Niger delta. In the Niger delta a surprisingly low incidence of immunity to yellow fever was discovered. In Lagos it was shown that there has been no spread of yellow fever for many years, probably about 30. Consequent upon this survey Dr. Meers of the Federal Pathology Service was able to undertake a very important and significant trial of 17D mouse brain vaccine. This trial raised the problem why in other areas a higher proportion of failures of this vaccine had been observed. Consequently a further trial is being conducted.

44. *Yellow fever histopathology.* The morphology of the liver cells of healthy and yellow fever-infected rhesus monkeys has been studied by electron microscopy, and the results obtained correlated with previous cytological and cytochemical findings. The earliest detectable change is a synthesis of ribonucleoprotein in the nucleolus. The nucleoprotein flows through the nuclear sap in a finely granular state and passes into the cytoplasm through the pores in the nuclear membrane. In the cytoplasmic matrix the ribonucleoprotein granules, considered to constitute the genetic material of the virus, aggregate to form small rosettes measuring about 100 m $\mu$ . The rosettes develop a dense background and subsequently contract to form

mature virus. The virus is spherical, usually shows little internal structure, and is 55–61 m $\mu$  in diameter.

At first only few virus particles are formed, but as the outpouring of granules from the nucleus continues the number increases until nearly all of the cytoplasm is filled. Both mitochondria and endoplasmic reticulum undergo degeneration but do not contain virus. Within the nucleus the deoxyribonucleoprotein breaks down because of the presence of excessive amounts of virus nucleoprotein. The deoxyribonucleic acid aggregates on the nuclear membrane, whilst the proteins precipitate to form the Torres inclusion body. This appears as amorphous material in electron micrographs. No mature virus is formed in the nucleus.

In studies on the histochemistry and histopathology of livers of African and Indian monkeys infected with yellow fever the differences between the responses of the liver to infection are being compared.

45. *Standard yellow fever immune serum.* Over 900 ampoules of yellow fever immune serum have been prepared for the World Health Organisation for use as a reference standard immune serum. The serum has been thoroughly tested by means of the intracerebral adult mouse protection test to form a basis for comparison with other tests which may be more sensitive. In the course of this work a heat-labile substance present in both the immune serum and non-immune serum employed as diluent of the immune serum has been demonstrated. This substance increases the slope of the curve—virus neutralised versus serum solution—so that the neutralisation index of undiluted serum with the labile substance is considerably greater than that without the labile substance. At high immune serum dilutions this effect is not noticeable, thus indicating that the enhancing effect of the labile substance is a function of the concentration of antibodies present.

46. *Enteroviruses.* In attempts to isolate these, 249 specimens of faeces from “normal” children, aged 0–12 months, collected at University College Hospital, Ibadan, were inoculated intra-cerebrally into infant mice; of these, 9 specimens required further investigations as containing possible viral agents. Of 54 specimens which had one passage in monkey kidney tissue culture, 31 specimens require further study; cytopathogenic effects may be due to non-specific factors in some instances. Fifteen faecal and 26 serum specimens from patients in West Africa, diagnosed as possible polio or Coxsackie virus infections, were inoculated into infant mice; no viral agents were isolated; all will be inoculated into monkey kidney tissue culture.

A laboratory is being reorganised to become a tissue culture production laboratory which will supply the routine needs of the staff. By next year there should be a system of close co-operation with the Department of Bacteriology at University College Hospital, Ibadan, for the isolation of viruses from undiagnosed cases presenting symptoms suggestive of viral aetiology.

47. *Influenza.* Early in 1959 an influenza virus (A/Lagos 1/59) was isolated from a patient in Lagos. At the World Influenza Centre, London, it has been confirmed that it is a typical strain of influenza A/Asia/57 and that it shows no antigenic deviation from the 1957 strains.

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48. *Entomology*. An entomological survey was made in the Niger delta at the same time as the serological survey. Over 40 species of mosquitoes were collected; *Aedes aegypti* was found only occasionally, and this species appeared unlikely to be of great significance as a vector of disease.

Work began on the behaviour and development of viruses in mosquitoes with the ultimate aim of determining why some species are good hosts and others poor. Initial experiments have shown that after a blood-meal fluid was usually rapidly absorbed through the gut wall and excreted via the malpighian tubes and hind gut. Owing to the rapidity of this process previous estimates of the size of blood-meals are considered too low. Virus was found in the haemolymph of mosquitoes in appreciable quantities as little as ten minutes after the ingestion of an infected blood-meal. Although the virus concentration then rapidly diminished to a level at which it could not be detected, virus could be recovered again after two to three days. When mosquitoes were infected by pricking them in the thorax with a fine needle previously dipped in a virus suspension, the subsequent loss and recrudescence of virus was similar to that in mosquitoes infected by ingestion.

#### *Publications*

BOORMAN, J. P. T. and ROCHE, P.—(1959) "The Nigerian Butterflies. Part V. *Nymphalidae*. Section 3." *Ibadan University Press*.

BOORMAN, J. P. T. and KNOTT, E. G.—(1959) "The construction of a simple tissue grinder for virus studies in small insects." *Virology*, 9, 291.

MACNAMARA, F. N., HORN, D. W. & PORTERFIELD, J. S.—(1959) "Yellow fever and other arthropod-borne viruses. A consideration of two serological surveys made in South Western Nigeria." *Trans. R. Soc. trop. Med. Hyg.*, 53, 202.

SURTEES, G.—(1959) "Influence of larval population density on mosquito numbers." *Nature, Lond.*, 183, 269.—(1959) "Galeal structure in adult mosquitoes." *Ibid.*, 183, 971.—(1959) "Functional and morphological adaptations of the larval mouth-parts in the sub-family *Culicinae* (Diptera) with a review of some related studies by Moutschadsky." *Proc. R. ent. Soc. Lond. Ser. A.* 34, 7.—(1959) "The genus *Uranotaenia* Lynch Arribalzaga 1891 (Diptera: Culicidae) in West Africa." *W. Afr. med. J.*, 8, 47.

#### (b) *The East African Virus Research Laboratory, Entebbe, Uganda*

49. The general policy of the Institute has remained unchanged, the approach to virus studies being essentially ecological, using the word in its widest sense to cover interaction between virus, host (both vertebrate and invertebrate) and environment. Moreover, attention continues to be confined to those viruses which are transmitted to man by arthropods (insects, ticks, etc.). About 60 different viruses are now known to be, or suspected of being, arthropod-borne. Mosquitoes are involved or suspected in the transmission of 48 of these, and man has been implicated in 47; 26 have been found in Africa, 14 of them in East Africa itself, and 11 of the 14 were originally isolated in this Institute, three of them this year. Clearly concentration on the ecological approach is sound.

The isolation of viruses from the living vertebrate host, including man, may often fail because of the transient nature of the viraemia. Nevertheless,

in addition to several strains isolated during an outbreak of yellow fever in the Congo, five isolations have been made in East Africa from man this year; three of these from members of the Institute's staff. Three of the five appear to be new agents, or at least new strains. One of the others was an accidental laboratory infection of *Wesselsbron virus*, and opportunity was taken of keeping full clinical records of the course of this very unpleasant disease.

Over 30,000 wild mosquitoes were caught and processed in the laboratory, without yielding virus. This is the second successive year in which this usually fruitful source of virus has been unproductive.

50. The work started last year on a possible vaccine against *Nairobi sheep disease*, the causal virus of which apparently involves man as well as sheep, has been further developed. The first field trial with the new experimental vaccine, made in collaboration with the East African Trypanosomiasis Research Organisation at Tororo, has fully justified earlier hopes.

51. Antibody surveys in local residents were extended by increasing the number of sera tested and by widening the spectrum of viruses used. Positive reactions were found in 9 of the 10 viruses used. Surveys in birds were restarted later in the year.

Results of antibody surveys on a large number of hippopotamus sera have given very unexpected results, and are difficult to interpret. A high proportion of the sera have given positive neutralisation against all five viruses tested. Laboratory studies on the viruses of Rift Valley fever, encephalomyocarditis, Semliki forest and yellow fever have been undertaken in rodents, primates, birds and insects.

52. The outstanding event of the year has been the completion of the 120 ft. steel tower in the Mpanga forest, which has considerably expanded the work on the biology of mosquitoes and other blood-sucking flying insects. The tower rises clear out of the forest canopy, and thus allows studies on the vertical distribution of biting insects to be extended to the region above the forest itself. Much of the work on the tower during its first year has been climatological, and important results have been obtained in studying the ratio of wind flow at various levels in the forest. Wind is one of the environmental factors that control insect activity and movements, including possible migration of disease vectors across the top of the forest. Observations have been made on the swarming habits of mosquitoes and tabanid flies above the forest canopy. These swarms take place over the tower each evening and sometimes just before dawn as well.

Mosquito catches on the tower have been made by two methods—one using human "bait", the other using mercury vapour light-traps. Forty 24-hour man-baited catches and fifteen light-trap catches have given much information not only on the biting-cycles and preferred levels of activity of female mosquitoes, but on male activity at different times and levels. Much useful information has also been obtained on the flight-activity of male and female mosquitoes by the use of mercury vapour light-traps positioned in the Institute compound.

53. The successful transmission of virus by mosquitoes depends partly on an adequate extrinsic incubation period during which virus multiplies

in the insect and reaches the salivary glands. Thus, if a species of mosquito is short-lived in nature, it is unlikely to take part in virus transmission, even though it may be an efficient transmitter in the laboratory. It is, therefore, very important to be able to tell the ages of wild-caught mosquitoes. While this can be done in certain species with considerable accuracy by dissection, it would be an advantage if such determination could be correlated with external characters. Work on this problem, started in 1951, was taken up again two years ago and has been continued and extended during the year. It is now clear that what applies in one species may not be applicable in another, and that different methods will have to be developed to suit different species and species groups.

54. A mass of data has been collected over the past 15 years in connection with standard 24-hour catches made in various parts of East Africa, and the formidable task of analysis is now completed. One conclusion of obvious importance is that, while in some species of mosquitoes the biting pattern is uniform over a very wide area, probably even on a continental basis, in others the pattern varies according to locality, environment or even level in the forest.

55. In continued studies of *A. aegypti*, with special reference to the morphologically distinct "races" that occur in East Africa, the main development has been the preliminary genetic study of these forms. Hitherto, genetic studies of this species have been confined to behavioural and physiological differences, and this is the first attempt at genetic studies of this renowned laboratory animal, using clearly defined morphological markers. The results are encouraging and may go a long way in clearing up the "race" problems in this species. More behavioural differences between strains of this species have also been studied, and observations on oviposition in the field have been extended.

Studies on other blood-sucking insects by means of mercury vapour light-traps have revealed sharp differences in the nocturnal behaviour of closely related species of tabanids.

#### *Publications*

BROWN, J. M. K., ALLBROOK, D. and MASON, P. J.—(1959) "Outbreak of virus influenza of the Asian type in a semi-closed college community." *E.A. med. J.*, **36**, 48.

CORBET, P. S.—(1959) "Recognition of individual nulliparous and parous mosquitoes." *Trans. R. Soc. trop. Med. Hyg.*, **53**, 297.

GILLET, J. D.—(1958) "Induced ovarian development in decapitated mosquitoes by transfusion of haemolymph." *J. exp. Biol.* **35**, 685.

*Idem*, CORBET, P. S. and HADDOW, A. J.—(1959) "Observations on the oviposition-cycle of *Aedes (Stegomyia) aegypti* (Linnaeus) III." *Ann. trop. Med. Parasit.*, **53**, 132.

HADDOW, A. J.—(1958) "The present state of knowledge concerning yellow fever in Africa." *Ann. Soc. Belge. Med. Trop.*, **38**, 271—(1960) "Studies on the biting-habits and medical importance of East African mosquitoes in the genus *Aedes*, subgenus *Aedimorphus*, *Banksinella* and *Dunnius*." *Bull. ent. Res.*, **50**, 759.

*Idem*, GILLETT, J. D. and CORBET, P. S.—(1959) "Laboratory observation on pupation and emergence in the mosquito *Aedes (Stegomyia) aegypti* (L.)." *Ann. trop. med. Parasit.*, **53**, 123.

LUMSDEN, W. H. R.—(1958) "Periodicity of biting behaviour of some African mosquitoes." *Proc. 10th Internat. Congr. Entom.*, **3**, 785—(1958) "The etiology of dengue." *E. Afr. med. J.*, **35**, 519.

MARSHALL, A. J. and WILLIAMS, M. C.—(1959) "The prenuptial migration of the yellow wagtail (*Motacilla flava*) from latitude 0.04'N." *Proc. Zool. Soc. Lond.*, **132**, 313.

MCCLELLAND, G. A. H.—(1959) "Observations on the mosquito *Aedes (Stegomyia) aegypti* (L.) in East Africa: I. The biting-cycle in an outdoor population at Entebbe, Uganda." *Bull. ent. Res.*, **50**, 227.—(1960) "Observations on the mosquito *Aedes (Stegomyia) aegypti* (L.): II The biting-cycle in a domestic population on the Kenya Coast." *Ibid.*, **50**, 687.

(c) *The Trinidad Regional Virus Laboratory, Port of Spain*

56. From this laboratory, established in 1953 by the Division of Medicine and Public Health of the Rockefeller Foundation with the co-operation of the Government of Trinidad for the study of viruses in man, animals and arthropods in the Caribbean Region, the Director, Dr. Wilbur G. Downs, reports that only 23 isolations of arthropod-borne (ARBOR) viruses were made during 1959. A very dry year, particularly in the first nine months, probably influenced this total. However, though small in number, the list is dignified by the isolations of eastern equine encephalitis (EEE) and Venezuelan equine encephalitis (VEE), new members of the Trinidad list of viruses, and three more agents as yet unidentified and possibly new. Also the finding of both EEE and western equine (WEE) in horses in the Rupununi District of British Guiana is noteworthy.

57. Yellow fever again appeared in Trinidad. After the 1954–1955 episode, no evidence of disease activity had been noted. However, in early 1959, two human cases were picked up in health department out-patient clinics. Both were woodcutters from the eastern heavily forested region of the island; both presented as undiagnosed fevers of only moderate severity, and both recovered. Virus was recovered from each. Despite vigilant observation, no further evidence of yellow fever activity has been uncovered except for the finding of a few monkey carcasses. Despite failure to observe yellow fever activity in the interval 1955–1959, it is felt that the virus has been on the island continuously and, indeed, that it is still present. Failure to uncover it only illustrates the present inefficient methodology as far as this disease is concerned, and emphasises that the practice in international quarantine circles, of regarding a region as "safe" when no reports come in from it, is a very short-sighted policy indeed.

58. *Venezuelan equine encephalitis* affords another challenging mystery. Present in 1943–1944 in a severe outbreak in equines, it has been absent since. Recent serological studies performed by Col. Tigertt at the Walter Reed Army Medical Research Center on selected Trinidad sera suggested that this virus, or a similar virus, was still about. Since virus studies had been conducted for six years in the regions he showed to be suspect, it seemed hard to believe that VEE virus was present but eluding detection despite large numbers of mosquitoes, birds, animals and human clinical

cases investigated. However, in late 1959, the virus has been repeatedly isolated from sentinel baby mice and from mosquitoes, in the central part of the Nariva Swamp. It appears here that shifting the collecting site only a few miles brought this virus to light. Why it may be thus quiet for years, and occasionally move out and provide a serious island-wide epidemic, is still a mystery.

59. The number of ARBOR viruses isolated in Trinidad now totals 22 distinct agents as follows:

- |                           |                                |
|---------------------------|--------------------------------|
| 1. Dengue                 | 12. Cache Valley (TRVL 20659)  |
| 2. Yellow Fever           | 13. TRVL 7994 (mosq.)          |
| 3. Ilheus                 | 14. TRVL 8362 (mosq.)          |
| 4. St. Louis              | 15. TRVL 8762 (mosq.)          |
| 5. EEE                    | 16. TRVL 9223 (mosq.)          |
| 6. VEE                    | 17. TRVL 9375 (mosq.)          |
| 7. Mayaro                 | 18. TRVL 10076 (mosq.)         |
| 8. Kairi (TRVL 8900)      | 19. TRVL 11575 (bat and mosq.) |
| 9. Manzanilla (TRVL 3587) | 20. TRVL 18462 (mosq.)         |
| 10. Oropouche (TRVL 9760) | 21. TRVL 26668 (mosq.)         |
| 11. Wyeomyia (TRVL 8349)  | 22. TRVL 27573 (mosq.)         |

Not included for the present is WEE (validity of isolation queried) and TRVL 5843 from a Saimiri monkey (possibly a large virus which has failed to pass a Seitz filter; probably DCA-sensitive).

60. Virus transmission studies involving mosquitoes have continued. Successful transmissions using several species of mosquitoes in each case have been obtained with *Kairi* virus, *Cache Valley* and TRVL 7994. Unsatisfactory results were obtained with EEE, *St. Louis* virus (SLE) and *Coxsackie* B4. Virus isolations from arthropods, along with EEE and VEE, also include two isolations of the 9223 prototype, our 18th strain of *Wyeomyia* virus, *Coxsackie* B4 from *Culex*, and two isolations of unknown agents. For the first time in six years we have made no recoveries of *Ilheus* virus either from mosquitoes or from any other source. The *Philornis* fly lead, which looked promising in 1958, has not continued thus attractive after conclusion of a critical experiment in which SLE viraemia in a host nestling and absence of virus in subsequently dropped *Philornis* larvae were demonstrated.

61. A serum survey was conducted in St. Vincent and in the coastal region of British Guiana; also, sizeable collections of serum were received from Curacao, Venezuela and Surinam. Laboratory analyses were continued on specimens from this year's and earlier surveys; analyses are nearing completion for Barbados, St. Lucia, Antigua, Jamaica and the Rupununi region of British Guiana, all surveyed in earlier years.

In the smaller West Indian islands, *dengue* appears to have been the only insect-transmitted virus disease of any prominence in recent years, with possibly a limited degree of activity of *St. Louis* virus on some of the islands. This point is difficult to define clearly because of confusing serological cross-reactions between these two related viruses. Jamaica presents a relatively simple picture, with a general high level of immunity to *dengue* and *St. Louis* viruses manifest. Trinidad presents a picture of great complexity, on the other hand. There, viruses isolated from cases of human disease include yellow fever, *dengue*, *St. Louis*, *Ilheus*, *Oropouche* and *Mayaro*, and

additional agents isolated from mosquitoes but not from man include EEE, VEE, Wyeomyia, Cache Valley, Kairi and other distinct and as yet unnamed arborviruses. Among these latter, immunity in humans has been demonstrated against Venezuelan equine, Cache Valley, Wyeomyia and several other agents, but the disease picture in Trinidad remains unknown.

In British Guiana the surveys of the hinterlands indicate a picture comparable with that of Trinidad; in addition, the virus of WEE has been recovered from the brain of a horse from the Rupununi Savannah region, and EEE was recovered from horse brain from the same region. In the coastal areas immunity seems to be localised largely to dengue and St. Louis.

62. An *influenza* outbreak in Trinidad was shown to be caused by Asian influenza virus. Kaolin adsorption of sera to be tested appears to be a useful modification of standard influenza diagnostic technique.

Progress was made with tissue culture, using hamster kidney, chick fibroblast and KB cell lines. Hamster kidney cell cultures are being used in routine virus isolation attempts from wild-collected birds. Exploration of the utility of tissue culture neutralisation tests done with chick embryo and hamster kidney cultures has been conducted, but such tests have not reached the point of being adopted as routine procedures.

#### *Publications*

AITKEN, T. H. G.—(1960) "A survey of Trinidadian arthropods for natural virus infections (August, 1953, to December, 1958)." *Mosquito News*, 20, 1.

FAIRCHILD, G. B. and AITKEN, T. H. G.—(1960) "Additions to the Tabanidae (Diptera) of Trinidad, B.W.I." *Ann. ent. Soc. America*, 53, 1.

SPENCE, L.—(1960) "Kaolin treatment of sera for removal of nonspecific inhibitors to Asian strains of influenza virus." *Proc. Soc. exp. Biol. Med.*, 103, 425.

#### (d) *Research on trachoma.*

63. *Current research in the Gambia.* The section of the Medical Research Council Trachoma Group stationed at Fajara made considerable progress in their studies of the clinical features, microbiology and epidemiology of trachoma. The most important findings are briefly summarised below by its Director, Dr. L. H. Collier.

*Clinical features.* In the villages under investigation it has now been established that the incidence of trachoma rises to a peak of 91 per cent. in children aged from 5–9 years. The usual age of onset is from 2–4 years; 74 per cent. of children in this age group are trachomatous. Virus was isolated from 3 babies within a month of birth, but it is not yet clear if these infants suffered from trachoma or inclusion blennorrhoea. After the age of 10 years, the incidence falls progressively, and only about 50 per cent. of adults show signs of the disease, implying that in the Gambia trachoma does not always leave sequelae.

*Virology.* By inoculating conjunctival scrapings into chick embryos, trachoma virus was isolated from almost every subject in whom inclusion

bodies were found, and from many inclusion-negative patients. Thus, of 36 patients with trachoma Stage III (MacCallan), virus was isolated from 25, whereas inclusions were found in only 17. It is now evident that, at all stages of active trachoma, chick embryo inoculation is more reliable for detecting the presence of virus than is the finding of conjunctival inclusion bodies. Virus was not isolated from any patient with inactive trachoma (Stage IV), or from non-trachomatous subjects.

Particular attention is now being paid to those patients with active trachoma in whom repeated attempts at virus isolation have yielded negative results. In a search for other viruses that might give the trachoma syndrome, conjunctival material from these subjects is being inoculated into suckling mice and tissue cultures.

*Bacteriology.* In parallel with the clinical and virological studies, the ocular bacterial flora of the villagers is being investigated, since it is still not clear what part is played by bacteria in the pathology of trachoma. A variety of micro-organisms were isolated from the eyes of both trachomatous and clinically normal subjects. In most their presence did not seem related to age or clinical status, but it is noteworthy that organisms of the *Haemophilus* group were more frequently isolated from younger children in whom trachoma is also most common. At the Lister Institute, Mr. A. F. B. Standfast and Dr. Jean Dolby examined strains of *Haemophilus* isolated in the Gambia. Most were identified as *Haemophilus aegyptius*, *H. influenzae*, or as organisms resembling one or other of these species. A few strains of *H. parainfluenzae* were also found, and a few strains could not be classified.

64. *Virological studies at the Lister Institute.* Investigations of trachoma viruses isolated in the Gambia continue. During the year a major advance was made in that strains of trachoma and inclusion blennorrhoea viruses were adapted to grow in tissue culture. This technique has greatly facilitated quantitative studies, and holds important implications for researches into virus replication, serology and chemotherapy.

(e) *The Arborvirus Research Unit, London School of Hygiene and Tropical Medicine.*

65. *Fractionation of arborviruses by chromatography on calcium phosphate columns.* Dr. Gordon Smith reports that, using infected mouse brain, Semliki Forest virus and a number of group B arborviruses have been studied thus. The majority have two haemagglutinins, one with a low infectivity/haemagglutinin ratio which is not sedimentable at 105,400 g. for 1 hour, and one with an infectivity/haemagglutinin ratio  $10^2$ - $10^7$  times higher which is sedimentable. While the complement-fixing antigen of Semliki Forest virus appeared to be sedimentable and correlated with the infectivity, most of the group B viruses studied had two complement-fixing antigens; the less potent one is sedimentable and associated with most of the infectivity, the more potent one is not (or only partially) sedimentable and has an infectivity/complement-fixing ratio  $10^2$ - $10^7$  times less than that of the sedimentable antigen. The low infectivity haemagglutinins and complement-fixing antigens do not appear to be identical. The haemagglutinin-inhibitor in brain elutes in fractions between the two haemagglutinins. There were differences between viruses and even between strains of the same virus, most notably between 17D and French neurotropic

yellow fever viruses; although the infectivity of the two behaved similarly, the high infectivity haemagglutinin of French neurotropic was mainly at 0.4 M and 0.5 M (1:25,600 at 0.5 M), while that of 17D was maximal at 0.3 M (>1:1024 and <1:2 at 0.5 M).

66. Haemagglutinins and complement-fixing antigens prepared in this way are stable and exceptionally cheap and easy to prepare. Freshly prepared column haemagglutinins have a much wider pH range of activity than similar antigens prepared by centrifugation. Haemagglutinins and complement-fixing antigens have been successfully concentrated without loss up to 100-fold by absorption of water with polyethylene glycol (M.W. 20,000) in a cellophane sac.

A desoxycholate resistant virus not yet identified but probably in the mouse encephalomyelitis group was also fractionated. Most of its infectivity, haemagglutinin and complement-fixing antigen eluted at molarities about a tenth of those required for the arborviruses.

67. *Electron microscopy.* By negative staining with phosphotungstic acid Semliki Forest virus was seen to have a roughly spherical but probably faceted central body (diameter 40-47 m) with visible subunits arranged around holes, covered by a coat with radiating units giving the appearance of a halo 7-12 m $\mu$  thick (total diameter 55-70 m $\mu$ ). Micrographs of column fractions showed that the number of particles was correlated with infectivity and complement-fixing antigen. In sections of chick-embryo cells infected with Semliki virus two types of particle were seen, a dense one (diameter 52-27 m $\mu$ ) in large and small groups in the cytoplasm, and a less dense one (diameter 62-83 m $\mu$ ) in "vesicles" in the cytoplasm sometimes arranged round the periphery of them.

68. *Malayan tick-borne viruses.* At least three more strains of TP-21, the Russian spring-summer group virus isolated in 1956 from *Ixodes granulatus* in Malaya, were isolated in late 1959 from the same species of tick in the same forest area. As yet there is no clear serological evidence of human infections, but antibodies were found in forest rats. The circulation of TB-21 in chicks, mice and rats is being studied with a view to experimental infection of ticks in collaboration with Dr. M. G. R. Varma.

69. *Yellow fever vaccination:* In collaboration with Dr. L. H. Turner, Malayan volunteers, mostly with pre-existing group B arborvirus antibody, were vaccinated subcutaneously with 53,000, 5,300, 530 and 53 mouse LD50 of 17D vaccine, and groups of British volunteers were given 5,000, 500, 50 and 5 LD50 of the same vaccine. All the Malayan volunteers had significant amounts of neutralising antibody (neutralising indices >1.7 log) after vaccination. Of the British volunteers, 50 per cent., 57 per cent., 75 per cent. and 50 per cent. at the above dose levels had significant neutralising antibody one month after vaccination. Using the haemagglutinin-inhibition test, 4-fold or greater responses were detected in all the Malayan volunteers except one who had pre-existing neutralising antibody presumably due to infection with other group B arborviruses. All the British volunteers given 5,000-50 LD50 had haemagglutinin-inhibiting antibody responses, and half of those given 5 LD50.

Other studies included experiments in tissue culture in which arborviruses were tried in a number of cell systems, some success being achieved with



ERK (embryo rabbit kidney cells), and studies of non-specific haemagglutinin-inhibitors in which the avidity of different strains of the same virus for non-specific inhibitors in brain and serum was found to vary widely. Certain azo-dyes and phenylmethane dyes were also found to inhibit yellow fever haemagglutinin.

*Training*: Dr. J. Guerra Mercado and Dr. C. C. Draper received training for a period of nine months.

#### *Publications*

GUERRA MERCADO, J., and SMITH, C. E. G.—(1959) "Inhibition of group B arbovirus haemagglutination by certain azo- and phenylmethane dyes." *Virology*, **9**, 482.

SMITH, C. E. G.—(1958) "Dengue in Southeast Asia." *6th Int. Cong. trop. Med. Malaria*, Lisbon. Abstracts, p. 163.—(1959) "Arthropod-borne viruses." *Brit. med. Bull.*, **15**, 235—(1960) "Factors in the past and future evolution of the arboviruses." *Trans. R. Soc. trop. Med. Hyg.*, **54**, 113.—(1960) "Evolution of arbovirus diseases." *Nature*, **185**, 740.

TURNER, L. H., ELISBERG, B. L., SMITH, C. E. G. and BROOM, J. C.—(1959) "Acute febrile illnesses in Malaya: Leptospirosis." *Med. J. Malaya*, **14**, 83.

#### *Genetics of Aedes aegypti*

70. Following preliminary work in Uganda, Mr. G. A. H. McClelland has begun an investigation into the genetics of the mosquito *Aedes aegypti* at the Department of Entomology of the London School of Hygiene and Tropical Medicine, under the scientific guidance of Professor D. S. Bertram and of Professor Maynard Smith of University College, London. The study is based on a strain from the Kenya coast which is highly variable. As a preliminary, sub-strains are being formed by rigorous selection for dark and pale coloration and from at least two extracted recessive mutants. Later, when the selected sub-strains have achieved stability, these and other strains will be compared for differences in physiology and behaviour, including vector efficiency and insecticide resistance.

71. A strain used for filaria transmission at the National Institute of Medical Research has been compared with the colony in New Delhi from which it was derived, and both have been shown to be markedly polymorphic for abdominal scale colour, the populations containing dark, pale, and intermediate morphs in stable proportions. Further analysis shows that the pale morph is more prone to larval mortality than the other forms and takes longer to develop. In spite of this adverse selection the genes for paleness remain in the population by virtue of the greater fitness and faster larval development of the hybrid form. It is hoped to test the efficiency of each genotype as a vector of *Dirofilaria immitis* initially.

In the field of pure genetics, studies include the effect of disruptive sexual selection on the polygenes controlling scale colour in strains originating in West Africa and Indonesia.

Strains resistant and susceptible to both D.D.T. and Dieldrin from Trinidad, Puerto Rico, Colombia, U.S.A. and the Sudan have so far been examined; it is hoped to survey many more in search of variation.

*Relapsing Fever*

72. Dr. G. A. Walton continued in London his genetical and morphological studies on the "*Ornithodoros moubata*" complex. The discovery of distinct species previously included under that name, and reported below, may provide a basic explanation for the paradoxical distribution of African tick-borne relapsing fever.

73. Reproductive isolation between the South African domestic form E, the East African domestic form A.1 (Meru, Kenya strain) and the East African wild form C was confirmed by repeating the crosses reported last year. Five per cent. of the C/E cross eggs (2,220) and 7 per cent. of the A/E cross eggs (2,505) were viable compared with 91 per cent. (2,051 eggs), 88 per cent. (1,411 eggs) and 82 per cent. (1,732 eggs) in the E, C and A.1 controls. After three months' starvation, survivals were 3 per cent. in C/E and 2 per cent. in A/E hybrid nymphs compared with 91 per cent., 55 per cent. and 85 per cent. in the E, C and A.1 controls. All eggs of the female C/male E cross (1,226) have failed to hatch. Since morphological differences are obvious in forms E, A.1 and C, they are regarded as distinct species in the strict allopatric sense (reproductive isolation remains to be proved in naturally occurring sympatric populations).

74. Two wild forms are now recognised in the Eastern African region. Form C (probably associated with porcupines) has a smooth intervalval-capitular area, blunt anterior hairs, about 20 vulval striae, small pale eggs and pale narrow first nymphs which do not "freeze". Form F, associated with wart-hogs, has a strongly mammillated intervalval-capitular area, tapering anterior hairs, about 40 vulval striae, large dark eggs and dark wide first nymphs which show a marked "freezing" reaction.

Crosses were made between the East African wild form C, the wild form F, the domestic form A.1 and the South African domestic form E. Eight per cent. of the F/E cross eggs (1,217) were viable, but 68 per cent. of the hybrid first nymphs were abnormal; less than 1 per cent. survived five months' starvation compared with 90 per cent. and 83 per cent. in F and E controls. In the F/C cross, 61 per cent. of the eggs (1,119) were viable, but first nymph hybrids developed violent ataxia. Form C control nymphs did not show ataxia but failed to withstand starvation. Survival after five months' starvation was 90 per cent., 4 per cent. and 2 per cent. in F, C and F/C hybrid nymphs respectively. In the F/A.1 cross, 79 per cent. of the eggs (1,183) were viable. After three months' and five months' starvation, percentage survivals were 91 and 90, 84 and 68, . 1 25 and 4 in the F and A controls and hybrids respectively. Thus the F/C and F/A.1 surviving hybrids have a greatly reduced vitality.

75. Representative pure domestic strains (uncontaminated by the wild form F) from the Kenya coast (form B), central Tanganyika (form D) and the central African Highlands (form A.2) agreed in the proportion requiring more than four nymph stages, i.e. 16, 13 and 17 per cent. respectively (mean 15.5), compared with 27.5 per cent. of the geographically isolated Mount Kenya form A.1. The difference, 12 per cent.  $\pm$  1.5, is highly significant. Forms B and A.2 hybridise freely with form F, but, in the A.1/F cross hybrid, vitality is reduced, as noted above.

76. Thus three distinct species occur in the Eastern African region. These are the wild (porcupine) species C; the South African domestic species E (S.E. Tanganyika); and a complex species including forms A.1, A.2, B, D and F, subdivisible into a wild subspecies F and two domestic subspecies, namely, subspecies A.1 from Mount Kenya (possibly Abyssinian), and subspecies A2.BD which is extremely abundant across Tanganyika and has three geographic races, B (chicken eater), D (mixed feeder) and A.2 (man-eater), in which morphological differences have been noted.

Form G from tortoises in South Africa is morphologically quite distinct.

#### *Publications*

WALTON, G. A.—(1960) "The reaction of some variants of *Ornithodoros moubata* (Argasidae, Ixodoidea) to desiccation." *Parasitology*, 50, 81.

#### *Identification of blood-meals*

77. The study of the feeding habits of *tsetse flies* was continued by Mr. Weitz and Miss Lee-Jones. More than 5,000 tsetse fly blood-meals were tested by the inhibition technique during the year, largely to check and confirm preliminary findings reported last year. The results of these identifications and of those done over previous years allow certain general conclusions to be made about the *natural* feeding habits of these insects, which can be summarised conveniently at this stage as the investigations are nearly completed.

78. Individual species of tsetse fly have characteristic feeding habits independently of the available fauna or location. *Glossina morsitans* and *G. swynnertoni* largely feed on warthog (46 to 90 per cent. of all feeds in various localities). In some areas, however, other animals may exceptionally take the place of warthogs as favourite hosts, e.g. kudu or hippopotamus. Some animals, such as zebra, are never fed on anywhere, and hartebeest, impala, wildebeest and waterbuck extremely rarely, although *G. morsitans submorsitans* in North Karamoja feeds regularly, although infrequently, on hartebeest. *G. longipennis* feeds characteristically on rhinoceros, and no fly of this species has been found in areas where this host is absent. *G. pallidipes* in East Africa and its counterpart *G. longipalpis* in West Africa mostly feed on bushbuck. *G. palpalis* appears to be a more adaptable fly and dependent on hosts which visit the water edge, but in undisturbed areas it feeds chiefly on water reptiles (crocodiles or varanus) and to some extent on waterbuck. Man is a favoured host when in contact with the fly. *G. tabaniformis*, a forest fly, feeds on porcupine quite regularly, *G. brevipalpis* on bushpig, *G. fusca* and *G. medicorum* on red river hog and also on aardvark.

79. These results indicate that in their natural habitat these insects favour or avoid some hosts more than others. There is no suggestion that the fly makes deliberate choice of host, and it would therefore be misleading to refer to these habits as preferences. Some recent studies at Kiboko and Talek in Kenya by Mr. Langridge have shown conclusively that the hosts are not used in relation to the numbers of animals present and available to the fly. The discrimination of the fly for its hosts must be at least in part genetic, as different species of fly consistently feed a certain way. It is reasonable to assume that such genetic characteristics, affecting the method of hunting for food as well as the habitat of choice, would result in a specific pattern of feeding habits.

Investigations are still proceeding to find out the importance of cattle in maintaining the fly in areas where game is being eliminated. At present it appears that although many flies feed on cattle in such circumstances, these are sporadic feeds which are unlikely to become the main source of food in the area.

80. The work which has been carried out by Mr. Weitz and his colleagues on the antigens of trypanosomes is reported in the Annual Report of the Tsetse Fly and Trypanosomiasis Committee.

81. The studies of malarial *mosquitoes* have continued and increased on a world-wide basis with the added collaboration of the World Health Organisation. The method of collecting blood-fed mosquitoes yielding reliable samples has been established on the basis of the results of a grand total of over 70,000 mosquito blood-meals. These results have shown that more than 75 per cent. of the blood-meals of the following species were from man: *Anopheles minimus*, *A. gambiae*, *A. leucosphyrus*, *A. moucheti*, *A. nili*, *A. sundaiacus* and *A. wellcomei*. Of the endophilous species, which include *A. barbirostris*, *A. fluviatilis*, *A. funestus*, *A. gambiae*, *A. nili*, *A. pharoensis*, and *A. sundaiacus*, 70 per cent. of those collected from human habitations had fed on man. Among exophilous species such as *A. flavicosta*, *A. leucosphyrus*, *A. moucheti*, *A. nili*, and *A. wellcomei*, it was found that over 70 per cent. of those resting outside had fed on man. It is clearly essential to identify the blood-meals of mosquitoes caught in all types of habitat in order to establish the anthropophilic tendencies of any species.

#### *Publications*

SMITH, A., and WEITZ, B.—(1959) "The feeding habits of *Anopheles gambiae*, with particular reference to subsidiary hosts." *Ann. trop. Med. Parasit.*, **53**, 414.

WEITZ, B.—(1960) "Feeding habits of bloodsucking arthropods." *Exp. Parasit.*, **9**, 63.—"A soluble protective antigen of *Trypanosoma brucei*." *Nature, Lond.*, **185**, 788.

WORLD HEALTH ORGANISATION and LISTER INSTITUTE.—(1960) "A study of the blood-feeding pattern of *Anopheles* mosquitoes through precipitin tests." *Bull. Wld. Hlth. Org.*, **22**, 685.

#### *Physiological and nutritional research*

##### (a) *Tanganyika and Uganda*

82. *Body composition*. Studies have continued on body composition at the East African Institute for Medical Research, Mwanza, by Dr. E. G. Holmes, Dr. Sylvia Darke, Dr. J. P. Greaves and Mr. W. W. C. Read. They included determinations of body-weight and total body-water by tritiated water. Particular attention has been given to studies on the "lean body mass" in apparently normal Africans, especially whether its composition, accepted by some workers as being constant in healthy subjects in Europe and North America, is equally constant in the Africans. Early results suggest that this is not so.

Comparative studies on the *energy cost of activities* of rural African women and of domestic science students were made by Miss F. Ritchie, and the daily energy expenditure determined.

83. *Serum protein studies* undertaken by Miss P. G. Lutz included determinations of the urinary excretion of iron by African children exposed to malaria. This work was done in collaboration with Dr. A. C. Allison of the National Institute for Medical Research, who carried out parallel examinations of the children's blood sera for haptoglobins. The concentration of iron in the urines was very small (mean 5.0/100 ml.).

Dr. Lutz also analysed samples of milk and of blood serum from African nursing mothers from an area 150 miles south of Mwanza where, owing to an exceptionally dry season, there was a considerable food shortage. Total nitrogen, non-protein nitrogen, total protein nitrogen, curd nitrogen, and whey nitrogen were determined. The results were similar to those obtained from a group of reputedly malnourished Ghanian lactating women previously analysed. The serum protein pattern was similar to that usually obtained in Africans, and showed the usual high gamma globulin and low A/G ratio. The albumin was not markedly reduced. In the urine, the urea nitrogen formed only 69 per cent. of the total nitrogen.

With Dr. D. S. McLaren, Dr. Lutz is using the technique of agar electrophoresis to investigate the soluble proteins of the lens.

84. *Nutritional ophthalmology*. A grant of \$87,225 for three years for a study of nutritional ophthalmology in East Africa by Dr. D. S. McLaren has been made by the National Institutes of Health, U.S.A. It will provide for an ophthalmologist, a laboratory technician, a mobile unit, and much special equipment.

85. *Surveys of nutritional and eye diseases*. Dr. D. S. McLaren and Mr. P. G. Ward made these surveys in the Lake and Central Provinces of Tanganyika. Nutritional status was assessed by clinical examination, and special examinations were made for eye disease. Vitamin A deficiency, as evidenced by keratomalacia in young children and milder eye signs in older children and young adults, was the outstanding deficiency problem in Central Province, but was not seen around Mwanza. Marked abnormalities of refraction consisting of a high incidence of axial ametropia, mixed astigmatism, anisometropia, and a wide scatter of the aberrations of emmetropia were also found in children in Central Province, but fewer in African and Asian children around Mwanza. Research continues into their aetiology.

Many African primary school children had very early "water-cleft" opacities in the extreme peripheral part of the lens. These did not appear in European primary school children who had spent most of their lives in the tropics, and were less common among Asian than among African children. This may explain the apparently high incidence of clinical cataract in late middle age among Africans. No correlation appears to exist between the incidence of "water-clefts" and accommodative power, suggesting that the former were not causally related to the latter.

86. *Ocular Leprosy*. Visits were paid to leprosaria at Kola Ndoto (Lake Province) and Makutupora (Central Province) of Tanganyika, and at Oicha (Belgian Congo). In Tanganyika, nearly 10 per cent. of all patients have serious ocular complications of leprosy; at Makutupora nearly 30 per cent. have eye conditions not related to leprosy, but the proportion was much

smaller at Kola Ndoto. The difference is ascribed to the greater frequency of trachoma and pterygium in the drier Central Province.

87. *Ocular Onchocerciasis*. Professor A. W. Woodruff, Mr. G. R. Barnley, Senior Entomologist (Medical), Kampala, and Dr. McLaren visited the Ruwenzori area of Uganda to examine members of the Bakonjo Tribe, almost all of whom have onchocerciasis. Amongst other investigations, full slit-lamp and ophthalmoscopic examinations were made of about 80 patients mostly heavily infected with the disease, together with photographic records of the anterior segment lesions and the fundal changes.

#### *Publications*

DARKE, S. J.—(1959) "Malnutrition in African adults. 5. Effects of hookworm infestation on absorption of foodstuffs." *Brit. J. Nutr.*, **13**, 278.—(1960) "The cutaneous loss of nitrogen compounds in African adults." *Ibid.*, **14**, 115.

HOLMES, E. G. and DARKE, S. J.—"Malnutrition in African adults. 4. Intestinal absorption." *Ibid.*, **13**, 266.—(1959) "Intestinal absorption of nitrogen." *Proc. VII Colloquium, Bruges 1959*, 220.

MCLAREN, D. S.—(1959) "Influence of protein deficiency and sex on development of ocular lesions and survival time of the Vitamin A deficient rat." *Brit. J. Ophthalm.*, **43**, 234.—(1959) "Complicaciones Oculares de la Malnutricion Proteica." *Bol. Ofic. Sanit. Panam.*, **46**, 272.—(1959) "Urinary excretion of Vitamin A in pregnancy." *Proc. Nutr. Soc.*, **18**, 30.—(1960) "The crystalline lens in human and experimental malnutrition." *Ibid.*, **19**, 78.—(1960) "Malnutrition and eye disease in Tanganyika." *Ibid.*, **19**, 89.

88. At the Mulago Hospital, Kampala, Uganda, the Medical Research Council's Infantile Malnutrition Research Unit under the direction of Dr. R. F. A. Dean has concentrated on two objectives: the development of the biscuit meal mentioned in previous reports, and biochemical changes caused by malnutrition in the tissues of young children.

89. The biscuit meal, which is made from the whole groundnuts, maize flour, cane sugar, cottonseed oil and dried skimmed milk in the proportions 41, 26, 12, 6 and 15, has been tested thoroughly in the Unit's wards in the treatment of kwashiorker, and at the Unit's Child Welfare Clinic in the prevention of malnutrition. It has given very good results, and a baking expert, provided by F.A.O., has reported on the possibilities of commercial production. If capital costs are excluded, a selling price of about 2.02 E.A. Shs./Kg. (or about 11d. lb.) should cover all other expenses, including purchase of raw materials. The biscuit provides 20 g. protein and 490 Calories/100 g., and may perhaps be regarded as nearer in value to full cream dried milk than to dried skimmed milk.

90. The nature of the essential cellular lesion in kwashiorkor was suggested some years ago by Waterlow, who found a reduction in ribonucleic acid, in relation to deoxyribonucleic acid, in muscle and liver. In Kampala, it has now been found that a series of compounds that are probably breakdown products of nucleic acid appear in the urine of children who are seriously ill, but disappear with recovery. There are simultaneous fluctuations of electrolyte excretion that seem to confirm the intracellular origin of the compounds.

In the acute stage of kwashiorkor, the child is losing large amounts of nitrogen despite a very low intake. Some of the nitrogen appears as urea, ammonia, creatine, creatinine, free amino acid, peptides and uric acid: a quarter of the rest appears in the new compounds, but the nature of the remainder is still to be discovered.

#### Publications

BURGESS, H. J. L.—(1960) "The Medical Research Council's Rural Child Welfare Clinic." *E.A. med. J.*, **37**, 391.

DEAN, R. F. A.—(1959) "Kwashiorkor in Malaya." *Bull. Wld. Hlth. Org.*, **20**, 727.—(1959) "Infant feeding in Uganda." *Quart. Rev. Pediat.*, **14**, 182.

DEAN, R. F. A., and SKINNER, M.—(1960) "A note on the treatment of kwashiorkor." *Proceedings, 3rd Inter-African Nutrition Conference, C.C.T.A.*, (1956) 85.

DEAN, R. F. A.—(1960) "The supplementation of the diets of African children." *Ibid.*, 109.—(1960) "Treatment of Kwashiorkor with moderate amounts of protein." *J. pediat.*, **56**, 675.—(1960) "Biochemical changes caused by protein deficiency in young children." *Clin. Chim. Acta*, **5**, 186.—(1960) "The use of plant proteins in the diets of young children." *E.A. med. J.*, **37**, 378.

FARMER, Ann P.—(1960) "Malnutrition as an ecological problem." *Ibid.*, **37**, 399.

JELLIFFE, D. B. and DEAN, R. F. A.—(1959) "Protein-calorie malnutrition in early childhood (Practical notes)." *J. trop. Pediat.*, **5**, 96.

MATTHEW, C. E. and DEAN, R. F. A.—(1960) "The serum lipids in kwashiorkor, 11. The relation of diet to total serum cholesterol." *Ibid.*, **5**, 135.

NELSON, G. K., and DEAN, R. F. A.—(1959) "The electroencephalogram in African children: Effects on kwashiorkor and a note on the newborn." *Bull. Wld. Hlth. Org.*, **21**, 779.

WAYBURNE, S., and DEAN, R. F. A.—(1960) "The alkaline phosphatase of the blood, and the state of bone development in infantile rickets." *S. Afr. J. Lab. clin. Med.*, **6**, 21.

WHITEHEAD, R. G., and MATTHEW, C. E.—(1960) "The analysis of urine in children suffering from kwashiorkor." *E.A. med. J.*, **37**, 384.

#### (b) Jamaica.

91. *Tropical Metabolism Research Unit.* Dr. J. C. Waterlow, the Director of this Unit of the Medical Research Council, reports on a variety of investigations on *protein malnutrition in infants*.

92. *Nitrogen metabolism and requirements.* In studies of nitrogen balance, designed to find the minimal intake that will secure nitrogen retention adequate for recovery and growth, results so far agree with the conclusions of the Princeton Conference on protein requirements. The Unit is also studying the utilisation of nitrogen from urea and from glycine, and the nutritive value of leaf protein preparations supplied by Mr. Pirie of Rothamsted.

93. *Basal metabolic rate.* Dr. R. D. Montgomery has continued measurement of the oxygen uptake of the malnourished baby. The absolute uptake

rises rapidly during the early stages of recovery and reaches a plateau, after which it remains more or less constant. The height of the plateau seems to represent the oxygen uptake that would be expected in a *normal baby of the same age*. The uptake bears no direct relation to the body weight, which is rapidly changing during recovery. It seems therefore that oxygen consumption cannot be used as a measure of the amount of active tissue in the body. The apparent relation to age poses the interesting problem of the nature of the regulatory mechanism. A method has been developed for measuring the uptake by the thyroid of radio-active iodine in a dosage of 0.01  $\mu\text{c}$  per kg. body weight, which is thought to be well within the limits of safety for an infant. The results so far show that an increase of thyroid function to hyper-active levels coincides with the rapid weight gain and the rise of oxygen uptake.

94. *Protein synthesis and breakdown.* Dr. D. Picou continued the work begun by Dr. J. S. Garrow, in which methionine S-35 was used as a tracer. Analysis of Garrow's results and of experiments reported in the literature suggested that protein depletion might have a striking effect on the rate of re-utilisation of amino-acids for the synthesis of essential proteins such as plasma protein. The first objective was to test the hypothesis, and for this it was necessary to use double labelling with I-131 and S-35. However, with small amounts of material of low activity it is very difficult to make accurate counts of one isotope in the presence of the other, and this technical problem remains unsolved.

A second approach has been to measure the uptake of labelled amino-acid during a continuous infusion for 30 hours. Garrow's results indicated that this is many times as long as the turnover half-time of free methionine, and so should allow ample time for uniform distribution. If the intake and output are known both of labelled and of total sulphur, it is possible to estimate not only the net retention, as in a balance experiment, but also the absolute rates of protein synthesis and breakdown in the body as a whole.

A new method has been devised for measuring sulphur excretion in small quantities of urine, based on precipitation of sulphate with radio-active barium.

95. *Magnesium deficiency.* Colorimetric micro-methods for magnesium had hitherto proved unsatisfactory. Dr. Montgomery has established the validity of the measurement of magnesium by flame photometry in the near ultra-violet. In malnourished infants muscle magnesium content was reduced by about 30 per cent. and urinary magnesium output was very low; but there was little change in the magnesium levels in serum or red cells. These findings fit in well with the earlier ones of Dr. Smith on potassium; with both of these intracellular minerals, blood levels may be normal in the presence of substantial depletion, as shown by analysis of muscle or measurement of urinary output.

96. *Enzyme changes.* Results obtained earlier suggested that in the malnourished liver there may be an increased fragility of the mitochondria; for in the malnourished liver, but not in the normal liver, oxidative phosphorylation was greatly reduced by treatments such as storage at 0°C., brief incubation at 37°C., or rapid homogenisation. Recently, as one likely



cause of this phenomenon is liberation of free fatty acids from the malnourished liver, which is usually also fatty, studies of the effect of human liver homogenates on phosphorylation by rat liver homogenates or mitochondria have been initiated.

Miss J. M. L. Stephen in London has been investigating the reliability of enzyme assays—particularly malic dehydrogenase and adenosine triphosphatase—as tests for the intactness of mitochondria, and the activity of these enzyme systems under various conditions. These tests gave no indication of increased mitochondrial fragility in the livers of protein-depleted rats, even when the liver was fatty. The next step is to apply these tests to human tissues.

97. *Phospholipids in tissues and blood.* The study of phospholipids in protein malnutrition was undertaken because of their relation to fat metabolism, and to transport to membranes of cells and mitochondria. Dr. L. Rathbone had difficulty in separating phospholipids by paper chromatography, in spite of having tested a large variety of solvent systems. Column chromatography on silicic acid gave promising results.

98. *Folic acid metabolism.* Tetrahydrofolic acid derived from exogenous folic acid is an essential co-enzyme for the final stage of breakdown of histidine to glutamic acid. In folic acid deficient subjects the resulting increased excretion of formiminoglutamic acid (F.I.G.L.U.) offers specific evidence of folic acid deficiency, and this effect may be enhanced by “metabolic loading” of the subject with histidine. Urinary F.I.G.L.U. may be assayed by various techniques, microbiological, chromatographic or enzymic, which have been the subject of special study by Dr. A. L. Lohby and his colleagues at the New York Medical College. In collaboration with Dr. Lohby, urinary F.I.G.L.U. estimations have been made on Jamaican infants suffering from protein malnutrition with associated gross anaemia in order to elucidate further the nature of this anaemia. The infants may be divided into two groups according to the nature of the bone marrow changes and the folic acid response. In typical cases with megaloblastic marrow the urinary F.I.G.L.U. appears to confirm a specific deficiency of folic acid. In a second large group the marrow is fatty and hypocellular but essentially normoblastic, and the response to folic acid therapy is variable and often incomplete. Urinary F.I.G.L.U. is not significantly raised in this group but it is hoped that histidine loading may provide a more sensitive guide to the folic acid state. Serum vitamin B12 levels are normal in both groups. There is evidence that in some of these cases gross protein deficiency prevents even a megaloblastic type of marrow maturation, which may however be unmarked during the initiation of clinical recovery.

99. *Composition of milks.* In furtherance of studies on the nutritional significance of human milk in the treatment of malnourished infants, Miss Stephen spent five weeks in Professor O. Mellander's Department of Medical Biochemistry, University of Gothenburg, where research on the protein composition of milks from different species is proceeding. Some of the techniques learnt will be applied to determining the nature of the nitrogenous compounds which are left after the proteins of human milk have been precipitated.

100. *Studies on an Idiopathic Paraplegic Syndrome in adults.* During the year some 30 adults were admitted to the Unit for special study of this

syndrome, of which nearly 300 cases have been seen at the University College Hospital of the West Indies. Studies have centred on the nature of the CSF changes, the epidemiology and the possible relation of some or all of the cases to treponematosiis. The disease shows a striking geographical distribution in inland rural areas. The CSF changes often resemble those of syphilis, but the specific tests are negative. Nevertheless recent evidence rather suggests that this disease may be an atypical late manifestation of treponematosiis, possibly non-venereal.

#### *Publications*

WATERLOW, J. C.—(1959) "Protein nutrition and enzyme changes in man." *Federation Proceedings*, **18**, 1143.—(1959) "Protein deficiency in tropical countries." *Biology and Human Affairs*, **24**, No. 3. "L'Etude des Enzymes Hépatiques chez l'Homme." *Exposés annuels de Biochimie médicale*, **21**, 17.—(1959) "The effect of protein depletion on the distribution of protein synthesis. (Further observations.)" *Nature*, **184**, 1875.

GARROW, J. S.—(1959) "The effect of protein depletion on the distribution of protein synthesis in the dog." *J. clin. Invest.* **38**, 1241.

STANDARD, K. L., WILLS, V. G., and WATERLOW, J. C.—(1959) "Indirect indicators of muscle mass in malnourished infants." *Amer. J. clin. Nutr.*, **7**, 271.

SMITH, R., and WATERLOW, J. C.—(1960) "Total exchangeable potassium in malnourished infants." *Lancet*, **1**, 147.

MONTGOMERY, R. D.—(1959) "Some observations on medical out-patient practice at the University College of the W. Indies." *W. Ind. med. J.*, **8**, 119.

MONTGOMERY, R. D. and STANDARD, K. L.—(1960) "Albers-Schönberg's disease: a changing concept." *J. Bone Jt. Surg.*, **42B**, 303.

101. *Action and metabolism of hypoglycin*. Dr. J. Patrick, of the Faculty of Physiology at the University College of the West Indies, Jamaica, investigating this problem with Dr. P. C. Feng, continued the studies on the conditions necessary for the transamination and deamination by tissue enzymes of hypoglycin, a hypoglycaemic amino-acid isolated from the ackee fruit. Attempts have been made to isolate other possible metabolites of hypoglycin after *in vivo* dosing of rats. A small quantity of C-14 labelled hypoglycin has been isolated from the leaves of ackee seedlings after exposure to C-14 O<sub>2</sub>, and further metabolic studies with this radioactive hypoglycin are planned. Studies on the inhibition of various enzymes by hypoglycin showed that the transdeamination of alanine by liver is partially inhibited by relatively large concentrations of hypoglycin.

102. *Urinary secretion of amino-acids*. Studies on urine collected from infants brought to Dr. Waterlow's unit are designed to find whether any noteworthy pattern of amino-acid excretion exists in malnourished infants. The amino-acids are being analysed by a combination of chromatographic methods using paper and ion-exchange resins.

103. *Diabetes*. Research on the changes in liver constituents from human diabetics indicated that there is usually a moderate increase in glycogen on stabilisation of the diabetes. Glucose-6-phosphatase is regularly and markedly reduced. The changes in the aspartic-glutamic transaminase and

alanine-glutamic transaminase are more variable, but these enzymes also are usually reduced by treatment of the diabetes. No significant changes are found in glutamic dehydrogenase or glucose-6-phosphate dehydrogenase. It is suggested that the glucose-6-phosphatase and the transaminases increase hepatic glucose production, and that insulin or other therapeutic agents may decrease glyconeogenesis by decreasing the activities of these enzymes.

A study on the utilisation of glutamic acid by diabetic patients has begun. It involves the administration of a test dose of glutamic acid followed by determinations of blood glucose serum, glutamic acid and serum alpha-ketoglutaric acid.

(c) *United Kingdom*

104. Professor B. S. Platt, Director of the Human Nutrition Research Unit of the Medical Research Council, London, has provided the following summary of the investigations on problems of nutrition of Colonial territories, which are the main theme of research in his Unit, and with which the work of the Department of Human Nutrition and the Applied Nutrition Unit at the London School of Hygiene and Tropical Medicine is closely associated.

105. The work on experimental protein malnutrition in young pigs has been continued, and the possibility of applying some of the results obtained to the development of simple objective indices of protein nutrition in human subjects is under review. Dr. B. T. Squires, at present Director of Medical Services, Bechuanaland, is expected to join the Unit shortly to participate in this study. More emphasis is being placed in the Unit's research programme on the effects of malnutrition on reproduction in experimental animals, with a view to determining the role of malnutrition in the pathogenesis of some complications of pregnancy in the mother and of abnormalities in the offspring. Studies of the effect of malnutrition on the development of the mammary gland and on lactation also continue.

106. Professor Platt was President of the Scientific Conference of the East African Council for Medical Research, held at Dar-es-Salaam in February, 1960, the subject of which was "The origin and effects of malnutrition in man and animals."

107. The Rockefeller Foundation have generously given a further grant to the Department of Human Nutrition of the London School of Hygiene and Tropical Medicine, for continuation of the work on the protein value of tropical foods and dietaries. Funds have been included for the provision of a number of Research Studentships to enable overseas workers to learn the techniques for the assay of protein values of foods, and for occasional visits of staff to overseas research centres to assist the returned students to set up studies in their own countries. Under this scheme Mr. D. S. Miller, B.Sc., is to visit Jamaica in September, 1960, to assist Miss Helen C. Fox, M.Sc., a former Colonial Research Student at the Unit, to continue her investigations into Jamaican foods and diets. Mr. Miller and Miss Fox have recently published evidence that hypoglycin, a hypoglycaemic substance obtained from the ackee fruit of Jamaica, is an anti-metabolite of riboflavin.

Dr. W. R. Aykroyd, the Director of the Nutrition Division of the Food and Agriculture Organisation of the United Nations since its

inception, has been appointed to the post of Senior Lecturer in Human Nutrition, and Dr. Ruth Schwartz to the post of Lecturer.

*Investigations on sickle-cell trait and sickle-cell anaemia.*

108. These have continued as a collaborative effort by workers in the field and in laboratories in Britain.

109. Dr. J. C. White (Postgraduate Medical School of London) has continued the study of abnormal haemoglobins in co-operation with Dr. G. H. Beaven (Medical Research Council Laboratories, London), and Dr. E. M. Shooter (University College, London). They were assisted by Miss. M. J. Ellis, B.Sc., who was awarded the degree of Ph.D. by the University of London for a thesis on the occurrence of foetal haemoglobin (Hb-F) in post-natal life.

110. Detailed studies were published on the unequivocal detection of Hb-F at low levels by a combined alkaline denaturation and spectrographic method, and on the application of this to haematological disorders other than the hereditary haemoglobinopathies. The proportion of Hb-F has fallen below the 1 per cent. level in two-thirds of apparently normal children by six months of age; in a further third, a slow curvilinear elimination occurs, reaching the 1 per cent. level at four to six months of age, so that a limited post-natal synthesis is necessarily continuing. This situation is exaggerated in the true haemoglobinopathies, where an abnormal persistence of Hb-F from early life is very common. However, a variety of haematological disorders quite unrelated to the haemoglobinopathies may exhibit Hb-F at varying levels. Some childhood leukaemias, hereditary haemolytic anaemias, and a high proportion of refractory normoblastic sideroblastic anaemias possess Hb-F. In some a re-activation of the mechanism for Hb-F occurs; this is most clearly seen in pernicious anaemia, where the proportion of Hb-F actually rises (though not usually exceeding 5 per cent.) during response to treatment, and then slowly disappears. The detection of Hb-F is not necessarily a diagnostic indication of either a haemoglobinopathy or of a primarily genetic condition.

111. The combination of the basic methods for haemoglobin investigation (boundary electrophoresis, zone electrophoresis on paper, the rate of alkaline denaturation, etc.) with newer electrophoretic methods in media such as starch block or gel and agar has been rewarding. In a co-operative investigation with Dr. J. E. O'N. Gillespie on thalassaemia in Cyprus a new haemoglobin variant (Hb-Cyprus I) has been described in a Turkish-Cypriot woman; her own blood presents a mild thalassaemia, whilst her son has a severely anaemic form of thalassaemia. The abnormal haemoglobin occurs together with an excess (60 per cent.) of Hb-A, is electrophoretically distinct (migrating between Hb-F and Hb-S), and is unique in also possessing a slow rate of alkaline denaturation yet the ultra-violet spectral absorption characteristics of an adult-type haemoglobin.

An abnormally unstable haemoglobin fraction was encountered in three cases of erythro-leukaemia in middle-aged subjects. Although it was similar to Hb-H in some electrophoretic properties and in the formation of intra-erythrocytic inclusions on incubation with brilliant cresyl blue, a distinction could be made; probably it was an acquired rather than an hereditary abnormality.

112. Supplementary to the foregoing determinations, Dr. G. H. Beaven and Mr. W. B. Gratzler at the Medical Research Council's laboratories have continued to study methods for the separation of human haemoglobin species with particular reference to the normal adult and foetal forms and the minor components. Electrophoresis in starch gel and agar gel has proved of value, especially when supplemented by direct spectroscopic examination of the separated zones. The high resolving power and reproducible behaviour of ion-exchange columns operating under the conditions devised by Schroeder and co-workers (*J. Amer. Chem. Soc.*, **80**, 1623, 1958 etc.) have been confirmed, and are being used to isolate and characterise the minor components of normal adult, cord and pathological bloods.

In addition to continuing studies on the occurrence and significance of Hb-F in a wide variety of circumstances, including the haemoglobinopathies, and to the studies summarised above, several other investigations on haemoglobins have been completed and published.

#### *Publications*

GILLESPIE, J. E. O'N., WHITE, J. C., ELLIS, M. J., BEAVEN, G. H., GRATZER, W. B., SHOOTER, E. M., and PARKHOUSE, R. M. E.—(1959) "A haemoglobin with unusual alkaline-denaturation properties in a Turkish-Cypriot woman." *Nature*, **182**, 1876.

WHITE, J. C., ELLIS, M. J., COLEMAN, P. N., BEAVEN, G. H., GRATZER, W. B., SHOOTER, E. M. and SKINNER, E. R.—(1960) "An unstable haemoglobin associated with some cases of leukaemia." *Brit. J. Haemat.*, **6**, 191.

BEAVEN, G. H., ELLIS, M. J. and WHITE, J. C.—(1960) "Studies on human foetal haemoglobin. 1. Detection and estimation." *Ibid.*, **6**, 1.—(1960) II. Foetal haemoglobin levels in healthy children and adults in certain haematological disorders." *Ibid.*, **6**.

BEAVEN, G. H. and GRATZER, W. B.—(1959) "Direct spectroscopic examination of electrophoretic zones in agar gel." *Nature*, **184**, 359.

GRATZER, W. B. and BEAVEN, G. H.—(1960) "The minor components of normal adult human haemoglobin." *Brit. J. Haemat.*, **6**, 191.

113. Dr. Lehmann of St. Bartholomew's Hospital, London, working with various collaborators, continued the study of the abnormal foetal haemoglobin, tentatively called Haemoglobin Bart's. The globin part of the haemoglobin molecule consists of two pairs of polypeptide chains, viz. two alpha and two beta chains in the case of adult and two alpha and two gamma chains in the case of foetal haemoglobin. With Dr. J. A. Hunt, Haemoglobin Bart's was found to be a foetal haemoglobin without alpha chains. With Dr. A. Kekwick, it was established that its molecular weight was the same as that of other haemoglobins, and it could therefore be described as Haemoglobin gamma 4. With Dr. Ramot from Israel and others, a family was studied where in two members Haemoglobin Bart's and Haemoglobin H were present together. Haemoglobin H was shown by workers in the United States to be Haemoglobin beta 4. It thus seems that a basic abnormality exists which consists of a deficiency of alpha chains and which can give rise to Haemoglobin H as far as adult haemoglobin is concerned and to Haemoglobin Bart's as far as foetal haemoglobin is concerned.

114. With Dr. J. A. M. Ager, and Dr. J. Vandepitte and Mme. P. Dherte from the Belgian Congo, two new D-like haemoglobins were discovered, Stanleyville I and II, in Nilotic-speaking regions rather than in Bantu areas. With the same Belgian colleagues a family was studied in which three adult haemoglobins were found in one individual: A, S and P; and another such person was studied with Dr. and Mme. J. Lambotte-Légrand. Such cases clarify considerably the understanding of the inheritance of haemoglobins. It is now accepted that some abnormal haemoglobins have their mutational change in the alpha chain and some in the beta chain.

115. In work on animal haemoglobins about 800 specimens of cattle blood from Africa were examined. No difference was found in the haemoglobin distribution in Afrikaander cattle (laeral horned Zebu) and Central African Sanga cattle (short horned Zebu).

In a study on the effect of magnesium on thrombin generation time, two children with sickle-cell anaemia were treated with magnesium. This had no effect on the haemoglobin level. The study continues, in the hope of finding a preventative treatment for infarctive sickle-cell crises.

#### Publications

LEHMANN, H.—(1959) "Classification and identification of human haemoglobin." *Proc. R. Soc. Med.*, **52**, 959.

*Idem* and NWOKOLO, C.—(1959) "The River Niger as a barrier in the spread eastwards of Haemoglobin C: a survey of haemoglobins in the Ibo." *Nature*, **183**, 1587.

HUNT, J. A. and LEHMANN, H.—(1959) "Haemoglobin Bart's: a foetal haemoglobin without alpha chains." *Nature*, **183**, 1373.

CHOREMIS, C., ZANNOS-MARIOLEA, L., AGER, J. A. M. and LEHMANN, H.—(1959) "Persistence of Haemoglobin 'Bart's' beyond infancy in a child with thalassaemia." *Brit. med. J.*, **2**, 348.

RAMOT, B., SHEBA, Ch., FISHER, S., AGER, J. A. M. and LEHMANN, H.—(1959) "Haemoglobin H Disease with persistent Haemoglobin 'Bart's' in an Oriental Jewess and her daughter. A dual alpha-chain deficiency of human haemoglobin." *Ibid.*, **2**, 1228.

DHERTE, P., VANDEPITTE, J., AGER, J. A. M. and LEHMANN, H.—(1959) "Stanleyville I and II: Two new variants of adult haemoglobin." *Ibid.*, **2**, 282.

DHERTE, P., LEHMANN, H., and VANDEPITTE, J.—(1959) "Haemoglobin P in a family in the Belgian Congo." *Nature*, **184**, 1133.

DOS SANTOS, W. D. and LEHMANN, H.—(1959) "Acetazolamide in sickle-cell anaemia." *Brit. med. J.*, **2**, 139.

ANSTALL, H. B., HUNTSMAN, R. G., LEHMANN, H., HAYWARD, G. W. and WEITZMAN, D.—(1959) "The effect of magnesium on blood coagulation in human subjects." *Lancet*, **1**, 814.

HUNTSMAN, R. G., HURN, B. A. L. and LEHMANN, H.—(1960) "Observations on the effect of magnesium on blood coagulation." *J. clin. Path.*, **13**, 99.—(1960) "Paradoxical effect of magnesium ions on blood coagulation." *Nature*, **185**, 852.

CRADOCK-WATSON, J. E., FENTON, J. C. B. and LEHMANN, H.—(1959) "TRIS buffer for the demonstration of haemoglobin A<sub>2</sub> by paper electrophoresis." *J. clin. Path.*, **12**, 372.

### *Leprosy*

#### *Northern Nigeria*

116. Dr. D. G. Jamison of Corpus Christi College, Oxford, and Tropical Research Fellow of the Royal Society, has contributed the summary of the work of the Oxford Leprosy Research group.

117. *Histological investigations.* Further investigation of formalin-fixed skin biopsies from five normal subjects in daily contact with "open" untreated lepromatous cases failed to reveal the presence of acid-fast bacilli in the skin, even after the examination of 2,230 serial sections. Biopsies from enlarged nerves in patients with various types of leprosy were examined by silver staining techniques, and the changes in nerve structure correlated with sensory findings. The dorsal cutaneous branch of the Radial nerve was selected for this investigation. The behaviour of Schwann cells in subjects with enlarged peripheral nerves was investigated after injections of Indian ink and suspensions of dead acid-fast bacilli. The results are being correlated with results from animal experiments.

The changes in the structure of skin and nerves were examined in various types of leprosy following treatment with "Etisul" ointment (Diethyl-dithiol-isophthalate) in 15 patients in Northern Nigeria. In all the lepromatous cases investigated very marked reduction in the number of bacilli in the dermis occurred following 3 weeks of treatment with daily application of Etisul. However, acid-fast bacilli could still be found in peripheral nerves in the same biopsy.

118. *Lepromin and tuberculin skin testing.* From two districts in the Katsina Province of Northern Nigeria, 791 children were selected for lepromin and tuberculin skin-testing. The lepromin was made in Oxford by Dr. R. L. Vollum from lepromatous material collected in Katsina Province; for the tuberculin test the Heaf multiple puncture technique and P.P.D. were used.

Also, 278 tuberculin negative (Heaf) children were vaccinated with lyophilysed *vole bacillus vaccine* irrespective of their lepromin responses. However, of the 278 vaccinated 222 were negative to both lepromin and tuberculin tests. It is hoped to re-investigate the tuberculin response in these vaccinated children after 6 months, and to extend the experiment to at least 1,000 children.

During each overseas visit lepromatous material was collected for cultivation studies and for the manufacture of lepromin at Oxford.

#### *Kenya and Uganda*

119. *Drug Therapy.* From the East African Leprosy Research Centre, Alupe, Kenya, Dr. J. M. B. Garrod, reporting on patients on *Diphenyl Thiourea compound* (CIBA 1906, DPT), who have completed three years of treatment, has noted signs of resistance, instanced at first by apparent lack of progress, followed by the appearance of new lesions and an increase of bacilli in lepromatous cases. In tuberculoid cases the sequence is the

same, but no bacilli have been found. When transferred to treatment with DDS, normal progress is resumed without any untoward reactions occurring. Seventeen lepromatous cases, five borderline cases and one tuberculoid case were treated with Etisul, in combination with any one of the drugs DDS, DPT, or *thiosemicarbazone* (TB1). The tuberculoid case did not respond much more quickly than is usual. Of the lepromatous and borderline cases, those on TB1 do slightly better clinically than those on the other two drugs. The Etisul quickly affects the bacilli, causing granular or beaded forms, loss of acid-fastness and break-up of globi, which tend not to reappear even when resistance appears later. Bacillary indices drop by a quarter in 4 months and nearly a half in eight months. Clinical progress is quickened threefold. However, progress then slows remarkably, even when the Etisul is continued, and by 18 months those on DPT or TB1 show signs of resistance. Apparently all the benefit from Etisul is obtained in the first few months. It is permanent and maintained if DDS is used as the accompanying and following drug.

There have been no toxic effects to Etisul; if morale is good there is little objection to the smell; and it would seem safe for general out-patient use, provided adequate administrative control is feasible.

120. *Biochemical studies.* Mr. G. A. Ellard, M.Sc., a biochemist provided and financed by Messrs. Ciba, reports that the estimation of DPT and similar compounds by means of ferric chloride has been made quantitative, which has made possible a study of their pharmacology in man. Thus the use of DPT in the treatment of leprosy has been put on a rational basis. The dosage recommended is 1.5 g. daily or, if possible, thrice daily. Much progress has been made in the study of the human metabolism of DPT, and it should soon be possible to isolate and characterise this drug's human metabolites, which have been shown to possess considerable activity against tuberculosis.

The results obtained by the ferric chloride method have been confirmed by the use of radioisotopes in collaboration with Dr. Naylor, at Makerere College.

Studies of the human pharmacology of three other leprosy drugs, di-dimethyl-amino-diphenyl thiourea, D.D.S. and diamino-diphenyl sulphoxide are also in progress, and the collection of basic data on the excretion of normal body-metabolites is continuing.

#### *Publications*

GARROD, J. M. B.—(1959) "Two years' experience with Diphenylthiourea (DPT or CIBA 1906) in the treatment of leprosy." *Lep. Review*, **30**, 210.

RHODES-JONES, R.—(1959) "A modified technique for staining leprosy bacilli in smears." *Ibid.*, **30**, 251.

121. From Makerere College, Uganda, Dr. R. F. Naylor, Senior Lecturer in the Department of Chemistry, has continued his studies on the measurement of dehydrogenase activity in saprophytic mycobacteria by the use of tetrazolium salts. But the extension of those studies to *Mycobacterium leprae* proved generally disappointing. Therefore, in order to develop a more sensitive method of detecting biochemical changes, he has turned to radioactive tracers.



In particular, he is using C-14 to detect protein synthesis in *Mycobacterium phlei* and to elicit the effect of the sulphone drugs on this, and also S-35 labelled drugs (DDS, DPT and Etisul) in an assessment of the actual uptake of those drugs (in collaboration with Mr. Ellard, the biochemist at Alupe).

#### *Publications*

NAYLOR, R. F.—(1958) "A study of the action of sulphones on the metabolism of *Mycobacteria*." *Int. J. Lep.*, **26**, 313.

#### *United Kingdom*

122. From the National Institute of Medical Research, London, Dr. R. J. W. Rees reports on his laboratory studies as follows.

123. *Studies on the morphology of leprosy bacilli* (in collaboration with Dr. R. C. Valentine). Irregular staining (by the Ziehl-Neelsen method) is seen in a high proportion of rat leprosy bacilli recovered from animals receiving chemotherapy (isoniazid) and in a variable proportion of leprosy bacilli recovered from man. Hitherto the significance of irregularly stained human leprosy bacilli has been uncertain. From a large series of rat and human leprosy bacilli a good correlation has been observed (*J. gen. Microbiol.* (1960) **22**, 443) between the proportion of irregularly stained bacilli seen in the light microscope and the proportion of "degenerate" bacilli (which in the case of rat leprosy have been shown to be non-viable, McFadzean and Valentine, *Trans. Roy. Soc. trop. Med. Hyg.*, **53**, 414) seen in the electron microscope. A technique has now been developed for examining the same stained bacilli in both the light and electron microscope; it demonstrates that an irregularly stained and degenerate bacillus is one and the same organism. These observations provide the first conclusive evidence that irregularly stained leprosy bacilli are non-viable and that simple staining methods can be used to follow the fate of the bacilli from patients under treatment.

124. *Multiplication of Myco. lepraemurium in cell cultures* (in collaboration with Miss Y. M. Barr and Miss E. W. Garbutt). Further extension of the work, reported in 1958 and 1959, has amply confirmed that cultures of rat fibroblast cells, strain 14 pf, infected *in vitro* with freshly isolated *Myco. lepraemurium* support the multiplication of the intracellular bacilli. By repeatedly sub-culturing the infected cells it has sometimes been possible to maintain more continuous multiplication of *Myco. lepraemurium* for periods up to 150 days. Bacilli from the infected cultures reinoculated into mice produce progressive and typical disease indicating full viability and pathogenicity. Unfortunately more continuous multiplication has been obtained in only a few experiments. Possible limiting factors, including the infecting dose and the conditions for maintaining the cell cultures, are under investigation. Several other types of cell cultures are also being studied.

125. *Attempts to transmit Myco. leprae to experimental animals* (in collaboration with Miss Y. M. Barr and Miss E. W. Garbutt). These attempts have been vigorously pursued and extended. A colony of the strain of hybrid black mice has been established in which K. R. Chatterjee (Calcutta) has claimed to have transmitted human leprosy. It is of interest that this hybrid strain of mice has proved to be much more resistant to tuberculosis yet more susceptible to rat leprosy than an albino strain of mice. These

transmission studies are being closely integrated with those of Dr. M. F. R. Waters at Sungei Buloh, Malaya, who also supplies much of the fresh leprosy tissue.

#### Publications

REES, R. W. J., VALENTINE, R. C. and WONG, P. C.—(1960) "Application of quantitative electron microscopy to the study of *Mycobacterium lepraemurium* and *leprae*." *J. Gen. Microbiol.*, **22**, 443.

REES, R. J. W.—(1959) "Recent advances in leprosy research." *W. Afr. med. J.*, **8**, 325.

KINNEAR BROWN, J. A., and REES, R. J. W.—(1959) "A simple apparatus for the transport of leprosy tissue on ice." *E.A. med. J.*, **36**, 495.

126. Dr. E. M. Brieger and Miss J. M. Allen of the Strangeways Laboratory, Cambridge, report on the results obtained during their visit to several leprosaria in Uganda and to Oicha in the Belgian Congo during December, 1958–May, 1959. The ultimate aim was to reveal changes in structure and life functions which leprosy bacilli undergo in their parasitic existence in the host tissues, during which they maintain and propagate the disease. The observations recorded are based on fifteen cases of leprosy, especially biopsies, from a variety of clinical types, lepromatous and tuberculoid, treated and untreated. In addition, changes were induced in the bacilli by maintaining explants in vitro and subjecting them to a variety of inhibitory factors, including a number of drugs effective in the treatment of leprosy.

127. Further information was obtained on the structural organisation of leprosy bacilli in lepromatous lesions by making an electron-microscope study of thin sections through lepromata. By treating osmium-fixed tissues with uranyl acetate it was possible to avoid much of the distortion seen in previous similar studies. Many bacilli showed a well preserved over-all structure with closely-fitting cell walls and a well-defined cytoplasmic cortex; the cytoplasm was penetrated by membranous sheets in almost parallel arrangement, frequently following the cytoplasmic membrane at points of cell division. (Brieger, Glauert and Allen, 1959.) One or both of the polar regions frequently contained inclusions of a uniformly granular material, different in texture from the cytoplasm and bounded by a membrane. They seem to correspond in position to the more deeply stained polar region in parallel Ziehl-Neelsen preparations, and to the polar bodies first described by Bishop in electron-micrograms of unsectioned bacilli. They are not likely to be spores, as they differ in structure from the endospores of a bacillus or the spores of *Streptomyces*, but they correspond to similar bodies seen in thin sections of avian tubercle bacilli (Brieger and Glauert, 1956). They are thought to be inclusions of metabolic material.

It may be of some significance that so far it has not been possible to demonstrate in these bacilli a structure in the nuclear region which is now considered to be the recognised pattern of the structural organisation of the deoxyribonucleic acid in bacteria.

128. It is not yet possible to interpret structural anomalies in terms of viability. Parallel functional tests have been applied. Potassium tellurite, if added to the growth medium, is reduced to insoluble deposits of tellurium

which in electron-micrograms of growing bacteria appear as fine needles or granules. With this technique respiratory activity could be demonstrated in a strain of human tubercle bacilli and in non-pathogenic mycobacteria, but not as yet in parallel experiments in leprosy bacilli. If these results are confirmed by current experiments, the absence of dehydrogenase activity would be another indication of the different organisation of leprosy bacilli from that of other micro-organisms. The above findings accord with those of Dr. Naylor that it is difficult to demonstrate respiratory activity with any accuracy in experiments using tetrazolium salts.

129. A pilot experiment was made with Dr. Naylor on the uptake of labelled amino-acids in bacilli recovered from explants after various lengths of time in culture. Compared with the results obtained in vigorously growing cultures of *Myc. phlei*, the uptake was meagre. Control experiments with heat-killed leprosy bacilli gave negative results.

#### *Publication*

BRIEGER, E. M., GLAUERT, A. M., and ALLEN, J. M.—(1959) "Cytoplasmic structure in *Mycobacterium leprae*". *Exp. Cell Res.*, **18**, 418.

#### *Tuberculosis*

##### *East Africa*

130. *Therapeutic trials in pulmonary tuberculosis.* The basis of these trials, conducted by members of the staffs of a number of hospitals and laboratories in East Africa in collaboration with the Tuberculosis Research Unit of the Medical Research Council, has been described in previous reports. The trials of companion drugs for isoniazid as alternatives to PAS and streptomycin have continued, in order to find cheap, effective and easily administered regimens suitable for routine chemotherapy under sub-optimal conditions of supervision.

131. A report (1960) on the Isoniazid Trial described briefly in the 1957-1958 report has been published, and an analysis is being made of the 24-month follow-up examination. The results showed that in terms of chemotherapy for severe, extensive disease in Africans, isoniazid alone in low dosage (200 mg./day) is inadequate, and, if used alone, higher dosage is indicated, in which case it should be accompanied by a Vitamin B preparation. Isoniazid plus PAS was more effective than isoniazid alone.

132. *Trial of isoniazid in combination with thiacetazone, with substituted diphenylthiourea SU1906 (DPT), or with PAS (TB1/DPT Trial).* The reasons for this trial were reported briefly in the 1958-1959 report. Analysis of the results at the end of the twelve-month trial period has shown that the combination of isoniazid 200 mg./day plus thiacetazone 150 mg./day in two equal doses was as effective as the standard combination of isoniazid 200 mg./day plus PAS (sodium salt) 10 g./day in producing negative sputum cultures and in preventing the emergence of isoniazid resistance. An overall assessment of the results, taking into account bacteriological failures, clinical or radiographic deterioration or severe toxic reactions to the drugs, showed that the isoniazid/thiacetazone combination was almost as satisfactory as the isoniazid/PAS combination. There was some evidence of toxicity of the thiacetazone/isoniazid combination which is to be given further study by testing a reduced dosage (see below).

The diphenylthiourea SU1906 (2 g./day) was found to be ineffective as a companion drug for isoniazid and was not studied after the first six months.

133. *Thiacetazone-isoniazid trial in in-patients.* Because the thiacetazone/isoniazid combination in the TB1/DPT trial promised an effective, cheap and easily administered combination for routine chemotherapy, further trials have been initiated to find the optimal dosage of the two drugs, in terms of efficacy and decreased toxicity. The thiacetazone/isoniazid regimes are being given once daily in a single tablet, and are being compared with isoniazid plus PAS.

The combinations being studied are :

- (1) Isoniazid 200 mg./day plus thiacetazone 150 mg./day.
- (2) Isoniazid 300 mg./day plus thiacetazone 150 mg./day.
- (3) Isoniazid 300 mg./day plus thiacetazone 100 mg./day.
- (4) Isoniazid 200 mg./day plus PAS 10 g./day.

The chemotherapy will be administered in hospital for the first six months and as out-patient treatment for the second six months. A total of 300 patients, 75 in each regimen, are to be studied.

134. *Thiacetazone-isoniazid trial in out-patients.* Concurrently with the above trial, a comparison is being made in out-patients of the already tested combination of isoniazid 200 mg./day plus thiacetazone 150 mg./day in divided dosage, and isoniazid 200 mg./day plus PAS 10 g./day given in cachet form. This investigation will be made in 300 patients and will run concurrently with the in-patient trial. The study of out-patients should bring conditions nearer to those likely in routine chemotherapy under conditions generally prevailing in developing countries.

A number of additional centres in all three territories will be participating in the thiacetazone trials.

135. *Prevalence of drug resistance in East Africa.* A report (1960) has been published, showing that isoniazid-resistant strains have been found with increasing frequency in the sputum of patients submitted to the successive chemotherapy trials. No isoniazid resistance was found in 1953-55, but by 1957 the prevalence was 16.0 per cent. There was evidence that some of the patients had in fact had previous but inadequate treatment, not admitted at the time of submission. The increase in isoniazid resistance threatens to impair the usefulness of this key drug for routine chemotherapy, thereby increasing the difficulties considerably. Suggestions for ameliorating this increasingly serious situation have been offered.

136. A review of the series of comparative trials of antituberculous chemotherapy in East Africa has been prepared by Professor A. W. Williams.

#### *Publications*

EAST AFRICAN/BRITISH MEDICAL RESEARCH COUNCIL ISONIAZID INVESTIGATION—(1960). *Tubercle, Lond.* **41**, 83.

PEPYS, J., MITCHISON, D. A., and KINSLEY, B. J.—(1960) "The prevalence of bacterial resistance to isoniazid and to PAS in-patients with acute pulmonary tuberculosis presenting for treatment in East Africa." *Tubercle, Lond.*, **41**, 32.

*West Africa*

137. *Chemotherapy trials.* Dr. W. J. Bell, the Director of the West African Tuberculosis Research Unit, the headquarters of which are now at Accra, reports that these trials ended early in 1959. Analysis of the data from the various drug combinations, outlined in previous reports, indicates that definitive drug therapy in pulmonary tuberculosis in West Africa is unsatisfactory. Out-patient chemotherapy is particularly so, because many fail to take constantly their drugs in the combinations and dosages prescribed over the necessary period of time. That oral drugs have not always been taken in combination is revealed by urinary PAS excretion tests. Therefore a high relapse-rate and a high degree of bacterial resistance, especially to isoniazid, have resulted.

A short investigation to define the place of hospitalisation in the initial chemotherapy of pulmonary tuberculosis showed that, on the basis of clinical, radiological and bacteriological changes, it offered little, if any, advantage.

138. *Bacteriological and epidemiological research.* Preliminary observations suggested that much bacterial resistance was developing among patients treated with standard chemotherapy, and that a significant number of new cases showed resistance to one or other of the major anti-tuberculosis drugs. A nation-wide survey of treated and untreated new cases is being made to determine the level of resistance to a number of anti-tuberculosis drugs in use in Ghana. An attempt will be made to define its cause by correlating resistance with a number of social indices, the radiographic pattern of the disease at an individual level, and the form of chemotherapy that has been employed. Since the commonest combination of drugs used is one containing P.A.S. and isoniazid, and since the level of resistance to isoniazid appears to be high, it is suspected that much resistance is developing as a result of patients not taking the P.A.S. fraction combinations prescribed; and P.A.S. excretion tests are being done on all.

In an investigation of the manner and extent of spread of tuberculous disease in Ghana, mass miniature radiographic surveys of certain industrial areas known to have a high morbidity and to have a floating labour turn-over have been started. When morbidity and migration figures have been gathered, further radiographic surveys will be undertaken to determine the mechanics of spread of the disease.

*B.C.G. vaccination.* An investigation of methods of applying B.C.G. vaccination in Ghana has begun. The application of B.C.G. vaccine on a large scale is made difficult by shortage of skilled staff, and a national vaccination campaign will be possible only when simpler techniques than those used at present can be introduced. A number of multiple puncture instruments are under trial among primary schoolchildren in Accra. Conventional intradermal vaccination is being compared with multiple puncture vaccination using 20-needle instruments fitted with smooth and ground needles and 40-needle instruments similarly fitted. Some 5,000 vaccinations will be completed early in 1960, and conversion-rates will be estimated after 4 and 12 months.

*Publications*

BELL, W. J.—(1959) "The pattern of symptomatic pulmonary tuberculosis in Ashanti with particular reference to management." *W. Afr. med. J.*, 8, 258.

BROWN, P. P.—(1959) "A comparison of various methods used in the laboratory diagnosis and assessment of pulmonary tuberculosis." *Ibid.*, 8, 244.

*Research at the Medical Research Council Laboratories, The Gambia*

139. The Director, Dr. I. A. McGregor, has provided a summary of the activities of the Laboratories during the year. Excerpts from it pertaining to research on malaria and trachoma have been given in their appropriate context earlier in this Report at paragraphs 38–40 and 63–64 respectively. Other activities are given below.

140. *Anaemia in a rural Gambian village.* Following virtual elimination of malaria from a rural village for a period of twelve months by fortnightly administration of pyrimethamine (12.5 mg. for individuals under five years of age and 25 mg. for all others) all inhabitants were examined, and those with haemoglobin levels of 9.0 g. per cent. or less were investigated in detail. The characteristics of the anaemia and the incidence and degree of hookworm ova in the faeces were determined. Two groups were subsequently formed from the hookworm-infected subjects; one group received treatment with tetrachlorethylene at intervals in an effort to rid them of infection; the other was retained as an untreated control. Preliminary analysis of results indicates that on the commencement of the investigation the prevalent anaemia was microcytic and hypochromic in type. Tetrachlorethylene administration caused the complete disappearance of hookworm ova from the stools of approximately 50 per cent. of subjects and in the remainder reduced the density of ova by at least 80 per cent. After ten months of observation the mean haemoglobin value of the treated group was found to be slightly more than 1.0 g. per cent. higher than that of the untreated group.

Ultimately all anaemic subjects were placed in two groups and iron in therapeutic dosage was given to one group for at least two months, but withheld from the other. Preliminary results indicate that iron treatment caused substantial haemoglobin gains in treated adults as compared with untreated controls. Treated children, while improving with iron therapy, did not show haemoglobin gains as marked as did treated adults. The statistical analysis of the results continues.

141. *Bancroftian filariasis.* In 1959 the long-term results were assessed of an investigation to determine the efficiency of Hetrazan at a total dosage level of 12.5 mg. base/Kg. body-weight in the field control of Bancroftian filariasis. Two groups of infected subjects were formed in 1955; one (59 persons) was resident in a rural village in which mosquito control was practised by spraying with the residual insecticide Dieldrin; the other (36 persons) resided in an unsprayed village. Both groups were treated with Hetrazan 2.5 mg. base/Kg. body-weight daily for five successive days; a dosage which proved acceptable to the participants.

Forty-three months later a reduction in total microfilarial load of 91 per cent. was evident in the group resident in the unsprayed village, and 27 per cent. of members still harboured *Microfilaria Bancrofti* in the peripheral

blood. In the group resident in the sprayed village the comparable reduction in microfilarial density was 98 per cent., while the infection persisted in 11 per cent. of persons.

These results indicate the feasibility of field control of *W. bancrofti* infections in West Africa by mass treatment of populations at intervals of 3-4 years. They also confirm earlier observations that the best results of the drug are not evident until many months after treatment and may be due to a lethal or sterilising effect on the mature filaria worm. Further investigations using Hetrazan in reduced dosage are in progress.

142. *Malaria*. Statistical analysis of the importance of primary attacks of malaria in Gambian infants and young children has continued.

143. *Serology*. Despite the apparent absence of clinical diphtheria in the Gambia, antitoxin was found present in high titre in samples of serum from fifty adult Gambians. Sera obtained from African children show that a considerable proportion encounter diphtheritic infection in some way before the age of three years. Many of these children are known never to have presented the clinical symptoms and signs of respiratory diphtheria, and cutaneous infection is suspected.

Studies have begun, in collaboration with the staff of the National Institute for Medical Research, London, to determine accurately total serum gamma-globulin levels in Gambians and to assess the turn-over rate of this fraction. The investigation involves the use of two different protein-bound isotopes of iodine.

144. *Entomology*. Studies on the *Anopheles gambiae* complex have been reported earlier at paragraphs 34-36. In another study, between 20-30 species of *Culicoides* have been encountered, several new to science; in the majority the breeding-sites have been located and their relationship established to the soil vegetation zones recognised in the Gambia. Seasonal distribution has been investigated, and information gained on biting habits and population phenomena in the more abundant forms. Standard age-grading techniques have been found applicable to *Culicoides* through at least four gonotrophic cycles, and by use of these it has been shown that, while most species are anautogenous throughout life, two members of the *C. austeni* complex are autogenous in the first gonotrophic cycle.

*C. austeni* has been shown to comprise three biologically distinct species, which differ in habitat, presence or absence of an autogenous gonotrophic cycle and in mating behaviour. The two autogenous species are both salt-water forms occupying different habitats in the mangrove swamps, and both undergo regular fluctuations in population density which are associated with tides. As this is due to synchronised emergence, there is a marked change in population structure during each cycle, with young individuals predominating at peak densities and old individuals at low densities. Considerable differences have been found in the survival-rate of different age-groups. *C. schultzei* also showed strong evidence for the existence of two distinct forms breeding in salt and fresh water respectively, which, while identical in the adult, could be distinguished in the pupa.

145. *Phlebotominae*. Work on the distribution of *Phlebotomus* in relation to soil and vegetation in the West Kiang area of the Gambia has been undertaken in collaboration with Dr. D. J. Lewis, British Museum,

London. The analysis of adult distribution is nearing completion. Larval distribution, however, must await analysis of soil samples.

#### Publications

GILLIES, H. M. and MCGREGOR, I. A.—(1960) "Studies on the significance of high serum gamma globulin concentration in Gambian Africans. I. Gamma-globulin concentration in Gambian children in the first two years of life." *Ann. trop. Med. Parasit.*, **53**, 492.

HURLY, M. G. D.—(1959) "A method of estimating hookworm loads." *Ibid.*, **53**, 228.—(1959) "Administration of pyrimethamine with folic and folinic acids in human malaria." *Trans. R. Soc. trop. Med. Hyg.*, **53**, 410—(1959) "Potentiation of pyrimethamine by sulphadiazine in human malaria." *Ibid.*, **53**, 413.

LAURENCE, B. R.—(1959) "Oviposition by *Mansonioides* mosquitoes in the Gambia, West Africa." *Proc. R. ent. Soc. Lond. (A)*, pts. 10–12.

MURPHY, D. H. and GISIN, H.—(1959) "The preservation and microscopic preparation of *Anopheles* eggs in a lacto-glycerol medium." *Ibid.*, pts. 10–12.

146. *East African Institute for Medical Research, Mwanza, Tanganyika.* Dr. E. G. Holmes, the Director, has reported on the four main research projects in progress there, viz. *nutrition and biochemistry, nutritional ophthalmology, filariasis and schistosomiasis*. Summaries of the progress made in these, and relevant publications, have been included earlier in this Report in their appropriate context, *vide* paragraphs 82–83, 84–87, 17, and 21–26 respectively.

147. As these summaries and those in preceding Annual Reports indicate, the impetus of research at this Institute during recent years has steadily increased, most notably in the fields of schistosomiasis and nutrition. In the former, a compact research group, in liaison with another group at Makerere College, has been established; in the latter, an interesting digression has been the inception of field and laboratory studies of the role of malnutrition in the causation of ocular disease, which has attracted a three-year grant of \$87,000 from American sources. That diverse lines of research of very considerable scientific value and practical importance to the East African territories have been established owes much to the able guidance of the retiring Director, Dr. E. G. Holmes.

148. *Research on the biology of sandflies in East Africa.* Mr. D. M. Minter, based on the laboratory of Dr. R. B. Heisch in Nairobi, continued his studies designed to identify the vector of *kala-azar* in the Kitui area of Kenya. The inoculation into clean hamsters of suspensions of wild-caught sandflies and of the pooled spleens of small mammals collected in the area failed to yield any isolation of *Leishmania*. Thereby the hypothesis that there is an animal reservoir in Kenya appears weakened. It may be that the occasional isolation of *Leishmania* from ground squirrels and gerbils in the Kerio Valley is unrelated to the transmission cycle.

149. The detailed mapping and data-collecting begun eighteen months ago, covering the centre of the Kitui *kala-azar* area, has continued, protracted by many practical difficulties. The incomplete map, with the "family units" so far plotted, has already been of value in the selection of

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localities in which sandflies and mammals were collected for screening, such localities being chosen for the highest density of human cases recorded in the previous two years.

150. From several collections of sandflies from places outside the kala-azar areas, two new species of *Sergentomyia* are being described, one from the highland zone near Kitui township, the other from gallery forest on the south-western flanks of Mount Elgon. A single specimen of what seems to be a new *Phlebotomus* appeared in routine collections of several thousand specimens at Kauriro in the heart of the Kitui kala-azar area. It was probably brought into the area from well to the north by some vagary of the air circulation associated with the Mount Kenya massif, reminiscent of the single specimen of *P. orientalis* found in the same locality some years ago but not since.

151. The visit of Dr. D. J. Lewis was of great profit to the field and the laboratory work. A collaborative study was made of the anatomical changes associated with different physiological conditions in sandflies of several species. The result of the greatest practical importance emerging from this study is that parous and nulliparous females can now be speedily and reliably distinguished by an examination of the accessory glands. (This is applicable only to females before the start of a gonotrophic cycle however.) The method has been known for many years in the case of certain Palaeartic species, but its reliability was unknown, and its applicability to the Ethiopian species in Kenya was previously uncertain. Its use has shown that the percentage of parous females of a given species in local populations may vary widely over very short distances. One group of flies had only 3 per cent. of parous females; another group, from the same type of habitat approximately one mile distant were 50 per cent. parous. These findings indicate the need for a preliminary survey on a local scale before mass dissection or mass inoculation of sandflies is attempted. Such extreme local variation in the percentage of parous females may partly explain the failure so far of the mass inoculation technique in the search for the vector species, since "pockets" of flies with a high proportion of parous individuals are comparatively uncommon.

152. A fully portable battery-operated suction trap has been devised for use in the field, so constructed that a bait animal, or group of animals, can be housed in it as an attractant for biting insects. It retains the principle developed by Lumsden (1958), but differs considerably from it in its mechanism. Such a trap was required partly for work on *Culicoides* and related biting midges in a search for the insect vector of *Hepatozoon kochi* in monkeys and baboons. It seemed that it might likewise facilitate the study of the bionomics of sandflies in relation to various animal hosts. The three traps made are very effective for catching both midges and sandflies, alive if required, and are very reliable during lengthy usage in the field.

153. An interesting incidental observation was the finding of a spirochaete in the blood of a *Tatera nigricauda* collected in the course of this work; this is possibly a new species.

*Entomological research on Simuliidae and Phlebotominae*

154. Dr. D. J. Lewis, of the external staff of the Medical Research Council, has furnished the following report on oversea visits made by him,

aided by grants awarded on the recommendation of the Committee, and on the examination at the British Museum (Natural History) of material brought back by him.

155. *Distribution of Phlebotominae.* The examination of collections from the Gambia and Nigeria was completed, and specimens from Aden and British Guiana were examined as part of a general study of the family. A review of the classification of the *Sergentomyia africana* complex was prepared for publication.

156. *Internal structural changes in African Phlebotominae.* Dr. Lewis visited Nairobi, and Kauriro and Marigat in the kala-azar areas of Kenya, and collaborated with Mr. D. M. Minter in a study of internal age changes of the sandflies, with the principle object of establishing a practical means of recognising parous females and thus contributing to the search for the vector of kala-azar. The ovaries are so small that attention was concentrated on the relatively large accessory glands which are known to be useful for recognising parous individuals of certain European species. They proved valuable for this purpose in most cases, and it was found that, in searching for infected flies, more than 90 per cent. could sometimes be discarded as nulliparous, with considerable saving of time.

Dissection of bred *Phlebotomus papatasi*, provided by the United States Naval Medical Research Unit in Cairo, showed that they were producing eggs without having sucked blood, and drew attention to the need for ascertaining whether any other African species are autogenous and can thus complicate the process of picking out females which have sucked blood.

157. *The Simulium neavei complex.* The Director of Medical Services of Nyasaland provided facilities for studying *Simulium nyalandicum* and *S. woodi* in the Mlanje and Cholo areas, and it was found that the Kenya simuliids hitherto known by these names are new species. *S. woodi* proved to be extremely scarce, and it is believed that, since its discovery in 1917, the increase of tea-growing and consequent deforestation may have controlled this species as Buckley's bush-clearing scheme controlled *S. neavei* on the Riana and Yabe rivers in Kenya.

Identification of chironomids on crabs, and the finding of simuliid eggs on dragonfly larvae near Salisbury, Southern Rhodesia, added to the knowledge of the series of commensal associations of which the simuliid-crab relationship is a part.

158. *Simulium damnosum.* Dr. Lewis visited the Helminthiasis Research Unit at Kumba in the Southern Cameroons, and found that parous *S. damnosum* do not always have a distinct biting-cycle like that previously observed in Nigeria and Sierra Leone. The distribution of adult flies suggested that thick bush restricts their movements and lessens their contact with man. Further observations were made, in several territories, on localities where this species causes little or no trouble although conditions appear to be suitable for it. A striking example is the area of rapids above the Victoria Falls where pupae of *S. damnosum* occur.

#### Publications

LEWIS, D. J.—(1959) "Simulium flies—pest of man and beast." *Span*, 2, 31.—(1960) "The *Simulium neavei* Roubaud complex (Diptera: Simuliidae) at Amani in Tanganyika." *Proc. R. ent. Soc. Lond. (B)*, 29, 7.

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LEWIS, D. J., and GARNHAM, P. C. C.—(1960) "The Simuliidae (Diptera) of British Honduras." *Bull. ent. Res.*, 50, 703.

159. *Toxicity of bush-teas in Jamaica.* Professor G. Bras, of the Department of Pathology, University College of the West Indies, reports on the research project designed to define the role of toxic substances in medicinal plants habitually taken by Jamaicans in the causation of *veno-occlusive disease*. From information obtained from patients with this disease, substantiated by visits to their homes, bushes which appeared to be incriminated have been collected at differing times of the year. Watery extracts are made from the leaves, and are fractionated, some by the Department of Chemistry, others by Dr. Paul Gyorgy at the University of Pennsylvania, for experimental testing. In Jamaica they are being given to rats, sheep and monkeys, and in Philadelphia to rats fed on varied diets of low and high protein content or deficient in various vitamins or supplemented with extracts derived from *Entamoeba coli* (infection with which is suspected to be a factor in the causation of veno-occlusive disease).

Tissues from the experimental animals are being subjected to histochemical examination designed to demonstrate toxic lesions. Techniques using fluorescein-labelled antibodies have recently been applied.

160. *Epidemiological research in Jamaica.* A series of epidemiological studies was undertaken in Jamaica by Dr. W. E. Miall, of the Medical Research Council's Pneumoconiosis Research Unit, South Wales, in collaboration with Dr. K. L. Stuart and Dr. J. Ling of the University College of the West Indies, Dr. I. Rerrie of the Kingston Chest Clinic, and Dr. E. H. Kass of Harvard University. The primary objective—a comparative investigation of factors influencing arterial pressure in Jamaica with those in Wales—was undertaken in two representative communities. Urban and rural populations were defined by private census; stated ages were checked against birth certificates in 80 per cent. of cases by the Department of the Registrar-General, and over 95 per cent. co-operation with the survey teams was obtained from these defined populations. Jamaica was thus shown to be a country in which a population of African descent satisfied certain basic requirements necessary for this type of epidemiological study; the work is being continued by Dr. Stuart, Dr. J. A. Tulloch and Dr. E. H. Kass.

161. The data collected are in process of analysis, but preliminary results confirm that the prevalence of hypertension, as defined in terms of any of the generally accepted arbitrary criteria, is higher in Jamaica than that shown in exactly comparable surveys in Welsh populations. This difference was present in all age groups and both sexes, but was much more marked in females than males.

A comparison between the two Jamaican populations shows that hypertension is much commoner in the rural than the urban population; again the differences were much more pronounced in females. The differences in the prevalence of hypertension between urban and rural females in Jamaica are indeed greater than those between urban Jamaican and Welsh females, though the populations are racially similar and living within twenty miles of each other. These findings suggest an important environmental influence of arterial pressure operating in Jamaica and particularly affecting females.

162. Pyelonephritis is the renal disease with the largest preponderance amongst females. An attempt has been made to determine the prevalence of bacteriuria in Jamaican women, and to determine its relationship with hypertension. The preliminary findings suggest that this condition is commoner in the rural population. It is hoped that the further analysis of the material will reveal other personal and environmental differences which may give clues to the aetiology of hypertension amongst Negro populations.

163. These surveys of arterial pressure and bacteriuria were followed by chest X-ray and tuberculin sensitivity surveys in a rural population of about 10,000 subjects. Over 90 per cent. of the adult population were X-rayed, and 74 per cent. of the children aged 5-14 were tuberculin-tested. The prevalence of active tuberculosis was low, but that of cardiovascular and heart disease, as determined radiologically, was found to be remarkably high. The abnormality seen most commonly was a gross dilatation and unfolding of the thoracic aorta, with or without left ventricular enlargement. This finding in Jamaica simulates that reported recently to the Caribbean Medical Research Society from a chest X-ray survey in Barbados. All subjects under the age of 65 with this condition are being compared with age and sex balanced controls drawn at random from the same population in a study at present being carried out by Dr. Stuart and Dr. Tulloch. Each subject is being investigated clinically and serologically, and it is hoped that the possible roles of hypertension, syphilis and yaws in the pathogenesis of the condition will be determined.

*Field trial of anti-typhoid vaccines in British Guiana*

164. During the year an important large-scale trial of two anti-typhoid vaccines has been launched in British Guiana. As significant results will not emerge until the end of 1961, only its inception can be noted here, and that in the barest outline. In that country the incidence of typhoid fever is very high, and the Medical Department has pressed for extensive vaccination. The Standing Advisory Committee for Medical Research in the British Caribbean and the Colonial Medical Research Committee have responded readily. With the collaboration of the World Health Organisation, the Walter Reed Army Institute of Research, Washington, the Central Public Health Laboratory at Colindale and Messrs. Glaxo, comprehensive planning was undertaken in the light of experience gained in the similar trial initiated in Yugoslavia in 1954. Funds were provided largely from C.D. & W. research funds, supplemented by contributions in funds and in kind from the other collaborators. Two scientists well-fitted for the field and laboratory aspects entailed, Dr. M. T. Ashcroft and Dr. J. Morrison Ritchie respectively, were secured. The Government of British Guiana has given whole-hearted co-operation.

165. Two anti-typhoid vaccines are being used, one acetone-dried, the other carbolised, and tetanus toxoid as a control. Seven teams, each of 6 persons, are in the field. Some 68,000 school children aged 5-14 years, in whom the incidence of infection is highest and to whom the trial is limited, have been vaccinated twice, at a 30-40 day interval, and some 1,500 paired sera have been collected. The results are awaited with the utmost interest.

*Dermal leishmaniasis in British Honduras*

166. In the Annual Report for 1957-58 the problem of this disease in British Honduras was described at some length, following a pilot survey

made by Professor P. C. C. Garnham and Dr. D. J. Lewis. The upshot has been that a long-term research project has been launched. Funds from the C.D. & W. research allocation have been provided, and a parasitologist, Dr. R. Lainson, and an entomologist (Dr. J. Strangways-Dixon), are now in the field. Housing, transport and laboratory accommodation have been secured at the Central Farm, El Cayo, with the ready help of the Medical and Agricultural Departments. As a preliminary, the two scientists visited the Gorgas Laboratory, Panama, for a brief period, where every facility was afforded them to become familiar with the appropriate field and laboratory techniques there in use. The project will be an arduous one, beset by difficulties of terrain and climate; but information on vector and possible reservoir, much-needed for planned control measures, should ensue.

*Miscellaneous projects aided by relatively small research grants*

167. During the year, additional to the considerable funds allocated to the larger research projects summarised earlier in this Report, many smaller grants were given, or renewed, for a miscellaneous range of problems to make possible the study of some facet that might otherwise be neglected. The problems included aspects of cancer and liver disease in East Africa, the sickle-cell trait and sickle-cell anaemia, leprosy, schistosomiasis, virology, nutrition and physiology, onchocerciasis, malaria and the related development of resistance in vector mosquitoes, attempted vaccination against kala-azar, the toxæmias of pregnancy in Hong Kong and anaemia in the Seychelles. The recipients were various workers engaged on research with a tropical application at hospital medical schools in London, Birmingham and Liverpool, at University Colleges in Colonial territories, or in research units in those territories. Progress reports on all such work are reviewed from time to time by the Committee.

One such grant was again given to Professor J. N. P. Davies, of the Faculty of Pathology at Makerere College, Uganda, to provide a qualified assistant for the analysis and distribution within East Africa and overseas, of the abundant necropsy and surgical material available in his department. Amongst interesting conditions represented in this material are histoplasmosis, abdominal actinomycosis, trypanosomiasis, multi-central sarcoma of the jaw, lymphomas, Kaposi sarcoma, liver cancer and endomyocardial fibrosis.

Another such grant was contributed to facilitate an investigation by an expert haematologist, Dr. Henry Foy, of the Wellcome Trust Research Laboratories, Nairobi, into the considerable problem of anaemia in the Seychelles. A very comprehensive study has been made on the incidence, degree and nature of anaemia, and of the comparative role of nutrition, intercurrent infections and infestations, and personal hygiene as contributory factors.

#### **RESEARCH WORK UNDERTAKEN AND FINANCED BY THE MEDICAL DEPARTMENTS OF COLONIAL TERRITORIES**

168. Summaries of the objectives and progress of such current research in Colonial Territories, including that of Colonial Universities and Colleges, have been provided by various Governments. It is not possible to include them in full in a necessarily restricted report of this nature. Some of these investigations are being undertaken in collaboration with the staff of research projects financially sponsored, at least in part, by the Committee, and have been recorded in the foregoing pages. Among them are the work

of Mr. G. Webbe, of the Tanganyika Malaria Field Unit, on schistosomiasis at Mwanza, and the investigations in Kenya, Uganda and Tanganyika of the specialist tuberculosis officers of those Governments which have contributed much to the chemotherapeutic trials there proceeding.

169. In Jamaica the serious *sandfly nuisance* near Montego Bay made research imperative, and the Government was fortunate to secure the secondment of Dr. D. S. Kettle from the Department of Zoology at the University of Edinburgh to undertake it. He has summarised his findings to date, as follows. Two primary objectives were pursued, viz. how many species of sandflies are there in Jamaica, and how many are important as sources of nuisance? Initially, 7 species had been recorded; 4 have now been added. It is already clear that at least three species are involved and possibly a fourth. These are three species of *Culicoides*—*furens*, *barbosai* and *insignis*, and one of *Leptoconops*—*L. bequaerti*; *C. insignis* is important elsewhere in the neotropical region but so far has only once been found sufficiently abundant to constitute a nuisance.

170. The sandfly problem is essentially quantitative. One or two sandflies are interesting but unimportant; one or two hundred are a nuisance and intolerable. Therefore a quantitative technique for the estimation of populations must be adopted. Various methods and modifications have been tried for their comparative utility. After considering the advantages and disadvantages of both "light" and "sticky" traps it was decided to concentrate on standardising biting rates. These are affected by many factors, viz. individual "bait", limb offered, position on site, time of day, and meteorological conditions.

171. All three species which bite man abundantly in Jamaica, viz. *C. furens*, *C. barbosai* and *L. bequaerti*, agreed in which two of the five "baits" they disliked, but showed different specific preferences. This was complicated by *C. barbosai* and *C. furens* selecting paler skins as the light faded at sunset. Most of the time *C. barbosai* bit arms and legs impartially, while *C. furens* and *L. bequaerti* were always more abundant on the legs. With *L. bequaerti* this was very marked, the leg catch being four times that on the arm. *C. barbosai* alone showed a definite preference among the four positions on the site. At one position it was nearly twice as numerous as elsewhere. The meteorological data await full analysis. With *C. furens*, wind proved to be the dominant factor, with a limiting value for sandfly activity at 4 m.p.h. Below this speed the biting rate increased fourfold for each m.p.h. decrease. Correction factors calculated from one series of trials were found to be valid for another series; so it may be possible to reduce all biting rates to a common standard.

172. Using this quantitative technique, the island will be surveyed and the amount of seasonal variation determined. A biological study of the three pest species has begun, especially of their breeding potential and the limits within which they survive. Two major ecological problems await attack, viz. where they breed and how the larvae are distributed within the site, and how far the adults disperse from the breeding sites and whether by a gradual outward movement or by deliberate migration.

173. From the Division of Insect-borne Diseases of the Kenya Medical Department, Nairobi, Dr. R. B. Heisch, and his co-workers, report that in a settlement of 1,200 Africans living in the Shimba Hills in an area where *malaria* is holoendemic, the parasite-rate in children was reduced from 70 to

8 per cent. by a single mass dose of Darachlor; since then transmission has been almost completely controlled by this means. The sporozoite-rate of the anopheline vectors (*A. gambiae* and *A. funestus*), which was high (10 per cent.), has fallen much more slowly than the parasite-rate and, after three months, is still 2 per cent. Probably insufficient attention has been paid to drugs in the control of communal malaria in Africa.

174. Dr. Heisch has isolated the rickettsia of "Q" fever (*R. burneti*) from a striped mouse (*Lemniscomys* sp.) caught in his garden, and complement-fixing antibodies for this disease were found in a leopard, 2 mongooses (*Myonax* sp.), *Arvicanthis* sp., *Aethomys kaiseri*, and a porcupine. There is also evidence that *Rhipicephalus simus* is a vector. *Rickettsia conori*, the causal agent of tick typhus, has now been isolated from six species of rodent (*Lemniscomys*, *Arvicanthis*, *Otomys*, *Rhabdomys*, *Aethomys* and *Lophuromys* sp.) in Kenya, which indicates a vast rodent reservoir of the infection. Considerable progress has been made in working out the epidemiology of tick typhus and "Q" fever in Kenya, and soon sera from Nairobi *rattus* will be tested for *R. mooseri*. Dr. James Gear has given invaluable help on the serological aspects of this work.

175. An intensive search (in collaboration with Professor P. C. C. Garnham) is being made for the vector of *Hepatocystis kochi*, a common parasite of monkeys in East Africa. The suspected vector is *Culicoides*, and two species found in association with monkeys were fed on infected animals but there was no subsequent oocyst development. The vector is still unknown.

176. Other investigations have included a trial of the molluscicide, Bayer 73, studies on the vectors of *Wuchereria bancrofti* on the Kenya coast which indicate that *Culex fatigans*, *A. gambiae* and *A. funestus* are the sole vectors, and the isolation of *Pasteurella pestis* from *Otomys angoniensis* and *Dinopsyllus lypusus* from a new focus of rodent plague near Nyeri.

177. From the Malaria Unit of Northern Nigeria Dr. H. M. Archibald reports that the results to date of the Western Sokoto Scheme indicate that it should be regarded as a project for malaria control rather than for eradication. The parasite-rate in the area of 6,000 square miles is still about 50 per cent.; however, the rate in the Fulani trekking southwards through the area with their cattle has been greatly reduced, and the people in the area are very appreciative of the degree of mitigation that has been achieved.

The role of routine chemotherapy to supplement the original restriction to insecticide spraying has been studied. Three newer preparations, "Lapudrine", chloroquine tannate and coated chloroquine diphosphate were tested alongside Daraprim and commercial chloroquine diphosphate. It was found that "Lapudrine" showed much the same activity as Daraprim, but that neither of the two chloroquine preparations effected quite the degree of clearance of the trophozoites of *Plasmodium falciparum* as did the commercial chloroquine diphosphate.

178. Other investigations reported by the Ministry of Health, Northern Nigeria, have included the use of various larvicides in the control of mosquito-breeding in borrow-pits, the control of the vector of onchocerciasis, *Simulium damnosum*, in river water by D.D.T., a comparison of the efficacy of Triostam and Stibophen in the treatment of schistosomiasis, and the assessment of the role of "Etisul" in the out-patient treatment of leprosy.

Colonial  
Pesticides Research Committee  
Thirteenth Annual Report  
(1959-1960)

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London School of Hygiene and Tropical Medicine,  
Incorporating the Ross Institute  
(University of London),  
Keppel Street (Gower Street),  
London, W.C.1.  
28th September, 1960.

SIR,

I have the honour, on behalf of the Colonial Pesticides Research Committee, to transmit to you the Thirteenth Annual Report of the Committee, covering the period 1st April, 1959 to 31st March, 1960.

I have the honour to be,

Sir,

Your most obedient servant,

(P. C. C. GARNHAM),

*Chairman.*

The Rt. Hon. Iain Macleod, M.P.,  
Secretary of State for the Colonies.



## COLONIAL PESTICIDES RESEARCH COMMITTEE

**Membership**

- DR. W. J. HALL, C.M.G., M.C., D.Sc., Director, Commonwealth Institute of Entomology (*Chairman* until 31st October, 1959).
- PROFESSOR P. C. C. GARNHAM, M.D., D.Sc., D.P.H., London School of Hygiene and Tropical Medicine. (*Chairman* from 1st November, 1959.)
- PROFESSOR G. E. BLACKMAN, M.A., Department of Agriculture, University of Oxford.
- MAJOR-GENERAL P. J. L. CAPON, C.B., Q.H.P., M.R.C.S., L.R.C.P., D.P.H., Director of Army Health, War Office.
- MR. G. V. B. HERFORD, C.B.E., M.Sc., Director, Pest Infestation Laboratory, Agricultural Research Council.
- MR. A. S. G. HILL, B.Sc., F.Inst.P., Chemical Defence Experimental Establishment, War Office.
- DR. J. C. F. HOPKINS, D.Sc., A.I.C.T.A., Director, Commonwealth Mycological Institute.
- PROFESSOR H. G. H. KEARNS, O.B.E., B.Sc., Ph.D., Department of Agriculture and Horticulture, University of Bristol.
- DR. R. LEWTHWAITE, C.M.G., O.B.E., D.M., F.R.C.P., Secretary, Colonial Medical Research Committee.
- DR. A. B. P. PAGE, Ph.D., Imperial College of Science and Technology.
- MR. E. O. PEARSON, M.A., Commonwealth Institute of Entomology. (Director from 1st November, 1959.)
- DR. C. POTTER, D.Sc., D.I.C., Head of Insecticides Department, Rothamsted Experimental Station.
- MR. D. RHIND, O.B.E., F.L.S., Secretary, Committee for Colonial Agricultural Animal Health and Forestry Research.
- PROFESSOR R. L. WAIN, D.Sc., Ph.D., F.R.I.C., F.R.S., Wye College, Ashford, Kent.
- PROFESSOR V. B. WIGGLESWORTH, C.B.E., M.A., M.D., B.Ch., F.R.S., Department of Zoology, University of Cambridge.
- THE SECRETARY, Tsetse Fly and Trypanosomiasis Committee.

**Ex-Officio Members**

- The Secretary of State's Medical, Agricultural, Animal Health and Forestry Advisers.
- MR. G. W. THOM, O.B.E. (*Secretary*).
- MR. K. WILSON-JONES, M.Sc. (*Scientific Secretary*) (Until September, 1959).
- DR. H. S. HOPF, Ph.D., A.R.C.S., D.I.C. (*Scientific Secretary*) (From December 1959).
- Officer-in-Charge Colonial Pesticides Research—DR. R. A. E. GALLEY, Ph.D., D.I.C., F.R.I.C.

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 pesticides which may be referred to the Committee by him ;
- (ii) to examine and advise upon research and experimental projects relating to pesticides which may be referred to it ;
- (iii) to initiate research in pesticides 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 pesticides 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 three Sub-Committees whose membership is as follows:—

#### SUB-COMMITTEE ON INSECT VECTORS OF DISEASE

PROFESSOR P. C. C. GARNHAM, M.D., D.Sc., D.P.H., Director of Department of Parasitology, London School of Hygiene and Tropical Medicine (*Chairman*).

...

DR. J. R. BUSVINE, D.Sc., London School of Hygiene and Tropical Medicine.

MAJOR-GENERAL SIR GORDON COVELL, C.I.E., M.D., D.P.H., D.T.M. & H., Ministry of Health Malaria Research Laboratory, Horton Hospital, Epsom.

DR. W. J. HALL, C.M.G., M.C., D.Sc., Director, Commonwealth Institute of Entomology. (Until 31st October, 1959.)

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

DR. R. LEWTHWAITE, C.M.G., O.B.E., D.M., F.R.C.P., Secretary, Colonial Medical Research Committee.

PROFESSOR G. MACDONALD, C.M.G., M.D., D.P.H., D.T.M., Director, Ross Institute of Tropical Hygiene.

MR. E. O. PEARSON, M.A., Director, Commonwealth Institute of Entomology (From 1st November, 1959).

DR. A. M. WILSON RAE, C.M.G., M.D., Ch.B., Chief Medical Officer, Colonial Office.

MR. R. MOWFORTH (*Secretary*).

#### SUB-COMMITTEE ON METHODS OF APPLICATION

PROFESSOR H. G. H. KEARNS, O.B.E., B.Sc., Ph.D., Department of Agriculture and Horticulture, University of Bristol (*Chairman*).

MR. J. D. FRYER, M.A., Department of Agriculture, University of Oxford.

MR. S. H. O. FRYER, A.M.I.Mech.E., Chemical Defence Experimental Establishment, War Office.

- DR. A. B. HADAWAY, D.I.C., Ph.D., Colonial Pesticides Research Unit, Porton.
- MR. A. E. H. HIGGINS, A.R.C.S., D.I.C., Imperial College of Science and Technology Field Station, Silwood Park.
- MR. R. F. HILL, A.F.R.Ae.S., Colonial Pesticides Research Unit, Porton.
- MR. A. C. PEACOCK, B.A., A.R.I.C., Chemical Defence Experimental Establishment, War Office.
- MR. G. W. THOM, O.B.E., Secretary, Colonial Pesticides Research Committee.
- MR. K. WILSON-JONES, M.Sc., Scientific Secretary, Colonial Pesticides Research Committee. (Until September, 1959.)
- DR. H. S. HOPF, Ph.D., A.R.C.S., D.I.C., Scientific Secretary, Colonial Pesticides Research Committee. (From December, 1959.)
- MR. R. MOWFORTH (*Secretary*).

#### CROP PROTECTION SUB-COMMITTEE

- DR. W. J. HALL, C.M.G., M.C., D.Sc., Director, Commonwealth Institute of Entomology (*Chairman*) (Until 31st October, 1959).
- DR. R. A. E. GALLEY, Ph.D., D.I.C., F.R.I.C., Officer-in-Charge, Colonial Pesticides Research.
- MR. G. V. B. HERFORD, C.B.E., M.Sc., Pest Infestation Laboratory, Agricultural Research Council.
- DR. J. C. F. HOPKINS, D.Sc., A.I.C.T.A., Director, Commonwealth Mycological Institute.
- SIR GEOFFREY NYE, K.C.M.G., O.B.E., Agricultural Adviser, Colonial Office.
- MR. E. O. PEARSON, M.A., Director, Commonwealth Institute of Entomology (From 1st November, 1959).
- MR. D. RHIND, O.B.E., F.L.S., Secretary, Committee for Colonial Agricultural, Animal Health and Forestry Research.
- MR. G. W. THOM, O.B.E. (*Secretary*).

COLONIAL PESTICIDES RESEARCH COMMITTEE  
THIRTEENTH ANNUAL REPORT

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## COLONIAL PESTICIDES RESEARCH COMMITTEE

### THIRTEENTH ANNUAL REPORT

#### PART I.—GENERAL

1. The Committee was convened four times during the year and there was one Meeting each of the Sub-Committee on Insect Vectors of Disease and of the Crop Protection Sub-Committee. Other Sub-Committees on Methods of Application and on Colonial Spraying Equipment did not meet during the period under review.

2. Dr. W. J. Hall retired from the chair in October, 1959, after some 9 years service and was succeeded by Professor P. C. C. Garnham, M.D.(Lond.), D.Sc., D.P.H. The former Scientific Secretary, Mr. K. Wilson-Jones, M.Sc. left to take up an appointment with C.S.I.R.O., Australia, as Director of the Rice Research Station, near Darwin, N.T. His position has since been filled by H. S. Hopf, Ph.D., A.R.C.S., D.I.C., formerly of I.C.I. Ltd. and F.A.O., whose main research in the past has been concerned with studies of the mode-of-action of insecticides.

3. *General.* The year under review has been a general consolidation of interests along a broad front.

#### 4. *Staff.*

*Headquarters :* Dr. R. A. E. Galley visited East and West Africa between 24th October and 24th November. The opportunity was taken to visit several University Colleges and Research Organisations undertaking work on local natural products. During his tour Dr. Galley attended a W.H.O. Symposium on Pesticides at Brazzaville (9–13th November).

5. A small research unit has been set up at Headquarters, under the direction of the Scientific Secretary. R. L. Muller, Ph.D. has been appointed to this unit, which will, for the time being, be chiefly concerned with the work of interest to the World Health Organization in the control of vectors of Bilharziasis.

6. *Home :* Mr. R. F. Hill officiated as a session organizer at the International Agricultural Aviation Conference held at the College of Aeronautics, Cranfield, on 14th–18th September, 1959, and read a paper on "Distribution Equipment". Dr. A. B. Hadaway also attended the conference and presented a paper on "The problem of distribution; the physics of falling droplets and particles. The drift hazard", prepared by Mr. D. Yeo of C.P.R.U. Arusha.

7. Dr. A. B. Hadaway attended the first meeting of the Scientific Group on Research on the Evaluation and Testing of Insecticides held at the headquarters of the World Health Organization in Geneva from 30th November to 4th December, 1959.

8. Collaboration with other research organizations has continued, and visitors to the Unit have been numerous. Those from overseas include Mr. I. J. Lewis and Mr. R. Wallace, Tsetse Control Officers, Bechuanaland, for demonstration of aerial spraying and assessment techniques. Dr. J. Press and Mr. R. Regamy of the World Health Organization worked for a month in the chemical laboratory on methods of analysis of some organo-phosphorus insecticides.

9. *Overseas*: Mr. K. S. Hocking attended a meeting of the Colonial Pesticides Committee and of the Sub-committee on Insect Vectors of Disease in London, in June; a meeting of the World Health Organization Scientific Group on Research on Insect Resistance and Vector Control in Geneva from the 30th November to 5th December; the East African Agriculture Research Co-ordinating Committee in Kampala in December; the East African Medical Research Co-ordinating Committee and the East African Trypanosomiasis Research Advisory Committee in Dar es Salaam in January, and the East African Specialist Entomological and Insecticides Committee at Kikambala, also in January; also with Messrs. Yeo, Parr and Armstrong a World Health Organization Symposium on Pesticides at Brazzaville, and with Messrs. Yeo, McKinlay and Hyde-Wyatt the meeting of the Interterritorial Committee on coconut pests research in Zanzibar in May. He spent from 11th June to 12th July as a consultant to the World Health Organization Insecticide Testing Team at Skala in Greece.

10. Mr. S. D. Hocombe attended a conference on the use of Dalapon in Nairobi in February and a meeting of the Specialist Committee on Agricultural Botany in Arusha in March.

11. Mr. P. O. Park visited research stations in England, Holland and Switzerland during his vacation leave.

12. Dr. R. Foster attended a meeting of the Bilharzia Co-ordinating Committee in Mwanza in April.

13. Dr. G. W. Ivens returned to the Unit for a month from late November after the arrival of Mr. Hocombe and accompanied him on visits to research centres in the vicinity of Arusha and on two long safaris, one to eastern and central Tanganyika, and one to Nairobi and the highland areas of Kenya. These visits gave the new botanist a valuable introduction to the agriculture, flora and weed problems of East Africa and an opportunity to meet other workers in the herbicide field.

## PART II.—REVIEW OF RESEARCH WORK

### Colonial Pesticides Research Unit, Porton

(Dr. A. B. Hadaway in charge)

14. *Screening of Insecticides*. The toxicity of various insecticides to houseflies and mosquitoes has been compared in topical application and in residues on different building materials. "Baytex" and malathion proved very effective in respect of a long term residual activity on plywood and other non-porous surfaces, deposited initially at 100 mg/sq. ft. Unfortunately none of the compounds tested maintained a residual contact toxicity to mosquitoes on porous surfaces.

15. *Residual Properties of Insecticides*. A study has been made of the relative loss of activity of insecticide deposits through evaporation or decomposition on various surfaces. On non-porous surfaces the loss is mainly due to evaporation; on porous surfaces loss is chiefly attributed to sorption of the insecticide and its subsequent decomposition. During the course of this work it has been found that wettable powders formulated from liquid insecticides may dissociate to varying extents into their component parts when mixed with water, the insecticide portion tending to

form an emulsion which, on spraying, is readily absorbed by a porous substrate.

16. Experiments with dispersions of pure, solid insecticides of the chlorinated hydrocarbon and organo-phosphorus type, in wetting agent solutions, have shown that there is a marked variation in their rate of sorption even on highly active soils. Decomposition rates of the compounds after sorption are generally greatest on the red lateritic earths. Work is in progress on formulations of liquid insecticide with a view to increasing dosage retention at porous surfaces thereby enhancing the biological activity and persistence.

17. *Pick-up of Deposits.* The physical properties of solid insecticides are being examined in relation to their pick-up and penetration through insect cuticle. Measurements to date indicate that dosages of "Resitox" and "Sevin" picked-up from deposits by mosquitoes are significantly less than those of DDT under comparable conditions. The amount of a dry lipophobic dye, croceine scarlet, picked up by walking larvae of *Busseola fusca*, the African maize stalk borer, has been determined.

18. *Dispersion of Molluscicides.* Preliminary trials with glass frits containing copper have shown that adequate amounts of copper ions for snail control can dissolve into water from such a formulation. One difficulty is that the rate of solution depends upon the pH and carbon dioxide content of the water and is therefore likely to vary from one natural water to another. Much more work is clearly necessary before this method of application can be evaluated.

19. *Application of Pesticides from Aircraft.* Investigation of the performance of the Dragonfly helicopter and S.A.6 boom and nozzle spray equipment in terms of dosage distribution, volume recovery, swathe width and underleaf cover, for a droplet spectrum representative of that used in normal crop spraying, is in progress. The object of the investigation is to determine how and under what conditions the performance of the helicopter as a spraying machine differs from that of a fixed wing aircraft.

20. *Other Investigations.* In view of the varying susceptibilities of different mosquito species to organo-phosphorus compounds it is intended to investigate the properties of the esterases in these insects and their response to poisoning by insecticides. A start has been made with work on the type and distribution of the enzymes in two species as shown by histochemical methods.

21. In a general study of the effect of insecticides on lepidopterous larvae, the change in weight with time of different instars of *Pieris brassicae* has been examined from egg to adult. Work on the response of larvae of different weights and instars to topical applications of endrin is in progress.

22. It has been shown that spraying the stems of young maize is important for field control of the maize stalk-borer, but that a deposit of insecticide in the central whorl has the most effect. The results of a survey made in Kenya in 1957 have been analysed and given in a report "A Survey of the Use of Maize Stalk-Borer Control Methods in East Africa." The distribution of infested plants in a field in Western Tanganyika has been re-examined and a report issued on the statistical distribution found.



23. Use had been made of the one foot square section wind tunnel to obtain further data regarding the deposition of small diameter droplets on obstacles and collecting surfaces.

24. Comparative measurements of the sensitivity of possible tracers for field and laboratory use have commenced.

#### **Agricultural Research Council, Unit of Experimental Agronomy, Oxford**

25. *Field Experiments.* The effectiveness of various herbicides against bracken (*Pteridium aquilinum*), wild oats (*Avena* spp.), and *Agropyron repens* is being investigated. Other work is on weed control in kale, field beans and maize; the control of aquatic weeds; the response of cereals and of cultivated and native grasses to herbicides; and the persistence of herbicides in the soil.

26. *Pot Experiments.* The two major projects during the year have been: an evaluation of the potentialities of 4-chloro-2-butynyl-N (3-chlorophenyl) carbamate for the control of *Avena fatua* and of factors affecting its selectivity; and the determination of the persistence of dalapon, simazine, propazine and methoxypropazine in two soil types under field conditions. Other investigations have been concerned with the evaluation of the selectivity of a number of potential new herbicides, the estimation of the effects of mixtures of herbicides, the biological effects of additives to reduce spray drift and the chemical destruction of potato haulm.

27. *Physiological Studies.* Research has continued on the movement of 2,4-D, applied externally to leaves of *Phaseolus vulgaris*. Attention is now being directed to the factors concerned with its penetration. Work continues on the physiology of ageing in leaf tissue with special reference to the control of leaf senescence by auxins.

28. *Chemical Investigations.* The chemistry section has continued to make analyses of plant materials in connection with the New Crops programme and has organised the assay of C<sup>14</sup> and Cl<sup>36</sup>. A variety of organic materials with herbicidal and plant growth regulatory activity has been prepared on a small scale for use by other members of the Unit and for use overseas. These compounds include radioactively labelled materials which are not available commercially.

#### **Imperial College Field Station—Silwood Park**

29. *Mode of Action of Insecticides.* A radio-active tracer technique is being used to compare the uptake of oil from residual deposits by a range of insect species. The object of this series of experiments is to assess the influence of size, structure and habit of these insects on the rate of their contamination by such an oil film. It has been demonstrated, for example, that soft-bodied, fleshy, cylindrical-shaped larvae of *Carpophilus* more rapidly acquire and retain a heavier external oil film than more chitinised *Tribolium* adults of the same weight, although both species crawl about almost continuously under experimental conditions.

30. *Cholinesterase Studies.* The effect of dieldrin on insect cholinesterases has been continued. Under experimental conditions it has now been shown that true acetylcholinesterase only is inhibited by dieldrin in both dieldrin susceptible and resistant strains of the housefly. An attempt is being made to elucidate the route whereby acetylcoenzyme A, necessary for

the formation of acetylcholine, is synthesised in insects, and the effect of dieldrin on this synthesis and on that of choline acetylase.

31. *Olfaction in Insects.* In contrast with the normal fatty acids previously examined, ethyl and ammonium derivatives have not been found attractive to *Stomoxys calcitrans*. In another experiment the saturated vapour of a mixture of the fatty acids as found in human sebum was shown to be less attractive than palmitic acid, which is one of the more attractive compounds and is also present in the greatest concentration in human sebum.

32. Preliminary work has been undertaken on formulations which reduce the evaporation rates of fatty acid constituents. A flame ionisation detector of high sensitivity has been constructed to facilitate these experiments.

33. An electrophysiological technique is being developed to enable the electrical activity of sensory nerves in the antennae to be detected.

#### Long Ashton Research Station, Bristol

34. With the support of a Colonial Development and Welfare Grant, work was continued during the year on spray application problems and other specialist studies relating to tropical crops.

35. *Spraying Techniques.* Work on the use of fluorescent tracers in spray liquids has demonstrated that they provide a reliable and rapid method of assessment of droplet impaction. The method is particularly useful in cases when chemical assay is slow or unreliable. A study of the spraying of cigar-wrapping tobacco in North Borneo was undertaken by Mr. H. R. Mapother, who visited the territory in February and March, 1960. The crop bears very dense foliage and it was found that low volume applications with a mist-blower gave the best results. Samples were sent to Long Ashton during the trial for determination of the level of spray deposit.

36. *Sampling Techniques and determination of spray residues.* Further experience was gained on methods of sampling tropical crops for spray residue and conveying the samples satisfactorily to Long Ashton for assay. A leaf sampling tool has proved valuable for easy and accurate sampling. Assays have been carried out on DDT residues on coconut spadices in connection with experiments in Kenya on the control of the Nutfall Bug (*Pseudotheraptus*), on dieldrin on coffee bark, treated for the control of Stem Borer from Lyamungu in Tanganyika and on mercury on limes from Zanzibar, where trials are in progress in collaboration with Dr. Wheeler on the control of Wither Tip (*Gloeosporium limeticola*) by an organic mercury fungicide.

#### 37. *Spray Physics and Machinery.*

- (a) *Flying spot particle resolver.* Techniques for the satisfactory operation of this apparatus (the installation of which was recorded in the 1958-59 report) by a junior operator have been evolved.
- (b) *Mist-blower sprayer.* Investigations were continued on methods of atomisation of fluids suitable for use with large mist-blower sprayers.
- (c) *Light-weight 2-pint pneumatic sprayer.* In response to a request from Kenya for a light-weight sprayer for use on the spadices of coconuts, a commercial sprayer was modified for safe use by local labour. The brass canister was pressurised up to 40 lbs. p.s.i. by means of a foot-pump and a safety valve was fitted. The nozzle, a protected batwing ceramic, could be reversed on its mounting for cleaning by flow pressure.

**Rothamsted Experimental Station**

38. *Toxicity and Persistence of Insecticidal Deposits.* The work on the factors influencing the toxicity of residual films was continued. The toxicity was assessed by the thermal preference technique using houseflies as test subjects and a five-minute exposure time. Further experiments on the effect of age on the toxicity of residual films of DDT showed that deposits from DDT-xylene emulsion on wax-coated glass plates exhibited increased toxicity after two days, while DDT-xylene-liquid paraffin solutions applied in the same way did not. Suspensions of 60 $\mu$  needles of DDT deposited on glass plates increased in toxicity after 16 days.

39. The addition of coumarone resin or aluminium monostearate to DDT-xylene emulsions in amounts equal to  $\frac{1}{10}$  the DDT content, gave deposits on glass which were two or four times as toxic as those from plain emulsion, but no difference was found when the formulations were applied to a cabbage leaf surface. The addition of large amounts of Arochlor resin reduced the toxicity of deposits from the emulsion on leaves.

40. A replacement is being sought for Mr. J. Ward who resigned in June, 1959, to take up an appointment in Kenya.

**Colonial Pesticides Research Unit, East Africa**

(K. S. Hocking in charge)

41. *Experiments on Tsetse.* The northern block at Chungai (about 11 sq. miles) was treated eight times from July, 1959, to March, 1960, with dieldrin 2½ per cent. oil based spray at 0.125 gal. per acre, per application. Despite a number of setbacks the result has been very satisfactory. Work in the laboratory has been concerned with the evaluation of LD<sub>50s</sub> and LD<sub>95s</sub> for various insecticides applied topically to the scuta of *Glossina morsitans* and *G. swynnertoni*. An important result was to show that a lethal dose of dieldrin or gamma BHC could be contained in a small enough drop to penetrate vegetation, the dieldrin one being the lesser and therefore more effective of the two.

42. *Experiments on Mosquitoes.* The Taveta Pare Malaria Scheme was brought to a close in April, 1959. The Unit is continuing entomological observations, in co-operation with the East African Malaria Institute, on the rate of return of vector anophelines following cessation of residual spraying. Densities of the *Anopheles funestus* group remain generally low but there has been a great increase in the density of *A. gambiae* during the past year. At Magugu, the huts treated with BHC/Cereclor at 0.5 g. per sq. m., two years ago are still giving 100 per cent. kill of *A. gambiae* following 3 and 8-hour exposures on mud walls and grass roofs respectively. Twelve huts have lately been reconditioned for the examination of "Baytex" and malathion, as part of the W.H.C. insecticide testing programme. Four new experimental houses have been built at Muheza for an investigation into the relationship between hut design and mosquito entry. Also being studied: the susceptibility of *Anopheles gambiae* and *Aedes aegypti* to insecticides.

43. *Pseudotharptus.* The overall increase in coconut yield of about 40 per cent. recorded at Tanga during the first year of insecticide spraying has not been maintained during the second year of protection. It is considered

that a more significant contribution to improving yields is to check the undergrowth beneath the palms, confirmation for which is awaited from Kidichi, Zanzibar, where a large scale experiment is in progress.

44. Other matters relate to the control of red spider on cotton with "Rogor" and "Metasystox" at 0.125 lb./acre per application; and to a record of the persistence of parathion on coffee leaves.

45. *Biting Fly Research Team, Uganda.* Field operations have been transferred to a site in the Koja Peninsula. The experimental area comprises Matubu II and Sabaddu (each 17 square miles in area) the latter having been earmarked as the "control" area in the projected insecticide schedule. Unfortunately, this trial was disrupted because of adverse weather conditions. In the laboratory, various insecticides are being examined to assess their LD<sub>50s</sub> against *Stomoxys*.

46. *Fungicides—East Africa.* Examination of the persistence of copper fungicides applied to coffee leaves has continued. Some preliminary work has been carried out to determine the effect of spray deposits on the actual copper content of the leaves.

47. *West African Fungicides Research Unit.* Further improvements have been made in a laboratory technique for assessing the effectiveness of fungicides against black pod (*Phytophthora palmivora*) of cacao. None of the fungicides tested, with the exception of a cuprous oxide formulation, proved significantly better than Bordeaux mixture. A chemical technique is being further developed for the estimation of residues on the pods. Good correlation of laboratory results has been obtained in a field trial at Owena.

48. *Herbicides.* Trials with hormone weed killers for the control of the woody species *Lippia javanica*, *Aspilia* sp. and *Solanum incanum* have been started. An investigation is proceeding on the control of *Cyperus* spp. Results are reported of trials for the control of other herbaceous weeds including *Oxalis* spp. *Trichodesma zeylanicum* and the effect of dalapon on grassland weeds. Other investigations are concerned with weed control in coffee, beans, cotton, maize and pyrethrum. The growth of several water weeds was suppressed for three months using aminotriazole at 20 lb./acre.

49. *Molluscicides.* Application of a new Bayer molluscicide on the Mwea-Tebere irrigation scheme at an estimated dosage of 0.75 p.p.m. for 8 hours resulted in high mortality of snails for a period of three months. Fish were killed throughout the area at concentrations as low as 0.25 p.p.m.

50. *Miscellaneous.* Work in this section is largely on methods of application and of the correlation between physical and biological results. Assessment procedures are described. The report also refers to the construction of a molluscicide dispenser and a motor-driven wall sprayer; to drop spectra from rotary brushes fitted to a D.H. Beaver aircraft and to rotary atomisers fitted to an Auster; to the drift of toxic chemicals; to the pick-up of insecticide by settled locusts; and to the persistence of aldrin on soil.

#### **Regional Research Centre Herbicide Unit, Trinidad**

51. Field trials on groundnuts failed to confirm the ability of the crop, implicit in earlier pot experiments, to tolerate sufficiently high dosages of 2,4-DB in post emergence applications. Work has commenced on a study of nut-grass (*Cyperus rotundus* L.). It is proposed to estimate the degree

of infestation, its effect upon crop yield and its control by desiccation. A comparative study is being made of line transect and point quadrat sampling methods for the estimation of weed populations.

### PART III. PESTICIDES RESEARCH NOT UNDER THE AEGIS OF THE COMMITTEE

#### *Aden*

52. *Agriculture.* Investigation of *Diparopsis* has continued. The incidence of *Diparopsis* appears to vary in successive years, depending upon the area of land watered in relation to the cotton acreage of the preceding year. Thus there is a high incidence on cotton situated in, or surrounding, unwatered land cropped with cotton the previous year, and conversely a lower incidence in cotton growing on large areas uncropped the previous year. Further studies have confirmed the emergence of moths over the two months following watering, consequent on a reduction of soil temperatures, and occurring in large part before the crop is suitable for breeding. The interception of the main moth flight after watering by stand-over or very early sown cotton has been shown to result in locally high incidence of *Diparopsis*. Spraying experiments now in progress confirm the results of the previous season that cotton can be kept virtually free of *Diparopsis* by weekly application of 0.125 per cent. endrin emulsion at high volume.

53. Work continued on Abyan root rot, both at Cambridge and Abyan, with a view of determining the identity of the causal organism, possible control measures and factors influencing the incidence of the disease.

#### *Barbados*

54. *Agriculture.* Insecticidal measures have been carried out against several sugar cane pests. Dieldrin has been recommended for root borer control. Further field experiments with different varieties and new insecticides have been laid down. Mealy bug has been controlled by better cultivation and a shorter ratoon cycle. A small experiment testing a number of insecticides was carried out. Endrin gave good results.

55. The mass liberation of *Trichogramma minutum* Riley which has been the standard method of moth borer control in Barbados for 30 years has been shown to be ineffective. Liberations did not reduce the *Diatraea* potential (the number of eggs hatching per acre), and were often greatly outnumbered by the natural parasite population. Now four strains of *Lixophaga* have been obtained from different islands, and crosses made between them. The results to date, although not spectacular, are quite promising.

#### *Bermuda*

56. *Agriculture.* Spittlebug, *Clastoptera undulata* Uhler, on extensive *Casuarina* plantings is increasing. Detailed studies of its life history and habits and chemical control investigations have been initiated. Promising results have been obtained with malathion and dieldrin sprays. Preference is, however, for a biological control measure and shipments of an encyrtid parasite, *Carabunia myersi*, have been received from Puerto Rico.

57. The campaign against the Mediterranean fruit fly (*Ceratitidis capitata*, Wied.), was continued for the third successive year. The use of traps baited

with an attractant, along with foliar and ground insecticidal sprays, have steadily reduced the amount of damage done by the fruit flies to citrus and peach crops.

58. An investigation was undertaken by the entomologist to secure information on the current position of the juniper scale—the insect primarily responsible for the death of Bermuda cedars. It appears that the cedar scale is not increasing or spreading as rapidly as it did eight or ten years ago. Loss of virility on the part of the scale or a build-up in resistance on the part of the remaining cedars, or a combination of both factors, was advanced as a possible explanation for the slow down in scale developments.

59. Experiments were conducted to determine whether weed growth along the highways in Bermuda could be successfully controlled by chemical means. Of the many materials tested a spray containing a combination of 2,4-D and sodium chlorate showed the most promise.

#### *British Guiana*

60. *Agriculture.* Outbreaks of rice water weevil, *Lissorhoptrus simplex*, occurred particularly in late-sown broadcast rice. Approximately 10,000 acres were seriously affected resulting in considerable loss in yield. Due to lack of adequate drainage and irrigation facilities, control of the pest by draining the land was impracticable. The rice caterpillar, *Laphygma frugiperda*, also caused damage to rice, but control was obtained through the effective use of dieldrin.

61. A campaign aimed at eradicating the leaf-cutting acoushi ants, *Atta* spp., was started, and approximately 12,000 nests were destroyed by fogging with a mixture of aldrin and dieselene. Dieldrin continued to be effective against the giant moth borer of coconuts which is a severe pest on plantations.

62. Blast disease of rice, *Piricularia oryzae*, was observed on approximately 1,500 acres of rice cultivated along the banks of the three main rivers, Demerara, Berbice and Essequibo, but the disease was not as serious as in the previous year. Investigations carried out have shown that it might be controlled to a great extent by spraying with Verdasan, an organo-mercuric fungicide, three times before the flowering time at the rate of one pound per acre.

63. Leaf scald disease of sugar cane, *Xanthomonas albilineans*, which was a hazard a few years ago continued to be on the decline through the planting of resistant varieties. All new varieties undergo resistance tests before being recommended for commercial planting. During 1959 an unprecedented invasion of rats into sugar cane fields occurred and much damage was done. The rat menace was brought under control by using poisoned pellets based on endrin and zinc phosphide.

#### *British Honduras*

64. *Forestry.* Mahogany sample plots have been maintained and also experiments with systemic poisons are being tried to control *Hypsyphylla* (shoot-borer) attack on young trees. The effect of interplanting with teak or balsa is also being investigated.

*Cyprus*

65. *Agriculture.* Local and imported varieties of citrus root-stocks resistant to *tristeza* are to be tested with grapefruit and Valencia and Washington navel oranges.

66. *Forestry.* The main items of study were: the incidence of *Myelophilus* attack in summer-thinned *Pinus brutia* forest; the relation of fire injury of *Pinus brutia* to borer attack in burnt areas; and the life cycle of *Thaumetopoea wilkinsoni*.

67. *Veterinary.* For the control of sarcoptic mange in sheep, believed to have been introduced through a batch of Sardinian sheep imported during 1957, careful hand dressing and removal of the thick scabs are necessary in addition to dip treatment.

*Fiji*

68. *Agriculture.* Attempts are being made to introduce from Timor a parasite of the banana scab moth, *Nacoleia octasema*, with a view to securing the biological control of this pest in Fiji. Aerial spraying of the coconut stick insect at Vuna resulted in a 95-100 per cent. kill, although application conditions were described as unfavourable.

69. *Forestry.* Tree clearing experiments have been carried out with arboricides such as sodium arsenite, 2,4,5-T and 2,4-D formulations, applied by various methods. After 4 months, arsenite treatment into frill girdles appears to be the most effective and economical in use.

70. *Medical.* Investigations into the insect vectors of filariasis and the application of drugs and treatment were completed during 1959. The results are being issued as a separate report.

*Gambia*

71. *Agriculture.* Work has continued with seed dressing trials for groundnuts in an attempt to replace the more toxic "Agrosan" fungicide at present used by many farmers in the territory. Contrary to earlier work, dressings containing thiram appear superior to organo-mercurial compounds.

72. "Bexone" applied as a pre-emergence weedkiller depressed germination considerably; both "Agroxone" and "Bexone" when applied as a post-emergence treatment gave a good control of broad-leaved weeds and sedges. Dalapon gave a complete control of wild rice and grasses at 5 and 10 lb. per acre. It was applied when wild rice and grasses were about 9 inches high. "Simazin" in dosages up to 10 lb./acre was ineffective against wild rice and grasses.

*Jamaica*

73. *Agriculture.* Maize bagged in 100 lb. lots, exposed to heavy pest infestation, was protected for 5 months with dusts containing (a) 0.1 per cent. pyrethrins synergised with 1.6 per cent. piperonyl butoxide and (b) 0.025 per cent. gamma-BHC applied at 8 oz. and 1½ lb. per 300 lb. respectively. Trials of wettable powders on whitewashed and limewashed plastered concrete building blocks have confirmed that DDT will give longer persistence than dieldrin, gamma-BHC or malathion and indicate that an application rate of 200 mg/sq. ft. should give satisfactory performance for annual treatment.

74. Investigations were carried out to determine the effectiveness of a number of recently developed insecticides and fungicides in the control of certain well known crop pests and diseases. The fungicides "Dithane Z-78" and "Cupravit", and three antibiotic compounds obtained from the Pfizer Corporation were used in a trial on the control of pimento rust. Best results were obtained from "Dithane Z-78" at a concentration of 3 lb. per 100 gal. of water, applied with a low volume mist sprayer. A trial on the control of late blight of Irish potatoes was carried out using the fungicides Bordeaux mixture (8:10:100) with the sticker "Triton", "Manzate", "Cupravit" and "Coppesan" (the latter three at 2 lb., 3 lb. and 3 lb. per 100 gal. of water, respectively). Best control was obtained from the Bordeaux mixture with "Triton" applied as a low-volume spray. A first trial with the bacterial formulation "Thuricide" (a suspension of *Bacillus thuringiensis*) in the control of looper caterpillars on pasture grasses gave promising results. A first trial was also carried out on chemical control of the vegetable parasite Dodder, *Cuscuta americana*, which has become a persistent and unsightly attachment to many garden hedges and ornamental trees in various parts of the Island. It was found that on a Privet hedge, *Pithecolobium* sp., the Dodder can be killed by spraying with a mixture of MCPA (1/250) and PCP (1/25) without permanent damage to the hedge.

75. *Public Health.* Good initial progress is reported from the Sandfly Research Unit under the direction of Dr. D. S. Kettle. Eleven species of sandfly have so far been recorded of which at least three *Culicoides* species and possibly one *Leptocanops* are sufficiently abundant to constitute a nuisance. The programme includes studies of their biting habits and it is already evident that variations in the biting rate can be related to changing meteorological conditions. Biological and ecological studies of the main pest species are planned.

#### Kenya

76. *Agriculture.* Cotton pests caused less damage than usual but the bollworm *Heliothis armigera* caused considerable damage especially towards the end of the season. Excellent results were achieved against cotton pests by aerial spraying on the Tana River Irrigation Scheme but a sudden late attack of *Heliothis* bollworm occurred after the completion of the main spraying operations.

77. Dieldrin spraying against banana weevil gave smaller yield increases than did mulching. In the Rift Valley Province seed dressings of dieldrin, heptachlor, or aldrin against barley fly gave superior control to all others. Dieldrin seed dressing at 3½ oz. of actual dieldrin per 100 lb. of seed, was as effective as the recommended dose of 5 oz. Severe attacks of the chafer grub *Schizonycha* spp. occurred in maize and wheat in the Trans Nzoia, and spraying with dieldrin and chlordane did not give satisfactory control. Seed dressings of dieldrin, aldrin and heptachlor showed promise in shallow trays. Good control of pyrethrum thrips' outbreaks has been achieved by spraying DDT twice at an interval of 10 days. "Metasystox" gave good control of both thrips and red spider mite. Work on *Nematocerus* weevils is being assured a high priority because of serious damage to wheat. A second large maize stack experiment, using polyethylene covers to give long-term protection, was completed and gave results which justify further



large-scale trials. A stack experiment involving layer dusting of maize with 1 per cent. lindane gave conclusive proof that the technique was not economic. Results from a crib experiment showed that when sprayed hessian sheet was used within, the addition of resin had no significant effect.

78. *Eretmocerus serius*, a parasite of the black fly of citrus, *Aleurocanthus woglumi*, a serious pest of coastal citrus, introduced from the Seychelles, appears to have established itself successfully.

79. *Forestry*. Results obtained from the investigation of flight and oviposition preferences of the Cerambycid borer, *Oemida gahani* Dist. are, with knowledge gained of the comparative susceptibility of indigenous stumps and logs to attack, being applied to practical methods of reducing damage to cypress plantations.

#### *Mauritius*

80. *Agriculture. Insecticides*. Further spread of the fruit fly, *Pardalaspis cyanescens* Bezzi, attacking tomatoes, is reported. Good control has been achieved by the use of "Dipterex" sprays which have the added advantage of controlling *Heliothis armigera* Hb., the tomato fruit worm. A new acarine pest of tomatoes, *Vasates lycopersicae* (Masse), has been identified. This can be controlled, as well as *Tetranychus marianae* McG., the major mite pest of tomatoes, with "Tedion V-18", and other acaricides.

81. In citrus, "Dieldrex 15" on trunks of trees has proved effective against the black ant and "Dimecron" has been found to give excellent control of the aphid *Toxoptera citricidus* Kirk., scale insects and lepidopterous pests.

82. A new species of mite has been discovered damaging tobacco seed beds. "Dimecron" has given complete control of the tobacco leaf miner, *Gnorimoschema operculella* Zell. and the aphid, *Aphis gossypii* Glov. Toxaphene and "Dimecron" have given excellent control of the tobacco budworm.

83. The aphids, *Toxoptera aurantii* B.d.F. and *Macrosiphum* (Sitobion) *africana* H.R.L. have been found causing severe curling of young tea leaves. The question of possible taint from the use of these insecticides is being investigated. The soft brown scale, *Coccus hesperidum* L. has been found to damage young tea plants severely.

84. *Fungicides*. Fungicidal trials to control late blight of potatoes, *Phytophthora infestans* (Mont.) de Bary indicated that the fungicides captan, zineb and copper oxychloride were equally effective in general but copper oxychloride appeared to be slightly more effective under conditions of severe attack.

85. Zineb effectively controlled the rusts, *Puccinia sorghi* Schw. and *P. polysora* Und. which were prevalent in maize crops maturing in the wet summer months. Crops maturing in the cooler autumn and winter months were less affected by maize rusts and of the two species, *P. sorghi* Schw. predominated. The leaf spot, *Ascochyta zae* Stout. was recorded for the first time in several localities.

86. *Public Health*. Regular insecticidal spraying of walls and ceilings of byres, barns and other buildings with malathion, diazinon, "Baytex", "Trolene" and DDT together with baits of malathion and diazinon resulted

in a marked reduction in the population of *Stomoxys nigra* Macq. and *Stomoxys calcitrans* L. Fogging of buildings with pyrethrins and synergists is desirable, particularly in wet localities. "Baytex" appears to have a very long residual effect and diazinon appears to be better than DDT in some areas. The larvae of *Musca domestica vicina* can be controlled in farmyard manure by diazinon, malathion and "Agrocide" 25 per cent. wettable powder.

#### Nigeria

87. *Agriculture.* Investigations on the biology of the major cotton pests continue, and the use of insecticides under the correct conditions has given substantial increases in yield. A series of trials is in progress to determine whether dusting of early planted seed yams will give protection against yam beetle damage. Promising control of the pest has been obtained with dusts containing 0.5 per cent. gamma BHC and 2½ per cent. aldrin. Methods of control of citrus pests, based on earlier investigations on the biology of the insects concerned, are being tested.

88. Taxonomic and biological studies of termites in the Region continue to be carried out by an officer of the Colonial Termite Research Unit. Control of termites on forestry and agricultural crops has been studied and advice on the use of insecticides given.

89. At Kano, work continues on a study of the routine misting of groundnut stacks with malathion. Estimation of the effect on infestation has not been easy. Meanwhile chemical assessment of contamination has shown that calculated on the total weight of a stack, contamination is negligible after 5 successive applications of malathion. At Ibadan and Kano work has continued on the use of insecticidal dusts for protecting grain from infestation. BHC on sorghum and maize and malathion on maize have been tested.

90. Formulations of malathion, dieldrin, diazinon, synergised pyrethrins and BHC and DDT have been tested for toxicity and persistence against *Tribolium castaneum* under Nigerian condition of climate and surfaces. Special attention is being paid to malathion in Kano, and an experiment is in progress to test the effect of humidity on persistence.

91. *Forestry.* Young *Eucalypts* have been successfully protected from termite attack by application of dieldrin to the planting holes.

#### North Borneo

92. *Agriculture.* Experiments on artificial breeding of the Tachinid larval parasite, *Chaetexorista javana* on its host *Setora nitens* were started in May for biological control at Tawau. At present the best measure appears, as previously, the rearing of the pupae of *Setora nitens* collected from the fields and the release of the emerged *Chaetexorista javana* back to the infested area.

93. Abaca stools in some areas are being sprayed with dieldrin at 0.5 per cent. or malathion at 0.1 per cent. Lissapol N is added as a wetter at 1:500.

94. The main pests of vegetables continue to be caterpillars of diamond-back moth, *Plutella maculipennis*, and cutworm, *Agrotis* spp.; these are well controlled by endrin which, for safety reasons, may only be used in the early life of the crop.

95. *Forestry*. Arborescence investigations have continued. It has been shown that the use of a wetting agent with sodium arsenite has a small but insignificant beneficial effect. Arsenic pentoxide was found to be a very effective arborescence in place of sodium arsenite, though it suffers from the same high animal toxicity. Tests on formulated compounds of butyl ester hormones were initiated in an endeavour to reduce the cost of butyl ester arborescences, which is due largely to the expense of buying and transporting dieselene to the forest. 2,4-D in dieselene is now being used on a large scale in routine girdling work.

#### *Northern Rhodesia*

96. *Agriculture*. *Cercospora* leaf spot on the susceptible varieties of groundnut again proved amenable to control by such fungicides as zineb and maneb and resulted in a marked increase in yield, as much as 750 lb. per acre kernels. Fungicide application on a variety more tolerant of leaf spot gave no significant increase in yield.

97. The use of fungicides on wheat has improved the yield of summer varieties, and further tests will be made. Results from trials of cultivation methods and weed killers were spoiled by particularly severe lodging caused by storms at the time of heading. Stem rust was unimportant on summer-wheat but on wheat sown on seepage sites between the season of summer-wheat and winter-wheat was severe enough in conjunction with bird damage to lead to disappointing yields of about 4 bags to the acre.

98. Spraying cotton with insecticides probably increased yields though the season has been one of comparatively light insect attack, the American bollworm, *Heliothis armigera*, being the only pest of much severity. In cotton growing trials a series of paired half-acre plots, with one of each pair treated with insecticide and the other left untreated, gave encouraging yields at over a dozen centres covering the Territory. Yields from the sprayed plots ranged from 600 lb. per acre of seed-cotton to over 1,700 lb. per acre and spraying on the average increased yields by some 25 per cent.

99. The disease situation on plants in general followed its usual pattern of development, with insect pests prominent at the beginning of the rains and fungus and other diseases more conspicuous as the season advanced. Corn root-worm of maize appears to be on the increase and this season it was reported not only from the Southern Province, where it was first noted several years ago, but from the Central Province also. Maize streak virus was again widespread. In Turkish tobacco frog-eye (*Cercospora*) was the most serious disease of the year but anthracnose (*Colletotrichum*) was present as a disease in fields as well as in seedbeds, while rosette was unusually abundant and mildew was locally serious.

#### *Seychelles*

100. *Agriculture*. The standard method of controlling *Melittomma insulare* on coconut palms has been for several years to fumigate the palms with paradichlorobenzene. Recent trials now indicate that a more effective treatment is to gouge out the rotting tissues through as narrow an opening as possible and then to apply to the bared wood a mixture consisting of coal-creosote (60 per cent.) and coal-tar (40 per cent.).

101. Consignments of a *Cryptolaemus* lady-bird and of a tiny *Tetracnemus* wasp were received from California and liberated on the madreponic Poivre island to control the long-tailed mealy-bug.

#### *Sierra Leone*

102. *Agriculture.* Further trials carried out against black pod disease, *Phytophthora palmivora* (Butler), of cocoa were designed to test the effect of lengthening the interval between spray applications, the efficiency of various spraying machines and to confirm previous results as to the best spray to use. The most satisfactory and practical results were obtained from spraying Carbide Bordeaux mixture once every three to four weeks using a "Mysto" No. 155 sprayer. This information was the basis of the start of extension work on control of black pod through cocoa Co-operative Societies.

103. Trials are also being conducted against capsid. Special attention is being given to the best time for application and to the most economical spray rate. The interval between spray applications is also being investigated. Aldrin 40 per cent. and "Gammalin" 20 per cent. emulsifiable concentrates are the principal insecticides, although endrin 20 per cent. emulsifiable concentrate is being used on a smaller scale. The latter is highly recommended by W.A.C.R.I. but it is both more expensive and more dangerous than the first two insecticides, and is therefore being kept under closer observation.

104. Against coffee twig borers, *Xyleborus* spp., a pilot trial using a 0.5 per cent. dieldrin spray at 1-1.5 lb. per acre gave an effective control, but this insecticide has not come up to expectations with regard to persistence, as the effect of the insecticide had almost been lost after three and a half months. Further trials were started on a larger scale using three insecticides.

#### *Tanganyika*

105. *Agriculture.* Large quantities of cotton seed were dressed with "Perecot", a copper based fungicide, applied evenly at 1:200 w/w. Fifty tons of UK 55 have been treated with "Abavit B", a mercurial formulation, with a view of assessing its effectiveness against bacterial blight on a commercial scale.

106. The application of 1 per cent. gamma BHC dust has become routine practice on pyrethrum estates where soil pests are numerous. "Rogor" 0.04 per cent. spray has been found excellent for the control of red spider. Aldrin 40 per cent. wettable powder used as a seed dressing applied at 1 lb. per 100 lb. seed has been partly successful against the bean fly, *Melanoagromyza phaseoli*.

107. *Medical.* Malaria control methods continued to be drainage and larviciding in settlements using "Malariol" high spread or BHC powder, depending on the nature of the anopheline breeding site. In two areas of the territory large-scale residual spraying of houses was undertaken. There is a considerable demand for insecticidal powders in small, cheap, sprinkler containers for application by householders.

108. During the year, the sixth and final residual spray cycle of the Pare Taveta control scheme was completed. This scheme, which commenced some four years ago, was aimed at interrupting malaria transmission solely by

residual spraying. A review of results following the last cycle made it clear that although there had been a substantial reduction in the amount of malaria in the treated area transmission had not in fact been completely interrupted. Nevertheless the reduction in malaria that was achieved had a beneficial effect on the population, as reflected by a reduction in the general and infant mortality rates, and by an increase in birth rates and an increase in the haemoglobin levels.

#### *Trinidad and Tobago*

109. *Agriculture.* No success was obtained from attempts to control razor grass (*Scleria reflexa*) by hormone weed killers. Very promising results were obtained in further experiments with "Trithion" by high and low volume application for the control of citrus rust mite, *Phyllocoptruta oleivora* (Ashn.). Florida red, *Chrysomphalus aonidum* (L.) and purple *Lepidosaphes beckii* (Newm.), scale insects, were also kept under control by this insecticide. Low volume application of copper-dithiocarbamate controlled *Septoria* spotting, and cuprous oxide gave significant control over scab on grapefruit. Low volume sprays of oil alone gave the best control of banana leaf spot, *Mycosphaerella musicola*. Preliminary spraying trials over a period of nine months have shown that the spread of *Ceratocystis fimbriata* on cocoa can be reduced by monthly, low volume applications of toxaphene.

#### *Uganda*

110. *Agriculture.* A detailed investigation of the biology of spiny bollworm, *Earias* spp., of cotton is in progress. Striking yield increases were obtained after spraying cotton at Serere four times with DDT at 1 lb/acre. Tea mite, *Hemitarsonemus latus*, is controlled by the normal DDT spray. No convincing evidence of yield loss was obtained and it appears that, at least at present, tea mite is not a serious pest of cotton in Uganda. Red spider mite (of the *Tetranychus telarius* complex) was more than usually prevalent, but no relationship with spraying was evident.

111. Experiments into the control of bean pests are in progress, using three varieties, mutike, banje and Canadian Wonder. The first two are very susceptible to bruchid attack, but the last appears to possess considerable resistance. Irrespective of variety, damage to beans treated with 1 p.p.m. 0.04 per cent. gamma BHC is very slight.

112. The main investigation on coffee has been into the biology of the lacebug, *Habrochila* spp., consequent on the locally severe outbreaks in Bugisu during 1959.

113. *Forestry.* Work has continued on the use of systemics to control the psyllid bug, *Phytoloma lata*, the insect responsible for *Chlorophora* gall. It is hoped that an economic control may shortly be achieved.

#### *Zanzibar*

114. *Agriculture.* A trial involving the spraying of coconut palms from the ground in order to control *Pseudotheraptus wayi* was continued. Application of the insecticide, in September, 1958, at approximately double the standard rate appeared to effect a sharp reduction in the population of *Ps. wayi*, as measured by counts of damaged nutlets, and the numbers remained low for six months instead of the customary three. There has

not, however, been a commensurate increase in crop. The yield of the treated area during 1959 was less than that of the untreated area, although half the gatherings had enjoyed the apparently complete protection following the spraying of September, 1958. This result is the reverse of that obtained in the previous year. Analysis of the data suggests that close spacing, encouraging *Oecophylla smaragdina*, may increase yields and mask the effects of the spray. The physiological capacity of the palms to bear enhanced crops for two years in succession is also now open to question. To investigate this point, clean weeded plots have been incorporated within the trial, in which spadix and *Ps. wayi* counts are being made.

115. Investigations on withertip disease of limes were concerned primarily with the extension and elaboration of spraying trials using a proprietary fungicide containing phenyl mercury nitrate. During a period of one year trees sprayed with this fungicide produced over twice as many limes as unsprayed trees when spraying was done every third day during flushes of new growth. Field trials with other mercurial fungicides showed these to be equally effective but more expensive. Two non-mercurial fungicides failed to give adequate control, while a third approached the required standard but only at a high concentration and cost.

#### PART IV.—APPENDIX

##### Reports and Publications

###### *C.P.R.U. Porton*

A survey of the use of maize stalk borer control methods in East Africa. P. T. Walker. C.P.R.U./Porton/Rep. No. 163.

The toxicity of some organo-phosphorus compounds to mosquitoes and houseflies. A. B. Hadaway and F. Barlow. C.P.R.U./Porton/Rep. No. 164.

Half-yearly progress report, 30th September, 1959. C.P.R.U./Porton/Rep. No. 165.

The contact toxicity of "Trithion" and Methyl "Trithion" to *Anopheles stephensi*. A. B. Hadaway and F. Barlow. C.P.R.U./Porton/Rep. No. 166.

The contact toxicity of some organo-phosphorus insecticides to *Anopheles stephensi*. A. B. Hadaway and F. Barlow. C.P.R.U./Porton/Rep. No. 167.

The toxicity of "Sevin" to mosquitoes. A. B. Hadaway and F. Barlow. C.P.R.U./Porton/Rep. No. 168.

The distribution of spray on maize plants. P. T. Walker. C.P.R.U./Porton/Rep. No. 169.

Tests with "Ruelene" and "Delnav" against mosquitoes. A. B. Hadaway and F. Barlow. C.P.R.U./Porton/Rep. No. 170.

Tests with "Baytex" formulations. C.P.R.U./Porton/Rep. No. 171.

Tests with malathion formulations. C.P.R.U./Porton/Rep. No. 172.

The distribution and sampling of maize plants infested with the stalk borer, *Busseola fusca*, in East Africa. P. T. Walker. C.P.R.U./Porton/Rep. No. 173.

The progress of stalk borer control in East Africa. P. T. Walker. Proc. IVth International Congress of Crop Protection, Hamburg, 1957, I, 761-763, 1959.

Insecticide studies on East African agricultural pests. III. Seed dressings for the control of the bean fly, *Melanagromyza phaseoli* (Coq), in Tanganyika. P. T. Walker. Bull. ent. Res., 1960, 50, 781-793.

#### *U.E.A. Oxford*

Uptake of growth substances. I. Factors controlling the uptake of phenoxyacetic acids by *Lemna minor*. G. F. Blackman, G. Sen, W. R. Birch, and R. G. Powell. J. exp. Bot., 1959, 10, (28), 33-54.

Uptake of growth substances. II. The absorption and accumulation of 2, 3, 5-tri-iodobenzoic acid by the roots and frond of *Lemna minor*. G. F. Blackman, and J. A. Sargent. J. exp. Bot. 1959. (In press.)

Problems involved in the cultivations of maize for fodder and silage. Part I. E. S. Bunting and L. A. Wiley. J. agric. Sci., 1959, 52, (1), 95-105.

The cultivation of maize for fodder and ensilage. Part II. E. S. Bunting and L. A. Wiley. J. agric. Sci., 1959, 52, (1), 313-319.

Chemical renovation of pasture. J. G. Elliott. Agriculture, 1959, 66, 222-6.

The use of mixtures of phenoxyacetic and  $\alpha$ -phenoxybutyric herbicides. K. Holly. Proc. 4th Int. Congr. Crop. Prot. 1959, 509-12.

A direct-plating method for the precise assay of carbon-14 in small liquid samples. C. C. McCready. Nature, Lond. 1958, 161, 1406.

Control of leaf senescence by auxins. D. J. Osborne. Nature, Lond. 1959, 183, 1459-60.

The role of auxins in the control of leaf senescence. Some effects of local applications of 2,4-D on carbon and nitrogen metabolism. D. J. Osborne, M. Hallaway, and G. E. Blackman. Proc. 4th Int. Congress on Plant Growth Regulators. Boyce Thompson Institute, 1959. (In press.)

A pilot survey of herbicide practice in N.W. Oxfordshire. E. K. Woodford and B. M. Church. The Farm Economist, Vol. IX, No. 6, 252-8.

#### *Long Ashton*

Spray application problems: LX. The uptake of mercury by plant tissues. J. A. Pickard and J. T. Martin. Ann. Rep., Long Ashton Res. Sta. 1959.

Spray application problems: LXI. The persistence of derris and lonchocarpus. J. T. Martin. *Ibid.*

Spray application problems: LXII. The limits of visibility of fluorescent tracers in spray liquids. Ann R. Tapscott and H. R. Mapother. *Ibid.*

The cuticles of apple fruits. R. F. Batt and J. T. Martin. *Ibid.*

A note on the possible origin of crotch cankers on apple trees. Nora M. Waugh and R. J. W. Byrde. *Ibid.*

The effect of dinitro-ortho-cresol on apple buds in relation to the control of mildew. Nora M. Waugh. *Ibid.*

Black currant leaf spot: treatment of overwintered leaves with fungicides: summary of experiments 1953-59. A. T. K. Corke. *Ibid.*

A spraying trial against strawberry grey mould (*Botrytis cinerea*). M. A. Rashid Khan. *Ibid.*

A simple suction apparatus for the uniform deposition of dry fungal spores on detached leaves. N. G. Morgan. *Ibid.*

The behaviour of the Black Currant Gall Mite (*Phytoptus ribis* Nal.) during the free living phase of its life cycle. B. D. Smith. *Ibid.*

Effects of temperature and photoperiod on black currants and on the behaviour of the Gall Mite (*Phytoptus ribis* Nal.). B. D. Smith. *Ibid.*

A note on the control of brown rot of apples by griseofulvin. R. J. W. Byrde. *Plant Pathology*, **8**, 90–93.

Eradicant fungicides. R. J. W. Byrde. *Proc. IX Int. Bot. Congress, Montreal 2 (Abstr.)*, 56.

Fungicidal activity and chemical constitution: VIII. A study of the structural specificity of seven fungicides. R. J. W. Byrde and D. Woodcock. *Ann. appl. Biol.*, **47**, 332–338.

Fungal detoxication: 4. Metabolism of 2-methoxynaphthalene by *Aspergillus niger* R. J. W. Byrde, D. F. Downing and D. Woodcock: *Biochem. J.*, **72**, 344–348.

The infection of pruning wounds by *Gloeosporium perennans*. A. T. K. Corke. *J. hort. Sci.*, **34**, 85–95.

An investigation into the possible control of the mealybug vectors of cacao swollen shoot virus by trunk implantation with dimefox. H. R. Mapother (with A. D. Hanna, W. Heatherington and R. Wickens). *Bull. ent. Res.*, **50**, 209–225.

Studies on plant cuticle: III. The composition of the cuticle of apple leaves and fruits. D. V. Richmond and J. T. Martin. *Ann. appl. Biol.*, **47**, 583–592.

Determination of rotenone in *Lonchocarpus* root and oleo-resin. D. V. Richmond and J. T. Martin. *J. Sci. Fd. Agric.*, **10**, 404–408.

Studies on plant cuticle: III. The cutin component of the cuticle of leaves. Margaret F. Roberts, R. F. Batt and J. T. Martin. *Ann. appl. Biol.*, **47**, 573–582.

The response of apple stems to wound infection by *Gloeosporium perennans*. R. O. Sharples. *J. hort. Sci.*, **34**, 72–84.

Further orchard sources of infection by *Gloeosporium* spp. R. O. Sharples. *Plant Pathology*, **8**, 71–72.

Observations on the perfect state of *Gloeosporium perennans* in England. R. O. Sharples. *Trans. Brit. mycol. Soc.*, **42**, 507–12.

Control of *Gloeosporium perennans* with formulations of eradicant fungicides. R. O. Sharples and E. Somers. *Plant Pathology*, **8**, 8–12.

A new colour reaction of dieldrin and endrin. E. J. Skerrett and E. A. Baker. *Chem. and Ind.*, 539.

The colorimetric determination of dieldrin in extracts of coffee bark. E. J. Skerrett and E. A. Baker. *The Analyst*, **84**, 376–380.

The preparation of Bordeaux mixture. E. Somers. *J. Sci. Fd. Agric.*, **10**, 68–72.

Studies of spray deposits. IV. Polyvinyl acetate as a sticker for copper fungicides. E. Somers. *Ibid.*, 548–552.



Fungitoxicity of metal ions. E. Somers. *Nature*, **184**, 475-76.

Physical aspects of the efficiency of sprays. E. Somers. *N.A.A.S. Quart. Rev.*, **11** (46), 68-75.

The relation of chemical structure to fungicidal activity. D. Woodcock. Chapter 25 (pp. 267-279) in *Plant Pathology—Problems and Progress, 1908-1958*. University of Wisconsin Press, 1959.

#### *C.P.R.U. Arusha*

Control of land crabs ("Lairo Tui") in Fiji. G. F. Burnett. *Agric. J. Fiji*, 1959, **29**, 36-8.

The effects of arboricides on East African trees and shrubs. III. *Combretum* and *Commiphora* species. G. W. Ivens. *Trop. Agric. Trin.*, 1959, **36**, 219-29.

Toxicities of various acaricides to mites of the *Tetranychus* complex in East Africa. K. S. McKinlay. *E. Afr. agric. J.*, 1959, **25**, 28-30.

Results of screening *Anopheles gambiae* for resistance to dieldrin in the Pare area of north-east Tanganyika. A. Smith. *Bull. Wld. Hlth. Org.*, 1959, **21**, 239.

The feeding habits of *Anopheles gambiae* with particular reference to subsidiary hosts. A. Smith. *Ann. trop. Med. Parasit.*, 1959, **53**, 414-20.

Malaria in the Taveta area of Kenya and Tanganyika. A. Smith and C. C. Draper. *E. Afr. Med. J.*, 1959, **36**, 629-643.

Droplet size distributions from flat-spray nozzles fitted to aircraft. D. Yeo. *J. agric. eng. Res.*, 1959, **4**, 93-9.

Dosage distribution upon hand-sprayed cotton. D. Yeo. *E. afr. agr. J.*, 1960, **25**, 193-8.

A report on the W.H.O. test kit for bioassay of insecticide deposits on wall surfaces. J. Armstrong and W. R. Bransby-Williams. *C.P.R.U. Tanganyika Misc. Rep. No. 229*.

Preliminary notes on a laboratory method of assessing fungicides for the control of black pod (*Phytophthora palmivora*) of cacao. P. O. Park and E. C. Hislop. *C.P.R.U. Tanganyika Misc. Rep. No. 230*.

Species of acacia as weeds. G. W. Ivens. *C.P.R.U. Tanganyika Misc. Rep. No. 231*.

Trials with a new molluscicide. R. Foster, G. F. Poulton and C. Teesdale. *C.P.R.U. Tanganyika Misc. Rep. No. 232*.

Some observations on the laboratory breeding of the tsetse fly *Glossina morsitans*. R. Foster. *C.P.R.U. Tanganyika Misc. Rep. No. 233*.

A means of attaching pins to table tennis balls for use in spray deposit assessments. G. F. Poulton. *C.P.R.U. Tanganyika Misc. Rep. No. 234*.

Drop spectra from rotary brushes fitted on the D. H. Beaver aircraft. D. Yeo. *C.P.R.U. Tanganyika Misc. Rep. No. 235*.

Aircraft applications of insecticides in East Africa. An attempt to reduce the cost of controlling the tsetse species *Glossina morsitans* West., *G. swynertoni* Aust., and *G. pallidipes* Aust. in savannah woodland. R. Foster P. J. White and D. Yeo. *C.P.R.U. Tanganyika Misc. Rep. No. 236*.

The pickup of insecticides by settled locusts. D. Yeo. and H. J. Sayer. C.P.R.U. Tanganyika Misc. Rep. No. 237.

Susceptibility tests for tsetse flies. W. R. Bransby-Williams. C.P.R.U. Tanganyika Misc. Rep. No. 238.

Analysis of data in the coconut pest research progress report for the period ending 31.3.1959. K. S. McKinlay. C.P.R.U. Tanganyika Misc. Rep. No. 239.

Report on assignment as short-term consultant to W.H.O. Insecticide Testing Team. K. S. Hocking. C.P.R.U. Tanganyika Misc. Rep. No. 140.

An apparatus for the prolonged and accurate dispensing of suspensions and solutions. R. Foster and G. F. Poulton. C.P.R.U. Tanganyika Misc. Rep. No. 241.

The susceptibility to insecticides of *Anopheles gambiae* from Kampala and district. J. Armstrong. C.P.R.U. Tanganyika Misc. Rep. No. 242.

The problem of distribution. The physics of falling droplets and particles. The drift hazard. D. Yeo. (Paper presented to International Agricultural Aviation Conference, England, Sept. 1959.) C.P.R.U. Tanganyika Misc. Rep. No. 243.

The physical and mechanical problems related to the application of insecticides. D. Yeo. (Paper presented to Symposium at Brazzaville, November, 1959.) C.P.R.U. Tanganyika Misc. Rep. No. 244.

Gamma BHC/Cereclor—a new long-acting lindane formulation for malaria control. K. S. Hocking, J. A. Armstrong and F. S. Downing. C.P.R.U. Tanganyika Misc. Rep. No. 245.

The practical significance of sorption. K. S. Hocking. C.P.R.U. Tanganyika Misc. Rep. No. 246.

The bioassay of insecticide deposits on wall surfaces and interpretation of the results. J. A. Armstrong. C.P.R.U. Tanganyika Misc. Rep. No. 247.

Notes on the construction of experimental huts. R. E. Rapley. C.P.R.U. Tanganyika Misc. Rep. No. 248.

Dispersal of insects—a theoretical model based on random movement. D. Yeo. C.P.R.U. Tanganyika Misc. Rep. No. 249.

Dosage distributions on coffee plants. D. Yeo and H. H. Coutts. C.P.R.U. Tanganyika Misc. Rep. No. 250.

Physical assessment of some hollow cone nozzles. C. E. McKone and D. Yeo. C.P.R.U. Tanganyika Misc. Rep. No. 251.

Persistence of insecticide dust and emulsions in irrigated soil. E. T. Mesmer. C.P.R.U. Tanganyika Misc. Rep. No. 252.

Persistence of aldrin emulsions sprayed on to soil. E. T. Mesmer. C.P.R.U. Tanganyika Misc. Rep. No. 253.

Relationship between physical and biological assessment of the performance of a spraying machine against coffee leaf miner, *Leucoptera meyricki*. D. Yeo, K. S. McKinlay and C. E. McKone. C.P.R.U. Tanganyika Misc. Rep. No. 254.

The relationship between insect damage, crop formation and the final yield of coconuts. K. S. McKinlay, C.P.R.U. Tanganyika Misc. Rep. No. 255.

The effect of simulated insect damage on the cotton plant. K. S. McKinlay. C.P.R.U. Tanganyika Misc. Rep. No. 256.

The economics of spraying coconuts from the ground in Zanzibar. B. H. Hyde-Wyatt and K. S. McKinlay. C.P.R.U. Tanganyika Misc. Rep. No. 257.

Performance of Britten-Norman spinning cage spray gear fitted to a D. H. Beaver aircraft. C. E. McKone, C. W. Lee and J. Sayer. C.P.R.U. Tanganyika Misc. Rep. No. 258.

A simple constant flow dispenser suitable for the application of a molluscicide suspension. G. F. Poulton. C.P.R.U. Tanganyika Misc. Rep. No. 259.

Effect of dieldrin treatment on the susceptibility of adult *Aedes aegypti*. W. R. Bransby-Williams. C.P.R.U. Tanganyika Misc. Rep. No. 260.

Committee on Colonial  
Road Research  
(1959-60)

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Road Research Laboratory,  
Harmondsworth,  
West Drayton,  
Middlesex.  
14th July, 1960.

SIR,

I have the honour, on behalf of the Committee on Colonial Road Research, to transmit to you the Final Annual Report of the Committee, covering the period 1st April, 1959, to 31st March, 1960.

I have the honour to be,

Sir,

Your obedient Servant,

W. H. GLANVILLE,

*Chairman.*

The Right Hon. Iain Macleod, M.P.,  
Secretary of State for the Colonies.

## COMMITTEE ON COLONIAL ROAD RESEARCH

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- PROFESSOR GILBERT WALKER, D.Litt., Faculty of Commerce and Social Science, University of Birmingham.
- R. S. MILLARD, Esq., Ph.D., M.I.C.E., Head of Tropical Section (*ex officio*).
- F. H. P. WILLIAMS, Esq., M.A., A.M.I.C.E. (Secretary).

### Terms of Reference

The terms of reference of the Committee are to advise the Secretary of State for the Colonies on matters of road research for the benefit of the Colonies.

## COMMITTEE ON COLONIAL ROAD RESEARCH

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## COMMITTEE ON COLONIAL ROAD RESEARCH

### FIFTH ANNUAL REPORT

#### I. Introduction

1. The Committee held its fifth annual meeting in July, 1959. In addition to members from the United Kingdom, representatives attended from Aden, Basutoland, the Federation of Nigeria, Northern Nigeria and Tanganyika. At this meeting opportunity was taken to review the first three years work of the Tropical Section of the Road Research Laboratory, and to revise the research programme in the light of this experience. The main headings of this research programme are :

- A. Economic justification for roads and road improvements.
- B. Costs of constructing and maintaining roads and of operating road transport.
- C. Standards to which roads should be constructed and maintained.
- D. The road user in overseas territories.
- E. Roadmaking materials.
- F. Pavement design and moisture movement.
- G. Bituminous surfacings.
- H. Drainage and erosion.

2. This report contains a review of progress on all the items, with the exception of D and G, on which work has been done in the past year. Reference is contained in the report to papers in which more detailed descriptions are given of the individual researches. A list of these papers, issued during the year under review, is contained in Appendix 1.

3. The report contains a record of overseas visits and of the other activities of the Tropical Section of the Road Research Laboratory in liaison with those concerned with roads and road transport in the overseas territories and in providing training for engineers from overseas in the testing of road materials.

4. It is gratifying to record the conferment of the honour of a knighthood on the Chairman of the Committee, Sir William Glanville, the Director of Road Research.

#### II. Visits

5. The year has been marked by an increase in the number of visits overseas, which has accompanied the increased activity on specific research studies. In this section of the Report the visits are listed, with brief descriptions of the purpose of each. More detailed information on the research studies is contained in the section of the Report concerned with research.

*International meetings, etc.*

6. The Chairman of the Committee, Sir William Glanville, and Dr. Millard attended the XIIIth Conference of the Permanent International Association of Road Congresses in Rio de Janeiro in September. Other members of the Committee, Mr. Henry Grace and Mr. S. Mehew, were also

present. One of the features of this conference was the attention paid to the road problems of less well-developed territories. Commonwealth delegates were present also from Australia, Hong Kong, India, Malaya, Nigeria and Southern Rhodesia and they were able to meet on several occasions to discuss mutual problems.

7. In October Dr. Millard attended a Traffic Study Week in Bombay, organised by the Inland Transport Committee of the Economic Commission for Asia and the Far East. He returned via Kenya where he made arrangements for further studies of moisture conditions under roads, with the Ministry of Works and with the East African Agricultural and Forestry Research Organisation, and for new work studying the standards obtained in new road building.

8. In October Mr. Clare attended the Second African Regional Conference on Soil Mechanics and Foundation Engineering in Lourenço Marques. Representatives were present from Nigeria, Uganda, Tanganyika, Nyasaland and Northern and Southern Rhodesia, as well as from many other African territories. Mr. Clare presented a paper contributed by Mr. Russam on the connection between climate and moisture conditions under road pavements.

#### *Liaison visits*

9. Dr. Millard visited Trinidad in September whilst returning from the conference in Rio de Janeiro. There is severe and growing congestion in Port of Spain and many of the roads and bridges outside the towns in Trinidad appear to be inadequate for the traffic which wishes to use them. Road accidents are causing concern. In the report on this visit (Paper CRR. 107) these problems are reviewed and some suggestions made for solving them.

10. Whilst in South Africa for the Second African Regional Conference on Soil Mechanics and Foundation Engineering, Mr. Clare had the opportunity to visit Basutoland and by invitation the National Institute for Road Research in Pretoria. In Basutoland he discussed ways whereby the Laboratory could assist road development in the territory, and in Pretoria information was exchanged on matters of common interest in pedology and soil stabilisation.

11. Prior to returning from East Africa, Mr. Tanner visited the Seychelles in August, to advise on problems of road building and maintenance. Information about the roads of the territory and the road building methods is contained in the report prepared on the visit (Paper CRR. 97).

#### *Traffic studies*

12. In June, July and August Mr. Bonney and Mr. Dalby visited Nyasaland and Southern Rhodesia to study speeds, weights and distributions of traffic on roads of different character. On his return Mr. Bonney made a short stay in Kenya to assess the data available on the costs of vehicle operation.

13. In February and March Mr. Bonney returned to Central and East Africa to initiate a study of the effects of road conditions on the operating costs of vehicles, in collaboration with the local government and transport concerns.

14. Mr. Tresidder completed his period of study of traffic engineering and urban transportation in the United States of America. After a brief stay



in the United Kingdom, he travelled to Hong Kong with Mr. Dalby where he is undertaking a study of the cross-harbour traffic in order to advise on the feasibility of a bridge or a tunnel between Hong Kong Island and the mainland.

15. Dr. Webster of the Traffic and Safety Division of the Laboratory visited Jamaica in February at the request of the Jamaican Government to advise on traffic control and signal installations in Kingston.

*Moisture movement under roads and airfields*

16. A team of three officers, Messrs. O'Reilly, Tanner and Baker completed the programme of investigation of moisture conditions under roads in Kenya. Messrs. Baker and Tanner returned to the United Kingdom in August and Mr. O'Reilly has stayed on in East Africa to extend the scope of the investigation to cover Uganda and Tanganyika.

17. Mr. Russam visited Kenya in June and July to collect undisturbed samples of soil from the sites which have been investigated.

18. In January, February and March Mr. Russam visited Nigeria with Mr. Roberts, traversing the country to obtain data on the effects of climate on moisture conditions under roads. During his visit he was able to attend the third Nigerian Conference on Materials Testing held in Lagos in January.

*Roadmaking materials and processes*

19. Mr. Clare and Mr. Beaven visited Nigeria in September and October to make a survey of roadmaking materials in that territory.

20. Mr. Williams visited Uganda in November in connection with full-scale trials on road oiling, undertaken in co-operation with the Uganda Public Works Department.

21. In January, February and March Mr. Williams visited Nigeria, together with Messrs. Daniel and Hitch, to engage in the laying of experimental bitumen-sand mixes on the Maiduguri-Bama road. This experiment is being undertaken in collaboration with the Federal Government of Nigeria, with consulting engineers and with an oil company. During the visit Mr. Williams took the opportunity to make arrangements for a field study which is planned in Northern Nigeria concerning the use of aerial photographs to indicate the engineering properties of soils.

### III. Research

22. The references given are to the serial numbers of the relevant items in the current Research Programme.

*The growth of road traffic overseas (Item A)*

23. A study has been made of different aspects of the growth of road traffic in eight selected territories, Barbados, British Guiana, Fiji, Nigeria, Northern Rhodesia, Nyasaland, Uganda and Hong Kong. This shows that the proportional increase in road traffic has been higher in these territories than in more fully developed countries such as Great Britain, and it is

expected that the high rates of increase will be maintained. Over the period since 1954, the annual increases in the eight territories ranged between:

Registered vehicles—7–20 per cent.

Motor fuel imports—8–13 per cent.

Traffic flow index (four territories only)—12–26 per cent.

Fatalities in road accidents—5–20 per cent.

This information has been incorporated in a report (Paper CRR.83) which has since been issued as Overseas Bulletin No. 11.

24. The collection of this and other information on the growth of road traffic is of value in assessing the importance of road and traffic problems in the overseas territories. It is hoped to continue the collection of such information as a regular feature of the Section's work.

*The characteristics of traffic (Item A)*

25. Information on traffic flow, vehicle weights and speeds, etc., is needed both for the planning of road layouts and for pavement design. In the visit to Central Africa last June–August, records were taken of the characteristics of traffic on nine roads in Nyasaland and 21 roads in Southern Rhodesia. These ranged in type between main roads carrying predominantly industrial and commercial traffic and rural roads where the traffic was chiefly agricultural. They included roads with gravel surfaces, "strip" roads and roads with single-lane and two-lane bituminous surfacings. Measurements were made of the axle loading of commercial vehicles, of the speeds of travel of vehicles of all types, and of the transverse distribution of traffic across the roads. The axle loadings of commercial vehicles were generally similar to those observed on similar vehicles in Great Britain. Data were obtained on the effects of road width, surfacing type and layout on the speeds of vehicles of different classes. The data collected have now been analysed and a report will be issued shortly.

26. The different items of traffic-measuring equipment were demonstrated to the Minister of Roads in the Southern Rhodesian Government and to other interested authorities, and at the conclusion of the visit it was arranged that the Nyasaland Government should take over for their own use the portable weighbridge and the traffic counters employed in the investigation.

27. The survey of the performance of automatic traffic counters on roads overseas, referred to in the previous Annual Report, has been completed and a report has been issued (Paper CRR.84). Most of the mechanical faults referred to by correspondents had also been discovered during operation of the equipment at the Road Research Laboratory and the report contains plans of modifications to a particular traffic counter in order to improve its performance.

*The economic value of roads (Item A)*

28. In the previous year work was started to evaluate the impact of road construction or improvement upon the economic and social development. During the present year this work has been in abeyance because of shortage of staff but plans are being considered for an examination of the effects of the programme of feeder road construction in North Borneo and Sarawak.

*Costs of operating road transport (Item B)*

29. Very little is known about the effects of varying standards of road construction on the operating costs of road transport, particularly about the effects of changes from earth roads to gravel roads and from gravel roads to roads with bituminous surfacings. During the year an investigation has been started in Central and East Africa in which the transport departments in the local governments and a number of commercial transport concerns are co-operating by keeping records of the operating costs of their transport over routes which have been selected as typical of different forms of construction.

*Traffic studies (Item C)*

30. At the request of a consulting engineer, a study is being made in Hong Kong of the likely use which would be made of a road connection between Hong Kong Island and the mainland. This work was started in January and will continue for about five months. The existing cross-harbour traffic is by ferry and the investigation involves a study of the origins and destinations of the present traffic which uses the ferries, and of the volume of traffic which a road crossing of the harbour would generate. The impact will be considered of such a road crossing on traffic conditions in the Colony generally.

31. Very few investigations of this type have so far been undertaken and the work will be of considerable value both in the indications it gives of the feasibility of the crossing and the light it throws on methods of conducting investigations of this character.

32. The object of the visit of Dr. Webster of the Traffic and Safety Division to Jamaica in February was to advise the Kingston and St. Andrews Corporation about the places where it would be necessary to install traffic signals, what type of signals would be suitable (vehicle-actuated or fixed-time) and whether signals along certain routes should be linked. In addition the Corporation asked for advice on traffic flow at busy sections in the suburban areas and the Ministry of Communications and Works asked for advice concerning intersections at Montego Bay.

33. A census was taken of the traffic at all major junctions in the central area of Kingston before the visit and these figures are now being analysed. With this information and with observations obtained during the visit it will be possible to tender advice based on facts. At some junctions it was estimated that in peak periods the signals would be running to capacity almost immediately and the possibility was considered of adopting certain one-way street systems to overcome this difficulty. The street plan of the central area is of the block pattern which is normally suitable for the use of linked systems of signals and the data obtained during the visit are now being studied to determine the extent to which linking of the signals will improve traffic flow. A report is in preparation.

*Standards of normal practice in road building (Item C)*

34. There are difficulties in framing specifications for road construction, and in applying these specifications, because too little is known about the standards and practical tolerances which can be worked to in the field.

This subject was discussed at the meeting of the Committee in 1959 and a general research programme was agreed. Further the Committee recommended that initially research should be concentrated on a study of the variables which affect the standards of compaction in embankments, sub-grades, sub-bases and bases of roads and of the mixing and laying of stabilised soil bases.

35. During the year arrangements have been made to undertake this work in Kenya, Tanganyika and Uganda in co-operation with the road authorities there and the investigation began in March 1960.

*Roadmaking materials and processes (Item E)*

36. *Tropical gravels.* The investigation of tropical gravels was continued and information is given below on the individual studies.

37. A laboratory investigation has shown that the "10 per cent. fines aggregate crushing test" is suitable for measuring the crushing strength of the coarse particles in tropical gravels. This work is reported in Paper CRR.82, which also contains the results of this test on a range of tropical gravels.

38. The results of the petrological examination of thin sections of a range of tropical gravels are being analysed, particularly with a view to determining whether there is any relation between the pore structure and the strength and compaction qualities of the material. A report is being prepared.

39. A laboratory study has been made of some of the factors affecting reproducibility of the results of unconfined compressive strength tests and cylinder penetration ratio tests on cement-stabilised tropical gravels. It was shown that with both tests a reliable result requires that the mean strength should be obtained from at least four test repetitions and that with the cylinder penetration ratio test the C.P.R. value most appropriate to the mean density of the specimen is the average value for both ends of a dynamically-compacted specimen. The work is reported in Paper CRR.90.

40. An investigation has been made of the suitability for stabilisation with Portland cement of a nodular laterite from the Gambia. It was discovered that for the higher cement contents, 6 per cent. and 8 per cent., hydration of the cement was not complete at the optimum moisture content although theoretically there appeared to be sufficient water available. It was found that clay held within the pores of the nodules had a greater affinity for water than had the cement. Also the high strength obtained with low cement content suggested that there was some chemical present in the soil which accelerated the rate of hardening of the cement. A report is being prepared.

41. A laboratory study has been made of a lateritic gravel and of two sands from the Bo—Freetown road in Sierra Leone. All three materials were shown to be suitable for stabilisation with 3-4 per cent. of Portland cement. The investigation has been reported in Paper CRR.88.

42. Overseas Bulletin No. 8 drew attention to the fact that the rate of gain in strength with cement content was less for the soils from the tropical forest belt than for the soils from the savannah regions in Ghana. One of the possible explanations for this difference was that organic

material in the soils from the forest belt was interfering with the hardening of the cement. Examination of samples received from Ghana showed that the soils from the tropical forest belt had generally a higher organic content than those from the savannah, but the number of samples containing an appreciable organic content was small and the data are as yet inconclusive. This work has been reported in Paper CRR.95.

43. Trials were undertaken in November 1959 in co-operation with the Uganda Public Works Department to examine the possibilities of road oiling to improve the performance of gravel roads. The work was carried out on roads with lateritic and with quartzitic gravel surfacings. Four different bituminous binders were used, one being the locally-available furnace oil, two the same oil containing 10 per cent. and 40 per cent. of 80/100 pen. bitumen, and the fourth a slow-curing cut-back bitumen of the type used in Sweden for road oiling. In addition the effect of incorporating an adhesion agent in the binders was examined.

44. Little difficulty was experienced in incorporating the binders into the gravels using the technique of spraying the binders onto the surface in a number of increments, using a blade grader to mix the material after each increment. The use of the adhesion agent appeared to have no effect on the mixing.

45. The maximum percentage of binder used in the trial sections was just over 4 per cent. by weight of the nominal 2 in. processed depth. Results of the trials have been disappointing; over the range of binder contents examined none of the mixtures showed the self-healing properties reported with the oiled gravel road materials in Sweden. This result is probably associated with the relatively high clay content of the materials and possibly with the absorptive properties of the lateritic gravel. It is possible that better results would be obtained with higher binder contents and with binders of higher viscosity. If such were done the cost of such treatment is likely to approach that of preparing a more permanent base and surfacing. This suggests that the method of treatment is not worth pursuing for general use with tropical gravels although it may have a value where binders can be obtained relatively cheaply.

46. The results of the study made in 1958 of roadmaking gravels in the Central African Federation are now being published as Overseas Bulletin No. 12. A similar investigation has been undertaken in Nigeria. Mr. Clare and Mr. Beaven visited all three regions and the Southern Cameroons in September 1959 to study the formation, distribution and engineering properties of the roadmaking gravels and soils. At least 18 groups of gravel and sand useful in road construction have been recognised. The parent geological formation exerts the major influence on the properties of roadmaking materials in the country and much useful information has been obtained from the Geological Survey Department. In the Western Region, drainage and drift have also been recognised to play a significant part. Here it is hoped to extend the work done by members of the staff of the Ministry of Works in the Western Region, based on the agricultural soil survey, a description of which has been published by the Laboratory as Overseas Bulletin No. 10.

47. *Sands*. In using bitumen to stabilise non-cohesive sands it has in the past been normal to attempt to produce both a surfacing and a road base in the same material. Such mixtures normally contain between 4.5 and 6.5 per cent. of cut-back bitumen. Even so they frequently require surface treatments shortly after laying to resist the abrasive action of traffic.

48. In remote areas particularly, a large part of the cost of such mixtures derives from the cost of the bitumen. Substantial savings could be made if mixtures with lower bitumen content could be employed. Laboratory investigations have shown that mixtures with as little as  $1\frac{1}{2}$  per cent. of bitumen can be prepared and that such reductions in binder content were not accompanied by a significant loss in stability, although the mixtures were naturally less resistant to abrasion. Practical experience was necessary to determine whether bitumen-sand mixes with low bitumen contents could be satisfactorily mixed and laid and whether their performance merited their more general use. During the past year the Laboratory has co-operated with the Federal Ministry of Works and Surveys in Nigeria, with a firm of consulting engineers and an oil company in full-scale trials on the Maiduguri-Bama road. The experimental materials were laid in January, February and March 1960. Three cut-back bitumens were used in the viscosity ranges: 7-20 seconds at 25°C, 200-300 seconds at 25°C, and 100-150 seconds at 40°C, all measured on the standard tar viscometer, 10 mm cup. Conclusions from the experiment so far are:

- (a) With the sand at normal temperatures of between 20 and 22°C, and with the binders heated to the recommended temperatures for mixing, mixtures can satisfactorily be made in a twin-shaft paddle mixer, using binder contents down to  $1\frac{1}{2}$  per cent. with the 7-20 second bitumen, down to 2 per cent. with the 200-300 second bitumen, and down to 3 per cent. with the 100-150 second (at 40°C) bitumen.
- (b) With the two more viscous cut-backs the mixtures could be spread and rolled satisfactorily immediately after mixing. With the most fluid of the cut-back bitumens a period of curing was found to be required before compaction.
- (c) It appeared to be desirable to prime the materials before surface dressing.

49. Two sections of sand-cement base were laid for comparative purposes.

50. A point of interest which arose was the working of ants, especially the harvester ant, which was found to be capable of making a hole through 5 in. of bitumen-sand mix with a surface dressing. The extent to which ants can damage this type of surfacing in the locality is not yet evident.

51. A laboratory examination has been made of the properties of sands from a housing estate at Dar-es-Salaam in Tanganyika. Trial series of cement-stabilised bases with this sand were laid by the Municipal Authority in 1955 and one purpose of the investigation was to compare the results of cylinder penetration ratio tests and unconfined compressive strength tests on the stabilised soil with the performance of the mixtures in the field. After four years in the field mixtures with 3 and 5 per cent. of cement

are performing satisfactorily under housing estate traffic, including omnibuses. This experience suggests that a design criterion of 120 per cent. C.P.R. after seven days is appropriate when considering the stabilisation of this soil with cement. The tests were made on specimens prepared at densities equivalent to those obtained on the B.S. Compaction test. The work is reported in Paper CRR.106.

52. A laboratory investigation is being made on a range of sands from a number of African territories with the object of determining their suitability for stabilisation with Portland cement and hydrated lime in relation to the gradings of the sands.

53. *Other soils.* A laboratory investigation has been made of five soils from British Honduras and of their suitability for stabilisation with hydrated lime. The work showed that a lime made from British Honduran limestone was as effective as a British lime for soil stabilisation. The work has been reported in Paper CRR.94. Of the five soils examined only one, a sandy clay, was suitable for stabilisation with lime but during a visit to the territory in March 1959 other soils, alluvial gravel-sand-clays, were located and these appeared to be eminently suitable for lime stabilisation. Field trials in British Honduras have been suggested to examine the prospects of stabilising these locally available soils with lime. (See Paper CRR.96.)

54. In the previous report reference was made to laboratory tests undertaken to examine the suitability of red volcanic clay from Kenya for stabilisation with Portland cement and hydrated lime. These clays exhibit unusual properties in the field; they have extremely low *in situ* densities and are relatively free-draining and they have a crumbly structure which, in comparison with other clays, makes them easy to work. The clays are unusual in containing a significant proportion of iron oxide and also in that the mineral halloysite is present, both in the hydrated form and in the dehydrated form. The object of the present investigation is to determine the effect of the type of halloysite on the properties of the soils.

55. An investigation is in progress on the suitability for stabilisation with Portland cement and hydrated lime of two soils from North Borneo. This work is being undertaken by an Executive Engineer of the Public Works Department during a period of attachment to the Laboratory as a voluntary worker.

56. *Aggregates.* The physical properties of three samples of limestone aggregate from Malaya have been examined in the Laboratory. The tests included resistance to crushing, abrasion and polishing. The results showed that the aggregates were susceptible to polishing. This work was undertaken by a Senior Executive Engineer from the Public Works Department of Malaya whilst attached to the Laboratory as a voluntary worker. It is reported in Paper CRR.101.

57. A similar investigation has been carried out on 15 samples of limestone aggregate from the Caribbean area. The samples ranged from the soft detrital limestones which are the only roadmaking aggregates available in Bermuda and the Bahamas, to tough siliceous limestones from Jamaica. This work was undertaken by an Executive Engineer on the staff of the Barbados Public Works Department, whilst attached to the Laboratory as a voluntary worker. It is reported in Paper CRR.105. Further

samples of aggregates from Malaya and the Caribbean area are now being examined in the Laboratory.

58. *Use of aerial photographs.* The potentialities of aerial photographs in identifying soils and roadmaking materials have been illustrated in Overseas Bulletins No. 4, "The use of aerial photographs in road construction in Nyasaland" and No. 5 "Nyasaland laterites and their indications on aerial photographs". Aerial photographs are not as yet used a great deal in this way in the overseas territories. One of the main reasons is the lack of detailed surveys from which ground keys can be made for different regions to relate engineering properties of soils with their appearance in aerial photographs.

59. An informal meeting was held at the Road Research Laboratory in June to discuss what could usefully be done. This meeting was attended by representatives from the Crown Agents, the Ministry of Transport and Civil Aviation, the Directorate of Overseas (Geodetic and Topographic) Surveys, consulting engineers, contractors, an aerial survey firm and the military authorities who have a natural interest in the development.

60. The meeting concluded that there was a need in the civil field for more knowledge of this subject and recommended that a joint civil-military steering committee be formed with working organisations to meet civil and military needs. These recommendations were endorsed by the Colonial Road Research Committee and by the Road Research Board and a working group has now been set up under the chairmanship of Dr. R. S. Millard and is to hold its first meeting in April, 1960.

61. In the meantime one member of the Tropical Section has been selected to specialise in this type of work, and it is planned that he should spend a tour of duty in Northern Nigeria working with the Northern Region Agricultural Survey at Samaru, the Federal Geological Survey at Kaduna, and the Ministry of Works, to study the relationship between the agricultural and engineering classification of soils and to determine how successfully aerial photographs can be used in the area to indicate the engineering properties of soils and sources of roadmaking materials.

62. *White line road markings.* Experience with thermo-plastic white line marking in some of the overseas territories has been disappointing. There have been complaints of discolouration and, in some cases, pushing under traffic. It is known that the performance of these materials is critically dependent on the consistency of the fluxed rosin base and that this must be adjusted according to the road temperatures prevalent in the area where the lines are used.

63. Following a visit to the Far East in 1956, an experiment has been undertaken in collaboration with the Hong Kong Public Works Department in which a series of thermo-plastic white line compositions, designed from a knowledge of local road surface temperatures, have been used to mark a pedestrian crossing on a heavily-trafficked road in Hong Kong. Experimental materials were laid in February, 1959 by the Hong Kong Public Works Department which has since provided regular information on the performance of the materials. Use of thermo-plastic material of this type to mark pedestrian crossings on heavily-trafficked roads is a very severe test for the material. It provides in effect an accelerated test for the normal use of the



material as a traffic-lane marking. From the results of the experiment it has been possible to produce tentative recommendations for the compositions of thermo-plastic white line markings for use in the tropics and a report is in preparation.

*Pavement design and soil moisture movement (Item F)*

64. The analysis of data on the moisture content of soils from airfields in tropical and sub-tropical areas, collected by the Air Ministry, has been completed. A full account of the airfield investigation is now being prepared for publication as a Technical Paper.

65. The airfields included in the studies were situated in widely differing territories and the conclusions which have been drawn from the results should apply over wide areas overseas. They show that moisture conditions under roads and runways can be predicted:

(a) where the major influence is that of a water table within approximately 20 feet of the surface

and (b) in desert conditions where the determining factor is the humidity of the atmosphere.

66. The remaining common condition is in areas of seasonal rainfall where there is no permanent water table close to the surface. Here moisture conditions in the soil are a function of rainfall, evapotranspiration and run-off.

67. This concept is used by agriculturalists for assessing the amounts of water available for irrigation and the growth of plants and if it can be applied to the prediction of moisture conditions under sealed surfaces it will represent an advance in dealing with road design overseas. Data on rainfall and temperature are widely available and these are used by Thornthwaite<sup>(1)</sup> in calculating the moisture balance in the soil. A preliminary analysis of the data already available suggests that there may be a direct relationship between the Thornthwaite index and the suction of the soil under roads and airfields where this is not influenced by conditions in the verge.<sup>(2)</sup>

68. To examine this possibility field measurements of soil suction under roads and airfields are being made in a range of different climatic regimes. So far measurements have been made in East Africa and in Nigeria.

69. The field investigation in Kenya has shown that the concentration of water at the road edges, due to run-off from the road surface, can have a considerable effect on moisture conditions under the edge of the road. Natural gravel bases were weakened to a distance of some 2 ft. from the edge. The effect on the soil subgrades varied with their permeability.

70. This investigation in Kenya was, in its final stages, expanded to include sites in Tanganyika and Uganda. Field work was completed in January 1960. An interim report has been prepared (Paper CRR.78) and the considerable mass of data is now being analysed to produce final reports.

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<sup>(1)</sup> THORNTHWAITE, C. W. An approach toward a rational classification of climates *Geogr. Rev.* 38, 1948, 55-94.

<sup>(2)</sup> RUSSAM, K. Climate and moisture conditions under road pavements. *Proc. 2nd African Regional Conference of Soil Mechanics and Foundation Engineering* (Lourenço Marques), 1959 (in the press).

71. In view of the obvious importance of these edge effects, further field measurements are being carried out in co-operation with the Central Roads Laboratory of the Department of Roads and Road Traffic in Southern Rhodesia, and a full-scale experiment is being planned in collaboration with the East African Agricultural and Forestry Research Organisation and the Ministry of Works in Kenya. In Southern Rhodesia the work is being undertaken on a main road near Salisbury. Measurements of soil suction are being made, using a tensiometer modified to facilitate *in situ* studies under roads. This tensiometer has been described in Paper CRR.89. Tensiometers made and tested at the Road Research Laboratory have been despatched to Southern Rhodesia for this study.

72. The experiment in Kenya is planned to be carried out over several years in the grounds of the laboratories of the East African Agricultural and Forestry Research Organisation near Nairobi. It is intended to examine the effects of vegetation on the shoulders and other edge conditions on the moisture distribution under roads constructed on the typical red coffee soils of Kenya.

#### *Control of roadside vegetation (Item H)*

73. Information sent in from 55 organisations in 33 overseas territories regarding the use and control of vegetation on roads and airfields has now been received and analysed and a report has been prepared (Paper CRR.93). Some experiments in weed control are already in hand in some overseas territories, and proposals have been submitted for the co-ordination of some of these and the initiation of others where desirable. Contact is being maintained with the chemical industry in this field.

74. Some information on the construction and maintenance of grass surfacings for airfields has been obtained. The Air Ministry is planning to extend this by inviting additional information from its overseas establishments.

#### **IV. Relevant Work on the Programme of the Road Research Board**

75. The Committee notes with interest the results of other investigations which form part of the programme of the Road Research Board and which, though undertaken in United Kingdom conditions, have direct application in the tropics. Reports of these investigations, in the form of Research Notes, are sent to Colonial Governments and to the Laboratory's nominated correspondents in Works departments and in the police forces. A list of the Research Notes circulated during the past year is given in Appendix II. Brief notes of some of these follow below.

#### *Casualties, accidents and contributing factors*

76. A study has been made of the trends in casualties, accidents and factors contributing to them in Great Britain for the years 1949 and 1951-56. Though trends may be different, many of the factors involved will be operative overseas (RN/3161).

#### *Priority rules for traffic at intersections*

77. Most territories are concerned about priority rules for road traffic at intersections, particularly at roundabouts. The Laboratory has reviewed

the information available for a number of countries and has examined the arguments for and against the priority rule, together with other suggestions for improving roundabouts (RN/3621).

#### *Roadmarking materials*

78. An experiment to compare white lines made of various road paints with thermo-plastic markings showed that road paints complying with British Standard 2086 and based on natural gum rosin have poor durability; more expensive road paints, based on synthetic resins and chlorinated rubber, have a longer life but on heavily-trafficked roads last only half as long as thermo-plastic material (RN/3300).

#### *Textbook on bituminous materials*

79. A textbook on bituminous materials is in preparation as a companion volume to "Soil mechanics for road engineers", 1952, and "Concrete roads: design and construction", 1955, published by H.M. Stationery Office. Sections of the book are first being issued as research notes and some of these, of special interest to engineers overseas have been circulated. They include notes on surface dressing (RN/3486); roadmaking aggregates (RN/3531); adhesion of bituminous binders to road aggregates (RN/3573); the sampling and testing of bituminous road binders (RN/3602); the "retread" process (RN/3613); the sampling and analysis of bituminous road materials (RN/3623) and bituminous road emulsions (RN/3658).

#### *Compaction of soils*

80. Work on compaction equipment continues and a recent examination has been made of a 13½ ton grid roller, which was originally developed as a tool for breaking down rock *in situ* but which showed itself at the tests to be of considerable use in compacting soil, particularly in dry conditions (RN/3563).

#### *Soil stabilisation*

81. Further tests have indicated that the laboratory method for determining the cement or lime content of stabilised soil, described in a previous note (RN/3310), is not suitable for use with certain iron-rich tropical soils, of relatively wide occurrence, and a new method has been evolved for use with these soils (RN/3619).

82. An investigation has also been made into the effect of temperature on the rate of hardening of soils stabilised with lime and cement (RN/3655).

### **V. Information Services and Training**

83. During the year two further Overseas Bulletins have been issued:—

Overseas Bulletin No. 10.—The engineering classification of some western Nigerian soils, and their qualities in road building.

Overseas Bulletin No. 11.—The growth of road traffic in British overseas territories since 1946.

A further Bulletin is in the press:

Overseas Bulletin No. 12.—Roadmaking gravels in Central Africa.

84. The demand for these Overseas Bulletins continues to grow. Now 1,000 copies are prepared of each new Bulletin. 550 of these are distributed on a regular circulation and the remainder is used for special enquirers.

85. The Section has continued to circulate to Overseas Governments, Public Works Departments and Police Forces copies of Research Notes of interest. A list of the Research Notes circulated in the period under review is given in Appendix II.

86. Of the total number of 251 engineers attending the Laboratory's short courses on Soil Mechanics, Bituminous Materials and Concrete in the period October–December, there were 49 engineers from Public Works Departments in the Colonial territories and a similar number of consultants and contractors with overseas interests. Following the success in 1958 of the one-day extension to the Soil Mechanics Courses, devoted to road building problems in the tropics, similar courses of three days duration were run in 1959. A total of 60 engineers attended the two courses. It is planned to hold similar courses in 1960.

87. A growing number of overseas police and engineers are attending the courses run by the Traffic and Safety Division of the Laboratory.

88. The arrangement whereby engineers from British overseas territories are attached to the Tropical Section for periods as voluntary workers is being increasingly used. The preferred arrangement is that these men work in the Section for at least 6 months, from July to December. They start by gaining experience in methods of testing road materials; they normally spend several weeks on full-scale experiments or other works of interest in the field; they attend the short courses on Soil Mechanics, Bituminous Materials and Concrete and finally they undertake a short investigation concerned with roadmaking in their own territory. Below are listed those who were attached to the Section in this way in 1959.

Mr. G. D. Hayward, Executive Engineer, Barbados, July–December.

Inche Ismail bin Ngah Marzuki, Senior Executive Engineer, Malaya, July–December.

Mr. A. Tunbridge, Executive Engineer, Ghana, July–August.

Mr. B. R. Bakshi, Engineer, India, July–August.

Mr. S. K. Okonkwo, Vacation Student, Nigeria, Mid July–August.

Mr. I. Ekhaese, Vacation Student, Nigeria, Mid July–August.

89. Another engineer from Malaya, Inche Mohd. Tahir bin Haji Abdul Manan, worked for a fortnight in the Section during a study tour of six months in this country in 1959.

90. An Executive Engineer, Mr. C. K. Gray of the North Borneo Public Works Department, started a period of 6 months attachment to the Tropical Section, in February, 1960.

91. There is a continuing rise in the number of enquiries both on matters of road building and on road traffic problems. The Section has welcomed some 200 individual visitors during the year, amongst whom there were the Hon. Mr. L. N. Constantine, Minister for Works and Transport, Trinidad; the Hon. Mr. H. E. Walter, Minister of Works, Mauritius; Mr. M. de N. Ensor, Secretary to the Foundation for Mutual Assistance in Africa and Mr. F. E. V. Smith, Secretary to the National Research Council of Ghana.

**VI. Staff and Accommodation**

92. The number of staff in the Tropical Section during the period under review was:

	<i>Staff at 1st April, 1959</i>	<i>Staff at 31st March, 1960</i>	<i>Authorized complement at 31st March, 1960</i>
Scientific Officers ... ..	8	8	16
Experimental Officers ... ..	10	16	19
Assistants, Scientific ... ..	1	4*	5

\* Includes a Ghanaian undertaking a sandwich course at the University of London.

93. It is still proving difficult to fill the Scientific Officer posts. This is a particularly serious problem with the Tropical Section because of the comparatively long periods which the senior staff spend away from the Laboratory.

94. Agreement has not yet been obtained for additional posts over and above the existing complement to establish the pool of Materials (Research) Engineers. However it has been agreed that officers for the pool may be recruited within the existing complement and it is hoped that it may be easier to recruit such officers than those required for research work.

95. The accommodation for the Section is becoming cramped, and it is likely that the situation will not improve for some time owing to the pending move of the whole of the Road Research Laboratory to another site. The new buildings provided for the Section were designed for a much smaller staff. Members of the staff are being accommodated in such buildings as the Laboratory can make available.

## APPENDIX I

LIST OF RESEARCH NOTES ISSUED BETWEEN  
1ST APRIL, 1959 AND 31ST MARCH, 1960

<i>RN No.</i>	<i>CRR No.</i>	<i>Title</i>
3408	73	A pilot study in Uganda of the effects upon economic development of the construction of feeder roads.
3425	74	Road-making gravels in Central Africa.
3447	78	Investigation to study moisture conditions under roads in Kenya. Interim report.
3449	79	Climate and moisture conditions under road pavements. Appendix to above.
3458	80	Road problems in the Bahamas.
3489	82	A laboratory investigation of the resistance to crushing of some tropical gravels and aggregates.
3495	83	The growth of road traffic in British overseas territories since 1946.
3496	84	The use of automatic traffic counters in British overseas territories.
3508	86	Lagos traffic survey, 1958.
3518	88	A laboratory investigation of the properties and stabilization of three soils from Sierra Leone.
3517	89	A modified tensiometer for use under road or airfield pavements.
3519	90	An investigation into the variability of C.P.R. and unconfined compressive strength results obtained from tests on a tropical gravel stabilized with 4 per cent. Portland cement.
3529	93	The use and control of vegetation on roads and airfields overseas.
3553	94	A comparison between a hydrated lime made from British Honduras limestone and a British lime when used to stabilize five soils from British Honduras.
3572	95	An investigation into the relation for Ghanaian soils between organic matter content and the strength of soil cement.
3542	96	Roads and road problems in British Honduras.
3616	99	The movement and distribution of moisture in soils at overseas airfields. VI. Habbaniya airfield, Iraq.
3622	100	An investigation of soil moisture conditions at three airfields in Southern Rhodesia.
3627	97	Roads and road problems in the Seychelles.
3654	101	Results of physical tests on three samples of limestone from Malaya.
3696	104	Principles and standards of road highway and traffic legislation for British overseas territories: a comparative study and assessment.
3703	105	A laboratory investigation into the physical properties of limestone from Bermuda and the West Indies.
3706	106	A laboratory investigation of the properties and suitability for stabilization of sands from Dar-es-Salaam, Tanganyika.
3711	107	Some problems of roads and road traffic in Trinidad. Notes on a visit in October, 1959.
3717	108	Some considerations in planning territorial road systems.
3719	110	List of research notes, papers and publications on overseas roads and road traffic.

## APPENDIX II

**LIST OF RESEARCH NOTES AND PUBLICATIONS WHICH HAVE BEEN  
CIRCULATED TO THE OVERSEAS TERRITORIES BETWEEN 1ST  
APRIL, 1959 AND 31ST MARCH, 1960**

**Traffic engineering, road safety and road economics**

<i>RN No.</i>	<i>CRR No.</i>	<i>Title</i>
3161	—	Some trends in casualties, accidents and factors contributing to accidents.
3496	84	The use of automatic traffic counters in British overseas territories.
3571	—	The prevention of injuries in road accidents.
3608	—	Accident rates per vehicle-mile, based on August censuses, 1956-58.
3621	—	Priority rules at intersections with special reference to roundabouts.

**Road materials and methods of construction**

<i>RN No.</i>	<i>CRR No.</i>	<i>Title</i>
3217	48	Roads and road problems in Aden and the Protectorate.
3300	—	A full-scale road experiment to compare some modern road paints with thermo-plastic markings.
3350	72	A laboratory examination of the properties of twelve Kenya soils.
3363	—	An investigation of the performance of a 13 cwt vibrating-plate compactor for compacting soil and granular base material (Summary only).
3486	—	Surface dressing.
3489	82	A laboratory investigation of the resistance to crushing of some tropical gravels.
3517	89	A modified tensiometer for use under road or airfield pavements.
3518	88	A laboratory investigation of the properties and stabilization of three soils from Sierra Leone.
3529	93	The use and control of vegetation on roads and airfields overseas.
3531	—	Roadmaking aggregates.
3563	—	An investigation of the performance of a 13½-ton grid roller in the compaction of soil.
3573	—	The adhesion of bituminous binders to road aggregates.
3585	—	Equipment for a central laboratory and a mobile laboratory for the testing of bituminous road materials.
3602	—	The sampling and testing of bituminous road binders.
3613	—	The "retread" process.
3619	—	Laboratory method for the determination of the cement or lime content of cement- or lime-stabilized soil.
3622	100	An investigation of soil moisture conditions at three airfields in Southern Rhodesia.
3623	—	The sampling and analysis of bituminous road materials.
3655	—	The effect of temperature on the gain in strength of soil stabilized with hydrated lime and with Portland cement.
3658	—	Bituminous road emulsions.

Colonial  
Social Science Research Council  
Sixteenth Annual Report  
(1959-1960)

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London School of Economics  
and Political Science,  
Houghton Street,  
Aldwych,  
London, W.C.2.

26th September, 1960.

SIR,

I have the honour, on behalf of the Colonial Social Science Research Council, to transmit to you the Sixteenth Report of the Council, covering the period from 1st April, 1959 to 31st March, 1960.

I have the honour to be,  
Sir,

Your obedient Servant,

ARNOLD PLANT,  
*Chairman.*

The Right Honourable Iain Macleod, M.P.,  
Secretary of State for the Colonies.



COLONIAL SOCIAL SCIENCE RESEARCH COUNCIL SIXTEENTH  
ANNUAL REPORT

**Membership**

- PROFESSOR SIR ARNOLD PLANT, B.Sc. (Econ.), B.Com., Sir Ernest Cassel Professor of Commerce, University of London. (Chairman).
- MR. L. FARRER-BROWN, J.P., Director, The Nuffield Foundation.
- PROFESSOR VINCENT HARLOW, C.M.G., M.A., D.Litt., Beit Professor of History of the British Commonwealth, University of Oxford.
- MR. H. V. HODSON, M.A., Editor of "The Sunday Times", formerly Reforms Commissioner, Government of India.
- MISS MARGERY PERHAM, C.B.E., LL.D., M.A., Fellow of Nuffield College, University of Oxford.
- MISS A. I. RICHARDS, C.B.E., M.A., Ph.D., Vice-Principal of Newnham College, University of Cambridge.
- PROFESSOR K. E. ROBINSON, M.A., Director of the Institute of Commonwealth Studies, University of London.
- PROFESSOR I. SCHAPER, M.A., B.Sc., F.R.S.S.Af., F.B.A., Professor of Social Anthropology, London School of Economics and Political Science.
- MR. TRAFFORD SMITH, C.M.G., Assistant Under-Secretary of State, Colonial Office.
- PROFESSOR R. W. STEEL, B.Sc., M.A., John Rankin Professor of Geography, University of Liverpool.
- PROFESSOR SIR RALPH TURNER, M.C., M.A., Litt.D., F.B.A.
- MR. A. J. PECKHAM, Secretary to December, 1959.
- MR. R. C. H. GREIG, Secretary from January, 1960.

**Terms of Reference**

The terms of reference of the Council are to advise the Secretary of State on matters relating to the social sciences in or for the benefit of the colonial territories.

## COLONIAL SOCIAL SCIENCE RESEARCH COUNCIL

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IV.—The Rhodes-Livingstone Institute.	

## COLONIAL SOCIAL SCIENCE RESEARCH COUNCIL

### SIXTEENTH ANNUAL REPORT

#### I. INTRODUCTION

1. The Council held four meetings during the year 1st April, 1959, to 31st March, 1960. There were seven Committee meetings.

#### II. GENERAL

2. The issue of funds from the Social Science allocation during the year ended 31st March, 1960, totalled £87,144. Further grants of £9,773 and £6,416 were made to the East African Institute for Social Research and the Nigerian Institute for Social and Economic Research respectively. New grants of £3,737 were made for a demographic survey in the British territories in Africa and £3,070 for a socio-anthropological survey of Seychelles. Other grants included £105 for a visit to Dakar by the Sierra Leone Government Archivist and £1,600 for linguistic research in Sierra Leone.

3. Work continued on the final draft chapters of volumes I and II of the Regional History of East Africa and tentative plans for volume III were made.

4. The Council's open competition for field research grants attracted a record number of entries. Under the Chairmanship of Mr. H. V. Hodson, a selection board considered twenty-seven applicants and recommended four awards.

5. During the year the Council devoted much time to the consideration of the estimated requirements of funds for social research to be made available under the new Colonial Development and Welfare Acts. The total sum estimated as being required during the new quinquennium for the continuation of existing schemes and for new schemes which had already been put forward was £386,447. Full provision for this was made in the allocation for social research, but the Council's estimate for possible new research had to be reduced in common with those of other Committees and Councils. It was considered, nevertheless, that the total allocation should, if administered carefully, meet most of the requirements for social research. This allocation included the continuation of assistance at a reduced level to the East African Institute of Social Research, the West Indies Institute of Social and Economic Research and the Rhodes-Livingstone Institute to whose estimates the Council gave particular attention. This reduction does not mean that less research is to be done. A larger share of the cost is being found by local and other sources.

6. The Council also devoted much time to the consideration of programmes for new research. The Council reviewed proposals for sociological, anthropological, historical and administrative research put forward by the Colonial territories and recommended those projects which it was considered should be given priority. These included election studies in the East African territories, the social consequences of land consolidation and the changes in the administrative structure and personnel of the civil service in territories which had achieved Independence.

### III. REGIONAL INSTITUTES OF SOCIAL AND ECONOMIC RESEARCH

7. The full reports of the Institutes will be found at the end of this report as appendices I-IV.

During the year steps were taken to lessen the reliance of the East African Institute for Social Research upon Colonial Development and Welfare funds. The Institute secured a Ford Foundation grant for the establishment of a new Applied Research Unit which would enable attention to be concentrated upon matters affecting administrative and industrial problems. In future, the Institute will receive from Makerere College a gradually increasing contribution towards its running costs.

8. The Nigerian Institute of Social and Economic Research report the completion of the field work on Dr. M. G. Smith's study of changes in the structure of government in various northern states of Nigeria in the nineteenth and twentieth centuries.

9. In October, 1959, the West Indies Institute for Social and Economic Research became an integral part of the Economic Department of the University College of the West Indies. Under this arrangement the Institute was able to retain its own identity and pursue the dual function of teaching and research.

10. The Rhodes-Livingstone Institute continued its programme of research. Dr. Apthorpe began a study of their indigenous political systems of Central Africa and of their adaptation to modern conditions.

### IV. RESEARCH IN THE COLONIAL TERRITORIES FINANCED INDEPENDENTLY OF COLONIAL DEVELOPMENT AND WELFARE FUNDS

11. *Hong Kong*: A comprehensive programme of historical, social and linguistic research was carried out by the University of Hong Kong. Studies undertaken included a history of Hong Kong and the New Territories, a review of the problems of higher education, and a study of vernaculars arising from contact between the West and Asia.

12. *British Honduras*: The University College of the West Indies began compiling a history of British Honduras.

13. *Northern Rhodesia*: The Rhodes-Livingstone Institute continued its researches into the material culture of the Northern Rhodesia African tribes and those of the neighbouring Bantu. Mr. L. Gann was appointed Official Historian to the Northern Rhodesian Government and began preliminary work on the history of that territory.

14. *Sierra Leone*: Under the direction of Dr. Kenneth Little, workers from the University of Edinburgh continued investigations into the problems arising from urbanisation.

15. *Sarawak*: The first volume of the ethnological and folklore survey financed by the Sarawak Government has been prepared for publication.

## V. COLONIAL DEVELOPMENT AND WELFARE PROJECTS IN PROGRESS

### Projects undertaken by the International African Institute

16. *Handbook of African Languages*: The final volume, "Bantu Languages of Africa", compiled by M. A. Bryan was published. A further volume, "Linguistic Analyses: the Non-Bantu Languages of North Eastern Africa", has been submitted for publication by Professor A. Tucker and Miss M. A. Bryan.

### Other African projects

17. *Election Studies*: Mr. T. E. Smith's study of electoral procedures used in Tropical Africa, South East Asia and the British Caribbean was published. Also published in book form was "Five Elections in Africa: a group of electoral studies", edited by Professor W. J. M. MacKenzie and Professor K. E. Robinson.

18. *Study of Land Tenure in Zanzibar*: Dr. Middleton of the University College of London completed his report which will be published in the Colonial Research Studies series.

19. *Study of Land Tenure and Land Usage among the Swazi*: Mr. A. G. B. Hughes continued his investigations among the Swazi which will probably now take four years instead of three to complete.

20. *The Ahmadiya Movement in West Africa*: Arrangements for the publication of Mr. Fisher's report were undertaken by the Nigerian Institute of Social and Economic Research.

21. *Study of the Acholi, Uganda*: Dr. Girling's report was placed with the printers for publication in the Colonial Research Studies series.

22. *Gwembe Dialect Survey*: Mrs. Carter submitted a further report to the Council on the progress of her study. Heavy rain hampered the last stages of her field work and delayed completion of the final report.

23. *Study of the Samburu tribe in Kenya*: Mr. Paul Spencer continued his investigations among the Samburu and Rendile tribes of Kenya.

24. *Study of the Mbemba of Southern Nigeria*: Miss Harris has now submitted her final report.

### Other projects

25. *History of Aden*: Dr. R. J. Gavin returned from a visit to Aden and is now preparing his material for publication.

26. *Social Organisation of an Arab tribe in Aden*: Mr. J. G. Hartley, a successful candidate in the 1959 competition for field research grants, continued his Study of an Arab tribe in Aden.

27. *Study of Indians in a plural society*: Dr. Benedict's report relating to Mauritius will be published in the Colonial Research Studies series.

28. *Development of Trade Unions in the Colonies*: Mr. Warmington, Research Officer at the London School of Economics, continued his investigations into the development of trade unionism in the colonies.

29. *Social and Anthropological survey of the Seychelles*: Dr. Benedict of the London School of Economics travelled to the Seychelles in March, 1960, to undertake a social and anthropological survey there.

30. *Land and Population in Fiji*: Mr. R. G. Ward, Auckland University, and a successful candidate in the 1959 competition for field research awards, made the first of two visits to Fiji.

**VI. THE STANDING COMMITTEES OF THE COUNCIL**

31. The present composition of the Standing Committees is as follows :—

*Committee on Anthropology and Sociology*

Professor I. Schapera, University of London (*Chairman*).  
 Dr. J. H. M. Beattie, M.A., B.Litt., University of Oxford.  
 Professor Daryll Forde, University of London.  
 Mr. R. S. Hudson, C.M.G., Colonial Office.  
 Mr. G. I. Jones, M.A., University of Cambridge.  
 Dr. E. R. Leach, M.A., University of Cambridge.  
 Professor P. E. Vernon, University of London, Institute of Education.

*Committee on History and Administration*

Professor Vincent Harlow, C.M.G., University of Oxford (*Chairman*)  
 Mrs. E. M. Chilver, M.A., Director of the Institute of Commonwealth Studies, Oxford.  
 Professor G. S. Graham, University of London.  
 Mr. H. V. Hodson, M.A., Editor of "The Sunday Times".  
 Professor W. J. M. Mackenzie, The Victoria University, Manchester.  
 Dr. Lucy Mair, M.A., University of London.  
 Mr. F. J. Pedler, M.A., The United Africa Company.  
 Miss Margery Perham, C.B.E., University of Oxford.  
 Professor C. H. Phillips, University of London.  
 Professor K. E. Robinson, University of London.  
 Dr. R. E. Robinson, M.A., University of Cambridge.

*Linguistics Committee*

Professor Sir Ralph Turner, M.C., University of London (*Chairman*).  
 Professor J. R. Firth, O.B.E., University of London.  
 Professor M. Guthrie, University of London.

*Secretary of the Standing Committees*

Mr. E. T. Barnes, Research Department, Colonial Office.

**VII. PUBLICATIONS BY WORKERS ASSISTED FROM COLONIAL DEVELOPMENT AND WELFARE FUNDS**

32. Publications by workers assisted from Colonial Development and Welfare funds (new publications in the year under review and additions to the list of publications noted in the Fifteenth Annual Report) are:—

Ardener, E. W. (*with* D. W. McRow).—"Cameroons Mountain", *Nigeria*, 62, 1959.

Bryan, M. A.—"The Bantu Languages of Africa", *Handbook of African Language*, Part IV, 1959.

Fisher, H.—"Ahmadiya in West Africa", *West Africa*, No. 2216, 21st November, 1959.

Hogg, V. W.—"Nigeria", *Road International*, No. 35, Winter 1959-60.

Jayawardena, C.—"Marital Stability in Two Guianese Sugar Estate Communities", *Social and Economic Studies*, Vol. 9, No. I, March, 1960.

Lloyd, P. C.—“Some Notes on the Yoruba Rules of Succession and on Family Property”, *Journal of African Law*, Vol. 3, No. 1, Spring 1959.

“The Yoruba Town To-day”, *The Sociological Review*, Vol. 7, No. 1, July, 1959.

Perlman, M. L.—“The Structure of Settlements in Toro”, E.A.I.S.R. Conference Paper, December, 1959.

“Property Rights of Women”, paper read at “The Status of Women in Relation to the Marriage Laws” (Uganda) Conference, sponsored by the Uganda Council of Women.

Prothero, R. M.—“Map of population distribution in the Northern Region of Nigeria: 1/1,000,000”. Published by Director of Overseas Surveys, 1959; D.O.S. (Misc.) 237.

Richards, Dr. Audrey—“East African Chiefs”. Faber 1960. (Collaborators: J. La Fontaine; J. H. Scherer; J. W. Tyler; P. Reining; J. H. Beattie; L. A. Fallers; P. Baxter; J. Middleton; D. Stenning; B. K. Taylor; A. W. Southall; E. H. Winter; E. M. Chilver; G. Liebenow).

Smith, M. G.—“The Hausa System of Social Status”, *Africa*, Vol. XXIX, No. 3, July, 1956.

“Social and Cultural Pluralism”, *Annals of the New York Academy of Sciences*, January, 1960.

“Dark Puritan”, *Caribbean Quarterly*, Vol. 5, No. 4, pp. 284-291, June, 1959. Vol. 6, No. 1, pp. 48-59, March, 1960.

Comment on “The Relation between Plantation Systems of the New World” by R. N. Adams, *Plantation Systems of the New World*, Pan American Union, Social Science Monographs VII, Washington, D.C., pp. 81-2, October, 1959.

“The British Caribbean”, *New Horizons in the Caribbean*, World Alliance of Y.M.C.A.'s, Geneva, pp. 12-23, 1959.

Smith, R. T., and Jayawardena, C.—“Marriage and the Family amongst East Indians in British Guiana”, *Social and Economic Studies*, Vol. 8, No. 4, December, 1959.

Southall, A. W.—“Alur Homicide and Suicide”, *African Homicide and Suicide* ed. P. Bohannan, Princetown 1960 “A note on Local Descent Groups” *Man*, No. 90, April, 1959.

Van Velsen, J.—“Notes on the History of the Lakeside Tonga of Nyasaland”, *African Studies*, Vol. 18, No. 3, 1959.

“The Missionary Factor in the History of the Lakeside Tonga”, *Rhodes-Livingstone Journal*, No. 26, 1960.

#### **Papers to be Published**

Ardener, E. W.—“Social and Demographic Problems of the Southern Cameroons Plantation Area”, Proceedings of the E.A.I.S.R./I.A.I. Conference, January, 1959, to be published by O.U.P.

Ardener, E. W., and Warmington, W. A.—“Plantation and Village in the Cameroons”, to be published by O.U.P.

## APPENDIX I

**EAST AFRICAN INSTITUTE OF SOCIAL RESEARCH**  
**REPORT OF THE CHAIRMAN OF THE EXECUTIVE**  
**COMMITTEE, 1959-60**

1. Effective steps were taken during the course of the year to lessen the dependence of the Institute on the Colonial Development and Welfare Fund. After a year of planning and negotiation, it was announced that the Ford Foundation had made a grant to enable the Institute to establish an Applied Research Unit consisting of a Research Secretary and three Research Workers for an initial period of three years. For over ten years the Institute's own staff and its associated workers have been engaged in numerous studies designed to increase knowledge of social and economic conditions in East Africa and the results of these have been published in books and articles. The central task of the Institute will continue to be basic research of this type which, in addition to increasing the store of fundamental knowledge available, often provides information of immediate practical use. An additional need exists, however, for the solution of specific problems which arise for Governments, both Central and Local, industrial organisations and other bodies concerned with development in East Africa. The new Unit will be particularly concerned with this type of research which has a definite practical objective in view. It is hoped that the results of the work of the Applied Research Unit will be such that it will be enabled to continue its work, after the spending of the Ford Foundation Grant, with the assistance by way of grants and fees of the various Governments and private bodies mentioned above.

Makerere College also agreed to contribute a gradually increasing amount to the Institute for the coming year and subsequent years of the 1961-66 quinquennium.

The Advisory Committee of the Institute met in November. Considerable interest in the plans for the Applied Research Unit was shown by delegates from Kenya and Uganda. Unfortunately none from Tanganyika were present. There is every prospect that the work of the Applied Research Unit will provide a field for much more positive and fruitful joint planning by official territorial and other representatives on the Advisory Committee.

2. *Staff:*

Professor A. W. Southall	...	Chairman.
Dr. D. J. Stenning	...	Applied Research Unit.
Mr. H. W. Ord	...	Senior Research Fellow.
Mr. R. G. Abrahams...	...	Junior Research Fellow.
Mr. J. C. Woodburn	...	Junior Research Fellow.
Mr. M. L. Perlman	...	Junior Research Fellow.
Mr. A. J. Maleche	...	Junior Research Fellow.
Mr. F. K. Kamoga	...	Research Assistant.
Miss G. B. Hunter	...	Administrative Secretary.
Miss D. E. Jennett	...	Publications Secretary and Librarian.

*Associates:*

Mr. L. Gerlach	...	U.S. Educational Commission (Fulbright).
Mr. J. Pilgrim...	...	Goldsmiths' Company.
Mr. J. S. Read	...	School of Oriental and African Studies.
Professor M. H. Segall	...	Ford Foundation.
Mr. A. Sommerfelt	...	Norwegian Research Council.
Dr. M. Southwold	...	International African Institute.
Mr. P. Spencer	...	C.S.S.R.C. and William Wyse Studentship.

Dr. Stenning, a former research fellow of the Institute, has been appointed Research Secretary in charge of the Applied Research Unit and hopes to arrive in East Africa in July.

Mr. Ord has continued his collection of case material for his survey of public and private capital investment in East Africa. Mr. Abrahams completed his period of

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field work among the Nyamwezi at the end of March and is returning to Cambridge to write up his material. Mr. Woodburn is nearing the completion of his field study of the Hadza click-speaking hunting bands in Northern Tanganyika. He has visited nearly all camps and mapped out the complex network of informal relationships which binds the society together. Mr. Perlman has collected detailed case histories from members of the rural community among whom he has been living in Toro. He is endeavouring to isolate the relevant factors in the context of regular and irregular marriages, male and female migrant labour and economic differentiation. Reliable data can only be collected in such a community where neighbours are so well known both to the investigator and to one another that there are too many cross checks for errors to pass unnoticed.

Mr. Maleche, an old student of Makerere College, graduate of Cambridge University and of Ohio University, has been appointed to extend the study of wastage among primary school leavers. This study was started by Professor Southall at the urgent request of the Uganda Minister of Education and Labour. The field investigation was carried out by Mr. F. K. Kamoga, and Mrs. Susan Elkan subsequently assisted with the analysis and wrote the first report. This evoked considerable official interest and a desire to put the enquiry on a wider long-term basis. Plans are now under consideration for including Kenya and Tanganyika in an East Africa wide survey.

Mr. Gerlach has nearly completed his period of field work among the Digo of the Kenya coast. In this society the ingredients of traditional structure, pagan belief, slavery, Islam and colonial administration have led to a very intricate manipulation of cultural alternatives and resulted in the maintenance of strong tribal feeling despite great apparent diversity. Mr. Pilgrim in his study of the Kipsigis has concentrated especially upon the problems of controlling fragmentation and an intensive structural analysis of local communities. The Kipsigis have changed from predominant pastoralism with shifting cultivation to enclosed agriculture and cattle keeping with maize and, more recently, tea production for cash. Land inheritance rules were influenced by traditional cattle inheritance. It remains to be seen whether the Kipsigis can succeed, both on paper and on the ground, in maintaining the minimum size of smallholdings by restricting the inheritance rights of sons.

Mr. Read intends to make comparative studies of customary law in two different areas of Uganda. He is also exploring the ground for the Nuffield sponsored scheme of the School of Oriental and African Studies for a "Restatement of African Customary Law". He arrived in Uganda in January. Professor Sgall is doing a pilot survey of the differences of acculturation and especially of perception among different categories of the population of Ankole. Mr. Sommerfelt has extended his study of the Konjo to neighbouring parts of the Belgian Congo, where the pattern of relevant factors provides a valuable contrast to that in Uganda.

Dr. Southwold, a former research fellow of the Institute, has returned with a grant from the International African Institute, to carry out comparative studies of village structure in Buganda on the basis of sampling for royal, official and private estates, degree of subdivision and sale, climatic and soil variation. Mr. Spencer has almost completed his study of Samburu tribal structure from ecological, social, economic and ritual aspects. He has also extended his study to the Rendille, neighbours of the Samburu in Kenya's Northern Frontier District.

### 3. Departures:

Dr. P. A. Lienhardt spent the final months of his tour in the area of Kilwa in the Southern Province of Tanganyika, rounding off his field study of Arabs in East Africa and returned to Oxford in July. Dr. Van Velsen took up a teaching post at the University of Rhodesia and Nyasaland in June, but returned to Uganda for a short field trip from December to February to complete his work on the Kuman. Mr. G. E. T. Wijeyewardene spent the final months of his field tour at Mambrui on the Kenya Coast and returned to Cambridge in December.

Of the associates, Mr. C. H. W. Howe completed his research in May and returned to Boston and Mr. J. D. Nyhart went on to Nigeria in December to continue his study of the legal aspects of financial institutions of economic development.

#### 4. Conferences

The usual Institute conference was held in July, at which the following papers were read:

The Dynamics of Samburu Religion ...	P. Spencer.
The Collection of Swahili Literature and Its Relation to Oral Tradition and History ...	J. W. T. Allen, Makerere College.
Land Ownership in the Kipsigis Reserve ...	J. Pilgrim.
Report on Current Research in Kampala ...	V. G. Pons, Makerere College.
Hadza Kinship ... ..	J. C. Woodburn.
Preliminary Report on Study of Kinship and Marriage in Toro ... ..	M. L. Perlman.

Since four different Institute research workers were interested in the Coast situation from different points of view, the Chairman held a coastal conference in May, at Pangani, Tanga Province, through the kind co-operation and assistance of the District Commissioner. The following papers were read:

Some Aspects of Digo Social Structure ...	L. Gerlach.
Kinship and Ritual in the Swahili Community ... ..	G. E. T. Wijeyewardene.
Social Organisation and Ritual in Kilwa ...	P. A. Lienhardt.
The Influence of Swahili Culture in Nyamwezi	R. G. Abrahams.

The December Conference included miscellaneous papers from economists and sociologists on their current research as follows:

The Uganda Development Corporation and the Promotion of Entrepreneurship ..	J. D. Nyhart.
The Employment of Capital in East Africa...	H. W. Ord.
The Structure of Settlements in Toro ...	M. L. Perlman.
A Preliminary Report on Psychological Research in Ankole ... ..	M. H. Segall.
Land and Leadership in a Ganda Village ...	M. Southwold.
Mambrui: Status and Social Relations in a Multi-Racial Community ... ..	G. E. T. Wijeyewardene.

The conference concluded with a Symposium on African Conceptions of Health and Disease, to which contributions were made on the Ganda, Toro, Konjo, Kuman, Sebei, Kipsigis, Samburu, Nyamwezi, Digo and Swahili. The professors of Pediatrics and Preventive Medicine, the Director of the Medical Research Council Infantile Malnutrition Research Unit and other medical colleagues also contributed.

#### 5. Publications:

*East African Chiefs: A Study of Political Development in some Uganda and Tanganyika Tribes* edited by Audrey I. Richards. Faber and Faber for E.A.I.S.R.

##### *East African Studies Series:*

- No. 12. *Crops and Wealth in Uganda* by C. C. Wrigley.  
 No. 13. *Tribal Maps of East Africa and Zanzibar* by J. E. Goldthorpe and F. B. Wilson.

##### *Other Papers:*

- A. W. Southall: "Alur Homicide and Suicide" in *African Homicide and Suicide* edited by Paul Bohannan. Princeton University Press.  
 "A note on Local Descent Groups". *Man*, April, 1959, No. 90.  
 "The Alur" in *East African Chiefs* edited by Audrey I. Richards. Faber and Faber.  
 H. W. Ord: "East African Companies" in *East African Economics Review*, Vol. 7, No. 1, 1960.  
 P. A. Lienhardt: "The Mosque College of Lamu and its Social Background". *Tanganyika Notes and Records*, No. 53, October, 1959.

6. *Visitors:*

Among the many visitors to the Institute were the following: Mr. and Mrs. Francis Sutton and Miss Dorothy Soderlund of the Ford Foundation; Professor Sol Tax, Chicago University; Mr. Eliahu Elath, Israeli Ambassador to U.K. and Mr. Ben-Horin, Director, Asian-African Division of the Israel Foreign Ministry; Dr. Davies, Dean of the Institute of Psychiatry, London; Dr. Prothero, University of Liverpool; Mr. Henry Dietz, Department of State, Washington; Mr. Acharya Kalelkar, Vice-President, Indian Council for Cultural Relations; Mrs. Vera Micheles Dean, Foreign Policy Association, University of Rochester; Mr. Jacoby, F.A.O.; Countess Johannishus, Sweden; Mr. M. J. Wantman, Education Testing Service, Princeton; Mr. E. M. Woodman, Ford Foundation; Mr. H. Briggs, Labour Adviser, Unilever; Dr. Junod, Pretoria, South Africa; Dr. Polomé, Elizabethville, Belgian Congo; H. A. Fosbrooke, Director of the Rhodes-Livingstone Institute; Mr. and Mrs. S. Stanley, University, Addis Ababa; and from the Department of African Studies of the University of Delhi, Messrs. Gopala Krishnan, Amba Prasad and P. K. Sircar.

## APPENDIX II

**NIGERIAN INSTITUTE OF SOCIAL AND ECONOMIC RESEARCH  
UNIVERSITY COLLEGE, IBADAN**

ANNUAL REPORT 1959-60 (1ST APRIL-31ST MARCH)

*Staff*

The Research Staff during the year was as follows:—

Dr. M. G. Smith	...	Senior Research Fellow (Anthropology) (Contract expired on 31st December, 1959).
W. M. L. Bispham	...	Senior Research Fellow (Economics) (From 1st February, 1960).
E. W. Ardener	...	Research Fellow (Anthropology).
J. S. Boston	...	Research Fellow (Anthropology) (From 1st March, 1960).
V. W. Hogg	...	Research Fellow (Economics).
S. A. Adu	...	Junior Research Fellow (Economics and Statistics).
Miss J. L. M. Dobbin	...	Research Assistant (From 1st January, 1960).

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Bursars	...	...	Mrs. F. Elumeze (Social Anthropology).
			Miss B. Fajembola (Social History).
			Mr. H. J. Fisher (Islamic Studies).
			Miss C. Gertzel (Economic History).
			Mr. K. W. J. Post (Electoral Studies).

*Programme of research*

Dr. Smith completed the field work for his study of changes in the structure of government in various Northern States in the 19th and 20th centuries. Much new information was obtained, both written and oral, from Kano, Katsina, Bornu, Daura, Maradi, Zaria, Hadeija, and Sokoto. Dr. Smith is working on this material and will be occupied with it for some considerable time because of its complexity and volume. He prepared a paper on "Hausa Inheritance and Succession" in connection with information on intestate succession in Nigeria which the Institute is compiling.

Mr. Ardener completed the fertility and marriage stability survey of the Bakweri and the manuscript is undergoing final revision for publication. In August he attended a Seminar on African Demographic Statistics in Paris where he presented a resume of the findings of this survey. His compilation of an outline grammar of the Bakweri language has proceeded.

Mr. Ardener's work on a social and economic history of the Cameroons continued, together with an examination of the problems involved in the rationalisation of land tenure in areas affected by migration.

Mr. Boston recently took up appointment and has proceeded to Idah in Kabba Province to set up his centre for field work on a study of the Igala. It is intended to make a general survey of Igala culture and a detailed study of agriculture, the language, religion, types of family organisation, and political and legal institutions. It is hoped to collect information about historical traditions and to use it both to show the internal development of the kingdom and its relation to neighbouring groups such as the Jukun, the Edo, the Yoruba and the Ibo.

Mr. Hogg has continued his work on the economics of road communications in Nigeria. He has almost completed the collection of data for an economic report on the Nigerian highways. A forecast of motor vehicle population size and fuel consumption in Nigeria in 1968 has just been completed, which is also to be used as a basis for a forecast of highway user revenues. A paper on the pattern of the internal movement of Nigerian export crops with flow maps is under preparation. Memoranda were submitted to Government on the subject of highway planning, and were used by the Federal Public Works Department in the formulation of the highway inventory which is now under way.

In October, 1959, he visited the Transportation Center at Northwestern University for two weeks, to discuss with its officials and research students problems of highway economics, and to have access to their voluminous collection of documents on transportation. Whilst there, he lectured, and took part in a seminar on the transport potential likely to exist in underdeveloped countries in the late 1960's. He also spent five days in Washington where he made contact with several international organisations such as the Transportation Division of the International Bank.

Mr. Adu continued his study of factors affecting agricultural productivity, which he has now limited to the oil palm industry. In June he undertook an exploratory tour of the Mid-West Area and in July he again toured Urhobo Division, collecting background material, arranging for field assistance, and selecting sample areas in which to carry out surveys. He later visited the Eastern Region for a similar purpose.

In October, 1959, the Federal Government requested that he be seconded for a few months to assist with the National Income Survey and for the remainder of the year he has been engaged on this task.

Miss Dobbin took up her post as Research Assistant in January, 1960. To date she has been cataloguing the Institute's research material and is compiling a bibliography for the use of research workers in the Social Sciences in Nigeria.

Mrs. Elumeze carried out fieldwork for a short study of Western Ibo culture.

Miss Jajembola, who is a research student at Oxford, spent the long vacation at the Institute carrying out field work for her thesis "The Development of Ibadan 1861-1914".

Mr. Fisher completed his study of Ahmadiya in West Africa. His thesis was accepted by Oxford University for the degree of D.Phil. Work was commenced on a revision for publication.

Miss Gertzel travelled to Nigeria from East Africa in order to do field work to amplify her thesis on "John Holt: a British Merchant in West Africa in the Era of Imperialism". She spent about six weeks in Nigeria and uncovered valuable material both from the National Archives and from research in the Delta Area.

Mr. Post toured extensively in connection with his study of the 1959 Federal Election. In the course of his work, he conducted two public opinion polls among electors in urban and rural constituencies. The results of his researches are being written up.

Mr. J. D. Nyhart, working in the Institute as an Associate Research Fellow, has been conducting an enquiry into the relationship between the growth of Nigerian enterprise, the legal forms of business organisation adopted by Nigerian businessmen, and the legal framework within which Nigerian businesses operate. He is also studying the administrative aspects of financing local business men.

Professor R. G. Armstrong, a Visiting Professor to N.I.S.E.R., whom the Institute has been glad to welcome back, has been working on Yoruba language and law; as part of this work he has examined the traditional numeral system and has proposed a new decimal system of counting, which it is intended to publish. He visited Benue

Province to collect historical materials for the Institute of Commonwealth Studies, Oxford, and the Idoma in connection with his Idoma Dictionary.

The Institute is closely associated with a research scheme which was commenced by Mr. I. G. Stewart and Mr. R. Ogley of the Department of Political Economy of the University of Edinburgh, into the pattern of import consumption and domestic production of agricultural commodities. Arising from this, the University of Edinburgh has most generously offered the Institute funds for a two-year Junior Research Fellowship—a gift for which grateful thanks are here recorded.

The Institute planned and organised a radio audience survey for the N.B.C., Enugu, which was conducted by Mr. O. Ugwumba. The data sheets have been sent to the Overseas Audience Research Department of the B.B.C. for mechanical analysis.

Professor F. A. Wells, Professor of Industrial Economics in the University of Nottingham, carried out work on the factors determining industrial productivity, with special reference to labour. This work was done as part of a project (Joint Project No. 5—Absenteeism and Labour Turnover) being fostered in several countries by the Commission for Technical Co-operation in Africa South of the Sahara and the Inter-African Labour Institute, and in which N.I.S.E.R. is taking part. The plants selected for study were a sawmill and plywood factory and a number of groundnut oil mills. The Institute is grateful to the managements of the firms concerned for the way in which they have welcomed and assisted these studies. Mr. Bispham joined the Institute towards the end of the year and is engaged on a preliminary study along similar lines in the coal industry at Enugu, and it is planned to do further research in other industries.

Professor R. Taylor Cole of the Duke University Commonwealth Studies Center and Professor R. Gray Cowan of Columbia University both spent periods of a few months at the Institute studying problems of government and public administration.

#### *Publications*

The following publications by present and by past members of the Institute, arising out of their work here, appeared during the year or were in preparation at the end of the year:—

Adu, S. A. ...	... "Statistics in a Developing Economy, with special reference to Nigeria".	Nigerian Journal of Economics & Social Studies. Vol. 1, No. 1.
Ardener, E. W. ...	... "Social and Demographic Problems of the Southern Cameroons Plantation Area".	Proceedings of the EAISR/IAI Conference, January, 1959. O.U.P. In Press.
Ardener, E. W. (with McRow, D. W.).	"Cameroons Mountain" ...	<i>Nigeria</i> , 62, 1959.
Ardener, E. W. and Warmington, W. A.	"Plantation and Village in the Cameroons".	O.U.P. In Press.
Barback, R. H. ...	... "Nigeria and the Future of the Sterling Area".	<i>Oxford Institute of Statistics Bulletin</i> , Vol. 21, No. 4.
Barback, R. H. ...	... Chapter on Nigeria's trade and development, in "The Commonwealth and Europe".	In Press. Economist Intelligence Unit.
Fisher, H. ...	... "Ahmadiya in West Africa"	<i>West Africa</i> , No. 2216, 21.11.59.
Hawkins, E. K. ...	... "Capital Formation in Nigeria and Chana, 1946-55".	<i>Oxford Institute of Statistics Bulletin</i> , Vol. 21, No. 1.
Hogg, V. W. ...	... "Nigeria" ...	<i>Road International</i> , No. 35, Winter, 1959-60.
Lloyd, P. C. ...	... "Some Notes on the Yoruba Rules of Succession and on Family Property".	<i>Journal of African Law</i> , Vol. 3, No. 1, Spring, 1959.
Lloyd, P. C. ...	... "The Yoruba Town Today" ...	<i>The Sociological Review</i> , Vol. 1, No. 1, July, 1959.
Post, K. W. J. ...	... "Registering for Nigeria's Elections".	<i>West Africa</i> , 5.9.59.

- Post, K. W. J. ... "Eve of Poll in Nigeria" ... *West Africa*, 12.12.59.  
 Post, K. W. J. ... "Federal Election, 1959—an Outside View". *Ibadan*, No. 8, 1960.  
 Prothero, R. M. ... "Migrant Labour from Sokoto Province, Northern Nigeria". Government Printer, Northern Region, Nigeria.  
 Smith, M. G. ... "The Hausa System of Social Status". *Africa*, Vol. XXIX, No. 3, July, 1959.  
 Smith, M. G. ... "Social and Cultural Pluralism". *Annals of the New York Academy of Sciences*, January, 1960.  
 Warmington, W. A. "A West African Trade Union" O.U.P., 1960.  
 Warmington, W. A. "C.D.C. and the Cameroons" *West Africa*, No. 2233, 19.3.60.

Proceedings of the 1958 N.I.S.E.R. Conference were also published.

#### *Building*

The Institute's new building is nearing completion. It is centrally situated in the University College grounds alongside the Department of Economic and Social Studies, on a fine site generously made available by the University College. It will provide more adequate accommodation for the Institute's activities than is available in its present building and will facilitate contact with colleagues in the Department.

#### *General Activities*

The Director and Research Fellows were frequently called on for advice by Government and commercial bodies. The Director continued to serve as a non-official member of the Federal-Regional Joint Planning Committee. He attended the Seminar on African Demographic Statistics in Paris in August. Mr. Ardener advised Shell-BP at Port Harcourt on some problems relating to personnel management, notably concerning Ibo attitudes to employment, as well as giving assistance to various government departments when requested. He was appointed Southern Cameroons member of the National Archives Committee. Mr. Hogg continued to serve on the Lagos Traffic Advisory Committee.

#### *Visitors*

As always, there was a large number of visitors to the Institute during the year, and the following list is far from comprehensive:—

- Dr. P. J. C. Dark, Benin History Scheme (formerly Administrative Secretary, W.A.I.S.E.R.).  
 Dr. P. K. Gopalakrishnan, Department of African Studies, University of Delhi.  
 Mr. David Brown, Mars Ltd., Slough.  
 Mr. D. N. Leich, Shell Co. (formerly Administrative Secretary, W.A.I.S.E.R.).  
 Dr. Ambaprasad, Department of African Studies, University of Delhi.  
 Dr. E. Mercer, Social Service Department, Colonial Office.  
 Dr. Daleep Singh, Department of African Studies, University of Delhi.  
 Mr. T. Haighton, Director, Inter-African Labour Institute (Brazzaville).  
 Dr. P. Okigbo, National Income Survey.  
 Mr. and Mrs. P. Leis, Northwestern University.  
 Mr. H. A. Fosbrooke, Director, Rhodes-Livingstone Institute.  
 Professor Sol Tax, President of the American Anthropological Association, and also Professor of Anthropology, University of Chicago.  
 Mr. E. R. Chadwick.  
 Professor P. J. Idenburg, Afrika Studiecentrum, Leiden.  
 Monsieur M. D'Artigue, UNESCO.  
 Mr. P. J. Foster, Centre for Comparative Education, University of Chicago.

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- Professor W. O. Brown, African Studies Program, Boston University.  
Mr. Arnold Rivkin, Center for International Studies, M.I.T.  
Mr. C. S. Whittaker, Princeton University.  
Mr. W. A. Warmington, London School of Economics.  
Professor S. Carlson, Professor of Economics, Uppsala.  
Dr. A. I. Tannous, American Department of Agriculture, Washington.  
Mr. J. F. Gehr, Agricultural Attache for West Africa, Embassy of U.S.A.,  
Monrovia.  
Miss Dorothy Soderlund, Program Assistant, Ford Foundation.  
Sir Alexander Carr-Saunders.  
Mr. W. Diebold, Director of Economic Studies, Council on Foreign Relations,  
New York.  
Professor and Mrs. Taylor Cole, Commonwealth Studies Center, Duke Univer-  
sity, U.S.A.  
Monsieur de Lusignan, Deputy Director, I.L.I., Brazzaville.  
Mr. A. Clymer, Harvard University.  
Mr. S. Fingland, Adviser on Commonwealth and External Affairs to Federal  
Government.  
Mr. J. Plimsoll, Australian Representative, U.N.O., New York.  
Mr. N. Z. Taylor, Head of Department of Economics, University College of  
Rhodesia and Nyasaland, Salisbury.  
Miss M. Perham, Nuffield College, Oxford.  
Mr. and Mrs. G. Hunter, Institute of Race Relations, London.  
Dr. C. Van den Burg, Institute of Land and Water Management Research,  
Wageningen, Holland.  
Monsieur A. M. Berthet, National Accounts Officer, E.C.A.  
Mr. D. Owen, Executive Chairman, Technical Assistance Board, U.N.  
Mr. R. Muller, Assistant to the Under-Secretary for Economic and Social Affairs,  
U.N.  
Dr. A. J. W. Spitz, Western Area Representative, W.H.O.  
Mr. K. Satrap, Deputy Resident Representative, Ghana, U.N. Technical  
Assistance Board.  
Professor L. Gray Cowan, Columbia University, U.S.A.  
Monsieur M. Hoffman, Centre d'Études Sociologiques, Paris.  
Professor F. Harbison, Princeton University.  
Mr. G. J. Lighthart, Economic Affairs Officer, E.C.A.  
Mr. Richard Cox, Institute of Directors, London.  
Mr. W. E. Moran, Jr., Director, African Programme, Stanford Research Institute,  
California.  
Mr. E. Rado, Department of Economics, University College, Ghana.  
K. de Graft Johnson, Department of Sociology, University College, Ghana.  
Mr. D. Brokensha, Department of Sociology, University College, Ghana.  
Mr. Wilton S. Dillon, Director of Research, Phelps-Stokes Fund, New York.  
Dr. Paul J. Braisted, President, Hazen Foundation, New Haven, Connecticut.  
Mr. C. M. Roelandts, Shell Company of Nigeria Limited.  
Mr. E. F. Jackson, Director, Oxford University Institute of Statistics.

R. H. BARBACK,  
*Director.*

## SOCIAL SCIENCE

## APPENDIX III

INSTITUTE OF SOCIAL AND ECONOMIC RESEARCH  
UNIVERSITY COLLEGE OF THE WEST INDIES

## ANNUAL REPORT

1st April, 1959—31st March, 1960

## STAFF

Director—H. D. Huggins

M. G. Smith  
L. E. Braithwaite  
G. E. Cumper  
D. T. Edwards  
C. O'LoughlinR. T. Smith  
L. Best  
J. Braithwaite  
C. Jayawardena  
E. R. Chang

## GENERAL

The Institute was originally established to integrate research in the social sciences in the Caribbean. In the College's view the time had arrived, by 1959–1960, for a broadly expanded programme in the social sciences in which both teaching and research would take an appropriate place. In the past, the College had undertaken teaching only for the B.A. (Genl.) but during the year a start was made with teaching for the honours degree. Understandably the senior members of the Institute were called upon to take the part for which they had been preparing for many years and to become formally members of the teaching staff of the College. A re-constituted Department of Economics was established in October, 1959 and of this the Institute became an integral part. This meant that for the period under review the members of the Institute's staff who were either transferred or about to be transferred to the teaching staff were in large measure pre-occupied with the preparation of their courses of lectures. In addition this train of circumstances led to the Institute's finding itself, during the year, largely concerned with laying plans for recruiting new members of a research staff.

The Principal and the College were of the view that while integration would have the advantage of removing any inappropriate distinction between teaching and research it was desirable that the Institute retain its distinct identity.

## ECONOMIC STUDIES

*National Accounts*

The first stage of the programme which was designed to provide a set of accounts for the area as a whole has been almost completed. Dr. C. O'Loughlin who was in charge of the project has now published accounts for British Guiana, Montserrat, Antigua and St. Kitts-Nevis-Anguilla. Dr. Braithwaite has sent to press a set of accounts for Barbados and Mr. E. R. Chang spent a year in the Windward Islands and was well advanced in the preparation of a set of accounts for those Islands. The Governments of Jamaica and Trinidad have continued to publish their own accounts annually.

Towards the completion of the first stage of the project the Institute organised during the summer of 1959, a Seminar on National Income for the social accountants and analysts in the area in order to plan for the continuation of an integrated area-wide programme for the preparation of accounts. It was accepted that in future the co-ordination of work on the preparation of accounts would be undertaken by the Federal Government and a set of principles of action for future work was sketched in the Report of the Seminar which has since been published. Already, this has been followed by a Federal publication: "The National Income of the West Indies".

The Institute has entered upon the second stage—the refinement of the broad accounts and the analysis of economic performance in crucial sectors of the island and Federal economies. As part of the project, Mr. L. Best has been working on a study which has two main aims: first, to extend the contribution of import trade statistics to national accounting and, secondly, to throw some light on the participation of an important part of the merchant sector in the economic activity of the Jamaican economy.



*Labour*

Mr. G. E. Cumper worked on the analysis of consumption and expenditure data from Barbados and British Guiana and has been preparing a short paper on "West Indian Household Budgets". He has also prepared chapters on employment and consumption for the forthcoming book, "The West Indian Economy" which he has edited.

*Study of Tourist Expenditure*

The results of the study of tourist expenditure carried out by Prof. P. Sargent Florence and Mr. G. E. Cumper have now been published.

*Economics of Agriculture*

Mr. David Edwards completed his monograph on the economics of small farms in Jamaica and sent it to the printers and has since begun to work on a general study of the West Indian agricultural economy.

*Industry Study*

Dr. H. D. Huggins continued work on a study of the integration of the bauxite industry, with special reference to the location of alumina manufacture.

**Studies in Geography**

At the end of the previous academic year Mr. David Niddrie of the Department of Geography, University of Manchester, carried out three months field work on land use in Tobago, in association with the Institute.

Through the collaboration of the American Geographical Society Dr. David Lowenthal carried out general surveys of Montserrat and Dominica focussing on the potentialities and utilization of the resources of these islands.

**SOCIOLOGICAL STUDIES***Population*

Mr. Lloyd Braithwaite collaborated with Mr. George Roberts in a joint study of the sociological aspects of population growth in Trinidad. Field work was completed and analysis of the data begun. Along with Dr. F. R. Augier, Mr. Braithwaite worked on documents relating to federation. The first draft of an introduction to these documents was drawn up. Papers dealing with the current crisis in the Federation were drafted.

*Social Structure, British Guiana*

Dr. R. T. Smith continued work on his study of the social structure of British Guiana. Mr. Chandra Jayawardena worked on the late stages of his study of processes of social control amongst East Indians in British Guiana, a project complementary to Dr. R. T. Smith's.

*Sociological Study of Land Tenure among the Maroons*

A small grant was made to Mrs. R. Nuis to undertake a field study of land tenure among the Maroons.

*Studies in Nigeria and Jamaica*

Dr. M. G. Smith carried out research in Nigeria and has prepared papers on the following: Hausa Marketing and Exchange, Inheritance and Succession among the Hausa, Kagoro Political Development, The Plural Framework of Jamaican Society and Education and Occupational Choice in Rural Jamaica.

**Other Activities**

Dr. M. G. Smith was away on leave of absence and was attached to the Nigerian Institute of Social and Economic Research.

During May, 1959 a Conference on Social and Cultural Pluralism in the Caribbean was held in New York under the joint auspices of the New York Academy of Sciences and the Research Institute for the Study of Man. Papers were presented by Dr. M. G. Smith and Mr. Lloyd Braithwaite on "Social and Cultural Pluralism" and "Social Stratification and Cultural Pluralism" respectively.

Mr. Lloyd Braithwaite acted as a Consultant to the Second Caribbean Conference on Mental Health, held in the Virgin Islands in April, 1959. He presented a paper on "The Family and the Child in the Caribbean".

Dr. R. T. Smith visited British Honduras at the request of the government to advise on the social aspects of land use.

Dr. R. T. Smith resigned to take up a post in the Department of Sociology, University of Ghana. Dr. C. O'Loughlin resigned to take up a post with the W.I. Federal Government. Dr. J. Braithwaite resigned to take up a post with the Jamaica Government.

#### AWARDS

Mr. George Cumper was awarded the degree of Doctor of Philosophy of London University. His thesis was on "The Relation of Certain Social Characteristics of the Labour Force in Jamaica and Barbados to Productivity and Economic Development".

Mr. D. T. Edwards was awarded the degree of Doctor of Philosophy of London University. His thesis was on: "Economics of Small Farming in Jamaica".

Mr. Chandra Jayawardena was awarded the degree of Doctor of Philosophy of London University. His thesis was on: "Social Structure of a Sugar Estate Community in British Guiana".

#### Seminars

A seminar of national income accountants brought together statisticians actively engaged in national income work in the West Indies (see National Accounts, above). The topics discussed included requirements of a standardized approach. Some general lectures and discussions were also included. Mr. Dudley Seers acted as consultant.

The Institute was pleased to act as host to the International Seminar on Economic Development. The co-sponsors of the seminar were The Economic Development Institute of the International Bank for Reconstruction and Development and the University College. This seminar was an important event since it was the first occasion on which the Economic Development Institute of the International Bank decided to make an experiment with its courses overseas. The Institute of Social and Economic Research was especially happy to offer this collaboration since it has had a programme for many years devoted to pioneering work of research in the field of applied economics and social change in the Caribbean area. The problems relating to economic development, planning and policy have been of especial interest in the College's programme. The seminar was in many ways complementary to the international seminar on economic development which the College held in 1957 and the Report of which has been published.

#### Projects under Active Consideration

The Ford Foundation agreed to furnish financial support for projects to be carried out on research into the economic problems arising out of the creation of the W.I. Federation. The principal topics suggested for study are the following: 1. Central Banks in the West Indies; 2. inter-island migration; 3. fiscal problems in the Windward and Leeward Islands; 4. the effect of customs union on manufacturing industries; 5. inter-island trade in agricultural products; 6. trade relations with Canada and the U.S.A. These projects would be undertaken by the Institute through a grant from the Ford Foundation.

At the request of the United States Department of Agriculture, the Institute planned to undertake a study to forecast the import demand for selected agricultural products from the West Indies and British Guiana in 1965 and 1975. This would be part of a project to assess the long-term supply and demand for agricultural produce in world markets.

#### Publications

The quarterly Journal, *Social and Economic Studies*, now in its ninth volume has appeared regularly and has achieved an encouraging international circulation.

Jayawardena, Chandra

"Marital Stability in Two Guianese Sugar Estate Communities". *Social and Economic Studies*, Vol. 9, No. 1, March, 1960

O'Loughlin, Carleen

"The Economy of British Guiana". *Social and Economic Studies*, Vol. 8, No. 1, March, 1959

The Economy of Montserrat. S. & E.S., Vol. 8, No. 2, June, 1959

The Economy of Antigua. S. & E.S., Vol. 8, No. 3, September, 1959

The Economy of St. Kitts, Nevis, Anguilla. S. & E.S., Vol. 8, No. 4, December, 1959

Smith, M. G.

Dark Puritan. *Caribbean Quarterly*, Vol. 5, No. 4, pp. 284-291, June, 1959.  
Vol. 6, No. 1, pp. 48-59, March, 1960

Comment on the Relation between Plantation Systems of the New World by R. N. Adams. *Plantation Systems of the New World*, Pan American Union, Social Science Monographs VII Washington, D.C. pp. 81-2. October, 1959

The British Caribbean. *New Horizons in the Caribbean*, World Alliance of YMCAs, Geneva, pp. 12-23. 1959

Smith, R. and Jayawardena, C.

Marriage and The Family amongst East Indians in British Guiana. S. & E.S., Vol. 8, No. 4. December, 1959

The Yale University Press, in association with the University College of the West Indies, has launched a new Caribbean Series. The first book to be published was "Free Jamaica" by Dr. Douglas Hall of the Extra-Mural Department. There was also on the press W. F. Maunder's "Employment in an Economically Underdeveloped Area".

#### APPENDIX IV

### THE RHODES-LIVINGSTONE INSTITUTE FOR SOCIAL RESEARCH DIRECTOR'S REPORT FOR THE YEAR ENDING 31st MARCH, 1960

#### I. Introduction:

The end of the year under report also marks the end of the four year period of C.D. and W. Scheme R.698. Though this report does not purport to cover that period in full, it may be convenient to examine certain aspects of the Institute's work on a four year basis rather than to adhere strictly to the period under report.

#### II. Administration:

i. *Board of Trustees*: As forecast in last year's report the Constitutional changes in Northern Rhodesia reflected in the composition of the Board of Trustees. Mr. Franklin retired on the dissolution of the Legislative Council and the Governor appointed Sir John Moffat, O.B.E., M.L.C. to the Board: he was elected Vice-President at the first meeting of the year in June, 1959. Mr. Little resigned on taking up the post of Secretary for African Education and Mr. Anderson was appointed in his place. The Board held two meetings in July and October, 1959. Membership is as follows:—

#### *Board of Trustees*

His Excellency, Sir Evelyn Hone, K.C.M.G., C.V.O., O.B.E. (President).	Governor of Northern Rhodesia.
*Sir John Moffat, O.B.E., M.L.C. (Vice-President).	
*R. A. Nicholson, Esq., C.B.E. ... (T. C. Gardner, Esq. acted for much of the year).	Minister of Finance, Northern Rhodesia.
*†G. S. Jones, Esq., C.M.G., M.B.E. ... (M.G. Billing, Esq. acted for much of the year).	Minister for Native Affairs, Northern Rhodesia.

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\* Indicates Member of Standing Committee.

† Indicates Member of Research Committee.

O. B. Bennett, Esq., O.B.E. ... ..	Rhokana Corporation, Kitwe, Northern Rhodesia.
R. H. C. Boys, Esq. ... ..	British South Africa Co., Salisbury, Southern Rhodesia.
*Professor B. A. Fletcher, M.A., B.Sc.	Vice-Principal, University College of Rhodesia and Nyasaland.
J. H. Ingham, Esq., C.M.G.... ..	Secretary for Local Government and Social Services, Nyasaland Protectorate.
R. Howman, Esq., B.A. ... ..	Ministry of African Affairs, Southern Rhodesia.
J. B. W. Anderson, Esq. ... ..	Native Courts Adviser, Northern Rhodesia.
J. M. Mwanakatwo, Esq., B.A. ... ..	Education Officer, Kasama Junior Secondary School, Northern Rhodesia.
M. J. Lamb, Esq. ... ..	Under-Secretary to the Prime Minister and Cabinet Office: Federation of Rhodesia and Nyasaland.
F. M. Thomas, Esq., B.A. ... ..	Provincial Commissioner, Central Province, Northern Rhodesia.
L. Tucker, Esq. ... ..	Rhodesia Selection Trust, Salisbury, Southern Rhodesia.

ii. *Committees and Consultants*: The composition of the Standing Committee was adjusted in June, 1959. It now consists of Sir John Moffat as Chairman, the Minister of Finance, the Minister of Native Affairs, the Secretary for African Education and the Director, of whom only the three first-named are Trustees. This Committee met three times during the year whilst further business was transacted by circulation of papers.

Due to overseas movements it was not possible to call a meeting of the Research Committee, but members were kept in touch as far as possible by correspondence.

In the course of the year the Director was able to make personal contact with all the Consultants of the Institute: Professor Gluckman resigned from his position of Consultant, but stayed on the Editorial Board.

The composition of the Committees and a list of consultants are as follows:—

#### *Committees and Consultants*

##### *Standing Committee:*

As indicated in paragraph II and including the Secretary for African Education, W. C. Little, Esq., M.A., O.B.E. and the Director.

##### *Research Committee:*

Professor B. A. Fletcher, M.A., B.Sc. (Chairman).	Vice-Principal, University College of Rhodesia and Nyasaland.
J. Desmond Clark, Esq., Ph.D., C.B.E.	Director, Rhodes-Livingstone Museum, Livingstone, Northern Rhodesia.
H. A. Fosbrooke, Esq., M.A. ... ..	Director, Rhodes-Livingstone Institute.
G. S. Jones, Esq., C.M.G., M.B.E....	Minister for Native Affairs, Northern Rhodesia.
W. C. Little, Esq., M.A., O.B.E. ... ..	Secretary for African Education, Northern Rhodesia.

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\* Indicates Member of Research Committee.

*Professor J. Clyde Mitchell, B.A., D.Phil.	Professor of African Studies, University College of Rhodesia and Nyasaland.
C. A. L. Myburgh, Esq., M.Com., Ph.D.	Deputy Director, C.A. Statistical Office, Salisbury, Southern Rhodesia.
Roger Summers, Esq. ... ..	Keeper of Antiquities, National Museum, Southern Rhodesia.

*Consultants:*

Professor H. Blumer, Ph.D. ... ..	Department of Sociology, University of California, Berkeley, U.S.A.
*Professor Elizabeth Colson, Ph.D. ...	Professor and Chairman of Department of Anthropology, Brandeis University, U.S.A.
Professor K. Kirkwood, B.Sc., M.A.	Rhodes Professor of Race Relations, St. Anthony's College, Oxford.
Professor R. H. Steel, B.Sc., M.A. ...	Professor of Geography, University of Liverpool.

*Editorial Board:*

As indicated \* above, and including Professor M. Gluckman of the University of Manchester.

iii. *Headquarters Administration:* The Headquarters and Research staff are as follows:—

*Staff*

Director ... ..	H. A. Fosbrooke, M.A.(Cantab.).
Administrative Secretary ... ..	G. G. Murrell.
Research Officer, Headquarters ...	A. A. Dubb, B.A.(Witz.), B.A.Hons. (Rhodes).
Librarian ... ..	Mrs. U. K. N. Stevenson, B.A.(Cantab.), F.L.A.
Librarian's Assistant ... ..	D. C. Mumba.
Statistical Assistant ... ..	E. A. Mbewe.
Research Officers ... ..	R. J. Apthorpe, D.Phil.(Oxon.), B.A.Hons.(Durham), W. J. Argyle, B.A., B.Litt.(Oxon.), Dip. Soc. Anthropol. G. Kay, M.A.(Liverpool). P. J. M. McEwan, M.A.(Edin.). P. J. A. Rigby, B.A.(Cape Town).
Local Research Officers ... ..	Miss A. C. Tweedie, B.A.(Oxon.), Kasama, Northern Rhodesia. R. Newton-Howes, Salisbury, Southern Rhodesia.

The post of Research Secretary was redesignated Research Officer Headquarters as an indication of the fact that the holder, in addition to his routine duties, was expected also to make a contribution to research. After holding this post for two years, Dr. Apthorpe undertook a field assignment as from November, 1959: Mr. Dubb, from the Institute of Social and Economic Research, Rhodes University, will take his place as from 1st April, 1960.

Mention was made last year of the increasing complexity of the finances of the Institute, and attention drawn to the necessity of a readjustment in the organisation. A first step was taken when the Administrative Secretary's contract expired: a replacement was sought with accounting experience. It was also considered, in view of the duties involving control of staff, maintenance of vehicles and upkeep of buildings and grounds, that the post was best filled by a man.

Later in the year a critical audit report necessitated further adjustments. The services of the outside accountant were terminated by Trustees and a Government accountant is now employed on a spare-time basis: the latter's qualified experience in governmental systems of accounting is of great advantage when so many of the transactions are with Government Departments and with the audit conducted by Government auditors. The arrangement has the disadvantage that all accounting discussions and consultations have to be conducted out of office hours, but the staff concerned have loyally accepted this burden without complaint. By the close of the year the system was working smoothly and it will be possible in future to present the accounts in a form acceptable to the auditors. In this connection it has been decided to publish the accounts with the annual report to be laid on the table of the Legislative Council of Northern Rhodesia.

In view of the growing amount of legal advice which the Institute has been obliged to seek, authority was obtained to employ a legal firm on a retainer basis. With the aid of these advisers amendments have been made to the terms of service, including the provident fund scheme, which are due to come into force as from 1st April, 1960. In unifying the terms of service, the African staff receive provident fund benefits on the same rate as expatriate staff, viz: 10 per cent employer's contribution and 5 per cent employee's, in place of the previous  $7\frac{1}{2}:7\frac{1}{2}$  per cent.

iv. *Buildings*: No building works were undertaken during the year but recent additions took on a pleasing established appearance as trees and shrubs, hedges and lawns matured.

The pressure on shelf space in the library and the over-crowding in the seminar room when conferences and meetings are held emphasises the necessity for a new library and an enlarged hall. Modest but suitable plans have been drawn up for both, which would also enable the space vacated to be suitably utilised as additional office and study space, but no attempt has yet been made to raise the funds for this extension.

v. *Recruitment*: Events in the political sphere, both locally and throughout Africa, have undoubtedly had an adverse effect on recruitment. Vacancies, now handled through the Inter-University Council for Higher Education Overseas, are not easily filled, but appointments were made to three research posts in the course of the year, a sociologist, a geographer and a linguist. These acquisitions were offset by one resignation almost at completion of contract, and another after only five months' service.

### III. *Finance*:

Local subscriptions continued on the previous scale, yielding about £18,000 per year. A further £9,392 was received during the year from various Governments and quasi-governmental organisations in respect of commissioned research. Expenditure kept pace with income to within a few hundred pounds, but the accumulated balance gave the Institute an appearance of affluence which it does not in fact possess. This led to the "freezing" of our contribution from the Colonial Development and Welfare fund with a result that claims against allocated funds amounting to some £11,500 have not been met. This sum excludes certain contributions to publications, the position concerning which has not been clarified.

### IV. *Research*:

Whilst the greater proportion of the Institute's research is undertaken by its own staff, the work receives considerable reinforcement from affiliated workers from overseas. These may be fully financed by some foundation or university, in which case a fee is charged for the Institute's services: in other cases a worker may have received a grant insufficient to carry out his programme, in which event the fee may be waived and a supplementary grant made from Institute funds. The work of both staff and affiliates is described in the appropriate sections hereunder. It will be noted that the Institute's programme covers all the communities, European, Asian and African, and all three territories of Central Africa.

#### A. *African Studies*:

i. *Sociographic Work*: The fieldwork commitments in this sphere were luckily completed when Dr. Bettison accepted a teaching appointment in Australia, leaving

Rhodesia in June, 1959. But analysis of the field material continued till the end of the year on lines laid down by Dr. Bettison, whilst he and his helpers continued to prepare a steady stream of publications during the year. Appendix II shows two Communications issued in the period under report, with one further Communication and three articles either in or ready for the press. Some of these cover the work done in the Blantyre/Limbe area, and in Lusaka, whilst others draw comparisons between the data which Dr. Bettison collected whilst working in the three territories of Central Africa.

ii. *Rural Work*: Mr. John Argyle, the Field Anthropologist, concluded his fieldwork amongst the Soli and returned in January to Oxford, where he is now engaged on the writeup of his material.

Dr. Apthorpe moved over in November from his post of Research Officer Headquarters, to a field assignment involving a study of the indigenous political systems of Central Africa and of their adaptation to modern conditions. Whilst taking up his new task Dr. Apthorpe completed the writeup of his earlier research among the Nsenga, preparing one paper for this Institute and one for the Rhodes-Livingstone Museum. He also completed a joint paper with Dr. Bettison arising from a visit to the Institute's field of study in Nyasaland.

Miss Tweedie continued her work amongst the Bemba of Kasama district, where with the aid of three Research Assistants she is studying the rural economy. Another study supported by the Northern Province Development Commissioner was launched in July when Mr. George Kay took up his post as Human Geographer and established himself in Fort Rosebery, working in conjunction with the Health and Nutrition Scheme there.

Dr. and Mrs. Roumequere, affiliates from the Sorbonne and holders of a research grant from the International African Institute, continued to receive assistance in funds and transport in their study of the Kalanga group of Southern Rhodesia. The ramifications of this extensive study led them as far afield as the Okovango area of Bechuanaland and to the Northern Transvaal.

Mr. La Muniere of Harvard arrived in December, 1959 with a Ford Foundation Foreign Area Training Fellowship, to commence his study of the socio-economics of the fishing industry, and by March was established in the field on the Kafue River, which he is making the primary region of study.

iii. *Urban Work*: Efforts were made to recruit an Urban Sociologist in place of the candidate who at the end of last year failed to take up his post, and/or a Sociographer to replace Dr. Bettison, but unfortunately no appointment was made and the work necessarily fell into abeyance. The only urban research conducted was the enquiry into Absenteeism and Labour Turnover, organised on a continent-wide basis by the Inter African Labour Institute, itself a protegee of the Commission for Technical Co-operation for Africa South of the Sahara. For reasons of finance and recruitment this enquiry got away to a slow start, but since the middle of the year recording and questioning have been going on in factories in Ndola, Salisbury and Bulawayo.

#### B. *European Sociology*:

Mr. McEwan continued his work, commenced March, 1959, in Salisbury on the adaptation of European immigrants into Southern Rhodesia society. In this he was assisted by his wife, also an Edinburgh graduate (psychology and statistics) who remained in sole charge of the project during Mr. McEwan's two month visit to England and Israel in connection with his enquiry. Response to questionnaires and to interviews has been good, and a large quantity of material is now being collated and analysed.

#### C. *The Asian Community*:

An affiliated Fulbright worker, Professor Dotson, a sociologist from Connecticut University, assisted by his wife, a Ph.D. from Yale, commenced his study of the Asian communities of Central Africa in July, 1959. Based at the Institute he has concentrated mainly on Lusaka during this first year of study, and his application for a further year's study having been granted he intends to supplement the extensive work already undertaken in other areas by more intensive study.

#### D. *Linguistics:*

Mrs. Carter, lately of the School of Oriental and African Studies, was given a C.S.S.R.C. grant for the study of Tonga: circumstances have necessitated the work originally planned for one year being extended over a longer period.

Dr. I. Richardson of S.O.A.S. is spending a year on a study of Bemba. It was arranged that Mr. P. Rigby, appointed as socio-linguist to the Institute, should commence his project by studying Bemba under Dr. Richardson but unfortunately after five months in the field Mr. Rigby resigned.

#### E. *Miscellaneous:*

Additional work tackled by affiliates covered a variety of subjects. Mr. R. Rotberg, an American Rhodes Scholar at Oxford, continued in the field till January, 1960, working on his study of the part played by the Missions in the development of Northern Rhodesia. Assisted jointly by C.S.S.R.C. and the Institute, he received an additional grant from the Rockefeller Foundation which enabled him to undertake more extensive travelling than would otherwise have been possible.

Dr. Monica Cole of the University of North Staffordshire was granted affiliation to undertake a four month (June–September, 1959) study of the relationship between the distribution of the vegetation and the geomorphology of Central Africa.

Mr. M. Miracle of the Food Research Institute, Stanford University, California, was resident at the Institute for some time in connection with his Africa-wide study of Maize: another visitor was Mr. Dean, an American graduate student engaged on a study of African marketing.

Mr. Sutcliffe, the student affiliated to the Institute in connection with the Voluntary Service Overseas organisation, returned to England in September, 1959 to take up his place as an undergraduate at Worcester College, Oxford. In addition to rendering general assistance in all departments, he completed a study, in connection with a wider Social Security enquiry undertaken by the Director, on the degree to which Africans were making use of existing saving facilities.

#### F. *Future Research Plans:*

Much time and thought was devoted throughout the year to the formulation of a research programme for the next four years. After taking into consideration the views of the Government departments concerned in Northern and Southern Rhodesia and Nyasaland, and after discussions with the University College Social Science Research Committee, a finalised programme was accepted by Trustees at their last meeting and is now under consideration by the Colonial Social Science Research Council.

At the time of writing Trustees have authorised the filling of the posts of Sociographer or Urban Sociologist, Agricultural Economist, and Social Psychologist, the last named to conduct a study into the impact of mass media on African opinion throughout the Federation.

Plans for Phase II of the Kariba study are developing satisfactorily. Dr. Elizabeth Colson paid a short visit to the area at the request of the Northern Rhodesia Government in January, 1960 and the opportunity was taken of discussing the second study of the Gwembe Tonga to ascertain the adaptations in their social and economic life arising from their move. It is hoped that the original team, Professor Colson and Mr. T. Scudder, will be in the field once again for the academic year October, 1962–September, 1963.

The Northern Rhodesia Government has formulated comprehensive plans for detailed survey work into the Kafue River Basin, setting aside £200,000 for the work and applying to the United Nations Special Fund for a similar sum. The Institute was asked to formulate plans for research into the human aspects of the problem and submitted a scheme, incorporated into the over-all plan, extending over three years and costing £42,000.

#### V. *Public Relations:*

i. *Local:* The steadily rising membership reveals the increased interest in the Institute shown by the public of Northern Rhodesia. The published works of past and present members of staff reviewed in the local press, talks to clubs and societies, broadcasts, evening seminars and conferences have all helped to make the Institute's



work better known and appreciated throughout Central Africa. A picture poster prepared by the Northern Rhodesia Information Office, directed to the literate African and distributed throughout all three territories, has made our existence more widely known in the rural areas. It is a source of gratification and surprise that our workers are so well received wherever they go: only in cases of acute political tension has research work been handicapped through lack of co-operation from the African. The Director visited Nyasaland twice during the year, and made frequent visits to Salisbury, Southern Rhodesia.

ii. *Overseas*: Rising overseas membership, queries on specific topics, and enquiries concerning affiliation all testify to increasing interest in the Institute. On his three month visit to Europe the Director visited London, Oxford, Cambridge, Manchester and Liverpool in connection with Institute matters, and had discussions with colleagues at Brazzaville, Ibadan and Jos, West Africa; at Stresa in Italy and at Makerere and Nairobi in East Africa.

iii. *Visitors*: The number of visitors maintained the level of the last two years, being in the region of 400. Sir Evelyn Hone, our President, honoured us by opening the Fourteenth Institute Conference in February, and in the course of the year nearly all of our Trustees succeeded in paying us a visit. No attempt is made to record our Lusaka visitors, who represent every walk of life in the capital, Government and Municipal, European, Asian and African.

The University College at Salisbury was well represented on our visitors' list, the names including Dr. Adams the Principal, Professor Fletcher, Vice-Principal, Professors Stokes and Harker, Drs. Rogers, Ranger, Lewis and Van Velsen, and Messrs. Reed and Brown. Other visitors from Salisbury, and from other African territories, are listed in Appendix I. The United Kingdom list and United States list reveal the number of academicians who are now travelling in Africa, and emphasise how far removed are the days when a research assignment in Africa meant academic isolation.

iv. *Institute Conferences*: It proved possible to organise five Conferences in the four year period 1956-1960. After a General Conference in April, 1957 the 11th Conference, Lusaka, January, 1958, dealt with the interrelations between rural and urban life in Central Africa. The 12th Conference was held in Bulawayo in October, 1958 on the subject of social relations in Central African industry, and the 13th, back in Lusaka in February, 1959, discussed the adaptation of indigenous political systems to modern conditions. The published proceedings of these Conferences are listed in Appendix (II).

For the 14th Conference, held at the Institute from 26th to 29th February, 1960 the subject chosen was Myth in Modern Africa. After the opening by the Governor and an introduction to the theme of the Conference by the Director, our guest speaker, Professor Monica Wilson of Cape Town University, read a paper on *Myths of Precedence*. A group of papers followed dealing with Central Africa, some on a general basis and some confined to specific tribal subjects: the speakers were the Rev. F. J. Sillett from Luanshya, Dr. Apthorpe on mythical African political structures, Mr. Argyle on the Soli, Mr. St. John Wood of the Provincial Administration and Messrs. White and Chinjavata, the Land Tenure Adviser and his assistant. After Dr. Richardson and Mr. Rigby had discussed Language and Myth, contributions were submitted on comparative areas of study, Southern Rhodesia (Dr. Rogers), East Africa (Mr. Friedland), Ruanda (M. d'Hertfelt), Mexico (Professor Dotson) and India (Mr. Khurana). The proceedings are due for publication shortly.

v. *Conferences Attended*: The Director attended the Cambridge Summer Conference, August-September, where the subject discussed was "Rural Economic Development". He then proceeded to the 4th World Congress of Sociology at Stresa, where many valuable contacts were made or renewed.

The Director was also invited to Nyasaland in November to address the inaugural meeting of the Nyasaland Council of Social Services.

vi. *Courses and Seminars*: In the course of the year the Institute was visited by numerous courses, including the International Affairs Seminar, a group of American High School students. From nearby we entertained and talked to a group of African advanced Mine employees, a couple of Police courses, and several courses from the

Chalimbana Native Authority Development Centre, including groups of Senior African Civil Servants, African business men, and European and African administrators.

The Northern Rhodesia Society, based on Livingstone, inaugurated a Lusaka section, making the Institute its headquarters. Lusaka members of the Society are invited to evening lectures and seminars on the same basis as our associate members, and the joint meetings are better attended than would be the individual meetings organised by each group separately.

The following is a list of subjects and speakers for the last year:—

- “*Perfection in Education*”, by Dr. B. Lamar Johnson, Professor of Higher Education, University of California.
- “*National Monuments*”, by Dr. Desmond Clark, Director of the Rhodes-Livingstone Museum.
- “*University Development in the Congo*”, by Professor Maquet, Professor of Anthropology at the Official University of the Belgian Congo and Ruanda-Urundi.
- “*Economics and Agriculture in Central Africa*”, by Mr. P. Miracle, Research Associate of the Food Research Institute, Stanford University, California.
- “*Political Science and Partnership*”, by Dr. B. T. G. Chidzero, Research Fellow, Nuffield College, Oxford.
- “*Some Impressions of Nigeria*”, by Mr. H. A. Fosbrooke, Director, Rhodes-Livingstone Institute.
- “*The Institute’s Tropical Africa Study Project*”, by Mr. Guy Hunter, of The Institute of Race Relations, London.
- “*Crime in Northern Rhodesia*”, by Mr. W. Clifford, Director of Social Welfare, Northern Rhodesia.

#### VI. *The Sir Gilbert Rennie Library:*

The task of promoting membership is not an easy one, but no opportunity is lost in bringing home the advantages of membership to those who come into contact with the Institute. As a result the paying membership has continued to rise: this year there was a nett gain of 62. The table which follows sets out the position for the year, and for the sake of comparison gives the figures at the beginning of the present four year period, during which the official (free) membership was practically halved and the paying membership has almost doubled.

	At 1.4.56	Gains and Losses 1956-59	At 1.4.59	Resigned 1959-60	Joined 1959-60	At 31.3.60	Gains during year
Honorary ...	27	+ 6	33	—	—	33	—
Official ...	339	—150	189	—	8	197	8
Exchange ...	78	+ 22	100	—	—	100	—
Paying ...	171	+100	271	6	68	333	62
Total ...	615	— 22	593	6	76	663	70

Of the total membership of the Institute, 217 are in Northern Rhodesia, 232 in the rest of Africa, 102 in Europe, 75 in the United States of America, 5 in Canada, 6 in Asia and 4 in Australia. Both associate members and staff are making increased use of the facilities available. Ninety-one parcels of books were despatched by post representing 176 volumes, whilst 728 books were borrowed locally. This indicates that the number of borrowers has almost doubled since 1955-56 when figures were last published in the Annual Report. Records of borrowers and readers—as distinct from other visitors—are now maintained and show that 60 people came to the Institute for such purpose over the last three months; insignificant figures perhaps, but considering the isolated situation of the Institute enough to show that our existence is becoming increasingly known and appreciated.

The Library has continued to expand steadily. This year 600 books and pamphlets have been added; 800 were added last year, but 350 of these were a special gift from the Carnegie Corporation of New York, and 60 were given by the Information Department of the American Consulate General in Salisbury. We have continued to receive gifts from this Consulate from time to time throughout the year, and also from the German Consulate in Salisbury. A small, but welcome and interesting, collection of books was presented by the Provincial Entomologist at Ndola, Northern Rhodesia.

The total of 600 additions mentioned above does not include the annual reports and other publications of Government Departments in Central and East African territories; these have continued to augment the library stock in even greater numbers than before. A further source of supply has been the grant from the Rockefeller Foundation, of which 500 dollars was allocated to the Library over a period of three years; 300 of these dollars have now been spent on books which were all ordered from America, and consisted mainly of recent works dealing with sociology and allied subjects.

200 periodicals are now taken in the Library. This is 12 less than last year, but while some have been discontinued, some new journals have been taken in their place. The language section of the Library has also continued to expand, since, besides receiving numerous newspapers and newsletters in the various vernaculars of Central Africa it has continued to absorb a steady stream of all the vernacular publications issued by the Publications Bureau of Rhodesia and Nyasaland.

All these acquisitions are putting heavy pressure on existing library space; in spite of constant readjustment—the introduction of new stacks, the partitioning of existing rooms, and the use of corridors for storing newspapers—by the end of the current year the library will be full to bursting point. It is essential that the earliest consideration be given to the plans for expansion already formulated, to ensure that the best library of its kind in Central Africa does not lose much of its utility through overcrowding, just at the moment when in addition to the Institute's own staff, the public are making much greater use of the facilities provided by visiting both to borrow and to read.

As was mentioned in the Report for last year, the early out-of-print Papers of the Institute have all been micro-fiched and are on sale at the Institute; at first few buyers were found for these, but the sales have increased remarkably over the period under review, the Papers being mostly bought by American University Libraries which already possess micro-fiche readers, and are anxious to complete their sets of the Papers.

The bibliography of anthropological and sociological information concerning Central Africa has been continuously added to throughout the year, and has proved useful in answering a great variety of queries from ministers of religion and students of politics, doctors of philosophy and medicine, members of the provincial administration and of the legal profession, compilers of wireless programmes and film producers. This bibliography, which originally appeared as Communication No. 7, has been revised and enlarged: it is still a matter for consideration whether this will be printed or roneoed.

#### VII. *Publications* (See Appendix (II) for full particulars):

The series of recurrent publications are almost up to date. Following two Journal issues in the year under report, No. 26—due December, 1959—was delayed by the printers' strike but came out early in 1960. No. 27—due June, 1960—was in the hands of the printers by the end of March, so should be issued on time.

Two companion Papers by Mr. C. M. N. White on aspects of Luvale social and economic organisation were handled during the year, No. 29 being issued and No. 30 proof-read before the end of March.

Communications at the rate of four a year were issued and material is available for issue at the same rate for the next two years. The proceedings of the 13th Conference were issued in 1959 and the material for the 14th Proceedings was all available and being edited at the close of the year.

There has been some hold-up in books in the press: none was issued during the course of the year, though Dr. Cunnison's work on the Luapula is expected shortly, and the reprint of *Seven Tribes* should be issued before this appears in print. Thanks to speedy authorship Professor Colson's book on the Gwembe Tonga was in the

hands of the printers by March, 1960, and should be published in the autumn, a welcome change from the disappointing delays of the past.

The revolving fund is working smoothly, and with the 10 per cent. levy on current research combined with the receipts from past publications and a 75 per cent. share of subscriptions, should enable us to maintain a steady output of material. On the sales side the publishers statement for the year ending 31st July, 1959, showed a rise in overseas sales from £1,048 to £2,002 whilst local sales through the Institute have remained as last year at £367.

The Institute now has 81 publications to its credit, an increase of 31 since the commencement of the 1956-60 period. Apart from the editorial work involved it will be appreciated that holding stock and accounting for sales for such number of publications is a considerable administrative task.

#### VIII. *Conclusion:*

It is unfortunate but inevitable that an Institute existing financially from hand to mouth cannot build up a permanent staff. There is constant coming and going as one project is completed and a new one commences, as one C.D. & W. Scheme expires and funds are sought for a new quinquennium. There is hope, however, that greater stability may result from some form of closer association between the Institute and the University College of Rhodesia and Nyasaland. The situation is currently being examined by the Trustees of the Institute and by the College authorities, and whilst it is still too early to report on the form which this association will take or when it is likely to come into force, there seems little doubt that the two institutions will find a mutually agreeable means of making closer and more formal the bonds which already exist between them.

In spite of the instability of personnel which circumstances have in the past imposed, the work of research has continued, and every year of the Institute's existence had added to the body of knowledge in the social sciences available to the politicians and administrators of Central Africa. At no time more than the present has accurate knowledge been required as a basis for sound judgment, and though many decisions are taken on an emotional rather than a scientific basis there is sufficient demand for the Institute's services to encourage us all in the belief that we are not only contributing to knowledge but also, in small measure, to a solution of the present pressing problems of Central Africa.

H. A. FOSBROOKE,  
*Director.*

Lusaka.  
June, 1960.

## APPENDIX (I)

## VISITORS TO THE INSTITUTE

Visits from neighbouring towns and territories in Africa were received from:

- Mr. Alan Paton, Natal, South Africa.
- Mr. R. Berger, German Consul General, Salisbury, Southern Rhodesia.
- Mr. Vernon Brelsford, Federal Information Department, Salisbury, Southern Rhodesia.
- Commander Wall, United Kingdom High Commission, Salisbury, Southern Rhodesia.
- M. Ph. Berthet, United Nations Economics Commission for Africa, Addis Ababa.
- M. C. Cheysson, Secretary General, C.C.T.A., Lagos, West Africa.
- Mr. J. H. A. Long, University College of Ghana.
- Dr. and Mrs. Mokoena, College of Technology, Kumasi, Ghana.
- Mr. S. Lockhart, British Consul, Elisabethville, Belgian Congo.
- Mr. K. Leaver, Information Branch, Southern Rhodesian Government, Salisbury.
- Mr. B. Jones-Walters, Chief Information Officer, Zomba, Nyasaland.
- Mr. and Mrs. Khurana, Indian Commission, Salisbury, Southern Rhodesia.
- Dr. S. Biesheuvel, National Institute of Personnel Research, Johannesburg, South Africa.
- Dr. H. Holleman, University of Natal, South Africa.
- M. d'Hertefeldt, I.R.S.A.C., Ruanda, Belgian Congo.
- Professor Monica Wilson, University of Cape Town, South Africa.
- Major and Mrs. Buxton, Mombasa, Kenya.
- Mr. T. Haighton, International Labour Institute, Brazzaville.

From overseas we welcomed:

*United Kingdom:*

- Sir Gilbert Rennie, Rhodesia House, London.
- Mr. John Hatch, M.P., London.
- Mr. W. Allan, Manchester University, Manchester.
- Mr. Harold Rodgers, Queen's University, Belfast.
- Mr. A. Allott, S.O.A.S., London University, London.
- Dr. Chidzero, Nuffield College, Oxford.
- Mr. Philip Mason, Institute of Race Relations, London.
- Mr. D. M. Neale, Oxford University Press, London.
- Mr. W. A. Warmington, London School of Economics, London.
- Mr. David Howarth, Kent, England.
- Mr. Robert Houssler, St. Antony's College, Oxford.
- Dr. E. B. Worthington, Nature Conservancy, London.
- Mrs. Elspeth Huxley, Oaksey, Malmesbury, Wilts., England.
- Mr. Guy Hunter, Institute of Race Relations, London.
- Mr. H. Molson, M.P., London.
- Professor Jack, King's College, Newcastle.
- Rev. R. A. W. Shepherd, Edinburgh and Lovedale, South Africa.

*United States:*

- Miss Edith M. Gates, the Pathfinder Fund, Milton, Mass.
- Mr. F. Taylor Ostrander, American Metal Climax Inc., New York.
- Professor Arthur Schiller, Columbia University, New York.
- Dr. J. B. Christensen, Columbia University, New York.
- Mr. Harvey Glickman, Princeton University, New Jersey.

Dr. E. A. Tiriyakian, Princeton University, New Jersey.  
 Dr. Willard Rhodes, Columbia University, New York.  
 Mr. and Mrs. H. J. Spiro, Harvard University.  
 Professor and Mrs. Guy B. Johnson, University of North Carolina, North Carolina.  
 Dr. Vernon McKay, School of Advanced International Studies, Washington, 9, D.C.  
 Mr. Philip Quigg, Assistant Editor, "Foreign Affairs", New York.  
 Mr. Erich Isaac, City College, New York.  
 Mr. Robert July, Rockefeller Foundation, New York.  
 Mr. Edwin R. Dean, South Bend, U.S.  
 Mr. Alan Pifer, Carnegie Corporation of New York.  
 Professor E. Colson, Brandeis University, Mass.

*Other Overseas Visitors:*

Mr. A. A. J. Van Bilezen, Brussels.  
 Mr. G. Labouchere, British Embassy, Brussels.  
 Miss H. Zinder, Ministry of Education, Jerusalem.  
 Mr. Amba Prasad, Delhi University, India.  
 Mr. Chaman Lal, President's Estate, Simla, India.  
 Dr. P. K. Gopalakrishnan, Delhi University, India.

APPENDIX (II)

PUBLICATIONS

I. Publications by Workers assisted from Colonial Development and Welfare Funds.

A. *Published during period 1st April, 1959 to 31st March, 1960.*

i. *Journals:*

*The Rhodes-Livingstone Journal*—"Human Problems in British Central Africa", XXIV (June, 1959) and XXV (December, 1959), with articles by the following past and present members of staff and affiliates:

COLSON, Elizabeth—"Plateau Tonga Diet". Pp. 51-67.

TUDEN, Arthur—"Ila Slavery". Pp. 68-78

FLOYD, B. N.—"Changing Patterns of African Land Use in Southern Rhodesia". Pp. 20-39.

GANN, L. H.—"Liberal Interpretations of South African History: a review article". Pp. 40-58.

ii. *Papers:*

*Rhodes-Livingstone Paper, No. 29. "A Preliminary Survey of Luvale Rural Economy"*; by C. M. N. White (November, 1959).

iii. *Communications:*

No. 13. *Aushi Village Structure in the Fort Rosebery District of Northern Rhodesia*, by E. M. Richardson (April, 1959).

No. 14. *The Bantu Languages of the Federation: a Preliminary Survey*, by G. Fortune (May, 1959).

No. 15. *Blindness in the Kawambwa District, Northern Rhodesia*, by C. M. Phillips.

*African Medicines in the Mankoya District, Northern Rhodesia*, by S. A. Symon (November, 1959).

No. 16. *Numerical Data on African Dwellers in Lusaka, Northern Rhodesia*, by D. G. Bettison (February, 1960).

No. 17. *Further Economic and Social Studies, Blantyre-Limbe, Nyasaland*, by A. A. Nyirenda, H. D. Ngwane and D. G. Bettison (December, 1959).

iv. *Conference Proceedings:*

Proceedings of the Thirteenth Conference of the Rhodes-Livingstone Institute: *From Tribal Rule to Modern Government*, ed. with an introduction, by R. J. Apthorpe. This publication includes the following papers by past and present members of staff and affiliates:

APTHORPE, R. J.—“Northern Rhodesia: Clanship, Chieftainship and Nsenga Political Adaptation”; Pp. 69-98.

ARGYLE, W. J.—“Northern Rhodesia: Soli Chieftainships and Political Adaptation”. Pp. 99-112.

BETTISON, D. G.—“Nyasaland: The Official Headman and Yao Lineage Structure in Peri-Urban Blantyre-Limbe”. Pp. 137-148.

FOSBROOKE, H. A.—“Tanganyika: the application of Indirect Rule to Chiefless Societies”. Pp. 17-29.

— “Tanganyika: a note on successes and failures in Luguru Adaptation”. Pp. 173-179.

SUTCLIFFE, R. B.—“A Note on the Use of Local Courts in the Northern Province of Tanganyika, with special reference to the Masai”. Pp. 29-36.

WHITE, C. M. N.—“Northern Rhodesia: Luvale Political Organisation, and the Luvale Lineage”. Pp. 113-120.

B. *Publications at present in the Press:*i. *Full-length Books:*

CUNNISON, I. G.—*The Luapula Peoples of Northern Rhodesia*.

VAN VELSEN, J.—*The Lakeside Tonga of Nyasaland*.

A reprint of *Seven Tribes of British Central Africa*, ed. by E. Colson and M. Gluckman (due May, 1960).

COLSON, E.—*Human Problems of Kariba*, Vol. I. Social Organisation of the Gwembe Tonga (due September, 1960).

ii. *Journals:*

*The Rhodes-Livingstone Journal*, “Human Problems in British Central Africa”, No. XXVI and No. XXVII, with articles by the following past and present members of staff and affiliates:

VAN VELSEN, J.—“Missionary Factors among the Lakeside Tonga”.

BETTISON, D. G.—“The Poverty Datum Line in Central Africa”.

SCUDDER, T.—“Fishermen of the Zambezi”.

iii. *Papers:*

*Rhodes-Livingstone Institute Paper No. XXX*. “Outline of Luvale Social and Political Organisation”, by C. M. N. White.

iv. *Communications:*

No. 18. *Crime in Northern Rhodesia*, by W. Clifford.

No. 19. *Land Usage in Barotseland*, by D. U. Peters.

No. 20. *Patterns of Income and Expenditure in Blantyre-Limbe, Nyasaland*, by D. G. Bettison and P. Rigby.

v. *Conference Proceedings:*

*Myth in Modern Africa*: Papers read at the 14th Conference of the Rhodes-Livingstone Institute. This publication includes the following papers by members of the Rhodes-Livingstone Institute staff and affiliates, though it should be noted that contributions are by no means confined to them.

APTHORPE, R. J.—*Mythical African Political Systems in Northern Rhodesia*.

ARGYLE, W. J.—*The Soli View of Europeans*.

DOTSON, F.—*The Democratic Myth in Mexico*.

FOSBROOKE, H. A.—*Introducing the Theme of the Conference*.

RIGBY, P. J. A.—*Myth and Language*.

C. *Works in Preparation:*

- Ethnographic Notes on the Nsenga of Northern Rhodesia*, by R. J. Apthorpe (Rhodes-Livingstone Museum Occasional Paper).
- Status Differentiation Among the Nsenga of Northern Rhodesia*, by R. J. Apthorpe (Rhodes-Livingstone Institute Paper).
- Social and Political Organisation of the Soli*, by W. J. Argyle (Thesis and book).
- Authority and Residence in a Peri-Urban Social Structure, Ndirande, Nyasaland*, by D. G. Bettison and R. J. Apthorpe (Article submitted to Nyasaland Journal).
- Factors in the Determination of Wage Rates in Central Africa*, by D. G. Bettison. (Article for Rhodes-Livingstone Journal, No. XXVIII).
- A Study of the Processes of Urbanisation in Africa*, by Professor J. Clyde Mitchell. (A full-length book).
- A Family Budget Study of Africans on the Copperbelt*, by E. Richardson.
- Influence of Missions on the Development of Northern Rhodesia*, by R. Rotberg. (Thesis and Paper).
- Human Problems of Kariba* Vol. II. The Ecology of the Valley Tonga, by T. Scudder. (Full-length book.)

II. *Publications not assisted from Colonial Development and Welfare Funds:*A. *Published during the period under review:*

- BETTISON, D. G.—“The Private Domestic Servant of Blantyre-Limbe, Nyasaland”. *Nyasaland Journal*, Vol. 12, No. 1 (January, 1959). Pp. 36-45.
- EPSTEIN, A. L.—“Linguistic Innovation and Culture on the Copperbelt, Northern Rhodesia”. *South Western Journal of Anthropology*, Vol. 15, No. 3 (Autumn, 1959). Pp. 235-253.
- FOSBROOKE, H. A.—“Social Security: A Felt Want in East and Central Africa”. *Inter-African Labour Institute Bulletin*, Vol. VI, No. 3 (May, 1959). Pp. 8-48. Due to be reprinted in the *Bulletin of the International Association of Social Security*.
- “The ‘Masai Walls’ of Moa: Walled Towns of the Segeju”. *Tanganyika Notes and Records*, No. 54 (March, 1960).
- with YOUNG, Roland—*Land and Politics among the Luguru of Tanganyika*. (Kegan Paul, 1960). Published in America as: *Smoke in the Hills: Political Tension in the Morogoro District of Tanganyika*. (Northwestern University Press, 1960).
- GLUCKMAN, Max.—“The Technical Vocabulary of Barotse Jurisprudence”. *American Anthropologist*, Vol. 61, No. 5, Part 1 (October, 1959). Pp. 743-759.
- “Tribalism in modern British Central Africa”. *Cahiers d'Études Africaines*, I (January, 1960). Pp. 55-70.
- MITCHELL, J. C.—“Migrant Labour in Africa South of the Sahara: the causes of labour migration”. *Inter-African Labour Institute Bulletin*, Vol. VI, No. 1 (January, 1959). Pp. 8-46.
- VAN VELSEN, J.—“Notes on the History of the Lakeside Tonga of Nyasaland”. *African Studies*, Vol. 18, No. 3 (1959). Pp. 105-117.
- WATSON, W.—“Migrant Labour and Detribalisation”. *Inter-African Labour Institute Bulletin*, Vol. 6, No. 2 (March, 1959). Pp. 8-32.

B. *Works in Press:*

- APTHORPE, R. J.—“Political Change, Centralisation and Role Differentiation”. Article in *Civilisations*, Vol. 10, No. 2 (June, 1960).
- “The Introduction of Bureaucracy into African Politics”. *Journal of African Administration*, Vol. 12, No. 3 (July, 1960).
- “Problems of Tribal Political History: the Nsenga of Northern Rhodesia”. Paper to 1st Federal Science Congress, Salisbury.
- FOSBROOKE, H. A.—“African Agricultural Adaptation”. Paper to 1st Federal Science Congress, Salisbury.



MCEWAN, P.—“The Relation of Knowledge to Action in Social Science”. Paper to 1st Federal Science Congress, Salisbury.

C. *Works in Preparation:*

FOSBROOKE, H. A.—“Thornton in East Africa, 1861-1862”. Paper to be read to Leverhulm Inter-Collegiate Conference, History, Salisbury (September, 1960).

— “The Kilimanjaro Diaries of Richard Thornton”. Chatto and Windus, The Robins Series. (Full-length book).

— “Team work in African History”. Article for *Journal of African History*.

Tsetse Fly and  
Trypanosomiasis Committee  
Report for 1959-1960

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The Wellcome Research Laboratories,  
Langley Court,  
Beckenham, Kent.  
30th August, 1960

SIR,

I have the honour to transmit herewith the Report of the Tsetse Fly and Trypanosomiasis Committee for the year ended 31st March, 1960.

I have the honour to be,

Sir,

Your obedient servant,

H. W. MULLIGAN,  
*Chairman.*

The Right Honourable Iain Macleod, M.P.,  
Secretary of State for the Colonies.

## TSETSE FLY AND TRYPANOSOMIASIS COMMITTEE

REPORT FOR 1959-60

**Membership**

- COLONEL H. W. MULLIGAN, C.M.G., M.D., D.Sc., The Wellcome Research Laboratories (*Chairman*).
- PROFESSOR T. H. DAVEY, O.B.E., M.D., D.T.M., Liverpool School of Tropical Medicine.
- MR. R. N. T. W. FIENNES,\* M.A., M.R.C.V.S., The Zoological Society of London.
- PROFESSOR P. C. C. GARNHAM, M.D., D.Sc., London School of Hygiene and Tropical Medicine.
- DR. L. G. GOODWIN, B.Pharm, B.Sc., M.B., B.S., The Wellcome Laboratories of Tropical Medicine.
- DR. F. HAWKING,\* D.M., M.R.C.P., D.T.M., National Institute for Medical Research.
- PROFESSOR D. L. HUGHES,\* Ph.D., Dip., Bact., Lond., F.R.C.V.S., Liverpool University.
- PROFESSOR W. E. KERSHAW, V.R.D., M.D., D.Sc., D.T.M. & H., Liverpool School of Tropical Medicine.
- DR. L. HARRISON MATTHEWS, M.A., F.R.S., Scientific Director of the Zoological Society of London.
- DR. T. A. M. NASH, C.M.G., O.B.E., D.Sc., formerly Director of the West African Institute for Trypanosomiasis Research.
- MR. W. H. POTTS, formerly of the East African Tsetse & Trypanosomiasis Research & Reclamation Organisation.
- MR. B. WEITZ, M.R.C.V.S., The Lister Institute of Preventive Medicine.
- MR. W. F. DAWSON,\* M.B.E. (Secretary up to the 2nd November, 1959).
- MR. E. W. A. SCARLETT,\* O.B.E. (Secretary from the 5th November, 1959).

\* Also a member of the Chemotherapy Panel.

**Ex-Officio Members**

The Directors of the East African Trypanosomiasis Research Organisation and the West African Institute for Trypanosomiasis Research; the Secretary of State's Deputy Chief Medical Officer, and Advisers on Agriculture and Animal Health; the Director of Colonial Medical Research; the Secretary of the Colonial Pesticides Research Committee.

It is the practice to invite the Scientific Liaison Officer for the Federation of Rhodesia and Nyasaland to attend all meetings.

**Terms of reference**

“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 1959-1960

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## TSETSE FLY AND TRYPANOSOMIASIS COMMITTEE

### I. THE COMMITTEE

1. The Tsetse Fly and Trypanosomiasis Committee and the Chemotherapy Panel set up by the Committee met three times each during the period under review.

2. Dr. T. A. M. Nash joined the Committee in May, 1959, following his retirement as Director of the West African Institute for Trypanosomiasis Research. Mr. E. W. A. Scarlett took over from Mr. Dawson as Secretary in November, 1959.

3. Mr. B. Weitz visited E.A.T.R.O. and territorial departments in East Africa during January, 1960, and attended the first meeting of the East African Trypanosomiasis Research Advisory Committee and the thirteenth meeting of the East African Agricultural and Fisheries Research Council. Dr. L. G. Goodwin and Dr. F. Hawking attended in March, 1960, an *ad hoc* committee meeting on research into drug resistance in trypanosomes which was convened by the Director of E.A.T.R.O., and also visited East African territorial departments. Dr. F. Hawking and Professor P. C. C. Garnham visited W.A.I.T.R.

4. Mention was made in the Committee's last report of how during the year the Committee had noted many instances where it would seem that the advances in knowledge in some aspects of the trypanosomiasis problem in Africa had reached the stage where resources available in the United Kingdom to tackle such problems could usefully be exploited to a greater extent than had previously been the case. It was suggested that the encouragement of research into the fundamental problems at a chain of research centres in the United Kingdom would be a useful means of rendering continued scientific assistance in this field to the emergent territories. With this in view a Working Party was set up in November, 1959, under the Chairmanship of Professor W. E. Kershaw with Dr. F. Hawking, Mr. B. Weitz and the Directors of E.A.T.R.O. and W.A.I.T.R. as members and Mr. R. W. Wootton as Secretary, to encourage research of this kind and to keep it under review.

### II. FINANCE

5. The allocation of Colonial Development and Welfare money for tsetse and trypanosomiasis research over the five-year period ending the 31st March, 1960, was £655,000. Expenditure against this allocation was £496,331.

### III. EAST AFRICAN TRYPANOSOMIASIS RESEARCH ORGANISATION

(*Director* : Dr. W. H. R. Lumsden, D.Sc., M.B., Ch.B., D.T.M., D.T.H.)

6. Last year's report described the changes in approach to the trypanosome diseases of Africa—sleeping sickness in man and nagana in cattle—which have dictated the reorganisation of the research attack on these diseases. To recapitulate briefly it may be said that until about ten years ago the only methods which appeared likely to lead to the control of these diseases

were measures directed towards the complete eradication of the main carriers of the diseases—the tsetse flies. However, advances in other fields, notably that of chemotherapy, have opened possibilities of control of the disease by other methods. More efficient drugs for the arrest of the human disease have come into use and the development of prophylactic drugs for animals has made possible the productive maintenance of cattle in areas which are lightly infested with tsetse.

7. When complete eradication of tsetse was the aim, research into these flies was the main avenue explored and was primarily directed towards the elucidation of the ecology of the flies so that fuller understanding of this might lead to the improvement of existing methods of control and the devising of new ones. With the change of emphasis interest is centring now mainly on epidemiological problems, studies of the inter-relations in nature of the insects, the parasites and the hosts, so that the chains of transmission may be more clearly understood and therefore the attempt to interrupt transmission more logically developed. A major problem in the epidemiology of sleeping sickness is that the disease does not always appear in areas where the conditions for its existence would seem to be suitable. In nagana basic epidemiological problems are also involved in the development of methods for measuring the degree to which cattle are exposed to infection—the “trypanosome risk”. These measurements are necessary for the rational development of control by chemoprophylaxis. In the control of the cattle diseases by chemoprophylaxis the appearance of strains of trypanosome resistant to drugs is an ever present danger and so this field also calls for intensive study.

8. Reorganisation of E.A.T.R.O. to adapt to these new conditions is now far advanced. Essentially the changes have involved the closing down of all outlying isolated stations and the concentration of all research disciplines in one central laboratory, at Tororo in Uganda, which offers good facilities for all aspects of the research—medical, veterinary, protozoological and entomological. Closing of all the permanent outlying stations has now been accomplished, not without many regrets in the case of the old established laboratories of Shinyanga and Tinde which were rich in associations with such famous pioneer workers as C. F. M. Swynnerton and J. F. Corson.

9. Some important decisions by the East African Agricultural and Fisheries Research Council have affected E.A.T.R.O. during the year. The decisions have affected staff, directly by alterations of the establishment to adapt the structure to the new lines of research, and indirectly by limiting the yearly expenditure during the quinquennium 1960–65 to £100,000.

10. There have been a number of staff changes during the year and it may well be a year or more before the full new staff is recruited and settles down on to its new lines of research. Good progress has, however, been made in reorganising and re-orienting the work of the Institute. The advantages of collecting the various different research aspects in one laboratory are already evident in the appearance of co-operative studies between workers of different disciplines. Various physical necessities for the prosecution of the research are being built up; a satisfactory mouse colony is now in being, and plans are being prepared for the centralisation of essential services and for the improvement of the hospital accommodation. The

amalgamation of the libraries of the previous components of EATRO is far advanced and standard systems of classification and indexing have been introduced. The collection of deep-frozen strains of trypanosomes has been augmented and is now offering a valuable service to workers in other parts of the world; recently-isolated strains for special study have been supplied to three laboratories in the United Kingdom and one in West Africa.

11. The committees concerned with trypanosomiasis research in East Africa have been the subject of a great deal of discussion during the year. The first meeting of the East African Trypanosomiasis Research Advisory Committee took place in Dar-es-Salaam in January, 1960, and it was agreed that this Committee will meet once every two years. Meetings will be preceded by a Seminar and Specialist Committee; as, however, it was considered desirable that these two-yearly meetings should follow fairly closely the International Scientific Committee for Trypanosomiasis Research, the next meetings will be in 1960-61.

12. Traditionally the reports of the Organisation have been divided into three parts, human trypanosomiasis, animal trypanosomiasis and tsetse. With the change of approach described above it is felt that it is now time to emphasise the essential unity of the whole group of trypanosome diseases—which is indeed the reason for the existence of EATRO—by reclassifying the work under more general headings—protozoology, epidemiology, biochemistry, chemotherapy and chemoprophylaxis, and vector control.

#### *Protozoology*

13. Protozoological work—the study of the trypanosomes which cause these diseases—has taken second place to research into tsetse for many years. With the increasing interest in co-ordinated studies described above interest in the protozoological aspects has been increased.

14. Studies on the trypanosomes are being developed mainly towards an understanding of immunology—the relationships between them and their host animals. Immunology was considered the field of research most important to develop first as knowledge of this aspect may be expected to have important applications in other studies, especially epidemiology and drug resistance studies. Two workers are engaged on this aspect and a start has been made with *Trypanosoma congolense*, an important parasite of cattle, which is reasonably promising as far as laboratory handling is concerned. It does, however, offer difficulties as compared with some of the human trypanosomes.

15. The methods of storing trypanosomes alive in the deep frozen state have come under scrutiny and essential basic procedures have been standardised. A collection of trypanosome strains for the study of the development of drug resistance is being built up.

#### *Epidemiology*

16. Understanding of the mechanisms by which a disease is transmitted and maintains itself and under what conditions it may spread—the epidemiology of a disease—involves concerted studies in the field on several different aspects at the same time. Studies of this sort are being developed on both the human and the animal diseases.

17. In the study of the epidemiology of the human disease the South Busoga fly belt and the offshore islands are being used as a main experimental area. Work is at present directed towards the detailed mapping of the area so that the distribution of the human population may be known, and the occurrence of cases accurately located. At the same time the distribution, movements, periodicity of activity, and so on of the tsetse species in the area are being investigated.

18. Most of the past work on tsetse has been based on the "flyround", a method of collecting the tsetse attracted to a moving party, which is primarily adapted to yield population estimates rather than estimates of the risk of infection. Interest is now centring on catches of tsetse biting human and animal hosts, in various environments, to build up information on the localities most infested, on the periodicity of attack by the different species and on the incidence of infection in different species. Work on the inter-relationships between tsetse and the various animal hosts on which they depend for their blood meals, and from which they derive their infections, has continued. Feeding habits and resting places have been studied, and many blood meals have been collected for the identification of the host fed on. The range of dispersal of an important species has been studied. Physiological investigations into the metabolism of tsetse, particularly with regard to fat, have shed light on their behaviour in nature.

19. Work is also in progress in constructing and testing various kinds of trap for tsetse with particular reference to the relationship existing between trap catches and the flies actually biting the hosts under study—man and cattle—to determine if trapping methods may be used to estimate the degree of exposure to infection.

#### *Chemotherapy and Chemoprophylaxis*

20. In the past EATRO has contributed to the field testing of new anti-trypanosomal drugs for cattle and this work sometimes absorbed a very large proportion of the potential research effort available. Although the work was of some immediate practical application it tended to preoccupy the research potential so that advance in the fundamental, and ultimately more important, problems of drug resistance was impeded. It has now been decided that the routine testing of new drugs for cattle prophylaxis shall be a concern of the territories rather than of EATRO and so the recruitment of staff for fundamental studies on drug resistance is receiving attention.

21. On the human side, however, some drug testing has continued. Nitrofurazone has been examined as a drug of possible application for the treatment of late cases of sleeping sickness which have proved refractory to Mel B, the best drug available previously. It has had limited success but, studies on its toxic effects in man, with a view to limiting them in administration, have led to important observations on the mechanism of causation of damage to the heart and nerves by toxic drugs. A study has been begun with another drug, Mel W, which has some practical advantages over Mel B.

#### *Biochemistry*

22. Biochemical studies have been concerned with two main matters—the changes undergone by a drug, nitrofurazone, in the body and the

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assessment of the accuracy of two commonly used field methods for the estimation of protein in the cerebrospinal fluid, a measurement used to assess the progress of a sleeping sickness patient. The substances into which nitrofurazone is converted in the body have been separated and to some extent purified so that studies on their individual toxic and curative activities may be made. Discrepancies between the two methods of cerebrospinal fluid protein estimation have been found to be due to differences in the ratio between two constituents of the protein.

#### *Vector control*

23. A widely used method of control of tsetse is "discriminative clearing", that is bush clearing limited to the small proportion of the tree cover, considered essential to the tsetse's survival. A study of the effect of a particular method of discriminative clearing against *G. morsitans* in Ankole, Uganda, has been made. No reductions in fly density were detected nor did the tsetse population show any signs of stress. It was concluded that tsetse were established in vegetation types other than those included in the discriminative clearing plan.

#### *Methods*

24. Methods for handling and feeding tsetse in the laboratory have continued to be studied. Particular attention has been paid to methods of feeding tsetse on blood through artificial membranes. Although it is not yet possible to maintain a colony of tsetse permanently by this means it enables uninfected flies for experimental use to be produced more rapidly than by hatching from wild-caught pupae. The membrane feeding method has also been used for the isolation of trypanosome strains from wild flies.

25. Thirty-one scientific papers were published or accepted for publication in the course of the year.

26. Requests for advice on problems of trypanosomiasis were received from many sources, including some outside East Africa—Southern Rhodesia, Nyasaland and Ethiopia. The South Busoga work has been especially valuable for advisory purposes, providing basic information which allowed us significantly to assist the Uganda Government regarding the resettlement of the area.

### **Publications**

Papers appearing, or accepted for publication in 1959

ASHCROFT, M. T. (1959).—"A critical review of the epidemiology of human trypanosomiasis in Africa." *Trop. Dis. Bull.*, **56**, 1073-1093.

ASHCROFT, M. T. (1959).—"The importance of African wild animals as reservoirs of trypanosomiasis." *E. Afric. med. J.*, **36**, 289-297.

ASHCROFT, M. T. (1959).—"The Tinde Experiment. A further study of the long-term cyclical transmission of *Trypanosoma rhodesiense*." *Ann. trop. Med. Parasit.*, **53**, 137-146.

ASHCROFT, M. T. (1959).—"The sex ratio of infected flies found in transmission experiments with *Glossina morsitans* and *Trypanosoma rhodesiense* and *T. brucei*." *Trans. R. Soc. trop. Med. Hyg.*, **53**, 394-399.

ASHCROFT, M. T. (1959).—"The effect of cortisone on *Trypanosoma rhodesiense* infections in Albino rats." *J. infect. Dis.*, 130-137.

ASHCROFT, M. T. (1959).—"The relative virulence of *Trypanosoma brucei* to young and to adult white rats." *Ann. trop. Med. Parasit.*, 53, 89-92.

ASHCROFT, M. T., BURTT, E., and FAIRBAIRN, H. (1959).—"The experimental infection of some African wild animals with *Trypanosoma rhodesiense*, *T. brucei* and *T. congolense*. *Ann. trop. Med. Parasit.*, 53, 147-161.

BAKER, J. R. (1959).—"The effect of nitrofurazone on *Trypanosoma rhodesiense* infections in mice." *Brit. J. Pharmacol.*, 14, 408-410.

BURSELL, E. (1959).—"The water balance of tsetse flies." *Trans. R. ent. Soc. Lond.*, 111, 205-235.

BURSELL, E. (1959).—"Determination of the age of tsetse puparia by dissection." *Proc. R. ent. Soc. Lond.*, 34, 23-24.

BURSELL, E. (In press). "The effect of humidity and temperature on the extent of abdominal pigmentation in *Glossina pallidipes* Austen." *Bull. ent. Res.*

BURSELL, E. (In press). "The effect of temperature on the consumption of fat during pupal development in *Glossina*." *Bull. ent. Res.*

BURSELL, E. (In press). "The measurement of size in tsetse flies." *Bull. ent. Res.*

FORD, J., GLASGOW, J. P., JOHNS, D. L., and WELCH, J. R. (1959).—"Transect flyrounds in field studies of *Glossina*." *Bull. ent. Res.*, 50, 275-285.

GLASGOW, J. P. (In press).—"Variations in the venation of *Glossina*." *Proc. R. ent. Soc. Lond.*

GLASGOW, J. P. and DUFFY, B. J. (1959). "Bush clearing experiments in the South Nyanza district of Kenya." *E. Afric. agric. J.*, 25, 21-34.

JENKINS, A. R. and ROBERTSON, D. H. H. (1959). "Hepatic dysfunction in human trypanosomiasis. Part II. Serum proteins in *Trypanosoma rhodesiense* infections and observation on the alterations found after treatment and during convalescence." *Trans. R. Soc. trop. Med. Hyg.*, 53, 524-533.

JENKINS, A. R., ROBERTSON, D. H. H. and MANSON-BAHR, P. E. C. (1959). "Serum proteins in East African kala-azar." *Ann. trop. Med. Parasit.*, 53, 93-96.

KNIGHT, R. H. (1959). "Metabolic effects of nitrofurazone in man." *E. Afric. Med. J.*, 36, 510.

MORRIS, K. R. S. (1959). "The epidemiology of sleeping sickness in East Africa. Part I. A sleeping sickness outbreak in Uganda, 1957." *Trans. R. Soc. trop. Med.*, 53, 384-393.

MORRIS, K. R. S. (In press).—"The epidemiology of sleeping sickness in East Africa. Part II. Sleeping sickness in Kenya." *Trans. R. Soc. trop. Med. Hyg.*

MORRIS, K. R. S. (In press).—"The epidemiology of sleeping sickness in East Africa. Part III. The endemic area of Lakes Edward and George in Uganda." *Trans. R. Soc. trop. Med. Hyg.*

MORRIS, K. R. S. (In press).—"The epidemiology of sleeping sickness in East Africa. Part IV. Sleeping sickness in the West Nile District, Uganda." *Trans. R. Soc. trop. Med. Hyg.*

ROBERTSON, D. H. H. (1959).—"Nitrofurazone in *Trypanosoma rhodesiense* sleeping sickness." *E. Afric. Med. J.*, **36**, 509-510.

ROBERTSON, D. H. H. and JENKINS, A. R. (1959).—"Hepatic dysfunction in human trypanosomiasis. Part I. Abnormalities of excretory function, with observations on the alterations of these tests during treatment and convalescence." *Trans. R. Soc. trop. Med. Hyg.*, **53**, 511-523.

SMITH, I. M. (1959).—"Chemoprophylaxis against bovine trypanosomiasis. Part I. The duration of protection from Prothidium and Ethidium and R.D. 2902 suraminates, in an area of high tsetse density." *J. comp. Path.*, **69**, 105-115.

SMITH, I. M. (1959).—"The blood picture of Ankole longhorn cows." *Vet. J.*, **115**, 27-30.

SMITH, I. M. (1959).—"The blood picture of normal Zebu cows in Uganda." *Vet. J.*, **115**, 89-96.

SMITH, I. M. and BROWN, K. N. (In press).—"Chemoprophylaxis against bovine trypanosomiasis. Part II. Duration of protection afforded by preparations of Metamidium, Prothidium and Antrycide Prosalt in an area of high tsetse density." *J. comp. Path.*

WELCH, J. R. (In press).—"Variation in the venation of *Glossina morsitans orientalis* Vanderplank." *Proc. R. ent. Soc. Lond.*

#### IV. WEST AFRICAN INSTITUTE FOR TRYPANOSOMIASIS RESEARCH

(Director: Dr. K. C. WILLETT, M.A., M.B., B.S., L.R.C.P., M.R.C.S.)

##### General

27. During most of the year covered by this report the staff situation has been fairly good, with only one vacancy, that of a medical officer, unfilled throughout the year. Mr. T. M. Leach was appointed Deputy Director in July, 1959, the vacancy for an entomologist was filled by the appointment of Mr. D. A. T. Baldry in January, 1960, and one Laboratory Superintendent vacancy, now redesignated Maintenance Superintendent, was filled by the appointment of Mr. A. Farrimond in July, 1959. Unfortunately almost at the end of the year under review we lost first Dr. J. Williamson who is going to a post with the Medical Research Council and whose departure is a serious loss to the Institute, and then Mr. W. A. McDonald, who, after several years here in which he has made valuable contribution to the entomological work, is returning to the United States.

##### Research Work

28. The form of this report is being slightly changed this year. Rather than divide the report on research into Medical, Veterinary and Entomological sections the sub-division is being made by the type of work, so that all closely related investigations are reported together.

*Protozoology*

29. Studies were continued on the factors influencing infection of *G. palpalis* with *T. gambiense*. It had already been established that flies are most readily infected on their day of emergence. No differences of infection rates attributable to sex could be demonstrated. It was shown that the incubation temperature of pupae directly affects the subsequent infection rate of the flies, thus flies from pupae incubated at 25° to 26° C. are more readily infected than those from pupae incubated at 20° C. Flies from pupae incubated at 28° C. were often crippled and failed to become infected.

30. It was found that infection rates in flies feeding on monkeys bore a statistically significant relationship ( $P < 0.05$ ) to the absolute number of short-stumpy forms of the trypanosome present in the blood. In an attempt to obtain a direct check on this result, obtained solely by statistical examination, flies were fed on rats infected with *T. brucei* and the proportions of the three different forms of the trypanosome in the blood were determined. The flies were then killed at three hourly intervals and the gut contents examined. The long-slender forms began to disappear after three hours, though some changed to shorter forms. After six hours many of the intermediate forms showed signs of degeneration. After twelve to twenty-four hours the short-stumpy forms had started to change into gut forms and a few intermediate forms were also seen changing in this way. These experiments give further confirmation to the conclusion of Miss Muriel Robertson nearly fifty years ago that it is the short-stumpy forms which infect the fly.

31. Research continued on the infection of *G. palpalis* with *T. gambiense* by anal feeding and it was shown that infection rates decline with age in anally fed flies, as in those allowed to feed normally. In one experiment eighteen of forty anally fed flies which survived for three weeks were infected (45 per cent.). Nevertheless, higher mortality in most batches of anally fed flies still renders this technique little more efficient as a means of obtaining infected flies than normal feeding within twenty-four hours of emergence.

32. Observations on variations in the length of various forms of *T. brucei* in blood films taken from an infected rat at daily intervals showed that the mean length of both long-slender and short-stumpy forms decreased significantly during the course of three consecutive examinations. This result supports the hypothesis that polymorphism is a manifestation of shrinkage of trypanosomes, in contrast to the view that the three forms are genetically distinct entities. Examination of very thin films failed to support the theory that positively charged trypanosomes adhered to the negatively charged erythrocytes, whereas negatively charged trypanosomes did not; nor could any difference in mean lengths of attached and unattached trypanosomes be demonstrated. The increase in numbers of postero-nuclear forms of *T. brucei* was studied in a rat showing a decreasing parasitaemia. The number of postero-nuclear forms was found to be doubled within three hours and it therefore appears certain that these forms are produced by movement of the nucleus through the cytoplasm, and not by division of short-stumpy forms, of which not a single example was seen in 1,000 short-stumpy forms examined.

33. Biometric studies have continued on trypanosomes of the *Congolense* group. It is now considered that the strain previously reported as  
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*T. dimorphon* (?) resembles *T. dimorphon* Laveran and Mesnil, 1904, sufficiently closely to be described as a Vom strain of *T. dimorphon*. Studies on *T. dimorphon* maintained by sub-inoculation in rats have shown that the mean lengths of the trypanosomes vary widely, whereas strains passed by fly transmission show relatively constant mean lengths. Numerous comparative measurements of the *T. congolense* and *T. dimorphon* strains maintained in the Institute by fly transmission have confirmed that the latter is consistently longer and that the mean length of both species vary with the mammalian host.

34. A comparative study of *T. dimorphon* and *T. congolense* in blood films from infected cattle showed that, of a hundred trypanosomes counted in each of six films taken on different occasions from four oxen infected with the former organism, 27.6 per cent. were typical *T. dimorphon* forms i.e. long trypanosomes with a pointed posterior end, the kinetoplast at some distance from the posterior end and the undulating membrane relatively distinct, with several folds, while 10.6 per cent. were typical *T. congolense* forms, i.e. short trypanosomes with a rounded posterior end, a kinetoplast that is just sub-terminal and an indistinct undulating membrane. In similar counts on films from three oxen infected with *T. congolense*, the *T. dimorphon* forms comprised only 1.0 per cent., whereas the *T. congolense* forms constituted 50.3 per cent.

35. The pathogenicity of various strains of *T. congolense* and *T. dimorphon* has been studied in cattle, sheep and rats. With the exception of one strain, *T. congolense* caused very low grade parasitaemias in the three host species and all were of low pathogenicity. *T. dimorphon* caused the deaths of two oxen and was more rapidly fatal in rats than *T. congolense*; it is also more pathogenic in sheep.

36. Studies have continued on the physico-chemical constitution of trypanosomes by paper electrophoresis and the presence of four distinct fractions has been demonstrated; attention is now being given to their chemical identification. At the same time, freeze-dried trypanosome material is being examined in a study of the lipids present in *T. gambiense*.

37. Towards the end of the period under review, preliminary observations were started on the preservation of trypanosomes by deep freezing. *T. brucei*, *T. gambiense* and *T. rhodesiense* have all been shown to be infective after various periods of storage. Work is continuing to determine maximum storage periods and on the preservation of other species of trypanosomes.

#### *Clinical Pathology*

38. In view of the relatively low standard of accuracy of field diagnostic tests at present employed in *T. gambiense* sleeping sickness, a comparative study is being carried out, using the complement fixation test, which is considered to identify 95 per cent. of positive sera and not to give false positives, to compare the efficiency of the formol-gel and colloidal gum mastic reactions, both of which are suitable as field procedures. In small-scale preliminary tests, these two techniques have shown a promising degree of accuracy.

39. Observations have continued on the responses of Zebu and N'Dama calves to trypanosomiasis, a second pair of calves having begun to receive

regular challenges during the year. The original pair are now two years old and considerably under weight; they also show a progressive anaemia, the N'Dama being more severely affected in both these respects.

40. A horse purchased in a fly-free area was infected with *T. dimorphon* by fly challenge. A scanty parasitaemia developed but waned rapidly, trypanosomes only being seen once in daily examinations from the eighth to nineteenth weeks after their original appearance. The formol-gel test became positive twenty-four days after infection was noted; blood values fell at first but had returned to pre-infection levels within seven weeks. Gamma-globulin values rose when parasitaemia occurred and were still above pre-infection levels six months later. There was no pyrexia accompanying the initial parasitaemia, but the temperature rose to 104.4° F eighteen days later. Three subsequent peaks occurred with slight increases in the parasitaemia, but the temperature remained steadily at pre-infection levels after seven weeks. Oedematous plaques appeared where the flies were fed six days before trypanosomes were first observed and re-appeared ten to fourteen days afterwards. The horse remained alert and lively throughout, gaining 15 kg. in the first two months after infection, and the infection was probably eliminated without treatment.

41. With the objective of detecting pathological changes due to drug toxicity, observations have been made on the levels of serum glutamic oxalacetic transaminase (SGOT) and serum glutamic pyruvic transaminase (SGPT) in normal and infected cattle. There were no increases in enzyme levels after treatment, but SGPT values rose when trypanosomes first appeared in the blood and only returned to pre-infection levels after treatment. This rise has been confirmed in three further infected cattle, and also in infected sheep, but not in the horse infected with *T. dimorphon* referred to above. It now appears that the trypanosomes themselves may well be the source of the enzymes because high levels of SGOT and SGPT have since been demonstrated in trypanosome homogenates.

#### *Immunology*

42. Immunological relationships of *Brucei* group trypanosomes are being assessed by means of a respirometric technique. The activity of antisera from sheep on homologous and other species of trypanosomes has been studied. These results have been contrasted with those obtained in a series of observations on monomorphic strains of *Brucei* group trypanosomes maintained by syringe passage in rats. When a sheep was infected with a freshly isolated, polymorphic strain of *T. brucei*, the resulting antiserum reacted with the homologous strain, cross-reacted slightly with an old monomorphic strain of *T. brucei* and gave no cross-reaction with the monomorphic strains of *T. gambiense* and *T. rhodesiense*. When maintained in rats the strain gradually became monomorphic and it then cross-reacted with the monomorphic strains of the other species of *Brucei* group trypanosomes. Similar results were obtained with a polymorphic strain of *T. rhodesiense*. This pattern of reactions is now being studied in other strains of polymorphic trypanosomes and, if similar results are obtained, further emphasis will be given to the need to study immunity with "authentic" strains in their natural hosts.

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43. Using methods employed in earlier studies on the immune response in susceptible and resistant breeds of cattle, similar observations are being made on various species of antelope, some of which are regarded as reservoir hosts. A reedbuck, gazelle and duiker have been challenged with *T. vivax* and another gazelle with *T. brucei*. The reedbuck was completely refractory to *T. vivax*, but the other two antelope reacted like infected sheep, showing a series of relatively intense parasitaemic attacks. The gazelle challenged with *T. brucei* became infected and subsequently died, probably from the infection. One of the most interesting results has been the change in the serum protein pattern after challenge. Uninfected antelope sera contains a relatively low amount of protein, mostly albumin. After challenge, the protein shows a marked increase, principally due to augmentation of  $\beta 2$ , and Y-globulins. These results differ from those observed in cattle. Sera collected from antelope shot in fly areas showed relatively high  $\beta 2$ - and Y-globulin levels, whereas those from the same species in fly free areas had a low total protein, with small amounts of globulins. These findings in the field lend confirmation to the laboratory results, but the extension of all this work is hampered by the scarcity of game animals in Nigeria.

44. By means of the double diffusion technique in agar gel, the presence of precipitating antibodies has been demonstrated in sera from infected animals and from those which had received a course of inoculations with material of trypanosome origin. Antigens have been successfully prepared from washed suspensions of *T. vivax*, *T. brucei* and *T. gambiense*, but attempts to prepare material from *Congolense* group trypanosomes have so far been unsuccessful. Precipitins have been demonstrated in cattle, horse, human and rabbit sera and, so far, no false positive reactions have been observed in uninfected controls. At least six different lines of precipitation have been recorded with an homologous system of *T. vivax* antigen and antibody. The potential value of this method in various aspects of trypanosomiasis research is great and particular attention needs to be given to its development.

#### *Chemotherapy*

45. Further work has been carried out on the action of basic trypanocidal drugs on cell-free trypanosome extracts. Dilute solutions of Berenil caused a heavier precipitation of protein from the extract of a drug resistant strain than from that of a sensitive strain. Results from the electrophoretic separation of the components of trypanosome protein are described below and the portions of protein precipitated by Berenil were found to be Fraction 1 and, probably, a portion of Fraction 2. The precipitate, which is a complex of drug and trypanosome protein, possesses prophylactic activity greater than can be attributed to the action of the drug on the protein alone. This quality is being studied further, including the hypothesis that the protein fraction plays a part by an immunising action.

46. Work by Dr. Williamson which has extended over the last eleven years has now been collated and published in the *British Journal of Pharmacology*. He had completed the analysis of the biochemical pattern of cross-resistance during his time in W.A.I.T.R. and the findings in this work led him to begin investigations on possible changes in the proteins of trypanosomes which

might account for the observed phenomena. Trypanosome homogenates were prepared by the use of a Mickle disintegrator and from these nuclear and granular material could be separated without difficulty by centrifugation. The supernatant fluid then contained the cytoplasmic protein and probably also the cell wall constituents. These were examined in a number of ways including determination of the isoelectric point of the protein, electrophoretic separation of the protein constituents and analysis of the protein hydrolysates for amino-acids by paper chromatography. Although no clear differences could be found between the preparations from normal and drug-resistant strains, the work has given several other interesting results and, as it bears on immunological problems, has been taken up by Dr. Desowitz, as well. It is of particular interest that there appears to be little carbohydrate material associated with the cell wall so that antigenic properties arising from cell wall polysaccharides are unlikely, in contrast to many bacteria. Analysis of amino-acid constituents has so far shown no distinct qualitative difference between *T. rhodesiense*, *T. brucei* and *T. vivax*. However, analysis of the free amino-acids in the trypanosome cytoplasm has shown marked differences from the pattern of bound amino-acids in that it contains large amounts of glucosamine and much reduced amounts of aspartic acid, one of the seventeen bound amino-acids presumptively identified so far.

47. Attempts continue to reduce or eliminate local reactions to the Homidium Suramin complex. It is hoped to reach a decision on the value of undertaking further development work on this compound early in 1960. Further trials with Prothidium Suramin complex are at present held up by technical difficulties over presentation of the drug and the presence of drug-resistant strains of trypanosomes in the wild-caught flies required for the challenge.

48. The prophylactic activities of Metamidium Chloride, a medium suspension of the Suramin complex of Metamidium (M. & B. 4427), Metamidium Embonate and Antrycide Pro-salt (revised formulation) were tested in cattle. The dosage rates were 3.0, 5.3, 4.75 and 7.4 mg./kg. respectively and the drugs were each given to five cattle, being injected subcutaneously into the neck. Metamidium Chloride caused too severe a reaction to be acceptable by this route. The mean protection periods were 133, 124, 192 and 71 days. Seventeen of the initial infections were *Congolense* group and the others *T. brucei*. All infections in treated cattle were re-treated with 3.5 mg./kg. Berenil. The cattle in the Antrycide Pro-salt group all relapsed after this treatment. They then received 1 mg./kg. Metamidium Chloride and remained negative to the end of the observation period. The only other animal to relapse following Berenil treatment was in the M. & B. 4427 group. It was given 2 mg./kg. Prothidium and did not relapse again.

49. From the results of a trial on the chemoprophylaxis of *T. simiae* infection in pigs it appears that a single dose of 40 mg./kg. Antrycide Suramin complex or 50 mg./kg. Antrycide Chloride will probably protect pigs weighing over 75 lb. at the time of injection for six months. Pigs below this weight would be protected for three months. The drugs were injected subcutaneously behind the right ear. A confirmatory experiment is now in progress. The therapeutic activities of Metamidium Chloride, at 3.0 mg./kg. and 6.0 mg./kg., Tozocide Chloride, at 4.0 mg./kg., and Nucleocidin (Lederle), at 0.05 mg./kg.,



were tested in groups of three pigs each against a challenge of wild caught *G. morsitans*. All the pigs became infected with *T. simiae* within five days of the first exposure to fly. Those treated with Tozocide Chloride and Nucleocidin died in mean periods of nine and twelve days after treatment. One pig in each Metamidium Chloride treatment group survived, infection apparently having been eliminated. The other two treated with the lower dosage lived nineteen and fifty days after treatment; those on the higher dosage survived forty-one and sixty-two days. No serious signs of toxicity were observed.

50. Three Zebu cattle infected with *T. vivax* from wild caught *G. morsitans* were treated with 0.025 mg./kg. Nucleocidin (Lederle) in a 0.02 per cent. aqueous solution, injected intramuscularly. The animals relapsed in a mean period of twenty-five days and one died forty-five days after treatment. The survivors were observed for ninety-five days and neither animal appeared seriously ill as a result of the relapse infection.

51. Trypanosomes developing resistance to several drugs are often of low pathogenicity to the host in which they have been maintained. Thus an ox treated with 10 mg./kg. Metamidium Suramin complex relapsed to *T. congolense* after 105 days. It was then treated with 0.2 mg./kg. Metamidium Chloride and relapsed again 167 days later. After further treatment with 0.8 mg./kg. of the same drug it relapsed 34 days later. Finally it was given 2.7 mg./kg. Homidium Bromide and relapsed after a further 134 days. The ox thrived throughout the observation period, gaining 83 kgs. body weight in the six months after the first treatment with Metamidium Chloride. An attempt to transmit the infection to a second ox by tsetse flies was unsuccessful, but the animal developed trypanosomiasis eleven days after receiving 300 ml. of citrated blood from the original ox. The second animal was kept under observation for eighty-nine days and never became clinically ill. Further experiments are planned to study the fly transmissibility and pathogenicity of drug resistant strains and the response to infection with susceptible trypanosomes by animals already infected with resistant strains.

52. In the chemotherapy of human trypanosomiasis, a final review of the results of Berenil treatment given three years ago have been re-examined and a preliminary trial of the new drug "Mel W" has been begun.

### Entomology

53. The Field Station at Ugbobigha, Benin Province, was placed on a "care and maintenance" basis at the end of the year, the various projects having been completed; the results are being prepared for publication. Some of the information collected is summarised below.

54. Of 2,490 female *G. palpalis* dissected at the Field Station, 30.7 per cent. had eggs *in utero* and 8.9 per cent. had larvae *in utero*. These figures may be contrasted with 5,545 similar dissections in Kaduna, the corresponding figures in which were 39.0 and 37.0 per cent. Some adverse factor appears to cause early abortions in the forest belt; it is not thought to be related to climate, as there is no seasonal periodicity.

55. Catching of *Fusca* group flies using a bait ox on a fly round in the forest over the past four years has resulted in a marked fall in the numbers taken, due to catching out. Nevertheless, the numbers of *G. tabaniformis*,

*G. fusca* and *G. nigrofusca* always were at their maximum in the middle of the rains and at the minimum in the dry season. A marking experiment on *G. fusca* and *G. medicorum* in riverine forest in the savannah, carried out previously in the wet season, was repeated in the dry season. Although fewer flies were caught, the evidence suggests that *G. medicorum* is better able to withstand dry conditions than *G. fusca* and can thus penetrate further into the savannah. A decrease in activity by both species was noted in the heat of the day, a phenomenon not occurring in the wet season.

56. Infection rates of *Fusca* group flies and *G. pallicera* dissected at the Field Station were as follows, the total number of each species dissected being given in brackets. *G. tabaniformis* (3,230) 3.2 per cent., *G. fusca* (827) 13.3 per cent., *G. nigrofusca* (179) 24.6 per cent., *G. medicorum* (132) 15.2 per cent., *G. pallicera* (21) 9.5 per cent. Flies caught at the Olokemeji Forest Reserve, near Ibadan, during the year showed the following infection rates, *G. fusca* (467) 20.3 per cent., *G. medicorum* (69) 15.9 per cent. Not all the blood meals from flies caught at the Field Station and in the Olokemeji reserve have yet been identified, but it appears that Red River-hog (*Potamochoerus porcus*) is the "favoured" host of *G. fusca* and *G. medicorum*, though both will feed on bush buck (*Tragelaphus scriptus*) in the absence of Red River-hog. Aardvark (*Orycteropus afer*) is an important secondary host of both these species of tsetse.

57. The staff of the Field Station carried out a tour of the Southern Cameroons before returning to Kaduna at the end of the year. The principal objective was to study *Fusca* group flies in a fresh area. *G. haningtoni* and *G. nashi*, which are not found at the Field Station occur in this area and the former is the commonest *Fusca* group species in the Cameroons forest. *Fusca* group species were found to be widespread, but in low density, in contrast to their distribution at the same time of year in Southern Nigeria. The habitat is much wetter and it may be that their numbers are minimal in the Cameroons at the end of the rains. Flies rested much higher than in Nigeria, often well over twelve feet from the ground. They appeared to move lower during the day possibly because there is a marked temperature gradient under the thick canopy, the lower levels being the cooler. One specimen of *G. nashi* was taken and the habitat, which had not previously been described and consisted of ancient, probably primary, high forest, was photographed. Infection rates of the various species dissected were as follows, all the infections being with *Vivax* group trypanosomes, *G. palpalis* (180) 1.7 per cent., *G. pallicera* (64) 1.6 per cent., *G. caliginea* (7) none, *G. haningtoni* (59) 8.5 per cent., *G. tabaniformis* (29) 6.9 per cent. *G. haningtoni* had not previously been proved to be a vector of trypanosomiasis.

58. *G. palpalis* and *G. caliginea* were caught from canoes in creeks near Tiko, east of Victoria. *G. pallicera* is very common throughout the forest country to the west of Mamfe and the males, in particular, appear to "swarm"; on one occasion fourteen were caught in one hour off two buttresses of a small tree, though only very few could be seen resting anywhere else nearby. One hundred and one blood meals were collected from various species of fly and their identification is awaited.

59. The numbers of blood meals of *G. palpalis* and *G. morsitans* collected near Kaduna and identified at the Lister Institute of Preventive Medicine:

have both been increased by about half, but the additions have not changed the feeding patterns previously recorded.

60. Identification of the nocturnal resting sites, by releasing flies marked with luminescent paint and observing them with ultra-violet light, has shown that, while *G. morsitans* rests up to fifteen feet above the ground, with the majority over seven feet, about half the population of *G. palpalis* rests on leaves and twigs within a foot of the ground. On the basis of this finding, a pilot scheme is being carried out by spraying the lower two or three feet of the broad-leaved bushes bordering a stream near Kaduna. Two gallons of 4 per cent. Dieldrin emulsion were used to spray 1,500 yards of stream bed in mid-December and the number of flies taken fell from 19 and 15 in two weekly catches immediately before spraying to 1, 0, 0 in the three succeeding weeks. A monthly fly round will be carried over a year and it is expected that reinvasion will occur with the start of the rains in May or June, 1960.

61. Routine fly rounds and a fly marking experiment have been started to study the persistence and movement of *G. morsitans* in the Guinea Zone woodland, to form a basis of knowledge for subsequent control operations.

62. *G. morsitans* has been infected with *T. dimorphon* (Vom) by means of the anal feeding technique, but the flies failed to infect two clean rats. It is hoped to use the technique to infect adequate numbers of *G. morsitans* with *T. simiae*, a trypanosome which has been very difficult to transmit from pigs by flies in the past.

63. The installation of air-conditioning in the fly room at the end of 1958 has eliminated climatic variation as the main factor in the success of the *G. palpalis* colony from month to month. Considerable progress has been made in establishing a colony of *G. morsitans submorsitans*. Care in feeding, including coaxing flies to feed, and clean culture are important factors and the adoption of a larger cage than the standard Bruce box has nearly doubled the number of pupae produced per fly.

### Publications

Reports and scientific papers published or accepted for publication during the year are listed below in alphabetical order of authors.

DESOWITZ, R. S.—“Studies on Immunity and Host-Parasite Relationships: I. The Immunological Response of Resistant and Susceptible Breeds of Cattle to Trypanosomal Challenge.” *Ann. trop. Med. Parasit.*, **53**, 3.

DESOWITZ, R. S.—“Paper Electrophoresis of Trypanosomal Extracts.” *Nature*, Lond., **184**, 986.

DESOWITZ, R. S.—“Denaturant Effect of Basic Trypanocidal Drugs on the Protein of Cell-Free Trypanosomal Extracts.” *Exp. Parasit.* (in press).

MCDONALD, W. A.—“Nocturnal Detection of Tsetse Flies in Nigeria with Ultra-violet Light.” *Nature*, Lond. (in press).

NASH, T. A. M.—“The West African Institute for Trypanosomiasis Research, Annual Report, 1958.” London: Harrison & Sons.

STEPHEN, L. E.—“The Prophylactic and Therapeutic Activity of Metamidium and its Suramin Salt against Trypanosomiasis in Cattle.” *Vet. Rec.*, **72**, 80.

STEPHEN, L. E., and GRAY, A. R.—“The Trypanocidal Activity of Nucleocidin against *Trypanosoma vivax* in West African Zebu Cattle.” *J. Parasit.* (in press).

STEPHEN, L. E., and MACKENZIE, C. P.—“Experimental *Trypanosoma vivax* Infection in the Horse.” *Vet. Rec.*, **71**, 527.

WIJERS, D. J. B.—“Thesis. Studies on the Behaviour of Trypanosomes, Belonging to the *Brucei*-subgroup, in the Mammalian Host.”

WILLIAMSON, J.—“Drug Resistance in Trypanosomes; Selective Interference with Trypanocidal Action.” *Brit. J. Pharmacol.*, **14**, 431.

WILLIAMSON, J.—“Drug Resistance in Trypanosomes; Effects of Metabolic Inhibitors, pH and Oxidation-Reduction Potential on Normal and Resistant *Trypanosoma rhodesiense*.” *Ibid.*, **14**, 443.

WILLIAMSON, J., and ROLLO, I. M.—“Drug Resistance in Trypanosomes; Cross-Resistance Analyses.” *Ibid.*, **14**, 423.

## V. ACTIVITIES OF TERRITORIAL DEPARTMENTS

64. In Northern Rhodesia comparative field trials of Prothidium, begun in the previous year, had to be abandoned, owing to the withdrawal of the drug by the makers. During the first year, Antrycide methyl sulphate at 4.4 mg/kg every 2 months, Antrycide prosalt at 10 mg/kg every 4 months and Prothidium at 2 mg/kg every 6 months prevented infection. In one herd under heavy challenge, when Prothidium was no longer available, *T. vivax* broke through at the 188th day.

65. A strain of *T. vivax* from Chisamba reputedly resistant to Antrycide was submitted to critical examination, but proved fully susceptible to Antrycide methyl sulphate, Dimidium, Ethidium bromide, Novidium and Berenil at normal dosage levels.

66. Unsuccessful attempts were made to organise routine collection of blood smears from game animals captured in the course of game rescue work from Kariba Lake Islands. From the small number of smears obtained, heavy infection with *T. congolense* was noted in wild pig and duiker.

67. In the course of the rescue work, the effects of chlorpromazine (Largactil, M. & B.) on game animals were noted. It proved effective in the smaller animals (i.e. under 200 lb. body weight) at a dosage rate of 2.5 mg/kg, but in large antelope and zebra, at a lower dosage rate of 1 mg/kg, it caused enhanced excitement and toxic symptoms, proving fatal to Impala.

68. The Tanganyika Veterinary Department held a large-scale trial of prophylactic drugs during the year. Previous trials had shown that the poor protection obtained from Prothidium was due to the formation of an inactive compound in the production of tablets through the reaction of the active powder and the excipient.

69. A study by the Kenya Veterinary Department of game animal *Glossina swynnertoni* associations in the Talek river area of Masailand showed that *G. swynnertoni* has a food preference for pigs; 40 per cent. of its blood meals were from warthog. It also feeds to a lesser extent on elephant, buffalo and giraffe, but apparently only occasionally, if at all, on some of the most numerous animals in the area such as zebra and hartebeest.

70. At Kiboko further studies on the host preferences of *G. longipennis* again confirmed that rhinoceros, elephant and buffalo are the animals on which this fly most frequently feeds, whilst waterbuck—the commonest antelope—was not favoured at all. Exposing cattle within the experimental area at Kiboko showed that *G. longipennis* will feed on cattle when they are first introduced into an area, particularly if its preferred hosts are absent, but later it rejects the cattle in favour of its normal hosts when they are present.

71. Good progress by the Department was made in chemotherapeutic studies of animal trypanosomiasis. Field trials carried out during the past five years have furnished much practical information about the advantages and drawbacks of the drugs available. It is now possible to select the most suitable drug-regime for each type of problem. The main drawback continues to be the development of drug-resistance, but study of this phenomenon is beginning to show ways in which it can be controlled under field conditions.

72. Investigations into the development of partial immunity to trypanosomiasis by cattle repeatedly infected and cured, and into the inheritance of passive immunity by their calves, have indicated interesting lines for further research.

73. In South Nyanza, 78 miles of the Awoch river were sprayed with Dioldrex, while the 14 miles of lake shore treated in 1958 remained fly-free. In the Kuja-Migori area about 1,000 square miles of country has now been rendered free of *G. palpalis* since 1955, involving the spraying of some 692 miles of river and 63 miles of lake shore, at a cost of approximately £50,000. An experiment to exterminate *G. pallidipes* from the Sikiri peninsula, an area of about 500 acres, proved successful after the third application of Dioldrex.

74. The investigation in the Nyasaland Lower River area into the factors restricting livestock production has shown that the most important factor in the area was trypanosomiasis largely spread by mechanical transmission, the very great prevalence of biting flies in this very low, hot and humid area being an important contributory cause. The trypanosome was identified as a monomorphic organism of the *congolense* group. The causal organism had become resistant to Dimidium bromide and there was strong evidence that it had also acquired resistance to other phenanthridial drugs, notably Ethidium. The policy was adopted of attempting to sterilise the animals of infection by the injection of all the cattle in the affected area with Antrycide in its prophylactic and therapeutic forms using Berenil to control any breakback of infection.

75. In Northern Nigeria investigation and research into spraying methods, necessary for the eradication of *Glossina morsitans* associated with *G. tachinoides* continued throughout the year. This work has been carried out both in the Sudan and Guinea Zones of vegetation.

76. In the Sudan Zone both the area and extent of tree trunks sprayed together with the percentage concentrate of the spray have been consistently reduced, from year to year, and the method has now become standardised. Complete eradication can now be obtained after a single spraying of tree trunks with diameter in excess of 9 inches, to a height of 5 feet from ground level, with an aqueous suspension of 2½ per cent. DDT wetttable powder. Only trees within the forest islands and clump thickets are sprayed.

Spraying operations are only possible during the dry months from December to May and, working on these principles, 350 square miles along the flood plains and adjoining uplands of the Komadugu Gana River have now been rendered free from tsetse.

77. In an attempt to apply the same technique to *G. morsitans* areas in the Guinea Zone, a large experimental block was surveyed in the Ririwai area of Bauchi Province and spraying operations were initiated, in December, 1959, assisted by finance granted by I.C.A. The object of the experiment was to find the most economical method, especially in the selectivity of spraying vegetation in the drainage lines and adjacent *Isobertia* woodland.

78. While tree trunks only had been sprayed in the Sudan Zone it was soon obvious that *G. morsitans* in the Guinea Zone of vegetation were resting on the underside of branches and boughs during the early forenoon. Thus spraying had to be extended to include these resting sites up to a height of 14 feet. Again in the Sudan Zone, only the forest islands and clump thickets required attention, but in the Guinea Zone drainage lines, *Isobertia* woodland and various types of ecotones required investigation.

79. Promising results have already been obtained and eradication achieved by spraying only the underside of boughs and branches between heights of 5 and 14 feet in water courses and adjoining *Isobertia* woodland with 3½ per cent. DDT wettable powder suspended in water. Much experimental work still remains to be done.

80. Spraying against *G. palpalis* in the Guinea Zone of vegetation in South Zaria continued, using Dieldrin as the main insecticide. Here again the strength of the Dieldrin spray has been gradually decreased and the spraying made more selective until eradication has now been achieved with one spraying of 2 per cent. Dieldrin emulsion concentrate, and restricting spraying to one bank only of the narrow rivers and in some cases only spraying on each side of river crossings. Four hundred miles of rivers and streams have been reclaimed to date. Experimental work in this area continues, using both DDT and Dieldrin emulsions in the wet season, to find out the minimum strength required to eliminate *G. palpalis* with a single application.

81. Work on the Mayo Ine river in Adamawa on the eradication of *G. tachinoides*, again in the Guinea Zone of vegetation, was completed. Various techniques such as fogging and spraying and various insecticides have been used but the most economical and successful was a single application of 3½ per cent. DDT wettable powder applied to the dry season foci, giving complete eradication with one application.

## VI. RESEARCH IN THE UNITED KINGDOM

82. With the co-operation of the University of Liverpool, Professor R. M. Gordon has continued with his work on the development of the infection in the mammalian host from the time of biting of the tsetse fly and the maintenance of the different forms of trypanosomes in culture. The general pattern of the development of infection of *T. gambiense* follows that of *T. rhodesiense*, in that the blood of the bitten animal remains infective throughout the incubation period and that in some instances a proportion of the trypanosomes remain at the site of the bite and cause a chancre and these tissue trypanosomes always have the appearance of the "blood forms".

83. In the rabbit the pattern of *T. gambiense* infection differs from that of *T. rhodesiense* infection in that gambiense infection is not so often associated with the formation of a chancre and to date efforts have failed to demonstrate more than a few trypanosomes (1 to 4) in any fresh or stained preparation made from even well developed chancres, whereas a chancre of a similar development caused by *T. rhodesiense* would contain vast numbers.

84. Culturing the metacyclic trypanosomes on the same medium used successfully for *T. rhodesiense* gave successful or partially successful results in about half the attempts.

85. Under Mr. B. Weitz a systematic investigation of the antigens of trypanosomes was continued at the Lister Institute of Preventive Medicine. *Trypanosoma brucei* was obtained from the blood of infected rats at the height of parasitaemia and before the formation of antibody in the rat. At this stage of infection the serum of the rats contains a soluble antigen of *T. brucei* which is referred to as exoantigen. The exoantigen occurs on the surface of the protozoa and can be removed *in vitro* by washing, a process which causes the trypanosomes to lose their viability rapidly. Trypanosomes, washed partially free of exoantigen, can be made more infective to mice by the addition of more exoantigen to the suspending medium. The effect is to preserve the viability of trypanosomes *in vitro* for longer periods than without exoantigen. Exoantigen is also responsible for the agglutination of trypanosomes *in vitro* by the action of antisera from rabbits chronically infected with *T. brucei*. The agglutinating antibodies can be neutralised by specific absorption with exoantigen. The exoantigen is immunogenic and antisera prepared in rats or rabbits agglutinate trypanosomes *in vitro* and neutralise the infectivity of trypanosomes to animals.

86. Animals can be actively immunized with exoantigen and are then protected or partially protected against infection according to the severity of the challenge dose. The antibody to exoantigen has been shown to be present in the serum of cattle naturally infected in the field, thus indicating that the mechanism is of some practical significance.

87. The specificity of the exoantigen in relation to other strains and species of trypanosomes is being studied at the Institute as also is the cross immunisation with the antigens of *T. brucei* which are more closely bound to the cell.

#### *Publications*

Ref.: WEITZ, B.—“A soluble protective antigen of *Trypanosoma brucei*.” (1960) “*Nature*” *Lond.*, 185. 788-89.

88. Under Dr. W. E. Ormerod work is continuing at the London School of Hygiene and Tropical Medicine on nuclear protein inclusions in trypanosomes. From December to April he visited East and Central Africa and Bechuanaland studying the epidemiology of *T. rhodesiense* with these inclusions.

#### *Publications*

“A study of cytoplasmic inclusions in *Trypanosoma lewisi* and their relationship to the formation of antibody.” (1959), *J. Gen. Microb.*, 21, 287-294.

Report of the Director,  
Anti-Locust Research Centre,  
on Locust Research and Control  
(1959-60)

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Anti-Locust Research Centre,  
1, Princes Gate,  
Kensington,  
London, S.W.7.  
2nd August, 1960.

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 1959-60.

I have the honour to be,

Sir,

Your obedient Servant,

T. H. C. TAYLOR.

The Right Honourable Iain Macleod, M.P.,  
Secretary of State for the Colonies.



## LOCUST RESEARCH AND CONTROL, 1959-60

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## LOCUST RESEARCH AND CONTROL 1959-60

### ANTI-LOCUST RESEARCH CENTRE

#### *Personnel*

1. Dr. B. P. Uvarov, founder and Director of the Anti-Locust Research Centre, retired from the directorship at the end of March, 1959, and became Consultant.

2. Dr. T. H. C. Taylor was appointed to succeed him as Director, and the post of Deputy Director which thus became vacant was filled by the appointment of Dr. P. T. Haskell.

#### *Research workers from overseas organisations*

3. As in previous years, many scientists from overseas anti-locust organisations worked at the Centre during the year for periods of weeks or months. They included representatives of the Desert Locust Survey, the International African Migratory Locust Organisation, the International Red Locust Control Service, the Department of Agriculture of South Africa, the F.A.O./U.N.E.S.C.O. Desert Locust Ecological Survey, the W.M.O. Technical Assistance Mission for Desert Locust Control and the anti-locust Service of Ethiopia.

#### *Publications, "Acridological Abstracts" and "Current Research on Orthoptera"*

4. Two Anti-Locust Bulletins were published during the year, one dealing with the colour patterns of hoppers of the Desert Locust in relation to their ecological history, and the other with reproduction in the Red Locust; the former was by Dr. Stower of the Desert Locust Survey and was illustrated by five coloured plates paid for by the Survey, and the latter was by Dr. M. J. Norris (Mrs. Richards) of the Centre.

5. During the same period, 37 papers by members of the Centre's staff, its extra-mural research workers, and other scientists supported or helped to some extent by the Centre, were published in journals.

6. Four issues of "Acridological Abstracts" have been prepared comprising 435 abstracts.

7. The great interest aroused by the first issue of "Current Research on Orthoptera", which is a mimeographed list of names, addresses and research projects of scientists concerned with locusts and related insects, resulted in many new records of current research being sent to the Centre. A second issue, suitably revised, was prepared and distributed during the year; it contains 335 names from 45 countries.

#### *Records, summaries and forecasts of the locust situation*

8. The Desert, Red, Migratory and Tree Locusts occurred in swarming form during the year. Many hundreds of reports containing thousands of swarm and hopper records, mainly of the Desert Locust, were received and mapped.

9. The Desert Locust plague continued through the year and spread to India and Pakistan. The International Desert Locust Information Service, conducted by the Centre and partly financed by F.A.O., continued to issue monthly summaries and forecasts.

10. Summaries of the principal developments in the Desert Locust plague were prepared by Miss Waloff for the F.A.O. Desert Locust Committee and the Committee of the Desert Locust Survey.

*Conferences, committees, tours and lectures*

11. Dr. Uvarov attended a meeting of the Desert Locust Committee (i.e. the Committee of the Desert Locust Survey) in London in July. As Special Consultant to F.A.O., he attended the meeting in Rome in April of the F.A.O. Panel of Experts on the Strategy of Desert Locust Plague Control, of which he was Chairman, and the meeting in June, also in Rome, of the F.A.O. Desert Locust Control Committee. He was present at the annual meeting of the Council of the International African Migratory Locust Organisation, which was held in London in June. In November and December he toured Australia, at the invitation of the Commonwealth Scientific and Industrial Research Organisation, to acquaint himself at first hand with locust problems in Australia and advise on them, and also to meet research workers there.

12. The meeting of the F.A.O. Panel on the Strategy of Desert Locust Plague Control of which Dr. Uvarov was Chairman was attended by Miss Waloff who, as Adviser to the Panel, outlined the principal conclusions on Desert Locust migrations and seasonal breeding based on the analysis carried out by and under her in the Geographical Section of the Centre. Her statement formed the basis of the deliberations and recommendations of the Panel.

13. Miss Waloff also attended the London meeting of the Desert Locust Committee, and that of the Scientific Commission of the International African Migratory Locust Organisation.

14. Dr. Taylor attended meetings of the Executive Committee of the International African Migratory Locust Organisation in Paris in April and December, and the annual session of the Council of that Organisation held in London in June. As a member of the U.K. delegation, he participated in the meeting of the F.A.O. Desert Locust Control Committee held in Rome in June. He went to Lourenço Marques in July for the annual meeting of the Council of the International Red Locust Control Service.

15. Dr. Haskell attended the London meeting of the Desert Locust Committee and visited locust research workers and their supervisors in the universities of Bristol, Cardiff, Reading, Birmingham, Oxford and London. He also gave a discourse at the Royal Institution on "Research in the War against Locusts" and a broadcast talk on "Locust Research" in the Overseas Service of the B.B.C. In January he attended a meeting of the Desert Locust Committee in Nairobi and visited research workers in the field in eastern Africa.

16. Dr. Rainey served on the F.A.O. Panel of Experts on the Use of Aircraft for Desert Locust Control which met in Rome in April; the results of research work on the use of aircraft in locust control were summarised by him as Working Papers which were presented to the Panel and discussed by it. He also attended the F.A.O. Desert Locust Control Committee meeting in June as a member of the U.K. delegation, and was present at the meeting of the Scientific Commission of the Inter-

national African Migratory Locust Organisation in June and the session of the Desert Locust Committee (of the Desert Locust Survey) in July. In November–December he spent five weeks in East Africa, visiting research workers of the Desert Locust Survey in the field and attending, at the invitation of the World Meteorological Organisation, a symposium on tropical meteorology in Nairobi at which he read a paper on “Applications of synoptic meteorology to problems of locust control”.

17. Mr. MacCuaig attended the International Agricultural Aviation Conference held at Cranfield in September.

*Co-operation with overseas organisations*

18. *The International African Migratory Locust Organisation.* Close and valuable co-operation between this Organisation (O.I.C.M.A.) and the Centre was maintained. For the first time, the annual session of the Council of the O.I.C.M.A. was held in London. The session was preceded by a meeting of the Scientific Commission which was held at the Centre, and an informal evening gathering was arranged to enable the members of the Council to see something of the Centre’s work; an exhibition of the work of the Laboratory and the Geographical Section was prepared for this occasion.

19. This Organisation suffered a very severe loss in an aircraft disaster in September, when Mr. J. T. Davey (Director of Research) and two other officers, as well as wives and children were all killed. This catastrophe seriously hindered the programme of research and presented the Organisation with most difficult staffing problems. In order that the delay in research might be as short as possible, arrangements were made for Mr. D. Yeo, of the Colonial Pesticides Research Unit, Tanganyika, who was already well acquainted with the outbreak area on the Niger and the type of research required, to be seconded to the O.I.C.M.A. for several months from January 1960.

20. *The International Red Locust Control Service.* Dr. Gunn, Director of this Service since 1952, resigned and was succeeded as Director by Mr. Du Plessis, formerly Chief Locust Officer, South Africa, and for several years President of the Service. These changes made the 1959 meeting of the Council held in Lourenço Marques particularly important. The Director of the Centre attended the meeting at the invitation of the Service.

21. *The Desert Locust Survey (East Africa High Commission).* This organisation held a Committee meeting at the Centre and invited several members of the Centre’s staff to attend. This provided a particularly fruitful opportunity for ensuring continuation of the very close collaboration which has existed in the past between the Survey and the Centre.

22. Dr. Stower of the Survey was at the Centre until April 1959 when he had largely completed the writing-up of his very considerable field studies of the behaviour of the Desert Locust. He then went to India for further field studies and to visit scientists concerned with locust research and control there, and six months later, when he was returning to Africa, he spent two further weeks at the Centre to discuss future research on the Desert Locust and the preparation of his typescripts for publication.

23. Mr. Sayer, also of the Survey, spent four months at the Centre mainly to analyse vertical photographs of flying locusts with reference to the speed, displacement and orientation of individuals, particularly in relation to wind structure. This important and interesting research, developed largely by Mr. Sayer over a period of years, was conducted in close co-operation with members of the Centre's staff. During his stay in England he also participated in trials of a new type of aircraft spray-gear that is being developed for the Desert Locust Survey in co-operation with the Centre.

24. Mr. Stephenson, Director of the Survey, visited the Centre for a few days in December in order to discuss future developments in research and control, particularly in the international field.

25. *The World Meteorological Organisation.* Dr. H. Sebastian, Chief of the WMO Technical Assistance Unit, spent several days at the Centre in May discussing various aspects of the work of the WMO Technical Assistance Mission for Desert Locust Control, which is based in Nairobi and led by Mr. Aspliden. This welcome visit further strengthened the already good relations that existed between the WMO and the Centre, as did a visit of Mr. D. A. Davies, Secretary-General of the WMO, in July and Dr. Rainey's participation in the WMO symposium in Nairobi at the end of the year.

26. Mr. Aspliden worked at the Centre for six weeks during July and August, in order to correlate his study of the meteorology of the whole Desert Locust area for the selected year 1954-55 with the relevant locust data which had been suitably prepared at the Centre (with financial assistance from the Desert Locust Survey). It is anticipated that the work of this Mission and the corresponding work at the Centre will be completed in 1961.

27. *The Food and Agriculture Organisation of the United Nations.* Very important meetings, in which the Centre was closely concerned, took place during the year. Two of them were meetings of panels of experts convened by FAO to make recommendations respectively on the Use of Aircraft for Desert Locust Control and the Strategy of Desert Locust Plague Control. The reports of these two panels were presented to the Sixth Session of the FAO Desert Locust Control Committee, which had mainly to consider an application which was to be made by interested countries, through FAO, to the United Nations Special Fund for financial support for an Expanded Inter-Regional Project on Desert Locust Control, designed to develop more effective control of the Desert Locust.

28. The representation of the Centre at all these meetings has already been indicated. An essential part in them was played by Dr. Uvarov, who was Chairman of the Strategy Panel and Consultant to FAO, and in the latter capacity was enabled to bring his knowledge and experience to bear on the Project to be submitted to the United Nations Special Fund.

29. The Project was approved by the Special Fund in December, and the Centre was pleased to receive a visit soon afterwards from Mr. O. B. Lean, Desert Locust Specialist of FAO, who was visiting interested countries and organisations in order to obtain their comments on a draft Plan of Operation of the Project. When the Plan is approved, probably in mid-1960, funds will be released for the commencement of operations. This will concern the Centre in many ways, but most directly by providing for the expansion,

by the utilisation of current weather data, of the International Desert Locust Information Service which is already conducted by the Centre. Plans for this purpose are specifically included in the Project as an essential part of it.

*Work in the Centre's laboratory*

30. The demand for live locusts for research purposes for both intra- and extra-mural workers was greater than ever, and production was increased accordingly. A new type of breeding cage was constructed and a new room was acquired and equipped for temperature control. About 7,000 hatchlings and 1,000 adults of the Desert Locust were produced each week, together with smaller numbers of other locust species. The latter included *Schistocerca paranensis*, an American relative of the Desert Locust and a new addition to the laboratory. Stocks of several species of African grasshoppers were maintained. It is estimated that altogether some 60,000 adult Acridids were produced during the year.

31. The booklet describing methods of rearing and breeding locusts in the laboratory was much in demand and became out of print. A revised and enlarged version of it is being prepared for publication.

32. Visitors to the laboratory during the year included scientists from Australia, Germany, France, Poland, Turkey, Iran and Egypt.

33. Dr. P. T. Haskell, with assistants, continued his investigation of the responses of locust hoppers to air movement and to olfactory stimuli in controllable conditions of radiation and temperature in a flat-bed wind-tunnel. Various modifications of the equipment have proved necessary in the light of experience. This research, which arises from the need to understand several aspects of behaviour of hoppers in the field in relation to certain control techniques, will be continued and extended. Dr. Haskell continued his study of the responses of the hairs of the aerodynamic sense organ on the locust head; this work has an important bearing on the direction of flight of adult locusts in relation to moving air.

34. Mr. P. Hunter-Jones, in addition to his responsibility for the general supervision of the laboratory, continued experiments on the accumulation of phase characters over several successive generations, and also studied the gross effects on incubation of the eggs of the Desert Locust of a range of water-contents of the soil in which the eggs are laid.

35. Mr. G. G. Cavanagh, utilising the entirely artificial and largely synthetic diet developed by Dr. Dadd for feeding locusts in the laboratory, conducted preliminary experiments on the effects on locusts of supplementing the diet with small quantities of different parts of plants of different ages and various unrelated species. This investigation, carried further, will be complementary to field work in Africa, and it is hoped that the two approaches will throw light on the effects of different natural foods on development and fecundity.

36. Mrs. M. J. Richards continued her research on the factors, including the presence of other sexually mature locusts, which influence the selection of sites for egg-laying by the Desert Locust. She showed that while females can detect small differences in water-content of the sand and choose their oviposition sites accordingly, the presence of other females already laying is an overriding factor resulting in the grouping together

of ovipositing females. She also continued her work on the effect of length of day on maturation of the Red Locust.

*Extra-mural laboratory research (other than insecticide research)*

37. Two important and rewarding projects, both supported for several years by fellowship grants from the Centre, terminated during the year. These were studies of the nutritional needs of locusts, by Dr. R. H. Dadd, and of the olfactory stimulation of one locust by another, especially in relation to sexual maturation, by Dr. W. Loher. Accounts of the work done under these fellowships are in the course of preparation for publication. Dr. Dadd and Dr. Loher worked at Imperial College, London, and its Field Station at Silwood Park, respectively.

38. Dr. P. E. Ellis and her assistant continued their investigation of the aggregation of locust hoppers leading to the development of gregariousness. Dr. Ellis, with Dr. D. B. Carlisle of Plymouth Marine Laboratory, also began a comparative study of the prothoracic gland in solitary and gregarious locusts of various species, with particular regard to its size and persistence in the adult.

39. Dr. L. J. Goodman, working at Queen Mary College, London, extended her study of the visual responses of flying locusts to include their stability in the rolling, pitching and yawing planes, a problem related to the behaviour and spacing of locusts flying in swarms.

40. Other projects wholly or partially financed by the Centre included investigation of the blood chemistry of locusts at the University of Leeds; of particular aspects of the problem of vision in locusts at Newcastle (University of Durham) and the University of Reading; and of thermo-reception in locusts at the University of Birmingham.

*Insecticide research*

41. Mr. R. D. MacCuaig and his assistants, accommodated at the Chemical Defence Experimental Establishment of the War Office, continued to assess the toxicity to locusts of new insecticides and new formulations, and Mr. MacCuaig again visited Africa, in full co-operation with the Desert Locust Survey, in order to relate his laboratory work to field practice and to participate in field research.

42. Miss T. Kikal (Mrs. Gessner) brought to a close her work at St. Mary's Hospital Medical School, where, as a holder of one of the Centre's grants, she investigated the detoxication of insecticides for three years. She prepared her results for publication. A further appointment was made to ensure the continuation of work on these lines under Dr. J. N. Smith.

*Biogeographical and bioclimatic research*

43. Most of the members of the Geographical Section were involved, under Miss Waloff, in the preparation of special cartographical material for the FAO Panel of Experts on the Strategy of Desert Locust Control. The Panel urged that this material, which demonstrated strategically important situations and distributions and which was the basis of its deliberations, should be published in full.

44. Miss Waloff and Miss J. V. Laszlo continued their extraction from field reports of information on geographical variation in the durations of the developmental stages of the Desert Locust in its various breeding areas.

The correlation of these data with the temperatures recorded at meteorological stations in the relevant areas was commenced.

45. Miss Waloff continued her study of data on the Desert Locust in the Red Sea basin and extended analysis of breeding in this area to the Arabian coast, where frequency of breeding and opportunities for the rapid production of successive generations appeared to be similar to those on the other side of the Sea. She also examined records of the occurrence of the Desert Locust at sea.

46. Miss E. Betts completed her review of historical data on the plagues of the Migratory Locust in Africa. Miss V. Horler has begun a detailed study of the available material relating to the last major plague of this species and has completed maps of swarm movements and breeding in the initial years (1928 and 1929).

47. Miss J. I. Magor, continuing her research on the rainfall characteristics of the Desert Locust breeding areas, embarked on a more detailed examination of one of these areas in India to determine in the first place the amount of rainfall associated with the beginning of laying.

48. Dr. R. C. Rainey, investigating the distribution and movements of Desert Locust swarms in relation to weather, paid particular attention to the degree of constancy of direction of each of several individual swarms on which aircraft observations had been made. He has related long-range displacement and effectively static flight behaviour to correspondingly different wind-régimes experienced by the swarms. The importance in relation to the strategy of control of the recognition of areas in which large locust populations remain static for extended periods is evident.

#### *Taxonomic research*

49. Dr. V. M. Dirsh, assisted by Miss J. B. Mason, prepared for publication keys to the classification into families and subfamilies of the locusts and grasshoppers of the world. This undertaking is a necessary preliminary to publication of his keys to the African genera, the text and illustrations of which were virtually completed during the year, after several years of intensive work.

#### *Statistical work*

50. A paper was prepared by Mr. D. E. Davies and Mr. I. B. Jones, jointly with Dr. W. J. Stower of the Desert Locust Survey, on an investigation, by multi-variant analysis, of the morphometrics of field populations of the Desert Locust of known histories. This paper has been accepted for publication.

## REGIONAL ORGANISATIONS

### *International Red Locust Control Service*

51. This organisation maintained control of the Red Locust in its recognised outbreak areas. It also carried out aerial operations against swarms of the Red Locust which appeared in the Wembere plain, near Tabora in Tanganyika.

52. Its research has been concentrated on the natural mortality that occurs in each stage of the locust, the characteristics of the grasslands in



which the locust breeds, the forecasting of locust populations on the basis of the known rainfall during the two previous seasons, and the utilisation of aircraft for both survey and control without assistance on the ground.

*International African Migratory Locust Organisation*

53. There was no increase in the populations of the Migratory Locust in its outbreak area on the Niger, which was kept constantly under survey, but this organisation was energetically engaged in controlling the swarming population of the Red Locust which developed in that area. The Red Locust was successfully brought under control and prevented from leaving the area, by spraying mainly from aircraft but also from ground vehicles using the exhaust sprayer.

54. The secondment of Mr. Yeo of the Colonial Pesticides Research Unit, Tanganyika, to this organisation, following the aircraft disaster already mentioned, resulted in valuable research being done despite the serious loss of personnel. The main purpose of the research was to develop the use of aircraft for survey and control as far as the conditions prevailing in the outbreak area permit. Due attention was paid to those lines of ecological research, including population assessment, upon which such operations depend if they are to be efficiently and economically conducted.

*Desert Locust Survey*

55. The Desert Locust plague continued and extended during the year. The Desert Locust Survey maintained its control campaign, with aircraft and ground forces, in the Somali peninsula, in close co-operation with the anti-locust services of Somalia and Ethiopia. The Survey's research programme was mainly directed towards further improvement of the techniques of barrier and lattice spraying with highly concentrated persistent insecticide at very low area-dosages, and towards the development of better methods of assessing the severity, source and future gregarious tendencies of locust populations.

ADVISORY COMMITTEE ON ANTI-LOCUST RESEARCH

Membership

- SIR STUART GILLETT, C.M.G. (*Chairman*).
- DR. W. E. CHINA, C.B.E., M.A., Keeper of Entomology, British Museum (Natural History).
- DR. A. G. FORSDYKE, Assistant Director, Climatological Research, Meteorological Office, Air Ministry.
- MR. R. C. H. GREIG, Colonial Office.
- DR. P. T. HASKELL, Deputy Director, Anti-Locust Research Centre.
- PROFESSOR O. E. LOWENSTEIN, D.Sc., F.R.S., Mason Professor of Zoology and Comparative Physiology, University of Birmingham.
- SIR GEOFFREY NYE, K.C.M.G., O.B.E., Agricultural Adviser to the Secretary of State.
- MR. E. O. PEARSON, M.A., A.I.C.T.A., Director, Commonwealth Institute of Entomology.
- PROFESSOR O. W. RICHARDS, M.A., D.Sc., F.R.S., Professor of Zoology and Applied Entomology, Imperial College of Science and Technology.
- MR. K. F. SAWYER, B.Sc., Chemical Defence Experimental Establishment, Ministry of Supply.
- DR. T. H. C. TAYLOR, Director, Anti-Locust Research Centre.
- DR. B. P. UVAROV, C.M.G., F.R.S., formerly Director, Anti-Locust Research Centre.
- PROFESSOR G. C. VARLEY, M.A., Ph.D., Hope Professor of Zoology (Entomology), University of Oxford.
- PROFESSOR V. B. WIGGLESWORTH, C.B.E., M.A., M.D., F.R.S., Director, Agricultural Research Council Unit of Insect Physiology; Quick Professor of Biology, University of Cambridge.
- DR. C. B. WILLIAMS, M.A., F.R.S., formerly Chief Entomologist, Rothamsted Experimental Station.
- MR. A. T. THOMPSON, B.Sc., Secretary, Anti-Locust Research Centre (*Secretary*).

Terms of reference

1. To guide the work of the Anti-Locust Research Centre on its scientific side with the object of ensuring continuity and co-ordination of its research in all its aspects;
2. To advise the Director of the Centre in regard to the preparation of a programme and the means of ensuring the fullest co-operation of scientific bodies and Government departments in carrying it out;
3. To consider the estimates of expenditure of the Centre.

RESEARCH MATTERS NOT COVERED BY THE ACCOMPANYING  
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**A. BUILDING AND HOUSING RESEARCH****Tropical Building Section, Building Research Station, Department of Scientific and Industrial Research.**

1. The first of a new series of publications, *Tropical Building Studies*, appeared in March 1960. The series, which is being published by Her Majesty's Stationery Office, makes available material of technical interest to those concerned with building in the tropics and sub-tropics in more permanent form than intended by the Section's Overseas Building Notes. The first study examined the factors determining densities in housing areas and, by means of diagrams and tables, provides the tools with the aid of which better decisions on local standards can be made. The study was prepared by Mr. P. H. M. Stevens, formerly town planning officer in the Tropical Building Section and now Town and Country Planning Officer, Barbados. A second study dealing with the design of buildings for the storage of crops in warm climates, is ready for publication.

*Visits*

2. Mr. G. A. Atkinson, Head of the Section, visited Mauritius at short notice from 19th March to 7th April, 1960. His main task was to assess the damage to housing caused by cyclones Alix (18th-19th January) and Carol (28th February) and to advise on reconstruction measures. His report was presented to the Secretary of State for the Colonies in April 1960. It was estimated that between 20,000 and 25,000 dwellings had been destroyed or damaged beyond repair. Most were the thatched huts of peasant farmers and agricultural workers and were scattered throughout the island. It was recommended that the reconstruction programme be in three phases: 12,000 dwellings; 8,000 dwellings; 5,000 dwellings. The third phase would merge with the island's general housing programme.

3. Experience of damage to buildings in the cyclones showed that well built and maintained concrete and timber houses both withstood the high winds well. It was recommended that priority be given to building large numbers of cyclone-resistant timber houses, it being considered easier thus to control the quality of workmanship on scattered sites. Recommendations were made on the organisation needed for reconstruction and other relevant matters. In doing this, use was made of the now considerable information relating to reconstruction after disasters which the Tropical Building Section has in its records.

4. To investigate the wind forces which were encountered during the cyclones and their effects on different kinds of structures, arrangements were made for Mr. C. W. Newberry, of the Building Research Station, to visit Mauritius also. He spent from 30th March until 22nd April, 1960, on the island surveying and photographing damage and discussing the effects and lessons of the cyclones with engineers, architects and others concerned. His report is in preparation.

5. Owing to the Mauritius emergency, a visit by Mr. Atkinson to West Africa had to be postponed until later in 1960. Mr. P. Whiteley, the Paint Research Fellow, however, spent three weeks in January 1960 at the West African Building Research Institute to assess the existing paint exposure trials and to prepare a new series. Mr. W. M. Woodhouse, senior architect,

was lent to the Commonwealth Relations Office from February to April 1960, to go to Pakistan and advise on architectural education and, on the way back, visited Aden mainly to advise on housing. Mr. Atkinson, in June 1959, paid a brief visit to Malta to advise further on aspects of the Government's housing programme.

6. A short visit was made in April to the Persian Gulf to advise a commercial concern on some particularly rapid and severe paint failures. Useful general experience was gained on steel corrosion in a hot, maritime climate.

#### *Enquiries and Technical Investigations*

7. *Environmental aspects of tropical building.* Much interest has been shown in the scale of subjective warmth devised by an extension to the climatic range of the Singapore Comfort Index to which reference was made in the 1958-59 Report. By combining information derived from climatic changes experiments conducted by the Medical Research Council and embodied in the  $P_4$  SR (predicted 4-hour sweat rate) scale, with data from factories in the United Kingdom obtained by Dr. T. Bedford, and with data from Singapore, a scale has been prepared which has properties superior to those of any previous scale of subjective warmth. It is believed that the scale, which has been named the Equatorial Comfort Scale, will be applicable to low-latitude indoor climates in general; it has been combined in a nomogram of standard type, copies of which have been distributed to interested workers. It has also been described in a recent Overseas Building Note which examined the thermal design of low-latitude buildings with particular reference to ventilation.

8. Though assistance has been given to a number of individual enquirers, it has not yet been possible to complete a note now in preparation on the daylighting of buildings in tropical climates. Daylight calculations for buildings in temperate climates commonly assume that the sky is densely overcast. The calculation techniques employed have, however, only a limited application in building design for hotter and more sunny climates where either, under the blue sky conditions met with at the Tropics, the sky is insufficiently bright to provide adequate illumination by itself or, as often happens near the equator, it is so excessively bright that measures must be taken to screen it from direct view. Under such conditions, buildings may depend on reflected sunlight rather than on sky light for their illumination.

9. *Building materials.* Enquiries continued to be received from overseas, and from United Kingdom concerns with overseas interests, on a wide variety of subjects. Enquiries dealt with have included flooring materials for a hospital in the Virgin Islands, lightning protection to buildings, and the behaviour of mastics.

10. Further interest has been shown in storage buildings for crops and advice has been given on the design and construction of cocoa stores in Ghana and Fiji. Together with members of the Pest Infestation Laboratory and Tropical Products Institute, the Materials Officer has served on a working party set up at the instigation of the Stored Products Sub-Committee. The working party has prepared a note on the behaviour of the Ctesiphon grain bins in Cyprus for the consideration of the Sub-Committee.

11. Much interest has been shown in the behaviour of the increasing number of plastics being used for building elements and equipment. A survey of the factors affecting the durability of such materials and their likely behaviour in tropical climates has been prepared. Exposure trials on polyvinyl chloride coated metal and timber window frames were organised in conjunction with the West African Building Research Institute. The coating is meant to provide a permanent decorative finish.

12. *Tropical paint research.* The Advisory Panel concerned with this work met in March, 1960 to review progress at the end of the initial three year period of the Fellowship which has now been extended for two further years. In his report, Mr. P. Whiteley, Tropical Paint Research Fellow, noted that the exposure tests at the West African Building Research Institute has occupied a large part of his time. The results to date had shown that the type of paint at present offered as 'fungicidal' had an inadequate exterior performance and life. A short series of paints with higher than normal concentrations of present principally-used fungicides were being put on trial. At the same time consideration was being given to the production of media inherently fungus resistant.

13. On the other major topic which has been investigated, the lime staining of emulsion paints, a laboratory test method which simulates the defect has been evolved. Various sealers and treatments are under test, together with a series of experimental paints made from various emulsions. Conveniently, practical trials have been carried out in West Africa. Tests of primers and other protective treatments for steel were continued, and are being extended to sprayed metal coatings.

14. Special issues of Overseas Building Notes on painting matters have been written. The first (No. 65) dealt with Emulsion Paints; the second (No. 67) on Mould Growth on Paint in the Tropics. In view of many requests from paint manufacturers for copies of these Notes, arrangements were made with the Export Group of the Paint Industry for bulk purchase direct from Her Majesty's Stationery Office of 500 copies of each of the two issues concerned.

15. *Structural problems.* Reference has been made to the investigation into the effects of high winds on buildings in Mauritius during recent cyclones. On the basis of experience gained, it is proposed to assemble and bring up to date the information which the Station has published on cyclone-resistant building. In particular, designers' attention is being drawn to the very high negative pressures which may occur locally especially on flat and low-pitch roofs. Experience has shown that each roof, particularly if of lightweight construction, requires much more careful attention to methods of fixing than commonly is given.

16. Accounts of the damage which occurred in the Moroccan and Chilean earthquakes confirmed the usefulness of recommendations made in Overseas Building Notes No. 63 which were mainly devoted to a note on earthquake-resistant construction. The note, based on a review of modern practice, was written as a guide to designers building in tropical countries where earthquakes may occur. The requirements of different building codes were discussed. The attention of builders of smaller structures was drawn to a number of important though relatively simple points of detailed design.

17. *Building control.* The Mauritius disaster has underlined the importance of ensuring a reasonable standard of construction if extensive damage to buildings is to be avoided. A principal way of ensuring this is through up to date and efficient building control. Work in this field continues, help with drafting revised building rules having been given to Mauritius and North Borneo among other territories.

*Dissemination of technical information*

18. *Courses and visitors.* The ninth annual course for architects and engineers in the Overseas Service was held at the Station in September. Members of the Section have also lectured at the Architectural Association School's Department of Tropical Architecture, at the London School of Hygiene and Tropical Medicine, and to the Overseas Labour Officer's course run by the Ministry of Labour and National Service. Further assistance has been given with the preparation of a syllabus by the City and Guilds Institute for courses in building construction overseas.

19. Recent visitors have included the Secretary, Ghana Research Council, the Minister of Works, Mauritius, the Director of Public Works, Bermuda, the Director of Public Works, North Borneo, and other officers from Housing and Public Works Departments in Colonial territories as well as a number of Commonwealth and United Nations officers.

20. *Publications.* Since the last Report, six issues of Overseas Building Notes have appeared:

No. 62—"The post-war housing programme of the Imperial Tobacco Company African Organisation, Central Africa; Housing in Kuala Lumpur, Malaya."

No. 63—"Building in earthquake areas; Publications on housing finance."

No. 64—"Sources of information; South African housing publications; Maintenance and building repairs."

No. 65—"Emulsion paints."

No. 66—"Ventilation in warm climates; A study of the influence of ceiling height in dwelling houses."

No. 67—"Mould growth on paints in the tropics."

The following papers have appeared:

Webb, C. G. (1959)—"*An analysis of some observations of thermal comfort in an equatorial climate.*" British Journal of Industrial Medicine, Vol. 16, pages 297-310.

Webb, C. G. (1960).—"Thermal discomfort in an equatorial climate; a nomogram for the Equatorial Comfort Index." Journal of the Institution of Heating and Ventilating Engineers. Volume 27, pages 297-304.

Tropical Building Studies No. 1.—"*Densities in Housing Areas*" by P. H. M. Stevens. London: Her Majesty's Stationery Office, 1960.

### **West African Building Research Institute**

#### *General*

21. The Institute's planned scheme of expansion continued during the year. 8 of the 19 senior staff posts are now filled but junior technical staff continue to be difficult to recruit.

22. Good progress was made with the building programme and some of the Institute's new buildings in Accra were occupied early in 1960. Rapid progress was made in providing research facilities, and many experimental features are being incorporated in these buildings.

*Advisory Service and Enquiries*

23. Government departments, statutory corporations, consultants and contractors have continued to make full use of the Institute's advisory service. Architects and engineers with no previous experience of West African conditions are increasingly being sent to the Institute for information and more than 600 enquiries were dealt with, the majority being on the durability of materials.

24. Work on the new Accra Building Regulations was completed. Regulations for rural building and also building and civil engineering Specifications for use in West Africa are under consideration.

*Liaison and International Co-operation*

25. Exchange of information and publications has continued with thirty organisations in other parts of the world. The Director represented the Institute at an International Congress on Building Research and Documentation in Rotterdam in September, 1959.

*Research*

26. Some of the alkyd-type gloss paints previously exposed for 12 and 26 months are being tested again together with some new formulations. Thirty-five emulsion paints for external surfaces are also being tested in Accra. Exposure tests of paints and of roof sheets have been set up at Lagos, and Zaria, and anti-corrosion materials for structural steel are being tested at a marine exposure site near Accra.

27. The investigation into the resistance of West African timbers to attack by subterranean termites showed that no one timber is resistant to all species of termite in all localities.

28. Recommendations on the results of laboratory durability tests on more than 100 West African soils have been made to organisations using soil-cement as a building material. The relation of these tests to performance in the field and the development of a simpler and quicker test are being studied.

29. The various factors, including seasonal moisture changes in clay soils, causing damage to buildings are being analysed.

30. Results of the measurement of indices such as dry and wet bulb temperatures, air movement, radiation temperatures and vapour pressure in the Institute's buildings at Accra are now being analysed and similar studies have been undertaken also at Zaria. Preliminary analysis of the studies at both of these places give the following figures:—

	Dry Bulb Temp. °F.		Corrected Effective Temp. °F.	
	Accra	Zaria	Accra	Zaria
Upper Comfort Limit ... ..	85.0	89.0	81.0	77.5
Optimum ... ..	80.0	77.5	77.5	68.5
Lower Comfort Limit ... ..	75.0	65.5	74.0	59.5

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31. Other investigations in progress included the causes of trouble with flat concrete roofs, natural lighting of buildings, the comparative performance of mortar and renderings containing a vinsol-resin type air-entraining agent, the testing of algicides to control mould growth on asbestos-cement sheets, and exposure tests of poly-isobutadiene sheeting and some commercial putties. Work was begun on the problems associated with the design of timber and reinforced concrete structures using local materials.

## B. FALKLAND ISLANDS DEPENDENCIES SURVEY

*Director* : Sir Vivian Fuchs, M.A., Ph.D.

### *Annual Relief of the Bases*

32. The annual relief of the southern bases during the Antarctic summer of 1959-60, was again hampered by severe ice conditions in the Graham Land area, but the five most northerly bases, were relieved without difficulty by the F.I.D.S. relief ship, R.R.S. "John Biscoe". The ship then entered the Weddell Sea, and after penetrating several hundred miles of heavy sea ice succeeded in relieving the Halley Bay base (Z) on 20th January.

33. The second relief ship, R.R.S. "Shackleton", spent two weeks measuring gravity and magnetism along the Scotia Arc, and the ship also visited several of the bases before proceeding to Cape Town on charter to the South African Government.

34. The charter ship M.V. "Kista Dan" left the Falklands at the beginning of January and carried two aircraft—a Beaver and an Otter. Both aircraft were assembled at Deception Island and the Beaver, fitted with floats, was taken on board and used to reconnoitre a route through the ice further south. Base F at the Argentine Islands was relieved in mid-February but it proved impossible for the ship to get into Marguerite Bay, even with assistance from the American icebreaker, U.S.S. "Glacier". Plans to establish a new base (T) on Adelaide Island and re-open Base E (Stonington Island) as an air-base therefore had to be abandoned, and Base Y (Horseshoe Island) was then relieved by air. The six-man Base T party were left to winter at the old Base F hut (Winter Island, Argentine Islands) and the six-man Base E party are wintering at Deception Island (B); both parties were flown south in the spring.

The total number of men wintering at the nine bases in 1960 was 87.

### *Field Work*

#### *Physical Sciences*

35. The Argentine Islands and Halley Bay bases (F and Z) have maintained a full programme of geophysical, meteorological, auroral and tidal observations. The upper-air programme was limited at Halley Bay to one ascent a day, owing to a shortage of radio-sondes, but the average heights were the greatest ever achieved in the Antarctic and consistently above 20 km. except for a period in May, 1959.

A Phosphorus Pentoxide Electrolytic Hygrometer was successfully tried out at Halley Bay and showed that this instrument could be used for continuous measurements of humidity at temperatures below  $-20^{\circ}\text{C}$ .

Ionospheric soundings and radio research have been carried out at Halley Bay and Port Lockroy (A), but were temporarily discontinued at Halley Bay while the equipment was sent home for overhaul.

A magnetometer survey of the Tabarin Peninsula, Duse Bay and the northern part of the Crown Prince Gustav Channel was completed by parties from Hope Bay (D), and Dr. D. H. Griffiths (Birmingham University) used a ship-borne proton resonance magnetometer to carry out a preliminary magnetic survey of the Scotia Arc and parts of the South Shetlands. Gravity measurements were undertaken in the South Shetlands and on the north-west coast of Graham Land.

Dr. G. de Q. Robin (Scott Polar Research Institute, Cambridge) investigated the damping effect of sea ice on wave motion in the Weddell Sea, by means of a wave-recorder fitted to the "Biscoe".

Meteorological and auroral observations have been maintained by eight bases.

#### *Topographical Survey*

36. Surveyors operating from Hope Bay during the southern winter of 1959, extended the triangulation of the Trinity Peninsula to provide ground control for mapping from the 1955-57 vertical air photography. During the 1959-60 summer, priority was given to the tellurometer link-up between the triangulations of the South Shetlands and Trinity Peninsula and, for this purpose, parties were transported by ship and helicopter to various localities in the Bransfield Strait. Work during the 1960 winter has been curtailed by the failure to re-open Base E and establish the new Base T as planned.

#### *Geology*

37. The detailed geological survey of the Argentine Islands, King George Island and parts of the north coast of South Georgia were completed, and reconnaissance work has been carried out on the north-east part of Livingston Island. Parts of the James Ross Island Group and exposures on the west coast of the Crown Prince Gustav Channel have been mapped in detail with particular reference to the stratigraphy/palaeontology. The Neny Fjord area of Marguerite Bay was mapped with special reference to the stratigraphy of the Basement Complex.

#### *Glaciology*

38. Routine sea ice observations were maintained at all bases. Glaciologists at Hope Bay undertook routine observations on accumulation, ablation, temperature profiles and firn stratigraphy, and on the movement of several glaciers.

At Admiralty Bay, King George Island, investigations were continued on cirque and valley glaciers.

Accumulation, ablation and movement of an ice shelf were studied at Halley Bay, and the rate of movement was found to be 413 yards per year. The rate of formation of sea ice was investigated in relation to energy balance.

#### *Biology*

39. At Signy Island, South Orkneys, research continued into the population dynamics, and migrating and breeding habits of three species of

seals. The study of soil fauna, and the collection of fresh-water and marine littoral material have been initiated. The ornithological programme has included work on migration, longevity, and the breeding behaviour of penguins and petrels.

Detailed work on the life cycle of the Emperor Penguin continues at Halley Bay, a precisely-timed series of embryos having been obtained in 1959.

Human physiological studies were carried out at three bases, and at Halley Bay these included an investigation of micro-climates.

#### *Examination of Field Data and Publication of Results*

40. The geological and glaciological work is being written-up at the F.I.D.S. Geology Department at Birmingham University, and a number of publications are in course of preparation.

Work is in progress on a collection of mosses at Birmingham University, and the examination of the F.I.D.S. collection of lichens at the Farlow Herbarium, Harvard, is now almost complete.

Magnetic data and some of the meteorological data from the Argentine Islands and Halley Bay are being prepared for publication at F.I.D.S. Office, London.

Sea ice records are being analysed at the Scott Polar Research Institute in Cambridge.

Ionospheric data have been passed on to the Radio Research Station, Slough, information on "whistlers" to Professor M. Morgan of the Thayer School of Engineering, Dartmouth College, New Hampshire, and auroral records to Mr. J. Paton of Edinburgh University.

Physiological data are being studied at the Medical Research Council Laboratories, Hampstead, and the embryological work is under the direction of Dr. T. W. Glenister of Charing Cross Hospital Medical School. The British Trust for Ornithology is now responsible for handling the ornithological data.

The Directorate of Overseas Surveys continues to publish F.I.D.S. maps in two main series, 1:500,000 and 1:200,000. The first two maps based on the 1955-57 vertical air photography have now been produced: one is sheet W6564 in the 1:200,000 series, and the second is a 1:25,000 hill shaded map of Deception Island.

Scientific publications during the past year include the following F.I.D.S. Scientific Reports, published by Her Majesty's Stationery Office:

No. 23.—"The King Penguin (*Aptenodytes patagonica*) of South Georgia." By B. Stonehouse, B.Sc., D.Phil.

No. 24.—"Upper Cretaceous Decapoda and Serpulidae from James Ross Island, Graham Land." By H. W. Ball, B.Sc., Ph.D.

### **C. GEODETIC AND TOPOGRAPHICAL SURVEYS**

#### *Staff*

41. Staff in post, other than those locally recruited abroad, totalled 432 at the end of March 1960, compared with 427 in March 1959. These included eleven Officers and senior Other Ranks seconded from the Military Survey Service. Improved recruitment was offset by an equivalent wastage.

*Geodetic Surveys*

42. The programme of astronomical observations and tellurometer measurements required in connection with adjustment of the Kenya primary triangulation was completed.

43. Primary triangulation was completed in the Copperbelt of Northern Rhodesia and good progress was made with reconnaissance of the Kasempa loop which runs through Solwezi and southwards to join existing primary triangulation, and, in the Southern Cameroons, primary triangulation was completed.

44. Despite adverse weather conditions in Sierra Leone, reconnaissance of primary triangulation was completed and angular observations and tellurometer measurements were commenced.

45. Along the east coast of North Borneo the Sandakan-Tawau triangulation was completed.

*Minor Triangulation and Control for Mapping*

46. Triangulation and height control were completed for the Usangu Flats area in Tanganyika, mapping of which was urgently required in connection with development schemes under investigation by the Food and Agricultural Organisation of the United Nations. Reconnaissance was started on a large extension of triangulation in the Bubu River area for irrigation projects.

47. Reconnaissance for ground control by tellurometer traversing was completed in the Maralal-Lake Baringo area of Kenya. Height control was established in the Voi and South Nyanza areas.

48. In the Eastern Province of Uganda the secondary network of tellurometer traverses was completed and a good start was made with the extension westwards into the Kyoga area.

49. Secondary triangulation and height control were completed for the Fort Jameson area of Northern Rhodesia, and work was re-commenced in the adjoining Central Province area of Nyasaland after being suspended for eight months owing to the emergency. Secondary triangulation in the Copperbelt and height control in the Katanino area were completed.

50. In the Southern Cameroons, ground control by tellurometer traversing was commenced in the Bamenda area.

51. The programme of triangulation and tellurometer traversing in the Bahama Islands was continued, work in Eleuthera, Cat and Grand Bahama being completed.

52. Triangulation of the Falkland Islands was completed.

53. Provision of control by tellurometer traversing was commenced in Sarawak.

54. Establishment of height control was commenced in the Jos area of the Northern Region of Nigeria.

*Air Photography*

55. About 5,800 square miles were added to the air photo cover of British Guiana.

56. Exceptionally good air photography was obtained for 21,000 square miles of Eastern Province, Uganda.

57. In West Africa, air photography covering a further 8,600 square miles of the Southern Cameroons and 3,700 square miles of Sierra Leone was obtained from the contracts reported last year. Under the current contracts, which were still in progress at the end of the year, it was estimated that 2,800 square miles of photography had been obtained for the Southern Cameroons and 5,000 square miles for Sierra Leone. Flying was in progress over the Seychelles at the end of the year.

#### *Map Production*

58. Production was maintained at the previous year's high level. It was devoted primarily to 1:50,000 mapping, although the proportion of fully coloured specialist maps and larger scale maps continued to increase.

59. Mapping at 1:50,000, including many contoured or form-lined sheets, was in progress for extensive areas of Northern Nigeria, northern and western Uganda, southern Kenya, central Tanganyika, Northern Rhodesia and Nyasaland. Planimetric mapping for British Guiana, the Falkland Islands and Sarawak continued and preliminary work was commenced for north-western Sierra Leone, the Southern Cameroons and central and south-eastern Borneo. Preparation of the contoured edition for Basutoland and Swaziland, and the form-lined edition for Fiji, continued.

60. Good progress was made with 1:25,000 contoured maps for the Leeward Islands and Malta; small areas of the Falkland Islands Dependencies and Somaliland Protectorate were also in preparation at this scale.

61. Production of 1:10,000 mapping continued for Cyprus and Tobago.

62. Mapping continued at 1:100,000 for Aden Protectorate and at 1:125,000 for Bechuanaland Protectorate.

63. Land use mapping at 1:25,000 was completed for the Gambia and further land use maps were in preparation for north-western Sierra Leone.

64. Fully coloured geological and soil maps were included among the large number of maps prepared to illustrate official reports.

65. Training attachments, varying from three to six months in length, were arranged for thirteen officers from Overseas and Commonwealth Survey Departments.

66. In the Forestry and Land Use Section the survey of 2,500 square miles of the Gambia was completed with the measurement of the areas occupied by each of the land use categories. The area of rice cultivation was found to have increased nearly two-fold between 1946 and 1956. Details of vegetation and land use were mapped for three swamp areas in north-western Sierra Leone and for St. Christopher and Nevis in the Leeward Islands. The survey of the gregarious timber tree *Terminalia brassii* was extended to the whole of the British Solomon Islands Protectorate. Local forest mapping was also carried out in parts of Tanganyika, Nigeria and Zanzibar.

#### **D. GEOLOGICAL SURVEYS**

67. The Geological Surveys in the Overseas Territories, which have grown steadily since the war, provide an ever increasing amount of fundamental

geological information in the light of which questions of mineral deposits, water supplies and engineering can be judged. Certain aspects of this work must include an element of research but this of necessity has to be undertaken to arrive at a proper understanding of the basic geological background. Despite the increased numbers of geologists available only a fraction of the area concerned has been covered to a reasonable standard and much remains to be done in the years ahead.

68. The headquarters of the Overseas Geological Surveys in London moved in January to new well equipped offices and laboratories in Gray's Inn Road. This organisation offers facilities in specialist aid to the overseas territories, and it is interesting to note that as the various countries become independent they show a desire to retain these facilities.

69. Contact was maintained with the overseas territories by visits to the Pacific by the Director and to several African countries by the Deputy Director, and a new geological survey which will be staffed by British geologists was set up in the Condominium of the New Hebrides.

70. A team of geophysicists visited Tanganyika to carry out a country-wide gravimeter survey as part of the I.G.Y. programme. Another team operated seismic instruments in the coastal region of Kenya in an attempt to delineate the fault which marks the eastern edge of the Pre-Cambrian rocks. Aerial survey work in East Africa was undertaken under contract by three different firms using several methods of aerial geophysics in order to determine the virtues of these techniques in tropical countries. Two photogeologists also went to Tanganyika to undertake a survey in the Eastern Province. A photogeological assessment of the geology of Aden was also undertaken during the year as a preliminary to the possible further examination of the country on the ground.

71. Palaeontological examination of specimens from the Overseas Territories continues to be carried out at the Natural History Museum. A specialist from the Mineral Resources Division of the Overseas Geological Surveys was seconded to the Age-Determination Unit at Oxford in order to assist in dealing with the many specimens which are coming in from Africa and elsewhere.

72. Work was undertaken by members of university staffs in the Solomon Islands, Somaliland, Uganda and Nigeria. Several countries tend to maintain links with certain colleges.

73. Probably the most important economic discovery made during the year was that in the Pakaraima Mountain of British Guiana where very large deposits of bauxite were found by the Geological Survey. The first comprehensive account of the geology of the Borneo Territories was issued as a joint work of the Royal Dutch Shell and the Geological Survey.

74. Considerable attention was given to the problem of water supplies from bore holes both by geologists in the territories and geophysicists from the London office.

75. The Seismic Investigation Unit at the Imperial College of Tropical Agriculture, Trinidad, continued its work in the Caribbean and many earthquake tremors were recorded at the various stations. Some amount of heat flow measurement and geological work was also undertaken.

**E. INDUSTRIAL AND ENGINEERING RESEARCH***East Africa*

76. At the East African Industrial Research Organisation investigations on the efficient use of fuel have been continued. The major portion of the advisory work continued to be the design of incinerators. A design for a plant to dispose of condemned carcasses and also to provide hot water was requested by the Aberdare County Council.

77. Research into the mechanical drying of coffee was developed to a point where results could be applied in practice. The investigation demonstrated how moist coffee could be stored safely without fear of deterioration until weather conditions were favourable for sun drying. Drying of groundnuts, edible canna, sisal and sisal waste were also studied.

78. The metallurgy section's investigation of the reduction of arsenic content in cement copper was brought to the plant scale for trial. It has been amply demonstrated that absorption with ferric hydroxide is a practical proposition which can be achieved at an economic cost. The treatment of oxidised copper ores by wet metallurgical process was studied and a laboratory investigation of the extraction of uranium from samarskite has been completed.

79. Various chemical investigations were undertaken during the year including the processing of agricultural produce such as jasmine, cashew nut shells, avocado pear and pineapple stems.

80. The Ceramic Specialist completed the construction of an electric tunnel kiln for firing glazed stoneware bowls and evaluated the probable cost of their production on a small scale. Laboratory investigations dealt with the production of refractories and meerschaum products.

*Hong Kong*

81. In the Department of Civil Engineering of the University of Hong Kong experiments have been carried out on the behaviour of prestressed concrete in a two-storey, three bay frame, on the behaviour of composite steel and concrete structures, and on the buckling of built-up steel girders.

82. A method of analysis of indeterminate structures was investigated as were problems in stress-distribution treated by conformal transformation. Analyses were made, for local engineering and architectural firms, of tall buildings and foundation problems.

*Crown Agents for Oversea Governments and Administrations*

83. Crown Agents' officers continued to represent the Colonial Office as Assessors on the D.S.I.R. Boards of Road, Building, Water Pollution, Hydraulics and Mechanical Engineering Research, and in this way the close contact established with the work at the laboratories concerned where research work of benefit to Colonial Territories is undertaken was maintained. The Engineer-in-Chief continued to be a member of the Colonial Road Research Committee.

84. As Secretariat of the Sixth Conference on the Standardisation of Railway Mechanical Equipment which was held in London early in 1960, the Crown Agents were responsible for the detailed arrangements and for

the preparation of the technical papers on which the discussions were based. Delegates to the Conference included senior officers from several Colonial Railways and the subjects discussed covered the design and operation of locomotives, rolling stock and their components, and in particular, matters affecting interchange of running between adjacent railway systems.

85. Railway research problems on the annealing of metals, condemning limits for worn parts, derailment of wagons and the possible re-use of filtered crank case oil from diesel engines were dealt with during the year. Other problems were investigated at the site during oversea visits by Crown Agents' technical officers.

86. The work of the Crown Agents also involved research into various development schemes, mainly related to industrial processes including salt production, brick making and provision of hot water by solar heating.

#### F. MANPOWER RESEARCH UNIT JAMAICA

87. In March, 1959, the Jamaican Government directed that a Manpower Research Unit should be established within the Ministry of Labour, to conduct a continuous Employment Market Information Programme, and, in particular, to carry out the following functions:

- (a) To bring together all available information on the Island's labour force, and to present it in a document which would provide a basic reference book on manpower.
- (b) To engage in a continuous collation of new data becoming available and in the analysis of such data, which would then be presented to Ministries and other interested persons or bodies.
- (c) To keep in close touch with all developments in the field of labour, and in particular, with the work of the Ministry of Labour and the Ministry of Education on such matters as Labour Training, Apprenticeship, Employment Services, Industrial Training, Vocational Guidance, Professional and Scientific Training.
- (d) To be available for consultation and to give advice on matters relating to general labour policy, e.g. impact of industrial incentives on the supply of and demand for labour, the spread of relief works by region and the minimisation of competition for labour between the Government and the private sector in such programmes, the manpower requirement implicit in the Development Programme.

88. To help with the initial establishment of the Unit, the services of Mr. F. W. Mahler were made available under the Expanded Programme of Technical Assistance by the International Labour Office, for a period of four months. The Unit came into existence in early July, 1959, and its first assignment was the preparation of a basic reference book on the Manpower Situation in Jamaica.

89. This Report brings together measurements of manpower supplies and manpower demands. In doing this it indicates past trends, the present position and likely future developments; and where possible, measurements are given for occupations, branches of economic activity, areas and special categories of workers. Discrepancies between manpower supplies



and manpower demands are assessed, manpower problems are summarised and the principal line of action for their alleviation are referred to. The Report is before the Government for its consideration.

90. The following assignments have also been undertaken :

- (a) A Study of the labour content of the Capital Estimates 1960-61.
- (b) The start of the preparation of the Standard National Occupational Classification System and the first completed ones are garment, footwear, sugar and tobacco.
- (c) A Study on 1958 School Leavers of grant-aided secondary schools and their experience on entering the labour market.
- (d) Effects of Mechanisation in the sugar industry and any consequent change in the demand for labour.
- (e) A Paper on Labour Training.
- (f) A Review of the Labour Management Situation.

### G. METEOROLOGY

91. Local research continued in Colonial territories in spite of staff shortages and continued participation in the extension of the International Geophysical Year activities, by taking part in the International Geophysical Co-operation, 1959.

92. As mentioned in last year's Report, Dr. A. G. Forsdyke's study on research requirements into tropical meteorology formed the basis of discussion at the Commonwealth Meteorological Conference held in May last year, and a resolution was passed to set up a Commonwealth Co-ordinating Committee to co-ordinate and advise on meteorological research in the tropics ; several of the Colonial territories have nominated members to serve on this committee.

93. Work has continued in East Africa to determine the most suitable method of applying cetyl alcohol to the water surface of reservoirs to reduce evaporation losses, and large scale tests were carried out with a 4 per cent. cetyl alcohol emulsion on a 12 acre reservoir. The experiments have now reached a stage where comparison should be made between the use of the kerosene solution and the more expensive method of applying large quantities of emulsion which would cover additional water surface. As the study of the physical properties of the surface film and the rates of flow and preparation of emulsion or solution are more appropriate to the physical chemist or engineer it is now being urged that the evaporation control project should be transferred to the East Africa Industrial Research Organisation to take this project on to economic success.

94. During 1959 technical advice and assistance was given by the East Africa Meteorological Department to two artificial rain making enterprises in Kenya. As a result of promising results gained from these tests and experience gained in the artificial stimulation of rainfall since 1951 it has been decided that a properly conducted experiment over a period of four months with the object of obtaining quantitative data should be carried out if possible in 1960-61. The statistical analysis of rainfall continues but the results have not yet reached the stage of publication. The statistical

distribution of yearly rainfall totals was finally determined, making it possible to draw maps of the probability of rainfall of various amounts, and two probability maps of East Africa have been prepared and will be published. The assembling of data for the study of rainfall intensity/frequency regions has now started and it is hoped that some useful progress can be made. The temperature factor has been fully analysed for Kenya and incorporated in the first part of a publication "Temperature Data for Stations in East Africa". The data for the analysis for Tanganyika temperatures are now being extracted.

95. The forecasting research programme in East Africa continued during the year. The main purpose of the work has been to gain knowledge of the rain-producing agencies which operate in equatorial latitudes and to develop methods of rainfall forecasting. In addition studies were begun specifically to improve aviation forecasting, including the nature of low-latitude jet streams and conditions giving rise to low cloud and poor visibility at Nairobi airport. An analysis of five years' data was made of the use of radio sonde ascents in local rainfall forecasting. A report to be prepared will discuss and classify the upper air soundings and will enable the forecaster to give proper weight to the radio sonde information. Daily charts of the rainfall at several hundred climatological stations are being studied; an appraisal of the behaviour of the daily patterns will require about two years' data, about fourteen months' charts have been plotted and seven months have been analysed. A study of the relation between rainfall and the upper flow was begun at the end of 1958 and a short account of the work of the potential value of the upper pressure charts to equatorial forecasting was published in "Nature" in October, 1959, and a more detailed paper was read at the Symposium on Tropical Meteorology held in Nairobi in December, 1959. Frequent long range flights by aircraft equipped with Doppler wind-finding radar are yielding valuable data on the structure of jet streams in the equatorial zone and in the sub-tropics, and the data are being studied in conjunction with high level wind and pressure charts, and investigated. A study of the incidence of minimum conditions of morning fog and low stratus is being made at Nairobi Airport.

96. In mid-1959, the first comparison of Weather-Locust maps mentioned in last year's Report took place at the Anti-Locust Research Centre in London. This trial covered the first five months of the research period (1st May to 30th September, 1954). The outcome of this preliminary comparison was very promising and a further indication that the locust problem is to a very large extent a meteorological problem. Towards the end of 1959 during the Desert Locust invasion season in East Africa, an additional network of stations was again set up in the Northern Frontier Province of Kenya. The reports from this network are now being analysed in close collaboration with Desert Locust Survey officers. It is envisaged that these officers will be able to carry out similar analysis-investigations without supervision in the future. This research project is now coming to an end. By July-August 1960, the entire period will have been analysed and thereafter, two reports will be drafted; Part One will be completed in Nairobi and deal solely with meteorological aspects, and Part Two which will be more entomological in character, will be drafted in London after completion of the final comparison work there, in early 1961.

97. The Geomagnetic Survey of East Africa mentioned in last year's Report was carried out in 1959 by a team from the United Nations Bureau of Technical Assistance Operations consisting of Dr. K. Whitham of the Canadian Dominion Observatory Branch, and Dr. E. Hoge of the Belgian Meteorological Institute. This team visited 58 stations throughout the East African territories, covering some 18,000 miles by road and several hundred by air, and was assisted in Uganda and Tanganyika by the geophysicists of the respective Geological Survey Departments. Wherever possible the three-component stations set up by earlier surveys—including some of the original Carnegie Institute sites—were reoccupied. A circuit at a low level was made of Kilimanjaro and the results passed to the East African Directorate of Civil Aviation. Geological profile studies were also made between Mombasa and Tororo over coastal sediments, basement rocks and tertiary volcanic rocks. In the time available, virtually only the field work could be completed; the reduction of the observations, their mapping and the preparation of the final Report will be done in Canada by Dr. Whitham. The most important map will be a regional chart of magnetic deviation for use in marine and aeronautical navigation but others will be prepared in rather more detail for survey and civil engineering purposes. These charts will be incorporated into the world magnetic charts produced by the British Admiralty and the U.S. Hydrographic Office, besides their immense practical importance, they form the basis of many investigations in pure science, e.g. researches into the geomagnetic field in the upper atmosphere and exosphere, and theoretical studies of the earth's core, mantle and crust. The survey has established a new foundation network of primary stations suitable for reoccupation in the future for determination of secular variation and for inter-comparison of observations in aerial surveys.

98. In West Africa particular attention was given throughout the year to upper air work in view of the impending introduction of higher flying aircraft. New and more satisfactory radar equipment for upper wind finding was brought into operation at Ikeja, and automatic ground equipment for radio sonde is now being introduced, which it is hoped will give more accurate observational data as well as effecting some economy of staff. To meet hydrological requirements, the routine monthly publication of rainfall records was considerably amplified to show daily falls as well as five-daily and a monthly rainfall map is now included in the publication. A further substantial number of new rainfall stations was opened during the year. Some work proceeded on evaporation; a number of Gunn-Bellanni radiation integrators have now been installed and it is hoped to derive evaporation estimates from empirical formulae involving these readings and Piche evaporimeter records. A network of radioactive fallout sampling stations was set up during the year with the assistance of the United Kingdom Atomic Energy Authority, and a report submitted on the effect in Nigeria of the nuclear explosion in the Sahara on 13th February.

99. In Hong Kong a programme of increased upper air measurements, both radio sonde and radar wind ascents, was carried out during World Meteorological Intervals and on Regular World days in connection with the International Geophysical Co-operation, 1959. Research was undertaken on a variety of problems, mainly in applied meteorology. The most important of these was a study of the problem of the siting of a nuclear

reactor ; this investigation is continuing and field tests are being planned for next year. Work in progress in Hong Kong consists of a study of the rainfall intensities over various periods of time in Hong Kong in connection with the design of reservoir catchments ; a study of winds and temperature on air routes ; an investigation of cold surges over South China during winter ; and an examination of the diurnal variation of upper-winds over Hong Kong.

100. In Mauritius rainfall investigations were carried out by compilation of normals for all stations (about 250) and the drawing of normal rainfall maps. A technical note and rainfall map was produced regarding the local flood which occurred in parts of Mauritius in November 1959. An investigation into wind gustiness factor and rainfall intensity and total quantity during Cyclones "Alix" and "Carol" has not yet been published.

101. The West Indies Meteorological Service continued its participation in the Hurricane Research Project of the United States Weather Bureau, but from 1st July, 1959, operated only the rawinsonde station at Palisadoes, the station at Grand Cayman being taken over entirely by the U.S. Weather Bureau. Research on the material obtained from the project was carried out by the United States which issued 10 Reports during the year 1959. Data were sent to the World Meteorological Organisation until 31st December, 1959, in connection with the International Geophysical Cooperation. The weather radar set at Nassau proved very useful. A study at Piarco of the causes of high swells affecting the Lesser Antilles enabled improved forecasts of damaging swells to be issued to islands of the Lesser Antilles and to British Guiana. A paper on a severe whirlwind which affected Port of Spain was prepared by a member of the Piarco staff and published in "Weather". Rainfall continued to be collected at two stations in Jamaica for radio-activity analysis in the United Kingdom.

102. A number of papers were produced by the East African Meteorological Department on such various subjects as artificial stimulation of rainfall, rain making, presentation of meteorological data for the use of architects, the value of contour analysis in equatorial meteorology, and rainfall-altitude relation and its ecological significance in Kenya. Five papers were also presented to the Symposium on Tropical Meteorology, on meteorology and the desert locusts, some streamlines and controls over the equator, and bioclimatology and the meteorological services, and two papers Part I and Part II on forecasting research. Staff of the Royal Observatory, Hong Kong published three papers during the year on tropical cyclones in the Western Pacific and China Sea area, the effect of meteorological conditions on tide height at Hong Kong, and results of experimental radio-sonde ascents at Hong Kong during the solar eclipse in April, 1958, while a paper on the cyclone season, and another paper on the effects of cyclones on sugar crop were published by the Mauritius Meteorological service. The West African Meteorological Department published a meteorological note on upper air temperature and winds at Ikeja, and four technical notes on forecasting the developments of cumulus cloud from the tephigram at Ikeja/Lagos, the serial correlation of 300 m.b. winds at Kano in winter, a nomogram to calculate evaporation from Penman's formula, and dust haze in relation to pressure gradients which has proved of practical assistance in forecasting.

## H. TROPICAL PRODUCTS INSTITUTE

103. On the 1st April, 1959, the Tropical Products Institute became one of the research stations of the Department of Scientific and Industrial Research. The basic reason for this development was to be found in the changing shape and nature of the Commonwealth. Countries which had recently achieved independence, and thus no longer came within the scope of the Colonial Office, might still wish to avail themselves of the services of the Institute. The Institute continued to provide a full service to all Colonial territories.

104. The Institute has as its aim the improvement of the technology of industries that already exist and the introduction of new industries as a result of research into new uses for tropical plant and animal products (including waste products of existing industries). The expansion of the staff of the Institute following its move to new premises in Gray's Inn Road has been linked with a proposed reorganisation of the Institute into four divisions: the Advisory Division, the largest in the Institute in terms of Scientific and Experimental staff, which has continued to deal with the wide variety of enquiries and problems on tropical products; the Research Division, formed to study selected projects of a long-term nature likely to have importance for those tropical countries most needing assistance; an Economics Division, to carry out market research and economic surveys of value to tropical countries and to assist in the selection of suitable projects for research and development and in the advisory work of the Institute; and an Administrative and Development Division, in which the Development Section would select and examine promising projects for development, with a view to providing new industries and improving existing ones.

105. While the Tropical Products Institute remains primarily an advisory body, its effort being largely devoted to the numerous and varied requests received from all over the world for technical assistance concerning plant and animal products, the establishment of the Research and Development Division has led to a considerable increase in the volume of research carried out by the Institute during the past year. In addition to the research carried out by these two divisions a considerable number of the enquiries submitted to the Advisory Division involved laboratory investigations, some of a long-term nature. Other research projects are being conducted extra-murally at various Universities and Colleges within the Commonwealth, with the financial assistance of the Department.

### Advisory Division

106. This division dealt with a wide variety of enquiries concerning the renewable resources of the tropics; 646 enquiries, of which 101 required laboratory investigation, were dealt with during the year by the specialised Sections of this Division. Examples of some of the more interesting problems are given below.

### Essential Oils, Spices, Gums and Resins

#### *A new Sesquiterpene Hydrocarbon*

107. Work continued on the structure of the new sesquiterpene hydrocarbon, strobilanthene, which was isolated from the essential oil of *Strobilanthopsis*

*linifolia* from Northern Rhodesia. Details of the isolation and preliminary work on the structure have already been published (W. S. Matthews and G. B. Pickering, *Industrie Chimique Belge. Compte Rendue XXXIe Congrès International de Chimie Industrielle, Liège, Septembre 1958, Vol. II, p. 635*). The Hydrocarbon has a cadalene type of structure and yields cadinene dihydrochloride with hydrochloric acid. Preliminary examinations of this compound in which infra-red and ultra-red and ultra-violet absorption spectra have been an essential feature have indicated that part of its molecule might be structurally analogous to the monoterpenes sabinene and  $\alpha$ -thujene in that an ethylenic linkage is conjugated with a cyclopropane ring. Strobilanthenone, sabinene and  $\alpha$ -thujene all have ultra-violet absorption maxima in the region of 211 m $\mu$ , a wavelength somewhat greater than that shown by compounds containing single ethylenic bonds, but less than that normally associated with the simpler conjugated olefines. It is believed that this higher wavelength of maximum absorption is due to the conjugation of the cyclopropane ring with a double bond which is *exocyclic* in the case of sabinene and *endocyclic* in  $\alpha$ -thujene. Thus, these studies, together with the evidence of infra-red absorption spectra, support the view that strobilanthenone contains a cyclopropane ring with a conjugated *exocyclic* double bond. Attempts at ozonolysis and other methods of degradation to yield identifiable products have proved surprisingly difficult, but some progress along these lines is now being made.

#### *Gas Chromatography for the Examination of Essential Oils*

108. All samples of essential oils which were received by the Institute were examined by gas chromatography in addition to any other type of examination which was necessary. Samples which previously would have been subjected only to a routine determination of the analytical constants were examined and their chromatograms compared with those of oils known to be of good commercial quality. This showed at once any peculiarity in the composition of the sample and was a good guide to its quality.

109. Useful information was obtained by comparing the chromatograms of the oils as received with those obtained after the oils had been treated with reagents which were specific for certain types of compound. For example the reaction products remaining after the determination of the ester value, the carbonyl content by the hydroxylamine hydrochloride method, and alcohol content by acetylation, were used for this purpose. Most of the oils examined were treated in this way before any attempt was made to identify the individual components. Even when it was impossible to identify the components of an oil by gas chromatography alone, the information obtained by this technique was a useful guide to the planning of an analysis by older methods.

110. The possibility of determining the structure of the carbon skeleton of a terpene by hydrogenation followed by a comparison of the retention time of the product with those of completely reduced terpenes such as pinane, camphane, *p*-menthane, etc. is being investigated.

111. Gas chromatography has also proved to be useful in following the course of a fractional distillation, or the elution of a sample from an adsorption chromatography column, and in determining the purity of the material produced. It is being used in this way in an investigation of the

structure of strobilanthene (see above), in the examination of the oil of *Tagetes minuta* and in the isolation of pure terpenes for use as standards in gas chromatography, infra-red and ultra-violet spectroscopy.

112. Since the nature of the stationary phase has a very great influence on the resolution of the components of a given mixture, a number of substances have been studied in order to assess their utility as stationary phases for the analysis of essential oils. As a result of these experiments squalane, benzylidiphenyl, and polyethylene glycol 400 were found to be very useful. Some remarkable separations have been achieved by means of polyethylene glycol 400. A chromatogram of geranium oil, for example, obtained by means of a column containing poly-(propyleneglycol sebacate) indicated the presence of 14 compounds, whereas the same oil on a polyethylene glycol column gave 24 peaks. Other oils have behaved in a similar manner.

113. Polyethylene glycol, however, is not very stable and cannot be used at temperatures above 100°, which is too low for the analysis of oils containing sesquiterpene alcohols. There is thus a need for a more stable compound with similar resolving properties and a search is being made for such a compound.

114. A gas chromatography apparatus has been designed and constructed for operation on a preparative scale and preliminary trials are being undertaken.

### **Oilseeds, Oils and Fats**

#### *Bleachability of Palm Oil*

115. Investigations concerning the difficulty of bleaching Nigerian palm oil, which were referred to in *Colonial Research*, 1958-1959, have been continued.

116. It was previously shown that Nigerian palm oil, prepared according to a method devised by the Institute in which oxidation and delay in processing were minimised, had excellent bleachability, generally superior to the best of the Malayan oil. It was also noted that the delay in processing which usually occurs in primitive extraction methods resulted in a major deterioration in the bleachability of the oil.

117. Further studies confirmed that delay in processing is one of the main causes of deterioration in bleachability and that this deterioration is associated with the presence of a lipoxidase in the fruit. When oils of good bleachability were treated with lipoxidase preparations obtained either from palm fruit especially flown to the United Kingdom or more conveniently from dried haricot beans, considerable deterioration in bleachability occurred. This deterioration was irrespective of whether heat, bleaching earth, or combined heat and bleaching earth procedures were employed for the treatment of the oil, although the effects were most marked with bleaching earth. During oxidation there is a rise in the conjugated diene content of the oil and an increase in its peroxide value. However, enzymic oxidation evidently differs somewhat from atmospheric oxidation, as indeed has been shown by studies published elsewhere on the oxidation of methyl linoleate. The resultant methyl 13-hydroperoxy-octadeca-9:11-dienoate and the methyl

9-hydroperoxy-octadeca-10:12-dienoate resulting from atmospheric oxidation were optically inactive, whereas those resulting from enzymic oxidation showed optical activity. This activity can be enhanced by reduction of the hydroperoxide when the resultant hydroxy acid has an activity similar to that of 12-hydroxyoleic (ricinoleic) acid, the main fatty acid constituent of castor oil.

118. Oxidation of the linoleic acid present in palm oil is accompanied by changes also in the nature of the carotenoids present. This was demonstrated by differences in the spectra of palm oils which were easy and difficult to bleach.

119. Evidence was also obtained to indicate that the colour remaining after the bleaching of an inferior oil is predominantly found associated with the fatty acid (which is coloured yellow). It was concluded that the cause of the difficulty experienced in bleaching Nigerian oil was due to coupled oxidation between the carotenoids and the unsaturated fatty acids present, resulting in the formation of coloured compounds, which are difficult to bleach. These could be due to the combination of oxidised fatty acids with the carotenoids or their decomposition products.

120. Meanwhile it has been clearly demonstrated that good quality oil can be produced from Nigerian palm fruit if the speed of processing is rapid and undue heating and concomitant oxidation avoided. The West African Stored Products Research Unit are therefore experimenting in Nigeria with methods designed to apply these findings in practice and it is hoped that Nigerian oil of improved bleachability will result. One difficulty is to recover the increased processing costs by the sale of the improved quality oil in the United Kingdom market.

121. Nigerian oil has a relatively high carotene content, normally more than double that found in Malayan oil. When the oil is inefficiently processed the presence of this carotene is related to the appearance of chromogens associated with difficulty in bleaching. Hence the long-term aim in Nigeria should be to breed palms yielding a light-coloured oil.

## **Vegetables Fibres**

### *Surface Structure of Fibres*

122. In order to supplement previous work carried out at the Institute on the identification of fibres of vegetable origin, an investigation was undertaken to study the surface structure of such fibres in various stages of mechanical and chemical degradation. A technique of surface replication and subsequent metal shadowing of the replica was used, thus allowing surface detail not normally observable under the microscope to be seen. In addition to providing information on the structure of vegetable fibres which will be a valuable supplement for identification purposes, it is hoped to use this technique to clarify the dependence of mechanical properties on histological structure.

## **Economics Division**

123. The Economics Division began to function as a separate Division at the beginning of 1959, having been formed primarily to relieve the technical



and scientific staff in the Institute of work relating to the marketing and economic aspects of various tropical commodities and to provide statistical information not only for the Division itself but for the work of the Institute as a whole. During the year practically all the enquiry work relating to the marketing of products which was formerly answered by the commodity sections was taken over by the Division. Consequently, marketing problems accounted for over 65 per cent. of the enquiries dealt with, being concerned with beeswax, coffee, beche-de-mer, kenaf and ramie fibres, turpentine and rosin, Burley tobacco, garlic, ginger, papain, cinchona, essential oils, various foodstuffs, rum, tea and industrial alcohol.

124. An important part of the Institute's work is to answer enquiries regarding new cash crops or products which might help to diversify the economy of a particular country or, independently, to advise tropical countries of commodities for which the market is expanding and for which a new source of supply would be desirable. Since castor is one of the crops which might be suitable for this purpose, a survey was made, in co-operation with the appropriate commodity section, of the world markets for castor seed and oil and of trends in the use of oil. The main obstacle to establishing a new source of castor oil in the United Kingdom market is the tendency of users to be chary of unfamiliar producer's areas and reluctant to change. Oil from new sources, therefore, would need to be very competitive in price and at least equal in quality to that from India, the main supplier to this country. New industrial applications for castor oil, particularly as a raw material for chemical manufacture, seem likely to expand the demand for the oil, and in the U.S.A., which is the largest single market for the oil, consumption is expected to increase considerably in the next ten years. At the same time, however, domestic production of the seed is being encouraged in the U.S.A. in order to make the country self-sufficient. The future world market for new supplies from other sources will therefore depend considerably on the progress of domestic production of the seed in the U.S.A.

125. As development proceeds in various tropical countries there is invariably a desire to establish small industries which can make use of locally produced raw materials and process them either for export or for sale locally in order to reduce imports. Thus, enquiries were dealt with concerning the setting up of a small plastics industry, a match factory; a button industry and a rubberised coir industry. Advice on the establishment of small industries such as these will probably become one of the more important functions of the Economics Division.

126. Requests were received during the year from two East African countries for economists to be seconded to them for work in connection with surveys of local markets and for studies in farm economics. With the present small staff of the Division secondments for periods as long as twelve months or more are obviously impossible but it is appreciated that, as the Division expands, provision will need to be made for staff for work of this nature. It will also be necessary to send staff overseas to study the market requirements and conditions for raw materials of tropical origin, particularly those materials where the main markets are normally in non-European countries.

127. With the Division's recent creation and the consequent extension of the Institute's activities into the economics field, it has been necessary to build up a collection of economic literature and indexed information comparable to that which already exists to serve the scientific divisions. A good deal of time during the year was devoted to this task. Contact was also established with other organisations working in closely related fields, such as the Stanford Research Institute, the International Co-operation Administration, the Commonwealth Economic Committee, and the United Kingdom Social Survey.

### Research Division

128. The activities of the Research Division can be described in broad terms as the study of the chemistry and physics of natural products, from which it is hoped to secure their more effective utilisation.

129. The Research Division consists of five sections whose individual duties are:—the study of the organic chemistry of natural products; the preparation and examination of surface-active materials based on sugar (sucrose); the study of naturally-occurring insecticides; the examination of plants possessing physiological activity and the isolation and study of their active principles; and physico-chemical studies of plants and other natural products.

#### *Surface-active Agents derived from sugar*

130. The potential world production of sugar is at present far in excess of requirements so that it has been necessary to limit, by agreement, the level of exports from the sugar-producing countries. This has seriously disturbed the economy of these countries, and especially of those countries where sugar production was practically the sole means of livelihood of their people.

131. Virtually the whole sugar production of the world is consumed as food yet sugar has a number of attractive features which should commend it to industry for exploitation. The present investigation is being supported financially by the United States from funds made available under Public Law 480 administered by the U.S. Department of Agriculture. The terms of the contract define the work as being directed towards the production of materials, based on sugar and naturally-occurring fatty acids, which have surface active properties. If such materials could be made with properties comparable with existing commercial detergents and competitive in price, they would find a wide field of applications as they would be non-toxic and also readily decomposed during the normal sewage disposal processes.

132. A number of papers and patents have already appeared which describe the preparation of sucrose esters such as the oleates, palmitates, stearates etc. by interacting the sucrose with an ester, such as methyl stearate, in homogeneous solution in the presence of an alkaline catalyst.

#### *Physiologically active substances from plants*

133. The use of plants and plant extracts for the treatment of disease has been practised for so long that there now exists a vast store of information on the topic. The scientific sifting of this information is, how-

ever, such a tremendous task that it is never likely to be carried out completely, and it is, therefore, customary to select certain facets for detailed study.

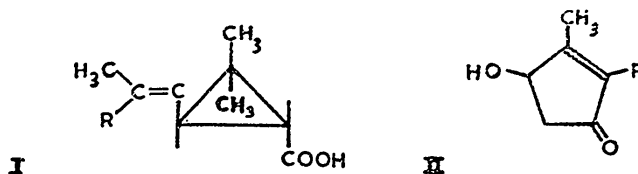
134. This section, which has only recently come into being, has studied publications and other information relating to local medicines in various Colonial territories and plants are being selected for examination which are reputed to be of value in the treatment of mental disorders, or which affect blood pressure.

135. Various extracts of these plants will be made and submitted to the Institute's Pharmacological Testing Unit, Birmingham University for examination of biological activity. On the basis of this examination certain plants will be selected for more detailed study and their active principles isolated and characterised. Structural studies will be made of any substances isolated which possess outstanding value and whose constitution is unknown.

136. Investigations continued on plants suspected of containing steroidal sapogenins. Particular attention was paid to diosgenin-containing *Dioscoreas*, and as a result of an earlier trip by Dr. S. Bampton to British Honduras to search for new sources of diosgenin, a trial plantation of a *Dioscorea* sp. found there is being set up in the territory to determine the possibility of its introduction as a new cash crop.

#### *Naturally-occurring insecticides*

137. The insecticidal activity of pyrethrum extract is considered at present to be due to the presence of four unsaturated esters which are derived from two acids, chrysanthemic acid (I, R = Me) and pyrethric acid (I, R = COO.Me), and two alcohols pyrethrolone (II, R =  $-\text{CH}_2-\text{CH}=\text{CH}-\text{CH}=\text{CH}_2$ ) and cinerolone (II, R =  $\text{CH}_2=\text{CH}-\text{CH}_3$ ).



The two esters derived from the combination of chrysanthemic acid with pyrethrolone and cinerolone are called pyrethrin I and cinerin I respectively, and the two esters from pyrethric acid and the two alcohols are called pyrethrin II and cinerin II. The methods of chemical analysis of pyrethrum extract in current use are based on the assay of the two acids and no attempt is made to determine the relative amounts of cinerins and pyrethrins. The value of the materials, however, resides in its insecticidal potency but until the relative toxicities of these four esters, alone and in admixture, are known it is impossible to predict whether or not the existing analytical methods will give a reliable guide to this property.

138. Attempts have been made in the past to determine the relative toxicities of these esters but conflicting results have been obtained by different workers. This lack of agreement was due to at least two causes. First, the difficulty of preparing pure samples of the esters; indeed, it is now known that the methods used for some of the earlier preparations could not have given pure materials. Second, the great difficulty that has been experienced in the accurate bio-assay of insecticides. In the present

work the biological testing has been done by Dr. R. Sawicki at the Rothamsted Experimental Station using five to six day old female houseflies as test insects. They were treated topically with a 1 ul drop of solution in acetone, and examined for mortality after 24 hours at 20°C.

139. Previous workers had already shown that small quantities of the four esters could be separated by displacement chromatography on alumina. In the present investigation, eluates obtained from three different samples of commercial pyrethrum extract using this type of chromatographic column were examined for biological activity and chemical and physical properties, e.g. infra-red and ultra-violet absorption spectra and characteristic reactions with phosphoric acid and Denigé's reagent. The results strongly suggest that the insecticidal activity of pyrethrum extract is due solely to the pyrethrins and cinerins. Since the proportions of those four esters in the pyrethrum extract can be determined from the chromatographic analysis, it is possible to reconstitute the original extract using the pure cinerins and pyrethrins. Solutions prepared in this way corresponding to the three different extracts were tested biologically and found to be identical with the original extracts. These results confirm that within experimental error all the insecticidal activity of pyrethrum is due to the pyrethrins and cinerins and indicate that no natural synergists are present in the commercial extract.

140. The relative toxicities of the four esters, prepared by chromatography, were found to be, at the lethal dose (LD) 50 per cent. level, pyrethrin I, 100; pyrethrin II, 130; cinerin I, 40-50; while cinerin II, which was present only in small amounts, appeared to have a similar value to cinerin I. Preliminary studies also indicated that mixtures of these compounds have a toxicity which is the sum of the toxicities of the separate components and consequently they possess no mutual synergism. There are indications that the relative toxicities vary with the technique of application and the solvent used.

141. This information is not only useful for analytical purposes but can also be of value to the plant-breeding programme in Kenya. Thus, the results suggest, in so far as toxicity is concerned, that it would be sufficient to breed for high pyrethrin content and to pay less attention to the ratio pyrethrin I/pyrethrin II which has been considered to be so important in the past. But a characteristic of the insecticide which is equal in importance to the toxicity is its rapid "knock-down". It was considered that techniques where the insects are anaesthetized or chilled to immobilise them for treatment were not reliable for assessment of knock-down. A new technique was therefore desired whereby the flies were attached to a terylene gauze by suction and then dosed. The fate of the dose under the airflow conditions of test was studied under U.V. light using acetone, cellosolve and odourless kerosene containing fluorescent dyes. Kerosene spread very rapidly over the body of the insects, while the other solvents evaporated rapidly.

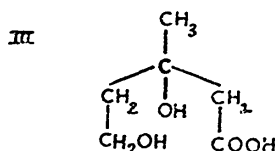
142. Using this technique it was found possible to assess the knock-down of fully active houseflies 15 minutes or less after dosing.

143. A study has been started of some aspects of the biochemistry and physiology of the pyrethrum plant to provide further information of value both to the plant-breeding programme and farming practice in Kenya. A part of this work has involved feeding compounds labelled with C<sup>14</sup> to

isolated pyrethrum flowers. It has been found, as might have been expected from previous work on terpene biosynthesis, that labelled acetic acid is incorporated into pyrethrin I and pyrethrin II. Further, the pyrethrin II molecule has been split and it has been found that both the acidic and alcoholic moieties are labelled.

144. The labelled acetic acid can be fed to the flower through the stem, or by placing the radioactive solution containing a little detergent directly on the disc florets of the open flower. However, the best method for incorporation is to impregnate the isolated ovules of the flower. This suggests that the ovule is the most active site for the synthesis of pyrethrins in the flower head. It has also been shown that ovules dissected from unopened, and therefore non-fertilised, disc florets synthesise pyrethrins as effectively as those from opened disc florets and may even surpass them. This matter will be referred to again later.

145. In recent years it has been found that a common precursor in the biosynthesis of terpenes and steroids is mevalonic acid (III), which on decarboxylation and dehydration gives isoprene.



It is of interest to determine whether this compound is incorporated into the pyrethrins. By feeding experiments similar to those described above, it has been shown that 2-C<sup>14</sup> mevalonic acid is incorporated into pyrethrins I and III. An attractive biochemical route to the rather unusual *cyclopentenone* ring of pyrethrolone and cinerolone would be by the cyclisation of mevalonic acid. This attraction would be novel in that the carboxyl carbon atom would be retained whereas in all other cases it is lost by decarboxylation to give the isoprene skeleton. It was found, however, that 1-C<sup>14</sup> mevalonic acid fed to isolated ovules gave pyrethrins totally devoid of radioactivity and consequently the postulated reaction could not have taken place. Since it had been established that acetic acid is incorporated into the pyrethrolone ring under these conditions, it is clear that this compound is being synthesised during the course of the experiment. An alternative possibility is that this five-membered ring is an oxidation product of a more complex system which is made up of isoprene units. This possibility is at present being investigated.

146. A study has also been made of the distribution of pyrethrins in mature pyrethrum seed. It has been found that fertile seeds contain five to ten times as much pyrethrins as infertile seeds do and that the majority of this is contained in the ovary and only little in the husk. The observation that infertile seeds contain little pyrethrin is interesting because, as mentioned above, the ovules of unfertilised disc florets are actively synthesising pyrethrins. The fate of this pyrethrin content on ripening and drying is as yet unknown. The experiments with labelled compounds have shown that fertilisation is unlikely to be a large factor in pyrethrum production if the flowers are gathered before they are "overblown"; this is in accord with current practice. The reverse conclusion might have been drawn from experiments on the examination of pyrethrum seed.

*Physico-Chemical Studies*

147. This section differs from other sections of the Research Division in that much of its activity is associated with problems which are being examined from other angles elsewhere in the Institute. One such problem concerned the determination of piperine in alcoholic extracts of black pepper (*Piper nigrum* L.) which was carried out conveniently using ultra-violet absorption spectroscopy. An essential preliminary to this operation was the isolation of pure piperine for the preparation of the calibration curve, achieved by successive recrystallisation, progress being checked by following the ultra-violet absorption and by using the molar extinction coefficient as a criterion of purity.

148. Infra-red absorption spectra played a very valuable part in the characterisation of the pyrethrins and cinerins present in pyrethrum extracts, and they were also used with success to confirm the presence of diosgenin in chloroform extracts of kernels from *Balanites orbicularis*.

149. A start has been made in the building up of a collection of infra-red absorption spectra relating especially to those types of substance which are of particular interest to the Institute. This involved the rigid purification of the various substances to a degree well beyond that normally associated with these materials. So far, the infra-red absorption spectra have been recorded of pinene,  $\alpha$ -thujene and sabinene, all of which were purified by column chromatography. In addition the spectra have been recorded of a number of substances of more general interest and which are already well known.

150. Considerable attention was paid to certain aspects of plant nutrition, including determinations of potassium, calcium, magnesium and manganese, using the Lundegardh flame technique, on samples of sisal leaves, and determinations of trace elements in coffee plants.

151. When determinations of trace elements in organic materials are being made, it is necessary to effect a preliminary concentration by destroying the organic matter. This is commonly achieved by dry-ashing which, although convenient, needs careful control. In the work on coffee leaves, a wet oxidation using nitric acid was used to destroy the organic matter and to give solutions suitable for the spectrographic determinations of copper, manganese, iron, molybdenum, zinc and boron. It was found, however, that a small amount of waxy material survived this oxidation procedure and that its presence in the solutions together with the larger inorganic constituents, reduced the accuracy of the determinations. Study is therefore being made of procedures which involve a supplementary oxidation to destroy this wax-like material, or which attempt to separate the trace elements from it. In this latter connection, ion exchange and solvent extraction techniques are being examined as well as coprecipitation methods.

152. In this work it has been considered advisable to analyse a range of samples by an independent method. This was done by using a modified precipitation technique, followed by the final determination of the trace elements polarographically.

**Administration and Development Division****Development**

153. The function of the Development Section is to examine the results of investigations in the Institute and elsewhere and to select from them

ideas which might lead to valuable new products or processes for tropical areas. Where appropriate the Section will then carry out pilot scale examination of the selected projects or, alternatively, may encourage other organisations with suitable facilities to do so.

154. The Section's attention so far has been directed into three main lines :—

1. *The Extraction of Protein from Tropical Vegetation.* A survey of current methods for the extraction of vegetable protein has been made preparatory to a practical examination of the best of them on certain of the more readily available tropical plant materials.

2. *Utilisation of Solar Energy.* An experimental flat plate collector was set up on the roof of the Institute building to study the effect of plate design, plate surface, type of cover and spacing, turbulators, throughput rates etc. and to afford experience of solar water heating generally. The collector was designed to hold three separate collector plates measuring 6 ft. × 2 ft., so that a direct comparison could be made between different collector plate designs. Water circulation is by means of a pump operated on a closed system and a 12-line continuous recorder has been installed to study temperatures at various positions in the collector.

It is planned also to examine air heating along similar lines as a preliminary to the investigation of the possibilities for artificial crop drying by solar means.

3. *Bonded fibre mattresses.* Some tests have been carried out on the production of resilient bonding compositions from naturally occurring products. Although none satisfactory has yet been obtained, some show promise. Samples of natural rubber, synthetic rubber and plastic latices were obtained and some small scale tests of fibre bonding carried out. Coiling of coconut fibre is being examined and modification of the fibre by chemical means will be considered. Investigations of the influence of coil diameter, modification of the fibre, nature and quantity of the bonding agent, etc. will be continued.

#### **Extra Mural Activities**

155. Reports follow on extra-mural work being carried out for the Institute.

#### **Natural Products Research Unit in the Department of Chemistry, University College of the West Indies**

##### *Studies on the Constituents of some West Indian Plants*

156. With the object of finding new pharmacologically active substances, and also establishing the toxicity of certain local plants, a survey of the literature relating to poisonous and medicinal plants of the West Indies was made and a short list prepared of those considered worthy of examination. Standard extracts of 32 plants have so far been submitted to pharmacological testing and as a result of these tests three plants are being examined further.

*Portulaca oleracea*. The aqueous extract of *Portulaca oleracea* is a powerful hypotensive agent when administered intravenously in the dog, and this activity was shown not to be due to the concentration of oxalate ions present. By preparative chromatography a material was obtained which was pharmacologically estimated to be much more active than dopamine, but only having one-third to one-half the activity of nor-adrenaline. The material contained traces of ninhydrin positive material, was highly unstable and behaved in colour and other tests in a manner more comparable with nor-adrenaline than with DOPA, dopamine, epinine and adrenaline. Paper chromatography indicated that DOPA and dopamine might also be present in the crude extracts.

*Stachytarpheta jamaicensis*. This was reputed to contain a glucoside and is used in folk medicine for a variety of purposes, including the control of high blood pressure. Standard extracts proved toxic to rats and appeared to contain both pressor and depressor substances. The pressor component was found to be unstable and difficult to purify by chromatography without loss of activity, while the depressor component though more stable and not subject to loss of activity in chromatography was less evident in fresh extracts, indicating that it might be a decomposition product, or masked by the pressor component. The factor responsible for toxicity has not been studied in detail but appeared to be greatly reduced by drying of the plant material.

*Pluchea odorata*. While showing no activity in standard extracts, *P. odorata* or the related plant *P. purpurescens* have been reported as responsible for a case of poisoning with hallucinations. Extracts with 3 per cent. aqueous tartaric acid or with methanol and 10 per cent. ammoniacal methanol caused the internal haemorrhage and death of rats. Extracts appeared to contain no alkaloids, but in view of the hospital report samples are to be tested further, particularly for hallucinogens.

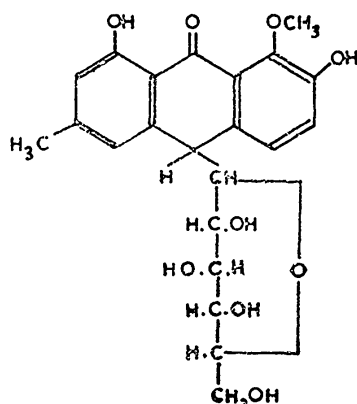
157. An examination is being made of the purple pigment of the local St. Vincent Yam (*Dioscorea* sp.). The pigment fades on exposure to light, changing through brown to red and has a U.V. absorption spectrum showing peaks at 545 and 280m $\mu$ . It has been tested and examined for anthocyanins, but while the results indicated pelargonidin they were not sufficiently conclusive and further studies are to be carried out on more purified material.

*Phorodendron Wattii*. The hypertensive activity of aqueous extracts of the leaves was shown by chromatography to be due to tyramine, the phenylethylamine nucleus being known to confer pressor activity.

*Persea gratissima*. Aqueous extracts of Avocado Pear leaf were shown to have a fairly prolonged hypertensive effect and isolation of the active principle has been attempted. Alkaloidal extraction followed by column chromatography of the crude base yielded an alkaloid-containing oil. Analyses and spectroscopy of the picrate and perchlorate of the base indicated an empirical formula of C<sub>9</sub>H<sub>17</sub>NO with one carbonyl and a primary amino-group, corresponding to one unsaturation or one ring.



158. Work has continued on homonataloin, isolated from Natal aloes. Experiments suggested that like the known barbaloin, homonataloin is a C-glycosyl derivative of a substituted anthrone with the formula.



159. Preliminary experiments were carried out on the three components extracted in each case from Curacao aloes, Cape aloes and the dried juice of *A. candelabrum*.

#### Birmingham University, Department of Pharmacology

##### *Pharmacological Testing Unit*

160. Pharmacological investigations were made on plant extracts submitted by the Natural Products Research Unit, University College of the West Indies, the Tropical Products Institute and the Department of Chemistry, University College of Swansea. The tests included acute toxicity tests and subsequent determination of mode of action. In addition each extract was also tested on a range of standard isolated organ preparations, and other tests were carried out where special indications suggested them.

161. Of the extracts from the Natural Products Research Unit, six were selected as worthy of further examination. Four caused paralysis, this being correlated in two of them with an effect on the neuromuscular junction and in one with an effect on the isolated heart. Two other extracts were found to have a very marked "adrenaline-like" effect on the isolated heart, one of them causing an initial rapid lowering of bloodsugar level.

162. The examination of extracts from the Tropical Products Institute and University College, Swansea is in progress.

163. Tests have now been completed on the toxicity of "Comirin", a fungicidal antibiotic discovered at the Colonial Microbiological Research Institute, Trinidad. Owing to its haemolytic action Comirin has not been used clinically, but its activity against fungi has led to its consideration as an antimould agent in paints. The toxicity tests gave completely negative results for oral toxicity and skin sensitising action.

#### Makerere College, Uganda, Department of Agricultural Engineering

##### *Methane fermentation*

164. Experiments have continued on the production of methane from organic waste materials. In batch experiments with elephant grass using

either cattle dung or liquid from a daily-fed pilot plant as "starter", the following aspects have been studied:—

- (i) The effect of time of year at which cattle dung is collected on gas production. A mixed sample of fresh and old cattle dung, collected at random from a cattle pen, was found to have the same "starting" qualities regardless of the time of year that it was collected.
- (ii) The effect of ratio of dung of elephant grass. For successful starting of a methane fermentation the minimum ratio of dung to elephant grass on a dry weight basis was found to be 2 to 1. For optimum rate of digestion the ratio was found to be 3 to 1.
- (iii) The effect of agitation on yield. Daily agitation of a daily-fed pilot plant resulted in a 25 per cent increase in gas yields.

165. Laboratory studies are continuing to determine the optimum feeding point of elephant grass to the starter dung. At present results indicate that a marked increase in the rate of digestion will occur when it is fed to the dung after digestion of the dung itself has commenced.

166. Experiments are also in progress to determine the optimum feeding point when using liquid from a fermentation previously started from dung.

#### **Makerere College, Uganda, Department of Chemistry**

##### *Investigation of Steroid and Triperpenoid Constituents of East African Plants Constituents of tea leaves and seed*

167. Work has been concluded on the constituents of the unsaponifiable portion of the lipid fraction of tea leaf and tea seed. The sterol was shown to be  $\alpha$ -spinasterol, the other major constituents being a saturated wax hydrocarbon mixture ( $C_{29}$  dominating), and a saturated wax alcohol mixture ( $C_{30}$  dominating).  $\beta$ -amyrin was detected in small quantities.

*Dioscoreas*. Several expeditions were made with the object of finding *Dioscorea* having a high content of diosgenin. A species not hitherto obtained was collected but was found not to contain any sapogenin.

*Balanites*. A sapogenin, possibly yamogenin, was isolated from the fruits of *B. wilsoniana*, and other species are being collected for investigation.

##### *Acid Catalysed Dehydration of Steroid alcohols and related compounds*

168. Following earlier work on the conjugative and stereochemical factors affecting acid catalysed dehydration of diosgenin and other  $C_3$  hydroxy steroids, preliminary studies of the kinetics of the reaction were put in hand. Acid catalysed dehydration studies on aromatic alcohols were discontinued when it was found that  $\alpha$ -(*p*-chlorophenyl) isopropyl carbinol did not undergo dehydration in aqueous acid.

#### **University of Hong Kong, Department of Chemistry**

##### *Chemical Investigation of Local Plants*

169. Work has begun on the investigation of alkaloids and other compounds of possible interest in plants collected in the main islands of the Colony and from the New Territories.

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**University College, Swansea, Department of Chemistry***Greenheart Alkaloids*

170. The gross alkaloids from Greenheart (*Ocotea rodiei*) seeds have been extracted and largely fractionated, two crystalline compounds of the bisbenzylisoquinoline group being isolated from the ether soluble fraction. The alkaloid fractions are at present being investigated by the Pharmacology Unit at Birmingham.

**Birmingham University, Department of Chemistry***Chemical and Biochemical Synthese of New Antibiotics Containing Amino- and Deoxy-Sugars*

171. A stock of methylnovioside has been accumulated by acid hydrolysis of the antibiotic novobiocin. This will be used in attempting the synthesis of new disaccharides by growing micro-organisms in the presence of methylnovioside, and disaccharides such as maltose, cellobiose or lactose.

*Structure of Oligosaccharides obtained from Chitin and by Synthesis*

172. Work is in progress on the degradation of disaccharides containing amino groups with the object of determining the points of union between the monosaccharides. Particular attention has been focused on the method for disaccharides containing a 1-4 linkage.

**Leeds University, Department of Leather Industries***Constituents of Mangrove Bark and Related Vegetable Tanning Materials*

173. Recent work has been directed towards the separation, identification and quantitative estimation of the anthocyanidins derived from mangrove (*Rhizophora mucronata*) extracts. A study of the conditions and rate of production of anthocyanidins by a number of acids was made and the separation of anthocyanidin fractions on polyamide ("perlon") columns was investigated and a satisfactory experimental technique evolved. Various methods of purifying the fractions so obtained were attempted and purified fractions examined by paper chromatography and spectrophotometry.

**Bristol University, Department of Organic Chemistry***Strychnos toxifera Alkaloids*

174. Several alkaloids have been isolated and purified and attempts are now being made to elucidate their structure. One of the alkaloids is almost certainly xanthocurine.

**Forest Products Research Laboratory, Princes Risborough***Preparation of Hardboard from Colonial Timbers*

175. Board making experiments were carried out on four species of timber grown in North Borneo, Kapur (*Dryobalanops* sp.), Keruing (*Dipterocarpus* sp.), Red Seraya (*Shorea* sp.), and White Seraya (*Parashorea plicata*). Satisfactory hardboards according to the current British and U.S. Federal Standard Specifications were made on an experimental scale from each of the four

species and from a mixture of two of them. After treatment of the wood chips in a laboratory Asplund Defibrator no further refining of the fibre or additions of water-proofing or bonding agents were found to be necessary. The required strength and water resistance properties were obtained by a suitable choice of conditions in the press followed by hot air treatment of boards. In some cases the production of Super Hardboards, according to the above Specifications, was found to be possible by these methods.

### I. WATER POLLUTION RESEARCH

176. No experimental work was undertaken by the Water Pollution Research Laboratory for Colonial territories during 1959-60 but advice on diverse subjects was provided by letter. Information on methods of treating slaughter house wastes was sent to Tanganyika and on distillery wastes to Trinidad. Advice on determination of biochemical oxygen demand was provided for Kenya, Tanganyika, and Hong Kong, and Hong Kong was also advised on the possible effects on sludge digestion of the use of sea water for flushing lavatories. Malta was advised on possible methods for tracing a leak from a reservoir.

177. Information about the work of the Laboratory was sent regularly to Colonial correspondents.

