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COLONIAL OFFICE

COLONIAL RESEARCH

1956-1957

REPORTS OF THE

Colonial Research Council
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 Products Council
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
November 1957*

LONDON

HER MAJESTY'S STATIONERY OFFICE

ELEVEN SHILLINGS NET

Cmnd. 321

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Colonial Research Council
Annual Report
on Colonial Research
(1956-1957)

Colonial Office,
The Church House,
Great Smith Street,
Westminster,
S.W.1.

1st October, 1957.

SIR,

As Lord Lloyd's successor as Chairman of the Colonial Research Council, I have the honour to submit to you the Council's Annual Report on Colonial Research for the year 1956-1957.

I have the honour to be,

Sir,

Your obedient servant,

PERTH,

Chairman.

The Rt. Hon. Alan Lennox-Boyd, M.P.,
Secretary of State for the Colonies.

COLONIAL RESEARCH COUNCIL

Membership

- THE MINISTER OF STATE FOR COLONIAL AFFAIRS (*Chairman*).
- THE DEPUTY UNDER-SECRETARY OF STATE IN CHARGE OF ECONOMIC AFFAIRS (*Vice-Chairman*).
- SIR CHARLES DODDS, M.V.O., D.Sc., M.D., F.R.C.P., F.R.I.C., F.R.S. (Chairman, Colonial Products Council).
- DR. W. H. GLANVILLE, C.B., C.B.E., D.Sc., M.I.C.E. (Chairman, Committee for Colonial Road Research).
- DR. W. J. HALL, C.M.G., M.C., D.Sc. (Chairman, Colonial Pesticides Research Committee).
- SIR HAROLD HIMSWORTH, K.C.B., M.D., F.R.C.P., F.R.S. (Chairman, Colonial Medical Research Committee).
- DR. H. W. MELVILLE, F.R.S. (Department of Scientific and Industrial Research).
- PROFESSOR SIR ARNOLD PLANT (Chairman, Colonial Economic Research Committee and Chairman, Colonial Social Science Research Council).
- SIR WILLIAM SLATER, K.B.E., D.Sc., F.R.I.C., F.R.S. (Chairman, Committee for Colonial Agricultural, Animal Health and Forestry Research).
- PROFESSOR SIR ALEXANDER TODD, M.A., D.Sc., F.R.I.C., F.R.S. (Professor of Organic Chemistry, University of Cambridge).
- MR. C. E. LAMBERT, C.M.G. (*Secretary*).

Terms of Reference

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

COLONIAL RESEARCH COUNCIL

ANNUAL REPORT OF COLONIAL RESEARCH FOR 1956-1957

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Table I: List of schemes approved for Research grants under the Colonial Development and Welfare Acts during the period 1st April, 1956, to 31st March, 1957.

Table II: Allocations for Research under the Colonial Development and Welfare Acts, 1940, 1945, 1950 and 1955 to 31st March, 1957.

Table III: Actual issues in respect of Research Schemes, 1940-1957.

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

Agricultural, Animal Health and Forestry.

Economic.

Fisheries.

Medical.

Pesticides.

Colonial Products and Colonial Products Laboratory.

Road Research.

Social Science.

Tsetse and Trypanosomiasis.

Locust Research and Control.

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

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COLONIAL RESEARCH COUNCIL (1956-1957)

INTRODUCTORY

The report of the Council 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; Colonial Products; Road Research; Social Science, and Tsetse and Trypanosomiasis research. Other research matters, also not covered by the reports of these Committees, are discussed in report number XII in this volume.

2. Sir Edward Salisbury, on retirement from the post of Director, Royal Botanic Gardens, Kew, relinquished his membership of the Colonial Research Council. The Council wish to record their sincere appreciation of the long and valuable assistance which Sir Edward Salisbury gave during his period of membership. Dr. H. W. Melville, F.R.S., on taking up his appointment as Secretary, Department of Scientific and Industrial Research, was appointed a member of the Colonial Research Council. Professor Sir Alexander Todd, M.A., D.Sc., F.R.I.C., F.R.S., Professor of Organic Chemistry, University of Cambridge, was also appointed a member of the Colonial Research Council during the year.

3. Meetings of the Regional Research Advisory bodies in East Africa, West Africa and the West Indies were again attended by members of the Council and Committees. Two meetings of the East African Agricultural and Fisheries Research Council and one meeting of the West African Standing Advisory Committee for Agricultural Research were held during the year and the Committee for Colonial Agricultural, Animal Health and Forestry Research was represented on each occasion. The Colonial Medical Research Committee was represented at meetings of the East African Council for Medical Research, the West African Council for Medical Research and the Standing Advisory Committee for Medical Research in the British Caribbean. The Chairman and Secretary of the Colonial Products Council made a visit to the West Indies and extensive visits were also made by the Secretary of State's advisers on agriculture, animal health, forestry and fisheries, his medical advisers, the Secretary for Colonial Agricultural Research, the Director of Colonial Medical Research and the Officer-in-Charge of Colonial Pesticides Research. International meetings on locust matters were attended by the Director and Deputy Director of the Anti-Locust Research Centre together with a member of the Colonial Office Research Department, and Specialist Meetings convened by the Commission for Technical Co-operation in Africa South of the Sahara were attended by members of the Colonial Social Science Research Council. Many of these visits are referred to in more detail in the accompanying reports of the individual committees.

The Rt. Hon. the Earl of Limerick, Chairman of the Medical Research Council, made a visit to East Africa. He was accompanied by Sir Harold Himsworth, Secretary of the Medical Research Council and Chairman of the Colonial Medical Research Committee.

4. As foreshadowed in the report for 1955-56, expenditure during the year under review shows an appreciable increase over previous years. During the year 1956-57 expenditure was approximately £1,538,412 as compared with £1,374,323 during the previous year. A review of the whole field of Colonial research, where Colonial Development and Welfare assistance is involved, is being undertaken with a view to ensuring that full use is made of the funds remaining for Colonial research during the period of the current

Colonial Development and Welfare Act and in order to determine whether additional funds should be sought to fulfil the programmes envisaged by the various committees. The Council will then consider the possible reallocation of funds between the various fields of Colonial research in order to achieve this purpose.

GENERAL

Colonial Development and Welfare Research Schemes made in 1956-57 and their Cost.

5. 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. One hundred and one new schemes and 59 supplementary schemes were made, involving grants totalling £2,202,880. These compare with 88 new schemes and 66 supplementary schemes made during the previous year entailing grants totalling £1,889,486, but it will be appreciated that many of the schemes shown as new schemes are in fact a continuation of schemes for which provision had been made up to the 31st March, 1956. As will be seen from Table II, these grants bring the total sum allotted to Colonial Development and Welfare Research schemes since 1940 to nearly £17,571,108. The net commitment, after allowing for revision of schemes and unspent balances, was on the 31st March, 1957, about £16m. of which some £12.5m. is chargeable against the funds provided under the 1945 and 1950 Colonial Development and Welfare Acts. The financing of many of these schemes is assisted by Colonial Governments from their own resources. Table III shows the actual disbursements made each year since 1940-41 which now total approximately £12,141,881.

6. About 35 per cent. of the gross allocation of £17.5m. has been for agricultural, animal health and forestry schemes, 17 per cent. for medical research, 10 per cent. for fisheries research, 9 per cent. for tsetse and trypanosomiasis research, 8 per cent. for social science and economic research, 8 per cent. for pesticides research, 5 per cent. for research sponsored by the Colonial Products Council, 3 per cent. for anti-locust research, and 5 per cent. for miscellaneous schemes including building and road research. Approximately 39 per cent. of the gross allocation has been for schemes to benefit the East African territories, 17 per cent. for the West African group, 9 per cent. for the South-East Asian territories and Hong Kong, 10 per cent. for the West Indian colonies, British Guiana and British Honduras, 5 per cent. for the Central African territories (Northern Rhodesia and Nyasaland) and 20 per cent. for other territories and for schemes of general interest. The constant demands on the pools of United Kingdom-based staff have justified their continued existence for the benefit of those Colonial territories which are unable to appoint their own specialist staff. Advisory visits overseas by specialists from the United Kingdom have again proved to be a valuable form of providing assistance (other than financial assistance) to Colonial territories.

7. New projects during the year include: in the United Kingdom, the provision of a tropical greenhouse for work on Colonial problems by the Unit of Experimental Agronomy; provision for the specialised training of malacologists: a survey of research requirements for tropical meteorology: assistance towards the preparation of a history of Uganda: a study of African co-operation and African leadership: studies of elections in Kenya, Sierra Leone and Eastern Nigeria: a study of the economics of African farming systems: a contribution towards the preparation of a history of

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the Kenya Legislative Council: in Tanganyika, the organization of agricultural research and land-use planning: a contribution to the Agricultural Research Services, Northern Rhodesia: cotton pest research in Nyasaland: the establishment of an Experimental Rice Station, Malaya: in the West Indies, research on herbicides at the Imperial College of Tropical Agriculture; a study of family attitudes in Jamaica; a contribution towards hurricane research sponsored by the United States Weather Bureau: in Malta, a soil survey; economic research: the preparation of a history of Basutoland; chemoprophylactic drug trials against trypanosomiasis in West Africa. Further financial assistance was provided in other new and supplementary schemes for: the continuation of the regional institutions for agricultural, veterinary, medical, fisheries and trypanosomiasis research in East and West Africa: fisheries research in Northern Rhodesia and Nyasaland: agricultural research in connection with the Abyan Development Programme, Aden: the agricultural research and experimental station, Nyasaland: the Medical Research Council's laboratories at Fajara, Gambia; the Gambia Rice Farm: the livestock experimental station at Ebini, British Guiana: banana breeding research in Jamaica: coconut pest research in the British Solomon Islands and in Zanzibar.

Research Branch of Her Majesty's Overseas Civil Service.

8. During the year 34 new appointments were made to the Research Branch. This brought the total complement of the Branch, in March, 1957, to 189 officers as compared with 176 officers in March, 1956. In addition, two Research Fellows continued investigations on behalf of the Colonial territories. Fourteen research studentships were awarded to train candidates for research appointments in agronomy (4), stored products entomology (2), entomology (2), soil chemistry (1), virology (1), genetics (1) and medicine (3).

9. The basis for Research Branch emoluments was revised to give conversion to appropriate local salary scales. As a result officers' pensionable emoluments have been improved considerably. A Panel has been established to review annually the status and grading of all non-medically qualified officers in the Research Branch. The first review took place in November and the Panel's recommendations have been referred to colonial governments for consideration. The Personnel Sub Committee of the Colonial Medical Research Committee continues to review the status and grading of all medically-qualified officers in the Research Branch.

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

10. The Eighth meeting of the Council took place in 1957 at Salisbury, Southern Rhodesia. Among the research activities in Africa South of the Sahara reviewed by the Council at this meeting were geology, geophysics, climatology, physical hydrology, forestry, animal husbandry and epizootic diseases, hydrobiology, oceanography and sea fishes, public health and social sciences.

11. During the year a number of specialist meetings have been held; among these have been meetings on the use of radio-isotopes, the cartography of vectors of disease; stored food products and a symposium on the quelea bird. A specialist meeting on the environmental factors affecting the physiology of man and a symposium on sea fisheries on the west coast of Africa are to be held later this year.

12. Mons. F. Hendrickx has been appointed as Scientific Secretary in place of Mons. H. Bredo who resigned last year. Professor J. V. Phillips of the University of Ghana has been appointed as a member of the Council.

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

13. Close co-operation has continued during the year under review. Notes in respect of research in the fields of building and water pollution will be found in the accompanying report No. XII. Officers in the service of Colonial Governments have made visits to the hydraulic research station during the year.

Technical Assistance

14. The Food and Agriculture Organization continued to provide specialists for the Ebini Livestock Experiment Station, British Guiana, and the Gold Coast Pilot Irrigation Scheme. Cyprus also benefited from the assistance of a livestock specialist and surveys of the Rufiji basin, Tanganyika, and of certain swamp soils in Sarawak were undertaken with F.A.O. assistance.

15. In addition to the reports listed in the Reports of the Specialist Advisory Committees the following reports have been published by Her Majesty's Stationery Office:—

Colonial Research Publications Series.

No. 13 (Revised). Land Registration, by Sir Ernest Dowson and V. L. O. Sheppard (25s.).

No. 18. Report on Roads and Road Problems in South East Asia and the Caribbean, by F. H. P. Williams (13s.).

Colonial Research Studies Series.

No. 19. Social Organization of the Lo Wiili, by J. R. Goody (15s.).

No. 20. Chinese Family and Marriage in Singapore, by Maurice Freedman (30s.).

No. 21. Underground Storage of Grain, by D. W. Hall, G. A. Haswell and T. A. Oxley (2s. 6d.).

APPENDIX

TABLE I

LIST OF SCHEMES APPROVED FOR RESEARCH GRANTS UNDER THE COLONIAL DEVELOPMENT AND WELFARE ACTS DURING THE PERIOD 1ST APRIL, 1956, TO 31ST MARCH, 1957

Scheme No. (Prefix "R")	Benefiting Territory	Description of Scheme	Amount
97E	General	Secretariat of the Colonial Social Science Research Council and Colonial Economic Research Committee (1945-55). (Supplementary provision.)	£ 43
168C	do.	Colonial Insecticides Research Unit in the United Kingdom. (Supplementary provision.)	450
367A 367B	do.	Production and publication of reports in the "Colonial Research Publications" series. (Supplementary provision.)	1,500 1,500
494G	do.	Maintenance of the Anti-Locust Research Centre. (Supplementary provision.)	1,800
689A	do.	Secretariat of the Colonial Social Science Research Council and the Colonial Economic Research Committee (1956-60). (Supplementary provision.)	1,790
696	do.	Colonial contribution towards the cost of maintaining the Common Services Section of the British Commonwealth Scientific Office (London). Further grant under Scheme No. R. 696. Scheme No. R. 696 (1957-58).	800
702A	do.	Secretariat of the Colonial Agricultural, Animal Health and Forestry Research Committee. (Supplementary provision.)	3,145
716A	do.	Secretariat of the Colonial Medical Research Committee. (Supplementary provision.)	1,880
724A	do.	Headquarters of the Colonial Pesticides Research Committee. (Supplementary provision.)	2,555
729A	do.	Appointment of Adviser on Tropical Soils at Rothamsted Experimental Station. (Supplementary provision.)	1,565
730A	do.	Appointment of Colonial Liaison Officer and staff at the Pest Infestation Laboratory, Department of Scientific and Industrial Research. (Supplementary provision.)	2,696
733	do.	Maintenance of the Anti-Locust Research Centre. Further grant under Scheme No. R. 733. Scheme No. R. 733 (1957-58).	57,550
737 737A	do.	Augmentation of the staff at Long Ashton Research Station, Bristol (1956-60).	16,846 2,068

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Scheme No. (Prefix "R")	Benefiting Territory	Description of Scheme	Amount
738	General	Construction of a tropical greenhouse at the Field Station of the Department of Agriculture, University of Oxford.	£ 3,600
753	do.	Preparation of precipitin sera at the Lister Institute (1956-60).	22,204
756	do.	Employment of an Assistant on sickle-cell research at the Post-Graduate Medical School of London.	1,375
759	do.	Provision for purchasing separates of scientific articles written by officers employed under C.D. and W. schemes (1956-60).	100
761	do.	Visit of entomologist to Canada to attend 10th International Congress of Entomology.	350
775 775A	do.	Onchocerciasis research at the London School of Hygiene and Tropical Medicine.	1,036 123
784	do.	Provision of ice-boxes for the transportation of leprosy material to the United Kingdom for study.	850
788	do.	Maintenance of the Colonial Section, Building Research Station, Department of Scientific and Industrial Research.	41,823
789	do.	Provision of apparatus for sickle-cell research at the Department of Chemistry, University of London.	200
791	do.	Leprosy research at the Strangeways Research Laboratory.	4,400
797	do.	Contribution towards the publication of a paper on "The Natural Hosts of some species of Glossina in East Africa".	50
798	do.	Employment of an Assistant on sickle-cell research at St. Bartholomew's Hospital.	2,218
800	do.	Training of two malacologists for research on schistosomiasis.	5,650
805	do.	Fundamental insecticides research at Silwood Park Field Station, Imperial College of Science and Technology.	15,308
808	do.	Survey of research requirements for tropical meteorology.	1,150
814 814A	do.	Visit of a member of Oxford University to Nigeria to collect skin samples from leprosy patients for histological study.	358 41
816	do.	Visit of a member of the London School of Hygiene and Tropical Medicine to East Africa for trypanosomiasis research.	400

Scheme No. (Prefix "R")	Benefiting Territory	Description of Scheme	Amount
818	General	Study of elections in African territories; visit to Sierra Leone.	£ 600
826	do.	Visit of Adviser on Tuberculosis to Aden, Somaliland and Dar-es-Salaam.	115
830	do.	Study of elections in African territories; visit to Kenya.	310
831	do.	Study of elections in African territories; visit to Eastern Nigeria.	150
832	do.	Colonial contribution towards the cost of maintaining the Agricultural Research Council's Unit of Experimental Agronomy, Oxford (1957-58).	6,600
799	Africa	Preparation of a survey of science in Africa	450
820	General	Study of the economics of African farming systems.	1,391
68J	East Africa General	Colonial Insecticides Research, Uganda. (Supplementary provision.)	11,159
408B	do.	East African Medical Survey (Supplementary provision.)	5,360
409J	do.	Economic research at the East African Institute of Social Research. (Supplementary provision.)	467
523c	do.	Colonial Insecticides Research Unit, East Africa. (Supplementary provision.)	8,542
527c	do.	East African Agriculture and Forestry Research Organisation. (Supplementary provision.)	9,816
530c	do.	Colonial Agricultural Insecticides Research Unit, East Africa. (Supplementary provision.)	1,993
550A	do.	Appointment of Botanist at the Colonial Insecticides Research Unit, East Africa (Supplementary provision.)	805
642B	do.	Employment of an Assistant to the Professor of Pathology at Makerere College, Uganda (1957-58). (Supplementary provision.)	800
688A	do.	Survey in East Africa of the incidence of insect pests of cereal crops. (Supplementary provision.)	125
693A	do.	East African Institute of Social Research (Supplementary provision.)	5,037
739	do.	East African Agriculture and Forestry Research Organisation (1956-60).	229,600

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Scheme No. (Prefix "R")	Benefiting Territory	Description of Scheme	Amount
745	East Africa... General	Study of plant steroids at Makerere College, Uganda.	£ 327
746	do. ...	Study of mealybugs in Africa South of the Sahara.	7,850
750	do. ...	Study of the production of methane from organic wastes in the tropics at Makerere College, Uganda.	270
757	do. ...	East African Trypanosomiasis Research Organisation (1956-57).	68,174
763	do. ...	Visit of expert to East Africa to attend a conference on tick-borne diseases.	390
765	do. ...	Office of the East African Council for Medical Research (1956-60).	8,745
766	do. ...	Physiological and biochemical research ...	26,478
767	do. ...	East African Medical Survey and Research Institute (1956-60).	65,169
768	do. ...	Research on relapsing fever (1957-58) ...	14,650
769	do. ...	East African Marine Fisheries Research Organisation (1956-60).	36,346
770	do. ...	East African Inland Fisheries Research Organisation (1956-60).	36,711
773	do. ...	East African Virus Research Institute (1956-60).	96,300
774	do. ...	East African Institute of Malaria and Vector-Borne Diseases (1956-60).	28,775
776	do. ...	Colonial Pesticides Research Unit, East Africa (1956-57).	97,150
801	do. ...	East African Veterinary Research Organisation (1956-60).	166,744
815	do. ...	Provision for the writing up of studies of African co-operation and leadership.	292
822	do. ...	Visit of a member of Wye College to East Africa to attend the East African Herbicides Conference.	450
827	do. ...	Establishment of an Office of the East African Agricultural and Fisheries Research Council.	1,957
836	do. ...	Visit to East Africa of an expert on the dynamics of fish populations.	216
684A	Kenya ...	Research on the biology of sand flies. (Supplementary provision.)	425
760	do. ...	Assistance towards the writing up of a history of the Kenya Legislative Council.	239

Scheme No. (Prefix "R")	Benefiting Territory	Description of Scheme	Amount
813	Uganda	Research into Uganda history	£ 550
824	do.	Land use studies in Uganda	200
796	Tanganyika	Organisation for Agricultural Research and Land Use Planning.	99,616
785 785A	Zanzibar	Research into the control of <i>Pseudotheraptus Wayi</i> on coconuts.	3,096 774
629B	Central Africa General	Preparation of a Flora Zambesiaca; contribution towards Cambridge University biological expedition to Nyasaland.	100
754	do.	Visit of an expert to Nyasaland in connection with an investigation into the control of cotton pests.	250
752	Northern Rhodesia... ..	Agricultural Research Services (1956-58)... ..	52,400
750	do.	Northern Rhodesia section of the Northern Rhodesia/Nyasaland Joint Fisheries Research Organisation.	18,711
772	Nyasaland	Agricultural Research and Experimental Station, Lilongwe (1956-60).	79,473
781 781A	do.	Nyasaland section of the Northern Rhodesia/Nyasaland Joint Fisheries Research Organisation.	9,022 1,579
817	do.	Research on cotton pests	14,487
833	do.	Provision of water supply to Silvicultural Research Station and Forestry Training School.	270
311D	West Africa General	West African Building Research Institute (Supplementary provision.)	7,611
424D 424E	do.	West African Institute for Trypanosomiasis Research. (Supplementary provision.)	10,450 119,050
471C 471D	do.	West African Maize Research Unit. (Supplementary provision.)	4,366 4,750
703A	do.	Visit of taxonomist to West Africa to study aphids and white flies. (Supplementary provision.)	1,120
741	do.	Maintenance of the Medical Research Council's Field Station, Fajara, Gambia (1956-60).	60,000
749	do.	West African Institute of Social and Economic Research.	7,483
771 771A	do.	West African Timber Borer Research Unit	2,100 1,280

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Scheme No. (Prefix "R")	Benefiting Territory	Description of Scheme	Amount
804	West Africa General	West African Standing Advisory Committee for Agricultural Research.	£
804A			3,045
806	do. ...	West African Council for Medical Research (1956-60).	2,952
819	do. ...	Trypanosomiasis drug trials at the West African Institute for Trypanosomiasis Research.	147,229
597B	Gambia ...	Investigation of insect attack on growing groundnuts. (Supplementary provision.)	1,609
755	do. ...	Research on bilharzia	341
762	do. ...	Maintenance of Rice Farm (1956-60) ...	3,180
598A	Gold Coast ...	Sociological research in the Northern Territories. (Supplementary provision.)	16,440
575B	Nigeria ...	Provision of a Research Chemist for the Western Sokoto Malaria Control Pilot Project. (Supplementary provision.)	438
795	do. ...	Study of differential mortality, physique, growth and fertility of sickle-cell and normal individuals in malarious areas of Nigeria.	3,000
825	do. ...	Nutritional and biochemical research at University College, Ibadan.	1,200
811	Sierra Leone ...	Appointment of a Systematic Botanist/ Ecologist.	2,080
	South Africa High Commission Territories		4,260
495A	Basutoland ...	Appointment of soil fertility worker. (Supplementary provision.)	1,037
758	do. ...	Continuation of appointment of soil fertility worker (1956-60).	8,750
792	do. ...	Provision of assistance towards the cost of a study of the history of Basutoland.	277
787	Bechuanaland ...	Contribution towards the preparation of a Flora Zambesiaca.	6,000
834	Swaziland ...	Soil Survey	5,877
	Middle East		
736	Aden ...	Agricultural research section of the Abyan Development Programme (1956-60).	40,815
	Mediterranean		
748	Malta ...	Economic research by the Royal University of Malta and the University of Durham.	5,150
786	do. ...	Soil survey	2,000

Scheme No. (Prefix "R")	Benefiting Territory	Description of Scheme	Amount
720A	Cyprus	Preparation of a Flora of Cyprus. (Supplementary provision.)	£ 560
	Western Pacific		
794	British Solomon Islands Protectorate	Research on coconut and other insect pests	11,287
823	Fiji	Research into the control of filariasis by insecticidal methods.	10,183
778	South East Asia General	Visit of an expert to Fisheries Research Stations in Malaya and Singapore.	500
593B	Federation of Malaya	Social Research Unit, University of Malaya. (Supplementary provision.)	4
747	do.	Maintenance of Experimental Rice Station (1956-60).	50,500
790 790A	do.	Leprosy research	3,800 100
803	do.	Visit of an expert to advise on soil research	95
751	North Borneo	Appointment of Forest Botanist (1956-58)	9,305
618A 618B	Sarawak	Investigation into the control of pepper disease. (Supplementary provision.)	3,760 338
828	do.	Establishment of a Soils Laboratory ...	21,000
793	Singapore	Visit of a research worker to the Singapore Botanic Gardens.	1,500
542A	West Indies General	Visit of inspection to the Institute of Social and Economic Research, University College of the West Indies. (Supplementary provision.)	21
623A 623B	do.	Appointment of a Junior Research Fellow at the University College of the West Indies. (Supplementary provision.)	745 1,050
671A	do.	Regional Agricultural Research Centre at the Imperial College of Tropical Agriculture, Trinidad. (Supplementary provision.)	13,235
697A	do.	Seismic investigations in the West Indies (Supplementary provision.)	2,010
779	do.	Herbicides research at the Imperial College of Tropical Agriculture, Trinidad.	1,600
782	do.	Research into natural products of medical interest at the University College of the West Indies.	33,700
802	do.	Sugar technology research at the Imperial College of Tropical Agriculture, Trinidad.	10,000

COLONIAL RESEARCH COUNCIL

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Scheme No. (Prefix "R")	Benefiting Territory	Description of Scheme	Amount
807	West Indies General ...	Banana breeding research (1956-60) ...	£ 15,118
812	do. ...	Maintenance of the Secretariat of the Standing Advisory Committee for Medical Research in the British Caribbean.	4,340
829	do. ...	Visit of a member of the Commonwealth Institute of Entomology to British Guiana and Trinidad.	300
764	British Guiana ...	Maintenance of the Livestock Experimental Station, Ebini (1956-60).	30,550
809	do. ...	Investigation into the possibilities of cotton production.	2,897
821	do. ...	Anthropological research on Amerindians...	600
810	British Honduras ...	Visits to British Honduras of the Cotton Investigation Officer, British Guiana.	500
586A	Grenada ...	Investigation into cocoa beetle infestation. (Supplementary provision.)	215
576B	Jamaica ...	Study of the economics of land use. (Supplementary provision.)	267
744	do. ...	Study of family attitudes and fertility ...	7,000
777	do. ...	Study of social mobility ...	500
783	do. ...	Investigation into "Vomiting Sickness" ...	385
835	do. ...	Visit of a member of University College Hospital Medical School, London, to the Tropical Metabolism Research Unit, Jamaica.	400
236J	Trinidad ...	Colonial Microbiological Research Institute. (Supplementary provision.)	1,263
350D	do. ...	Malaria research. (Supplementary provision.)	3,000
573C	do. ...	Appointment of British Laboratory Technician at the Rockefeller Virus Laboratory. (Supplementary provision.)	5,028
742	do. ...	Colonial Microbiological Research Institute	9,200
742A			9,200
742B			41,704
743	do. ...	Participation in a Hurricane Research Project of the United States Weather Bureau.	2,300
Total... ..			2,202,880

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

Period to	Totals	
	Allocation for period	Cumulative allocation
	£	£
31st October, 1942	57,158	57,158
31st March, 1943	15,340	72,498
31st March, 1944	224,835	297,333
31st March, 1945	116,795	414,128
31st March, 1946	660,776*	1,074,904*
31st March, 1947	1,099,382*	2,174,286*
31st March, 1948	2,073,340*	4,247,626*
31st March, 1949	1,666,229*	5,913,855*
31st March, 1950	1,814,124*	7,727,979*
31st March, 1951	2,514,536*	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*

* 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, 1940-1957

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	1,538,412
	£ 12,141,881

Committee for Colonial
Agricultural, Animal Health
and Forestry Research
Twelfth Annual Report
1956-1957

Agricultural Research Council,
Cunard Buildings,
15, Regent Street,
London, S.W.1.
6th September, 1957.

SIR,

I have the honour, on behalf of the Committee for Colonial Agricultural, Animal Health and Forestry Research, to transmit to you the Twelfth Annual Report of the Committee covering the period 1st April, 1956 to 31st March, 1957.

I have the honour to be,

Sir,

Your most obedient Servant,

W. K. SLATER,
Chairman.

The Rt. Hon. Alan Lennox-Boyd, 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.I.C., F.R.S., Secretary, Agricultural Research Council (*Chairman*).
- DR. N. C. WRIGHT, C.B., M.A., D.Sc., Ph.D., F.R.I.C., Chief Scientific Adviser (Food), Ministry of Agriculture, Fisheries and Food (*Vice-Chairman*).
- MR. F. C. BAWDEN, M.A., F.R.S., Head of Plant Pathology Department, Rothamsted Experimental Station.
- DR. G. D. H. BELL, Ph.D., Director, Plant Breeding Institute, Cambridge.
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- DR. J. CARMICHAEL, C.M.G., D.Sc., M.R.C.V.S., Dip. Bact., formerly Colonial Veterinary Service.
- SIR GEOFFREY CLAY, K.C.M.G., O.B.E., M.C. (*to June, 1956*),
- MR. G. W. NYE, C.M.G., O.B.E. (*from July, 1956*),
Adviser to the Secretary of State on Agriculture.
- MR. F. S. COLLIER, C.M.G., C.B.E., Adviser to the Secretary of State on Forestry.
- SIR FRANK ENGLEDDOW, C.M.G., M.A., F.R.S., Drapers' Professor of Agriculture, Cambridge University.
- DR. R. A. E. GALLEY, Ph.D., A.R.C.S., D.I.C., F.R.I.C., Director of Colonial Products Research and Officer-in-Charge of Colonial Pesticides Research.
- DR. W. J. HALL, C.M.G., M.C., D.Sc., Director, Commonwealth Institute of Entomology.
- MR. G. V. B. HERFORD, O.B.E., M.Sc., Director, Pest Infestation Laboratory, Department of Scientific and Industrial Research, Slough.
- MR. M. V. LAURIE, O.B.E., M.A., Chief Research Officer, Forestry Commission.
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- PROFESSOR A. B. STEWART, M.A., B.Sc., Ph.D., F.R.I.C., Department of Agriculture, Aberdeen University.
- SIR EDWARD SALISBURY, C.B.E., D.Sc., Sec.R.S., Director, Royal Botanic Gardens, Kew (*Resigned February, 1957*).
- DR. G. TAYLOR, D.Sc., F.R.S.E., F.L.S., Director, Royal Botanic Gardens, Kew (*from February, 1957*).
- DR. S. P. WILTSHIRE, M.A., D.Sc., Director, Commonwealth Mycological Institute (*Resigned October, 1956*).
- DR. J. C. F. HOPKINS, D.Sc., A.I.C.T.A., Director, Commonwealth Mycological Institute (*from November, 1956*).
- MR. D. RHIND (*Secretary*).
- MR. R. MOWFORTH (*Assistant Secretary*).

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- MR. R. V. WADSWORTH, Cadbury Brothers, Limited.
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- DR. J. C. F. HOPKINS, D.Sc., A.I.C.T.A., Director, Commonwealth Mycological Institute (*from November, 1956*).
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- MR. G. W. NYE, C.M.G., O.B.E. (*from July, 1956*),
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- DR. W. DAVIES, D.Sc., Grassland Research Institute.
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- DR. H. GREENE, D.Sc., Adviser on Tropical Soils, Rothamsted Experimental Station.
- MR. G. V. JACKS, M.A., Director, Commonwealth Bureau of Soil Science.
- DR. D. N. MCARTHUR, C.B.E., D.Sc., F.R.I.C., F.R.S.E., Macaulay Institute for Soil Research, Aberdeen.
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- MR. D. RHIND, O.B.E., Secretary for Colonial Agricultural Research.

DR. R. K. SCHOFIELD, Ph.D., F.Inst. P., Rothamsted Experimental Station.
 PROFESSOR T. WALLACE, C.B.E., M.C., V.M.H., F.R.S., Long Ashton Research
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 MR. J. YOUNG (*from March, 1957*),
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 MR. H. A. DADE, A.R.C.S., Asst. Director, Commonwealth Mycological
 Institute (*from 5.12.56*).
 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
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 Industrial Research, Slough.
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 Ministry of Agriculture, Fisheries and Food.
 MR. R. MOWFORTH (*Secretary*).

CROP PROTECTION SUB-COMMITTEE

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 Entomology.
 MR. G. V. B. HERFORD, O.B.E., M.Sc., Director, Pest Infestation Laboratory,
 Department of Scientific and Industrial Research.
 PROFESSOR J. W. MUNRO, C.B.E., D.Sc., M.A., Professor Emeritus of Zoology
 and Applied Entomology in the University of London.
 DR. S. P. WILTSHIRE, M.A., D.Sc., Director, Commonwealth Mycological
 Institute (*Resigned October, 1956*).
 DR. J. C. F. HOPKINS, D.Sc., A.I.C.T.A., Director, Commonwealth Mycological
 Institute (*from November, 1956*).
 DR. R. A. E. GALLEY, Ph.D., A.R.C.S., D.I.C., F.R.I.C., Director of Colonial
 Products Research and Officer-in-Charge of Colonial Pesticides Research.
 MR. D. RHIND, O.B.E., Secretary for Colonial Agricultural Research.
 MR. C. A. KIRKMAN (*Secretary*).

COMMITTEE FOR COLONIAL AGRICULTURAL, ANIMAL HEALTH
AND FORESTRY RESEARCH

TWELFTH ANNUAL REPORT

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COMMITTEE FOR COLONIAL AGRICULTURAL, ANIMAL HEALTH AND FORESTRY RESEARCH

TWELFTH ANNUAL REPORT

I. GENERAL

The Committee held five meetings.

2. Mr. G. W. Nye replaced Sir Geoffrey Clay on the Committee following the latter's retirement. Sir Edward Salisbury resigned on his retirement from the Directorship of the Royal Botanic Gardens, Kew, and was replaced by the new Director, Dr. G. Taylor. Dr. Wiltshire resigned on relinquishing the Directorship of the Commonwealth Mycological Institute and the new Director, Dr. J. C. F. Hopkins joined the Committee.

3. Overseas visits by members, advisers and other scientists were an important part of the Committee's activities. Mr. Nye visited Somaliland, Zanzibar, Kenya and Uganda and represented the Committee at the Sixth Meeting of the East African Agricultural and Fisheries Research Council. Mr. Roddan visited Northern Rhodesia, Nyasaland and the High Commission Territories. Mr. Collier visited West and East Africa. Mr. Marshall visited the Union of South Africa and the High Commission Territories and West Africa. Dr. Bell paid a prolonged visit to the West African Cocoa Research Institute. Dr. Carmichael and Mr. Laurie represented the Committee at the Seventh Meeting of the East African Agricultural and Fisheries Research Council, and toured Kenya, Tanganyika and Uganda. Mr. Herford attended the C.S.A. Meeting of Specialists on Stored Food Products at Salisbury, S. Rhodesia. Sir Frank Engledow visited Uganda and Kenya. Mr. Voelcker visited Malaya and North Borneo in connection with the development of cocoa at the request of the Colonial Development Corporation. Dr. Greene attended the Arid Zone Committee of U.N.E.S.C.O. in Australia and afterwards visited North Borneo, Sarawak and Aden. Mr. Hall visited Ghana and Nigeria at their request for consultations on storage pests and later visited Jamaica. Dr. Hopkins visited Nigeria and Malta. The Secretary visited East, Central and West Africa, attended the F.A.O. Consultative Committee on Rice standardisation in Rome and represented the Committee at the Sixth Meeting of the East African Agricultural and Fisheries Research Council and the Second Meeting of the West African Standing Advisory Committee on Agricultural Research.

4. Scientists not members of the Committee who made visits from the U.K. included Professor Wain of Wye College who attended the first conference on herbicides held at the East African Agriculture and Forestry Research Organisation, and who also visited adjacent territories; Mr. Pearson of the Commonwealth Institute of Entomology who went to Nyasaland and the Rhodesias in connection with research on Red Bollworm attacking cotton; Mr. Duffy of the same Institute to Trinidad and British Guiana on longhorn beetles attacking timber; and Mr. Milne-Redhead and Mr. Taylor made an expedition to Southern Tanganyika for work on the Flora of East Africa.

5. The attendance of members of the Committee and of its Sub-Committees at various conferences is invariably useful, but experience shows that the benefits following discussions between senior scientists from this country and those working overseas are of the greatest value both in enabling the Committee to appreciate problems and difficulties in dependencies and in bringing much up-to-date research information to those in comparative isolation.

6. The Committee made grants amounting to a total of £925,921 during the year. These include renewed assistance to long-term schemes as well as a number of new proposals.

7. Recruitment of scientific staff for overseas duties, to which reference was made in the Report for 1955-56 (para. 6), was somewhat better though there is difficulty in finding suitable officers for senior posts. Most research groups contain an undue proportion of young staff. The Committee continues to keep this matter under review.

8. In order to ensure closer co-ordination of work on pest and disease control a special Sub-Committee, the Crop Protection Sub-Committee, was set up jointly with the Colonial Pesticides Research Committee. It is intended that this Sub-Committee shall deal with those subjects which relate to the work of both main Committees. The various research projects with which the Sub-Committee dealt are reported in the appropriate sections of this report and that of the Colonial Pesticides Research Committee.

9. Several Colonial Territories continued to receive help from F.A.O. under the Technical Aid Agreement. Expert assistance was given for surveys of the Rufiji Basin in Tanganyika and the Accra Plain in Ghana. Livestock investigations in British Guiana were helped by the loan of a research officer and prompt help given to Cyprus in the control of an outbreak of sheep pox. An expert was provided for a survey of certain swamp soils in Sarawak and rice hybridization work continued under the sponsorship of the International Rice Commission (F.A.O.).

II. SUMMARY OF PRINCIPAL RESEARCH DEVELOPMENTS

Agriculture

10. Evidence is accumulating that an increasing volume of results from past research is going into practice in tropical agriculture. The extension of soil conservation measures with the concomitant practice of moisture conservation in areas of low or erratic rainfall has made large contributions to the improvement of farm outturns in a number of territories, such, for example, as Kenya, Swaziland, Uganda, Grenada and Somaliland. Improvements in crop husbandry inherent in these measures are succeeding in many places, e.g. cotton cultivation in Uganda and Tanganyika, groundnut growing in the Gambia, and maize farming in Northern Rhodesia.

11. Research into the use of fertilizers has given results which have led to economic returns in many areas. The soil nutrient status is gradually becoming clearer with discoveries of deficiencies of major and trace elements in many parts of Africa, particularly of phosphorus, nitrogen, sulphur, boron and molybdenum.

12. Plant breeding research has made valuable contributions towards better yields though generally these are contingent on a raised level of farming. Maize breeding in Africa has produced a series of varieties highly resistant to the tropical maize rust and of high yield. It is noteworthy that strains of maize from Mexico have been specially valuable in this breeding programme. Cocoa hybridization in the West Indies and West Africa has produced new material of exceptional yield and early bearing which is now being issued to farmers in considerable amounts. Many other crops, particularly food crops, have received attention and the output of improved seed continues to increase, though there is room for further advances in this respect.

13. The rapid growth of weeds in tropical countries makes them a specially serious menace to crop production, not only by the direct effect of lowering yields but also by restricting crop acreage to that which the family can

effectively weed. In consequence the use of organic weed killers figures prominently in research programmes and a large series of synthetic chemicals are under test in many countries.

14. Disease and pest control through chemical means have made notable advances and the adoption of these control measures by small scale farmers is slowly assuming importance. Research on capsid control on cocoa in West Africa has resulted in the widespread use of insecticides. A programme to spray 700,000 acres has been approved and about 100,000 acres have been treated with power sprayers. Over 20,000 hand sprayers have already been sold to cocoa farmers for treatment of young cocoa and for re-treatment of mature cocoa which has been sprayed with power machines. Considerable advances have been made in the control of pests and diseases of cotton as a result of experimental work with modern chemicals. Practical and economic control measures for certain major insect pests of sorghum and other cereals are now available as the result of research.

15. Examination of losses of produce in store has revealed the large extent of damage done by storage pests and active attention is being given to this problem in a number of territories. Loss and downgrade of produce is often serious so that research directed towards the discovery of control or preventative measures is yielding valuable results in terms of money. Particular attention has been given to rice, cocoa and groundnuts.

16. Research of a more fundamental nature has been assigned to the larger regional research organisations. These have made advances in such problems as the role and importance of organic matter in tropical soils, the nitrogen and sulphur cycles and on phosphate fixation. Soil moisture relationships have received special attention in East Africa. Banana breeding has made advances in the West Indies. Soil surveys as a preliminary to land-use planning have been extended. The examination and description of the flora of many areas received further attention and this long-term work now embraces floras of East Africa, the Zambezi Basin of Central Africa (Flora Zambesiaca), Cyprus, Malaya (Flora Malesiana), Tropical West Africa, Jamaica and Trinidad.

17. The very large mass of research now proceeding, both with C.D. and W. support and by local Governments, calls for measures of co-ordination and particularly for the prompt exchange of information between workers in allied fields. In East Africa the East African Agricultural and Fisheries Research Council continued to perform a most useful role, and together with its Technical Co-ordinating and Specialist Committees provided an excellent means for the exchange of information and the pooling of resources. In West Africa the West African Standing Advisory Committee for Agricultural Research, together with its panels, performed a similar function and in addition there was a further meeting of the Anglo-French Research Conference in the Ivory Coast, this time concerned with Oil Palms. Similar co-ordination in the West Indies is envisaged through the West Indian Technical Co-ordinating Committee which was recently set up.

Forestry

18. The valuable African timber tree *mvule* (*Chlorophora excelsa*) has always been difficult to grow in plantations. A special examination of this problem was made in collaboration with the Imperial Forestry Institute, Oxford, which it is hoped will prove a foundation on which to base further work.

19. Interest in hormonal arboricides has extended and work has shown that they can be very useful in eliminating weed trees when making improvement fellings and of course they are not dangerous to men and stock, as is

sodium arsenite. Their use for removal of mangrove from swamps needed for rice cultivation (e.g. in West Africa) is still under investigation.

20. Tropical pines are now receiving much attention and species trials are proceeding in many areas. Notable successes have been achieved in some areas, particularly in Central Africa and parts of the Caribbean.

21. The use of species of little known timber value from the mixed tropical forests received further study, notably in Malaya, and the production of hardboards was attended with some success.

22. Work on ambrosia beetles in West Africa has resulted in practical control measures which are being adopted, as well as a great deal of fundamental information about the beetles concerned.

Veterinary

23. Attention to animal breeding was widespread but this long-term work produced no spectacular results. Progress was, however, made in many places so that better quality stock is continually becoming available. The improvement is naturally a gradual one. Together with the production of better stock, improvements in animal feeding stuffs are essential and this received study in many territories, with emphasis on the importance of protein in feeds.

24. Vaccine production and the improvement of such biologicals occupied much of the time of veterinary departments. As a result of progress in this work it has been possible to achieve a high degree of control of animal diseases, so much so that there are hopes of the eventual elimination of some diseases from large areas. Notable successes were with rinderpest and pleuropneumonia of cattle and Newcastle Disease of poultry. Fundamental work on a number of protozoal diseases of animals made much progress on East Africa.

III. LIAISON WITH RESEARCH INSTITUTIONS

25. The Committee again acknowledges the great amount of help which has been received from numerous research organisations and Universities in the United Kingdom. Association with research in progress in the United Kingdom is proving very valuable not only in the purely research field but also in the provision of experts and in the training of specialists. The close association with the Agricultural Research Council and the Department of Scientific and Industrial Research and with their laboratories is especially highly valued.

Commonwealth Institute of Entomology

26. As in previous years, a considerable part of the work of the Commonwealth Institute of Entomology was concerned with colonial problems. In 1956-57, nearly 31,000 specimens were submitted for identification from 20 territories (including Ghana), and 3,382 identifications were sent out, representing over 42 per cent. of all those given by the Institute during the year.

27. Mention should be made of two projects which have received substantial assistance from the Institute's identification service in recent years: the survey of forest pests in East Africa, carried out by Mr. J. C. M. Gardner, of the East African Agriculture and Forestry Research Organisation, in the course of which the Institute has handled 109 collections, comprising 9,382 specimens, during the past seven years, and identified some 1,470 species; and the investigation of premature nutfall of coconuts in the British Solomon Islands Protectorate, carried out by Mr. E. S. Brown, which has involved

the handling (including the preparation and labelling) of 26,891 specimens contained in 44 collections and the identification of 1,215 species, during the past two years.

28. Volume 47 (1956) of the *Bulletin of Entomological Research*, published by the Institute, contained 21 papers occupying 37.5 per cent. of the volume, reporting the results of entomological work carried out in or concerned with the Colonies.

29. In May-June, 1956, the Assistant Director, Mr. E. O. Pearson, visited Nyasaland and Southern Rhodesia in order to advise on cotton-pest problems; the recommendations in his report (July, 1956) have been implemented, including the appointment of a small research team, operating in the two territories concerned, to which he is continuing to give general guidance. In March, 1957, Mr. E. A. J. Duffy, of the staff of the Institute, started a three-month visit to Trinidad and British Guiana to obtain further material for the next of his series of monographs on the immature stages of timber-beetles, which is to deal with the neotropical region.

Commonwealth Mycological Institute

30. The increased space provided by the new building has greatly facilitated the task of identification and has made it possible to accommodate visitors, eight of whom from the Colonial Dependencies have spent periods of up to six months studying in the Herbarium. The improved dark room facilities have enabled a number of small publications to be made at the Institute by the photo-offset method and for photostats of literature to be supplied in increasing quantities to overseas mycologists.

31. Material for identification has been received from 12 Colonial Dependencies, including the Federation of Malaya (a large collection), Nigeria, Cyprus, Northern Rhodesia, Kenya and Sarawak. The most important records were of banana leaf spot (*M. musicola*) identified in Sierra Leone, and two species of *Ramulispora* as important pathogens of sorghum in Nigeria. Cross-inoculation experiments on green cacao pods from Ghana and Nigeria with cultures of the black pod fungi from these two countries were done at the Institute in collaboration with the West African Cocoa Research Institute and the Nigerian Federal Department of Agricultural Research.

32. *Puccinia polysora* on maize was identified on material from the Philippines and what are apparently new physiologic races were reported from East and West Africa. The Herbarium is collaborating with Mr. Cammack of the West African Maize Research Unit in a statistical analysis of spore sizes of collections from different parts of the world.

33. There has been a considerable increase in the sales of *Commonwealth Phytopathological News*, which is also attracting attention in many foreign countries. It is well supported by contributions from pathologists and mycologists in the Colonial Dependencies. The book *Tobacco Diseases* by Dr. J. C. F. Hopkins, *Phytopathological Paper* No. 1, "Losses caused by plant disease in the Colonial Dependencies" by Dr. G. Watts Padwick and "The Genus *Phytophthora*" by Miss G. M. Waterhouse were published and are in much demand. Other publications included a list of plant diseases in Northern Rhodesia, *Mycological Papers* 65 and 66 dealing with species of *Corynespora* and *Deightonella*, "Witches' broom disease of cacao" by the late Professor R. E. D. Baker and P. Holliday and the indexes to Petrak's Lists for 1920-39. A revised list of common names of virus diseases is in the press and a list of seed-borne diseases, compiled by Drs. Mary Noble, Paul Neergaard and J. de Tempe in co-operation with the Institute, is in an advanced stage of preparation.

34. Dr. Hopkins visited Nigeria to survey a serious outbreak of leaf curl disease in flue-cured tobacco and to consult with the Federal Director of Agricultural Research on future investigations. On his way back he spent a week in Malta to study the plant disease position in the island. He recommended an immediate preliminary survey of economic crop diseases as existing information was insufficient for the formulation of a plant protection policy.

Adviser on Tropical Soils, Rothamsted Experimental Station

35. Dr. H. Greene, Colonial Office Adviser on Tropical Soils, visited British Guiana, Trinidad, British Honduras and Jamaica. He also attended the symposium on arid zone climatology jointly arranged by the Commonwealth Industrial and Scientific Research Organisation and the United Nations Educational, Scientific and Cultural Organisation in Australia, and on his return journey visited North Borneo, Sarawak and Aden.

36. In British Guiana, soils of the Intermediate Savannas at Ebini Stock farm have shown marked responses to phosphates and notable improvements of pastures leading to greater carrying capacity. Phosphate deficiencies were also very marked in British Honduras where residual effects from small trials are still showing up. On acid pine ridge soils, responses of pines to phosphate are specially striking, as also occurs in Trinidad.

37. Very satisfactory progress has been achieved in Jamaica with soil surveys, the results of which are being turned to practical use in land rehabilitation schemes in overcrowded areas. Soil surveys which have also progressed well are those of North Borneo, Malaya, Fiji (Viti Levu island) and Ghana.

38. Studies on soil fertility are now receiving very close attention in nearly all colonial territories. It is becoming clear that over large areas of Africa South of the Sahara temperature and rainfall would permit good growth of crops were it not for deficiency of plant nutrients. There is good prospect of remedying the deficiency of major and minor plant nutrients in ways that will raise the soils to a much higher level of productivity. This will not be achieved easily or quickly: there is need for continuing effort in well-designed experiments both in the field and in the laboratory. Interest extends not only to the inorganic constituents of soil but to the organic matter and to methods of husbandry that will build this up and maintain it at a high level. Very notable and important studies on rainfall reliability and on the water relationships of soils are attracting attention in East Africa.

Publication

H. GREENE—"Soil Resources": Guide book to research Data for Arid Zone Development, UNESCO, 1957.

Department of Statistics, Rothamsted Experimental Station

39. Primary responsibility for this work was delegated by Dr. Yates to B. M. Church, who was responsible for survey work, and M. H. Westmacott, who dealt with the design and analysis of experiments. H. R. Simpson and F. B. Leech were also concerned in particular investigations. Eight requests for advice or help in the design or analysis of experiments or surveys were received from Colonial territories and a number of discussions were also held with Dr. Herbert Greene (Adviser on Tropical Soils) about the design of experiments on which his advice had been sought by members of the Colonial Service. Six Colonial Service officers spent varying periods at Rothamsted, during which they either received general instruction in statistical methods, or worked on their own problems, in consultation with members of the Department.

40. At the request of the Tsetse Fly and Trypanosomiasis Committee, a theoretical investigation into the effect of introducing sterilized males into a natural Tsetse Fly population was carried out by H. R. Simpson. The electronic computer was used for this work. A report will be submitted to the Colonial Office, and a paper has been prepared for publication. F. B. Leech attended the Conference on the Use of Drugs for the Control of Cattle Trypanosomiasis held at the Colonial Office in July, and produced a report on the testing of drugs intended for use against trypanosomiasis.

IV. REGIONAL RESEARCH

(a) EAST AFRICA

East African Agriculture and Forestry Research Organisation

41. The inter-territorial work of the Physics Division has increased very considerably during the year under review. The most important development has been the organisation of four inter-territorial catchment area experiments, two in Kenya and one each in Uganda and Tanganyika. These experiments, which involve close co-operation between several Departments in each Territory and E.A.A.F.R.O., are designed to measure the effect of changing the land use of a whole catchment area on the evenness of flow of the river leaving the area, that is on the liability to flood in the rains and to dry up in the dry season. In the Kenya and Tanganyika experiments there are two or three catchments in each experiment, one of which will be in natural forest and the others in more intensive forms of land use. In the Uganda experiment the effect of grazing control on flash floods in a semi-arid area is being studied.

42. Work is continuing on the computation from suitable meteorological data of the water need by crops. The Plant Physiologist is assisting in this work. In conjunction with the Coffee Research Station at Ruiru, an irrigation advisory service has begun in order to help coffee planters to apply the most efficient quantities of scarce irrigation water. Soil structure and infiltration measurements are being taken on an increased scale.

43. The Head of the Division has also paid a number of advisory visits to the Territories, usually on problems concerned with the effect of changes in land use on water supplies.

44. The Plant Physiologist has prepared maps of the reliability of the long rains in Kenya and this work has been helped by Miss Kenworthy, a post-graduate student from Oxford University. His studies of the effect of drought in maize have shown that severe wilt causes closure of the stomata of the leaf and low, or even no, carbon assimilation so that the ability of the plant to make starch for further growth and grain production is markedly impeded and this impedence persists beyond the period of duration of the drought. Such studies of drought are being extended to include sorghum and the pasture grasses. The study of drought in the latter will be carried out in conjunction with an officer of the Kenya Government Grassland Research Station.

45. The Chemical Division, in conjunction with the Spectrochemist, has continued the analysis of soils and plants from fertiliser experiments made by the Territorial Departments of Agriculture with the object of finding improved chemical methods for predicting the response of crops to fertilisers. Work is now being undertaken to determine the factors governing the decomposition of soil organic matter. Laboratory and field studies have shown that with each recurrence of the rains, or rewetting of a dry soil, a short period of active decomposition (with the concomitant liberation of nitrate) occurs, followed by a much slower rate as moist conditions continue. The magnitude

of decomposition during the active period depends on the kind of soil and the intensity of drying prior to wetting. These observations have revealed a principle of fundamental importance in humus decomposition and soil fertility as affected by climate, soil, burning, ploughing, fallow, etc. It appears that decomposable organic material can be retained within the clay particles and protected from microbial attack, and that the release of this protected material, in fractional amounts, depends on the cycle of soil drying and rewetting.

46. Work has continued on the sulphur status of African soils with particular reference to the factors encouraging the production of sulphates during the decomposition of soil organic matter, for the sulphate status of many soils here is suspected of being rather too low for good plant growth. The results so far obtained are unexpected and not readily explainable. Work on the sulphur status of Lake Victoria muds has been continued and it has been shown that although the lake water is very low in sulphate, the bottom muds are high in organic forms of sulphur, and they contain no sulphides, but surprisingly sulphates absorbed in a form preventing them being reduced to sulphides. This behaviour is in sharp contrast to the lake muds of temperate regions. This sorption appears to occur in the presence of calcium ions on the diatomites which are present in some of these muds.

47. The Spectrochemical Division undertakes the routine determination of the major cations concerned with plant growth in both soils and plants. In addition the contents of 15 elements, including all the elements except nitrogen and sulphur, known to be important for plant growth have been determined on a number of soils and plants. Some of these have been submitted by the Territories because something appeared to be wrong with the crop growing on a given site, and the rest form part of a general study of the usual range of these elements found in East African crops. Typical soils from the major agricultural areas are being analysed as the first stage in a survey of the trace element status of East African soils. Developments in spectrochemical technique are being studied with the object of increasing the range of elements and samples covered and speeding up the output of data for survey studies.

48. The Soil Survey Division has continued work on producing a new, more detailed, soils map of East Africa to replace Milne's map of 1936. The work involves both the collection of data in areas inadequately surveyed, and also the examination of the most suitable ways of classifying the soils.

49. The Microbiologist arrived just before the period covered by this report, and has started work on problems relating to the production of nitrates in soils and on some problems concerned with the fixation of nitrogen by lucerne. Studies have also been started on problems connected with the successful inoculation of legumes in local soils.

50. He also spent five weeks at Kawanda, Uganda, helping the chemistry department there with a new technique for estimating the numbers of nitrifying bacteria in soil.

51. The Plant Breeding Division has continued its work on testing the value of the Brieger method for improving the yields of local maizes under East African conditions. But most of the work of this Division and some of the Plant Pathology Division is concerned with breeding cassavas and maizes resistant to certain diseases, and this work is being extended to sorghums in a co-operative scheme between an E.A.A.F.R.O. and a Tanganyika Department of Agriculture plant breeder at Ukiriguru. The cassava work has been centred at Amani for many years, and is concerned with resistance to the virus diseases of mosaic and brown streak. The next stage is to test the most promising Amani clones, or seed from promising crosses, at a number

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of Territorial centres to see which are worth bulking up and issuing to African farmers, and this work is now under way.

52. The maize work is mainly concerned with the genetics of resistance to Central American Maize Rust and has involved an extensive testing programme of the resistance of new crosses produced by Territorial plant breeders. Work is also in progress in breeding for resistance to the streak virus in maize.

53. The Pathology Division is also working on the viruses of sweet potatoes. It has been established that there are two distinct viruses, transmitted by different insects, one of which exists in a number of strains of varying virulence. Many weeds and crops are being tested as alternative hosts to these viruses, to establish if any are acting as an important reservoir of the virus in areas where sweet potatoes are temporarily not grown.

54. The work of the East African Plant Quarantine Station has steadily increased during the year and has handled consignments of Sugar Cane, Sweet potato, *Begonia*, *Chrysanthemum*, Dahlia, and *Cynodon dactylon*. Of these Sugar Cane has constituted the larger proportion. Ten new varieties have been released and a further 22 still remain in quarantine. One complete consignment of Dahlia was destroyed owing to the presence of Tomato Spotted Wilt Virus, which is still unknown in East Africa.

55. Following the termination of the Ecological Training Scheme the Ecologist has been largely concerned with preparation of arrears of data for publication. These have included detailed records of burning experiments of the Forestry Department, Northern Rhodesia, which have an important bearing on the ecology of *Brachystegia-Isoberlinia* woodlands in East Africa. A joint account with C. F. Hemming covers soils of the south Turkana region of Kenya, with observations on their vegetation, and further studies in vegetation-soil relationships are in progress. In connection with these a study has been made of structural differences in soils of the red earth order, which had become apparent during work in Nyasaland and have proved to be of much wider application. Vegetation reconnaissances for advisory purposes were carried out in western Kenya.

56. The Silviculture Division, in conjunction with the Horticulturist, has continued work on the techniques of raising tree seedlings in the nursery, the most suitable methods for planting them out either in transplant beds or in the forest, and obtaining and planting further plots of different species or strains of trees in the Arboretum. The Silviculturist has been writing up five years of experimental work on these subjects. He has also organised a further Course for Forest Officers held partly at Muguga and partly at Molo, and has extended the work of the Forestry Information Bureau by issuing a series of notes of recent work done elsewhere likely to be of interest to the Territorial Forest Officers. The Horticulturist has visited a number of forest nurseries in the Territories, at the request of the Chief Conservators, giving short courses on nursery practice and techniques, which are based on the results of the experimental work done at Muguga.

57. In July, 1956, the Silviculturist visited the Centre Technique Forestier Tropical at Nogent-sur-Marne, near Paris, and also attended the 12th Congress of the International Union of Forest Research Organisations at Oxford.

58. The Forest Entomologist has continued to give help to the Territories on the identification and control of any potentially harmful forest insects, and in co-operation with the Territorial Departments has continued supervising the collection and where possible the identification of insects found in the forests. He is also preparing a check list of all the insects so far found, with their identification when this can be given.

59. The staff of the East African Herbarium has been kept very busy on the naming of botanical specimens sent in from the Territories, particularly by officers engaged in vegetation surveys. In addition all the staff have spent some time in the field themselves collecting in different areas. The Herbarium staff is also giving assistance to the Royal Botanic Gardens, Kew, in the writing or compiling of the Flora of Tropical East Africa, and to other authors who are writing books on the plants of East Africa.

60. The Animal Industry Division, directed jointly by E.A.A.F.R.O. and E.A.V.R.O. lost the Head of the Division, Dr. M. H. French, by retirement half way through the year. The side of the work on which the E.A.A.F.R.O. members are mainly engaged concerns the composition of grasses at different stages of maturity, the digestibility of the nitrogen compounds in fodders, the preliminaries necessary to start a study on the heritability of the various parts of a Zebu steer which go towards a good beef carcass and carcass analysis of both indigenous and exotic stock. A programme for determining the conversion efficiency of pigs on different rations, that is the amount of food consumed per pound of liveweight gain from weaning till ready for the bacon factory has made good progress, and much interest has been shown by Kenya farmers in the results of including cassava in the rations.

61. In addition, two Colonial Development and Welfare Schemes have been attached to E.A.A.F.R.O. One allows for a survey of the principal cereal insect pests, particularly borers and shoot flies, in East African cereals, though mainly in maize and sorghum. The other is a survey of the damage done by plant disease nematodes in East Africa. Both these schemes will run for two years, and have only been started in the course of this year.

62. *Nematode Survey.* Mr. A. G. Whitehead, Colonial Research Fellow, has undertaken two long safaris in Uganda and Tanganyika respectively. Sixteen genera of known and suspected plant-parasitic nematodes have been found associated with East African crop plants. Nematode damage is both heavy and widespread and nearly all major economic crops are attacked as well as many minor crops.

63. *Survey of Sorghum Pests.* Dr. I. W. B. Nye of the Colonial Pool of Entomologists based at the Commonwealth Institute of Entomology, is spending two years in East Africa carrying out this survey in co-operation with departmental entomologists, and has begun field studies in all three Territories.

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East African Veterinary Research Organisation

64. The outstanding event of the year 1956-57 was the Opening of the new Laboratories and ancillary buildings of E.A.V.R.O., Muguga North, on the 21st February, 1957, by His Excellency, Sir Evelyn Baring, Governor of Kenya and Chairman of the East Africa High Commission. The ceremony was attended by some 350 guests from all parts of East Africa and was a notable and most successful occasion.

65. Although the new Laboratories had been completed towards the end of 1954, an official opening had been deferred until the scientific staff of the Organisation had been built up to a reasonable level. Good progress has been made in recruitment during the year and the scientific staff is now at 75 per cent. of full strength, comprising 17 Research Officers and 12 Laboratory Technicians. Six Research Officers have joined the Organisation in 1956-57, three of whom are men with some ten years experience in the branches of science in which they will be working in E.A.V.R.O. These officers and the work they will be doing are described below.

66. G. R. Scott was appointed as Senior Virologist and Head of the Division of Virus Diseases towards the end of the year, and is engaged mainly on rinderpest research. W. Plowright joined the Organisation as Pathologist and is doing research on pathology of major East African diseases, and carrying out studies on the pathological changes caused by viruses in cells grown in tissue culture. G. D. Phillips was appointed Physiologist, after holding a Colonial Veterinary Research Studentship at the University of Liverpool and the Rowett Research Institute, and is doing research on ruminant digestion, particularly comparisons between Zebu and exotic cattle. G. M. Urquhart joined the staff at the beginning of 1957 as Helminthologist. He will study diseases caused by helminths in East Africa, and is concentrating initially on research on fascioliasis and paramphistomiasis by clinical, pathological, epidemiological and experimental investigations. G. White was appointed as Bacteriologist, after a year at the Ministry of Agriculture Veterinary Research Laboratory at Weybridge on a Colonial Veterinary Research Studentship, and will do research on calf diseases and caprine pleuropneumonia. J. F. Griffiths, Bioclimatologist, was transferred from the Desert Locust Survey, and is to work on environmental physiology, particularly the influence of solar radiation on livestock.

67. Various lines of research on rinderpest have been carried out during the year. The most important contribution to research on rinderpest hitherto made by E.A.V.R.O. is the successful cultivation of virulent virus in bovine kidney cells by W. Plowright and R. D. Ferris late in 1956. They have made 17 serial passages in tissues culture, and have shown that the rinderpest virus is cytopathogenic and that these cytopathic effects can be neutralized by sera from rinderpest immune cattle, goats, hamsters and rabbits. The virus has also been cultivated in bovine embryonic testis. These are findings of great significance, which are being energetically followed up. G. R. Scott's work has included studies of virus which he has adapted to the hamster. At the end of the year he was successful in adapting two strains of rinderpest to the laboratory mouse; this is a notable advance, for numerous workers have attempted in the past to infect mice with rinderpest. R. D. Brown has been investigating the passive immunity of calves acquired from immune dams, in order to determine when such calves may be effectively immunised with attenuated virus vaccines in field campaigns—a problem which is becoming progressively more important as rinderpest is brought under control and vaccination confined to the annual calf crop.

68. Research has recently been started on two other important virus diseases, African swine fever and Rift Valley fever, and significant successes

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have been achieved. The virus of Rift Valley fever has been propagated in sheep kidney cells with pronounced cytopathogenic effects and work is being done on the development of a serum neutralization test. At the end of 1956 Rift Valley fever was adapted to the hamster by G. R. Scott.

69. African swine fever virus has been propagated in tissue culture by R. D. Ferris and D. E. DeTray, of the United States Department of Agriculture, using embryonic pig kidney cells, but hitherto cytopathogenic effects have not been observed. This work is being continued as part of the co-operative research with the U.S. Department, on African swine fever, which is described later. This will include studies of the virus in tissue culture and the developing egg, attempts to adapt the virus to laboratory animals, and the development of methods of laboratory diagnosis and immunisation.

70. S. E. Piercy, Deputy Director, and M. A. Witcomb have done considerable research on the development of an avianised rinderpest vaccine. Towards the end of the year, G. R. Scott began work on the elaboration of an adjuvant killed vaccine for rinderpest.

71. The production of the attenuated rinderpest virus vaccines was continued by S. A. Evans and C. S. Rampton. Largely due to the widespread immunisation campaigns against rinderpest carried out in Tanganyika during the past two years, the territory has been free of the disease since July, 1955—a situation without precedent since the great panzootic of the 1890's. In consequence, the requirements for vaccine of Tanganyika have been much reduced and there has been a corresponding decrease in the issues of vaccines by E.A.V.R.O. During the year 4,410,035 doses of K.A.G. virus vaccine and 402,900 doses of lapinized virus vaccine were sold.

72. Research on contagious bovine pleuropneumonia has consisted of two main lines of work, namely the development and improvements in avianized vaccine and studies on the serology of the disease. S. E. Piercy and G. J. Knight have done much work on improvement in the avianized vaccine first developed by Piercy and Sherriff at Kabete. This has consisted of studies on the organism in the developing egg and the application of these findings to improved vaccine preparation, as well as investigations on production techniques. C. R. Newing and A. K. MacLeod have developed a culture method by vortex aeration and an improved culture medium, which have resulted in much increased yields of the organism. They have applied these techniques to the production of a better antigen for the slide agglutination test, and to the elaboration of an improved complement fixation test for the disease. They have found that vortex aeration also produces greatly increased yields of *Pasteurellas*, a finding which has proved of considerable value in the preparation of vaccines by other institutions.

73. S. F. Barnett and his Division have continued their long-term research on East Coast fever, and particularly the nature of the disease in Zebu cattle, including the factors which determine susceptibility and resistance, and the duration of immunity, and the influence of tick numbers on the diseases. It has been found that the course of the infection depends on the number of ticks infesting the animal, but more particularly on the genetic history of the calf. Calves of exotic breeds and of Zebu stock from areas free of E.C.F. are highly susceptible, while those of immune stock show considerable resistance.

74. Results of much importance have been obtained by Dr. Barnett and P. Bailey from research on the treatment of E.C.F. by the oral administration of Auofac, a by-product of the manufacture of aureomycin. If Auofac is given at an appropriate dose level on the day on which E.C.F. ticks are first infested on to a calf, and this treatment is continued throughout the full period of a normal E.C.F. reaction, the disease is largely suppressed and the calf passes through a mild or almost undetectable infection and is thereafter

solidly immune. These findings apply to exotic and Zebu calves, and to grade yearling cattle. This method, although still somewhat expensive, promises to produce a practical means of immunising valuable stock against E.C.F., provided it is used in properly controlled conditions where the infestation of cattle with ticks can be satisfactorily carried out.

75. Miss J. B. Walker's research on ticks has included further laboratory studies on East African species and the completion of studies on the systematics of *Rhipicephalus pravus* and *R. humeralis*. She has done much work on the identification of collections of ticks submitted by the territorial Departments which is of considerable value for determining the distribution of the disease-transmitting species of East Africa.

76. Before proceeding on leave in June, Dr. J. A. and Mrs. Dinnik continued their researches into the systematics, distribution and life-histories of the stomach flukes of ruminants and liver flukes. Research on the development of liver fluke in molluscan and mammalian hosts was continued. This work was resumed on their return at the end of the year.

77. The Pathology Division of E.A.V.R.O. was established in the middle of the year with the appointment of W. Plowright as Pathologist. He and W. G. MacLeod have started long-term studies on the morbid anatomy, histopathology and pathogenesis of the major East Africa diseases of livestock. Relatively little knowledge has been acquired in the past on these subjects, which are of considerable importance to the understanding of these diseases. Much pathological material has already been obtained for study, and the accumulation of specimens from natural and experimental cases of disease will be continued to build up a major collection of pathological material for research and reference.

78. Towards the end of 1956 it was decided that the joint Animal Industry Division of E.A.V.R.O. and E.A.A.F.R.O. should be abolished and replaced by separate new Divisions of the two Organisations; the E.A.V.R.O. Division will be designated the Animal Production Division.

79. G. D. Phillips, one of the Physiologists who will work in the new Division, established and equipped a laboratory for research on ruminant digestion. This work will include highly fibrous fodders, studies on microbial activity in the rumen by manometric techniques, and research on the passage of food through the alimentary tract. In these several lines of research, comparisons will be made between indigenous and exotic breeds of stock.

80. A. Rogerson, the E.A.V.R.O. Nutrition Chemist, continued his investigations into the nutritive value of a number of feedingstuffs and studied green as well as dried herbage. He introduced a new technique into the estimation of feeding values of actively growing green feedingstuffs and has investigated the application of this to East African conditions. By combining a study along classical digestibility lines with bomb calorimetric determinations, it is hoped that a short method of assessment will be evolved capable of meeting conditions in the wet season in East Africa.

81. A number of valuable visits of some duration to E.A.V.R.O. by scientists from overseas occurred during the year, or have been arranged for the near future, in accordance with E.A.V.R.O. policy of encouraging such visits by experienced scientists wishing to work at Muguga on subjects falling within the broad research programme of the Organisation. The most important of these is a scheme recently agreed by the High Commission and the United States Department of Agriculture for co-operative research on virus diseases of animals to be carried out at Muguga by E.A.V.R.O. and the U.S. Department. This was initiated on the 1st January, 1957, and is planned to last for several years. Two experienced virus research workers

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have already been posted to E.A.V.R.O., Dr. D. E. DeTray and Dr. W. Malmquist. It is the intention that these officers shall change periodically, but each will probably spend about two years with the Organisation. The U.S. Department will meet the cost of the salaries and certain research expenses of these officers, and also pay an agreed annual sum to the High Commission in respect of technical and other services rendered by E.A.V.R.O. The project will concentrate in the first instance on African swine fever, which is the exotic disease of pigs which causes the greatest concern to the American authorities, due to the possibility of introduction by rapid air transport. Research on other important virus diseases will be undertaken in future, as shall be mutually agreed.

82. Dr. F. Hawking, of the National Institute for Medical Research, Mill Hill, spent three months in E.A.V.R.O. carrying out research on the propagation in tissue culture of *Theileria parva* and *Theileria annulata*, with a view to developing a method of preliminary screening of drugs for therapeutic effect in East Coast fever. Mr. D. W. Brocklesby of E.A.V.R.O. worked with Dr. Hawking and is continuing and extending this research.

83. Arrangements were well advanced at the end of the period under review for a visit of several months duration by Professor R. E. Hungate, Chairman of the Department of Bacteriology in the University of California, who is one of the world's leading authorities on ruminant digestion, and who will carry out research at Muguga in this field, comparing indigenous Zebu and exotic cattle. This work will be done in collaboration with Mr. G. D. Phillips.

Publications

H. R. BINNS—"The East African Veterinary Research Organisation—Its Development, Objects and Scientific Activities".

J. A. DINNIK and N. W. DINNIK—Observations on the succession of redical generations of *Fasciola gigantica* Cobbold in a snail host. *Z. Tropenmed, u. Parasit.*, **7**, (1956) 397-419.

S. E. PIERCY and G. J. KNIGHT—Studies with avianized strains of the organism of contagious bovine pleuro-pneumonia. Part 3. A further examination of growth and modification in embryonated eggs, *Vet. Rec.*, **68**, (1956) 367-373.

W. PLOWRIGHT and R. D. FERRIS—Cytopathogenicity of rinderpest virus in tissue culture, *Nature, Lond.*, **179**, (1957) 316.

JANE B. WALKER—*Rhipicephalus pravus* Donitz, 1910, *Parasitology*, **46**, (1957) 243-260.

Flora of Tropical East Africa

84. Work on the Flora of Tropical East Africa has progressed satisfactorily during the year, but there have been delays in printing finished parts. Parts published during the year include the *Calennaceae*, *Caryophyllaceae*, *Connaraceae*, *Menispermaceae* and *Rhizophoraceae*. Work is proceeding on *Leguminosae*, which is one of the largest families, and the part of it dealing with the *Mimosoideae* is now nearing completion. Work is also nearly finished on the *Celastraceae*, *Sapotaceae*, and the *Loganiaceae*, whilst the accounts of the *Gymnospermae* and several small families are about ready for press.

85. Certain specialists, both within and outside Kew are contributing to the project, and mention should be made of Mr. R. Ross, Dr. B. Schubert, Dr. G. Troupin and Dr. B. Verdcourt whose help is greatly appreciated.

whilst the closest co-operation with Dr. P. J. Greenway and the East African Herbarium continues as hitherto.

86. During the year Mr. Milne-Redhead, one of the joint editors of the Flora, and Mr. P. Taylor made extensive collections largely in the Songea District of Southern Tanganyika totalling nearly 5,000 gatherings. Many of the plants they collected were new to East Africa, being species more familiar to workers on the flora of Nyasaland and Northern Rhodesia.

(b) CENTRAL AFRICA

Flora Zambesiaca

87. No satisfactory flora exists of the great Zambesi basin in Central Africa. Prolonged consideration of a proposal for such a flora has now resulted in a project which will embrace the territories of the Federation of Rhodesia and Nyasaland, Bechuanaland and the Portuguese territory of Mozambique. Difficulties arising from differences in administration between the territories involved have been satisfactorily resolved thanks to their ready co-operation, particularly from the Government of Portugal. A grant from C.D. & W. Research funds has been made on behalf of Bechuanaland but the other territories have generously contributed their share and have helped with the loan of botanists on their staff. The authorities of the Royal Botanic Gardens, Kew, and the Botanical Department of the British Museum (Natural History) have greatly helped in bringing this project to a satisfactory beginning.

88. Thanks to much preliminary work which had been done before the start of this project, notably that in the British Museum and by Portuguese botanists, several plant families are already completed. These include the *Tiliaceae*, *Ranunculaceae*, *Elatinaceae* and the *Polygalaceae*. Work is well in hand on the *Capparidaceae*, *Hypericaceae*, *Menispermaceae* and *Dipterocarpaceae*. The first volume is expected to appear in 1958.

(c) MEDITERRANEAN

Flora of Cyprus

89. Drafts of the families *Ranunculaceae*, *Berberidaceae*, *Papaveraceae*, *Fumariaceae*, *Malvaceae*, and part of *Cruciferae* have been completed and typed; the remaining part of *Cruciferae* will be ready shortly. A complete card-index of Cyprus plant records has been prepared, and the two assistants for the Flora are at present working through herbarium material at Kew, separating Cyprian specimens from the general Oriental collections.

(d) WEST AFRICA

West African Standing Advisory Committee for Agricultural Research

90. The West African Standing Advisory Committee for Agricultural Research held its second meeting in Accra in 1957. The Secretariat for West African Agricultural Research continued to assist in the preparation of documents on inter-territorial research and the Inter-territorial Secretariat administered a number of research schemes. Constitutional changes in West Africa have entailed corresponding alterations in the form of research provisions. An Anglo-French Research Conference on Oil Palms was held at Abijan, Ivory Coast, and preparations are in train for the fourth Anglo-French Research Conference, to be held at Samaru, Northern Region, Nigeria, on Cotton in 1957.

West African Cocoa Research Institute

91. The search for alternative hosts of cacao viruses has revealed further natural infections of the silk cotton tree, and additional evidence to suggest

that the baobab tree has contributed to the spread of swollen shoot in Ghana. A small degree of resistance to virus infection has been confirmed in certain types of Upper Amazon cacao, but tolerance appears to be more generally found than resistance. In Nigeria, work on coppicing has led to the adoption of a more economical cutting-out procedure for the treatment of virus outbreaks. Preliminary experiments on the insecticidal control of ants attending mealybugs in mature cacao have given promising results, and large-scale trials to investigate the effect of formicidal spraying on mealybug activity and the spread of virus disease, have been organised.

92. The use of copper fungicides has given good control of black pod disease, and the effectiveness of frequent harvesting as a control measure has been demonstrated. Particular attention is now being paid to methods of application and timing of spraying. Studies on cushion infection suggest that, while the direct contribution to pod loss may be relatively small, infected cushions may play an important part in carrying over the fungus from crop to crop.

93. Comparative tests have stressed the importance for capsid control of insecticides having a fumigant action, such as BHC or Aldrin. Using BHC good results have been obtained with a portable fogging machine and a hand-operated pressurised knapsack-sprayer; routine spraying has been introduced throughout the Institute's experimental area. The effect of control measures on pollinating insects is being investigated. Biological studies have included observations on oviposition habits and on the capsid population cycle during the year.

94. The general lack of response in previous experiments on fertilizer application has led to a more detailed examination of nutrient uptake under controlled shade conditions. Radio-active phosphorus is being used to study phosphate accumulation. Small but significant responses to superphosphate treatment have been recorded in trials with Upper Amazon cacao. An extensive survey of the effect of declining soil fertility on the economic life of bearing cacao is in progress.

95. Variety trials in Ghana show Upper Amazon cacaos to be growing more vigorously than Amelonado everywhere. Similar trials, and trials of crosses between Upper Amazons and local hybrids, have been planted in Nigeria.

96. A study of fermentation methods has indicated that successful results can be obtained within fairly wide ranges of batch size, duration of fermentation, and frequency of turning. A better understanding of the fermentation process is developing from investigations of the biochemical reactions involved.

Publications

A. D. MCKELVIE—Cherelle Wilt of Cacao, I. Pod Development and its Relation to Wilt. *J. exp. Bot.* 7 (1956) 252.

R. G. DONALD—The Natural Enemies of some Pseudococcidae in the Gold Coast. *J. W. Afr. Sci. Ass.* 2 (1956) 48.

West African Institute for Oil Palm Research

Agronomy Division

97. Investigations on the establishment and care of nurseries expanded during the year. Nurseries in West Africa are still often patchy and the seedlings are uneven in growth. Although this is partly due to disease incidence it is considered that improvements can still be made in planting technique. In addition, there is the special problem of raising nursery seedlings in areas of heavy cultivation. The latter problem is being tackled

in the permanent site nursery experiments at the Main Station, Ogba and Abak. The results of the second planting of two of these experiments were obtained during the year and the value of watering and of applications of mulch and bunch refuse were confirmed. On the poorer of the two sites positive effects of potash and phosphate were found.

98. Several other lines of investigation intended to improve the growth and health of nursery seedlings were in progress during the year. These included trials of different methods of planting, comparisons of grass and bunch refuse mulches in combination with sulphate of ammonia, an investigation into the effect of varying the pH of the soil, and a trial of three different methods of irrigation. An experiment designed to test the effect on subsequent growth of time of germination, and hence the length of time a seedling spends in the raised trays, showed that the usual spacing of 1½ inches in the raised trays is too close for early germinated seeds. Transplanting experiments reached the stage when it became possible to issue an advisory leaflet dealing with the new root pruning technique. A root pruning experiment was laid down at Njala in Sierra Leone.

99. Increased attention was given to manurial experiments and a whole issue (No. 5) of the Institute's Journal was devoted to the subject. In addition to a review of all past manurial trials in Nigeria, a special account was written of an experiment at Umudike in which responses to a single application of potash have been maintained over a period of seven years.

100. Much consideration was given during the year to the problems of intercultivating oil palms with food crops. Previous experiments have shown that, although intercultivation has a beneficial effect on early yields, soil fertility, and later bunch yields, may be reduced. Cultivation and manurial systems need to be devised whereby soil fertility, food crop yields and palm bunch yields can all be maintained.

Chemistry Division

101. Soil variability studies to discover satisfactory methods of soil sampling in oil palm fields were started. Results showed that the variability of potassium was far higher than that of the other determinations made; the next highest was organic matter, while pH was a comparatively stable value. The results of this investigation will be of considerable value in all future soil studies.

102. Tests of Vanderweyen's method of estimating mesocarp oil content by determination of the moisture content were completed. The results confirmed that this method is suitable for routine determinations and it is now in use in the Plant Breeding Division. Work was started on the colour and bleachability of palm oil in conjunction with the Colonial Products Laboratory.

Plant Breeding Division

103. The investigation of controlled pollination methods has now been concluded. It has shown that present methods are satisfactory for large scale use but that whenever pollen for important breeding programmes must be stored for long periods, special storage conditions of temperature and humidity are required.

104. New standards have been devised for the selection of seed trees for Extension Work Seed production. The new standards give recognition to the fact that so long as both oil and kernels are being produced, it is a low shell content which is the main characteristic of a good fruit. The fruit from large areas at the Main Station from which seed palms are being selected is characterised by a comparatively high kernel content. At present

prices kernels are more valuable than mesocarp, so that to neglect palms which have a high kernel content and a low shell content, though a comparatively low mesocarp content, would be to discard valuable material. Another factor of importance is the height of the palm. A tall palm is not only difficult to harvest but it will probably be giving a yield which is higher than that of the surrounding palms mainly because it is obtaining more than its fair share of sunlight. The factors which are now being taken into account are therefore: (1) shell content of fruit, (2) yield, over a 10 year period, of "productive material" i.e. mesocarp and kernel, (3) yield of productive material per foot of height. Palms with a high production of palm oil are not being neglected. Many of the *tenera* seed trees, even in the areas of high kernel content, have over 70 per cent. mesocarp and individual palms with nearly 80 per cent. are not uncommon. A routine method of determining mesocarp oil content is now in use.

105. The Institute has accumulated, over the last fifteen years, many records of leaf and flower production. The figures most recently examined confirm earlier findings on the effect of climate on inflorescence production. Briefly, it has been shown that the amount of dry season rainfall is of considerable importance as it is correlated both with the average sex ratio (female inflorescences to total inflorescences) over the whole flowering cycle and with the intensity of the peak (maximum value) of the sex ratio. It has also been found that the progenies of certain palms are able to adapt themselves to a drier climate more readily than other progenies.

106. The planting of the concentration areas of just under 100 acres with progenies of *dura* and *tenera* palms selected at the Ufuma and Aba Selection Stations was completed. The object was to transfer to the Main Station progeny of all the best material existing at the selection stations, which were then closed down.

107. Another programme which reached the planting stage in 1956 was a series of *tenera* x *pisifera* crosses for the production of *pisifera* palms from high yielding parents for future breeding and seed production. Twenty-three acres were planted.

Plant Nutrition Division

108. On the recommendation of Dr. E. J. Hewitt of Long Ashton Research Station, it had been decided to set up a plant nutrition unit for the determination of nutrient deficiency symptoms. It is hoped that the unit will be fully equipped and in operation before the middle of 1957.

109. That the leaf symptom known as "Orange Frond" is caused by magnesium deficiency was first discovered in 1953 at Calabar Oil Palm Estate. A fertilizer experiment has now shown that the deficiency disease can be cured, and bunch yields thereby increased by soil applications of magnesium sulphate.

Plant Pathology Division

110. The Division is still concerning itself almost entirely with nursery diseases of which the most important is Blast disease. This disease kills many seedlings outright and its incidence has been increasing at the Institute's Main Station in recent years. Two fungi have been frequently isolated from the roots of plants suffering from Blast. These are *Rhizoctonia lamellifera* and *Pythium splendens*. Either or both of these fungi may be the cause of Blast disease and investigations are continuing.

111. The other diseases being tackled are the leaf diseases Anthracnose and Freckle. Experiments with fungicides showed that it is possible to achieve a good measure of control of Anthracnose by spraying with Ziram and

Thiram creams in the pre-nurseries (raised trays) and by reducing the density of the seedlings in these pre-nurseries. The most efficient fungicides tried against Freckle were Ziram powder, Dithane and Perenox.

Plant Physiology Division

112. Studies on germination have shown that, apart from the need for high temperature, the important limiting factor in germination is the oxygen supply to the embryo. Further experiments with kernels showed that the optimum range of temperature is 38–40°C, while the rate of germination was found to increase with oxygen concentration up to 1.75 atmospheres of pure oxygen. Under an oxygen pressure of two atmospheres, however, most of the kernels were killed. Attention was then turned to the rôle of the shell in germination and it was found that, for maximum germination, there is an optimum in the moisture range. This optimum is about two-thirds of the amount of water required to saturate air-dry nuts. It has been found possible therefore to germinate nuts without any medium provided the optimum moisture content of the shell is maintained. With nuts depulped by hand, this can be done quite simply by eye, as the colour changes with increasing moisture are very clear. With nuts depulped by the usual retting process, however, the colour differences are not so distinct. An experimental germinator which will embody very fine controls of temperature, humidity and aeration is now being built so that practical methods of making use of these findings may be worked out.

West African Rice Research Station, Rokupr

113. The arrival of the Soil Microbiologist in January, 1956, completed the establishment of specialist officers. The Soil Chemist resigned his appointment later in the year.

114. Botanical work included the growing of some 450 rice varieties, 170 for the first time. An investigation was started into methods of keeping rice seed viable for up to three years. Desiccation followed by storage in a sealed container in a refrigerator has kept seed viable for twelve months.

115. A phenological investigation started on the factors influencing duration in rice. This work is not complete yet, but preliminary results suggest that temperature may be an important factor. Work on statistical investigations of the experimental methods which will show yield differences best on the rather variable Rokupr soils continued, and work commenced on the development of a small rice drier.

116. Soil Chemical work has again been concentrated on the problems connected with the cultivation of cleared mangrove soils. Seasonal fluctuations in acidity have been clearly demonstrated in these soils, and have been shown to be accompanied by fluctuations in the concentrations of extractable iron and aluminium present. These ions are likely to be responsible for the toxicity of some empoldered mangrove soils. On the other hand, a striking feature of the fluctuations is that many soils which contain toxic concentrations of iron and aluminium during the dry season become cultivable during the subsequent wet season. In view of this it might be an advantage to delay planting rice in acid soils for as long as possible after the beginning of the wet season.

117. A specific investigation of the tolerance of the rice plant to acid conditions has enabled the limit of acidity for good rice growth to be fixed. Below this limit lies a range of soil acidity in which rice does not die, but in which yields are reduced owing to lack of tillering of the plants. Although, in general, liming of acid mangrove soils has been shown to be uneconomic,

soils of marginal acidity might be improved to a large extent by only a small dressing of lime.

118. The survey of an empoldered mangrove area which was begun in 1954 has been completed. In addition to contributing to the conclusions mentioned above, the work has given information on the recognition of areas likely to become toxic on empoldering, and on the soil conditions with which toxicity is associated. The work provides a basis for the subsequent investigation of the actual mechanisms of sulphur accumulation and acid formation.

119. Certain aspects of the microbiology of mangrove soils have been investigated. Emphasis has been laid on the mechanisms by which acid is formed in these soils, and evidence has been obtained which indicates that the process of acid-formation is carried out, at least in its final stages, by micro-organisms. The activities of the sulphur-oxidising bacteria have been shown to be of importance in this respect. Chemical analyses of soil and river water have been made to determine the source of sulphur involved. Preliminary investigations have been carried out to discover the part played by sulphate-reducing bacteria and iron-oxidising bacteria in seasonal soil changes.

120. Arborescence trials were laid down in the Scarcies areas, by an officer of the Colonial Pesticides Research Unit, on the use of chemicals to kill mangrove and also the grass *Paspalum vaginatum*. This work is not yet complete but already, after ten months, 4 per cent. 2, 4-D in diesel oil has given a good kill on the mangroves. Dalapon at 40 and 80 lbs./acre has given a 100 per cent. kill with no regrowth on the grass.

Publications

T. E. TOMLINSON—Relationship between Mangrove Vegetation, Soil Texture and Reaction of Surface Soil after Empoldering Saline Swamps in Sierra Leone. *Trop Agric. Trin.* 34 (1957) 41.

T. E. TOMLINSON—Changes in a Sulphide-containing Mangrove Soil on Drying and their effect upon the Suitability of the Soil for the Growth of Rice. *Emp. J. exp. Agric.* 25 (1957) 108.

T. E. TOMLINSON—A seasonal Variation of the Surface pH value of some Rice Soils in Sierra Leone—in the press.

H. D. JORDAN—Crabs as Pests of Rice on Tidal Swamps, *Emp. J. Exp. Agric.* 25 (1957) 197.

West African Maize Research Unit

121. During the year the Unit has been running on restricted funds and the opportunity has been taken of concluding a number of primary research projects; others which were envisaged have been placed on a care and maintenance basis and the building of glasshouses designed for rust and Helminthosporium testing is in abeyance. This has had an adverse effect on the breeding programme.

122. With the arrival of Mr. C. L. M. van Eynatten (Plant Breeder) in May, 1956, a full establishment was achieved. Work has continued with the introduction of the rust resistant genes from the Mexican series and field observations on other Central American maize varieties.

123. A preliminary analysis of material from the West African Maize Survey has shown the importance of anthropological factors such as the origin of tribal groups, trading patterns and agricultural practice within tribal groups on maize type selection. Differences are also apparent between maize types from different ecological zones. Evidence is accumulating that guinea corn traditions were applied to maize when this crop was introduced.

124. Studies have continued with an automatic volumetric spore trap at Ibadan. Diurnal and seasonal patterns of the fluctuations in atmospheric uredospore content have been established. Preliminary work on the prediction of the time of outbreak of rust by means of the air spore load has been encouraging and a value for the "epidemic threshold" has been established. It is hoped to extend this method to forecast outbreaks of rust and the expected severity of the attack.

125. The rust assay conducted in Nigeria and Ghana has been concluded and it is now known that the severity of rust attack is principally governed by two factors, temperature and humidity. Conditions most favourable to the rust are a mean temperature of approximately 80° F., a mean relative humidity greater than 80 per cent. and an annual rainfall within the range 50–100 inches. The assay has shown the rust to be most severe along the Guinea coast where conditions of consistently high humidity and high rainfall prevail and where temperatures are around 80° F. with a low diurnal and annual range. Towards the northern areas of the territories the rust becomes progressively less as temperatures become higher with a larger diurnal and annual range, average humidities lower and rainfall less. The behaviour of the rust in relation to climate has been supported by experiments on germination and infectivity in the laboratory and the greenhouse.

126. Seed dressings with thiram and BHC have given favourable results in preliminary trials in the field, with increased germination percentages.

127. Stocks of stem borer, *Busseola fusca* and *Sesamia botanophaga*, are being bred in culture and assistants are being trained in the technique of stock maintenance and egg implanting.

128. Experiment with a small air-conditioned chamber has shown that this is the most practical method of maintaining separate cultures of plants under controlled environment conditions, and is preferable to a complex conditioned greenhouse.

West African Timber Borer Research Unit—Investigations in West Africa

129. Consequent upon the reduction of the Senior Staff of the Unit to one officer, Mr. Tecwyn Jones, previous plans for the extension of investigations to Nigeria have not been realised. To minimise the effect of this regrettable restriction the programme of work for the past year has to a large extent consisted of the elucidation of these aspects of the Ambrosia beetle problem which it was considered would yield results generally applicable to both Ghana and Nigeria.

130. The further development of a programme of log protection has continued in the form of larger scale investigation than was previously employed. The appearance on the West African market of aldrin, dieldrin, endrin and gamma BHC in more suitable formulations for application to logs necessitated a re-assessment of the relative merits of these chemicals. Results have confirmed previous findings and indicated that gamma BHC is the most efficacious insecticide whether employed as a water emulsion, oil solution or when incorporated in a water-miscible paint. Water emulsions of gamma BHC were highly effective on both logs with bark intact and on logs devoid of bark whereas oil solutions of the insecticide were more efficacious on de-barked logs than on those possessing bark. When used as a water emulsion containing 0.5 per cent. active ingredient, gamma BHC provided 98 per cent. protection during the first few weeks after application to logs devoid of bark and this figure decreased to 90 per cent. over a period of ten weeks under conditions of heavy rainfall.

131. Investigations of the problem of preventing Ambrosia beetle attack on living seedlings and saplings were initiated as a result of a serious outbreak of infestation of young transplanted mahogany in the Central Provinces of Ghana. Two-year old seedlings of *Khaya ivorensis* had been severely infested by *Xyleborus mascarensis* and *X. semigranosus*, both hitherto unknown as borers of living trees, and heavy losses resulted. From observations it was concluded that the unusual conditions existing in the area of transplanting were responsible for this infestation. Several months prior to transplanting, all undesirable tree species in the area had been poisoned by sodium arsenite and these dying and dead trees permitted the build up of a very large population of Ambrosia beetles. As a result of emergencies the population density in the area was such as to cause considerable competition for breeding. The slight arrestation in growth of the transplanted mahogany permitted infestation to be established in the seedlings and, where the intensity of attack was such as to cause girdling of the stem, death of the host ensued.

132. Biological and ecological studies have included the accumulation of data on host-beetle relationships and the relative susceptibility of timbers. Investigations have extended to cover more than 60 timbers and the collection of beetle species and information on the distribution of species has increased considerably.

133. Investigations of the occurrence and duration of flight periods of Ambrosia beetles and the elucidation of factors controlling these periods of activity have shown that each species has well marked times of flight. The emergence of beetles from their host and the subsequent flight and establishment in new hosts occurs only when suitable conditions of saturation deficit and light intensity occur. Generally each known species is nocturnal, diurnal or crepuscular in habit i.e. appearing on the wing shortly after dark, during mid-day period or at dusk and dawn respectively and no variation from this rhythm of activity has been observed.

134. From the studies of life histories it has been established that the total length of life-cycle from egg to adult varies from 28 days in *Eccopterus sexspinus* to six weeks or more in *Trachyostus schaufussi*.

Investigations at Princes Riborough

135. Mr. J. M. Baker has continued his investigations on the oak pinhole borer, *Platypus cylindrus*, and its associated fungi. During the summer of 1956 additional oak logs were obtained for experimental infestation at the Laboratory and their subsequent attack by *Platypus* has yielded information on the behaviour of the insect and the development of its galleries, supplementing data obtained in the previous summer. Some work was undertaken on the mode of introduction of ambrosia fungi into the wood and interesting points have emerged. The initial fungal flora of the tunnel is established by the male beetle before the advent of the female but later, during the development of the brood, changes take place in the character of the flora.

136. Morphological and physiological studies are being made of the fungi associated with the beetle. The work is complicated by the fact that some of the fungi comprising the ambrosial complex can exist in widely differing growth forms and require special techniques for their study. A new set of feeding experiments was carried out during winter 1956-57 in which larvae were fed on specially prepared mats of fungus that had been separated from the culture medium and washed. This method had more success than the experiments made last year using fungus in culture for feeding larvae but it still proved impossible to rear the larvae through to adults under these artificial conditions and so to evaluate the relative nutritional importance of the different fungi.

137. Preliminary work on attraction was started. As is usual with ambrosia beetles, there is a selection by *Platypus cylindrus* of certain stumps and logs for attack whilst others are not attacked. Extractions of volatile organic substances from samples of attractive and non-attractive oak wood were made using a method of gas extraction based on that devised by Graham and Werner in Canada (*Bi-Month, Prog. Rep., Div. For. Biol., Sci. Services*, 12 (1) 1956). Highly scented extracts were obtained but in a small scale field experiment proved unsuccessful as bait in insect traps.

Publication

J. M. BAKER—Investigations on the Oak Pinhole Borer, *Platypus Cylindrus* Fav. Rec. 6th Conv. Brit. Wood Pres. Ass., Cambridge, 1956.

Flora of West Tropical Africa

138. Part 2 of Volume I, containing 53 families and occupying about 500 pages is expected to be published in 1957. In connection with this part Mr. R. W. J. Keay has published preliminary papers describing 26 new species and varieties and making six new combinations. The Supplement on Ferns and Fern Allies has been completed by Mr. A. H. G. Alston of the British Museum (Nat. Hist.).

139. Work on Volume II, part 1 (*Camopetalae*) is progressing. Mr. R. W. J. Keay has been occupied with the *Rubiaceae* and has undertaken a much needed and drastic revision of the numerous W. African representatives in the *Randia-Gardenia* complex. A number of other botanists are collaborating in the revision of certain groups which come into this part. Work on the *Scrophulariaceae* by Mr. F. N. Hepper of Kew, and on the *Compositae* and *Labiatae* by Mr. C. D. Adams and Dr. J. K. Morton respectively, both of the University College of Ghana, is well advanced.

140. A most welcome feature during the year has been the co-operation from French workers who have sent numerous specimens from various parts of French West Africa for study in connection with the F.W.T.A. revision.

Publications

BRENAN, J. P. M., and KEAY, R. W. J.—Nine new species of *Cola*, *Hooker's Icones Plantarum*, ser. 5, 6, tt. 3529–3537 (1956).

KEAY, R. W. J.—A new species of *Cassia* Linn. from West Africa, *Bull. I.F.A.N.* ser. A, 18, 375–376 (1956).

KEAY, R. W. J.—New taxa and combinations for the “Flora of West Tropical Africa”—I: *Linaceae, Euphorbiaceae, Icacinaceae, Santalaceae, Rutaceae, Meliaceae*; II: *Sapindaceae, Anacardiaceae*; *Bull. Jard. Bot. Brux.* 26, pp. 183–209 (1956).

KEAY, R. W. J.—African Vegetation: Yangambi Meeting; *Nature* 178, No. 4545, pp. 1273–1274 (1956).

Survey of the Aphids and White Flies of West Africa

141. On completion of the survey of aphids in East Africa (see para. 63 of 1955–56 Report) arrangements were made with the co-operation of the British Museum (Nat. Hist.) for Dr. Eastop to make a similar survey of aphids in West Africa but to include also the White Flies. Both these groups of insects include important pests and some are vectors of harmful virus diseases of crops. Dr. Eastop started work in Nigeria in 1956. It is expected that the survey will be completed during 1957.

*University College of Ghana**Soil Science*

142. Dr. Nye and Dr. Foster began an investigation, based on the use of radio-active phosphorus, into the feeding depths of annual and perennial crops and also of fallows, in order to study the utilisation of sub-soil phosphorus and to explain the mechanism of the "bush fallow".

143. Dr. Greenland completed a survey of the levels of ammonium and nitrate nitrogen throughout the year, under a range of ecological conditions. The survey indicated some profitable lines for study of the mechanism of the nitrogen cycle in the humid tropics, and further more intensive investigations on the nitrogen balance under a range of soil treatments have begun.

144. Utilising aerial photographs taken by the Aircraft Operating Co., Ghana, with two different contact scales and two contrasting film types, infra-red and panchromatic, Mr. Loxton commenced a study of the possible identification of the ten major commercial timber species occurring in the Pra-Amum Forest Reserve. In this he had the co-operation of the Forestry Department of Ghana. The possibility of identification of cocoa is also being examined.

Crop Production

145. Mr. Nyenhuis completed a study of the effect of plant hormones on the fruiting of Pineapple ("Smooth Cayenne"). It appears that with certain treatments the fruiting season may be controlled successfully within reasonable limits.

146. Some progress in variety trials was achieved, especially in Groundnut, Soya, Cowpea, Rice, Tobacco and Sorghum. Some attention was also given to Cotton, Yam, Sweet Potato, Oil Palm, Coconut, Coffee, Citrus, Fig, Guava, Avocado, Mango, Banana, Plantain, and Pineapple. Banana spacing and Pineapple spacing trials were continued.

147. New lines of study included a duty-of-water trial on Akuse clay and on methods of irrigation (furrow, basin, terraced beds) on several soil types.

Pasture Ecology and Management

148. Mr. R. Rose-Innes has made phenological observations at fortnightly intervals on 15 of the more important grass species at the Agricultural Research Station, Nungua; additional species have since been placed under study. In the course of this work he has extracted a number of monoliths to study the distribution of grass roots in the soil. He has made further studies on fire-protected plots at Nungua; and on the effects of light, medium and heavy grazing, for periods of one to four years, on the grassland of sandy and clay soils at Nungua.

Soil and Water Conservation

149. Mr. Smuts has made run-off and run-off intensity determinations from larger and small catchments on the Accra Plains. Information has resulted sufficiently reliable for most practical purposes. Arrangements were completed for several small weirs for the measurement of run-off intensities to be built for use next rainy season.

Animal Production

150. Mr. A. S. B. Wilson continued his studies at the Agricultural Research Station on sheep and pigs. Good progress has been made in the collection of field data regarding the forest-type sheep and cross-breeding projects involving these. The development and equipment of a poultry unit

progressed favourably following the introduction of foundation day-old chicks of several breeds from England. Observations of these under extensive and intensive systems of management are proceeding, the results so far being encouraging.

Agricultural Engineering : Mechanisation of Agriculture

151. Mr. Corbett designed, constructed and tested a new type of tiller planter at the Agricultural Research Station with Maize, Soya and Groundnut under trashy and wet soil conditions. The emergence of Soya and Groundnut was satisfactory but some modifications were necessary to ensure an even depth of planting of maize through trash on Akuse clay. He also developed a simple rotary slasher for grass and light woody vegetation as an alternative to hand-slashing or the reciprocating mower, the slasher being directly attached to and driven by a light-wheeled tractor.

Publications

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D. J. GREENLAND—The adsorption of Sugar by Montmorillonite. Pts. I and II. *J. Soil Sci.* **7**, (1956) 319.

D. J. GREENLAND—Is aerobic denitrification important in humid tropical soil? *Trans. 6th Int. Cong. Soil Sci. Paris*, 1956.

F. HAGENZIEKER—Studies on Sub-soil Fertilization. *Emp. J. exp. Agric.* **24**, (1956) 109.

P. H. NYE and W. N. M. FOSTER—Do plants differ in their ability to utilize sparingly available soil phosphate? *Trans. 6th Int. Cong. Soil Sci. Paris*, 1956, IV-39.

J. F. V. PHILLIPS—Aspects of the Ecology and Productivity of some of the more arid regions of Southern and Eastern Africa. *Vegetatio Acta Geobotanica*. Vol. VII, 1956.

A. S. B. WILSON—Sheep in other Climes—the Gold Coast Blackface. *Sheep-breeders Journal*, 1955.

University College, Nigeria

Crop Production and Agricultural Botany

152. Investigations have been continued on *Mundulea sericea* as a cheap source of insecticide. The bark has been harvested routinely and forwarded for analysis to the Chief Chemist of the Royal Institute, Department of Tropical Products, Amsterdam, Holland. Pawpaw trees are being bred in an attempt to obtain true breeding haemaphrodite strains. Research on *Crotalaria juncea* as a source of fibre (in conjunction with the Government Department of Marketing and Exports) has been curtailed until next year. Basic data is being collected for a study of the significance of seed size in the ecology of plant communities about Ibadan. Experimental taxonomy of *Amaranthus* is in progress.

Entomology and Grain Storage

153. 46,424 insects were collected from 62 crops in 1956. 34,632 of these were determined in the Division. A start is being made on the compilation of a check list of Nigerian insects, in conjunction with the Federal Government Entomologist at Moor Plantation, Ibadan. Work on the biology of *Callosobruchus maculatus* continues. Equipment for the joint grain storage project with W.A.S.P.R.U. is nearly complete and trials should start with the next maize harvest. A joint study of the effect of fumigants on the growth of maize is being undertaken with the Agricultural Botanist.

Soil Science

154. Studies are in progress on the movement of iron, aluminium and silicon in a soil of the Ibadan series under five different covers; the problem is being tackled both mineralogically and chemically. The effect of soil cover on temperature and moisture distribution is being studied on the same site. The application of thermal analysis to the fractionation of soil organic matter (in collaboration with the Government Soils Chemist at Moor Plantation, Ibadan), continues.

Animal Husbandry and Health

155. Dairy Husbandry—Observations on the dairy herd of white Fulani (Bunaji) zebu cattle under conditions of moderate exposure to infection with trypanosomiasis continues. During the period 1950-56 about 90 per cent. of the herd was infected with *T. vivax* although *T. congolense* was observed in 4 per cent. of cases. Although varying degrees of clinical symptoms occurred, the herd appeared to remain in a state of premunition, however, and in 32 lactations only one cow was treated for trypanosomiasis. Six foundation cows (from Shika Government Stock Farm, Northern Nigeria) averaged 3,606 lbs. (305-day record) in 21 lactations. Maximum yields were 6,506 lbs. in 427 days and 5,462 lbs. in 305 days. The average calving interval was 405 days. Ibadan-born heifers averaged 2,363 lbs. in 265 days with a calving interval of 381 days. Surplus bulls, beef steers, and working bulls have been treated routinely with Antrycide pro-salt and reared on mixed Star Grass (*Cynodon plectostachyum*) and Centrosema pastures. Eight 2-year olds average 700 lbs. in 2 years and 1,000 lbs. in 3 years.

156. Poultry, Pigs, Sheep and Goats—The performance of layers on deep litter, free range, and in batteries is being compared, using all-Nigerian rations with blood meal as the only animal protein supplement. In general, higher hen-housed averages (150-180 eggs p.a.) and lower mortality were obtained on the semi- and intensive systems. Broilers are being reared in cages. Carcass grading of three inbred lines of Tamworths, Large Whites, and Large Blacks and their tri-bred crosses continues. Liveweight and carcass measurements are being carried out on local Dwarf sheep. A survey of helminth parasites infecting sheep in the Western Region is also being carried out in co-operation with the sub-department of Parasitology. Cross breeding with Northern goats (Maiduguri type) in an attempt to breed a good milking type in the south has not, so far, proved successful owing to the high susceptibility of the Maiduguri (and also the Sokoto) to trypanosomiasis in the south.

157. Animal Health—The poultry pathology survey in the Western Region continues in co-operation with the Government Veterinary Department. Research on porcine schistosomiasis is in progress in collaboration with the sub-department of Parasitology.

Nutritional Chemistry

158. The chemistry of food and foodstuffs—The general study of the proximate composition of Nigerian foods and feedingstuffs in relation to environmental conditions of climate, soil and management which started in 1952 has been completed and results published. While locally grown oilseed crops tended to be somewhat low in proteins, high in oil and fibre and of average quality in mineral matter, the cereal and protein concentrates grown in Nigeria appear similar to those used elsewhere.

159. A study of the nutritive value of cassava including the HCN content of its many varieties grown locally is in progress. Preliminary results have shown that feeding raw cassava in a balanced ration leads to a higher rate of liveweight gain and conversion ratio and lower cost of producing one

pound of pork up to the porker stage only, with no adverse effects on carcass quality, when compared with either cooked cassava or guinea corn (sorghum) balanced rations. Work is in progress on balance studies of nitrogen, calcium, phosphorus and iron of cassava diets with the pig.

160. Pastures and pasture plants—Analyses of some 20 grasses, legumes and herbage plants studied in accordance with their stages of growth, frequency of cutting and seasonal effects, have been completed. Results have shown that the crude fibre and the soluble carbohydrate content of the grasses are directly, while the crude and true proteins and the silica-free ash are inversely, related to the age and maturity at which the grasses were sampled. It was confirmed that differences in the chemical constituents due to stages of growth at which the herbage is cut completely outweigh any differences due to species.

Publications

F. E. S. ALEXANDER and H. T. CLIFFORD—Differential Insecticide Damage in Maize varieties. *Nature*, **179** (1957) 109.

G. H. CASWELL—Observations on the biology of *Callosobruchus maculatus*, Coleoptera, Bruchidae. *Paper presented at the 6th Int. Conf., C.I.A.O., S. Thome*, 21st–28th August, 1956.

G. H. CASWELL—Some problems of grain storage in Southern Nigeria. *Paper presented at the 6th Int. Conf., C.I.A.O., S. Thome*, 21st–28th August, 1956.

H. T. CLIFFORD—Seed dispersal on Footwear. *Proc. Bot. Soc. Brit. Isles*, **2** (1957) 129–131.

H. T. CLIFFORD—Studies in British Primulas VI. On hybridization between Primrose (*Primula vulgaris*, Huds.) and Cowslip (*P. veris*, L.) *New Phyt.* in Press.

D. H. HILL—Current Investigation in Poultry Production and Diseases in the Western Region of Nigeria. *Section Paper No. 6 Western Region Veterinary Conf.*, December, 1956.

H. A. OLUWASANMI—Land Tenure and Agricultural Improvement in Tropical Africa. *J. Farm Economics, U.S.A.* (in the press).

V. A. OYENUGA—The composition and value of Nigerian Grasses. *Emp. J. exp. Agric.* **25** (1957) (in the press).

V. A. OYENUGA (with L. K. OPEKE)—The Nutritive Value of Cassava Rations for the Pig. *West African J. Biol. Chem.* **1** (1957) (in the press).

(e) WEST INDIES

The Imperial College of Tropical Agriculture, Trinidad *Agriculture*

161. *Animal Nutrition.* Studies in the grazing behaviour of cattle were concluded. Numerous digestibility trials were conducted on forage crops at different stages of growth. Studies on rumen flora were conducted in collaboration with the staff of the Colonial Microbiological Research Institute. Investigations on the composition of various grasses were continued, as were also studies in the feeding of low grade sugar to poultry. During the year approximately five thousand analyses were carried out.

Botany

162. The progress of the Flora of Trinidad and Tobago was marked by the publication early in 1956 of Vol. 2, Part 6. This part includes the *Myoporaceae*, *Verbenaceae*, *Avicenniaceae*, *Labiatae* and the *Plantaginaceae* which concludes the Gamopetalae. Some of the families in the Apetalae which follows are ready for the printer.

Soils

163. A preliminary study was made of a gas-analysis technique for measuring the assimilation of atmospheric nitrogen by blue-green algae in swamp-rice soils, similar to one recently described by workers in India. It was found that any appreciable growth of algae on samples of the moderately acid soil of the rice plots at the College new farm was dependent on addition of phosphate. (The botany department examined specimens of this growth, which was found to consist largely of blue-green algae of the families *Nostocaceae* and *Chroococcaceae*, and are working on their further identification). The indication given by the first trials of the gas-analysis procedure was that, if assimilation of atmospheric nitrogen occurred, the rate was less than 4 lb. of nitrogen per acre in a fortnight during active growth of algae (stimulated by addition of phosphate) in conditions similar to those in which swamp-rice grows.

*West Indies Regional Research Centre, Trinidad**Banana Research*

164. A new phase of the banana breeding programme began during the year with the use in Jamaica of a new group of male parents. These are the first useful products of crosses derived from diploid cultigens collected in British East Africa in 1948 by R. E. D. Baker and N. W. Simmonds. Only one family (derived from the edible diploid Sikuzani from Zanzibar) has yet yielded seedlings of value, but it is expected that an analogous family derived from another Zanzibar diploid, Paka, will reach a higher standard. Paka, which has the finest bunch known to us among the diploid bananas, is still being tested for disease resistance and, if satisfactory in this respect, may possibly be of use as a male parent on Gros Michel without further crossing.

165. Observations of wild bananas collected in the course of the 1954-55 expedition continue. Seedlings of many introductions have shown a high mortality rate, of which Panama disease has been the most important cause. As expected, special difficulty has been experienced with the highland forms from New Guinea and Malaya. The most promising collections of all (strains of *Musa banksii* from the highlands of New Guinea) have, it is disappointing to record, not done well for they are mostly susceptible to Panama disease; however, no important introduction has failed entirely and fruit has been obtained from some of the earliest collections (from Samoa). The first consignment of clonal material has been received from quarantine at Kew; it contained edible diploids from Malaya. Further consignments, of edible diploid material from New Guinea and Malaya, are expected to arrive this year, 1957, and arrangements are in train for the importation to Kew of supplementary material from Southeast Asia.

166. N. W. Simmonds has revised the classification of *Musa acuminata*, a highly variable species which includes all the varieties of importance to the banana breeder. The 1954-55 expedition, besides providing data on this important species, also yielded valuable information on other wild bananas, as a result of which three new species have been described and knowledge of the distribution and variability of many others greatly extended.

167. K. Shepherd has been working on the cytology of inter-specific hybrids in sections *Eumusa* and *Rhodochlamys* and on structural chromosomal hybridity within *Musa acuminata*. He has also continued his investigations of factors affecting the seed fertility of the edible bananas, with a view to improving, if possible, the seed yield of breeding plots of Gros Michel.

168. During the year under review J. M. Richardson of the New Guinea Department of Agriculture investigated fibre quality in the I.C.T.A. collections of *Australimusa* hybrids. The stimulus to this work arose from the difficulties which Abacá growing industries are now suffering, primarily as a result of disease; it was thought that *Australimusa* species allied to *Musa textilis* might provide useful sources of genes for hardiness and disease resistance. Richardson's results indicate that certain hybrids have promising fibre characteristics and that, therefore, this may well be a very promising approach to Manila Hemp improvement.

Cacao Research

169. All selfings and crossings envisaged at the beginning of the breeding programme have now been completed. Individual tree records on the oldest progenies have been continued with the object of selecting trees of outstanding performance. Yield figures below refer to dry fermented cacao beans.

170. An experimental planting (now five years old) to compare the performance of three Trinitario clones and their progenies, gave the following results:—

ICS 1 cuttings 783 lbs./acre	ICS 1 × ICS 8 517 lbs./acre
ICS 8 cuttings 752 lbs./acre	ICS 6 × ICS 8 403 lbs./acre (4 years old)
ICS 6 cuttings 534 lbs./acre	ICS 1 × ICS 6 308 lbs./acre
Mean 690	Mean 409

The average yields given for the two classes of material, with some reservations, may indicate that cuttings of certain Trinitario clones are more efficient producers of cacao than seedlings arising from crosses between the same clones.

171. Progenies arising from the hybridisation of ICS 1, ICS 6 and ICS 60 with SCA 6 and SCA 12 (made with the object of combining yield and good commercial characters with resistance to witches' broom disease) in their fourth year at a spacing of 7' × 7' and based on 160 trees each, yielded:—

ICS 1 × SCA 6	...	...	...	...	1,275 lbs./acre
× SCA 12	...	...	...	...	1,425 lbs./acre
ICS 6 × SCA 6	...	...	...	...	1,450 lbs./acre
× SCA 12	...	...	...	...	1,400 lbs./acre
ICS 60 × SCA 6	...	...	...	...	1,075 lbs./acre
× SCA 12	...	...	...	...	1,500 lbs./acre
Mean	...	...	...	...	1,350

These yields indicate a performance higher than has ever previously been experienced at River Estate, with any kind of planting material. (ICS 1 cuttings, spaced at 8' × 8', gave only 600 lbs./acre in their fourth year.) No vegetative or cushion brooms have been seen on the four hundred and eighty trees which have SCA 6 as a parent; a study of the progeny of SCA 12, on the other hand, has shown that some twenty-five per cent. of them have, so far been infected by witches' broom disease (vegetative parts). The incidence of pod infection by *Marasmius peniciosus* on SCA 6 progenies was of the order of 0.8 per cent.; on SCA 12 progeny, it was about 1.8 per cent. Black-pod losses amounted to 3.4 per cent. in the whole planting. At the moment, SCA 6 appears to be superior to SCA 12 as far as witches' broom resistance is concerned, although it is inferior in some agronomic characters. Pod size and bean weight of these seedlings are still rather small, but superior to both SCA 6 and SCA 12 as clones.

172. The yields obtained possibly indicate that local Trinitario material may most readily be improved (on a yield basis) by hybridisation with certain upper Amazon strains. If any, or all, of the six hybrid groups are proved to be satisfactory from the flavour point of view, and reproduce their promise on other soil types, a case could be made for the rapid bulking up of seed material for commercial distribution, in the place of expensive cuttings.

173. Various tissues have been analysed to investigate the changes that occur in the hormone levels during cherelle development, leaf flushing and root induction in cuttings. Three growth substances have been recognised, an acidic accelerator which is possibly β indolyl acetic acid, an acidic inhibitor and a neutral accelerator.

174. Preliminary experiments with maleic hydrazide have shown that although it acts as a growth inhibitor to cacao, the concentrations at which it is effective produce undesirable morphological changes. Petiole abscission experiments have been conducted to screen certain synthetic growth regulators with a view to their possible field application in the control of cherelle wilt and leaf fall.

175. Entomological and plant physiological work on the bionomics of cacao thrips has been continued. It has been evident for some time that the traditional view on factors governing the prevalence of thrips on cacao fail to account for all the facts and the discrepancies have become even more evident in the light of data collected during the present investigation. The conventional interpretation both of the mechanism and the phytopathological significance of cacao thrips outbreaks has to be discarded, and the task of framing a hypothesis which will satisfactorily accommodate the data is the main objective of this work. As far as outbreaks on cacao are concerned, a beginning was made using yield and growth data from trees of known history, and an account of this work was published in the Imperial College of Tropical Agriculture Report on Cacao Research for 1954. Further data on this aspect of the work have been collected since then.

176. The second phase of this investigation, carried out during the past year, has involved observational and experimental studies on the behaviour of cacao thrips on cashew (*Anacardium occidentale*), a common host plant. This work, now practically completed, was undertaken on account of the fact that large outbreaks of cacao thrips on this host usually occur in environmental conditions which are profoundly different from those prevailing when the abundance of cacao thrips on cacao is at its peak. This circumstance serves to eliminate from consideration a number of factors which it would be difficult to evaluate in an investigation limited strictly to observations made on cacao.

Soils Research

177. Preliminary investigations of cacao roots, with the object of providing a nutrient diagnostic factor in close association with the soil, led to a subsidiary pot experiment with cacao seedlings. The seedlings grown under differential nutrient deficiencies incidentally produced visual leaf-symptoms which have provided further evidence on previously conflicting results. Nutrient absorption by excised roots from these plants has been studied as a means of detecting deficiencies. The method is now being tested under field conditions.

178. Spectrographic investigation of the soils of the Rupununi savannahs, British Guiana, was undertaken in conjunction with the field survey of the area. Total and available quantities of trace elements were estimated and

also analyses of vegetation growing on the different soils. This work was accompanied by pot tests on the different soils, employing a method similar to that used by Webb in The Gambia. Nutrient solutions of spectrographic purity were used in all cases and lettuce initially chosen as an indicator crop. A high zirconium content in Rupununi soils is of considerable pedological interest. The relative accumulation of zirconium in Rupununi profiles is indicative of the extreme age of these soils.

179. An experiment carried out by the Agricultural Department to determine whether application of copper sulphate would reduce the number of snails in rice plots resulted in enhanced early growth of rice irrespective of snail incidence. Further experiments have now been made to investigate the possible rôle of copper in this phenomenon.

180. Applications of iron versenate to experimental cane plots under the supervision of the Agricultural Department have led to yield increases. An increase in the uptake of a trace element was suspected and cane leaf material from the plots was analysed accordingly. The results obtained suggested that in some way manganese uptake had been inhibited. Levels found, of approximately 45 p.p.m. were rather low for acid soils. The iron content was higher on the plots with heavier versenate dressings.

181. The analytical laboratory was heavily committed during the year's research programme. Samples analysed included 1,600 of soils and 1,462 of plant material, involving 22,000 separate determinations. These figures do not include several thousand spectrographic determinations.

Soil and Land-use Surveys

182. Jamaica : during the year the soil survey has been continued. Field work in the parishes of St. Catherine and Clarendon was completed and maps and reports are being prepared for publication. The Government of Jamaica will ultimately receive transparent overlays of aerial photographs at 1 : 12,500 scale with all soil data incorporated. A hand coloured map at 1 : 25,000 will also be supplied ; maps of the areas for publication will be at 1 : 50,000 scale.

183. St. Vincent : the soil map has been prepared, the surveyor completing the cartographic aspects of his work at the Directorate of Colonial Surveys, Tolworth, Surrey. His proof copy at 1 : 20,000 scale is now in Trinidad and is being edited with his report for publication.

184. British Guiana : the soil survey has been begun. Emphasis was first placed on the Rupununi savannahs where present land-use involves cattle ranching. Mr. R. F. Loxton was seconded, through the kind co-operation of Professor J. Phillips and the University College of Ghana, to help initiate this task. A reconnaissance soil survey of approximately twelve hundred square miles was completed before adverse weather stopped operations. This area is considered as being typical of the remaining eight hundred square miles of the Southern Rupununi and a report and maps at 1 : 50,000 scale are in preparation for publication. The Government of British Guiana have already received a provisional soil map of one hundred square miles of the survey area at 1 : 30,000 scale ; this was urgently needed since it included the recently established St. Ignatius Research Station.

Publications (selected list)

COPE, F. W., and JOLLY, A. L.—West Indian Clones. *Report of Cocoa Conference, Cocoa, Chocolate and Confectionery Alliance, September 1955*, 58-66.

FENNAH, R. G.—New and Little-known Lophopidae and Issidae from Australasia (Homoptera: Fulgoroidea). *Proc. R. ent. Soc. Lond (B.)*, **24** (1955) 165-173.

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T. A. JONES—Carbon and Nitrogen Studies on the Arid Irrigated Soil of the Sudan Gezira. *VIe Congrès International de la Science du Sol, Paris 1956. Rapports B*, 417-425.

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N. W. SIMMONDS—Fishing rod Botany; a Review. *Kew Bull.*, 1956 135-40.

N. W. SIMMONDS—A banana collecting expedition to South East Asia and the Pacific. *Trop. Agric. Trin.* **33** (1956) 251-71.

N. W. SIMMONDS—Botanical results of the banana collecting expedition (1954-55) *Kew Bull.* 1956 No. 3 463.

N. W. SIMMONDS and R. STEVENS—Occurrence of the Methylenedioxy Bridge in the Phenolic Components of Plants. *Nature. Lond.* **178** (1956) 752-3.

British West Indies Central Sugar Cane Breeding Station

185. Some success was obtained, for the first time in Barbados, with sugar cane breeding by the Hawaiian method, using cut canes of the parent varieties maintained in dilute sulphurous-phosphoric acid solution. Failure in previous experiments made a number of years ago is ascribed to the use of tap-water, which is calcareous and alkaline, and of metal containers ineffectively covered internally with protective paint. Success was obtained with rainwater and enamelled containers. Several hundred seedlings were obtained from certain crosses, but in others germination was very low in comparison with control crosses made by the Barbados lantern method, so that further experiments are necessary before the Hawaiian technique can be used on a large scale. However, the experiments have resulted in development of a method by which normal pollen shedding can be ensured in male arrows maintained in solution, which will result in considerable saving of time and labour during the hybridisation season. The technique can be used satisfactorily with the new cheaper and more easily portable arrow lanterns which are now in use.

186. Examination of seedlings grown to maturity from fuzz (seed) irradiated with X-rays at dosages from 50 to 1,000 r in the 1955 breeding season showed that there were no evident mutations in the populations.

187. It is evident, therefore, that dry fuzz is very resistant to irradiation within the range of dosages applied. During the 1956-57 breeding season, X-ray treatments were given to fuzz in which germination had commenced, in the hope that mutations would be induced more readily in such material.

188. Following a good growing season and excellent conditions for arrowing, a full breeding programme was carried out, which included several crosses not available before. Fuzz from selected crosses was again sent to Jamaica and British Guiana, where seedlings are being grown and tested in co-operation with the Station's officers to develop superior varieties resistant to mosaic disease and leaf scald, respectively. In Jamaica another virus disease, chlorotic streak, gives cause for concern in some areas and poses a complicated problem in plant breeding, for most of the better mosaic-resistant varieties bred in Barbados show little resistance to chlorotic streak. To provide basic information on the sources of resistance to this disease in the available material, a collection of breeding varieties was sent to Jamaica, and was planted in one of the worst chlorotic streak areas for observation. Information from British Guiana on the leaf scald resistance of Barbados varieties shows that of recent consignments, almost 60 per cent. are classified as tolerant or resistant. It is known that resistance is derived through *S. spontaneum* and to some extent through *S. sinense*, but not through *S. robustum*, whose forms show high susceptibility. The strain of causal bacterium differs from those in Mauritius, Hawaii and elsewhere in its effect on several varieties, so that information on varietal resistance in other countries is frequently of little value in its application to British Guiana.

189. In the cytogenetics research programme, further selfings were made in the development of pure lines from several foundation parents, and a collection of more than 200 varieties in the various inbred lines is available for further breeding. Certain of them have been used in preliminary crosses with proven parents and in inter-line crosses to assess their value for breeding commercial varieties. The first selections from these, which show undoubted "hybrid vigour" have been planted in full-season trials with comparable material from the regular crosses, and will be harvested in 1958. Interesting segregates in the pure lines are non-flowering forms of B.41211 and B.41227, both of which flower heavily in Barbados, and a series of "derived spontaneums" which appeared as the only viable genotype in second-generation selfings from B.4362, as reported last year. These forms, which show exceptional vigour, breed true to growth-type on further selfing, and have been used in crosses with a proven *S. officinarum* parent variety to investigate their potential value as producers of commercial varieties.

190. Such inbreeding programmes as have been carried out with other crops have been concerned mainly, if not exclusively, with material which is diploid and in which meiosis is regular. Many of the foundation sugar cane varieties from which the Barbados inbreds are derived are polyploid and aneuploid interspecific hybrids, in which meiosis is irregular and genomes are duplicated. It was to be expected that homozygosity might not be achieved by selfing as rapidly as in material of less cytological complexity. The assumption of meiotic regularity is, of course, a pre-requisite of true breeding. Results have shown the expected continuation of segregation in third-generation selfs in some of the lines while in others a considerable degree of fixation in vegetative characters such as cane colour and type, leaf habit and growth vigour has been established already. Degree of flowering and male-fertility are found to be characters which become established in the lines at early stages in the progress towards homozygosity. With a few notable exceptions, germination of seedlings from selfed material is, at the F_2 and F_3 stages, better than that from the majority of general programme crosses.

191. In the laboratory, the main work consisted of establishing the chromosome numbers for inbred material in the several lines. An approach to stability is to be discerned in several lines: those from B.35276 ($2n = 120$) are about 104, from B.4098 ($2n = 109$) about 109, and from B.41211 ($2n = 123$) about 120. The "derived spontaneums" from B.4362 ($2n = 118$) have lost the most chromosomes in two generations of selfings: counts for several of these are 87-95. Root-tip counts, from material pre-treated with α -bromonaphthalene, cut at $10\ \mu$ and stained in crystal violet, were found preferable to pollen-mother-cell smears, in which univalents and bivalents cannot always be distinguished with certainty. Some success was obtained with leaf-squashes from germinating buds, but the technique was found to be less reliable than the root-tip sectioning method, although the speed with which preparations can be made is an undoubted advantage.

192. First-generation selfs from B.4362, which on further selfing gave rise to the "derived spontaneums" described above, were examined cytologically: chromosome numbers were counted in root-tip sections, and pollen-mother-cell smears showed that meiosis was surprisingly regular in the cells examined, with fifty or more normal bivalents at metaphase I, and very few univalents. The change in growth type and the chromosome losses which accompany further selfing would indicate, however, that such rather regular configurations do not result in viable pollen.

193. A mutant form of the commercial variety B.37161, with striped canes, was planted at the Experiment Station as a museum specimen. This mutation has no commercial significance, but is interesting as an example of a genotypic change occurring spontaneously in cultivation: similar mutations, not discernable by eye, may affect yield and juice characters, and may account to some extent for the yield deterioration which is commonly found in varieties after some years in commercial cultivation.

194. Evidence from plantations in different districts of Barbados seemed to indicate that hot-water treatment to control the virus of ratoon stunting disease (50°C for two hours) results in increased flowering in the plant canes, an undesirable feature. An experiment has been laid down to obtain reliable information on this subject.

Publication

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(f) *SOUTH EAST ASIA*

Forest Research Institute, Malaya

Forest Botany

195. The Herbarium has now been brought up to date. Acquisitions amounted to 2,736 (2,636) of which 722 (1,152) were collected by the Forest Department in Malaya whilst the remainder were mostly duplicates received for identification from the Borneo territories. Some, however, were received from Singapore, Indonesia, Thailand, and New Guinea. The total number of specimens in the Herbarium reached 51,055 (49,319).

196. Fifty-nine Dipterocarps and one non-Dipterocarp were added to the arboretum bringing the total number of species to 369 of which 168 are Dipterocarps.

Silviculture

197. A total of 72 lots of tree seed was received. Exotic species received included *Acacia decurrens* Willd., three *Eucalyptus* species and *Araucaria*

bidwillii W. J. Hooker from Queensland; *Pinus merkusii* Jungh. & De Vriese, *Ochroma bicolor* Rowl. and *O. grandiflora* Rowl. from Indonesia; *Pinus Massoniana* D. Don. from Hong Kong; *Maesopsis eminii* Engl. from Kenya and Indonesia; *Calophyllum antillanum* Britton from Puerto Rico; *Entandrophragma cylindricum* Sprague, *Khaya ivorensis* A. Chev. and *Chlorophora excelsa* Benth. & Hook from Nigeria (only *Chlorophora* germinated); *Swietenia mahagoni* Jacq. from Ceylon; *Eucalyptus naudiniana* F. Muell. (*E. deglupta* Bl.) from New Guinea and *Casuarina sumatrana* Jungh. from Sarawak. Two provenances of *Eucalyptus salinga* Sm. seed (Kenya and Uganda) were received through the F.A.O. International Seed Exchange. Seeds of *Enterolobium saman* Prain. and *Styrax benzoin* Dryand. were sent to Queensland; *Albizzia falcata* Back. to Madagascar; *Fagraea fragrans* Roxb. and *Intisia aplembanica* Miq. to the Seychelles and *Eucalyptus naudiniana* F. Muell to Tanganyika and Borneo.

198. Further small-scale experiments were carried out to find a non-toxic arboricide that can replace Sodium arsenite. Interim results indicate that water-borne emulsions of 2, 4, 5-T and 2, 4-D butyl esters applied to a frill girdle are ineffective in strengths which are economic to use. These trials have confirmed Uganda experience that arboricides are more effective when mixed with diesel oil. A field trial at Sungei Menyala F. R., Negri Sembilan has confirmed that such a mixture of 2 per cent. 2, 4, 5-T butyl ester (80 per cent. acid equivalent) is fully effective when applied to a frill girdle. When inspected 10 months after treatment, nearly all trees were found to be dead, including large specimens of many species. This mixture costs \$1.50 per gallon (bulk prices) compared with 76 cents per gallon for Sodium arsenite. The Kepong trials indicate that 1.5 per cent. or 1 per cent. 2, 4, 5-T in diesel oil may also be effective if the frill girdling and application of arboricide is carefully done, though these mixtures are slower to act. Nothing less than 5 per cent. 2, 4, 5-T in diesel oil has been found effective as a contact spray. A 2 per cent. mixture used as a contact spray in the Sungei Menyala trial was ineffective for large trees and few trees over 2 feet girth had died at 10 months.

Ecology

199. In trials to reclaim lalang areas, the 1954 and 1955 plantations of batai (*Albizzia falcata* Back), the former planted directly in sheet lalang and the latter in cultivated strips continue to thrive. In the former, the canopy has closed at the shorter (14' x 14') planting distance, and volume plots have been established. Potential cabinet wood species, namely Mahogany (*Swietenia macrophylla* King.), Australian Maple (*Flindersia brayleana* F. Muell.) and Angsana or Sena (*Pterocarpus indicus* Willd.) were planted over some 35 acres of sheet lalang, in either manually cultivated patches or mechanically cultivated strips. In the former method, manurial treatments were included and response has been good. No new species for trial were planted, but to date the following are markedly vigorous: *Acacia auriculaeformis* Cunn., *Araucaria cunninghamia* Sweet., *Pinus caribaea* Mil., *Pinus merkusii* Jungh & de Vriese, *Pinus insularis* Endl., *Schima noronhae* Reinw., *Tabebuia pallida* Miers., and *Cunninghamia sinensis* Richard.

200. In trials to reclaim tin tailing areas, 7 acres of fertilizing trials, using batai and *Pinus caribaea* were planted on bare sand tailings at Mantin, Negri Sembilan. In the same area, but on slimed dredge tailings, 8 acres of species trials were laid down, using various indigenous and exotic trees and shrubs. Present indications are that better development can be expected from cow manure rather than with artificial fertilizers, but a complete organic/inorganic artificial gives results comparable to manure, and is much easier to apply.

Amongst the species trials and sand tailings, *Pinus merkusii*, *Acacia auriculaeformis*, *Pinus caribaea*, *Fagraea fragrans* Roxb., and *Eucalyptus deglupta* show promise.

Entomology

201. In connection with the study on susceptibility of Malayan timbers to powder post beetle attack three species of red meranti were tested for their starch content. None showed more than a "trace" indicating that they should be practically immune to powder-post beetle attack. Infestation tests proved this true. Reports of powder-post beetle attack on exported Malayan timber were received from Australia and South Africa. Bostrychids appeared to be mainly responsible. Drywood termites were recorded on fallen leng-gadai and tumu in Pulau Lumut mangrove forests. Tests of poles against insect attack continued satisfactorily. Some of them appear to be extraordinarily free from insect attack for at least the two years they have been undergoing infestation tests.

Chemistry

202. In fibreboard trials, experiments showed that the sample of rubberwood employed was capable of being made into good quality hardboard and a useful series of experiments into operating variables had been completed. Experiments are under way in which preservatives have been incorporated into the boards and the board-making techniques are being applied to other samples of rubberwood to determine whether the findings are generally applicable.

203. In paper trials, the arrival of the digester during the year allowed paper-making experiments to be started in August, but no conclusions can be recorded yet. Investigations on the paper-making properties of padi straw by the monosulphite process in addition to the Celdecor-Pomilio process are continuing.

Timber Research

204. Experiments have been made to determine the effectiveness of chromium-plated tooth-bits for converting difficult timbers with an inserted tooth saw. The timbers used were one log of Katong-katong (*Cynometra inaequifolia*), fifteen of White Meranti (14 *Shorea bracteolata*, 1 *Shorea taura*), two of Keranji (*Distium Platysepalum*) and one of Rengas (*Melanorrhoea wallichii*). The results are very encouraging, indicating that if a market is established for such excellent timbers as White Meranti, an abundant supply of sawn timber will be available.

205. Wood-turning tests have been revived with simple tests on four timbers. One of these was Medang gatal (*Schima noronhae*), which has also been tried for furniture manufacture with good results; the species seems likely to become important for re-planting in the future.

206. A number of roof frames of 24 feet span have been constructed, in which the most heavily-loaded joints are made in short curved laminated members, joined to solid timbers by a special form of glued, bolted joint. Six of the frames have been used in a workshop for the Forest Department Road Construction Unit, and the performance of their glued joints will be observed in future years. Others will be proof-tested by British Standard Code of Practice Methods. In collaboration with the Central Electricity Board, laboratory experiments have been made to discover a suitable design of spaced-column construction for timber transmission-line poles. The F.A.O. are interested in this work, and the Board have agreed to present a report to a forestry conference at Bandoeng in 1957.

207. A report has been written on the suitability for plywood manufacture of a number of timbers. Plywood boards of 15 species have been made, using ureaformaldehyde resin with four types of hardener; exposure trials have been started on samples from each board. In preparation for more detailed peeling trials, the variation of knife angle in the veneer lathe as the carriage moves towards the log has been calculated for all positions of the carriage guide. A recording pen and chart have been fitted, allowing a continuous record of the knife angle to be obtained, and an electrical mechanism is incorporated which makes a mark on the chart for each revolution of the lathe spindle. It is now possible to conduct experiments in which the knife angle is varied while peeling is in progress. The first experiment using this apparatus was started towards the end of the year on White Meranti (*Shorea bracteolata*). As well as varying the knife angle at intervals during peeling of a single log, the nose-bar was set at a slight angle to the knife, giving nose-bar pressures ranging from overcompression at one end to zero at the other. The quality of the veneer was assessed by tension tests at right angles to the grain, using small samples; this test method follows a procedure published recently in the U.S.A., and is found very successful.

Botani. Gardens, Singapore

Taxonomy

208. The Director carried out a preliminary botanical survey of the new Bako National Park at the mouth of the Sarawak River and also collected on the Tau Range of mountains in the interior, an area hitherto unvisited by botanists. Many interesting and new plants were discovered.

209. Mr. Sinclair completed his revision of Malaysian Myristicaceae. He has now extended his study to the Myristicaceae of the Malaysian region as a whole with the view to publishing it in the *Flora Malesiana*. Dr. Furtado continued his study of Malaysian palms and published a long and important paper on the genus *Calamus* (Rattans) of Malaya. Mr. T. C. Whitmore arrived in December to study the anatomy of the bark of Dipterocarpaceae (the most important family of timber trees in Malaya) in relation to taxonomy.

Orchid Breeding

210. Some 240 crosses were made in 1956, of which 88 produced seeds, while 48 new hybrids flowered for the first time, some of which were of high quality. Experiments were begun in the use of coconut water in the sterile medium of agar-agar with Vacin's solution in which the orchid seedlings are grown in the laboratory. This was found to speed up the early growth of the seedlings to a remarkable degree.

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V. OTHER RESEARCH PROJECTS UNDERTAKEN WITH ASSISTANCE FROM COLONIAL DEVELOPMENT AND WELFARE RESEARCH FUNDS

ADEN

Abyan Research Scheme

Cotton Breeding

211. Plant selections of BAR XL1 and AB3 (second bulk filter of AB1) were planted in progeny rows with controls from their parental bulk and are being filtered for desired characters. Emphasis is laid on lint length and regularity. BAR XL1, the first filter of BAR 1730L, was introduced from the Sudan in 1951 and has given the best overall performance in field and spinning tests. A multiplication plot of BAR XL1 at the station will provide seed for a commercial bulking area of 200 acres to give the next wave of new seed. AB3 bulked in this area last year has provided seed for approximately 7,000 acres at Yeramis and Giar and is replacing AB1 (the original bulked selections from Sudan-Egyptian X1730A). The Station is fortunate in having full responsibility for all cotton seed treatment and distribution.

212. Selection and propagation work continued on Domains Sakel, BLR 14/16, BLR 14/25 and Wilds Early. A propagation plot of Karnak was planted to provide further material for testing.

213. Wilds Early, an American long staple cotton, has exhibited a high degree of resistance to root rot (wilt) and work has continued on the attempt to transfer resistance to L types. This season the fourth backcross of Wilds Early X1730A hybrids was made to BAR XL1. Results obtained from

replicated rows of hybrids, BAR XL1 and Wilds Early planted on badly wilt-infected land have been promising.

Agronomy

214. No effective crop rotation has yet been established in the Abyan Delta, and this practice has led to reduced vegetative growth of the cotton plant, a decline in yield and, in conjunction with other factors, of grade. A rotation experiment has been laid down comparing two, three and four course rotations with cotton as 50, 33 and 25 per cent. of the cultivable area. Sorghum, lubia (*Dolichos lablab*) and dry fallow make up the other phases. Anticipating the possibility that nitrogenous fertilizers may prove economic, cotton and sorghum phases are split for application and non-application of nitrogen.

215. The use of fertilizers forms an essential part of the attempt to assess experimentally the limiting factors to plant growth. In 1955-56 a preliminary experiment indicated that nitrogen is a major limiting factor and that the application of nitrogenous fertilizers may be justified economically. Field experiments have been carried out this season with different forms, rates and times of application of nitrogen, in combination with other treatments, rates of irrigation water and silt versus silt-free water.

Entomology

216. Sudan bollworm (*Diparopsis perditor*), first recorded in Abyan in 1952, has now become widespread throughout the delta. Its study and control is a first priority in the entomology programme.

ANTIGUA

Cotton Research

217. The work of the Central Cotton Station, Antigua, was started in 1946 with the object of increasing the yield per acre of the Sea Island cotton crop of the West Indies and has proceeded along three main lines—plant breeding, cultural methods and protection against pests and diseases. The bulk of the work has naturally centred in Antigua but parallel investigations have also been carried out in the other main cotton growing islands.

218. The plant breeding programme has aimed at maintaining or improving the unique high quality of Sea Island while increasing the yield potential. A variety new to commercial production—VH8—was introduced in 1951 with a quality not far removed from St. Vincent superfine V135 and a yield at least equal to the Montserrat ordinary M.S.I. Together these three varieties now constitute the Commercial Sea Island crop with the low quality M.S.I. preponderating. Work is in progress with the VH10 variety which has a slightly better quality and a distinct yield advantage over M.S.I.

219. Work on cultural methods has included investigations of methods and times of land preparation, of spacing of fertilizer and manurial requirements, of weed control, and of rotation of crops. It has been found that early, thorough cultivation is essential especially where the land has been carrying heavy weed growth or fodder grasses. Ridge planting has shown no immediate advantage over flat but the latter is dangerously liable to erosion. A plant population of 11,000 per acre is optimum for soils of reasonable fertility but the number may be increased with advantage on poor shallow soils. Responses to artificial nitrogen have been large in St. Vincent but less so in Nevis while in Antigua they are dependent on cropping practice and rainfall. Super-phosphate and potash have given variable responses depending on soil type. Pen manure has given large responses and under Antigua and St. Vincent conditions has considerable residual effect. Control of weeds,

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especially in the early stages of the crop has been shown to be of prime importance. Pre-emergence herbicides—mainly PCP and petroleum fractions—have had limited success while the use of weed smothering crops e.g. sugar cane and sweet potatoes, in rotations holds considerable promise. Sugar cane and cotton have been found to be an excellent rotation. Evidence showing that fertility can be maintained by a green manure—cotton rotation, with the green manure occupying the land during the close season, is accumulating.

220. Field control of the major cotton pests by means of insecticides has been attempted. The use of DDT against pink bollworm has not been successful but control of *Nezara viridula* by Toxaphene, BHC and DDT has resulted in yield increases. The cotton stainer has been controlled by BHC. Improved early growth and freedom from bacterial disease has followed seed treatment with sulphuric acid and trials with seed bactericides are continuing.

BASUTOLAND

Soil and Crop Research

221. Research into soil and crop problems was continued at the Maseru Experiment Station and on 10 small district sub-stations. The deficiency of phosphate in Lowland and Foothill soils dominates the soil fertility picture. Responses to added phosphate were again shown to be large in all areas of these zones. For example the mean linear responses per acre to 200 lbs. superphosphate on 28 1955-56 station experiments were:—maize 968 lbs., sorghum 810 lbs., wheat 700 lbs. On 29 maize trials on Basuto farms the mean response to 150 lbs. superphosphate per acre was 332 lbs. representing a mean nett profit of 17.5s. per acre. In the former series the response to P was unaffected by the presence or absence or rate of N and K applied. The conclusion is drawn that the general annual use of relatively small dressings of phosphate fertiliser (or manure or manure ash) by farmers would make the territory more than self-sufficient in food production. The Mountain Black Clays are still extremely fertile and do not benefit from manuring.

222. An intriguing lack of response to nitrogen was again recorded. Thus from the results of 102 experiments in which nitrogen was a treatment, carried out during the last three years, only 13 contain significant positive N responses. Response to N by maize was shown to be related to plant population but no interactions were recorded between N and P or K. The question of nitrogen manuring of cereals is receiving increased attention. The soils of Basutoland are not deficient in potash.

223. Experiments on liming were continued and confirmation obtained that the liming of the acid red ferruginous soils increases yields significantly while on the acid grey-brown solonchic sandy loams liming is dangerous through the inducement of minor element deficiencies. The possibility was shown to exist that the foothill red loams are deficient in calcium and that the large responses obtained to phosphate fertilizers on these soils (mean of 3 trials 1348 lbs. grain per acre) is due at least in part to the calcium component of the fertilizer. On this soil 3 tons of lime per acre increased maize yields by 1326 lbs. per acre. Minor elements applied as dry salts before planting and as crop sprays did not improve the yield of maize in the Lowlands and mountains.

224. Variety trials and selection work were continued on maize, sorghum, wheat and beans and further data on the performance of varieties in relation to ecological regions accumulated.

BRITISH GUIANA*Livestock Investigations*

225. The establishment, fertilization and management of pastures on the sandy soils of the Ebini station received greater emphasis. The most promising grasses so far tried are *Paspalum notatum*, *Digitaria decumbens*, and *Panicum pedicellatum*. Herd management has been improved by the introduction of single sire units. Growth measurements on cattle have commenced.

Cotton Investigations

226. The incidence of spring and autumn dry seasons allows a possibility of two cotton crops a year, and this has actually been achieved with careful timing. The possibility of exploiting this situation by ratooning for a second crop, after the first pick, appears promising and is being actively explored.

227. Of the soil types, the pegasse (acid peat) will grow cotton if fairly heavy lime dressings are given. On the main coastal clays land preparation, drainage and weeding during the rainy season all pose problems which cumulatively appear to rule these soils out. On sand reef soils drainage is naturally better, weeding easier and good yields have been obtained where circumstances were favourable. A full manurial application seems necessary.

228. The main insect pests are stainers and jassids; both proved to be controllable.

229. All the main cotton types have been tried. Sea Islands prove difficult to pick. American types, particularly African Uplands, grow well but the value of the lint does not appear to make these cottons economic. Best results have come from the Egyptian and Sudan types, the blackarm-resistant strains of the latter being particularly suitable. Quality reports on these cottons have been uniformly favourable. The incidence of blackarm has been most marked where growth was originally poor.

FIJI

230. Work on heat tolerance of dairy cattle continues. The first calves have been secured from the imported Santa Gertrudis bulls which it is expected will improve carcase quality as well as heat tolerance of local beef cattle. Continuing chemical analyses of pasture and fodder trials add to knowledge of varietal and seasonal variations in nutritive value of local and introduced species. Preliminary studies have also been undertaken into factors affecting the germination of locally produced seed of blue-grasses (*Ischaemum aristatum* and *Dichanthium caricosum*) and guinea grass (*Panicum maximum*).

GAMBIA

231. The 1956 Groundnut trials, designed and conducted at the Yundum Experimental Farm by the agronomist, resulted in a record average yield of 2,019 lb. of unshelled nuts per acre from 11 acres. This high yield is mainly attributed to newly introduced methods of husbandry such as burning weedgrowth before preparation, harrowing instead of ploughing; plot-perimeter bundling to reduce erosion and, most important, the use of Agrosan seed-dressing and sowing two seeds per hole instead of one to obtain full stands, and greater attention to weeding. Organic and NPK trials all gave highly significant results with low standard errors but the very high yields of the untreated controls, a reflection of good husbandry, made such differences uneconomical. Higher and more economical differences were obtained from seed-dressing, greater population density and dry-mulching.

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232. All 25 varieties tested against the commercial G.O.M.B. seed out-yielded it by 15-78 per cent.—24 of them significantly. In storage these varieties and others showed a variation of 0-100 per cent. susceptibility to damage from the Brucid beetle, *Caryedon fuscus*, and a trial is being conducted to determine statistically whether these very important observed differences are genetic. Significant varietal differences in millipede and termite damage to pre-harvest nuts were also established by the Agronomist this season. By weight, the loss from millipedes varied from 101-331 lb. of unshelled nuts per acre but the loss from removal of the epidermal skin of the shell by termites was generally negligible.

233. Very poor stands, resulting from inefficient seed storage, caused variety trials of cotton, sesame, maize, sorghum, pennisetum, millets and legumes to be inconclusive but cotton, sesame, and new varieties of maize and sorghum appear very promising. Seed dressing of sorghum with copper carbonate and Agrosan completely controlled grain smut.

NORTH BORNEO

Forestry Research

234. Fairly comprehensive trials were carried out on a number of arboricides of the hormone type, and their effectiveness and costs compared with sodium arsenite. The best treatment so far, after considering both cost and effectiveness is a 4 per cent. basal spray of a mixture of the butyl esters of 2, 4-D and 2, 4, 5-T in the ratio of 2 : 1 applied in diesolene. To date the kill obtained by this spray is nearly equal to that of sodium arsenite and the total cost of only about 1.1/3 times that of the arsenite. These materials have the advantage of non-toxicity and ease of application.

235. The four silvicultural plots at Lungmanis laid down in 1952 were reassessed. These plots are each 20 acres and were laid down in areas logged 4, 3, 2 and 1 year prior to 1952. Half of each plot was poison-girdled and all the smaller weed trees felled. In 1956 the results can be briefly summarized as follows:

- (1) Treated halves of each plot have a much higher stocking of commercial seedlings.
- (2) The number of dominant individuals of the new crop is higher in the treated halves.
- (3) Indications point to the fact that at about five years after logging the number of seedlings on untreated areas tends to decrease due to suppression and death.

236. A small trial of five proprietary log insecticides was carried out in the Gum-Gum Forest Reserve. Urat mata (*Parashorea malaanonan*) was used as the test tree. The results have not yet been fully worked up but the following can be noted:

- (1) Beetle attack is far more severe on logs with the bark removed than those with bark intact.
- (2) Attack is over 10 times more severe when logs are left in shade.
- (3) Effective control for more than six weeks in billets with and without bark, was obtained with two of the materials, Hexastan and Lyxastan both applied as a water based spray. Two of the kerosene-based sprays, gave good control on billets with the bark removed, but were not so effective on billets with bark intact.

237. The figures obtained by the Forest Botanist in the Mt. Quoin area in 1955 show the strong soil preferences shown by some of the Dipterocarps and other families, e.g.:—

	Number per acre occurring on:	
	<i>Sedimentary Soils</i>	<i>Volcanic Soils</i>
<i>Dipterocarpus spp.</i>	4.75	0.60
<i>Shorea beccariana</i>	3.50	0
<i>Shorea multiflora</i>	3.25	0
<i>Shorea leptoclados</i>	0	5.80
Polygolaceae	14.50	2.20
Celastraceae	5.00	0.20
Ebenaceae	0.50	5.60

The Mt. Quoin volcanics apparently give a soil very similar to that supporting good cocoa on Table and Burut Estates near Tawau. This coupled with the peculiar type of forest it supports (few very large trees over a smaller understorey) points to its suitability for this crop, since the large trees could be left for high shade.

Colonial Pool of Entomologists at the Commonwealth Institute of Entomology

238. *Research on Premature Nutfall of Coconuts.* Premature Nutfall of Coconuts in the British Solomon Islands is caused by the Coreid bug *Amblypelta cocophaga*. In some areas very effective natural control is given by certain predatory ants. In nutfall areas, however, non-protective ant species (*Iridomyrmex myrmedociae* or *Pheidole megacephala*) occur on the palms. They fail to control *Amblypelta* and prevent the beneficial ants occupying the palms. Evidence is now fairly complete that the introduced ant *Anoplolepis longipes* gives almost, if not quite, as good protection against *Amblypelta* as the indigenous *Oecophylla smaragdina*, which has long been known to be highly beneficial. The continued spread of *Anoplolepis* in certain areas is thus a desirable feature. Considerable natural changes occur in the areas occupied by the various ant species and attempts have been made to investigate the factors responsible for these changes, in particular to find out if there is any correlation between the dominant ant species and the type of ground vegetation occurring in the area, as has been suggested by previous investigators. No such correlation has so far been discovered and it seems unlikely on present evidence that this line of approach will prove of practical value. Attempts to control the harmful ant species by means of poison baits and trunk spraying with insecticides have so far not been successful.

239. It now seems unlikely that the "ant approach" to the problem will provide a satisfactory solution. Although it is not being abandoned entirely, attention is now being concentrated on direct control of *Amblypelta* with insecticides. Assuming that effective measures can be worked out, there will still remain a formidable problem of application under plantation conditions in the Solomons.

240. In January, 1957, Mr. C. R. Wallace completed his field investigations and his report on the pre-harvest losses caused by insects to the groundnut crop in the Gambia, which he finds are principally due to the virus of rosette disease, transmitted by *Aphis craccivora* Koch. During the past year Mr. Wallace has also completed a very comprehensive report on his previous

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investigation, in British Guiana, of the damage to rice associated with the paddy-bug, *Solubea poecila* Dall. Dr. I. W. B. Nye has now completed the first year of his survey of the pests of tropical cereal crops in East Africa.

Pool of Plant Pathologists at the Commonwealth Mycological Institute

241. Mr. R. A. Altson returned from Sarawak and Mr. P. Holliday continued research on the serious root rot of pepper (*Piper nigrum*). Excellent advances have been made in this investigation and there now seems little doubt that the causal agent is a species of *Phytophthora*. Preliminary control experiments have been conducted without much success, so Mr. Holliday is visiting the pepper growing areas of India and Indonesia, where *Phytophthora* was once a problem, in order to seek resistant stock and to study methods of cultivation.

242. Dr. B. E. J. Wheeler successfully completed his researches in Nyasaland into the serious tobacco leaf spot caused by *Alternaria longipes*. The disease has now been brought under control by the local growers, using methods recommended by the Institute. Following on Dr. Hopkins' recommendation Dr. Wheeler has gone to Malta for six months at the invitation of the Maltese Government to survey crop diseases.

Termite Research Unit

243. The Unit has concluded field work in East Africa and two members (Mr. Sands and Mr. Wilkinson) started a survey in Northern and Southern Nigeria respectively. Large collections of termites were identified by the Unit's staff at the British Museum (Natural History). These collections came from Rhodesia, Nigeria, Solomon Islands, Nyasaland, Tanganyika, Delhi, Kuwait, Abadan, British Guiana, Belgian Congo, Irak, Sudan and Malaya. Several families were completely revised.

244. In Northern Nigeria a general survey of termites is being made with special attention to damage done to crops and trees and on their effects on the soil from mound building. Trials on the use of insecticides for the protection of trees and on the persistence of insecticides in the soil are in progress. In Southern Nigeria attention is chiefly directed to studies on dry wood termites infesting buildings.

245. Mr. Harris visited Malaya, Sarawak, North Borneo and Australia. The Unit received an increased number of enquiries of an economic nature with emphasis on termite damage to plastics such as cable coverings and plastic paints.

Publications

SANDS, W. A.—A new species of *Mineuterme*s from the Gold Coast. *Proc. Roy. ent. Soc. (B)* **25** (1956) 83-84.

SANDS, W. A.—Some factors affecting the survival of *Odontotermes Badins*. *Insectes Sociaux* **3** (1956) 531-536.

HARRIS, W. V.—Isoptera; Danish Expedition to the French Cameroons. *Bull. D'IFAN* **18** (1956) 926-937.

HARRIS, W. V.—Termite Mound Building. *Insectes Sociaux* **3** (1956) 261-268.

HARRIS, W. V.—Field Tests for Termite Resistance. *Col. Building Notes* No. 39.

HARRIS, W. V.—Termites destructive to Timber. *Rec. 1956 Ann. Convention B.W.P.A.* : 145.

SANDS, W. A.—Revision of the East African Nasutitermitinae. *B.M.N.H. Bull. (Ent.)* 5 (1957) 1–28.

SANDS, W. A.—Soldier Mandibles of the Nasutitermitinae. *Insectes Sociaux* 4 (1957) 13–24.

HARRIS, W. V.—Isoptera of Rennel Island. *Zoology of Rennel Islands*, pt. 14 (1957) Copenhagen.

HARRIS, W. V.—Colony Foundation in Isoptera. *Proc. X. Internat. Congr. Ent.* (in press).

Colonial Pool of Soil Surveyors

246. All six officers in the pool were on assignments in Colonies during the year, though one of these was still under training during a six month assignment in British Guiana. The remaining five are serving in British Guiana, Hong Kong, Northern Rhodesia, Swaziland and Malta. The Surveyor in British Guiana is a member of the team under C.D. & W. Scheme R.670. The Survey in Hong Kong was started under the guidance of Dr. Glentworth, Head of the Soil Survey of Scotland, who spent two months in Hong Kong with the Surveyor. The Survey in Malta has been carried out under the guidance of Dr. Osmond, Deputy Head of the Soil Survey of England and Wales, who has paid two visits to the territory. In Northern Rhodesia the Surveyor took part in an Agricultural Survey of the Copper Belt. The officer under training in British Guiana has since been appointed to the Pool and taken up his first assignment in Sierra Leone.

Colonial Liaison Officer at the Pest Infestation Laboratory, D.S.I.R.

247. The Colonial Pest Infestation Liaison Officer has a staff of four and this group together with the staff of the Pest Infestation Laboratory, D.S.I.R., and with the collaboration of the other Research Institutes, has continued to develop investigations on Colonial stored products problems as well as to give advice on specific enquiries.

248. As a result of the studies made by Mr. A. A. Green, of the Pest Infestation Laboratory (D.S.I.R.), the Gambia Government has agreed that results are sufficiently promising to warrant the introduction of legislation to make compulsory the insecticidal treatment of harvested groundnuts. A Pest Control Officer has been appointed to the Department of Agriculture to implement the recommendation.

249. Mr. G. A. Haswell, Assistant Colonial Pest Infestation Liaison Officer, visited East, Central and South Africa, and Mr. T. A. Oxley of the Pest Infestation Laboratory (D.S.I.R.), visited Uganda and Kenya for about two months to make recommendations for new storage for maize and wheat.

250. The seasonal variations in the physical conditions and the rate of insect infestation build up in small stacks of swamp raw and parboiled paddy in Sierra Leone, have been investigated. In this territory bagged raw paddy can be safely stored for at least a year with a moisture content between 12.5 per cent. and 14.5 per cent. Parboiled paddy, on the other hand, is more susceptible to insect attack. It is interesting to compare this with observations in British Guiana where raw paddy is more susceptible to insect attack than parboiled paddy. From laboratory experiments in Sierra Leone on susceptibility to attack by *Calandra oryzae*, it was found that upland native cleaned rice was most susceptible, parboiled milled rice rather less susceptible and swamp parboiled paddy susceptible only to a small degree.

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251. One of the essentials in the proper storage of commodities is to prevent the passage of water vapour through the floor. Various methods of proofing existing warehouse floors to eliminate the need for wooden dunnage have been investigated at the Laboratory. Different bitumen treatments have been tested and the general conclusions from this work are that good, well compacted concrete on gravel-type soil probably does not transmit much water vapour, that bituminous paints applied as two coats, and bituminous felts, are both good waterproofing barriers, while sisalkraft paper and a commercial bituminous compound containing rubber are of doubtful value.

252. Maize which has been infested during storage by insects, particularly the flour beetle *Tribolium castaneum*, has deteriorated chemically. The fat, phosphate and water-soluble acidities increase and the oil content decreases. Experiments are being carried out to investigate the nutritive value and palatability of maize meal prepared from maize infested with *T. castaneum*. In these tests there is collaboration between the Pest Infestation Laboratory (D.S.I.R.), the Colonial Products Laboratory, the Human Nutrition Unit of the Medical Research Council and certain Departments of the Governments of Uganda, Kenya and Tanganyika.

253. Experiments are being carried out in Ghana and Nigeria to determine the taint and toxicity hazards to cocoa when the insecticides DDT and lindane are used in certain prescribed ways. This work involves the co-operation of the Pest Infestation Laboratory (D.S.I.R.), the Cocoa, Chocolate and Confectionery Alliance (Cocoa Scientific Advisory Committee), the Colonial Products Laboratory, the Nigerian and Ghana Cocoa Marketing Boards, the West African Stored Products Research Unit, the Ghana Department of Agriculture and certain commercial organisations.

254. A thermocouple spear has been designed which can be pushed into a stack of bagged produce to measure the temperature within the stack. Six spears have been sent to a number of Colonial territories for efficiency trials.

Publications

D. W. HALL, G. A. HASWELL and T. A. OXLEY—Underground storage of Grain. Colonial Research Studies No. 21.

D. W. HALL—Food Storage in St. Lucia. Colonial Office.

D. W. HALL—Food Storage in Antigua. Colonial Office.

D. W. HALL—Stored Products Problems in Sierra Leone. Colonial Office.

D. W. HALL—Stored Problems in Northern Rhodesia. Colonial Office.

D. W. HALL—Food Storage in Nyasaland. Colonial Office.

D. W. HALL—The Copra Industry of Zanzibar. *Colon. Pl. Anim. Prod.* 5 (1955) 305-308.

D. W. HALL—Insect Damage Observed in Stored Groundnuts. *E. Afr. agric. J.* 22 (1956) 106.

Research Studentships

255. Eleven Research Studentships were awarded during the year covering training in Agronomy (4) Stored Products Entomology (2) Entomology (2) Soil Chemistry (1) Virology (1) and Genetics (1).

VI. RESEARCH UNDERTAKEN BY COLONIAL DEPARTMENTS OF AGRICULTURE, FORESTRY AND VETERINARY SERVICES

ANTIGUA

256. Research on sugar cane is undertaken by the staff employed by the Antigua Sugar Investigation Committee and is financed by the industry. Trials are in progress with new varieties produced at the Central Sugar Cane Breeding Station, Barbados, to determine which varieties are best suited to local conditions. In addition, agronomic experiments are being undertaken to determine the optimum time of planting, the effect of heat treatment on cane setts, the best type and spacing of planting material, the optimum manurial applications for different soils and the effect of different methods of cultivation.

257. The research work of the Department of Agriculture is perforce restricted by the limitations of staff. Spacing and manurial trials have been carried out on arrowroot: a further varietal trial with strains of improved castor from the U.S.A. is in progress: trials with imported strains of sorghum have given encouraging results and two varieties of tomato imported from Florida have shown considerable promise.

258. Pangola grass (*Digitaria decumbens*) and Coastal Bermuda grass (*Cynodon sp.*) have proved to be valuable pasture grasses under local conditions and their planting is extending. Trials using the Jamaica methods of pasture improvement by rotational grazing in small paddocks are giving promising results and these methods are being adopted commercially. It has been found possible in a peasant grazing area established and run on these lines to carry three animals on two acres of pasture alone.

BARBADOS

Agronomy and Agricultural Chemistry

259. Three sugar cane ratoon cultivation trials have shown little or no benefit from subsoil chiselling. Heavy cultivation of ratoons may even be detrimental especially on the free draining red soils. In a single trial, food crops including yams, sweet potatoes, maize and beans had no residual effect on the succeeding plant cane crop even when they were harvested two months after planting the cane. There was no increase in the yield of plant cane following a six month fallow.

260. The fertilizer trial on elephant grass (*Pennisetum purpureum*) has continued to give large potash responses. Consistent smaller nitrogen responses have also been found but no phosphate response. The strain of *Pennisetum purpureum* from the Cameroons has proved superior to others.

Irrigation

261. As a result of a comprehensive drilling scheme elevated sheet water basins have been found in St. Philip and large underground streams flowing from higher areas into St. Philip have been found and partly traced.

262. Plantation scale irrigation of sugar cane was continued at the stations at The Pine, Sandy Hill and Hope. Irrigation water was applied equivalent to a rainfall of four inches per month. Canes at Sandy Hill and The Pine were adversely affected by "Hurricane Janet" but preliminary indications at the latter station are that the yield of cane per arable acre, in the irrigated area, was increased by approximately 20 per cent. This is principally due to increased ratooning on the best fields and ratooning on others where this was not possible under previous non-irrigation conditions.

263. Evapo-transpiration figures have been calculated for several years from meteorological data. In conjunction with the average rainfall figures they

show that evapo-transpiration exceeds precipitation for five months of the year. Growth and soil moisture measurements have shown that water applications during 1955 were insufficient for maximum growth, that soil moisture was significantly greater under a trash mulch and that the growth curves show a marked seasonal pattern. The growth after September declined in spite of adequate soil moisture. Small plot irrigation trials have shown marked responses to irrigation. Response to nitrogen manuring was greater on the irrigated plots and it was shown that early nitrogen dressing is required if the cane is irrigated in the dry season. A single experiment on irrigated land suggests that there is no benefit from planting two months early, i.e., in September but that an increased yield is obtained by planting with a closer spacing.

BECHUANALAND

Fertilizer and Manurial Trials

264. Trials conducted at Lobatsi in the Southern Protectorate have been continued to test out the residual effect of phosphatic and manurial dressings separately and combined. After two years significant yield increases are still being obtained from treated plots over control plots. Supplementary evidence from co-operative experiments shows that while significant responses follow dressings of krall manure, which is readily available, optimum yields are obtained from combined dressings of manure (2-3 tons per acre) and super-phosphate (100 lbs. per acre). Elsewhere in areas where a marked phosphate deficiency does not exist, manurial dressings (2-3 tons per acre) give the best results.

Agronomic Investigations

265. The effect on yields of simple crop rotations which can be followed by African farmers is now being investigated and also the effect of grass leys. More attention is being given to disease and pest resistance of varieties than in the past. Progress in the pearl millet breeding project has been maintained and approximately forty homozygous lines have now been fixed.

Pasture Research

266. Long term grazing trials to determine the optimum carrying capacity of natural pastures and to test out different systems of grazing were continued. Results, so far, show no significant differences between the productivity of pastures continuously grazed and of those subject to deferred rotational and split season grazing systems. Debushing of natural pastures increases carrying capacity very considerably but no evidence is yet available that this practice is economical.

BERMUDA

Biological Control of Scale Insects Attacking Oleanders

267. Work on the two scale insects attacking oleanders, green shield scale, *Pulvinaria psidii* Mask. and oleander scale *Pseudaulacaspis pentagona* Targ. was continued with a view to determining whether the scales were increasing in importance. A factor of possible importance discovered was the effect of lizards (*Anolis grahami*) on the populations of several species of ladybirds which have been introduced to control the scales. The lizards certainly feed on the ladybirds and their larvae and may be a major factor in preventing the effective biological control of the two scales on oleanders. Liberations of *Prospaltella ? berlese* How. (material from *P. pentagona* in the South of France) were made on oleander scale but recovery studies have yet to be carried out.

Control of Land Crabs, Gecarcinus lateralis.

268. The land crab is of considerable importance in Bermuda. Tunnels made by the crabs ruin lawn areas and gardens and the crabs themselves cause damage to a variety of plants. Two baits showed excellent promise. One contained bran (20 lbs.), DDT 50 per cent. wettable powder (1 lb.), salt ($\frac{1}{2}$ lb.) and enough water to make the mixture moist. In the other bait, Dieldrin 50 per cent. wettable powder was substituted for the DDT. Experiments have indicated that a teaspoonful of either of these baits placed in the mouth of each crab-hole will result in virtually 100 per cent. control. Dieldrin is slightly more effective than DDT.

Herbicides

269. Wild Onion, *Northoscordum fragrans* was effectively controlled by a 2 per cent. Kuron solution. Two applications, six months apart, are required for complete control. Kuron and sodium chlorate have been used very successfully against *Oxalis* spp.—Kuron at 1 and 2 per cent. and sodium chlorate at the rate of 1 lb. per gallon of water. Sodium chlorate shows excellent promise as a means of controlling wire weed, *Sida carpinifolia*.

BRITISH GUIANA

Sugar Cane

270. Variety testing of seedlings from Barbados and from "fuzz" from variety crosses made in Barbados and British Guiana continued. The variety B.47258 has been recommended for commercial planting, while moderate plantings of B.45137 and B.43413 have also been recommended. B.41227 and B.37161 continue to be the major commercial varieties. The most promising of other varieties under test appears to be B.49119 which is, however, susceptible to leaf scald disease.

Insect Pests

271. The control of leaf cutting ants (*Atta cephalotes*) received study and more effective control was achieved with Aldrin as compared with Chlordane. Control of *Castnia daedalus* attacking coconuts with a 1 per cent. emulsion of Dieldrin proved more effective than nicotine.

Rice Storage Investigations

272. Investigations on insects affecting stored paddy and rice were undertaken. The damage and losses, in-bin storage and drying, vapour-proofing of floors in bonds, fumigation, and use of paper sacks were the principal subjects dealt with.

Animal Health and Diseases

273. Good progress was made with investigations into Cirrhosis of liver and paralytic rabies in beef cattle, swine fever and poultry diseases. Mineral deficiency and infertility problems in cattle were also under study.

Forestry

274. Experiments in the establishment of plantations of *Pinus caribaea* were continued. Trees planted on brown sands in 1954 and 1955 made very good progress. Those planted on white sands in 1955, were badly attacked by Coushie ants (*Atta* spp.). Growth was poor; many trees died and the plot was eventually abandoned. Two small (4 acre) plots were established on white sand recently cleared of secondary cover during the year and here the initial indications were much more encouraging than on the abandoned airstrip.

275. Extensive tendering operations were carried out in an area of exploited Greenheart forest which had received its initial experimental treatment in 1954.

Publication

CLARKE, E. C.—The regeneration of worked-out Greenheart (*Ocotea Rodiei*) Forest in British Guiana. *Emp. For. Rev.* 35 (1956) 173-181.

BRITISH HONDURAS

Livestock

276. In the course of grading up local stock with boars from the pedigree Berkshire herd, the half breds had twice the survival at 56 days of the pure breds and $1\frac{1}{2}$ times the local breed. In weight at 56 days the pure breds were nearly three times the weight of the local breed and twice the local pigs.

Agriculture

277. *Pastures.* Local natural pasture gave between 7,500 and 12,500 lbs. D.M./acre/annum over the 2-year period measured. There was little or no response to fertilizer. Three-quarters of this production was available during the six months June–November inclusive. In March and April production averaged only 120 lbs. D.M./acre/month. Botanically the pasture was about half weeds, mainly of a stemmy, wiry type.

278. Sweet grass (*Ixophorus unisetus*) has been selected locally and bulked up. Measurements designed to characterise the yield curve for the year have been started. A yield of 4,300 lbs. and 8,300 lbs. D.M./acre have been obtained from unfertilised and fertilised plots respectively in 17 weeks. Similar incomplete results on pangola grass (*Digitaria decumbens*) indicate yields of 6,300–6,800 lbs. D.M./acre in 15 weeks under fertilised conditions in various parts of the Colony. Blue panic (*Panicum antidotale*), Rhodes grass (*Chloris gayana*) and Buffel grass (*Pennisetum ciliare*) are all showing good promise.

279. *Crops.* It has not so far been possible to find any sugarcane variety which will yield consistently better than P O J 2878, although B4098 is gaining popularity. Chemical weedkilling has been hampered by regenerating forest since most land is recently cleared, 2,4-D is not the whole answer. Work continues with 2,4,5-T.

280. Various fertilizer trials on citrus now in their fourth year do not show any response in terms of tree height, circumference or girth. It is hoped that responses will be apparent next year when reaping commences. A fertilizer trial with coconuts on leached old alluvium indicates highly significant increases in growth of 3 and 4 year old coconut trees due to phosphate.

Forestry

281. To find a method of regenerating Pine on wet savannah without the expenses of nursery work and intensive ridge ditch ploughing, a series of experiments were laid out at Mango Creek to test different combinations of seeding methods, seed treatments, drainage techniques and harrowing techniques. Poor seed and the early onset of the rains which rapidly water-logged the land interfered with results. The only clearly successful technique was direct sowing by lines or patches along ploughed ridges.

CYPRUS

Agronomy

282. In the third year of wheat variety trials the Australian *Triticum vulgare* varieties Bencubbin 48 and Bungulla again gave good results, particularly under rainfed conditions. Further work was done on the identifications of physiologic strains of stem rust of wheat. In the 1956 survey, two races, 14 and 24, were isolated. Race 14 was again the most prevalent.

283. Trials of oil-bearing crops gave promising results. An Australian spineless variety of safflower (*Carthamus tinctorius*) produced yields as high as wheat and better than barley. It appears to be drought tolerant. An introduced variety of groundnut, Virginia, yielded well and gave indications of earlier maturity than the varieties grown locally.

Pasture and Forage

284. Introduction of varieties and strains of fodder plants has been carried out on a large scale for some years. This work entered a new phase, in so far as it was possible to eliminate thousands of unsuitable species and types. Work was concentrated on further testing, selection and multiplication of improved types. Research on methods of pasture establishment progressed satisfactorily and 300 acres of improved pasture have been sown. A research project to investigate the possibilities for arable/ley farming in Cyprus was established.

285. Experimental pastures were sown on 20 acres of land reclaimed by mechanical ripping of the hard limestone crust (kavkalla) which covered it. The experiment is designed to compare the productivity of the pastures with that of arable crops grown on the same reclaimed land.

286. A survey of the uncultivated lands of Cyprus was started in March, 1956, by a team of two, an ecologist and a soil surveyor, seconded to the Department of Agriculture by Hunting Technical Services. The object of the survey is to classify these lands according to their potentiality for improvement and to make a stocktaking of the Island's present and potential pasture resources.

Plant Nutrition

287. Residual effects of basic slag continued to be very marked in the fifth crop taken after the application of the fertilizer, while the effect of superphosphate disappeared after the second crop. An experiment with apple seedlings has shown that high dressings of animal manure and also heavy rates of irrigation induce symptoms of iron deficiency.

288. A chemical survey of the irrigation waters of Cyprus was made. It was found that many waters contain useful quantities of potassium, exceeding in some cases 20 p.p.m. Waters derived from the igneous formations usually contained less than 2 p.p.m. The total contents of potassium in Cyprus soils is generally more than 1 per cent.; it is present mainly in the silt and sand fractions.

Horticulture

289. Studies of the carob tree (*Ceratonia siliqua*) which is of great economic importance to Cyprus, were started. In an experiment designed to ascertain the effects of water and of different fertilizers on the growth of seedling carobs in pots and trees in the field, no response was obtained to top dressing the seedlings with nitrogen or phosphorus but plants which received adequate water were three times the weight of those which received smaller supplies. In the field experiments yield and girth measurements of trees are being made at yearly intervals.

290. The effects of saline water on the growth of young carobs was investigated. Water containing more than 1,000 p.p.m. NaCl was detrimental to growth: at this level plants grown in the shade appeared healthy while those exposed to direct sunlight suffered severe scorch and leaf fall. The connection between shade and salt tolerance is being investigated further. Addition to gypsum at two different concentrations appeared to have no beneficial effect.

Plant pests and diseases

291. Experiments on control of Mediterranean Fruit Fly (*Ceratitis capitata*), begun in 1955, were continued and valuable information was obtained on the effectiveness of the various concentrations of Dieldrin. It was found that a reduction of the concentration of dieldrin from 0.1 per cent. to 0.075 per cent. did materially reduce its effectiveness and that spraying alternate rows of trees in large citrus groves with a 0.1 per cent. dieldrin solution was almost as effective as spraying every tree in the grove. Further work with poison bait sprays containing protein hydrolysates showed that these sprays are effective against Mediterranean fruit fly when applied to large plots of trees. Useful information on the optimum concentration of the ingredients in the bait formula was also obtained. A study of the distribution of the pest and its relative abundance throughout the citrus-growing areas of the island was carried out by means of indicator fly traps. It yielded valuable data.

292. An experiment was started with the object of evaluating various materials and treatments for the control of Citrus Bud Mite on lemon trees. The materials used were white oil, chlorobenzilate, R-6199 (Plant Protection) and 4536 (Bayer, Metasystox). Very encouraging results were obtained with 4536 applied as a trunk treatment immediately prior to the spring flush of growth.

293. Experiments were also made with a number of treatments designed to give combined control of *Aonidiella aurantii*, *Myelois ceratnoiae*, *Cryptoblabes gnidiella* and *Pseudococcus citri* on citrus. These were conducted on grapefruit at Fassouri, the largest citrus plantation in Cyprus. A combination of parathion-malathion applied twice as a spray, on 18th July and 13th September, gave the best results. The performance of oil alone, under the conditions prevailing at Fassouri, was unsatisfactory.

294. A long-term investigation of the biology of the Cereal Leaf Miner (*Syringopais temperatella*) the most serious pest of wheat in Cyprus, was started. The primary object is to investigate rate of survival of larvae of the insect in soil cropped in different ways and kept fallow over different periods. Parallel investigational work is being conducted in the laboratory.

295. Populations of the Olive Fly (*Dacus oleas*) were so low in most areas that control experiments would not be continued. Observations at Meneou on the seasonal abundance of the insect indicated a marked decline of population during 14th August to 7th September and two subsequent flight peaks on the 1st and 28th of October.

296. In experiments on control of Olive Leaf Spot (*Cycloconium oleaginum*) using 10-1-100 Bordeaux mixture, one treatment applied on 20th October reduced the incidence of the disease by 92 per cent. Treatments applied in late January and late March had little or no effect. A second treatment applied at different periods in addition to the treatment given on 20th October increased the efficiency of the first treatment only slightly. Best control (95 per cent.) was obtained when the treatment of 20th October was supplemented by a second treatment on 29th December. The indications are that a second treatment may not be necessary except in years of abundant

rainfall. Counts of the incidence of leaf spot on a number of olive varieties indicated that the common Cyprus variety, "Ladoelia", is more susceptible to this disease than sixteen introduced varieties.

Animal husbandry

297. In a comparison of milk yields of Saanen and Damascus goats, conducted at Saitta, one of the Department's hill stations, the Saanen goats again gave considerably higher average yields than the Damascus.

298. A local pig ration containing 10 per cent. of an animal protein concentrate imported from the United Kingdom was tested against the same ration containing 10 per cent. white fish meal. There was no significant difference in the growth rate of pigs on the two rations up to an average live-weight of 120 lbs., the point at which the trial was terminated.

Animal diseases

299. Controlled trials were made on the effectiveness of Hibitane in the treatment of acute staphylococcal mastitis in goats and of Nitrofurazone in the treatment of caprine coccidiosis. A number of outbreaks of salmonellosis in sheep were diagnosed, the causal organism being *S. typhi murium*. This condition may not be new to Cyprus but it has not previously been recognised.

300. Work was undertaken on production of a strain of Newcastle disease vaccine suitable for administration to poultry in drinking water. This strain originated from Israel. Fowl pox vaccination trials were carried out on day-old chicks to determine the most suitable site for vaccination. An outbreak of fowl pox was observed in a flock vaccinated against the disease about four weeks previously. It was demonstrated that the vaccine batch used was still effective. There appeared to be strong grounds for associating the failure of the vaccine with a concurrent and severe state of vitamin "A" deficiency in this flock.

Forestry

301. Trials to discover suitable species for the afforestation of the semi-arid lowlands now consist of over 1,000 individual plots on 23 different sites. The majority of these trials concern nearly 50 Eucalyptus species.

302. In the coniferous mountain forest, preliminary assessments of natural regeneration indicated that the position is far from satisfactory. Results from artificial sowings were poor. Although this problem requires further study, preliminary indications show that the conifers of the mountain forests in many places cannot, under the present condition of the forest, be regenerated satisfactorily under a standing crop, either by natural or artificial seeding.

FIJI

Agriculture

303. Plant introductions during the year included varieties of sweet potato, colocasia, pepper, oil palm, cocoa, arabica and robusta coffee; a large variety of pasture grasses and legumes; and varieties of papaya, passion fruit, plum, tomato and miscellaneous vegetables.

304. The crop rotation studies on the Principal Agricultural Station are now in their sixth year and although not statistically designed, these are starting to yield valuable information on the practicalities of crop management in the Colony and in associated soil fertility maintenance problems. Fertilizer and varietal studies on crops are carried on as they appear in the rotations using for the latter, varietal material secured through the Plant Introduction Station.

305. *Rice* : Several promising Malayan introductions are under trial and the strong-strawed character of Serendah Kuning is of particular interest. Some of the F.A.O. *indica-japonica* hybrids have also been secured and are being further selected under local conditions. Fertilizer trials support the view that highly profitable returns from sulphate of ammonium applications are obtained on dry rice.

306. *Bananas* : The increasing interest in the cultivation of bananas on a plantation scale has necessitated extension of work on fertilizers (including trace elements), disease and insect pest control. Trials include Zineb for leaf spot control and Dieldrin as a weevil borer control.

307. *Cocoa* : Based on the reconnaissance soil survey, an estimate of potential cocoa soils has been made which revealed a total of 170,000 acres of "probable" and a further 250,000 acres of "possible" cocoa soils in the Colony. Surveys of existing cocoa trees in the Colony have revealed a number of promising high producing trees of the Amelonado type. All promising local and introduced clones are tested thoroughly both on agronomical factors and for flavour by the "micro" fermentation technique.

Entomology

308. Investigations into insecticidal control of Rhinoceros beetle continued and effective techniques have now been evolved. The search for effective parasites of the Rhinoceros beetle continues and *Scolia* wasps were introduced and liberated.

309. Other biological control work included examination of the value of a Plasmid parasite for the stick insect, *Graeffea* ; Tachinids for army worms ; investigations into the varying effectiveness of the established egg parasite of *Graeffea* and the effectiveness of a stem borer to control the weed *Lantana*.

310. With the assistance of funds provided by New Zealand Fruit Distributors, the services of Mr. R. W. Paine, previously Government Entomologist in Fiji, have been retained to undertake a special search in New Guinea for a parasite of the banana scab moth (*Nacoleia octasema*). This is a major project which if successful could confer immeasurable benefit on the Colony's banana industry.

GAMBIA

Veterinary Research

311. Research work has continued on the incidence of tuberculosis and brucellosis in cattle in this country. In collaboration with the Medical Research Council Unit an investigation has been started into the haematology of the local cattle, with incidental reference to a type of seasonal anaemia.

GHANA

Plant Pathology

312. Investigation of the cause of Cape St. Paul Wilt of Coconuts continued. Trials involving applications of NPK, FYM, Boron and Manganese, and experiments with trace elements applied to the leaves and injected into the trunks, gave no control. Palms which, by moulding up the trunks, had been induced to form new roots likewise died. Regular measurements of ground water level showed differences not apparently associated with the incidence of the disease, though it was noted that less disease occurred in areas where soil-water movement was influenced by tides. Salinity tests showed that palms were growing in water containing up to 12,000 p.p.m. total

chlorides; and that the disease was present in areas of both high and low salinity. The clearing of dead and diseased coconut trunks was continued in an effort to reduce the breeding sites of Rhinoceros Beetle (*Oryctes owariensis*), and some success was achieved. Dusting five-year-old palms with 1.5 per cent. gamma BHC at fortnightly intervals gave inconclusive results. No evidence could be obtained that Rhinoceros Beetle transmitted Cape St. Paul Wilt.

313. Information was obtained on the spread of Coffee Rust (*Hemileia vastatrix*). The disease has become common in the Eastern and Trans-Volta/Togoland Regions and has now been reported at Mampong (Ashanti).

314. A leaf spot survey has been conducted at Kumasi on 10 groundnut varieties. The per cent. of infection due to *Cercospora arachidicola* and *Cercospora personata* has been recorded. It appears that infection due to *Cercospora arachidicola* appears earlier in the growing period of the plant, whereas *Cercospora personata* appears later, the latter being responsible for the majority of the damage to groundnuts in Ashanti.

Plant Breeding

315. Trials of tall sorghums at Nyankpala and Manga showed that at both stations the midge resistant *Nunaba* types were highest yielding. A number of the new importations of dwarf sorghums showed promise.

316. Hybrid and synthetic line production of maize continued, and numerous ear selections within lines of introduced Central American varieties and their reciprocal crosses were effected. A number of other exotic lines were multiplied and further tested. Mexican 1 and Mexican 5 have demonstrated a high degree of resistance to Maize Rust (*Puccinia polysora*) but are susceptible to lodging.

317. Variety collections of rice have been maintained, and observation trials carried out in microplots on 40 local and introduced varieties, while large scale field trials were conducted in the Ashanti Rice Extension Scheme. Wide variations in yield and other characters were noted. Collections have been made of rice other than *O. sativa*, notably the red-grained *O. glaberrima*, to which many local upland varieties belong.

318. The variety collection of cassavas has been extended to include more of the local varieties. Some of the seedlings from the hybrid Amani seed has been multiplied into clones and tested at Ohawu, the centre of a cassava-growing district where cassava mosaic is rife. Of the 206 hybrids tested only 12 clones have remained completely free of mosaic symptoms. Another 273 hybrid clones will be tested in 1957. A crossing programme between the mosaic resistant hybrids and the highest yielding and the most palatable varieties has been initiated.

319. Research on crossing techniques and seed germination on yams is being continued in liaison with the Federal Research Organization, Nigeria.

320. Ten varieties of groundnuts imported from Senegal showed a high degree of resistance to rosette disease. On the basis of numerous station trials two imported varieties, No. 146 and Natal Common have been chosen for trial against the local variety on native farms.

Entomology

321. Extension work for the control of Maize Stem Borer in two new areas, Central Province and South Togoland, was carried out in September, 1956. Results from both areas are promising and the work will be expanded and continued next season. In Ashanti, the areas which have received two

free issues of insecticide are now expected to buy their own, and extension work is being concentrated on adjacent districts.

322. The importance of "volunteer" sorghums which grow between March-June, as a carry-over host for *Sesamia peophaga* Tams and Bowden, has been demonstrated. Further work is being done to determine the most suitable time for destruction of this crop, and also Millet stubbles for control of *Coniesta ignefusalis* Hampson, the Millet Borer.

323. Extension work on village silo storage of maize has gone extremely well in Ashanti. Over 80 tons are in store and further plywood silos have been ordered. Treating the maize with a 0.45 per cent. gamma BHC dust at 5 parts per million has given complete control of *Calandra oryzae*, but not of *Tribolium castaneum* and *Gnathocerus maxillosus* which are occasionally present. A heavy infestation of two psocids, *Liposcelis entomophilus* (Enderlein) and *Liposcelis bostrychophilus* Badonnel, were found in a silo in one village. They were also found in the village maize stores. The psocids did not appear to be affected by the BHC treatment. The infestation was not noticed until three months after treatment and storage.

324. A cob storage trial using cobs with sheath, cob minus sheath, and cob minus sheath plus gamma BHC at 5 p.p.m. and 12.5 p.p.m. respectively, has been carried out. By using exit holes as an index of *Calandra oryzae* damage after 6 months storage, it was shown that for prevention of attack from *Calandra oryzae* it is better to leave the sheath on the cob, unless the cob is to be dusted at 12.5 p.p.m. with gamma BHC. Following the 1955 "demonstration experiment" there has been a demand from the farmers, and in four villages used for demonstrations over one ton of 0.45 per cent. gamma BHC dust has been sold.

325. A survey of Grain Storage in the Northern Territories was carried out in April, 1956. All stores visited were infested, the most common species being *Tribolium confusum*, *Calandra oryzae*, *Corcyra cephalonica*, *Lasioderma serricorne*, *Oryzaephilus mercator*, *Tribolium castaneum* and *Rhizopertha dominica*. *Tribolium castaneum* was only found on Agricultural stations, but *T. confusum* was found both on stations and in farmers' silos. Experimental treatment of farmers' storage chambers, both with lindane dust and a 3.1 mixture of ethylene dichloride/carbon tetrachloride mixture was carried out. Preliminary results favour the lindane dust, which, however, is the more difficult to apply. The experiment continues.

Capsid control

326. Insecticidal trials against the cocoa capsids, *Distantiella theobroma* and *Sahlbergella singularis* continued, in both mature and young stands. Information obtained from 1955 trials led to the adoption of a standard treatment for control of capsids in mature cocoa, namely two applications of 4 ozs. gamma-BHC per acre, applied at 4-weekly intervals with a power-driven shoulder-mounted mistblower. Five gallons of wash per acre is recommended. Good control of capsids with less than 5 gallons of wash per acre has been obtained, but the higher rate was adopted to compensate for inadequate coverage due to inexperienced operators, difficult terrain, etc. By the end of the year the Department's programme for spraying upwards of 700,000 acres of capsid-damaged mature cocoa was well under way using the standard treatment applied by some 700 mistblowers.

327. Work is in progress designed to find the optimum times of the year for spraying and to study the rate and pattern of reinfestation of capsid-free cocoa. It is already apparent that the standard treatment gives an extremely high degree of control irrespective of time of year or capsid

populations. It is also clear that the major factor influencing reinfestation is the size of the experimental unit, large scale units of contiguous cocoa having a very considerable advantage over small scattered units.

328. Gamma-BHC applied with pneumatic knapsack equipment using atomising jets has now replaced jetting with DDT as the recommended control for capsids on young cocoa. 28 c. of a 20 per cent. γ -BHC emulsion let down into 1 gallon of water is used both for initial treatment and retreatment.

329. A serious problem is how to encourage farmers to retreat farms following initial treatment with the standard mistblower spray. The Department has demonstrated that retreatment can be satisfactorily effected using specially adapted long lance pneumatic knapsack sprayers, but such work is tedious, and different techniques are still under observation.

330. In conjunction with W.A.C.R.I. field trials have been carried out with Endrin, Dieldrin, Aldrin and Heptachlor. All except the last have given positive results, but Aldrin only is at present likely to compete with γ -BHC.

Swollen-Shoot control

331. A series of trials in co-operation with W.A.C.R.I. were commenced to attempt to reduce the spread of swollen-shoot disease by control of ants and mealybugs.

332. The trials are being undertaken on one 400-acre area of contiguous cocoa and 76 small discrete outbreaks, all in the Eastern Region of Ghana. Normal Swollen-Shoot disease control measures (cutting out, with and without removal of contact trees) are being compared with Dieldrin at 1-lb. toxicant per acre, in 22 gallons water, also with and without removal of contacts. The spray is applied twice by mistblower to the trunks of cocoa and forest trees. In some of the discrete outbreaks, a follow up spray of Malathion is being used to attempt complete eradication of the mealybugs. It is not yet possible to say whether these experiments will lead to a practicable or economic control of the disease but there is already evidence of appreciable decreases in both ant and mealybug populations.

Black Pod Disease

333. Field trials on the control of Black Pod disease (*Phytophthora palmivora*) continued, using copper sprays with both mistblowers and pneumatic knapsack equipment. Little appreciable control of the disease in harvested pods was achieved, but considerable increases in marketable crop were demonstrated in sprayed plots. This was of the order of 30-40 per cent. overall, the increases being particularly marked in mistblown plots. It has become apparent that there is in Ghana a very big loss through *Phytophthora* wilt in the cherelle stage. This aspect is being further investigated in 1957 in a new series of experiments which also include different spraying times and the use of spreaders and stickers.

Chemistry

334. The half replicate trials using trace elements were repeated on their same sites for the second year. None of the crops (maize, groundnuts and guinea corn) responded encouragingly to any of the trace element sprays; on the other hand scorching sometimes occurred, notably with copper sulphate and depressed yields. About 40 simple 4-plot trials to measure the effects of sodium molybdate both with and without other fertilizers were also completed and showed no benefit from the molybdate applications. Annual crops are probably not affected by any significant and widespread deficiency in Ghana of boron, copper, iron, zinc, manganese, molybdenum or magnesium.

335. Extension trials on farmers' land were carried out on groundnuts and yams in the Northern Territories, maize in Ashanti and cassava in the Accra plains. Once again single superphosphate proved to be better than triple superphosphate for the groundnuts. Responses with yams and cassava were promising but in Ashanti on maize NP fertilizers would have been barely profitable.

Soil, Vegetation and Land-Use Surveys

336. Detailed Preliminary Surveys were carried out in the following areas:—

- (i) Lower Tano Basin, an area of 2,800 square miles in the extreme south-west of the country. Survey commenced in November, 1954, completed January, 1957. This survey provided the opportunity to study soils developed under tropical rain forest receiving rainfalls up to 100 inches per annum. Soils in general become increasingly acid and more deeply weathered with higher rainfall. Ground-water podsoils were discovered occupying savannah-covered, infilled lagoons near the coast.
- (ii) Ho-Keta Plains, an area of 2,800 square miles in the extreme south-east of the country. Survey commenced in September, 1955, completed August, 1956. Soils are mainly developed on gentle topography over Basement Complex acidic and basic gneisses and Tertiary and Recent sediments. Annual rainfall is 30-50 inches and most of the region is under savannah vegetation. Soils are mainly young and, although possessing drift profiles, closely reflect the nature of the parent rock.
- (iii) Birim Basin, an area of 1,500 square miles in the eastern part of the cocoa-growing portion of the forest zone, surveyed between April-August, 1956. Soils are mainly developed over Lower Birrimian phyllites and terrace deposits derived from them under an annual rainfall of 50-75 inches.
- (iv) Pawmpawm Basin, an area of 770 square miles near the eastern edge of the forest zone. Survey commenced August, 1956, completed February, 1957. Soils are developed over Togo, Buem and Voltaian sediments (mainly sandstones) under 45-65 inches annual rainfall. Cocoa failed on these soils some 20-30 years ago, mainly due to drought apparently, but the area is now heavily food-farmed. This survey permitted the study of the Krobo farming system (land rotation cultivation within permanently-owned linear strips of land) in relation to soil and vegetation factors.
- (v) Mole-Lower Kulpawn-Daboya Region, an area of some 5,600 square miles in the north-centre of the Interior Savannah zone. Survey commenced in August, 1956, but had to be discontinued in December, 1956 when the officer in charge was withdrawn from field duties on medical grounds. By then, some 1,100 square miles in the south of the region had been examined. The object of the survey was to discover areas of soils suitable for settlement of population from the over-crowded northern frontier areas, but provided also an opportunity to examine soils developed over granites and Lower Birrimian phyllites, as well as Voltaian sandstones and shales, under Interior Savannah conditions. Soils are in general more highly ironstone concretionary than soils over comparable rocks in the forest zone, and have a much less satisfactory moisture and nutrient status.

- (vi) Detailed surveys were carried out of a number of Agricultural Stations and preliminary inspections were made in the selection of a suitable site for the University College's proposed forest farm and of sites for various Agricultural Development Corporation plantation projects. Investigations were made of the soils on a number of Forestry Department nurseries. The detailed survey of the Department of Animal Health's Pong Tamale station was completed. Advice has been given to the Public Works Department on the use of soils as subgrade material for roads.

Analytical investigations

337. *Methods.* Extensive study was given to the elaboration of an absolutely reliable method of determining exchangeable calcium and magnesium using a routine semi-micro procedure applicable without alteration to soils containing 0.1-5.0 m.e. exchangeable Ca and 0.1-2.5 m.e. exchangeable Mg. The versenate method was adopted and a suitable technique worked out accurate to 1 per cent. irrespective of the absolute amounts present except where less than about 2 m.e. are present. The average titration error does not exceed 0.05 ml. of a N/50 versenate solution. By suitable arrangement of the medium, interference by appreciable amounts of manganese can be completely eliminated.

338. Comparison of the results obtained by the ammonium acetate and barium acetate methods of determining cation exchange capacity revealed discrepancies in the case of several forest soils. Only the latter method, using 0.5-1.0 N barium acetate, was found to give reliable results.

339. *Soil properties.* An X-ray diffraction unit was obtained during the year and an extensive study of soil minerals has been launched. A geochemical study of the distribution of phosphorus (total) in Ghana soils was carried out. It was discovered that total P varies directly with total organic matter. Except in the case of highly ferruginous soils, no accumulation of P in the subsoil was noted. A statistical study of cation ratios and differential leaching in certain forest soils is now in progress with a view to providing information on the effects which more intensive cropping may produce on them.

Forestry

340. Natural regeneration experiments under the Tropical Shelterwood System were continued,

- (1) To find out the minimum cleaning requirements to ensure the survival and development of the regeneration with a view to reducing costs as much as possible.
- (2) To find out the degree of thinnings required in the tenth year of operations under the T.S.S. Where regeneration is prolific the faster growing light demanding species are suppressing the slower growing but more valuable Meliaceae.
- (3) To find out the effect of the removal of the shelterwood left after exploitation both on the increment of the regeneration and the probable increase in weed and climber growth.

341. Experiments in line planting of valuable species in exploited areas of poor forest were continued. The heavy canopy openings along the planted lines are producing beneficial results. *Entandrophragma angolense* and *E. utile* have proved particularly suitable for line planting. Direct sowing of *Terminalia ivorensis* in taungyas was continued experimentally. Results varied from 85 per cent. to total failure.

342. A series of experiments using hormone sprays to kill unwanted trees was carried out. Results obtained so far show that they are not as effective as a sodium arsenite solution in water poured into frills round the tree. Costs using hormones are higher owing to the necessity of using them in a diesel oil solution; they are not effective in a water solution.

343. In the Savannah-woodland zone experiments on nursery and plantation techniques were continued including thinning and pruning in young plantations. Experiments were started on the establishment of plantations on black cotton soils under irrigation. The three species planted out, *Anogeissus leiocarpus*, *Azadiracta indica* and *Dalbergia sissoo* are progressing very satisfactorily. A number of other species, including *Eucalyptus*, are to be tried.

Forest Utilization

344. In extension to Dr. J. Grant's report on Wood Pulp production from local timbers some more information was collected on the species which could be used for production of wood pulp. Studies on the possibilities of a large scale charcoal industry were made. The first chip boards made from local timbers without water were produced from sawmill and logging waste. The boards of good quality were made from timber previously regarded as completely useless. Positive results were obtained with band saws tipped with stellite, leading to efficient conversion of hard species. *Antrocaryon micraster* and *Cedrela mexicana* (introduced species) proved to be useful timbers. Further investigations are in progress. The Air Seasoning tests on small consignments of *Cedrela mexicana*, *Antrocaryon micraster* and *Borassus aethiopicum* proved that these species have good seasoning characteristics. A test of natural durability and resistance to termite attack was started by establishing graveyard tests. The investigation is carried out on behalf of the West African Building Research Institute.

Animal Health

345. In the treatment of Epizootic Lymphangitis, some success has been achieved with the use of protein therapy plus iodine and streptomycin. Investigation was made into the incidence and importance of parasitic arteritis in cattle caused by a species of *Onchocercus*. Work continues on the identification of microfilaria in blood films. In the therapeutic treatment of cutaneous streptothricosis, some success was obtained with the use of picric acid in a solution of detergent.

GRENADA

Cocoa Industry Improvement Scheme

346. The hurricane of 1955 has affected experimental results during 1956. Statistical analyses of the varietal trials designed to test the performance of the 79 local Grenada selected strains, reveal that with few exceptions the ranking of superior clones has been constant, but yields have been reduced. There is, however, every indication of increased yields in the next crop year. Interpretation of the effects of fertilizers in certain of the Cultural and Manurial trials has been doubtful due to the differential response of similar treatments from block to block. This might be an aftermath of the hurricane.

HONG KONG

Agriculture

347. After three years of fertilizer trials with rice the results indicate quite clearly that yield increases are obtained by the application of ammonium sulphate up to 60 pounds per acre. No significant responses have been obtained with potash or phosphatic fertilizers. Little response is evident from

liming trials. Best results are obtained when the whole of the fertilizer is applied during the preparation for planting. An experiment on vegetables was commenced two years ago comparing nightsoil with compost and nightsoil, compost and organic balanced fertilizer, compost and inorganic balanced fertilizer and organic fertilizer alone. Best results up to 22.6 per cent. increase in yield were obtained with nightsoil and compost. The other combinations gave similar results in the neighbourhood of 10 per cent. increase.

348. Work continues on the use of organic insecticides in the control of rice stemborer. Best results were obtained with endrin and parathion. Certain strains of local rice varieties display marked resistance to rice blast disease.

Livestock

349. Work continues on the selection and upgrading of local Chinese pig breeds by progeny testing. With the establishment during the year of herds of pure-bred Berkshire and Mid-Whites, work is being directed to a study of the reaction of these breeds to local conditions, the disease problems of exotic pigs and the reaction of the progeny to the local environment. Further work is being conducted at Saikung on carefully controlled feeding trials using the local pigs and also experimental cross breeding with genetically related local sows and Mid-White and Berkshire boars.

350. All local outbreaks of Foot and Mouth disease in cattle have been plotted and typed by Pirbright Research Centre. Typing of cases arriving from overseas is also carried out. The collection of data on incidence, location, seasonal variation and spread of Ephemeral fever has commenced with a view to investigating the mode of infection. Transmission experiments are to be set up to establish the vector concerned. Tuberculosis has been eradicated from the Colony's dairy herds.

351. Brucellosis in pigs has caused some concern over the past three years and has seriously interfered with departmental extension work in the setting up of boar centres. The abortion problem with particular reference to cross breeding work is under active investigation and further serological work will be undertaken.

352. The growth of Newcastle disease virus in embryonated eggs has been started both for diagnostic purposes and for practice in egg inoculation techniques.

JAMAICA

Agriculture

353. A new method of vegetative propagation of cocoa was investigated, and has been accepted as an alternative to the "rooted cutting" technique which has hitherto been practised. The method involves the use of shield budding and subsequent treatment to promote rooting of the scions. The cost of establishing "scionlings" in the field by this method is considerably less than is involved in the "rooted cuttings" technique.

354. Observations on the citrus rootstock trial which is now in its eighth year indicate that rough lemon, French lime, and Langpur lime rootstocks impart the greatest vigour to the scions under Jamaican conditions. Investigations were carried out into the causes of a condition known locally as "Brown Stem" which disfigures the stem-end of oranges and poses a threat to the island's fresh citrus export trade. The condition is most severe in thin-skinned oranges of small size but is also found on the larger fruit. Evidence to date indicates a physiological cause and no pathogen has been found. Trials are being carried out with the hope of establishing some correlation between the incidence of this condition and various methods of reaping and post-harvest treatment of the fruit, in conjunction with studies on the major and minor element nutrition of the trees and observation on fruit produced under various ecological conditions.

355. Seven field trials on coconuts have been laid down in the western section of the island to compare the resistance of three dwarf varieties and one tall variety of coconuts to the "Unknown" or "Lethal Yellowing" disease. Insect surveys were initiated in the diseased areas in the hope of detecting possible vectors of the virus and a number of interesting species have already been entrapped on the coconut trees.

356. Investigations were carried out during the year on a condition of coconuts known as Frond Drop, which produces dropping leaves and fruit bunches of affected palms and results in death of the plant within a year, or development of a lingering unthrifty condition. The cause of this malady is not known but the presence of a rot at the base of petioles and regular occurrence of scale insects and termites led to the establishment of an experiment in which plants were sprayed with Bordeaux mixture together with an insecticide after cultural conditions on and around the trees had been improved. Nitrogen and potash fertilizers were applied to one-half of the treated plants but after 10 months no marked response has been obtained to any of the treatments. Fungal isolations from various parts of healthy and diseased trees have produced no indications of a pathogen. Chemical analyses of leaves and spathes suggest that deficiencies of phosphate and iron may contribute to the condition.

357. With the expansion of irrigation schemes in the island the need for physical studies of the major soil types has become urgent and during the year a start was made on a comprehensive programme of investigations to provide information on which advisory work on the application of irrigation water can be based. Percolation rates were studied and pore space determinations were made on seven of the soil types defined by the B.W.I. Soil Survey team assigned to Jamaica by the Regional Research Centre in Trinidad. Investigations of a similar nature are being continued on other soil types.

358. With the improvement in the world production and supply of urea it was considered advisable to carry out trials to compare this high nitrogen material with sulphate of ammonia as a source of nitrogen for crops on Jamaican soils. Experiments were therefore laid down with rice, corn and pineapples during the year. It is proposed to extend these trials to other crops in due course.

Livestock

359. Research work on the four breeds of cattle being developed in Jamaica was continued during the year. Two of these breeds are being developed on Government stations and the other two on private farms. The Jamaica Hope dairy breed has passed its most difficult period and results are very encouraging. The average yields of cows of the second and third generations are above those of the first generation animals. Culling on the basis of production was not possible until the end of 1956. It is now possible to maintain the coefficient of inbreeding for the whole breed at 2 per cent. per generation. "Experimenta", the highest yielding dairy cow in Jamaica, produced over 20,881 lb. milk at 4.6 per cent. butter fat in 365 days.

360. The Jamaica Reds (a selection from the Red Poll x native cattle) are showing good promise and the yields from steers fed on grass show that the breed will be able to compete with any of the tropically adapted beef breeds. Several steers have reached 1,000-1,100 lb. live weight before 24 months of age. The herd is being increased so that a similar breeding plan can be adopted to that used for the Jamaica Hope dairy breed. The demand for breeding stock of this breed for export is greater than the available supply.

Pastures

361. A number of new grasses and legumes were introduced for testing amongst which were *Cenchrus ciliaris* (Buffel grass), *Ixophorus unisetus* ("sweet grass"), *Digitaria smutsii* and *Eragrostis curvula* ("love grass"). Of the introduced legumes only the Alfalfa (*Medicago sativa*) strains, *Centrosema pubescens* and *Pueraria phaseoloides* showed any promise. In a comparison of indigenous "commons grasses" (*Stenotaphrum secundatum*, *Paspalum notatum*, *Paspalum* spp. and *Cynodon* spp.) with Pangola grass (*Digitaria decumbens*) and Coastal Bermuda (*Cynodon dactylon* var.) it was found that whereas "Commons grass" could only carry between 0.4 and 0.8 grazing steers per acre, the improved grasses (unfertilized) could carry between 1.5 and 1.7 grazing steers during the year and that the production in live weight gain on the improved grasses was 2½ times that of "commons grass". It was also shown that Jamaica Red steers after weaning at 8-9 months could be finished off at 24 months of age with an average dressed weight of 581 lbs. when kept on fertilized plots of Pangola grass carrying 1.8-2 animals to the acre.

Publications

R. M. ARNOLD—Observations on the Morbid Anatomy and Histology of Manchester Wasting Disease of Cattle in Jamaica, and Related Conditions in other countries of the Americas—*Amer. J. Vet. Res.* 17 (1956) 630-639.

R. I. MOSS—A Guide to Coffee Culture in Jamaica.

Forestry

362. Progress has been maintained in discovering suitable species to use on the varying re-forestation sites. The problem has been mainly one of finding species of any worth able to thrive under adverse soil conditions. *Pinus occidentalis* appears very promising. The reaction from the young valuable species to early thinning is encouraging. The degree of opening required for each species of tree has been the subject of study.

KENYA*Agriculture*

363. *Grassland*: to facilitate the introduction of alternative husbandry into African agriculture, experimental work aimed at finding the most suitable grasses and legumes for leys, the best method of establishment and management of leys and of the production of dry season fodder has been in progress during the past few years at a number of stations in different ecological zones. For those areas that enjoy a good rainfall, it has been found that Nzoia Rhodes grass, Molasses grass, Star grass and the Nandi strain of *Setaria sphacelata* are reasonably satisfactory ley grasses, with Kenya White Clover (*Trifolium semipilosum*) and lucerne as the most promising legumes.

364. Among the many crops under trial in Nyanza Province as producers of green fodder for the dry season, the Uganda hairless strain of Elephant or Napier grass (*Pennisetum purpureum*) has been shown to be by far the heaviest yielder. A comparison of lucerne with Russian comfrey has shown that on manured plots, over nearly two seasons, lucerne produced just over 4 tons of dry matter and Russian comfrey just under 3½ tons. Owing to the ease of sowing lucerne and also of ploughing it under, compared with comfrey and also the nitrogen-fixing of lucerne, it seems preferable as a fodder crop.

365. *Soils*: In 1956, a total of 116 exploratory trials were conducted throughout five provinces and many of the more complex fertilizer experiments were in progress on a number of experimental stations. In Nyanza Province over large areas of the North Nyanza district, it has already been

proved that profitable increases in yield can be obtained from applications of phosphate.

366. The trial to test the residual and cumulative effects of double superphosphate, sodaphosphate and Uganda rock phosphate, applied over 1, 2 and 3 years, continued at Eldoret in its fifth year. All treatments, except double superphosphate applied in the first year only, have given significantly ($P = 0.01$) better wheat yields than the control with no phosphate.

Coffee

Entomology

367. Coffee Leafminers (*Leucoptera coffeella* Guér and *L. coffeina* Washb.). Experiments on the control of the larvae of these insects in their mines has continued. Diazinon has proved to be the most efficient insecticide so far tested. In experiments and in spray applications carried out by growers, kills of larvae in the region of 95-100 per cent. have been achieved.

368. Antestia (*Antestiopsis* spp.). Outbreaks of Antestia were again experienced towards the end of the cropping season. Opportunity was taken to test various insecticides and of them, Malathion showed the most promise. The optimum concentration of Malathion for use against Antestia had, however, not been determined by the end of the year.

369. White Borer (*Anthores leuconotus* Pasc.). Dieldrin spray-banding proved its worth against this insect in the experiment mentioned in the 1955 report. The method will therefore be adopted for routine control of White Borer in coffee.

370. Coffee Lacebug (*Habrochila* sp.). This insect had hitherto been thought to occur only in coffee west of the Rift Valley, but colonies were found in coffee in the Central Province during the year. No outbreaks occurred in the Central Province, however, as the insect was in association with its natural enemy, a Mirid predator, *Stethoconus* sp.

371. Coffee Leaf—Skeletonizer (*Leucoplemma dohertyi* Warr.). The larvae of this moth caused serious defoliation of small areas of coffee in the Ruiru district during the year. Damage was in evidence, to a lesser degree, on a number of estates. It was found that dusting with a synergised pyrethrum dust gave good control of the larvae on the leaves.

372. Field Trials—Mulching. The 1956 yields from the mulch and soil regeneration trial have confirmed the value of mulch to coffee grown under dry conditions. While the unmulched plots yielded at the rate of 12.17 cwts. of clean coffee per acre, the mulched plots produced 20.88 cwts. per acre. Over the seven years 1950-1956, the mean annual yield of the mulched plots has been 33 per cent. greater than the unmulched plots. This represents a mean annual increase in yield of between 2 and 2½ cwt. of clean coffee per acre.

373. The Rotavator trial, which also includes mulching treatments and has now run for three seasons, has shown a 39 per cent. increase as a result of mulching. This represents a mean annual increase in yield of 2 cwts. of clean coffee per acre.

374. Anti-leaf-fall (formerly Tonic) Spraying. Two years' results from trials at the Coffee Research Station, Ruiru and the sub-station on North Kitito Estate at Makuyu have both shown increases in yields of clean coffee of about 35 per cent. following spraying with a 2 per cent. copper spray during the Long Rains. In May, 1956, a new trial was begun at the Coffee Research Station to test the effect of applying only 10 gallons per acre, using a sprayer producing very fine droplets. Least leaves fell from the trees treated

with a 2 per cent. copper spray at 10 gallons per acre and it is probable therefore, that in 1957 these trees will yield more than trees which lost more leaves.

375. *Cambered Beds.* The trial of the Camber bed system of cultivation on vlel land areas is providing very interesting results. Good yields of Napier grass (*Pennisetum purpureum*), as a grass mulch crop, were cut and the plant crop of pineapples which was also harvested gave excellent yields. This system of cultivating otherwise utilised land areas is on the way to becoming an important part of Kenya's agriculture, although its full potential has by no means been completely defined to date.

376. *Coffee Berry Disease.* The work has, firstly, resulted in the development of techniques for the study of the fungus and the disease under controlled conditions. Studies of the infection process, and its relation to both host variety and climatic factors are almost complete. As regards the distribution of the disease, there is evidence that it is increasing in range in the East Rift area, having appeared on plantations hitherto free, and lower than previously recorded.

377. The liming studies begun in 1953 were continued in the field and in the laboratory. Nitrogen, phosphate and potash were applied to all field trials and all were planted to wheat. The Kaptagat wheat yields for 1955 were analysed. Growth failed on plots receiving neither lime nor phosphate. Plots given phosphate only yielded about 200 lbs. per acre and those given lime only about 500 lbs., while those given both yielded over 1,000 lbs. The main blocks indicated a large response to nitrogen and a positive interaction between nitrogen and phosphate.

378. Investigations of the nutrient requirements of problem soils were continued. Five soils from Njoro, Lesirke, Marindas and Kabete (2) were examined by the Kawanda Pot Test Method. Phosphate deficiency has been recorded in all the soils examined and the technique has indicated sulphur, copper, zinc and molybdenum deficiencies in some of the soils.

Horticulture

379. Preliminary results indicate that onions of comparable quality to those imported from Egypt or Tanganyika can be economically produced from sets. The Bombay variety is already being successfully produced from Indian seed on a considerable scale in Lumbwa district. Production of suitable onions is therefore, possible from either seed or sets.

380. There have been some interesting results from pineapple trials in the Thika area. The original fertiliser trial laid down in 1951 has been completed with the harvesting of the second ratoon crop. The residual effect of 2,000 lbs. per acre of sulphate of ammonia applied in 1951-52 was still evident in the second ratoon crop. Yield per acre from the sulphate of ammonia and nil treatments for the three crops combined was 39.0 tons and 30.5 tons respectively (10,000 plants per acre). The plant crop yield from a fertiliser trial planted on camber beds on badly drained vlel soil at the Coffee Research Station, Ruiru, shows that very good yields can be obtained from this type of soil with proper treatment. The most successful treatments were cattle manure at 10 tons per acre which gave 27.21 tons fruit per acre, and sulphate of ammonia at 10 cwts. per acre, which yielded at the rate of 26.04 tons per acre. The nil treatment gave 22.72 tons per acre (14,520 plants per acre).

381. A comparison of yield from irrigated and unirrigated citrus at the Kitale and Ruiru sub-stations, indicates that better yields might be obtained if the trees were dried off by withholding irrigation for a period each year.

*Forestry**Silviculture*

382. *Pruning*. With the exception of the long term experiment to ascertain losses of volume due to pruning, the series of cypress pruning investigations to ascertain correct silvicultural measures to minimise infection by the borer *Oemida gahani*, are practically complete. The last of the series, to ascertain at what season pruning should be done, was completed shortly after the close of the year. The operation of pruning must be done when soil moisture content is high to obtain the most rapid occlusion. Summarised, the results are as follows:—Early, frequent and high pruning can reduce the area per tree exposed to *Oemida* to a fraction of what that area used to be under the pruning schedules in force in 1950. By pruning only at times when soil moisture is high, the occlusion process starts within two or three weeks but may be delayed for as much as six months if soil moisture is low both before and after pruning. Once occlusion has started, it is entirely dependent on the soil moisture content as determined by subsequent rainfall.

383. *Planting*. Survival of softwoods after planting was found to be less dependent on the soil moisture at planting time than on the exposure of roots between lifting and planting. An analysis of soil moisture contents during rainy months, by a method proposed by the E.A.A.F.R.O. Soil Physics Division showed that in many Districts planting was unduly delayed.

384. *Mvule (Chlorophora excelsae)*. In the Coast Division, the progress of a plantation made in 1953 gave strong indications in favour of planting after clearing and burning by the "taungya" method. This gave rise to profuse regeneration of *Trema guineense* which appears to be having the effect of shielding the mvule from severe gall fly attack. Whether this will continue when mvule outstrips the *Trema* remains to be seen.

385. *Mensuration*. *Cupressus lusitanica* and *C. macrocarpa* crops between 13 and 21 years old were examined with a view of volume and yield table construction. A second degree curve formula for volume determination from total height and breast height diameter, irrespective of age and density, was calculated with a resultant high correlation coefficient of 0.95. So far as the data have been analysed, it appears that a single formula can be applied to both species.

Mycology

386. *Armillaria Root Rot*. An extended field programme has been started to study this disease with particular reference to pine plantations. It is also proposed to compare the variability of the fungus locally with that of isolates from other parts of the world.

Entomology

387. No new pests of economic significance were reported and attention was directed mainly to continued study of the life history and control of the *Corambyeid* beetle, *Oemida gahani*, and to measures to control damage caused by *Ambrosia* beetles.

*Veterinary Research**Bacteriology*

388. A small amount of research work was done on studies of *Clostridium chauvoei* vaccines in Kenya and a paper has been accepted for publication. A local *Pasteurella multocida* was studied by five different methods of vaccine production, four broth and one egg. The last was the least effective, the best being heat killed broth culture.

389. The complement fixation test for Johne's disease is now established as a routine and reveals a much more serious infection throughout Kenya than was previously suspected.

390. Bovine pyaemia gives considerable trouble in certain areas of Kenya and the causal organism has been studied. Some ten strains of *B. coli* were isolated, all highly pathogenic in mice and sensitive on *in vitro* tests to several of the sulpha drugs. Other organisms involved with *C. pyogenes* and *F. necrophorus*, pathogenic to the rabbit. Vaccination with *C. pyogenes* toxoid did not assist in prevention of infection, *F. necrophorus* being apparently the original invader. *B. coli* was also studied as the cause of calf scours. Fifteen strains were typed as type I, and three as *F. neapolitanum*. These were examined *in vitro* for guidance in chemotherapy. Streptomycin was most efficient, aureomycin less so, the latter according with the failure of aurofac to give much assistance.

391. Leptospirosis in sheep, goats and cattle was identified causing kidney damage, jaundice and death, in varying degree. It appears to be a new type of leptospira as samples sent to England have not yet given clear serological results. Until it is identified it is not easy to plan progress.

392. Apparently contagious caprine pleuropneumonia has assumed some importance in the Northern Frontier Province. The causal organism has been identified, as expected, as *Borellomyces* and attempts are being made to develop a practicable vaccine procedure for that district.

393. On pleuropneumonia of bovines, studies have diminished with the handing over of this interterritorial problem to the East African Veterinary Research Organization. However, as a matter of interest the organism has been adapted to the mouse, not being attenuated after 50 passages, but after 30 mouse passages and return to 20 egg passages it was attenuated for cattle. Studies of the vaccination response showed that maximum protection was achieved after five weeks using our egg adapted vaccine and that 75 per cent. of test cattle were still satisfactorily immune after two years. As a diagnostic method the injection of field strains in agar gel into rodents such as rats, mice, guinea pigs and hamsters, appears to be satisfactory. Some work was done on a haemagglutination test using tannic acid treated cells, but this is in its early stages. It is noteworthy that some cases of allergic response, including fatality, occurred following second injections into cattle of our egg vaccines; in native areas five cases occurred out of nearly 120,000 done with the egg adapted pleuropneumonia vaccine and a considerable number of European-owned, grade cattle have reacted similarly following a revaccination with our egg adapted Rift Valley fever vaccine.

Virology

394. A guest worker from the U.S.A. continued, but as yet unsuccessfully, his attempts to adapt the African swine fever virus to rabbits. Study of one or two cases of a surviving pig showed that with this disease an animal may show presence of both virulent virus and antibodies at the same time in the blood.

395. The virus of Nairobi sheep disease was propagated in the mouse brain for 14 serial passages during which its pathogenicity for sheep remained unchanged. Between the 14th and 22nd passage attenuation of the virus occurred and this attenuated virus proved capable of immunising sheep against challenge with virulent virus.

396. Rinderpest research was continued and it appeared that the virus is unlikely to obtain entrance into a new country by the importation of carcasses. The source of infection appears to be a live animal suffering from the disease.

397. Newcastle vaccine studies were completed suggesting that the dead vaccine was not useful under our circumstances, but the Komarov strain or live vaccine would be the one of choice. A survey of poultry submitted for normal diagnosis showed that nearly 8 per cent. contained Newcastle disease virus, only two-thirds of these showed any lesions whatsoever. Thus sub-clinical infection appears to exist in Kenya.

398. The enzootic sheep pneumonia vaccine developed a few years ago has now stood up to three years field test and the incidence of the condition at the abattoirs has dropped to a commendably low level. The virus has not yet been fully identified, but has reached the 80th egg passage, killing the embryo regularly on the 3rd to 4th day. Further work is necessary to evaluate possible attenuation. The position has been reached where another source of virus material other than clinically affected sheep must be sought owing to the success of control in the field.

399. Bovine infectious petechial fever or "ondiri-itis" suddenly reappeared in epizootic form on one property in the Rongai district, some 60 cattle being lost. The disease has been known for many years, but only occurring as a sporadic nuisance. Work has been resumed and it has been found that a filterable agent is present in blood in sufficient quantity to permit transmission of the disease by intravenous inoculation, so far only in the bovine, using amounts of approximately 100 c.c. Other tissues are not sufficiently infective nor does success attend blood inoculation by other routes. Convalescent serum has been proved not to be successful either in protecting an animal or in assisting recovery of fresh cases.

Biochemistry

400. Studies on the deterioration of sprays used in tick control were continued, it being found that a preferential removal from recirculatory type sprays does occur and necessitates an enhanced topping-up rate even during normal spraying. There has been no improvement in the chloride estimation technique for dip strength, no method appearing more satisfactory than the sodium xylene technique. It is gratifying that there appears to be a decrease in the number of under-strength samples being submitted. This is probably due to the departmental propaganda on the seriousness of this fault in the encouragement of resistant strains of blue ticks. The latter have assumed resistance over a considerable part of Kenya, on a few farms, to arsenic, BHC and toxaphene.

401. The mineral survey continued. There is a general deficiency of sodium in practically all areas visited and also in most a varying degree of phosphate deficiency. Analysis of monotype pastures from single soils shows an interesting variation in up-take of phosphorus, e.g. Kikuyu grass on one farm contained 0.614 grammes per cent. P_2O_5 whereas Rhodes grass on the same soil contained only 0.265 grammes. A trial continued on feeding bonemeal with an additional group on salt also, but the results have been disappointing and inconclusive. The subject of tainted milk has been investigated, being a seasonal occurrence known for many years, but of increasing severity and the resulting down-grading of the milk is a severe loss to the farmer. Using haematological and liver biopsy analyses it would appear that the reason may lie with the copper-cobalt complex and experiments are in hand to test this. More than 300 pasture samples, almost 3,000 blood and liver samples were analysed during 1956 showing an increased interest by the public in this mineral survey. This section is co-operating with the E.A.A.F.R.O. in evaluating the importance of phosphorus deficiency in low breeding status in a Zebu herd. The section is also co-operating with the Makerere Veterinary School in measuring the feed intake of grazing cattle

by the method of Lancaster based on chromic oxide dosage. Lancaster's analysis method has been modified as it was inconvenient in our hands and did not always give satisfactory agreement between duplicates. At present greater success appears to attend wet combustion of the faeces with nitric and perchloric acids.

Animal Husbandry

402. Experiments in grazing control were conducted with the ranch beef herd of exotic grade cattle as well as with a Zebu (Tuni), a believed dual purpose breed. The latter has, however, proved disappointing in that the milk yield is reasonable, but the beef conformation and quality has been lost. This is an interesting comparison with the herd at Naivasha Station at approximately 6,200 ft., and another similar herd at Mariakani almost at sea level near Mombasa, where the herd is doing extremely well. The dairy cows have been used at Naivasha to test several unusual feedstuffs available in East Africa, notably coffee hullings, phyrethrum marc and sisal waste. The piggery is functioning well and similar feedstuffs, including the above, have been tested as sources of carbohydrate for Kenya pigs with successful results.

MALAYA

Rice

403. Interim releases of pure line selections represent a potential increase in yield of 18 per cent. over 50,000 acres of rice. Results of variety trials indicate that with full use of final selections to be released in the next two to three years, yield increases of 25 per cent. can be achieved over 380,000 acres, nearly half the rice areas in the Federation. Multiplication of, and selection in hybrid progenies has been greatly increased and this is expected to give further yield increases in due course of at least 15 per cent.

404. In one experiment on control of rice stem borers, spraying with DDT at intervals of two weeks resulted in a yield increase of nearly 80 per cent. and increases of 30 to 70 per cent. were common. There is now a reasonable expectation of considerably reducing stem borer damage by spraying a month before flowering with insecticides less toxic to fish, such as DDT or dieldrin. The possibility of stem borer control by hybridisation with the apparently immune *Oryza ridleyi* is being investigated.

405. Yield increases of about 180 lb of grain per acre were obtained in a large number of tests of Ammophos 11:48 as a nursery manure. This fertilizer was applied to nurseries at the rate of 2 lb. per gallon of seed, which is equivalent to about 8 to 10 lb. fertilizer per transplanted acre.

Cocoa

406. Further additions of ICS, Grenadan, Samoan and Upper Amazon clonal selections have been made to the collection of selection and breeding stocks. Clonal and progeny selection projects are proceeding apace; two clonal selection trials and five progeny trials have been established at the Jerangau Experiment Station in Trengganu. The latter include sample populations from selected trees of Amelonado, Criollo, Trinitario and Upper Amazon types in all suitable combinations. In the selection blocks, Upper Amazon continues to be most promising in vigour and yield and Amelonado remains superior to Trinitario. One six year old planting of Amelonado is yielding at the rate of 900 lb. of dry cocoa per acre.

407. *Calonectria rigidiuscula* has been identified as the most serious and widespread disease affecting cocoa in Malaya and *Helopeltis* is the most

troublesome of the insect pests. Control measures for both have so far proved adequate.

408. Magnesium limestone and phosphate improved growth of young cocoa under thinned jungle shade at the Federal Experiment Station, Jerangau. Leaf scorch, chlorosis and die-back symptoms in this cocoa suggested that these fertilizers were not supplying the full needs of the crop for really healthy growth, however.

409. Using microfermentation methods, extraction rates of prepared cocoa from fresh bean were 37 per cent. for Amelonado and Java Trinitario, 31 per cent. for Upper Amazon and 26 per cent. for local Trinitario. The effects of bean ripeness, storage, and time and temperature of fermentation on cocoa quality, as well as the development of satisfactory drying criteria and methods, are being studied. Satisfactory chocolate has been prepared from Amelonado beans stored in a deep freezer at about -25°C ., though chilling to 1°C . resulted in poor chocolate. Evidently, death prior to fermentation does not necessarily prevent development of flavour precursors.

Oil Palm

410. Varietal improvement is primarily concerned with development of high yielding dumpy and tall Deli *tenera* types and some 800 acres of progeny selection blocks are being laid down over four years. Three more progeny trials have been planted and trials now fruiting show dumpy *dura* types take a year longer to come into bearing than good tall *dura*. Leaf analysis studies of oil palm have shown wide differences in nutrient uptake on different soils. Very large differences in ash content occur between palms grown on coastal clays and upland soils and five-fold differences in manganese uptake between coastal clays and peats.

Pineapple

411. Progressive improvement of canning quality of the Singapore Spanish fruit, as determined by high acidity and sugar content, results from increasing application of potash up to 200 lb. KCl per acre. This depends, however, on maintenance of an NPK balance and the P/K ratio in leaf tissues appears to be critical.

412. Substantial increases in yields of fruit were obtained at initial plant densities of about 7,000 per acre, as compared with the traditional 3-4,000 per acre. Evidence was obtained that still greater densities up to about 14,000 per acre would be even more productive.

413. Vacuum syruing of canned pineapple has been shown to produce a product of better appearance than the more usual thermal exhaust process. Correlations between fruit skin colour and chemical maturity as related to quality have been worked out as a guide to the canning industry. Determination of the recovery of edible matter and canning quality of fruit of the four locally available varieties have shown the Singapore Spanish to be superior to Sarawak (Smooth Cayenne), Mauritius and Selangor Green.

414. The two most prevalent pineapple diseases, fruit collapse and heart rot, have been shown to be due to the same bacterium, a strain of *Erwinia caratovora* pathogenetically distinct from those causing soft rot of carrot and other vegetables. Complete control of pineapple mealy bug has not been achieved by fumigation of slips and subsequent field spraying with dieldrin, but the number of wilted plants has been thus reduced from ten to three per cent.

Soils

415. Surveys of 401,700 acres of potential and developed agricultural land were completed during the year and revealed undeveloped land totalling some 100,000 acres suitable for cocoa planting, 30,000 acres suitable for rice and 30,000 acres suitable for rubber and other crops.

416. Pot experiments on peat and the highly sulphurous *gelam* soils suggest that these may be usable for rice cultivation with heavy dressings of nitrogen on peat, and liming and leaching the *gelam*. Other current small scale investigations are related to the optimum irrigation and drainage conditions for rice; the nitrogen cycle in swamp rice soils and the plant, and nutritional abnormalities conducive to the physiological disease *penyakit merah*.

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Veterinary Research

417. Experimental work on the anaemia/emaciation syndrome of local cattle designated "R" disease continued throughout the year. No definite conclusions as to its exact etiology have, however, been arrived at. In many respects the condition strongly simulates the virus diarrhoea/mucosal disease complex; transmission experiments have so far proved unsuccessful. The possible incrimination of blood protozoa also received close examination but without definite result. The condition continues to present an intriguing problem.

418. As in previous years much of the work at the Veterinary Research Institute was concerned with the production of viral and bacterial vaccines for use on local livestock. Much attention was paid to poultry diseases. Nearly 16 million doses of Ranikhet (Newcastle) disease vaccine were prepared for issue to the Federation and Singapore, as well as to Hong Kong, Sarawak, North Borneo and Brunei. An intra-nasal Rahikhet disease vaccine for use on day-old chicks is also prepared, as well as a chick-embryo vaccine against fowl pox.

419. The existence of Pullorum disease (*Salmonella pullorum*) in poultry in Malaya was confirmed for the first time. A survey to determine its incidence in the country is in hand.

420. Several isolations of *Listeria monocytogenes* from domestic livestock were made, and also a "fluorescent" strain of *Pasteurella*, a very virulent strain not previously encountered in Malaya, from poultry involved in a persistent outbreak of fowl cholera. A vibrio organism, not *Vibrio foetus*, was isolated from a pig foetus; it was found to be highly pathogenic in mice and guinea-pigs.

421. An isolation of *Pfeifferella whitmori* from pigs was also made for the first time in Malaya. As far as can be ascertained this organism has been recorded in pigs in only two other countries, Australia and Cambodia. With a view to aiding the detection of melioidosis in local goats and pigs a diagnostic concentrated synthetic melioidin was prepared and is now under test. The application of a complement-fixation test for the disease is also being investigated.

422. Fifty heifers of the Red Sindhi breed were imported from Pakistan in order eventually to increase the number of local-born pure-bred bulls. Young bulls from the original nucleus imported in 1950 are in great demand. It has been decided to concentrate on the Red Sindhi breed and to discontinue the breeding of pure-bred Sahiwals on Government Stations.

Forestry

(See under Forestry Research Institute, paragraphs 195 to 207).

MALTA, G.C.

Animal Health

423. An investigation into the extent and type of brucellosis in the animal population of Malta was begun in October, 1956. It is intended to use the information collected to formulate a plan for the control and eventual eradication of brucellosis from the Maltese Islands. Investigation of the number of infected cow herds was done by the examination of can samples of milk by the brucella ring test at the collection depot. Culture of individual milk samples from a number of infected herds has given a rough picture of the type of infection present.

424. The state of brucellosis in the goat herds has been investigated by bacteriological culture of glands and tissues taken from the abattoir and at the same time an investigation into the reliability of available diagnostic tests was carried out by testing the blood serum and milk of the donors of these glands and tissues.

425. A serological investigation into the extent of brucellosis amongst sheep has started.

Agriculture

426. An agricultural survey of the island was completed and a start was made on the mapping of Gozo. Analysis of this and the previous years' results is proceeding. An investigation was made of the production of milk in Malta. Records of feeding and production showed a wide range of feeding patterns.

MAURITIUS

Agriculture

427. *Tobacco*—The improvement of seed-bed technique, largely due to the use of aldrin and dieldrin at very low rates, has resulted in much more uniform stands of seedlings with a consequent lowering of seeding rates. This is important owing to the fact that the Department's Experimental Station supplies selected and graded seed to all tobacco growers. A locally raised strain of a flue-cured Virginian variety markedly resistant to black shank disease has now found such favour with growers that it accounts for over half their annual acreage under tobacco. Investigations on the use of steam in curing has been intensified in view of the promising results already obtained.

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428. *Fibres*—Trials with *Urena lobata*, Kenaf and Roselle have shown *Urena*—with yields up to 1,500 lbs. of air-dried fibre per acre—to be slightly superior to the other two species and more suited to the growing conditions in the Colony.

429. *Maize*—Attempts to produce a satisfactory hybrid maize have not so far been very successful, as in-breeding has not yet been pursued over a sufficient number of generations. Breeding *Polysora*-rust resistant varieties appears to be no longer a major problem as the attacking fungus seems to have lost much of its virulence and its rôle as a factor limiting maize cultivation is now in doubt. Much of the acclimatized local maize has proved as resistant as the imported strains.

430. *Grass*—New species have been introduced from Kenya, South Africa and Madagascar and have been tested in various localities. Only *Brachiara ruziziensis*, from Madagascar, has shown any distinct advantages over existing species. Fertilizer and spacing trials are being conducted on *Pennisetum purpureum* and *Setaria sphacelata*, attention being given also to minor elements which appear to be deficient in the wet uplands. An experiment on the possibilities of seeding *Setaria sphacelata* has shown good results from seed dusting with dieldrin.

431. *Legumes*—An evaluation of the potentialities of *Leucaena glauca* has been conducted. Legume species have been introduced from Kenya: only two show any distinct promise; namely *Trifolium rueppellianum* for the wet uplands and *Dolichos biflorus* for areas of medium rainfall.

432. *Tea*—Very good results have been obtained from storing tea seed in cold storage at 40°F. The seed, at that temperature, maintained its germinating power remarkably well up to 6 months, after which deterioration set in. It was found that with seed from cold storage the best germination results were obtained from soaking the seed in water at ambient temperature for 24 hours.

433. Following from small scale observation trials last year, internode cuttings from about 100 selected bushes are now under trial. The rooting qualities of selected clones vary considerably and on this characteristic alone a considerable proportion have to be discarded.

434. Bending young shoots, as opposed to pruning, in order to constitute a satisfactory bush, has been carried one step further during the year, i.e. shoots resulting from the original bend were themselves bent and pegged down. It is too early to assess results, which may not be apparent for some years, but preliminary observation suggests that the trial may prove of considerable interest. A comparative trial to compare the respective merits of intensive pegging and conventional pruning is being laid down at Midlands.

435. An observation trial with Karmex "W" in pre-emergence showed this weed-killer to be an effective weed suppressor while being at the same time innocuous to tea. If this is confirmed by further trials and costs can be brought down sufficiently, the experiment should prove of considerable value, as all the better known weedicides which have so far been tried in tea have produced prejudicial effects on the tea itself. Experiments with brush-killers with the object of ascertaining whether their use would be advantageous in large scale land-clearing operations under the Tea Development Project have so far failed to give satisfactory results.

436. *Livestock*—After a careful review of the impact of Friesian blood upon the acclimatized Creole cattle of the Colony, in regard more particularly to climatic conditions, availability of good fodder and methods of management, it has been decided to eliminate the Friesian from the breeding programme and to undertake the improvement of the Creole cattle—itsself of distant European origin—by selection within the breed.

437. Feeding trials with ureated molasses on both store and milk cattle have given interesting results and it has been determined that ureated molasses with sugarcane bagasse as the bulk constituent can be satisfactorily utilized, in particular during seasonal periods of fodder scarcity. Other feeding trials have provided information on palatability and proportion of rejected fodder in stemmy crops.

438. *Pests and Diseases*—In order to exercise greater natural check over *Perkinsiella saccharicida*, the known vector of Fiji disease of sugarcane from which Mauritius is still fortunately free, an effective predator (*Cyrtorhinus mundulus*) was introduced from Hawaii and liberated.

439. A predatory insect (*Lamprophorus tenebrosus*) was introduced from Ceylon as a first step to exterminate, if possible, the giant snail (*Achatina fulica*). Work on the biological control of the principal pests of the pigeon pea has continued, further consignments of parasites being received and liberated.

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NIGERIA—Federal Research

Agriculture

440. Further progress was made with the Cassava breeding programme designed to produce high yielding strains having increased protein contents with reduced hydrogen cyanide contents.

441. Work commenced on a study of organic matter in a virgin forest soil, and a mechanical separation prior to extraction methods has shown some interesting possibilities. The reaction of hydrogen peroxide on soil organic matter is being studied, and attempts are to be made at isolative procedures.

442. Investigations on cocoa seedling wilt have shown that the disease is caused by a species of *Phytophthora* which can be controlled by regular applications of copper fungicide applied as a spray. Investigations have been carried out to find the effect of environmental and other factors on the appearance and spread of the disease.

443. Work on cassava mosaic has been directed mainly at determining the virus/vector relationships and it has been found that white flies (*Bemisia* spp.) need only feed on healthy plants for very short periods (15–20 minutes) before transmitting the virus. The effect of mosaic on growth rate and yield is being studied and investigations have been commenced on the effects of high temperature on the symptom expression of infected plants.

Entomology

Cocoa Capsid Control

444. Following the extremely good results obtained by the use of BHC in 1955–56 cocoa season, the West African Cocoa Research Institute took over the main programme of capsid control experiments in Nigeria. This Section has however done three new trials on cocoa capsid control, namely the use of BHC aerosol, the use of knapsack sprayers applying four oz gamma BHC in eight gallons of water per acre, and the incorporation of gamma BHC into the Perenox spray used against black pod disease, applied to pods only.

Yam Beetle Control Experiments

445. Eight experiments on the control of the yam beetle were laid down, some in each Region of Nigeria. The uses of various insecticidal dusts applied to the yam set before planting was investigated. As in previous years, the most effective insecticide was a 0.45 per cent. gamma BHC dust which decreased average damage by 28 per cent. and increased average yield by 46 per cent. The yield increases were better than in previous years but the percentage decreases in damage were not so good. Other insecticides gave good yield increases but are more expensive than BHC.

Maize Stem Borer Control

446. An experiment on the control of stem borers of maize showed that endrin was the most successful insecticide giving an increase in yield of 30 per cent. over the controls. Two applications of all insecticides gave a 5 per cent. greater yield than did one application but this yield increase was not economic. Experiments indicated that the best time of application was one week after first emergence. Plants treated at this time gave a yield of 27 per cent. higher than plants which were first treated five weeks after emergence.

Stem-Borers of Cereal Crops

447. *Guineacorn*. The most important species attacking Guineacorn in Northern Nigeria is *Busseola fusca* Full. It is the dominant stem-borer over a large area but in the extreme north it may be superseded by *Coniesta ignefusalis* Hamps. and in the Southern provinces by *Sesamia* spp. An infestation of 30 per cent. of all stems is quite common and frequently more than half of the stems may contain borers. Investigation into the effect of borers on yield has shown that in a well-grown crop on soil of good fertility stem-borers are associated with the higher yielding plants. Significant positive correlations of yield on percentage stems bored have been obtained showing that plots with a high percentage of stems bored produce a high yield and *vice versa*. This apparent paradox is considered to be due to the fact that the higher-yielding stems are those which grow rapidly early in the season and are in a favourable condition for oviposition when the main flight of *Busseola* occurs. The low yielding stems develop later in the season, escape the peak of borer oviposition but, due to their lateness, produce a low yield.

Sorghum Midge

448. The sorghum midge, *Contarinia sorghicola* Coq. and other species occur on Guineacorn throughout Northern Nigeria. Estimation of losses due to the midge is difficult, but a combination of visual estimates and dissected samples has given a figure of 5-10 per cent. grain loss throughout most of Katsina province during the past season.

449. Despite the occurrence of alternative wild hosts the main increase of midge population occurs on the flowering Guineacorn crop and, with an overall life cycle of 14-24 days, a considerable build-up occurs when flowering is prolonged. This is particularly true of varietal trials where Guineacorn may be in flower for as long as three months and losses in the later flowering varieties approach 100 per cent. The midge enters diapause at the onset of the dry season and is carried over to the following rains in spikelets left in the field and particularly in trash which accumulates in the farmer's compounds after threshing. Reinfestation of the new crop would be minimised if this trash were disposed of during the dry season and methods of effective and useful disposal are under investigation.

Federal Rice Research Station, Badeggi

450. Good progress was made in developing this Station and a large programme of rice selection was carried out.

451. Six varietal trials were done to compare the several established varieties with improved varieties from W.A.R.R.S. Sierra Leone derived from one original parent stock.

452. A comparison of two local planting methods revealed no significant difference between the Edozhigi and Badeggi methods in terms of yield. This did not confirm the result from the same trial in 1955-56 when the indication was that the Badeggi method was superior.

453. Fertilizer trials at Badeggi gave a result similar to 1955 when both nitrogen and phosphate gave significant increases but the phosphate response declined at the higher levels of nitrogen. A trial of nitrogen and phosphate at Edozhigi on heavy clay indicated a significant response to nitrogen only.

Forestry

454. The scope of silvicultural and botanical/ecological forestry research work expanded. Work was carried on in 103 registered investigations or sample plots. Of these 34 are silvicultural investigations, chiefly concerned with regeneration or restocking of exploited forest or forest scheduled for exploitation; enrichment of degraded forest and afforestation of open savannah; 4 are botanical/ecological investigations in the forest; 65 are permanent sample plots (54 silvicultural, 11 botanical/ecological). These investigations and sample plots are distributed over all regions of the Federation.

455. The herbarium was well maintained, and many additions to the collections made. A variety of plant material was supplied to correspondents overseas, and numerous inquiries answered, among which were many requests from forest officers and others for identification of plant specimens. Mr. R. W. J. Keay continued his valuable work on revision of the Flora of West Tropical Africa, at the Herbarium, Royal Botanic Gardens, Kew.

456. Experiments on destruction of unwanted trees with butyl-ester hormone preparations of various formulations continued, with the object of finding non-toxic arboricides as substitutes for sodium arsenite.

Veterinary Research

Rinderpest

457. The establishment of a strain of avianised rinderpest virus was achieved. The use of this virus for vaccination of Zebu cattle is being studied at a laboratory level. Present indications show that it would be more suitable for the immunisation of non-Zebu (Muturu) cattle in Eastern and West in Nigeria. The production and issue of Rinderpest vaccines, both the Dried Goat Virus and Lapinised Rinderpest Virus, exceeded 2,250,000 doses. It was found that using groups of at least eight goats per dilution it was possible to obtain reproducible results when titrating Dried Goat Virus. The LD₅₀ for goats was in the region of 10⁻⁶. Results, using five cattle per dilution, were unreliable due to the apparent great variation in susceptibility.

Newcastle Disease

458. Strains of the virus isolated from field outbreaks of this disease showed no diminution in the high virulence of the Nigerian strains. Dried living virus vaccine (Komarov strain) was issued extensively in Nigeria, Gold Coast and Sierra Leone. Laboratory assessment of duration of immunity has shown that immunity is solid nine months after vaccination to a challenge dose of at least 10⁶ LD₅₀. This vaccine is the only method of controlling the disease under Nigerian conditions and demands for it are now in excess of a million doses per annum.

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Pleuro-Pneumonia

459. Research was concentrated on the improvement of the antigen for use in the Rapid Whole Blood Slide Agglutination Test. This work has resulted in more constant and reproducible field tests. Fundamental growth studies to find the nutritional requirements of the organism are being continued. It was found that the normal culture vaccine would elicit a definite serological response consistently if the vaccine was used before it was seven days old. Experiments with a dried culture vaccine incorporating adjuvants were promising.

Rabies

460. The production and issue of Canine Anti-Rabies (Flury Strain) was greatly expanded. The vaccine was produced and tested in strict accordance with World Health Organisation standards. Immunity tests with dogs gave very satisfactory results. Study of the possibilities of producing a Rabies Hyperimmune serum in horses was well advanced.

Streptothricosis

461. A field trial, involving spraying of cattle with a Gammexane dip, was carried out in co-operation with the North Region Veterinary Department based on previous laboratory experiments at Vom. Work was concentrated on discovering whether the tick, *Amblyomma variegatum*, was a prime factor in the spread of Streptothricosis as had been found at laboratory level. The field trial was not conclusive but is to be repeated during the 1957 rains.

Biochemistry

462. Much progress was made in the establishment of normal values for the blood of Zebu cattle. This work involved over 15,000 separate determinations and, when completed after the rains of 1957, will enable detailed assessments of mineral deficiencies to be studied with reference to the normals.

Parasitology

463. A detailed regime of treatment was worked out for the treatment of calves affected by *Neosascarios vitulorum*. In addition, studies on the life cycle and pathogenicity of this common parasite were initiated. A survey of the helminths and methods of controlling them in the Sokoto Red Goat under local conditions of husbandry in Sokoto Province was brought to the stage where a regime of strategic medication could be laid down and continuance of the work handed over to the field services.

*NIGERIA—Western Region**Agriculture**Soil Survey and Crop Nutrition*

464. During 1956, the Soil Survey Unit has been mainly engaged on reconnaissance soil survey work in North Abeokuta and North Ondo Provinces in which 2,000 square miles have been surveyed, bringing the total area covered by the reconnaissance survey to over 9,300 square miles of the cocoa growing area of the Western Region. This area has been re-assessed at 16,000 square miles. A number of semi-detailed surveys of small areas have been carried out to provide data on soil relationships and for land use recommendations. In addition a large number of soil samples from fertilizer-trial plots and land owned by more progressive farmers, have been received from Provincial Agricultural Officers and have been examined, classified and reported upon.

465. Six long term fertilizer experiments on arable crops were in progress during 1956. Five of these are sited on soils derived from metamorphic rocks, now under savannah vegetation, and the sixth at Agege, in the Colony

is in the forest belt, on soils derived from sediments. In the savannah areas yams, maize and guinea-corn have shown significant responses to 1 cwt. of sulphate of ammonia per acre. Only yams are likely to give sufficiently profitable responses to justify recommendations. Superphosphate has had no significant effects except in one experiment with maize at Eruwa where, in the presence of nitrogen, superphosphate and micronutrients together produced a considerable increase. Potash appears to act in this respect as a micronutrient or combination of micronutrients. At Agege, in a fertilizer experiment superimposed on a rotation of maize, yams and cassava, encouraging responses to muriate of potash have been obtained on cassava and yams. This confirms the results of previous years.

466. In addition the section has given advice on the carrying out of small "farmer's plot" fertilizer trials in most parts of the Region. These trials are carried out on a simple four plot basis (O, P, N, NP) to test the effect of ammonium sulphate and superphosphate (usually at a rate of 1 cwt. per acre) on rice (200 trials), yams (212 trials), early maize (60 trials) and late maize (142 trials).

467. Shortage of staff has limited fertilizer experimental work on tree crops, but a grass mulch/no mulch experiment on coppiced cocoa is in progress. The mulch has produced astonishingly rapid growth of the banana shade in the experiment but, as yet, there has been no visible effect on the cocoa. A study of nitrate fluctuations under mature cocoa at different spacings continued during the year. On all plots within eight days of the peak of 20-116 p.p.m. of nitrate nitrogen, the graph dropped to a trough of 0-3 p.p.m. on 23rd March and thereafter fluctuated inversely with soil moisture content. The results may well be due to the very heavy early rains of March, 1956, and are subject to closer examination.

Maize

468. The extensive maize variety trials reported last year were continued throughout the region. The variety Mexico 1 did not do so well as it did last year in the main maize growing area. In 12 trials it averaged only 30 per cent. higher yield than local maize compared with 45 per cent. last year. In the wetter areas however, where normally it does not yield well, it gave excellent results in this very dry growing season. The variety Mexico 7 was included in all trials, and it consistently gave 60 per cent. higher yield than local maize. Further trials over several seasons are needed to substantiate this apparent superiority. Preliminary trials with other maize varieties failed to show any improvement over the Mexican varieties.

469. Though substantially higher yielding than local maize, the Mexican varieties are slower to dry out in the field, on account of the larger cobs, and they appear to be much more susceptible to insect damage during storage.

470. Further trials on weed control in maize using 1½ to 2 pints per acre of an MCPA preparation, suggested that one pre-emergence spraying was equivalent to at least one hand weeding. Similarly encouraging results were obtained with post-emergence application.

Grasses

471. Giant Star Grass (*Cynodon plectostachyum*) and *Centrosema pubescens* continue to form the best pastures in the Western Region, with *Stylosanthes gracilis* showing considerable promise. *Cenchrus ciliaris* has not come up to expectation. It does not provide the bulk or quality of fodder that can be obtained from Giant Star Grass and establishment is more difficult, germination of seed being poor. Unfortunately work to date has been done on an

upright non-spreading strain of *Cenchrus*. Rhodes Grass has likewise proved disappointing in that it does not survive long in a pasture. Trials at the School of Agriculture, Ibadan, showed that Star Grass cuttings lost their viability after four days' exposure to the sun and that it can be completely eradicated by tractor-ploughing twice, but preferably three times, towards the end of the dry season. It seems probable that one good ploughing early in the dry season would be sufficient to eradicate it at least from the lighter soils in low rainfall areas. From these trials it appears that Giant Star Grass is not likely to become a pest of arable land as was once feared and expensive hand eradication on contour banks and waste places has now been dispensed with.

Cocoa

472. Investigations were started to determine the possibilities of bare root planting of seedlings, in order to avoid the expense and inconvenience of distributing potted seedlings. Preliminary trials showed that losses would exceed 50 per cent. unless some form of a "ball of earth" method was used.

473. Budding trials carried out with Amazon selections, indicate that no particular difficulty may be expected if this method of propagation is adopted. There was a suggestion that certain selections are more suitable for bud-wood, and others are more suitable for rootstocks.

474. The control of Blackpod disease has become a routine practice on many cocoa farms, particularly in Ondo Province. Investigation of the relative merits of proprietary fungicides is being carried out where it seems likely that a saving in cost or an increase in efficiency is probable.

Poultry

475. Selection originally started at Moor Plantation as far back as 1945 and derived from one cock of rather "Indian Game" appearance and a nucleus of local hens which had survived a series of outbreaks of Fowl Pox, Typhoid, Cholera, Roup, etc. The breed has been produced by using 3 half brothers on their half sisters in each generation and selecting the best of 3 resultant progeny on egg production, fertility and body size for repeating the breeding process in the next generation. The flock was transferred from Moor Plantation to Samaru in the Northern Region for a number of years but eventually returned to the "West" (Fashola) in 1953. The present birds, now known as the "Samaru Breed", are of a uniform colour—an attractive flecked brown and white markings—and almost up to the body weight of a pure Rhode Island Red; egg production and egg size are also approaching Rhode Island Red standards while native hardiness is still being maintained.

Stored Products Research

476. The West African Stored Products Research Unit (W.A.S.P.R.U.) is paid for in equal proportions by the Federal Government of Nigeria and the three Regional Marketing Boards. The Unit is under the administration of the Federal Department of Marketing and Exports and receives technical advice from the Stores Products Sub-Committee of the Colonial Office. The Unit consists of a balanced team of entomologists and chemists who carry out researches on stored foodstuffs in Nigeria, with an ultimate view to evolving control measures which will reduce losses. A storage Engineer is also on the staff of the Unit. The activities of the Unit were formerly largely confined to the Marketing Board commodities groundnuts and cocoa, but during the period under review they have been extended to include palm products and various foodstuffs.

Groundnuts

477. The reduction of infestation of groundnuts by *Trogoderma granarium* Everts has been proceeding very satisfactorily by routine fumigation. Several insecticides have been examined with a view to eliminating this pest from storage premises. The most satisfactory substance tested to date has been malathion and pilot scale work with this insecticide is being planned.

478. The major pest of stored groundnuts is still *Tribolium castaneum* Herbst which causes considerable damage in spite of routine treatment of bagged products with aqueous suspensions of BHC. It has been known for some time that the present measures are not entirely satisfactory owing to the poor stability of BHC under conditions in Northern Nigeria. *T. castaneum* in Kano appears to have developed a resistance to BHC about four times that of normal, though this is not serious compared with the degree of resistance acquired in other territories. The evolution of a new technique for controlling *T. castaneum* has been a matter of considerable investigation. DDT and various other chemicals have been considered but the most promising laboratory results have been obtained with finely divided silica. This material is readily suspended in water and applications with spraying equipment to bag surfaces leave a deposit which dries and becomes active within a few minutes. Pilot scale tests are in progress.

Cocoa

479. The setting up of a cocoa pest control unit operated by the Western Region Produce Inspection Service has provided a number of problems. The type of application best suited for the routine misting of stored cocoa with synergised pyrethrins has been the subject of investigation as has the activity and persistence of deposits given by different applicators under various conditions. It has been concluded that motorised knapsack type sprayers are generally more suitable for use in Nigeria though it has been found necessary to make modifications to the nozzles. It has been shown that cocoa stored in paper bags may be fumigated and is relatively immune to insect attack compared with cocoa in hessian sacks. Paper bags do not stand up well to handling and paper lined hessian bags are being considered.

Foodstuffs

480. Surveys were made of the damage by *Calandra oryzae* L. sustained by various maize varieties at the time of harvest. A further study has been made of the resistance to attack by this insect of various maize varieties in store. The observed differences of varietal susceptibility were rapidly accentuated during storage and the findings may be of economic importance if resistant varieties are suitable in other respects.

481. An assay has been made of losses of cowpeas (*Vigna unguiculata*) sustained under native storage conditions and a trial has been completed to investigate the egg laying preference of *Callosobruchus maculatus* Fabr. on various cowpea varieties. Preliminary work has been carried out on methods of insect control.

NIGERIA—Northern Region

Agriculture

482. Good progress has continued in the building up of the additional professional staff for the expanded research organisation, which now numbers 26 with 6 under training. A Federal ecologist has been permanently posted to the Region. Satisfactory progress has been made in the development of the groundnut substation at Kano, Sudan Zone sub-station at Katsina and the Southern Guinea Zone substation at Mokwa. Preliminary steps have been

taken towards opening a small area of investigation on irrigated vegetable crops adjacent to the site of the proposed Quarantine Station at Kano.

483. Work has been started on water relations of the Samaru soils and the first year's results have indicated that the effect of soil capping is so great on these soils as possibly to be one of the main factors limiting crop yields. Under an inert mulch of groundnut shells, yields of sunflower were increased by 138 per cent. in green matter for ensilage and by 266 per cent. in seed production. Yields of seed cotton under a similar mulch were increased by 33 per cent.

484. New groundnut importations from French Niger Territory have shown considerable promise in the extreme north of the Region, where Nigerian selections have not so far been very successful. Considerable promise has also been shown by selections from the East African Mwitunde variety for resistance to rosette disease in the Riverain Provinces. A sample survey on 300 farms in the multiplication area of the Kano 50 variety has confirmed the outstanding improvement represented by this variety in the Kano area. Farmers growing Stage I seed achieved a 95 per cent. increase over the local types. Growers of the later stages of multiplication were less successful on account of poor germination believed due to unsatisfactory conditions of storage, but the overall figure for all stages of the multiplication scheme showed an increased yield of 35 per cent. over the local types.

NIGERIA—Southern Cameroons

Agriculture

485. During the year, funds have been provided for research at Bambui Farm, Bamenda and from Colonial Development and Welfare funds for Barombi-Kang Farm near Kumba. Research has been affected by shortage of senior staff and by delaying building development.

486. A herd of cattle has been maintained at Bambui Farm for the last 16 years in an endeavour to obtain a milking strain from the local Adamawa type of cattle. It has been impossible to develop such a strain as the cattle give no more milk than is required for the well-being of the calf, no matter how well the cow is managed. In December, 1956, it was decided that improved milking capabilities could not be found by selection amongst local animals and a different approach would be necessary.

487. Two late blight resistant strains of potatoes, Nos. 1521 C and 1521 D, are the only ones out of 18 importations that have shown promise and they have been multiplied for general distribution.

488. The spacing, shading, planting, pruning and manurial requirements of cocoa under Cameroons conditions is being studied at Barombi Kang. The Amazon varieties ex-Tafo are more vigorous in growth than local varieties but they are too young to give comparative yields. Psyllid and jassid attacks on cocoa have been controlled by the use of gammalin and didimac sprays. The regeneration of abandoned cocoa farms is being studied and so far the most promising results are being given from coppicing of the old trees in February at 3 to 6 inches from the ground and earthing up.

NORTH BORNEO

Rice

489. Four varieties are considered to be proved for North Borneo, the varieties Siam 29 and Seri Raja ex Malaya, which yield well on most soil types, and the local Gantang and the Philippine Elon-elon which do better on the deeper soils. Work on the 38 strains of *indica-japonica* hybrids,

produced by the International Rice Hybridization Project, continued. Of 19 pure strains of varieties imported through the good offices of Dr. Ramiah of the Food and Agriculture Organization, the following six continue to show promise:—*Baoh* (Indonesia), P.T.B.16 (India), 108e/58 (Indonesia), BAM (India), BAM 6 (India) and Ngasein Theedat (Burma).

Abaca

490. A study of the symptoms of "Bunchy Top" expressed by plants which had developed from whole corms, quarter corms and single buds excised from the corms of plants showing early, intermediate and advanced symptoms was continued. These plants together with appropriate controls had been cultivated in an isolated area for a period of twenty-one months and had been sprayed with an insecticide twice weekly. Some of these plants expressed "Bunchy Top" symptoms but the disease did not have any obvious effect on the vigour of the plants. With the plants which expressed symptoms, the leaves which emerged later did not show symptoms and the number of plants showing symptoms decreased throughout the year until at the end of the year none of the plants bore symptoms. The spraying kept the plants free from aphids and it must be considered whether or not the results would have been the same, had the plants been infested with aphids and possibly "re-infected" by them. Banana plants which had developed from whole corms obtained from plants showing "Bunchy Top" symptoms were also kept under observation. With many of these several plants in a mat and numerous leaves of infected plants showed symptoms. Symptoms appeared on several young suckers.

491. Studies on the pattern of spread of "Bunchy Top" were continued and, as a result of information accumulated, the estate spraying policy was modified. When an infected plant is found this plant and three circles of surrounding mats are sprayed, after which the infected plant is eradicated. The three circles of surrounding mats are given a further five sprayings at weekly intervals.

492. The effect of various contact insecticides on *Pentalonia nigronervosa*, the aphid vector of "Bunchy Top" was studied. A field trial with Agrocide, DDT, Nicotine Sulphate, Dieldrin and Endrin was laid down. The incidence of disease in the experimental area was very low and it will probably be necessary to continue this experiment for a considerable time in order to accumulate sufficient data. Experiments were carried out on the persistence of contact insecticides with potted plants under cover and with abaca plants under field conditions. Caged aphids were fed on the treated plants for different periods, at intervals after spraying. The results obtained were variable but it could be concluded that none of the insecticides showed any marked persistence. Endrin and Agrocide had a better persistence than Dieldrin, DDT and Nicotine Sulphate, the persistence of Endrin being slightly better than that of Agrocide. The poor results obtained with Dieldrin were surprising. Several systemic insecticides were tested and at a fairly high level of application, good results were obtained with soil and foliar applications of Metasystox. The cost of these treatments was, however, prohibitive.

493. On Table Estate a "Wilt Disease" which had been of minor economic importance previously, increased in incidence during 1956 and sections of the nursery area were affected badly. A section of the nursery was selected for studying the pattern of incidence of the disease. There was no correlation between the pattern of incidence and the planting stock which was used. Initially there appeared to be "contact spread" from initial foci of infection but later this effect became less marked. A microscopic examination

of diseased tissues showed that a bacterium was present in abundance and a test indicated that this bacterium is the pathogen.

Animal Health

494. *Buffaloes*. The major disease problem is the control of *Ascaris vitulorum* which is considered to be the cause of high death rate in calves, up to 80 per cent. With few exceptions it is found that calves which survive to 3-4 months throw off the infection and live. Although with the short annual working period it may be several years before any definite results materialize certain trends are noticeable. Firstly whilst samples from some areas show large egg counts, those from other neighbouring places may be negative or show low counts. It is proposed to map the areas of high and low incidence over a period of years to see if there is any constant factor between such areas. Adult buffaloes and cattle are never found to be infected with *Ascaris* and no single specimen has been recovered from an adult animal. The weight of infection as indicated by egg counts tends both to increase rapidly as the calving season advances as does also the number of infections. It would thus be of value to find the method of carrying over from one calving period to the next.

495. *Pastures*. An investigation was made into the pasture land of the Colony. The available grazing falls generally into three types (i) open grassland at sea level, (ii) open grass land in the Interior at altitudes of 1,000-3,000 feet above sea level, and (iii) grass land under tree crops, predominantly coconuts, at sea level.

496. Sorob Cattle Farm may be taken as an example of the first type. The farm consists of rolling hills, covered with lalang (*Imperata cylindrica*) or Centipede grass (*Ischaemum barbatum*) with riverine flats between the hills. It was originally considered that this type of pasture was capable of carrying one beast to approximately 10 acres but it has been found that its carrying capacity is far higher than this. It has also been found that a practical way of improving these pastures is to fence them into areas of a manageable size, and stock heavily with buffaloes; the buffaloes "bull doze" the tall grass and scrub, much of the grass not being eaten but trampled into the soil where it provides valuable binding, which enables the method to be used without causing erosion on steeper slopes than would be expected. After allowing a short period for regrowth, controlled grazing with cattle encourages the growth of bottom grasses and the pasture is greatly improved. On the riverine flats it is comparatively simple to produce a good sward of carpet grass (*Axonopus compressus*) especially if shade is provided, for example by rain trees (*Enterolobium saman*), and it is hoped that paddocks on these soils will serve as fattening paddocks. It is likely that on this type of grazing the carrying capacity will be at least one beast to two acres.

497. Keningau Cattle Farm at 1,200 feet may be taken as an example of the upland pastures. Here the predominant grass is lalang and the dangers of invasion by trash appear greater. It has been found possible to improve these pastures very greatly by the use of a rotary mower followed by heavy rotational grazing and it appears likely that this land if well managed can carry more than one beast to the acre.

NORTHERN RHODESIA

Mount Makulu Central Agricultural Research Station

498. The establishment of the Station was virtually completed by the end of the year. The entire capital cost was provided under a Colonial Research Scheme which was sanctioned in 1950. A further grant has, however, been

obtained to provide additional facilities that have been found necessary or desirable in the light of experience for the establishment and development of comprehensive agricultural research services in Northern Rhodesia.

499. The Station, which extends to 2,800 acres, includes a full range of scientific laboratories together with a well developed mixed farm. It is, therefore, designed to enable the agricultural problems of the Territory to be approached on a broad front. The Station is already playing an important part in the development of the Territory and the Federation. The Chief Research Officer attended the meetings of the Federal Committee on Agricultural Research which is concerned to co-ordinate the agricultural research work of the three Territories.

Agricultural Chemistry

500. Evidence was accumulated to show that the main maize growing soil types in the Territory can carry populations of 12,000 to 15,000 per acre with appropriate fertilising. Populations up to 20,000 plants per acre gave proportionately smaller returns per unit of fertiliser applied. The maximum yield obtained under field conditions was 32 bags per acre on strong reddish clay at Mount Makulu and 22 bags per acre on sandveld at Muswishi in the Broken Hill district. Trials with nitrogenous fertiliser, in association with a basic application of phosphate, at rates of 40, 80 and 120 lbs. of sulphate of ammonia per acre applied to maize at planting time, gave negligible responses in comparison with side-dressing the growing crop about six weeks after planting at the rate of 200 lbs. per acre. There were, however, indications that applications heavier than that contained in the commercial basic mixture gave increases in yield. With high plant populations and high rates of fertilisation, split side-dressings, for example, half at four weeks and half at eight weeks after planting, were more effective than single applications of the same total amount of fertiliser. The advantage of the split applications, however, might be offset on economic grounds.

Soil Survey

501. The Report on the Soil and Land Use Survey of some 3,000 square miles of the Copperbelt was published in December, 1956. A detailed soil survey of some 12 square miles in the Mutundu area near Mufulira was completed for the Federal Department of Conservation and Extension for the assessment of areas suitable for intensive European farming. In addition 430 sq. miles were surveyed in other parts of the territory.

502. In connection with the resettlement problem associated with the Kariba Hydro-electric Scheme a survey was carried out of some 76 square miles near Chirmundu. A vegetation map was prepared from aerial photographs. Soil profiles of the different vegetation types were sampled and analysed with a view to assessing the agricultural potential. A close correlation between vegetation and soil was found and it was concluded that further areas of agricultural land in the Gwembe Valley could be detected from aerial photographs with the minimum of ground control. Detailed soil surveys were made of the Department's Chiansi irrigation plot and the Rhodesian Selection Trust's Nanga Polder on the Kafue Flats.

Plant Pathology

503. A collection of 50 native varieties of maize were under trial for resistance to *Helminthosporium* disease. Only three showed any signs of resistance. Severe outbreaks of Potato and Tomato Leaf Blight (*Phytophthora infestans*) occurred in the late wet season in the Copperbelt, Broken Hill and Lusaka areas; this disease must now be regarded as firmly established in the Territory.

504. In trials with weedicides preliminary indications were that the chloracetimide derivative type, for example CDAA, were distinctly effective in the control of Rapoko or Ox Grass (*Eleusine indica*) when applied as a pre-emergence spray in maize.

Pasture Research

505. Further results from fertiliser trials at several centres in the Territory with Star Grass, Makarikari Panicum and indigenous veld confirm the previously reported consistent responses to sulphate of ammonia and the sporadic negative response to lime in terms of quantitative measurements obtained by cutting. Ley establishment trials and observations have indicated the need for adapting management to the prevailing situation. On newly broken virgin land early planting can be carried out without danger of serious weed competition. On old arable land, however, thorough cleaning is necessary and consequent late sowing in order to prevent vigorous annual weed growth from interference with the stand. Ley establishment under wide spaced maize at the time of last cultivation is also a practical proposition; a yield of 10 bags maize per acre at 6' spacing with successful establishment of Bambatsi Panicum being achieved at Mount Makulu. In general, however, a high fertiliser application is desirable. Rolling the seed bed before and after sowing further enhances establishment. Both Rhodes grass and Bambatsi Panicum have been planted very successfully with a seeds/fertiliser drill, this method proving superior to broadcasting in both economy of seed and efficiency of establishment.

506. Management trials have indicated interesting trends in species composition under different rates of stocking. A trial of three management practices as compared with the use of a weedicide (2,4,5-T) for the eradication of young acacia seedlings in pastures indicated that the most effective and cheapest method was late burning.

507. Irrigated fodder crops were investigated further and several species were found to compare favourably with lucerne (Hairy Peruvian variety) which may be considered to be firmly established as a most valuable crop. Giant Sainfoin and Black Medick were extremely productive while rape, marrow-stem and thousand head kale, turnips and swedes gave yields comparable with British standards.

Plant Breeding

508. Seasonal conditions were unfavourable for groundnuts. Nevertheless the results of variety trials at three widely separated stations confirmed the outstanding quality of the variety Mwitunde. This variety, ex-Tanganyika, proved to be relatively resistant to disease particularly under poor growing conditions. It gave reasonable yields and the oil content is the highest of all of the varieties tested. Interesting and encouraging results were obtained with trials of dwarf beans (*Phaseolus vulgaris*). Yields of over 6 bags of dry, shelled beans per acre were obtained in trial plots. Varieties of Lima beans (*P. lunatus*) were particularly encouraging; when planted as late as February heavy yields were obtained and fruiting continued until the middle of the dry season. For winter cultivation under irrigation during the cool, dry season some varieties of wheat gave considerably better yields than those commonly grown in Northern Rhodesia. For the hot, wet season several varieties were selected for rust-resistance from a large collection but yields were low. Weed competition and damage by termites accentuated the inherently low-yielding potential of many strains and methods of controlling these problems had to be put in hand. Cereal investigations were further extended to include barley, oats and a range of indigenous food crops including Kaffir corn and various millets.

Irrigation

509. The question of the agricultural possibilities of the Kafue has been attacked in the most direct manner on two fronts. The Department of Agriculture has developed an experimental polder at Chiansi of some 35 acres. This has been made possible through a Colonial Research grant. Protection from flooding involved the construction of an embankment about 12 feet high all round a representative area of some 10 miles out on the flats proper. The soil is a remarkable heavy clay which has posed serious problems of management for crop production. Wheat, barley, rice and a wide range of minor crops were tried but without success. At the same time the Rhodesian Selection Trust, following a report by Dutch consultants, made a start with a relatively large scale pilot scheme of 600 acres at Nanga on the south bank of the river. At both polders high salinity in the deep sub-soil appears to constitute a threat and is one more factor that has to be watched. At Chiansi enormous numbers of wild ducks destroyed paddy almost as soon as it was planted.

Veterinary Research

510. Territorial surveys were made of animal helminthiasis and tick species. A detailed study of the biology of tick-species prevalent in Northern Rhodesia was made, giving emphasis to the ecological factors concerned.

511. Nucleus breeding experiments on indigenous breeds and Boran cattle has continued. A study of the comparative effects of supplementing cattle with protein, salt and phosphate at various levels was made. Climatological work included studies on physiology and skin histology of cattle in relation to heat toleration.

Forestry

512. With the completion of the new research offices and laboratories at Kitwe two specialist divisions were set up, (i) the Division of Forest Ecology charged with the study of trees in relation to their environment, the identification of plants, the determination of forest types and their qualities, and the choosing of the forest estate; and (ii) the Division of Silviculture, responsible for investigations into the cultivation of forest crops.

513. Work by the Division of Ecology continued on collating information on indigenous tree species and on herbarium material. About half the Northern Rhodesia check list being prepared by the Imperial Forestry Institute, Oxford, is now ready for the press. The classification of sites in the Copperbelt woodland was completed and a key prepared for easy recognition of timber-producing sites on the basis of dominant species, soil, and mean height of the canopy. Studies of the mean growth rates of the chief mining timbers showed that most lay between 15-19 rings per inch. With Silvicultural treatment it should be possible to keep up a growth rate of 10 rings per inch and produce new timber in 60-80 years time.

514. The more important silvicultural problems were made the subject of Project Plans in order to co-ordinate and give direction to studies and investigations. One was concerned with the introduction and trial of selected exotics in the territory as well as first attempts at growing exotic timber trees in plantation form. A separate project was devoted to the trial of species of Eucalypts suitable for pole and fuel production in the plateau region of the Southern Province. The preparation of land for planting pines in the woodland regions of the Copperbelt and of the Lake Bangweulu Basin was the subject of the fourth study. Investigations of weeding in Eucalypts grown on the Southern plateau have shown that clean hoeing twice in the first and second seasons results in a mean height of about 4 ft. 6 in. and very high

survival as compared with a mean height of about 2 ft. and losses of 40 per cent. or more in plots either spot weeded or slashed.

515. The value of applications of 4 oz. of NPK fertilizer (6:18:12) per tree on planting has been demonstrated by interim assessments of a replicated field trial. Mean height of fertilized trees at 12 months is 8 ft. compared with a mean height of 4 ft. in unfertilized plots. The fertilized plots show very much more even growth and are unlikely to require weeding in the second year.

NYASALAND

Agriculture

516. *Maize*. Breeding continues towards the production of a local variety with good storage quality as well as high yield per acre. A large number of single crosses and top-crosses have been made and have shown good combining ability as well as high yield. One of these outyielded hybrid maize at all Stations. Of the imported inbreds American, South African and S. Rhodesian have been somewhat disappointing in combination but some Mexican stocks are showing good promise.

517. Leaf Blight (*Helminthosporium turcicum*) does most damage and a very fair degree of resistance has been found in some families which will be incorporated in any maize used for distribution. *Puccinia polysora* has done considerable damage in the Shire Valley where conditions are ideal for its spread. The resistant genes were introduced in some types sent from EAAFRO and this resistance is being transferred to local stocks.

518. *Tobacco*. The production of improved seed continues and the great value of added nitrogen for improving both yield and quality has been shown. In Nyasaland tobacco does much better following a groundnut crop than after any other crop. Trials have shown that Turkish tobacco can be successfully grown in the Northern Province.

519. *Groundnuts*. As a result of a large series of variety trials the variety Mwitunde is being bulked for distribution for areas above an elevation of 2,500 feet and Gambia bunch for lower elevations.

520. *Tung*. A local clone of *montana* tung is proving superior to all new selections of *fordii*, both local and imported. Nitrogen is the one element which produces a consistent increase in the yield of tung. *Armillaria mellea* is being investigated further; it is occurring first in plantations eight years old then spreading rapidly. The content of elaeostearic acid varies in the oil expressed at the two factories and investigations by the Chemical Section suggest that this is due to the different climatic conditions in which the plantations supplying the factories are situated.

521. A consistent but slight variation in the gelation time of tung oil grown in two producing areas of the Southern Province was investigated by examination of the soil nutrients, age and clones of trees, changes in oil during expelling, and climatic differences. As all other possibilities gave negative results—it appears that the well-known effect of conditions during the ripening of seeds containing unsaturated oils is the cause—particularly as tung oil contains highly unsaturated glycerides. The rather higher temperatures and less wet and cloudy conditions of the Zomba area will lead to a shorter developing and ripening time and hence oil of a longer gelation period.

522. *Tea*—The series of experiments on the Establishment of Young Tea was concluded and from the results it has been possible to make valuable recommendations to the industry on this aspect of planting, the two most

important being a minimum stump diameter of $\frac{7}{8}$ inches at 4 inches above soil level, and the use of earthenware pots as collar shade.

523. The range of formal field experiments covering all aspects of tea growing, fertilizers, spacings, shade, pruning cycles, etc. has been increased by a new NPK experiment in the Cholo district, and preliminary studies on soil moistures in pruned and unpruned tea have been begun. Other new work on vegetative propagation techniques and selection has been started.

524. *Soil science*—A Nutrient Status map of the main Tea and Tung areas was produced and, although this was useful in making a general assessment of the Southern Province Soils, the many localised variations made it necessary to deal with soil problems on quite small units. The experiments started on the use and effect of saline water at Chilwa were completed and a full investigation of the Elephant Marsh Area (200 sq. miles) is in hand as this will be reclaimed as part of the Shire Valley Project.

525. The improvement of correlations between soil analysis and response to main soil nutrients (especially phosphate), for maize and tobacco is being attempted by a series of fertilizer experiments on a number of soils in the Northern and Central Provinces, representative of a wide range of textural groups with variable nutrient status.

526. Studies on the moisture use by maize, groundnuts and tobacco compared with that of indigenous volunteer weeds, and the effects of two types of fallow (clean weeded and shallow rooted cover crop) in storing moisture are proceeding.

Pathology

527. *Armillaria mellea* continues to take its toll in tung and forestry plantations. No satisfactory practical measure for control of this disease in established plantations exists at the present time.

528. Although the level of *Alternaria longipes* infection of tobacco has been reduced following the work of Dr. B. E. J. Wheeler of the Commonwealth Pool of Plant Pathologists, sporadic outbreaks of the disease still occur, particularly on the heavier soils.

Forestry

Experimental Plantations and Trial Plots

Indigenous Species

529. In the Southern Province the experimental under-planting of indigenous forest and *Pinus patula* on Zomba Mountain with Mlanje Cedar was continued, but the results are as yet inconclusive. At Chikangawa, the growth of cedar in the cleared rows in *Pinus patula* and *P. elliottii* is most successful, though the experiment has been marred by the heavy incidence of rodent damage to the young cedar. Experimental underplanting of *Pinus patula* with cedar was carried out in Chambe Forest, Mlanje Mountain, where normally there is little or no damage by rodents.

530. Experimental planting of mvule (*Chlorophora excelsa*) was continued in the Southern Province at Cholomwani and Mirale Forests. In the latter, a small plot was planted in December near the two naturally-grown mvule trees, on whose foliage small galls were discovered in 1955. The object of this experiment is to see whether similar galls will occur on the young plants, and if so, what effect they will have on their growth. There is still doubt whether these galls are really made by *Phytolyma lata*, since a plot about half-a-mile away from the trees has no sign of gall. By the beginning of March the plants had developed new shoots up to 18 inches in length, but

no galls could be found on any of them. At Cholomwani mvule was used for filling the gaps in the young teak caused by deaths from *Armillaria mellea*, and at the same place a one-acre plot of *Burttavya nyasica* was planted.

531. At Chikangawa, the *Hageria abyssinica* planted in 1955 has made extremely fast growth, after the plants had died back to ground level in the 1955 dry season, and the average height is now well over 4 feet. Further plantings will be made with this tree at the higher altitudes, as it may be of use as a nurse tree for more tender species. On the Nyika it grows up to altitudes of 8,000 feet or more.

Exotic Species

532. A total of 116.8 acres of trial plots were planted with a wide range of pines and eucalypts at the various experimental areas in different forests. Further experimental planting of six species of *Eucalyptus* was carried out at Mtangatanga on an area of clear-felled *Brachystegia* woodland. Response to intensive cultivation was very marked, particularly in the case of *E. maidenii* and *E. globulus*. Preparation of five new one-acre plots for further trials of *E. maidenii* and *E. globulus* was carried out, using the Howard Rotavator for thorough cultivation of the soil.

533. Further trial plantings of pines, cypress, and cedar were made at Lusangadazi, Luafwa, Luwawa, and Champila, all on the Vipya. At Kalwe, plots of *Entandrophragma angolense* and *Khaya nyasica* were planted under the shade of indigenous forest, and small plots of *Pinus caribaea* (syn. *P. hondurensis*), and *P. radiata* were also established. In the Central Province, trial plantings of pines in the Dzalanyama and Dzonze Forests have not been altogether successful and final results may indicate that these areas are definitely marginal for pines. In Mua-Livuleze Forest, a trial plot of teak is showing slow but promising growth.

534. In the Southern Province, small trial plantings were made with *Khaya grandifoliola* and *Entandrophragma utile* at Cholomwani. At Likabula, Mlanje Mountain (2,500 ft.), a further trial plot of *Pinus massoniana* was planted, in view of the successful growth of the original plot which was planted at the same place in 1951. On Zomba Mountain, plots of *Pinus avacahuite* and *P. leiophylla* were planted. The latter is an alleged straight form from Mexico.

535. A rooted cutting of the Giant Bamboo (*Dendrocalamus giganteus*) from the plant obtained from Ceylon in 1953 was planted at Likabula, together with rooted culms of *D. strictus* obtained from clumps growing at Zomba. Three rooted culms of an unidentified giant bamboo, kindly supplied by the Dutch Reformed Church Mission at Mkhoma in Lilongwe District, were planted at Chigamula.

536. On Zomba plateau the introduced Himalayan Raspberry (*Rubus ellipticus*) forms a dense ground cover in many places in the older stands of Mlanje Cedar, and inhibits natural regeneration. An experiment to control this pest using 2,4,5-T showed that wilting and death of foliage and soft shoots can be obtained quite easily, but that the older shoots remain undamaged.

Veterinary Research

537. No original research was possible owing to staff difficulties. Local disease problems were however investigated and resulted in the diagnosis of conditions not previously identified in Nyasaland. Clostridial disease of pigs and sheep was diagnosed, as was bowel oedema of pigs. A new form of histological technique for the diagnosis of rabies was adopted which

enabled diagnosis to be made within twenty-four hours of the submission of material. In co-operation with the Medical authorities an investigation of milk samples for evidence of *Brucella* contamination was carried out in Blantyre and Limbe. The ring test was used and so far the tests have failed to show the presence of the organisms.

538. The programme of investigation at the three Livestock Improvement Centres continued along the lines laid down for previous years, namely (i) a comparison of the productivity of Fresian and Jersey cattle breeds in the same environment and an assessment of the adaptability of these two breeds to local conditions, (ii) a comparison and study of the two local varieties of Zebu cattle, the Nyasa Zebu and the Angoni, under similar conditions of environment, (iii) a study of the Nyasa sheep and goats indigenous to the country and (iv) a study of the adaptability of a number of breeds of poultry to the local environment, and of the different systems of management under which they may be maintained in Nyasaland.

ST. HELENA

539. Investigations continued on the cultivation of *Lilium longiflorum*, on Flax (*Phormium tenax*), and on coffee. Resistance to the ravages of termites is being sought amongst locally grown trees.

ST. VINCENT

540. Fertilizer trials using NPK mixtures on sugar-cane and bananas are in progress but results with these long-term crops are not finalised. Studies on arrowroot include clonal selections from the local varieties "Banana" and "Creole" to increase yield and starch contents. Weedicide trials on banana and arrowroot have been started.

SARAWAK

Forestry

541. For basic forestry research, Sarawak depends mainly on various outside institutions, such as the Malayan Forest Research Institute, to which it contributes a small sum annually, the Singapore Botanic Gardens, the Colonial Products Laboratory, the Industrial and Scientific Research Organizations of the United Kingdom and of Australia, and others.

542. Studies of the swamp forests have reached an advanced stage, but their completion awaits the data from a number of experimental plots. Soils studies of *Kerangas* areas are completed and these are now being followed up by ecological studies.

543. The investigation, at the Laboratorium Himmelheber in Germany, of a number of Sarawak woods for the manufacture of particle boards showed most of the samples, and particularly *Shorea albida*, to be suitable for this purpose.

SIERRA LEONE

Agricultural Chemistry

544. Field responses of groundnuts to calcium, magnesium and potassium fertilisers were not as great as in the previous two years, possibly owing to a more equitable distribution of rainfall early in the growing season. If planting takes place in late March the plants can utilise nutrients which otherwise would be leached out once the top soil is saturated with water.

545. An extensive survey was made of savannah areas where the dominant tree species is *Lophira alata*, with the object of finding whether this land could be brought into economic agricultural production. The soils generally were found to be ancient and eroded, with a high proportion of pisolitic laterite and of very low fertility. Fires in these areas are normal in the dry season. The general conclusions from this survey and previous experimental work are that agricultural development would be very difficult and unlikely to be economic but that forest plantations might be a possibility.

Plant Pathology

546. Preliminary trials were carried out with Carbide Bordeaux and Perepod to control "Black Pod" disease of cocoa. Both sprays showed some effect up to spraying intervals of as much as one month. *Mycosphaerella musicola*, the leaf spot disease of banana, which was suspected as occurring in Sierra Leone in 1955, was confirmed. It is likely this came in from French Guinea, in recent years. A survey of this and other banana diseases commenced.

Forestry

547. Techniques for the regeneration and afforestation of exploited areas, whether systematically cut over to supply the sawmills or devastated by shifting cultivation and fire, are being improved as experience accumulates. These techniques include natural regeneration under a shelterwood and artificial regeneration by either the *taungya* system or line planting.

548. Experiments in killing unwanted trees by hormone sprayed on the bark are in progress. Results are not final but costs of spraying are much lower than girdling costs.

549. Experience in the use of local woods in furniture is being gained. Over thirty species are now used with the result that during natural regeneration operations a large variety of species can be classed as useful and retained.

Veterinary

550. Investigations were continued into the use of Wet Lapinised Virus to protect the Ndama cattle against rinderpest. Experiments indicated that the resulting period of immunity is at least 49 months.

551. Two titration tests each involving 25 Ndama cattle, were carried out in an effort to determine the quantity of Dried Lapinised Virus (of known titre) necessary to immunise 100 per cent. of Ndama cattle. Results seem to indicate that 2 mg. of Dried Lapinised Virus capable of infecting rabbits at 5 μ gr. is a safe dose.

SOMALILAND PROTECTORATE

Agriculture

552. Investigation still continues into the problem of the correct manner in which daughter shoots should be severed from adult date palms so as to ensure their survival as separate entities. Up to the present, the majority of shoots which have been severed have failed to survive and it is thought that this is due partly to the lack of care at the time of severance and partly to the fact that small shoots, as opposed to those weighing more than 20 kilos, are unlikely to survive. This is a problem which is not clear even to many Arabian date growing communities and it is obvious that if the date introduction scheme in this territory is to be extended an early solution must be found to this problem.

553. Research into sorghum and other grain yields is being undertaken at an experimental farm and it is now clear from the experiments which have been undertaken that unless adequate provision is made by bunding to conserve all available water which falls on the fields, no response can be expected from Kraal manure, local guano or artificial fertilizers. In banded fields, and particularly in those where the supply of water is increased by the intelligent use of surface run-off, very marked responses have been obtained from the application of kraal manure at the rate of 3 tons per acre and local guano at the rate of 4 cwt. per acre. Statistics have shown that these increased yields are most significant in the case of sorghum, and, converted to an acreage basis, it has been proved that grain yields can be increased by some 800 lb. per acre by the application of either dung or guano in banded fields.

Forestry

554. The forestry division has been concerned with the evolution of techniques for the management of deferred grazing systems in order to obtain the maximum production of both grazing and browse.

SWAZILAND

Soil Survey

555. A member of the Colonial Pool of Soil Surveyors has been engaged in studying and mapping 300 sq. miles of the Lower Usutu Basin, the contemplated location of a large irrigation project. Detailed mapping of 50 sq. miles in the Sipofaneni-Tovu district has been completed, the boundaries of both soil units and irrigability classes being plotted on aerial photographs. In addition two special surveys have been undertaken, at Mdutshane Government Farm, and in the Lower Komati Basin, on the proposed Zwibe Irrigation Scheme for Swazi plot-holders, where 900 acres of potentially irrigable land was delimited.

Animal Husbandry

556. From the basic herd of Ngune cattle with selective breeding within the breed, an attempt has been made at improvement. Individual records of each animal are being maintained as regards fertility, milk production, birth and monthly weights, etc. It is evidence that gradual improvement has occurred. In conjunction with the Ngune herd a purebred Africander herd is maintained on the farm as well as Africanders upgraded from the Ngune by using Africander bulls on Ngune cows. These animals receive the same treatment as the Ngune cattle and the same data are being collected. It is now possible to compare the Ngune with the Africander in this Territory. Valuable data has been collected on grazing management, carrying capacity, bush encroachment control, etc. Applications of 2,4,5-T failed to kill bush composed mainly of *Acacia karoo*.

TANGANYIKA

Agriculture

557. The re-organisation of the Department of Agriculture's research work is proceeding. The Territory has been divided into four regions each to be served by a Research Centre. Each region covers a wide range of climatic and soil types. A number of new sub-stations will be attached to each Centre to ensure as complete a coverage of these types as possible.

558. At Ilonga, Central Region, the research programme has been considerably expanded to include work on a wide range of crops without reducing the work on cotton. At Nachingwea, Southern Region, three departmental officers have been seconded to the Experimental and Research Department of

the Tanganyika Agricultural Corporation preparatory to the Department of Agriculture assuming responsibility for research in this area in September, 1957. At Tengeru, Northern Region, work has begun on the new laboratories. No expansion of work at Ukiriguru is yet possible owing to present shortage of water and fuel supplies. Small experimental sub-stations have been started on five irrigation schemes, three belonging to the Tanganyika Agricultural Corporation and two belonging to the Department of Agriculture. The Assistant Director (Research) is in charge of the work at these sub-stations.

559. A Territorial research policy has been drawn up so that officers in the research division have a clear picture of the overall programme. The programme is divided into main parts: Water conservation, Soil Fertility, Soil Management, Plant Breeding, Agronomy, Plant Protection. Of these, the first three are of prime importance. Unless they are adequately dealt with, advances in agronomy, plant protection and plant breeding may have only ephemeral value. Research on long term projects is so designed that where possible results of immediate importance are also obtained. As the pattern of agriculture changes from shifting cultivation to consolidated holdings, from hand hoe to ox plough and to highly mechanised cultivation the research division must be ready with answers to the problems that arise. Co-ordination of this programme with that of other East African Territories is effected through the East African Agriculture and Forestry Research Organisation.

Crop Research

560. *Cashew*. A general study of the biology of *Helopeltis bergrothi* Reut. and *H. anacardii* Mill has been started at Nachingwea. It has been shown that 0.5 per cent. gamma BHC applied eleven times will give very good control. This frequency of application is not economic and a thorough knowledge of biology of the pests might show how fewer applications can be effective. There are trees that are reputed to bear well even in bad years and a programme for the selection and testing of clonal material from these has been drawn up.

561. *Castor*. A programme of selection from local and introduced varieties has been drawn up for Ilonga paying particular attention to periods of maturity, high yield and oil content, non-shattering but easily shelled capsules. There is an indication that the yield of castor might be considerably increased by controlling a complex of sucking insects with dieldrin.

562. *Coconuts*. Work has started at Chambezi to improve the yield of mature palms with fertilizers and to reduce the ravages of *Pseudotheraptus wayi* Brown by biological control, i.e. by encouraging the establishment of nests of a predacious ant. Individual palm yield records are being examined to select high yielding palms for breeding; dwarf palms may be brought into the breeding programme if these should prove to have some resistance to *P. wayi*.

563. *Coffee*. A committee under the chairmanship of Dr. Russell, Director, East African Agriculture and Forestry Research Organisation, has made recommendations on the research programme of Lyamungu. The major recommendations are for research to be done on coffee and bananas as an agricultural system, time of application of fertilizers and close collaboration with the Kenya Coffee Research Station on leaf analysis for determining nutrient deficiencies. In Bukoba the Robusta coffee research programme has been revised. General agronomic studies and the collection of clonal material for selecting suitable breeding material are being done on land that is known to be satisfactory for coffee growing instead of trying to find ways of growing coffee on the generally poor soils of the area. A small amount of work is also being done on Arabica coffee in suitable areas. At Mbozi work continues on the cultivation of coffee in a difficult area from the rainfall point of view.

564. Work has now stopped on the control of white coffee Borer, *Anthores leuconotus* Pasc., as satisfactory measures have been worked out for control using $\frac{1}{2}$ per cent. dieldrin. Work to determine losses due to leaf-miners, *Leucoptera coffeella* (Guer) and *L. coffeina* Wshbn., is planned. Endrin is proving promising for the control of Coffee-Berry Borer, *Stephanoderes hampei* (Ferr), in Bukoba.

565. A new disease tentatively named Stem-pitting was discovered at Lyamungu. It is characterised by die-back of leaders and a bottle-like swelling of the base of the stem and can cause death of the bush. It only affects coffee planted since 1953. It has since been discovered in Kenya and Brazil. A virus is suspected. A full scale investigation is planned. Work to determine losses from Rust, *Hemileia vastatrix* B. and Br., will be done in conjunction with that on leaf-miners.

Cotton (Empire Cotton Growing Corporation).

566. The work at Ilonga has shown clearly that with well grown cotton a very worthwhile cash return can be obtained by controlling Bollworms with insecticides, DDT and BHC. This work is being developed to see if the amount of insecticide can be reduced without reduction of response. Also a number of other insecticides are being studied. Some biological work on Bollworms will begin shortly. The picture of cotton cultivation for the Eastern Province is now reasonably clear: early planting and Bollworm control. With this knowledge it is possible to define more accurately the type of plant that should be bred, i.e. a jassid resistant, short plant of compact habit that can be efficiently treated with insecticide and with high yielding capacity. Strains are being produced for rain-grown cotton areas and for irrigation areas. At Ukiriguru, breeding for general improvement and for black-arm resistance in conjunction with seed dressings is continuing. Out Station trials on pest control and the use of phosphatic and nitrogenous fertilizer are being increased in number in view of the favourable results to date.

567. *Groundnuts*. Agronomic work is being extended to new areas in view of general market demands for this crop. A big collection of varieties received from Dr. Bunting (Sudan) is being maintained at Ilonga. This may prove valuable in view of enquiries being received from the trade for types suitable for special purposes.

568. *Maize*. The production of several types of *Polysora*-resistant maize by the Tanganyika Agricultural Corporation's research staff is nearing completion. A new breeding programme to produce a short term maize, i.e. 70-80 as against 110 days, has been started. The control of stalk borer by $2\frac{1}{2}$ per cent. DDT has been shown to be economically successful only when the general standard of cultivation is high.

569. *Sesame*. A general agronomic programme has been started. The main point of interest will be to see whether the non-shattering types introduced from the Americas will retain this most valuable characteristic under local conditions.

570. *Sisal*. The general programme of research has continued. A new "leaf spot" condition of sisal has been reported. The "disease" takes the form of dark brown spots, roughly circular, and up to 10 mm. in diameter. The damage caused by these spots affects the peripheral fibres with consequent down-grading of the fibre. Histological study shows that initial damage occurs in the guard cells of the stomata. The development of the leaf-spot is consistent with the view that an insect is the causative factor.

571. *Sorghum*. The breeding programme at Ukiriguru continues and has been strengthened by the secondment of a plant breeder from the East African Agriculture and Forestry Research Organisation to work on *Striga* resistance.

572. *Soya*. The general agronomic programme is being extended to new areas. An extensive breeding programme at Nachingwea has reached the F_3 generation. The aim is to produce non-shattering higher yielding varieties with higher oil content. Two types are required one for mechanised harvesting having the pods thickly clustered on the main stem with pods formed 6 inches above ground level and few side branches and the other without qualification as to plant habit for peasant production.

573. *Sunflower*. High yielding strains with increased oil content and some degree of self pollination are being sought. This latter characteristic is most important for areas where the population of insect pollinators is low.

574. *Tobacco*. A broad agronomic programme, from seed bed experiments to rotations is in progress at the Seatondale Experimental Farm belonging to the Southern Highlands Tobacco Board. This programme is particularly important in view of the change from Ehlers tobacco to Virginia types. Small programmes on varieties, rotations and fertilizers are in progress in all areas where tobacco is of any importance.

575. *Wheat*. In collaboration with the Department of Agriculture, Kenya, a wheat breeding scheme has started at Tengeru. This will be directed mainly towards finding varieties less susceptible to stem rusts than those in production.

Water-conservation

576. Research has started at five sub-stations attached to potential irrigation schemes on water duty rates, maintenance of fertility and agronomy of a wide range of potential crops. In the drier areas work has begun on the conservation of early rainfall for later sown crops.

577. *Soil Productivity*. Many of the local soils have a low nutrient status; the lines of research in progress or planned that should contribute to the maintenance or improvement of soil fertility are:—the value of natural fallows, productive grass leys, proportion of legumes in a crop sequence, undersowing of legumes in cereal crops, mixed cropping as compared with pure stands, green manuring, use of properly made farm yard manure and fertilizers. Since a rapidly increasing area is cultivated by machines, work has begun to determine the minimum soil disturbance that is necessary to produce good crops on different soil types.

Forestry

578. A practical solution to the checking of *Pinus patula* in West Usambara nurseries was found in the use of a suitable mixture of acid and alkaline soils. Planting-out experiments with pines in very cold and exposed short-grassland areas showed very clearly that growth was limited more by grass competition than by exposure. In an experiment on *Cupressus lusitanica* in a fairly dry locality, pruning two year old trees to half height caused a slight reduction in third year height and girth increment. Pruning to two thirds and three-quarters height caused a severe loss of increment.

579. At the main centre for the replacement of mvule, *Chlorophora excelsa*, "nest" planting on heavily burned spots is now proposed and the upper canopy will be poisoned completely in the first year, and replaced by a spontaneous nurse-crop of *Trema*. It is also proposed to burn the stumps of all felled trees as this has been found to produce regeneration from root suckers instead of coppice. It has been found that *Ocotea usambarensis* can be poisoned without destroying their power to regenerate from root suckers.

580. Several insecticides were tested as a means of protecting young eucalypts from termites by sprinkling into the soil at the time of planting.

Aldrin and gamma-BHC were the most effective, and gave adequate protection for at least a year, at a cost of about fifteen shillings an acre. Thorough mixing with the soil was found to be as important as the amount used.

581. Trials were conducted to ascertain the types of axes and saws best suited to local conditions. Tests were carried out to determine the most suitable circular saws for use with four important secondary timbers, *Brachystegia spiciformis*, *Brachystegia microphylla*, *Baikiaea eminii*, *Cassipourea elliotti*. Planning and air drying tests were also carried out.

582. The work on Bee Botany was completed. The object of this work was to determine which plants are of importance to bees in Tanganyika, where these plants grow in abundance, and the periods of their nector flows. The results are based on the identification of pollen grains found in honey and hive material, together with ecological observations and recordings of hive weights. Pollen analysis of honey samples continued to be carried out, eighty five having been examined. Of first importance is the need to study how the management of beehives can be improved to produce increased and sustained yields of beeswax. As the world demand for beeswax exceeds supply and as it is an exportable commodity, the stress in management must be on beeswax production, with honey as a secondary consideration.

Applied Pedology

583. Extensive investigations have been made on the soils of the Lake Province, in particular those of the Manonga-Wembere basin. A wide range of saline-alkaline soils were found, presenting formidable but perhaps not unsurmountable difficulties in their reclamation and management under irrigation

584. An unusual type of "red earth" has been found in the Tanga Province. It contains a micaceous silt fraction concealed by iron oxides. The mica probably yields a steady supply of plant nutrients and this probably explains why the soil is valued for sisal growing. It is a more developed form of the "mbaragwila"—the water sorted micaceous silts of the Kilombero Valley and the Uluguru fans—and probably had a similar origin.

Plant Nutrition

585. The "dieback" of Wattle at Njombe has been eliminated in experimental plots by boron sprays and trials now in hand suggest that the disease can be controlled by 20 lbs. borax per acre as a soil application.

586. The combined "dieback" and "black tip" of Arabica Coffee at Mbozi can be eliminated by a boron-zinc spray and it has been shown that boron-zinc spraying can treble yield of crop. The correction of boron-zinc deficiency however seems to unmask a third deficiency and aggravates the leaf yellowing and mottling commonly found seasonally in untreated coffee. Investigations are now in hand to identify this deficiency. It seems unlikely that it is nitrogen, phosphorus, potassium or calcium deficiency as webbed mixtures of these gave no response in the spray trials.

587. At Bukoba exploratory micro-plots with millet and grass suggest that simple macro-micro-nutrient mixtures can be found to improve the unthriftiness of these crops and that they would probably be profitable to apply. For millet these nutrients are probably calcium, phosphorus and molybdenum.

588. In monthly analyses of Rubusta coffee and Banana leaves from Bukoba the iron content has been shown to drop markedly with the onset of the rains. In bad coffee the iron content drops lower than in the good and leads to a more unfavourable iron-manganese ratio. Other nutrient elements are less steady in the bad than in the good coffee.

589. Uwemba pyrethrum is being investigated in an attempt to explain falling yields. Interest is at present on phosphorus, sulphur, molybdenum, zinc, boron, iron and manganese. Of these phosphorus deficiency is proved. Molybdenum content of the leaf appears to be related to unfertilized yield on a range of farms, while field responses in yield and pyrethrin content to irrigation are possibly related to a general shortage of iron and manganese in the leaf.

Publication

W. E. CALTON and J. W. VAIL—Micro-nutrient problems in Tanganyika—*Proc. Sixth Internat. Congr. Soil Sci., Paris, 1956.*

Veterinary

590. *Rinderpest and rinderpest-like diseases.* Research was conducted into methods of improving the diagnostic techniques of protection from rinderpest and its differentiation from similar diseases. Incidental to this work was the study of the effect of cortizone on the reaction of the bovine to rinderpest challenge. The field trial of adjuvant rinderpest vaccine, which involved some 200 calves, was finalised. The experiment was designed to determine the value of rinderpest vaccine used on calves aged under twelve months, born of immune dams. A small amount of newly developed avianised rinderpest vaccine was tested for safety on exotic herds of cattle. Attempts were made to adapt the rinderpest virus to mice in order to provide a simpler method of dealing with the virus in the laboratory.

591. *Fluorosis.* A method was developed for the treatment of drinking water to reduce the fluorine content to a level safe for cattle and this was tested in the field.

592. *Pasture Research.* Fertilizer trials on Rhodes grass and maize were carried out in the Central Province. Testing of grasses with a view to discovering the varieties best suited to local conditions was continued.

593. *Livestock Research.* Work with dairy cattle included cross-breeding of *Bos taurus* X *Bos indicus* and the selection of Boran cattle for dairy purposes and the selection of Tanganyika Zebu for dairy cattle. Research into beef cattle included assessment of the value of Boran cattle for grading up other indigenous stock and the selection of Tanganyika Zebu for beef production. Work was also carried out on the selection of sheep using the Blackhead, Persian and Wiltshire horn in different cross-breeding products. Research into the value of Korodofan goats as sires for cross-bred dairy goats and into the Boer goat for grading up for meat purposes was continued.

594. Research into reproductive physiology included a large scale trial of the use of hormones in the control of ovulation in ranch cattle. An extensive study of the hereditability of fertility was made on the basis of records obtained from the Agricultural Research Council of the United Kingdom.

595. Studies were made in the physiology of lactation of the Tanganyika Zebu with particular reference to an assessment of the amount of milk consumed by calves following the suckling practices normally carried out in the territory.

Publications

H. J. VAN RENSBURG—Comparative Values of Fodder Plants in Tanganyika. *E. Afr. Agric. J.*, **22** (1956).

H. J. VAN RENSBURG—Theme Stock Farm, Iringa, Southern Highlands, Tanganyika, *E. Afr. Agric. J.*, **21** (1956).

*TRINIDAD AND TOBAGO**Agriculture**Cocoa*

596. Hybridization work with heavy bearing and witches' broom resistant clones and the selection of progeny combining these qualities is proceeding. Twenty-one promising F_1 hybrids have been selected for vegetative propagation. Low volume spraying of both water and oil based fungicides for the control of Black Pod Disease (*Phytophthora palmivora*) continue with a view to evaluating the phytotoxicity of oil on foliage and flowers.

597. Selection of pure lines of paddy continued and the production of desirable seed for distribution to farmers. The Surinam variety "Dima" is proving to be non-lodging and less sensitive to photoperiod than the commercial varieties now being grown.

598. Pasture management and grazing trials with Elephant Grass (*Pennisetum purpureum*), tropical Kudzu (*Pueraria phaseoloides*), Lucuntu (*Ischaemum timorense*) and Toco grass (*Ischaemum aristatum*) have shown that Toco grass is drought resistant and tolerant of poor soils while Lucuntu does best in the wet season.

599. The soil survey of Southern Trinidad was started and special surveys were made in the Nariva Swamp and in a section of the Fishing Pond Rice Expansion Scheme. Over 40,500 acres were completed in the soil survey of Southern Trinidad.

Animal Husbandry

600. A study is being made of the comparative suitability of Pure Bred White Plymouth Rocks, Pure Bred New Hampshires, White Plymouth Rock Cocks mated with Rhode Island Red Hens and Rhode Island Red Cocks mated with White Plymouth Rock Hens for broiler production under the deep litter system. It is found that there were no significant differences between the efficiency of feed conversion of any two groups of chicks used in this experiment. New Hampshire chicks showed superior feathering qualities to those of the other two groups of birds.

601. Pig feeding to compare the effect of feeding bananas plus fish meal *ad lib.* and a standard ration feed were done. It was found that only in the last four weeks of the sixteen week experiment were the results significant—fish-meal and bananas being significantly better than the standard ration in producing weight gains.

Forestry

602. Growth increment studies in naturally regenerated forests continued. The initial work begun in late 1955 was completed during 1956 and the 40 acres of plots will be left for 4 or 5 years before new measurements will be made.

*UGANDA**Agriculture**Fertilizers*

603. Nitrogen and phosphorus trials with finger millet showed a 40 per cent. increase on a 1,720 lb./acre crop at Kawanda from N plus placed P, a 151 per cent. increase on 1,100 lb./acre crop at Serere from N plus broadcast P and a 40 per cent. increase on a 1,080 lb./acre crop at Ngetta from N alone.

604. The role of sulphur in crop production was studied in a large experiment on finger millet. Sulphate of ammonia gave yield increases of 25-50 per cent. while N without S gave increases of only 0-20 per cent., all on a 1,490 lb./acre control crop.

605. A field experiment with trace elements at Kawanda gave a dry material increase on cotton of 73 per cent. in the presence of ample NPK. A similar experiment with trace elements and phosphate gave a 21 per cent. increase on a 1,346 lb./acre control yield of seed cotton, as compared with a 10 per cent. increase from P alone.

606. Ash from elephant grass increased the yield of cotton by 157 per cent. as compared with 83 per cent. from its equivalent as NPK fertilizer, with and without lime and trace elements, on a low control yield of 313 lb./acre.

Soil Chemistry

607. Studies of nitrate accumulation showed conclusively that this effect is due to micro-biological activity rather than physical factors.

608. In collaboration with the Grassland Research Station, Kitale, Kenya, it was shown that sulphur is essential to the nodulation and growth of legumes and very striking yield responses were obtained from its application.

Mineral Nutrition of Coffee

609. In collaboration with the Coffee Research Station, Ruiru, Kenya, it was shown that heavy grass mulching and dressings of coffee husk cause an excessive build-up of potassium in the soil which antagonises the entry of magnesium into coffee roots.

Physiology of Robusta Coffee

610. In a study of self-incompatibility it was found that an average of 4.1 per cent. of the flowers (range 2.5 per cent.-9.3 per cent.) set fruit when selfed. Examination of pollen tube growth in the style showed that lack of fertilization on selfing was due either to cessation of growth in the style, or the failure to effect fertilization on entering the ovary.

Stalk-Borers in Cereals

611. A country-wide survey was completed and showed that although stalk borers are widespread in cereals their incidence is not normally heavy and would rarely warrant the use of insecticides.

Livestock

612. Accumulated records on cattle at Serere were examined in detail. The conclusion was reached that the advances achieved by selection have been very slow and that some overhaul of policy is necessary if convincing results are to be achieved in reasonable time.

Forest Research

Silviculture of Natural Forests

613. A new system of assessing regeneration was introduced to allow precise estimation of basal-area increment per acre, and correlation with treatment, size, crown status and eventually age. An attempt to analyse the effect of density of stocking (the "crowding factor") in increment plots was started, whilst research continued on increment response to various types of silvicultural treatment. A one-thousand acre 5 × 5 latin square experiment on pre-felling treatments was laid down in Budongo forest.

Arboricides

614. About a dozen high forest species are now known to be resistant to the standard contact dose of 3 per cent. arboricide in dieseline, but all are susceptible if frilled before application. Work on individual chemicals and on seasonal sensitivity was continued.

Trials of exotics

615. There were 13 new introductions, mostly of Eucalypts, bringing the total number of exotics under trial to 110, covering a wide range of site conditions in all districts.

Utilisation

616. Four projects were completed during the year—general tests on *Aningeria altissima*, plywood trials on *Bosqueia* and *Chrysophyllum albidum*, and strength tests on a *Podocarpus* timber roof unit. Trials in progress include general tests on 10 species, a service test on flooring timbers, and comparison tests on the *Albizzia* complex.

Publications

H. C. DAWKINS—Rapid Detection of aberrant Girth Increment of Rain-forest Trees. *Emp. Forest Rev.* 35 (1956) 449.

Veterinary Research

617. Detailed studies were made upon the virus of Nairobi sheep disease following an outbreak in Uganda. The types of virus involved in outbreaks of Foot and Mouth Disease were investigated in collaboration with the Virus Research Institute, Pirbright. Observations continued on the incidence of Salmonellosis in cattle.

618. Methods of sampling foodstuffs used for digestibility trials were investigated, and the number and size of samples required to give consistent results determined. The evaluation of chemical analysis of local fodders continued. Several experimental batches of silage were prepared and investigated, particular attention being given to the losses encountered during preparation and to changes in chemical composition.

619. Further observations were made on the effect of management practices upon the grazing behaviour of Zebu cattle. Studies on the breeding behaviour of Zebu cattle continued and Artificial Insemination was performed at three experimental pilot centres for periods ranging from 6–12 months.

620. Observations were continued on the production of Shorthorn Zebu, Nganda and Ankole Longhorn cattle. Efforts to increase the number of twins produced by a flock of black head Persian type sheep by genetic selection were commenced.

Publications

BREDON, R. M.—Feeding of Livestock in Uganda. *Bull. Dept. Vet. Ser. & An. Ind. Entebbe.* Government Printer.

COYLE, T. J.—A preliminary survey of the liver fluke problem in Uganda Protectorate. Thesis, Royal College of Veterinary Surgeons, London. Liver Fluke in Uganda. *Bull. epiz. Dis. Afr.* 4, (1956), 47.

ROLLINSON, D. H. L.—The use of electro-ejaculation in the development of Artificial Insemination in African cattle. *Proc. III Int. Conf. Anim. Reprod.*, Cambridge, 1956.

ROLLINSON, D. H. L.—Problems of rabies control in Africa. *Bull. epiz. Dis. Afr.* 4, (1956), 7.

ROLLINSON, D. H. L.—Problems of rabies control in Africa. *E. Afr. Med. J.* 33, (1956), 455.

ZANZIBAR*Agriculture**Coconut Pest Research*

621. A new and more powerful mist spraying machine has been tested with particular attention to the spectrum of droplet sizes. The Entomologist reports that a rotary head which he has adopted for use has given a close approximation to the droplet spectrum which he considers to be most effective against *Pseudothraupis wayi*. A new experimental area of 100 acres of coconuts has been selected and a two-year programme of spraying commenced, using a formulation of DDT in diesel and kerosene. Spraying has already had the effect of reducing the overt damage observable on fallen immature nuts to 1.9 per cent. compared with 50 per cent. in the control areas. The frequency of spraying in this experiment depends on the rate of reinfestation of the sprayed area. Experiments are also in progress to observe the effect of ground spraying on the several species of ants the relations of which with *Pseudothraupis* have an important bearing on the problem.

Clove Disease Research

622. Long term experiments are in progress to find methods of successfully replanting clove areas previously stricken by sudden-death disease and also of restricting the spread of active sudden-death outbreaks.

Withertip Disease of Limes

623. Certain lime seedling trees have shown very marked resistance to withertip disease, and budded clones have now been established for laying down a resistance trial.

Soils and Fertilizers

624. Microplot experiments have so far indicated no shortages of magnesium in Zanzibar soils and the availability of other minor elements is being studied. In Pemba island field experiments with the major plant nutrients continue with special regard to the needs of rice. Amongst permanent crops useful yield responses to fertilizers have been obtained with limes. Manurial experiments with derris are also in progress and attention is being given to the effect of fertilizer on the development of rotenone in the roots.

Varietal Testing

625. Hybrid varieties of maize and cassava issued by the East African Agriculture and Forestry Research Organisation are being tested specially as regards disease resistance. Imported varieties of rice from Trinidad are also under trial.

Cattle

626. In order to make effective use of the strain of high milk yielding Zebu cattle bred at the Government stock farm experiments with artificial insemination have commenced.

VII. REPORTS OF STANDING SUB-COMMITTEES*(a) Stored Products Research Sub-Committee*

627. This Sub-Committee has held two meetings. It has endorsed the recommendations of a working party set up to consider the use of DDT and BHC with foodstuffs in British Colonial Territories. These amended the existing Code of Practice covering the use of these insecticides on stored foodstuffs and the appropriate parts of the Code are now as follows :—

628 "The recommended limits (*i.e.* 2.5 p.p.m. and 7 p.p.m. of BHC and DDT respectively) refer to the average insecticide content of foodstuffs at the time of consumption and it is suggested that the initial admixture of the insecticide may be allowed to exceed the stated limit if it can be shown, or reasonably expected, that (a) removal of insecticide by washing, screening, or similar processing, (b) loss of insecticide by volatilization during storage or processing, or (c) dilution of insecticide by mixing treated with untreated produce, will reduce the level in the particular item, when prepared as food, to or below the stated limit. The technical grade of BHC usually contains about 13 per cent. of the gamma-isomer of BHC with other isomers as impurities. These other isomers show only very slight insecticidal activity but are toxic to mammals and have a tendency to taint food treated with formulations containing them. As formulations based on gamma BHC (lindane) are now freely available, only these preparations should be used in the protection of stored foodstuffs destined for human consumption."

629. The annual meeting of the West African Stored Products Research Unit Reviewing Committee was held in January in Lagos and was attended by Dr. W. F. Jepson and Mr. D. W. Hall. The latter visited Nigeria and Ghana also to advise on methods of combating insect problems of stored cocoa. Both territories started in 1956 to carry out certain insecticidal control measures.

(b) *Cocoa Research Sub-Committee*

630. The Sub-Committee held one meeting. Dr. Wiltshire resigned on his retirement as Director of the Commonwealth Institute of Mycology and was replaced by Dr. Hopkins, the new Director.

631. The Sub-Committee reviewed the programmes of work on cocoa fermentation now proceeding in different places. Recent work has given useful practical results, particularly in Ghana. Attention was also given to capsid and black pod control, both of which are being extended in West Africa.

632. Trial plantings of cocoa in the Far East have given very encouraging early results but the widespread decline in yields after the early years presents a problem which requires investigation. The comparative yields of clones and seedlings also requires study over a number of years.

(c) *Soils Sub-Committee*

633. The Sub-Committee held one meeting. Mr. G. W. Nye joined the Sub-Committee in succession to Sir Geoffrey Clay. Dr. Greene visited the British West Indies and attended the meetings of the UNESCO Arid Zone Committee in Australia. Mr. Rhind visited the British West Indies and West Africa, East Africa and Central Africa. Dr. Osmond visited Malta.

634. Particular attention was given to the various soil surveys now in progress and it was recommended that one member of the Pool of Soil Surveyors should receive training in irrigation and should thereafter be available for those surveys involving irrigation projects.

Colonial Economic Research Committee Tenth Annual Report (1956-1957)

London School of Economics and Political Science
Houghton Street,
Aldwych,
London, W.C.2.
28th October, 1957.

SIR,

I have the honour, on behalf of the Colonial Economic Research Committee, to transmit to you the Tenth Report of the Committee covering the period from 1st April, 1956, to 31st March, 1957.

I have the honour to be,

Sir,

Your obedient servant,
ARNOLD PLANT,
Chairman.

The Right Honourable Alan Lennox-Boyd, M.P.,
Secretary of State for the Colonies.

COLONIAL ECONOMIC RESEARCH COMMITTEE

TENTH ANNUAL REPORT—(1956–57)

Membership

PROFESSOR SIR ARNOLD PLANT, Professor of Commerce, University of London,
(*Chairman*).

PROFESSOR S. H. FRANKEL, D.Sc. (Econ.), Professor of Colonial Economic
Affairs, University of Oxford.

DR. J. R. RAEBURN, Reader in Agricultural Economics, University of London.

PROFESSOR E. A. G. ROBINSON, C.M.G., O.B.E., Professor of Economics,
University of Cambridge.

MR. K. E. ROBINSON, Fellow of Nuffield College and Reader in Colonial
Government, University of Oxford.

PROFESSOR R. S. SAYERS, Cassel Professor of Economics, with special reference
to Banking and Currency, University of London.

PROFESSOR R. C. TRESS, Professor of Political Economy, University of Bristol

MR. A. F. COMFORT (*Secretary*).

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

Tenth Annual Report and Bibliography

I. INTRODUCTION

1. Three meetings of the Committee took place during the year.
2. No changes occurred in the composition of the Committee since those noted in the last Report.

II. GENERAL

3. Issues against the Economic Research allocation of £70,000 for the quinquennium totalled £18,598 at the 31st March, 1957.
4. During the year the Committee considered proposals submitted by Colonial Governments for the expenditure of the remaining balance of the allocation and decided upon an allocation of priorities. These are discussed in Sections V and VI below.
5. Economic research undertaken at the Institutes and Social Research Units is recorded in the Annual Reports of the Institutes. Among the publications of economic interest by Institute staff were Mr. M. G. Smith's report on Labour Supply in Jamaica, Mr. Elkan's studies of an African factory labour force in Kampala and Jinja, and Mrs. Humphreys' book on "The Gold Coast Cocoa Farmer." Other works in the Press included P. G. Powesland's "Economic Policy and Labour in Uganda" and Mr. Baldwin's study of the Mokwa Scheme.

III. RESEARCH FINDINGS PUBLISHED

6. Mr. F. H. H. King's *Money in British East Asia* was published in the Colonial Research Studies series shortly after the end of the year.

IV. RESEARCH COMPLETED

7. It is hoped to publish the study by Professor Gilbert Walker on *Nigerian Transport in 1950* (received in the previous year) shortly.
8. Mr. G. A. Petch's study of agriculture in Sierra Leone, completed in 1955-56, is being duplicated by the Sierra Leone Government.
9. Dr. A. R. Prest's *Fiscal Survey of the British Caribbean*, written with the assistance of Mr. W. G. Demas, was on the point of publication in the Colonial Research Studies series. The report by Mr. C. A. Moser of the London School of Economics on *Levels of Living in Jamaica* has been sent for printing and it is hoped to publish the report shortly in the Colonial Research Studies series.
10. The report on the inquiry by Professor Peacock of Edinburgh University, which he carried out with the assistance of Mr. Douglas Dosser, on the *National Income of Tanganyika* was completed during the year. Arrangements are being made for the printing of this report.

V. RESEARCH IN PROGRESS

11. Mr. D. T. Edwards, who has been attached to the Institute of Social and Economic Research of the University College of the West Indies, has completed his research on the analysis of the economics of small farms in Jamaica, which he has carried out in association with the Jamaican Department of Agriculture. A report on the study is expected shortly. As was

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stated in the Report for 1955-56, this study was prolonged by means of a supplementary grant in view of the unexpectedly large volume of findings involved.

12. As one of the schemes forming part of the Committee's programme approved during the year, Dr. Raeburn, of the London School of Economics, has begun, with the assistance of Dr. Robin Johnson, a large scale study of the economics of farming systems in Africa. This study, the aim of which is to bring together scattered information on subsistence and non-subsistence agriculture in about fifteen to twenty localities, is expected to yield far-reaching results. The report on the study will be drawn up with the co-operation of Departments of Agriculture in the African territories. It will cover such subjects as the economic organisation of farming, the price of products, means of increasing production and maintaining and improving soil fertility, labour costs, the best use of land, the use of capital and the net output of the various farming systems in the forms of cash and goods. Dr. Raeburn also intends to take account of social and ecological factors influencing agricultural production. Dr. Raeburn and Dr. Johnson will spend a substantial time in a large number of African territories and it is hoped that the report on the project will be completed early in 1959.

13. A formal scheme was drawn up during the year to provide finance for the investigation of the agricultural economy of Malta which is being carried out by the Royal University of Malta in conjunction with the University of Durham. The project has now got under way.

14. Mr. A. D. Knox is expected to submit a report during the year 1957-58 on the study which he undertook in 1953-54 of the development of trade between British West Indian territories.

VI. NEW PROJECTS

15. Under the programme drawn up by the Committee as a result of their study of requests submitted by Colonial Governments, the following projects were allotted priority :—

- (i) a study of the economics of road development in Uganda. This study is to be carried out by Mr. E. K. Hawkins of Nuffield College, Oxford, and will, it is hoped, begin in October, 1957.
- (ii) An economic survey of the Seychelles. Mr. Rowe, of Pembroke College, Cambridge, has been appointed to undertake this survey, which is now expected to take place in 1958, with a view to making recommendations as to those parts of the island's economy which might profitably be developed.
- (iii) A survey of farm production in British Honduras.
- (iv) A study of the Fijian community as an economic unit.
- (v) A study of the effects of diamond mining in Sierra Leone on a predominantly subsistence economy.

16. Further projects, which it is hoped to finance should further funds become available to the Committee, include a study of transport economics in North Borneo.

VII. ECONOMIC RESEARCH UNIT, UNIVERSITY COLLEGE OF THE GOLD COAST

17. Since 31st July, 1956, funds for the Research Division were provided at first by the Gold Coast Government and subsequently, after the independence of Ghana, by the Government of Ghana. The Division's annual report is now incorporated with that of the University College of Ghana.

18. Mrs. Humphreys and Miss McGlade continued their extensive work on the finances of cocoa farmers and on employment of labour on cocoa farms. Mrs. Humphreys' earlier results were incorporated in a book published by the Oxford University Press. A large amount of additional information has now been collected and analysed. Mr. Niculescu was concerned largely with Government planning of development programmes. His manuscript has been submitted for publication. He also undertook the editing and production of a monthly bulletin for the recently formed Economic Society of Ghana. This bulletin deals with topical events from an economic point of view.

19. Mr. Rado resigned from the Research Unit to take up an appointment as lecturer in economics.

VIII. CONFERENCES

20. Mr. Elkan, of the East African Institute of Social Research, attended a meeting of a Committee of Experts called under the auspices of the Inter-African Labour Institute at Salisbury, Southern Rhodesia, in November, 1956. The purpose of the meeting was to make further recommendations about the proposals for a study of human factors affecting productivity in Africa. At the end of the year the Committee had before them a proposal to finance a two-year study of such factors in two factories in Nigeria.

21. A meeting of economists was held at Nairobi in June, 1956, under the auspices of C.C.T.A. The meeting recommended the publication of a bibliography of economic research in progress in Africa South of the Sahara, based on a draft register prepared by Dr. P. Ady, of St. Ann's College, Oxford, and the setting up of a panel of national correspondents who would be responsible for collecting material for the territories of each member country of C.C.T.A. It is expected that the bibliography will be published early in 1958.

IX. PUBLICATIONS BY WORKERS ASSISTED FROM COLONIAL DEVELOPMENT AND WELFARE FUNDS

22. 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 Ninth Annual Report) are:—

Cumper, G. E., "Working Class Emigration from Barbados to the United Kingdom; October, 1955." *Social and Economic Studies*, Vol. VI, No. 1, March, 1957.

"Population Movements in Jamaica, 1830-1950." *Social and Economic Studies*, Vol. V, No. 3, 1956.

Elkan, Walter, "Incentives in East Africa." H.R.H. the Duke of Edinburgh's Study Conference Background Papers, No. XIII, O.U.P. 1956.

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Fearn, Hugh, "Problems of the African Trader;" E.A.I.S.R. Conference Proceedings, January, 1955.

"Report of an Investigation into Wholesale Trading Facilities for African Traders in the Nyanza Provinces of Kenya." Report published under authority of the Provincial Commissioner, Nyanza Province, March, 1955.

"Cotton Production in the Nyanza Province of Kenya Colony, 1908-1954." *The Empire Cotton Growing Review*, Vol. XXXIII, No. 2, pp. 123-136. April, 1956.

Hill, Polly, "The Gold Coast Cocoa Farmer." O.U.P. 1956.

Huggins, H. D., and E. R. Chang, "Depreciation Policy and the Investment Stream." *Social and Economic Studies*, Vol. V, No. 2, 1956.

Martin, Anne, "The Oil Palm Economy of the Ibibio Farmer." Ibadan Univ. Press, July, 1956.

Prothero, R. Mansell, "The Population Census of Northern Nigeria 1952: Problems and Results." *Population Studies*, Vol. X, No. 2, November, 1956.

"Population Patterns and Migrations in Sokoto Province, Northern Nigeria." *International Geographical Union*, 1956.

WEST AFRICAN INSTITUTE OF SOCIAL AND ECONOMIC RESEARCH, "Annual Conference Proceedings March, 1956" W.A.I.S.E.R. 1956.

Colonial Fisheries Advisory
Committee Annual Report on
Fisheries Research
(1956-1957)

The Church House,
Great Smith Street,
Westminster,
S.W.1.

1st October, 1957.

SIR,

As Lord Lloyd's successor as Chairman of the Colonial Fisheries Advisory Committee, I have the honour to submit to you the Committee's Annual Report for the year 1956-1957.

I have the honour to be,

Sir,

Your obedient servant,

PERTH,

Chairman.

The Rt. Hon. Alan Lennox-Boyd, 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*).
- MR. J. CROFT-BAKER, C.B.E. (*Resigned May, 1957*).
- 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, M.C.
- DR. C. F. A. PANTIN, Sc.D., F.R.S.
- DR. G. A. REAY, O.B.E., Ph.D., F.R.I.C.
- MR. F. S. RUSSELL, C.B.E., D.S.C., D.F.C., F.R.S.
- MISS 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*).

Terms of Reference

This 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
ANNUAL REPORT ON FISHERIES RESEARCH
(1956-1957)

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COLONIAL FISHERIES ADVISORY COMMITTEE
ANNUAL REPORT ON FISHERIES
RESEARCH, 1956-57

I. GENERAL

1. Four meetings of the Committee were held during the year.
2. Of the problems on which the Committee were called to advise, the most serious were those which concerned the local developments that led eventually to the curtailment of fishery research activities on a regional basis at the West African Fishery Research Institute, Sierra Leone, and the Interterritorial Fishery Research Station in Singapore. The West African problem arose first and was reported on by a Special Mission appointed by the Secretary of State consisting of Mr. R. S. Wimpenny, Deputy Director of the Fishery Research Laboratory, Lowestoft and a member of the Committee, together with Mr. R. Forman, Vice Chairman of the Scottish Herrings Producers Association and Dr. A. J. Went, Chief Fisheries Inspector to the Eire Government. Although the Mission were able to verify that there was a continuing need for fishery research in West African waters and tried to impress this on local opinion in the Gold Coast and Nigeria, it was not possible to ensure the continued support of those two countries. Consequently, there was no alternative but to accept the winding up of the Institute as an interterritorial body, but on the Committee's recommendation, plans have been laid to safeguard the results of the research so far carried out and to set up in consultation with the Sierra Leone Government a small territorial research unit, based on the Institute premises, and fully integrated with a local fishery development unit. Discussions with the Sierra Leone Government are proceeding to this end.
3. In the course of 1956 the Government of the Federation of Malaya decided not to continue to participate in the work of the Regional Fisheries Research Station at Singapore. Their decision was subsequently followed by the decision of the Government of Singapore to withdraw, and there was therefore no alternative but to wind the station up completely.
4. The Committee have felt bound to express their regret at these developments, since they find the need for fishery research to be reinforced rather than diminished by the advances made by local sea fisheries. In their view these advances hasten the day when such problems as over-fishing and general conservation will arise to confront an established and perhaps heavily capitalised industry on modern lines.
5. The Committee have been glad to note the progress made at the other official research stations in East Africa, Northern Rhodesia, Malaya and Hong Kong. They continue to be impressed by the very encouraging progress made in the development of local fishing industries, particularly in Aden, the West Indies, Gold Coast and Hong Kong.
6. The Fishery Research Vessel, Cape St. Mary, which formerly worked for the West African Fisheries Research Institute has made a successful start on a series of trawling surveys for the Government of British Guiana. The Fishery Research Vessel Manihine, which formerly worked for the Singapore Station, has been transferred to the East African Marine Fisheries Research Organization, Zanzibar, where it is being refitted to take the place of the Organization's obsolete craft the "Research."

II. STAFF

7. Endeavours are being made to place in other posts in the Overseas Research Service, the scientific staff displaced by events in West Africa and Malaya. All the officers concerned have been brought home to the United Kingdom to write up their scientific work before re-posting.

III. REPORTS ON INDIVIDUAL COLONIAL FISHERIES RESEARCH STATIONS**(a) East African Inland Fisheries Research Organization**

8. The results of research at the Jinja Laboratory have been used to advise the East African Governments on the probable consequences of proposed changes in legislation for the protection of fish stocks in Lake Victoria, and a memorandum has been submitted by the Director.

9. The Director published in "Nature" an account of how the electrical conductivity of the water of the White Nile could be used to estimate the relative contributions to the White Nile of the three affluents, the Semliki River, Lake Albert, and the Victoria Nile.

10. Work has continued on the bottom muds of Lake Victoria. A spectrographical analysis of bottom deposits from Pilkington Bay showed, incidentally, a relatively high content of titanium.

11. The rate of decomposition of the bottom deposits is probably the most important factor affecting the fertility of Lake Victoria, and hence of the yield of fish. It has previously been shown that sulphur, an essential element for plant and animal life, is present in such small quantity that it may be a limiting factor. Experimental evidence has now shown that organic sulphur, deposited on the lake bed in the form of plant debris, has little chance of being converted into available sulphates. But the muds readily yield *combined* sulphur after boiling, autoclaving, oven-drying or treatment with Morgan's reagent.

12. Snails perform a valuable function in secreting sulphuric acid, and grazing down submerged vegetation and its attached epiphytes, bringing nutrients into solution again through their excreta. But their interest as intermediate hosts for human and animal parasites has led to the observation that the ability of snails living in small streams and pools to survive the dry period depends on their degree of infestation by parasitic trematodes.

13. Observations have been continued on the life cycles of aquatic insects known to play an important part in the diet of fishes. Using the mercury vapour lamp to attract the insects into a trap, collections have been made for a hundred consecutive nights at Jinja, and also at various places round Lake Victoria. There are indications that several species possess a lunar rhythm of emergence. The correlations of the larvae of aquatic insects with their respective adults continue.

14. Recent control measures carried out by the Uganda Medical Department against Simulium (black fly) in the Victoria Nile have provided an opportunity to study the effects of D.D.T. on insectivorous fishes. Some species of fishes showed extreme adaptability and were able to use a wide range of alternative foods and insects; others changed their feeding grounds to areas where the insects were protected against the full effects of D.D.T. One species the spiny-eel (*Mastacembalus victoriae*) proved unable to change its feeding appreciably, and it seems that many individuals either starved or were forced to leave the area. There is no record of the fishes themselves being affected by the D.D.T.

15. Work on the food and feeding habits of insect eating and fish eating species of fish in Lake Victoria is now near completion. The stomach contents of over 9,000 fishes have been examined. The outcome of these studies will be of great interest and value.

16. Experimental fishing has continued, and special emphasis has been placed on the collection of data relating to the catch in net sizes which are at present not permitted in Lake Victoria. In this way some idea has been gained of the probable results which may follow any relaxation of the present restrictions on the use of certain mesh sizes.

17. Experiments on the effects of light intensity on growth of *Tilapia* have been started, and work has been continued on the significance of ring-formation, resembling the growth-rings used for age-determination in fishes of temperate seas and rivers, in *Tilapia* and other species of fish. It seems that, in Lake Victoria, these are not annual rings, but mark some critical points in the life cycle of the fish, notably spawning.

18. Now that the spawning of the important *Clarias mossambicus* has been discovered, work has been started on the growth rate and general ecology of this fish during the first two years of life. Growth appears to be slow. The eggs and embryos of another important fish, *Labeo victorianus* have been discovered, and the way cleared to a knowledge of its breeding habits.

(b) *East African Marine Fisheries Research Organization*

19. The year was marked by steady progress in the survey and assessment of the fish potential, and advances were made in new directions.

20. Work at sea in the research vessel "Research" has consisted in the continuation of trolling at the surface, for the determination of seasonal variations in the distribution of the pelagic fishes, and trials at deep water trolling by the use of a kite. An attempt was made at long line fishing, Japanese style, but the gear was lost in bad weather. Further trials will be made.

21. Research cruises were made in north Kenya waters in collaboration with the Kenya Fisheries Department. A new fishing ground was explored.

22. Improvements and strengthening of the trolling gear, as a result of experience gained, has resulted in the average weight of the fish successfully caught rising from 10 lbs. in 1951 to 15½ lbs. in 1956.

23. Further cruises were made to Lathom Island to observe the appearance of the Karambisi (*Caranx ignobilis*). This fish appears to have a lunar periodicity (well known in some other fisheries) and congregates at Lathom Island at the time of full moon in the early months of the year.

24. Work on the distribution and ecology of the fishes of coral reefs, and of bottom-dwelling fish generally, continued. Underwater guns and diving equipment were used, as well as lines, trammel nets and traps. Several papers are in preparation on certain important groups of these fishes.

25. The seasonal appearance of the Dolphin-fish *Coryphaena hippuris* has now been correlated with plankton and hydrographic data, and a paper has been submitted for publication.

26. The research vessel continues to give good service. Since her commission in 1951, she has steamed some 37,000 miles and spent 508 days at sea. She is shortly due for replacement by a larger vessel.

27. The marine fishponds at Chukwani, which have been in use for some years, were used for a successful experiment on the growth of a *Tilapia* species, related to *T. mossambica*. These fish grew to a weight of half a pound, and bred twice, in some seven months. A paper on this fish, and

on the chemical and biological characteristics on the ponds in which they are growing, has been written up for publication. In the Far East, *T. mossambica* will grow in salinities higher than those of the open sea, and is extensively cultivated in brackish water ponds.

(c) *Northern Rhodesia-Nyasaland Joint Fisheries Research Organization*

28. Work on Lake Nyasa by the full team ended in 1955-56, and the staff moved to Samfya on Lake Bangweulu.

29. Much time was at first occupied in completing the essential interior construction of the new Laboratory and, up to the end of the year being reported upon, there was no electric light and power, though the Laboratory is wired for these.

30. As so little is known about the fish, their ecology and environment in Northern Rhodesia, the policy of discovering basic facts was in general followed. Priority of research was given to Lake Bangweulu, the Bangweulu swamps and the Zambesi and Sanyati rivers in the area which is to be covered by the future Kariba Dam.

31. The collection of data was greatly facilitated by the arrival of the new shallow-draught launch. Data from the open water of Lake Bangweulu proceeded during the year, and much useful knowledge of the distribution and feeding habits of the fish was gained.

32. The importance of the shore line of Lake Bangweulu as a habitat for fishes is due to the fact that most of the bottom area of Lake Bangweulu consists of oozy mud, which is a poor habitat for fish. A narrow belt, only a few hundreds of yards wide, around the shore line, is comparatively rich in fish food, and hence in fish, and this narrow area is intensively fished with seine nets. Moreover, in the open lake there are no truly pelagic species, such as are found in other lakes, which might form the basis of a fishery.

33. The Bangweulu swamps, on the other hand, have an important commercial fishery, and regular launch tours are now being made to a number of stations to collect hydrological and ecological data, and to correlate these with observations and collections of the fish population. In particular, values of dissolved oxygen are found to fluctuate, and affect the distribution of the fish. Certain species of fish undergo a mass mortality, and this may be due to their being trapped in deoxygenated swamp water.

34. In general, a picture of fish populations moving about due to changes in oxygen conditions, as well as other causes such as breeding and feeding migrations, is being built up: such data are extremely important because of their effect on the important swamp fishing industry.

35. The importance of *Vossia* grass, so abundant in the swamps, as a habitat for fishes, including the juveniles of several very important commercial species, is being investigated. It appears that this grass, the roots and stems of which are flooded, particularly in the high water season, form a refuge and feeding habitat for the young of commercially important fish species.

36. A check list and a key to the fishes of the Bangweulu-Mweru-Luapula area have been made, and it is hoped to publish this shortly.

37. Visits have been made to the Zambesi and Sanyati Rivers in the Kariba Dam area. Intensive collecting has revealed the presence of only 28 species of fish actually occurring in the Zambesi at this point.

38. It has been shown that the spawning of fish in the river is of much shorter duration than is the case in the Central African lakes, and mainly confined to the time when the river is in flood.

39. The fish population is completely dominated by the predatory Tiger fish, which are extremely abundant and grow very rapidly. Though they chiefly prey on other fish, they can subsist on insects during the dry season.

40. Work on Lake Nyasa—chiefly on the Utaka group of fishes—continues.

(d) *Fish Culture Research Project, Malacca, Malaya*

41. This station was completed during the year, but work on the fishponds was delayed by the non-delivery of the electric pumps. These are expected to be installed in May, 1957.

42. Meanwhile, two scientists are in residence, and have begun work on the biochemistry of the waters around the research station, and on the algal flora. They have also worked on commercial fishponds.

(e) *Fisheries Research Unit, University of Hong Kong*

43. A hydrographic survey of the sea around Hong Kong has now been continued for two years, and some 28 stations are worked. Data from this survey will allow of an assessment to be made of the influx of the Pearl River, and of other factors, on the fishing grounds within range of the Colony.

44. Exploratory fishing operations, using experimental nets, have been carried out by the research vessel on fishing grounds as far distant as Hainan Island. It is anticipated that the Units survey and experiments will make available grounds at present unknown or unworked by the local fishing fleet.

45. An oyster experiment, involving both the transfer of local oysters from Deep Bay to Tolo Harbour, and the introduction of a small number of European and Japanese oysters, has given indications that the development of an edible oyster industry in Tolo Harbour may be possible.

46. Papers are in preparation for publication on the following subjects:

- (1) Techniques of age determination of tropical species of fish.
- (2) An analysis of the operations of a company-operated pair of trawlers.
- (3) A survey of the fishponds of the New Territories.
- (4) An analysis of a two-year hydrographical survey.
- (5) Details of an experiment with edible oysters.

47. The Unit undertook a survey in Deep Bay to define under what conditions a channel may be cut through the oyster beds in order to make available large deposits of building sand, without unnecessary danger or hazards to the valuable oyster beds.

The West African Fisheries Research Institute

48. During June the research trawler "Cape St. Mary" made a survey of the fishing grounds off Tema, on the Ghana Coast. The research launches have maintained inshore trawling observations both in the Sierra Leone estuary and outside it.

49. The trawling survey off Tema confirmed the results of French investigators off French Guinea, which is of considerable interest, as these places are 1,000 miles apart. In both cases, there is a distinct change, at about 10 fathoms, from fishes of an inshore, almost estuarine, type, to red and brown marine species. The same species occur in both areas and at the same depths. Clearly, conditions in this regard are uniform over a great part of the West African coast.

50. The rates of catch achieved are comparable with those got off Trinidad and Australia, and better than those got off the coast of India and the Patagonian Shelf. Night catches were more than 50 per cent. greater than day catches.

51. A series of trawling voyages were made off Sierra Leone, and, at the close of the year, off the Gambia. The results of these cruises are not yet available.

52. The results of several years survey of hydrography, plankton, benthos and fish in the Sierra Leone estuary are being worked up. Two papers have been published, and five are in preparation. They will comprise one of the most complete scientific surveys ever made in a tropical estuary.

53. An extensive survey of the bottom fauna on the Continental Shelf off Freetown has correlated this fauna with the nature of the sea-bed, and with the food of fish.

54. With some 15 scientific papers published or in preparation, the work of this station was just getting well started. It is the more to be regretted that West African governments have felt unable to continue to support this work.

Singapore Regional Fisheries Research Station

55. The twin-screw motor fisheries research vessel "Manihine" made long cruises at monthly intervals until August, when the Master fell ill. Fishing was done over a very wide area, from the North of Sumatra to the coast of Borneo.

56. Several fishing methods were tried. Surface trolling produced very poor results, and so did long-lining in the European manner. Drift nets caught little, and were liable to damage by sharks. The blanket net of the Philippines used in conjunction with a light to attract the fish, also failed. Trawling, however, gave some good results. In particular, one region in the South China Sea gave excellent trawl catches.

57. The fish and prawns taken in these cruises are being identified and worked up for their distribution and abundance.

58. Work on the seasonal fluctuations in abundance of fish eggs in the Singapore Straits, and their vertical distribution, was continued.

Colonial Office,
Sanctuary Buildings,
Great Smith Street,
S.W.1.

12th August, 1957.

Colonial
Medical Research Committee
Twelfth Annual Report
1956-57

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

26th August, 1957

SIR,

On behalf of the Colonial Medical Research Committee, I have the honour to transmit to you the Twelfth Annual Report of the Committee, covering the period 1st April, 1956 to 31st March, 1957.

I have the honour to be,

Sir,

Your obedient servant,

H. P. HIMSWORTH,

Chairman.

The Right Honourable Alan Lennox-Boyd, M.P.,
Secretary of State for the Colonies.

COLONIAL MEDICAL RESEARCH COMMITTEE

- SIR HAROLD HIMSWORTH, K.C.B., M.D., F.R.C.P., F.R.S., Secretary, Medical Research Council (*Chairman*).
- BRIGADIER J. S. K. 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.
- 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., 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 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. MAFGRAITH, 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 ERIC PRIDIE, K.C.M.G., D.S.O., O.B.E., M.B., F.R.C.P., Chief Medical Officer to the Secretary of State for the Colonies.
- SIR LANDSBOROUGH THOMSON, C.B., O.B.E., D.Sc., Second Secretary, 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.
- DR. R. LEWTHWAITE, C.M.G., O.B.E., D.M., F.R.C.P., 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 J. S. K. 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.
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 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 ERIC PRIDIE, K.C.M.G., D.S.O., O.B.E., M.B., F.R.C.P.
 DR. F. HAWKING, D.M., M.R.C.P., D.T.M. (*Secretary*).

HELMINTHIASIS

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 (*Chairman*).
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 London.
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 SIR ERIC PRIDIE, K.C.M.G., D.S.O., O.B.E., M.B., F.R.C.P.
 DR. J. WALKER, D.Sc., Ph.D., D.Phil., National Institute for Medical Research.
 DR. W. E. KERSHAW, V.R.D., M.D., D.T.M. & H., Lecturer in Medical
 Parasitology, Liverpool School of Tropical Medicine, University of
 Liverpool (*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., Assistant Secretary (Personnel), Medical
 Research Council.
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 DR. R. LEWTHWAITE, C.M.G., O.B.E., D.M., F.R.C.P. (*Secretary*).

LEPROSY

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 DR. A. R. D. ADAMS, M.D., F.R.C.P., Senior Lecturer in Tropical Medicine,
 Liverpool School of Tropical Medicine, University of Liverpool.
 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.
 SIR NEIL HAMILTON FAIRLEY, K.B.E., M.D., D.Sc., F.R.C.P., F.R.S.
 DR. P. M. D'ARCY HART, M.D., F.R.C.P., National Institute for Medical
 Research.
 DR. F. HAWKING, D.M., M.R.C.P., D.T.M.

- DR. E. MUTR, C.M.G., C.I.E., M.D., F.R.C.S.E., LL.D.; Hon. Medical Adviser, British Empire Leprosy Relief Association.
- DR. D. S. RIDLEY, B.Sc., M.B., Pathologist, Hospital for Tropical Diseases, University College Hospital.
- PROFESSOR E. T. C. SPOONER, M.D., Professor of Bacteriology and Immunology, University of London.
- DR. R. LEWTHWAITE, C.M.G., O.B.E., D.M., F.R.C.P. (*Secretary*).

LABORATORY PANEL OF THE LEPROSY SUB-COMMITTEE

- PROFESSOR E. T. C. SPOONER, M.D. (*Chairman*).
- BRIGADIER J. S. K. BOYD, O.B.E., M.D., F.R.C.P., F.R.S.
- DR. E. M. BRIEGER, M.D., Research Pathologist, Papworth Sanatorium, Cambridge.
- DR. S. R. M. BUSHBY, Ph.D., Wellcome Research Laboratories.
- DR. R. G. COCHRANE, M.D., F.R.C.P.
- DR. S. D. ELEK, M.D., D.C.P., D.P.H., Ph.D., Reader in Bacteriology, St. George's Hospital Medical School, University of London.
- DR. P. M. D'ARCY HART, M.D., F.R.C.P.
- DR. G. R. F. HILSON, M.D., Senior Lecturer, Department of Pathology, St. George's Hospital Medical School, University of London.
- DR. R. J. W. REES, B.Sc., M.B., National Institute for Medical Research.
- DR. D. S. RIDLEY, B.Sc., M.B.
- PROFESSOR J. M. ROBSON, M.D., D.Sc., F.R.S.E., Professor of Pharmacology, Guy's Hospital Medical School, University of London.
- 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*).

ADVISORY WORKING-PARTY ON THE SICKLE-CELL TRAIT AND
SICKLE-CELL ANAEMIA

- PROFESSOR A. W. WOODRUFF, M.D., Ph.D., F.R.C.P. (*Chairman*).
- DR. A. C. ALLISON, B.M., Ph.D., Student of Christ Church College, University of Oxford.
- DR. G. M. EDINGTON, M.D., D.C.P., Pathologist, Gold Coast Medical Service.
- DR. H. FOY, D.Sc., Ph.D., The Wellcome Trust Research Laboratories.
- PROFESSOR P. C. C. GARNHAM, M.D., D.Sc., D.P.H.
- DR. P. W. HUTTON, M.D., M.R.C.P., Medical Specialist, Uganda Medical Service.
- DR. H. LEHMANN, M.D., Ph.D., F.R.I.C., St. Bartholomew's Hospital, London.
- DR. A. E. MOURANT, D.M., D.Phil., Lister Institute of Preventive Medicine, London.
- DR. A. B. RAPER, B.Sc., M.D., M.R.C.P., National Institute for Medical Research.
- LIEUT.-COL. J. H. WALTERS, M.D., M.R.C.P., Physician, Hospital for Tropical Diseases, University College Hospital.
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COLONIAL MEDICAL RESEARCH COMMITTEE
TWELFTH ANNUAL REPORT

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COLONIAL MEDICAL RESEARCH COMMITTEE

WORK OF THE COMMITTEE

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

Development of Research Schemes

2. Forty-nine research projects were in varying degree under the scientific supervision of the Committee at the end of the year. They ranged 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. The fostering of research by seeding with grants certain departments of universities in Britain or Colonial territories that are undertaking basic research relevant to the problems of tropical medicine has continued to be prominent in the planning and financial recommendations of the Committee.

With one exception the various fields of research have remained the same. Research in one field, the highly specialised subject of the Physiology of Hot Climates, has been terminated owing to the selection of its Director, Dr. W. S. S. Ladell, for another important appointment in Britain. Its research in Nigeria and adjacent territories over a period of eight years has been very productive, and valuable contributions have been recorded in the literature. Research on *trachoma* in Jordan had to be suspended owing to the recent crisis in that region; it is intended, however, that the project shall be pursued elsewhere after appropriate re-planning. In *tuberculosis* the Research Unit in Ghana is now well-established, and has maintained effective contact with tuberculosis workers in Nigeria and Sierra Leone. In *leprosy* the formation of the Committee's Leprosy Sub-Committee has greatly stimulated interest and co-ordination; more grants have been made and more projects initiated. In *filariasis*, whether *loiasis* or *bancroftiasis*, pilot control measures founded on data that have been secured are being increasingly applied or planned.

3. Three new research schemes which constituted a notable innovation resulted from a recommendation of the Committee that a modest block grant should be placed at the disposal of each of the three Regional Organisations for Medical Research, in East Africa, West Africa and the British Caribbean respectively, from which each of them could make small immediate grants annually (within certain circumscribed limits) to provide some additional research facility that might be required by an individual research worker for the progress of his work. This recommendation by the Committee received financial approval, subject to annual retrospective scrutiny of disbursements. The Regional Organisations welcomed the block grants both as a tribute to their status in Colonial Research and as a means of obviating undue delay in assisting the research worker.

Personnel

4. The Personnel Sub-Committee has continued to advise on all medical appointments to the Research Branch of Her Majesty's Overseas Civil Service, to scrutinise annually the emoluments of all medical members of that Service, and to make recommendations accordingly. During the year four officers resigned on receiving other appointments. Five new overseas postings were made. Six Colonial Research Students are undergoing their specialised two to three years' training in Britain; the posting of four of these to existing research projects overseas is impending.

Finance

5. The appropriate apportionment of funds allocated to medical research under the Colonial Development and Welfare Act of 1955 necessitated continued assiduous consideration by the Committee, having due regard to existing research projects, the competing claims of new proposals, the need to retain an emergency reserve, and the increasing financial participation of the governments of Colonial territories. Preliminary consideration is being given to such re-adjustments in financial provision for medical research as may become necessary as Colonial Territories attain Commonwealth status.

Oversea Visits

6. Fourteen members of the Committee and its Sub-Committees visited various research units in the field during the year. Every unit or grantee in the field was visited. Thus the Committee was kept intimately informed of progress, and thereby enabled the more effectively to frame its financial recommendations for the maintenance, extension or curtailment of each of the research projects.

REGIONAL ORGANISATIONS FOR MEDICAL RESEARCH IN COLONIAL TERRITORIES

*East Africa**(a) East African Council for Medical Research*

7. This Council held its third meeting in Arusha in February, 1957. It was preceded a month earlier by a meeting in Dar es Salaam of its Standing Advisory Committee, which in turn was preceded by a successful three-day Scientific Conference on "Tuberculosis and Leprosy" over which Sir Harold Himsworth presided; it was attended each day by some 60 scientists. The Advisory Committee heard from the directors of East African research units the progress and outstanding problems of their work, and made recommendations to the Council accordingly. The Council reviewed these and, in turn, made recommendations to the East African governments and the Colonial Office concerning the priority of projects and the appropriate allocation of research funds. The Council, in welcoming the provision of the block grant, alluded to earlier, appointed a small panel from among its members to assist the Administrator of the East African High Commission in its disbursement.

Sir Gordon Covell and Professor G. Macdonald attended all meetings as delegates of the Committee. The Earl of Limerick and Sir Harold Himsworth, respectively the Chairman and Secretary of the Medical Research Council of Great Britain, attended the meeting of the Standing Advisory Committee.

*West Africa**(b) West African Council for Medical Research*

8. The third meeting of this Council was held in Lagos in February, 1957, and was attended by two delegates from the Committee, Professor B. G. Maegraith and Professor A. W. Woodruff. It was preceded by a meeting of its Scientific Committee, at which the reports of the component research units were considered and discussed with their authors, new projects debated, and appropriate recommendations made to the Council.

The Council recorded its gratitude for the initiative taken by the Committee in London in the provision of a block grant for the West African Region. It appointed a small "Grants Committee" to devise a procedure for applications, to scrutinise these, and to recommend allocations.

During the year Lt.-Col. J. H. Walters, M.R.C.P., resigned from the appointment of Secretary of the Council and Director of the Council's Laboratories on being appointed Consultant Physician to the Hospital for Tropical Diseases in London. He was succeeded by Dr. F. N. Macnamara, formerly Director of the Virus Research Unit. Lt.-Col. Walters had served the Council with distinction, both in the quality of his own research and in guiding the component research units and the administrative staff in the Council's formative years.

West Indies

(c) Standing Advisory Committee for Medical Research in the British Caribbean

9. The Standing Advisory Committee held its second meeting in April, 1957, in Port of Spain, Trinidad, under the Chairmanship of the Comptroller of the British West Indies Development and Welfare Organisation, Sir Stephen Luke. The meeting was formally opened by His Excellency, the Governor of Trinidad, Sir Edward Beetham. The delegates of the Committee were Professor A. C. Frazer and Sir George Pickering, Regius Professor of Medicine at Oxford.

The Standing Advisory Committee recorded its great appreciation of the proposal to provide a block grant for the assistance of small research projects in the region, and appointed a small Sub-Committee to assist the Chairman in its administration.

10. The meeting was preceded by a two-day Scientific Conference, the four sessions of which were devoted respectively to "Virus Diseases," "Parasitic Diseases," "Enteric and Spirochaetal Diseases" and "Problems for Clinical Research in the Caribbean Area." The Conference met on the first day in Port of Spain and on the second day at the new hospital in San Fernando. Professor Frazer was the Chairman of the Conference and summarised the discussions at the close. Some sixty-five scientists, drawn from various territories in the Caribbean region, were present at each session. The subject of the next Scientific Conference, to be held in Jamaica in April, 1958, will be "Food in relation to Health and Disease," a subject chosen not only for its intrinsic importance but also for the appeal it will have for scientists in the field of veterinary and agricultural research in the region.

REVIEW OF THE WORK IN PROGRESS

11. In addition to the reports from the research units under the scientific supervision of the Committee, summaries are included of medical investigations made by research units or organisations that are wholly supported by the Governments of British Colonial Territories or Mandated Territories. Other summaries are contributed by investigators deputed to work in those territories by research organisations based in the United Kingdom or the United States of America, and supported financially wholly or in part by them. For continuity of context some are placed immediately after kindred reports from units that are the scientific responsibility of the Committee.

Helminthiasis

(a) Loiasis and Onchocerciasis

Research in the Cameroons and Nigeria

12. *Entomological aspects.* An analysis of catches of *Chrysops langi* and *C. centurionis* made for two years revealed that these species bite only in the forest at canopy level, that they show a marked seasonal abundance in

November—December at the end of the rains, that almost all their biting activity takes place in the evening twilight period, and that compared with *C. silacea* and *C. dimidiata* they show a higher incidence of infections with *Loa* but the number of developing parasites in individual flies is smaller. They do not naturally feed on man but are believed to be the main vectors of the nocturnally periodic *Loa* parasitic in monkeys. Studies on *C. longicornis* in the coastal creeks of the Cameroons revealed that this species is also markedly seasonal and local, and that it bites most frequently one to two hours after sunrise. It is unlikely to be of great importance as a vector of *Loa*.

13. Studies on the dispersal, flight-range and longevity of paint-marked adult female *C. silacea* continued, laboratory experiments having shown that marking in no way affects the mortality-rates of the flies. Detailed analysis of the results of releasing over 6,000 flies is awaited, but certain facts have already emerged :

- (i) Dispersal of the released flies through the rain-forest is random. Although flies travelled as far as 1,200 yards in 24 hours, a high proportion apparently remained near the release-point. The maximum range at which a fly was recovered was two miles.
- (ii) A barrier clearing formed by a river 100 yards wide running between banks of high forest presented no obstacle to the passage of the flies.
- (iii) The longest period between release and recapture for a fly released unfed was 3 weeks. Flies released after feeding on infected or uninfected humans were recaptured in two waves, the first 5-6 days and the second 10-11 days after feeding.

14. Preliminary field trials of insecticides and of vegetational clearing as anti-larval measures have continued. The long life of the larvae of *Chrysops* (over one year, as compared with the life of the adult fly which is measured in days or weeks) makes anti-larval measures theoretically the ideal means of control.

A watery emulsion of 5 per cent. D.D.T. sprayed on to the mud of the breeding-sites at the rate of 4 pints per 100 sq. ft. killed all larvae of *Chrysops* and *Tabanus*, and there was no reappearance of larvae for at least six months after the application ; 5 per cent. Dieldrin granules applied at the rate of 360 per 100 sq. ft. gave similar results. Dosages of half these concentrations gave a considerable but not a complete kill of larvae ; it is intended to try 2 per cent. Dieldrin granules. Use of such high concentrations is very costly but may be economical in the rain-forest where the breeding-sites, though scattered and inaccessible, are small in total area.

Total clearing of the vegetation on the breeding-sites appears to prevent *Chrysops* ovipositing on the site and thus introducing new young larvae, but larvae already in the mud can complete their development. In such cleared breeding sites *Chrysops* readily oviposited near the top of stakes stuck into the mud, especially if a six inch square green board was nailed on to the top of the stake. Since some clearing of the vegetation is essential before it is physically possible to apply insecticides to the breeding-sites, both these measures, together with stake egg-traps, will probably be tried as practical means of control.

15. The survey of all potential *Chrysops* breeding-sites around Kumba is being extended to cover a concentric belt two miles in width. The total area of breeding-site in those parts of the belt already surveyed comprises less than one acre per square mile of ground. Routine fly catches at points

on the perimeter of the Kumba station clearing have begun, to act as a base-line for judging the effect of possible future control measures.

16. *Parasitological and pathological aspects.* More monkeys were infected by inoculation of infective forms of *Loa* obtained from "wild" *Chrysops* caught in the rain-forest. A monkey infected from a single "wild" *C. centurionis* developed an infection with a nocturnal periodicity and presumably of monkey origin. Another inoculated with many hundreds of infective forms from eleven naturally infected "wild" *C. silacea* developed a diurnally periodic infection, and at post-mortem the numerous adult worms removed were all typically those of the human strain when developed in monkeys. All attempts to passage the nocturnally periodic monkey strain of *Loa* to man have proved negative. After more than a year's observation none of the five volunteers has shown any evidence of the infection having developed.

Attempts to hybridise in monkeys the diurnally periodic human *Loa loa* and the nocturnally periodic simian parasite were more successful. "Diurnal" males crossed with "nocturnal" females produced abundant microfilariae of predominantly diurnal periodicity. The reverse cross produced scanty microfilariae of similar periodicity. The first generation microfilariae from both these crosses proved capable of developing in *Chrysops* and have been passaged to clean monkeys. It remains to be seen whether they in their turn will reach sexual maturity and produce microfilariae.

17. It was noted last year that infection with *Loa* in monkeys is characterised by an initial sharp rise in the numbers of microfilariae in the peripheral blood followed by a fairly rapid and permanent suppression of their numbers. Controlled experiments have now shown that superinfection of a monkey with a suppressed infection only causes a small temporary rise in the peripheral circulating microfilariae and that the second invasion of the blood is thus overcome more rapidly than the first. Moreover, an initial infection with the diurnally periodic parasite will protect against a superinfection with the nocturnally periodic strain and *vice versa*.

It is now known that the suppression of the numbers of microfilariae in the peripheral blood is due to their destruction in the spleen. Following splenectomy the numbers in the peripheral blood of a monkey with a suppressed infection rises steadily for several months until a high and fairly constant level is reached. The spleen in infected monkeys shows numerous peripheral volcano-shaped excrescences in the red pulp, which on section are seen to consist of a honeycomb of reticulin fibres filled with fixed macrophages, giant cells, disintegrating microfilariae, eosinophils and all the elements of the circulating blood.

18. The incubation period of loiasis in monkeys, viz. the time between inoculation of infective forms and the first appearance of microfilariae in the peripheral blood, varies from four and a half to seven months. Fertilisation is believed to occur about 100 days after inoculation of infective forms. A period of 15-35 days elapses between the birth of the microfilariae in the tissues and their first appearance in the peripheral blood, during which they probably pass through the lymphatics and accumulate in the lung capillaries before invading the peripheral blood.

Investigations of the serology of loiasis, especially of complement-fixation tests, using antigens prepared from *Loa* worms, are being made by a visiting worker, Dr. W. Minning, from the Tropeninstitut, Hamburg.

19. *Onchocerciasis.* Investigations began into the effects of Antrypol and of dimercaptosuccinate (TWSb) on the concentration of microfilariae in onchocerciasis. In a series of 22 patients examined immediately after a course of 6.5-9.5 g. of Antrypol, the overall concentration of microfilariae in

the body had been reduced to one-tenth of its pre-treatment value, and, after eight months, to one-hundredth. Smaller doses are under trial and appear promising. The immediate effect of TWSb given intravenously in a dose of 0.4 g. per day for seven days is to cause a marked reduction in microfilarial concentrations at the expense of moderate or severe reactions in the patients. It is intended to continue the follow up of these trials over the ensuing two years.

20. *Acanthocheilonemiasis*. Investigations into the possible role of *Culicoides milnei* (*C. austeni*) as a vector have shown that this species only rarely takes in the microfilariae of *Acanthocheilonema streptocerca* when feeding on infected skin, and for this reason it is unlikely to be an effective vector in nature. A case of infection with *A. streptocerca* in a European causing a severe itching eruption on the skin of the arm and shoulder has been seen; after an initial exacerbation the symptoms were relieved by treatment with Banocide.

Publications

DUKE, B. O. L.—(1956) "The intake of the microfilariae of *Acanthocheilonema perstans* by *Culicoides grahamii* and *C. inornatipennis*, and their subsequent development." *Ann. trop. Med. Parasit.*, **50**, 32.—(1957) "The reappearance, rate of increase and distribution of the microfilariae of *Onchocerca volvulus* following treatment with diethylcarbamazine." *Trans. R. Soc. trop. Med. Hyg.*, **51**, 37.

Idem, CREWE, W. and BEESLEY, W. N.—(1956) "The relationship between the size of the blood-meal taken in by *Chrysops silacea*, the development of the fly's ovaries, and the development of the microfilariae of *Loa loa* taken in with the blood-meal." *Ann. trop. Med. Parasit.*, **50**, 283.

Idem, and GORDON, R. M.—(1956) "The escape of the microfilariae of *Loa loa* into the haemorrhage produced by the feeding *Chrysops silacea*." *Trans. R. Soc. trop. Med. Hyg.*, **50**, 305.

LAVOPIERRE, M. M. J., and CREWE, W.—(1956) "A record of *Stasisia rodhaini* (Diptera, Calliphoridae) from a West African monkey." *Ibid.*, **50**, 305.

KERSHAW, W. E., DEEGAN, T., MOORE, P. J., and WILLIAMS, P.—(1956) "Studies on the intake of microfilariae by their insect vectors, their survival, and their effect on the survival of their vectors. VIII: The size and pattern of the blood-meals taken in by groups of *Chrysops silacea* and *C. dimidiata* when feeding to repletion in natural conditions on a rubber estate in the Niger delta." *Ann. trop. Med. Parasit.*, **50**, 95.

(b) Filariasis

East Africa

21. *Clinical studies*. Dr. P. Jordan, of the East African Medical Survey and Research Institute at Mwanza, Tanganyika (Director: Dr. E. G. Holmes) has continued the pilot project, reported last year, for the eradication of Bancroftian filariasis with diethylcarbamazine (Hetrazan) on Ukara Island, Lake Victoria. The three dosage regimes being used are:

(a) single tablet of 200 mg. monthly

(b) single tablet of 100 mg. monthly

(c) single tablet of 200 mg. every two months.

The whole population in each of three areas (a total of 3,000-4,000 persons) receive treatment. In the area where 200 mg. monthly were given, blood samples from 114 persons who were originally positive show that only

22 now have microfilariae in their blood. (In an American trial with a higher dosage of drug, 11·5 per cent. were positive after 17 months of treatment.) The drug will be continued for another 6 months in this area. In the other two areas assessment awaits the completion of 12 months of therapy.

Slow progress was made with lymphograms in elephantiasis cases. Attempts to obtain pictures are made whenever possible, but only 2 successes were obtained from 10 attempts. Many of the failures were in advanced cases of elephantiasis. In some of these no lymphatics were outlined by the dye. As the oedematous tissue is diffusely coloured by the dye, it is possible that the lymphatics are not capable of absorbing fluid, or are destroyed.

Attempts to treat elephantiasis with prednisolone acetate have been made, in one early case successfully; this man was kept ambulant during treatment. Three other cases (one early, two advanced) were confined to bed and the intake and output of fluid measured during treatment; but there was no increased output of urine, and no reduction in size of the limbs. This is contrary to American reports of cases treated with Cortisone.

22. *Laboratory studies.* These confirmed earlier findings that mosquitoes fed on blood with only one microfilaria per 40 ml. may develop infective larvae. Microfilariae surviving in the blood after treatment with Hetrazan proved capable of normal development into infective larvae. These and other studies in two colonies of *Culex fatigans* indicated that some 90 per cent. of microfilariae which are imbibed by mosquitoes fail to develop into infective larvae. *Aedes aegypti* appears experimentally a very poor vector of East African Bancroftiasis.

Infective larvae kept in serum from a European newly arrived from Britain survived for some 120 hours. The same number of larvae in serum from an elephantiasis case survived only for some 66 hours. These studies continue.

Publications

JORDAN, P.—(1956) "Filariasis in the Eastern, Tanga and Northern Provinces of Tanganyika." *E.A. med. J.*, **33**, 225.—(1956) "Filariasis in the Western Provinces of Tanganyika." *Ibid.*, **33**, 233.—(1956) "Filariasis in the Lake Province of Tanganyika." *Ibid.*, **33**, 237.

Malaya

23. *General.* Professor J. J. C. Buckley, London School of Hygiene and Tropical Medicine, again worked in the Kuantan Laboratory from June to September, 1956. Health officers and their staffs received advice, assistance and some degree of training prior to the start of a mass treatment campaign in two endemic filariasis areas in South Johore and Central Kedah respectively.

24. *Filarial infections in animals.* Infections with *Wuchereria malayi*-type microfilariae have now been recorded from three species of monkeys, two species of cats, the Malayan Civet, the slow loris, the domestic dog, and a pangolin. Examination of the adult worms showed that at least two species of *Wuchereria* were present; descriptions have been published. One species resembles the previous descriptions of *W. malayi* from man, while the other is new, and has been named *W. pahangi*. Domestic cats were found naturally infected with both species, but no mixed infections were identified. Measurements of formalin-fixed microfilariae show that those of *W. pahangi* are, on the average, significantly longer than those of *W. malayi*, but there is much individual variation, and no other definite points of difference have been distinguished. *Mansonia annulatus* is an efficient laboratory vector of *W. pahangi*, but the infection develops poorly in *M. longipalpis* and *M. uniformis*. The larvae which do develop cannot be distinguished from *W. malayi*.

25. *Transmission of W. malayi from man to animals.* Numerous efforts were made to transmit *W. malayi* from man to animals, and successful transmission was accomplished in a number of domestic cats and in one young long-tailed macaque monkey by the inoculation of infective-stage larvae from laboratory-bred *Mansonia uniformis*. The pre-patent period, from inoculation to the first finding of microfilariae in the blood, was 80-96 days.

Transmission of W. pahangi. This species was transmitted from cat to cat using laboratory-bred *M. uniformis*, and from loris to loris using wild-caught mosquitoes. The pre-patent period in both experiments was 81 days.

The Kedah strain of W. malayi. The microfilariae of *W. malayi* in human carriers living in endemic areas in Kedah, Penang, and Province Wellesley behave differently from those in carriers in East Pahang, and evidence for the existence of at least two different strains of *W. malayi* in man is accumulating. The two strains differ considerably in their degree of nocturnal periodicity, the readiness with which they shed their sheaths, and the species of mosquitoes that they infect. The larvae of the Kedah strain do not develop readily in *M. longipalpis*, which is an efficient laboratory vector of the Pahang strain. *Anopheles barbirostris* is an efficient laboratory vector of the Kedah strain, but not of the Pahang strain.

Transmission of the Kedah strain to two cats was successful, the pre-patent period being 94-99 days.

26. *Treatment of hospital patients.* Microfilaria carriers treated during 1954 and 1955 with various doses of Hetrazan have now been followed up for more than 12 months. The microfilaria counts have been reduced by 96-99 per cent., the greatest reduction being in those given 4 or 6 mg. (of citrate) per kg. body weight once a week or once a month for 6 doses. The treatment of elephantiasis remains disappointing.

Control experiments in rural areas. The populations of two small villages were given 5 mg./kg. Hetrazan once a week for six weeks, and once a month for six months, respectively; houses in a third village have been sprayed with Dieldrin at 100 mg./sq. ft. every six months since November 1954. In the drug-treated populations, microfilaria rates and counts fell rapidly, and have remained low up to one year later in the only one resurveyed (weekly treatments); there has been no change in the sprayed village in two years since the first spraying. The proportion of mosquitoes infected with filarial larvae has hitherto been unaffected by control efforts, but in one drug-treated village it was markedly decreased by the extension of drug treatment to the populations of adjoining villages, an encouraging result which is being followed up.

27. *Field surveys. Krian.* Many dark-winged *A. barbirostris*, trapped in the Krian area of Perak by Health Office staff and sent to the Institute for dissection for malaria parasites, were found infected with filarial larvae which appeared to be *W. malayi*. Investigation by the Health Officer then disclosed a focus of endemic filariasis around Kuala Kurau. Blood films were taken; 27 per cent. (19/70) contained microfilariae of *W. malayi*. The Health Officer found 15 persons with elephantiasis. Thus areas of endemic filariasis are now known to be present along the north-west coast of Malaya from Kedah Peak to somewhere south of Kuala Kurau in Perak.

Pahang. In surveys made near a *W. bancrofti* area on the Pahang River, one village population was found to have a *W. bancrofti* microfilaria rate of 10 per cent. Trapping and dissection of mosquitoes from this area has begun.

Publications

BUCKLEY, J. J. C. and EDESON, J. F. B.—(1956) “On the adult morphology of *Wuchereria* sp. (*malayi*?) from a monkey (*Macaca irus*) and from cats in Malaya, and on *Wuchereria pahangi* n. sp. from a dog and a cat.” *J. Helminth.*, **30**, 1.

(c) *Schistosomiasis*

28. Mr. W. F. H. McClelland, B.Sc., continued his studies on snails at Mwanza, Tanganyika, as a visiting worker at the East African Medical Survey and Research Institute, where the Director, Dr. E. G. Holmes, generously provided laboratory and housing facilities.

29. In *laboratory studies* of the systematics of snails, a fairly good variety of material has been obtained. The two species thought most likely to transmit *S. haematobium* are *Bulinus* (*P*) *africanus* and *Bulinus* (*P*) *nasutus*. There is still doubt about the identity of the latter, which may be a variety of *B. africanus*. Another snail which is a possible intermediate host of *S. haematobium* falls into the subgenus *Bulinus*, but has not yet been identified with certainty. Two species of *Biomphalaria* are found—*B. sudanica* and *B. pfeifferi*. Work on variation of the latter species is attempted whenever material becomes available.

Attempts to breed parasitically clean snails in the laboratory continue to disappoint. But young laboratory-reared snails are now being infected experimentally, the work being concentrated on the three species of *Bulinus* likely to transmit *S. haematobium*. The difficulty of finding suitable conditions for breeding snails in the laboratory has emphasised the lack of information about the natural history of snails. In the field, too, it is noticeable that definite species live in particular spots, even although another species may be found only a short distance away.

30. In *field studies*, surveys of different types of habitat are made at monthly intervals. Some physical characteristics of each habitat are noted, and snails are collected in a fixed length or area, for a fixed length of time. This kind of sampling is not entirely satisfactory, but it seems the best method, and the procedure is standardised as much as possible to reduce errors. The snails are examined for cercariae of schistosomes and other trematodes, separated into size groups and counted, and then returned to the spot from which they were taken. Preliminary results indicate that there may be a distinct cycle of development and infection which will be of importance in planning control.

In snails from various sources natural infections with schistosomes were very rare, but cercariae of other trematodes common, even in areas where over 90 per cent. of school children were found infected with urinary schistosomiasis, and up to 55 per cent. with *S. mansoni*. Consequently there is still no definite information about the species of snail which act as intermediate hosts of *S. haematobium* in the Mwanza area. Both the species of *Biomphalaria* mentioned above have been found infected with *S. mansoni*. Twice echinostome cercariae obtained from *Biomphalaria* were found to encyst on grass and on the bodies of snails. The metacercariae were fed to rats, but did not develop into worms.

31. Other studies were made by Mr. Rhodes-Jones. He investigated the incidence of bilharzia among primary school children in an area 15 miles from Mwanza. The infection—except in one locality—is almost entirely with *S. haematobium*, whereas in Mwanza, and in one of the district primary schools, in addition to a 90 per cent. infection of *S. haematobium*, a 65 per cent. infection of *S. mansoni* was also found. The incidence among the

school children is very heavy, being always greater than 90 per cent. on a single examination. The true incidence must, therefore, be near 100 per cent. The degree of infection in the positive cases was very high. (The incidence of hookworm infection among these children was found to be of the order of 80 per cent.)

A pilot control scheme is to be undertaken in the most suitable of these areas, as a joint enterprise with the Medical, Water Development and Education Departments and the Provincial Administration. It will include the provision of a protected water supply, instruction in the schools and to adults, and treatment of the children. The effect on the infection-rate in the schools will be assessed.

32. Mr. S. R. Smithers, B.Sc., concluded his studies in the Gambia on certain aspects of schistosomiasis. A focus of intestinal schistosomiasis, having been discovered early in the year at Jiborah, a village in Western Division, and this being the first record of *S. mansoni* from the Gambia, studies on vector ecology, epidemiology and clinical effects of the disease were undertaken. *Biomphalaria pfeifferi gaudi* (Ranson) proved to be the snail vector, and the transmission site a pool in the Allahein River, about one mile south of the village. Apparently other foci exist in villages along the same river. The disease appeared to be mild.

An experiment was done to determine an easy and economical method of applying molluscicide to the stagnant seasonal pools in Eastern Gambia, which harbour *Bulinus senegalensis* (Müller), an important vector of *S. haematobium*. The pools are formed during the rains, and dry up soon after, and as each one is completely isolated, it was expected that one application of molluscicide early in the rains would eliminate the vectors for the remainder of the season. The molluscicide sodium pentachlorophenate was either sprayed over the surface of the water in aqueous solution or dumped in a pool in small sacks. Concentrations of 2, 5 and 10 p.p.m. were used, and applied late in July, when the pools were about one month old.

Results, although not without success, were disappointing. Snails disappeared from treated pools for 6 weeks or so, but after 10 weeks they reappeared in small numbers, and after 20 weeks their numbers were comparable with those of the control pools. Nevertheless, the molluscicide had reduced the snail population to negligible numbers during October, which under normal circumstances is the peak transmission period. By late November, when snail counts were again high, pools which still contained water were foul and muddy, and no longer in use by the local people.

Publication

SMITHERS, S. R.—(1956) "On the ecology of schistosome vectors in the Gambia, with evidence of their role in transmission." *Trans. R. Soc. trop. Med. Hyg.*, **50**, 354.

(d) Guinea-worm

33. Dr. S. D. Onabamiro continued his investigations on guinea-worm at University College, Ibadan. In experiments on the effects of Hetrazan on the larvae of the guinea-worm, graded solutions in 20, 10, 5 and 1 per cent. concentrations respectively were tested on: (a) freshly discharged guinea-worm larvae, (b) first stage larvae inside *Cyclops*, (c) larvae in *Cyclops* shortly after the first ecdysis, (d) infection stage larvae inside *Cyclops* and (e) *Cyclops* not infected with guinea-worm larvae. The *Cyclops* used were *Thermocyclops nigerianus* (Kiefer), known to be the natural intermediate host

of the guinea-worm in several villages in Nigeria. Four main observations emerged:—

- (i) The drug, even in strong concentrations, has only a very slow effect on fresh discharged larvae of the guinea-worm.
- (ii) 1 per cent. solution of the drug has a very weak effect on all stages of the larvae. The difference between the effect of a 1 per cent. and a five per cent. solution is very pronounced; much more so than that between 5 per cent., or between 10 and 20 per cent. solutions.
- (iii) Second stage larvae and the *Cyclops* intermediate host of these larvae are more susceptible to the toxic effects of the drug than the others.
- (iv) Of the four stages of the guinea-worm on which the drug was tested, the one which is concerned with human infection is the third stage, that is, the one which has been inside the *Cyclops* for about a fortnight. The three grades of the drug solution, 5, 10 and 20 per cent., have a strong toxic effect on larvae in this stage; a 5 per cent. solution kills the larvae in 4½ hours, a 10 per cent. in 2½ hours and a 20 per cent. in 1½ hours.

This observation suggests a possible value of Hetrazan as a prophylactic to travellers journeying through endemic areas of dracontiasis. The effect of the drug on guinea-worm *in situ*, using dogs as the mammalian host, will be tested.

34. Journeys were made to Ilorin, Jebba, Bida, Mina and Zungeru in Northern Nigeria to collect *Cyclops* from areas where the guinea-worm is endemic, particularly around Bida, and to determine the species responsible for transmission there.

By a closer study of collections taken in the Western Region of Nigeria some time previously, the following new species of *Cyclops* were discovered and described:—*Mesocyclops salina* sp. nov. from Korodu, *Mesocyclops ogunnus*, sp. nov. from Abeokuta, *Tropocyclops confinis awiensis*, subsp. nov. from Awa, in Ijebu Province, *Tropocyclops prasinus shagamiensis* subsp. nov. from Shagamu and *Afroscyclops ikennus* sp. nov. from Ikenne. Of these, *Mesocyclops salina* and *Mesocyclops ogunnus* are believed to be capable of transmitting the guinea-worm.

Publications

ONABAMIRO, S. D.—(1956) "The effects of Hetrazan (Banocide), (diethyl-carbamazine) on the larval forms of *Dracunculus medinensis*." *W. Afr. Med. J.*, 5, 64.—(1956) "The early stages of the development of *Dracunculus medinensis* (Linnaeus) in the mammalian host." *Ann. trop. Med. Parasit.*, 50, 157.—(1956) "Some new species of *Cyclops* sensu lat. (Crustacea-Copepoda) in Nigeria." *Linnean Society's Journal—Zoology.* 14, 123.

Malaria

East Africa

35. At the East African Institute of Malaria and Vector-Borne Diseases, the establishment was completed during the year by the addition of a malaria engineer and an Assistant Director, the latter temporary. Alongside its research function, the Institute continued to fulfil its teaching function by conducting short training courses in malaria. A main preoccupation has been the Pare-Taveta Scheme, which is concerned with an attempt to control malaria in a hyperendemic area, and with the observation of the effect of control on human health in the area treated. Increasing attention has been given to the study of bilharzia.

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36. The discovery by Dr. M. T. Gillies of a body, that he has termed a "mating plug", in the common oviduct of freshly fertilised female *Anopheles* has provided an additional means of assessing the age of very young females; and, with the study of change in the oviducts themselves, the presence or absence of fertilization, and the linkage of blood-meal and ovarian development, it has proved possible in the field to determine with some certainty the age of female anopheles during the first few days of life.

Some studies of *Anopheles gambiae* larvae by Mr. M. G. Christie have opened up interesting possibilities. Thus the effect of predators, in the more permanent breeding places, in reducing larval survival has been confirmed; and this may be contrasted with the much greater survival that may be expected when predators are absent, as in temporary breeding places. Again, it has been shown that eggs can survive for some time on the muddy margins of temporary breeding places, an observation which may throw light on the size and timing of the fluctuating increases in *gambiae* populations.

37. The Institute has collaborated variously with the Colonial Pesticides Research Unit in Tanganyika. The Pare Scheme apart, combined activities included an assessment of anti-larval air applications at Dar es Salaam, which showed that a new formulation is a highly effective larvicide. This is a granulated Dieldrin, which, apart from the highly lethal Dieldrin content, owes its activity to its capacity to penetrate, rather than merely to impinge on, vegetation. Other work includes the assessment of the exposure hazard to men engaged in spraying Dieldrin, a project still in its early stages, and the testing of formulations in use, both for their insecticidal activity and their effect on fish. This latter project was greatly facilitated by the taking over of a series of well constructed fish-ponds, with means of evacuating the water, from the Agricultural Department of Tanganyika.

38. Certain biochemical investigations were undertaken by Dr. J. M. Press, of the World Health Organization. Among them were estimations of serum protein, as one measure of the effects of reducing malaria, and also estimations of the pyrimethamine levels in human milk, which, as a collaborative study with the Tanganyika Malaria Division, showed that significant quantities of the drug can be passed on to the suckling babe.

39. In the Pare-Taveta Scheme the third round of residual spraying of houses with Dieldrin, at a gross dosage of 0.5 g. per sq. m. was completed in March, 1957. Anopheline records, designed to elucidate the effect of this treatment, have been continued by Dr. A. Smith. After a large initial drop in house catches, there was a further fall, possibly attributable to a great efficiency in the spraying technique. There was also a drop in outdoor catches, around cattle-pens and elsewhere, and in the numbers coming to bite man indoors or out. While *A. gambiae* is still present in considerable numbers in the area, only two have been found infected in several thousand dissected, and *A. funestus* has disappeared. Tests of the susceptibility of the anophelines in the area have given no indication of the development of resistance to Dieldrin.

On the human aspect Dr. C. C. Draper has shown by some thousands of blood examinations that parasite rates have dropped from one-half to one-eighth of the pre-spray figures. The reduction was most evident in the youngest children, decreasing successively in the older. In the drier and less endemic parts the rates have dropped to a very low level. In general the reduction has been greatest in the case of *P. falciparum*, with a relative increase in the more persistent species, *P. malariae*. Investigation of the histories of infants indicates that there are still a few locally acquired infections. It is

as yet too early to gather much information from the biometrical records and vital statistics, but there have been a significant small increase in haemoglobin values, fewer raised oral temperatures, and fewer enlarged livers and spleens.

40. An extensive survey of the human incidence of bilharzia by Dr. G. Maclean in the foothills near the East African coast revealed an incidence of *Schistosoma haematobium* infection that varied from 54 per cent. in children 11-15 years old to 19 per cent. in older adults. A complementary detailed survey of snails was carried out in collaboration with the Tanganyika Malaria Division, and the probable local vectors identified.

Publications

CHRISTIE, M. G.—(1956) "Statistical treatment of the sporozoite-rate in Anopheline mosquitoes." *Ann. trop. Med. Parasit.*, **50**, 350.

DRAPER, C. G., and SMITH, A.—(1957) "Malaria in the Pare area of N.E. Tanganyika." *Trans. R. Soc. trop. Med. Hyg.*, **51**, 137.

GILLIES, M. T.—(1956) "Problem of exophily in *A. gambiae*." *Bull. Wld. Hlth. Org.*, **15**, 437.—(1956) "A new character for the recognition of nulliparous females of *A. gambiae*." *Ibid.*, **15**, 451.

MSANGI, A. S.—(1956) "Cetyl alcohol and larval mosquito control." *E.A. Med. J.*, **33**, 353.

CLYDE, D. F., SHUTE, G. T., and PRESS, J. M.—(1956) "Transfer of pyrimethamine in human milk." *J. trop. Med. Hyg.*, **59**, 277.

Nigeria

41. Although the Committee is not directly concerned with the work of the Federal Malaria Service, Nigeria, some account of it is included here. Salient points in the report of its Director, Dr. L. J. Bruce-Chwatt, are summarised.

42. *The Malaria Control Pilot Project in Western Sokoto, Northern Nigeria.* The Malaria Service is responsible for the scientific guidance and research content of this project, undertaken jointly by the World Health Organisation, U.N.I.C.E.F. and the Government of Northern Nigeria, and now in its third year. Details of the subdivisions of the area of 600 square miles and 125,000 population, and of the three insecticides used, were given two years ago. The technical measures have run smoothly and as planned. Total costs have averaged three shillings per annum per head of the protected population.

43. Malariometric data based on some 7,000 individuals showed a considerable decrease of spleen-rate and parasite-rate in infants in the first half of the year, but a substantial upward trend during the second half. In older children there was no striking difference between the rates recorded in the Project Area and the Check Area. Thus there was evidence that transmission was almost halved during the first six months, but that the trend was reversed in the second six months. There can be little doubt that the phenomenon of resistance discovered at that period in *Anopheles gambiae* was responsible for the renewal of the high degree of malaria in the Project Area. This was particularly in the Dieldrin zone, and accorded with entomological findings.

44. Mean room density-indices for *A. gambiae* in the whole Project Area were only one-ninth those of the Check Area during 1955; but during the first quarter of 1956 the difference became much less pronounced.

The sporozoite-rate in *A. gambiae* and *A. funestus* showed very little difference between the Project and the Check Areas. The Average Infective

Density calculated on the basis of the sporozoite-rate and the room density index for *A. gambiae* gave the inoculation-rate (number of infective bites per person per year) as 18 in the Project Area and 146 in the Check Area.

5. An extremely high resistance of *A. gambiae* to Dieldrin, with a lower cross-resistance to BHC, was discovered; no definite degree of resistance to DDT was found.

The genetics of the inheritance of this resistance were studied by the Ross Institute in London on a colony established from eggs sent by air from the Project Area. Evidence was obtained of inheritance of the specific resistance according to Mendelian principles, and three distinct groups were recognised within the population which differed from each other by the level of the Median Lethal Concentration for Dieldrin.

46. *Malaria and the sickle cell trait.* The investigation of a possible relationship between the amount of malaria in various Nigerian communities and the respective frequency of the sickling trait continued, especially in very young age-groups. Four samples totalling 3,000 children from south-western Nigeria, south-eastern Nigeria, Northern Nigeria, and Southern Cameroons showed sickling-rates ranging from 1.4 per cent. (Cameroons) to 27 per cent. (south-western Nigeria). In none of these groups was there any definite evidence of relationship between the frequency of the sickle cell trait on the one hand and the parasite-rate or parasite density on the other. The same conclusion applied to a fifth group of 375 infants mainly from Ilesha in Western Nigeria, with an overall sickling-rate of 19.7 per cent.

47. In an assessment of the comparative efficiency of single doses of chloroquine and amodiaquine in African school-children no significant difference in the speed of clearance of parasitaemia was observed. Other investigations included a field trial of Daraprim as a chemoprophylactic designed to detect any resistance that might be acquired by *P. falciparum*, continued work on the problem of transplacental transmission of *P. berghei*, and studies on insecticide resistance in a new laboratory with special facilities for them.

Publications

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Idem and SERVICE, M. W.—(1956) "An aberrant form of *A. gambiae*." *Trans. R. Soc. trop. Med. Hyg.*, **51**, 10.

ELLIOTT, R.—(1956) "Bio-assay methods for the estimation of insecticide residues using first instar larvae of *A. aegypti*." *W. Afr. Med. J.*, **5**, 80.

WALTERS, J. H. and BRUCE-CHWATT, L. J.—(1956) "Sickle-cell anaemia and *falciparum* malaria." *Trans. R. Soc. trop. Med. Hyg.*, **50**, 511.

ARCHIBALD, H. M. and BRUCE-CHWATT, L. J.—(1956) "Suppression of malaria with pyrimethamine in Nigerian school-children." *Bull. W. H. O.*, **15**, 775.

Gambia

48. At the Medical Research Council's Laboratories at Fajara, the Gambia, the permanent staff have continued the observations, begun in 1951,

on two groups of Gambian children, one of which from birth has been protected from malaria by weekly doses of chloroquine or Daraprim, the other group remaining unprotected. In another series of 30 infants it appears that the primary attack of malaria is tolerated very well; it is in subsequent attacks, apparently, that the disease attains its maximal mortality and morbidity.

Observations at Keneba on the bionomics of anopheline mosquitoes indicate that mosquitoes of the *Gambiae-melas* complex feed avidly on both man and cattle in the open air. Several anophelines hitherto unreported in the Gambia were taken. Other studies included the course and effects of malaria on pregnant and lactating Gambian women, and its effect on the serum-protein pattern.

49. Mrs. A. P. Wilson and Professor B. G. Maegraith have contributed the following summary (paras. 50-52) of their studies in the latter's laboratory at the Liverpool School of Tropical Medicine.

50. After preliminary and unsuccessful attempts to estimate the cytochrome oxidase activity of blood, the subsequent work was done on homogenates of liver tissue from normal rats and those with *Plasmodium berghei* infections of varying severity. The oxygen uptake, in Warburg flasks, has been determined for the complete succinoxidase system, using sodium succinate as the substrate, and for the cytochrome oxidase alone using sodium ascorbate or p. phenylene diamine as the reducing agent. Many of the experiments were of a preliminary nature, i.e. to determine the effect of keeping normal rat liver at -15°C .; the influence of different samples of cytochrome C on the oxygen uptake; using 0.25 ml. sucrose as the homogenising fluid instead of distilled water; comparison of the oxygen uptake of the livers of animals killed by stunning, by ether or by nembutal, and methods of determining the fat-free dry weight of the homogenates.

51. In several experiments we estimated the succinoxidase and cytochrome oxidase activity of tissue from rats, as far as possible from the same litter or of the same age and weight, at different stages following infection with *P. berghei*. There appeared to be little difference in the Q_{0_2} on a dry weight basis, but as the fat content tended to be higher in the livers of infected animals the Q_{0_2} on a fat-free basis appeared to increase. None of these rats, however, became heavily infected. As the results could be influenced to a marked degree by the cytochrome C used, in the later experiments a normal animal was killed for each of the infected ones examined and oxygen uptakes compared directly on a $Q_{0_2\text{DW}}$ and $Q_{0_2\text{FFDW}}$ basis. Some of these animals had up to 51 per cent. of infected cells. A small number of animals have been injected with phenyl hydrazine to produce a reticulocytosis, and the enzyme activities of their livers compared with those of normal rats to see if the increased oxygen uptake found in the livers of some of the heavily infected rats can be attributed to the increased number of reticulocytes present.

Liver homogenates from normal and *P. berghei* infected rats have been re-investigated after about 20 hours at 4°C . In animals which were fairly heavily infected and which appeared ill, the oxygen uptake, particularly of the complete succinoxidase system, fell off considerably, sometimes dropping to about 20 per cent. of the initial activity. This fall in activity could not be prevented by using sodium succinate or 0.25 ml. sucrose as the homogenising medium, instead of distilled water.

52. A further study has been an investigation of the effect of plasma on the succinoxidase and cytochrome oxidase activity of liver. Plasma from normal and infected rats has been added to liver homogenates of both normal

and infected rats. Early on in this work it was discovered that the addition of very small amounts of normal plasma to a control homogenate caused a decrease in the cytochrome oxidase activity of from 50-25 per cent. and this has complicated this part of the investigation. Rather surprisingly the oxygen uptake due to the complete succinoxidase activity is unaffected by the addition of plasma or serum. Similar tests have also been carried out using whole blood and washed red cells from infected and control rats, but, as might be expected, the results showed considerable variation.

Work on *P. knowlesi* is also proceeding.

Virus Diseases

(a) The West African Council for Medical Research Laboratories, Lagos, Nigeria

53. *Epidemiology.* From an outbreak of jaundice at Odegi Beki in Benue Province 51 sera were examined by the haemagglutination-inhibition (H.A.I.) technique and neutralization tests for the following viruses: yellow fever, Zika, Uganda S and West Nile. Results indicated that, whereas infections by all these viruses are common there, none caused the epidemic, which was probably infectious hepatitis. Similar studies were made on sera from the village of Kandandani near Katsina in Northern Nigeria. A pattern of widely separated epidemics rather than continuous endemicity was demonstrated for infections with yellow fever, Zika, and Uganda S. viruses. West Nile infection is endemic; 56 per cent. of children between 5 and 9 years gave sera which were positive to a West Nile H.A.I. test.

54. Serological studies continued on sera from Ilobi, a village in the rain forest belt 32 miles N.W. of Lagos, using the viruses already mentioned, and also Bwamba, Semliki Forest and Dengue (Trinidad strain) viruses. Except against West Nile and Semliki Forest viruses, the sera gave a high incidence of protection, of a pattern consistent with that of high endemicity. The highest incidence was against Dengue, viz. 73 of 207 sera. The results were analysed for evidence of serological cross-relationships.

The sera of several patients with dengue-like illnesses were tested. The results showed that one patient had been infected with dengue, but the others with some other agent or agents. These findings indicate the complexity of the situation and that clinical dengue may have a variety of causes.

55. *Hepatic pathology.* Histological studies on the development of the lesions in the livers of monkeys infected with viscerotropic yellow fever were undertaken to show not only the fundamental processes involved, but also the variability of the picture at different stages. Rhesus monkeys were infected with the Asibi strain of yellow fever virus and biopsies of the liver taken at intervals. Although lesions could usually be detected three days after inoculation, the most rapid and marked changes occurred only within twelve hours of death. The lesions tended to be focal at first and predominantly in the midzone of the lobule; as death approached they spread rapidly to produce the typical picture. Throughout the progress of the lesion, changes in the nuclei of the liver cells preceded those in the cytoplasm. A notable finding was that monkeys hyperimmunized against Zika virus were more tolerant to the yellow fever virus than the "normal" controls; the time between inoculation and death was considerably prolonged and allowed a more accurate appraisal of the pathological process to be made.

56. Cytoplasmic inclusions have been found in the salivary glands of several species of rodents; they may be of viral origin, but are distinct from those found in "salivary gland virus" infections, which have also been observed.

Studies on conjunctival scrapings from cases of trachoma have revealed that in this part of tropical Africa inclusion bodies may be observed.

A serological survey of influenza antibodies indicated that in Nigeria, although clinical infections with influenza virus are as frequent as in the temperate regions, clinical diagnosis is rare.

57. *Entomological studies.* These have been concentrated on the bionomics of *Aedes aegypti* in the village of Ilobi, bounded on one side by tall forest and on other sides by farms and cocoa plantations. At monthly intervals throughout the year continuous catches of mosquitoes through a period of four days were made by fly-boys stationed at various places in the village and the surrounding terrain; *A. aegypti* was found biting in the village and in the cocoa plantations, in numbers decreasing with increasing distance from the village. Evidence from these adult catches that there is a forest as distinct from a town population is lacking. The mosquito fauna of the cocoa plantations differed considerably from that of the forest which had been studied closely the previous year. *Aedes africanus*, rare in the forest, was more numerous in the cocoa plantations. *Aedes circumluteolus*, known to harbour pathogenic virus, occurred in fair numbers in the cocoa farms. Common species encountered were *Aedes grahmi* and the very prevalent *Taeniorhynchus africanus*.

58. The breeding densities and sites were studied with particular reference to ecology. Ten areas in and around the village were observed at frequent intervals. In each a record was kept of all possible breeding sites, and the numbers of larvae found; *A. aegypti* was found in greatest abundance in the village, also on fewer occasions in the surrounding forest, although never far from the village boundary. During the hot dry season it tended to enter the forest, where the microclimate was more humid and cooler. Bamboo and clay pots were placed in pairs at intervals extending from the centre of the village into the surrounding forest or farms, and larvae found in them collected monthly, classified and enumerated. The numbers of *A. aegypti* fell gradually from the centre to the periphery of the village.

Laboratory studies were made on the viability of mosquito eggs with varying time, and on the attraction of certain mammalian baits to the adult female *A. aegypti*. The rapidity with which successive generations of *A. aegypti* developed resistance to D.D.T. in the larval stage was demonstrated.

The technique of feeding infected blood to mosquitoes through a mouse skin membrane was further developed. Transmission by mosquito bite was demonstrated where possible by allowing the infected mosquito to bite infant mice, and harbouring of virus by the mosquitoes after an infective feed by triturating the mosquito and inoculating the supernate after mild centrifugation into mice; *A. aegypti* were able to transmit Zika and Uganda S. viruses, and *A. circumluteolus* able to harbour Zika virus.

Publications

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BOORMAN, J. P. T. and PORTERFIELD, J. S.—(1956) "A simple technique for the infection of mosquitoes with viruses. Transmission of Zika virus." *Ibid.*, **50**, 238.

PORTERFIELD, J. S.—(1956) "Further studies on the yellow fever haemagglutination test." *Ibid.*, **50**, 344.

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(b) *The East African Virus Research Institute, Entebbe, Uganda.*

59. *Yellow fever.* Laboratory investigations included one to determine how the virus reaches the brain (death in the mouse being due to encephalitis, not to liver destruction); another, to study the infectivity and haemagglutination titres in the blood of rhesus monkeys during the course of infection; another, the behaviour of the virus in the mosquito inoculated directly with the virus, it having been found that mosquitoes vary greatly in the degree to which they support virus growth irrespective of whether they had been inoculated with a large or a small dose.

The possibility that yellow fever in bush-babies may be transmitted by the mites which commonly infest these animals continued to be explored. Numerous technical difficulties having been overcome, large-scale experiments became possible. Results have not been encouraging. It is possible to detect virus in the mites just after the infective feed and for the next four days, but not longer.

60. In the field, tests on sera sent from Arabia, in an attempt to appraise the danger of virus being carried to India by dhows, indicated that the only immunes were men who had travelled to Aden or Africa and who presumably had been vaccinated. Surveys of wild monkeys continue; in Central Uganda the immunity rates have fallen considerably below those of previous years. A large sample from South Kavirondo District, Kenya, was entirely negative.

The immunity survey of bush-babies in Northern Rhodesia and Nyasaland, noted last year, is almost completed. Immune specimens of the large bush-baby (*Galago crassicaudatus*) were found in both countries, and of the lesser bush-baby (*Galago senegalensis*) in Northern Rhodesia, where the animal is common, but not in the few samples from Nyasaland. Altogether there were 31 positives among 213 bush-babies successfully tested, an immune rate of 15 per cent. There were no immunes among 29 monkeys and other mammals tested at the same time. Incidentally, the tiny forest bush-baby, *G. demidovii*, is not uncommon in the Entebbe area, but it is very hard to capture.

61. *Rift Valley Fever Virus.* Using the standard method of acetone-ether extraction, a haemagglutinin was demonstrated, agglutination of chick red cells being optimal at 25°C and pH 6.5. This shows that this virus is a member of the miscellaneous group of viruses not included in the major haemagglutination groups A and B. A haemagglutinin was also prepared without chemical extraction, simply by storage for 3 days at -20°C, and was active over a wider range of temperature and pH and agglutinated several additional types of red cells. Both types were rapidly adsorbed to chick red cells. The "incomplete" virus does not necessarily agglutinate. The haemagglutinin can be separated by appropriate means from the infective virus. After heating at 56°C for one hour haemagglutinin has disappeared.

The coagulation defect in this virus infection, as also in yellow fever infection, proved to be due to marked prothrombin deficiency; sick mice may have prothrombin levels of less than five per cent. of the normal. This is doubtless the reason for the haemorrhagic picture characteristic of both diseases. The virus is remarkably heat-stable; after one hour's treatment at 56°C the titre of the preparations was only slightly reduced, and even after three hours remained high.

62. The production of the "incomplete" Rift Valley fever virus has been studied further. It is present when the virus is passaged by means of

large inocula. "Incomplete" virus is antigenically active, combines with antibody and interferes with the growth of complete infective virus. While "incomplete" virus might be produced by the passage of a viscerotropic virus in concentrated form, this did not occur when a neurotropic strain was used. There are indications that "incomplete" virus may also be formed during the passage of viscerotropic yellow fever virus. Unfortunately this cannot be studied in mice, as in these animals yellow fever virus at once becomes neurotropic.

63. The histological changes in the liver were studied in relation to the cycle of virus growth in mice infected with huge inocula of Rift Valley fever virus, and it was possible to trace a definite cycle of tissue destruction on a close time scale. The earliest changes appeared one hour after inoculation. From six hours onwards no glycogen could be detected. The histological picture was different when the inoculum contained much "incomplete" virus.

The infectibility of the mosquito *A. aegypti* did not depend on the amount of "complete" virus in the injecting meal. The proportion of mosquitoes infected depends on the titre of virus circulating, regardless of its "completeness." As this mosquito apparently cannot transmit the virus by bite, though it may become infected, it was felt that there might be a substance inimical to it in the salivary glands. A virus preparation was accordingly put up in a suspension containing 500 pairs of freshly dissected and triturated salivary glands. On titration, however, the result was precisely the same as in a control suspension to which no glands had been added.

64. Two strains of Rift Valley fever virus were isolated from a strip of swamp forest at Lunyo, near the Institute, one from *A. circumluteolus*, the other from *A. africanus*. The two strains, while being very similar to one another, differ quite strikingly from normal Rift Valley fever virus in several particulars, though work by Dr. Max Theiler in New York has shown that they undoubtedly are strains of that virus. Remarkably, the Lunyo strains are transmissible by *A. aegypti*.

Field surveys for evidence of Rift Valley fever infections in wild and domestic animals from Karamoja continued; 91 cattle, 21 wild animals and 46 local Africans were tested with negative results. On the other hand, one immune rat (*Arvicanthis abyssinicus*) was found among a sample of 102 wild rodents from the Entebbe peninsula.

65. *Chikungunya Virus*. The first isolations of this important virus were made from human cases of a dengue-like disease and from mosquitoes in Southern Tanganyika, by staff of the Institute. This year we obtained a strain from *A. africanus* caught at Zika and another from a member of the catching team, who became sick with a disease resembling that originally noted in Tanganyika. There had been no Chikungunya virus in use at Entebbe for seven months prior to the isolations, so there is no possibility of a cross-infection having occurred. Re-isolations were also obtained from the original material.

66. *Sheep Disease*. When the Lunyo strains of Rift Valley fever were isolated, the Director of the Animal Health Research Centre at Entebbe was notified, in case he might wish to vaccinate his more valuable stock. He informed us that an outbreak of disease was going on among his sheep. This was investigated by Institute staff and many strains of a virus isolated, in one case from ticks collected from a sheep which subsequently sickened and died. The virus is not that of Rift Valley fever. Work so far suggests that it is probably that of Nairobi sheep disease.

67. *Semliki Forest Virus*. Studies in mice have begun; tissue changes may be apparent as early as 12 hours after intracerebral inoculation. The preparation of a haemagglutinin is being attempted. Even in 1-day old chicks, circulation and multiplication of the virus do not occur (though it is known to produce rapid death) in the chick embryo.

68. *Bunyamwera Virus*. Preliminary work on haemagglutination has so far been unproductive.

69. *Studies on birds*. Birds play a part in cycles of virus infection. Immunity to West Nile virus was found in four birds so far tested from the Entebbe area, and in one from Karamoja. Attempts to isolate virus from wild birds failed.

70. *Entomology*. A trap has been devised for collecting biting mosquitoes from small animals. Working on a time switch, one blower fan and one suction fan cut in at intervals. An insect feeding on the bait is picked up by the air current, carried through a gauge funnel and deposited in a cyanide killing bottle. At the moment, the trap works on cycles of 5 minutes off and 2½ minutes on, or 8 cycles per hour. Preliminary results are most encouraging.

Laboratory work on *A. aegypti* has shown that certain differences in oviposition behaviour are genetic in origin and that a multiple factor mechanism is involved. Ovulation in this species is, it has been found, under hormonal control. Various other strain differences, such as the fact that some strains of *A. aegypti* and *A. simpsoni* bite man readily in nature, while others do not, may have a similar explanation. More and more emphasis must be placed on the behaviour of local strains where epidemiology is concerned, as in species adequately investigated such differences are being noted increasingly.

Near Entebbe, where *A. aegypti* bites man rarely, the adult nesting places are being sought, in the hope that by examination of the blood-meals the host animals may be determined. The adults have proved most elusive; much oviposition goes on in out-door breeding-places, even in forest. Catches made with birds as bait showed that in the Entebbe area much the same species bite birds and man. The percentage of certain genera, however, notably *Culex*, was greater when bird bait was used. Catches were also made on cows and sheep, remarkably few mosquitoes being taken.

71. In a series of sixty 24-hour catches in the forest canopy at Zika near Entebbe, now completed, insects were caught on a minute-to-minute basis and the resulting figures will be used for analysis of the biting cycles. A long cycle of catches at ground-level in the Institute compound, made to study the seasonal incidence of various important species, has also been completed. Work on the genus *Taeniorhynchus* indicates that the presence, or rather the numbers, of parasitic mites found on the females may give a clue to age. Serological tests carried out in England indicate a preference for bird blood among mosquitoes of this genus collected near Entebbe.

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WILLIAMS, M. C.—(1956) "The susceptibility of *Cercocebus albigena johnstoni* (Lydekker) to yellow fever." *Ann. trop. Med. Parasit.*, 50, 150.

(c) *The Trinidad Regional Virus Laboratory, Port of Spain*

72. 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, has again had a most successful year. The Director, Dr. Wilbur G. Downs, has contributed the following summary (paras. 73 to 79).

73. Research has centred around epidemiological investigation of Ilheus virus infections, during which other interesting problems have arisen, and have been investigated as opportunity has permitted. In the Sangre Grande area, chosen for most intensive study, 211 cases with present or recent fever were seen at the clinic, but there was no evidence of Ilheus infections among them. Mosquito collecting continued in the Sangre Grande area and Ilheus virus was recovered from the mosquitoes, three times, early in the year. One isolation came from a mixed pool comprised of 7 genera and 13 species of mosquitoes; but, more significantly, an isolation was made from a pool of 7 *Psorophora ferox* and another from a pool containing *Psorophora ferox*, *Psorophora albipes* and *P. lutzii*. This is the first time this virus has been tied down definitely to a single mosquito species in nature. Search for an Ilheus reservoir among small mammals has been unrewarding, but immunity rates among equines in the area are quite high. Studies in birds of the region also indicate about 10 per cent. immunity rates in the small birds.

74. A significant break through occurred in November, when Ilheus virus was recovered from the 87th consecutive weekly blood specimen taken from

one of the mosquito catching men. (These men are not hired until proven to be Ilheus susceptibles.) He showed no temperature elevation at any time and had no symptoms. The picture of Ilheus illness in humans, as one now interpolates from the two known cases, ranges from the near fatal encephalitis case seen in 1955 to this asymptomatic infection seen in 1956.

75. In the course of Ilheus investigations important information has come to hand on St. Louis encephalitis virus. Three strains of this virus were recovered from pools of culicine mosquitoes in September, 1955; and in August, 1956, a strain was isolated from the blood of a nestling dove in the Sangre Grande region. These represent the first isolations of St. Louis virus in the new world tropics. They make somewhat more credible the hypothesis that St. Louis virus may have a reservoir in the tropics and may be transported into the United States periodically, presumably by and in migratory birds. Yellow fever, dengue and Mayaro viruses also received considerable attention. An island-wide survey to determine the incidence of Mayaro infections is in progress.

76. A serum survey of the island of Grenada was made and the laboratory work has nearly been completed. There is adequate evidence that dengue must have been widespread in the coastal areas, and that infections with other Group B "arbor" viruses, including yellow fever, Ilheus and St. Louis, are either uncommon or absent. Another serum survey was made in the Rupununi Savannah region of British Guiana; laboratory tests are awaited.

77. Over 75,000 mosquitoes, and a few simuliids and heleids, mostly collected in the Sangre Grande area, were ground and inoculated into 2-day old mice; 15 viruses were isolated from mosquitoes (3 Ilheus strains, the remainder still unidentified). Extensive collections of all blood-sucking insects, and detailed studies of several, are in progress. Virus transmission studies using mosquitoes have been begun. It has been shown in the laboratory that both *Aedes serratus* and *Psorophora ferox* are capable of becoming infected from feeding on low concentrations of Ilheus virus, with infections lasting at least 24 and 29 days respectively, although transmission was not effected. Seven experiments were conducted with Mayaro virus, inoculating 2,016 wild caught mosquitoes of 12 different species. Virus was recovered on grinding from 7 species after intrinsic incubation periods varying from 5-12 days. In 10 transmission trials *Aedes scapularis*, on one occasion, infected a baby chick by bite. The successful transmission through *A. scapularis* marks the first time Mayaro virus is known to us to have passed through an insect, and its membership in the "arbor" group of viruses thus confirmed.

78. With St. Louis virus, four species of mosquitoes transmitted virus after extrinsic incubation periods of 7, 10 and 11 days. The successful transmission by means of *Psorophora ferox* and two *Mansonia* species represents the first instances where mosquitoes of these two genera have been incriminated as possible St. Louis vectors.

79. Seven viruses were isolated from human beings in 1956. One has been identified, namely the Ilheus strain from the mosquito catcher. The other strains remain unidentified. Five strains of an as yet unidentified virus (or viruses) were isolated from the brains and salivary glands of two species of *Artibeus* bats.

Much attention is being directed toward identification of unknown agents gathered in the course of work from 1954 onward. Many of them are pathogenic for baby mice only, and often the virus titres attained are low. This makes production of immune sera and of antigens difficult, and slows down the process of identification.

Publications

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Animal-borne diseases in Malaya

80. *The yellow fever hazard.* Yellow fever does not occur in South-East Asia, but the danger of its introduction is increasing with the popularity and speed of air travel. It could be introduced by a traveller incubating it, by an infected mosquito, or by an infected animal. Precautions are taken, but the most efficient quarantine control will fail occasionally. Investigations at the Institute for Medical Research, Kuala Lumpur, have been mainly concerned with whether local mosquitoes and animals can transmit and maintain the disease, whether the known presence of other viruses in Malaya would affect its establishment, and with methods of vaccination and mosquito control. Virological work has been the responsibility of Dr. C. E. Gordon Smith. During Dr. Smith's leave it was done by Dr. L. H. Turner.

The distribution of the local *Aedes aegypti*, now known to be an efficient vector of yellow fever, was studied by Mr. W. W. Macdonald, and satisfactory methods for its control have been applied in Port Swettenham and around Kuala Lumpur airport.

The antibody responses to yellow fever vaccination are being studied in Malayan volunteers; they are complex owing to the high incidence of antibody to indigenous related viruses such as dengue and Japanese encephalitis.

81. *Arthropod-borne viruses.* Antibodies to the dengue viruses were very common in all the Malayan communities studied, whereas the incidence of antibodies to Japanese encephalitis virus varies markedly, being common in agricultural communities, less so in forest fringe, and virtually absent in the mountains. Antibody to Japanese encephalitis virus was very common in pigs and cattle, and less so in dogs and goats. Dengue-like antibodies have been found in a number of species of forest animals; transmission experiments are in progress to determine their significance.

Two viruses were isolated from ticks. One (TP.21), from *Ixodes granulatus* on a forest rat, very closely resembles that of Russian spring-summer encephalitis, and an account of it has been published; the other is as yet unidentified. Another virus, also unidentified, was isolated from the brain of a dog with pleural effusion.

82. *Leptospirosis.* The survey of animal reservoirs is almost complete. Animal hosts were found of almost all the serotypes of leptospire found infecting man in Malaya. They were found mainly in rats, but bats, cats and civets were also found infected. Antibodies to leptospire have been found in a wider range of animals extending to rodent-eating reptiles. Certain serotypes were found not to cause antibody production in their animal hosts, and this phenomenon is under investigation.

83. *Potential arthropod vectors.* An Institute Study, "Malaysian Parasites XVI-XXXIV," has been completed for publication, containing papers on culicine mosquitoes, fleas, ticks, helminths, and animal hosts, and thirteen papers on trombiculids including checklists, substantial revisions, and descriptions of many new species. The authors include a number of authorities

working outside the Institute as well as Lt.-Col. Robert Traub of the U.S. Army Unit in Kuala Lumpur. Much-needed studies of post-larval stages of trombiculids, and on comparative ecology, are being pursued in collaboration with workers in Queensland and the Belgian Congo. Advances have been made in the study of ticks in Malaya, the general host-distribution being clarified and several life-cycles partly or completely worked out in the laboratory. A laboratory colony of *Ixodes granulatus* has been started for future transmission studies.

84. *Animal hosts and potential reservoirs.* Some 3,000 animals were examined during the year, while mark-release experiments continue to provide ecological information. A study of survival-rates has been published, one of movements of ground-mammals is in press, and a contribution has been made towards clarifying the concept of range. Rats have returned "home" after release from as far afield as a mile, and it has been possible to explain this without invoking a special homing sense. Work on canopy animals continues to be held up by the activities of terrorists and security forces, but it is hoped that permission may be granted shortly for such work in a section of forest.

Publications

AUDY, J. R.—(1956) "Ecological aspects of introduced pests and diseases." *Med. J. Malaya*, **11**, 21.—(1956) "*Laurentella*, a new subgenus of trombiculid mites, with notes on biology and medical importance." *Bull. Raffles Mus.*, **28**, 5.—(1956) "Trombiculid mites infesting birds, reptiles, and arthropods in Malaya, with a taxonomic revision and descriptions of a new genus, two new subgenera, and six new species." *Ibid.*, **28**, 27.—(1956) "Malayan trombiculid mites.—1. *Schoutedenichia vercammeni* n. sp. with a note on the genus." *Ibid.*, **28**, 81.—(1956) "Malayan trombiculid mites.—2. Naked-eye observations on attached trombiculids with a simple checklist of Malayan species and details of preferred hosts." *Ibid.*, **28**, 86.—(1956) "Introducing study-groups." *Malay. nat. J.*, **10**, 149.

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LIM BOO-LIAT—(1956) "The natural food of some Malayan snakes." *Malay. nat. J.*, **10**, 139.

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SMITH, C. E. G., and THOMSON, W. G.—(1956) "An outbreak of influenza due to type B virus in a residential boys' school in Malaya." *Med. J. Malaya*, 10, 332.

85. Paragraphs 85–91 summarize the studies of the U.S. Army Medical Research Unit (Malaya) undertaken in collaboration with the staff of the Institute for Medical Research, Kuala Lumpur, the nearby British Military Hospital and the Walter Reed Army Institute of Research, Washington. The Unit has continued to concentrate on the clinical aspects, aetiology and epidemiology of acute febrile diseases. The investigative programme included the following five aspects:

- (1) Clinical and laboratory studies of children with "Pyrexias of Unknown Origin" in the General Hospital at Kuala Lumpur.
- (2) Investigation of outbreaks of these fevers in British military forces in Malaya.
- (3) Study of encephalitis in Singapore and the Federation.
- (4) Identification of viruses isolated from patients and wild-caught mosquitoes in Malaya.
- (5) Studies of ecology of potential vectors of viral diseases in Malaya, particular mosquitoes.

86. *Clinical and laboratory studies of children with Pyrexias of Unknown Origin.* The 387 pediatric patients so far studied represent highly selected patients who were carefully screened in an attempt to include the maximum number of patients whose illness would be in the category of "Fever of Unknown Origin." Acute phase and convalescent phase sera were obtained from each. Intensive laboratory and clinical study is under way. To date, 310 cases remain undiagnosed, 40 were shown to be due to infection with dengue or other closely related viruses and 37 to diseases such as leptospirosis, malaria, typhoid and tuberculosis. As a result of these studies during 1956 and 1957, six viruses have been isolated, representing a minimum of four different agents of which at least one has been definitely shown to be related to the disease of the patient. Though not yet identified, preliminary evidence suggests that they are agents not previously encountered in Malaya.

87. *Investigation of outbreaks of unknown fevers in British military forces in Malaya.* Three limited outbreaks were encountered. In two, no aetiological agent could be isolated by the techniques available. The third included cases with meningitic signs which serologically were shown to be leptospirosis.

88. *Study of encephalitis in Singapore and the Federation.* Frozen brain material from 14 fatal cases of encephalitis were studied in attempts to isolate virus. From 6, Japanese B virus was isolated. From 2 more, two viruses were isolated from mice inoculated with brain, but as yet it has not been possible to relate them to any form of encephalitis known to occur in Malaya. No agent was isolated from the remaining 6 brains.

89. *Identification of viruses isolated from patients and wild-caught mosquitoes in Malaya.* So far 57 transmissible agents have been isolated from man and wild-caught mosquitoes. In determining which might be important in the causation of local human disease, antigenically distinctive or unique agents were segregated and tentatively designated as prototype viruses. The remaining viruses were tentatively grouped with the prototype which it most closely resembled. In this manner 8 overtly different agents isolated from mosquitoes and 3 from patients have been designated as Malayan prototype viruses. Three additional groups of viruses have been

included in this study, viz. Japanese B virus isolated from both man and mosquitoes in Malaya, dengue-1, which has been isolated from humans by the Institute for Medical Research, and dengue-2 virus, which on serological grounds is suspected to be present in Malaya. By utilizing the prototype method, 11 presumably different unidentified viruses were recognized and made immediately available for further study, and prompt identification for only 11 agents was necessary instead of 57.

90. Two of the viruses isolated from Malayan mosquitoes belong to Casal's Group B, i.e. Japanese encephalitis virus and a second virus which is apparently new to science. At least one and probably three unidentified mosquito viruses belong to Group A; the remainder and all of the human agents remain unidentified.

91. *Studies of ecology of potential vectors of viral diseases in Malaya, particularly mosquitoes.* Prompted by the studies of viruses from mosquitoes, ecological observation of mosquitoes were made in three types of habitats: lowland dipterocarp forest, nipah palm-mangrove swamps, and open-type scrub terrain in two semi-rural areas.

In general, each type had distinctive groups of man-biting mosquitoes. Thus species of *Aedes (Finlaya)*, *Aedes (Stegomyia)*, *Armigeres (Leicesteria)*, and *Heizmannia* were characteristic and dominant in the lowland dipterocarp forest, where over eighty species of mosquitoes have been found to be attracted to man. In the nipah palm-mangrove swamps, small black mosquitoes in the *Aedes (Aedes) butleri* "complex" were extremely prevalent; *Aedes (Mucidus) aurantius*, *Culex (Neoculex) brevipalpis*, certain *Culex (Lophoceratomyia)*, and two *Armigeres (Armigeres)* were among the common species which were collected only in this habitat. The mosquitoes collected in scrub terrain were mainly *Culex (Culex)* and *Armigeres (Armigeres)*, and both of the localities in this type of habitat had essentially the same type of mosquitoes.

Only one species, *Aedes (Stegomyia) albopictus*, occurred in all four localities. Of the 30 kinds of mosquitoes listed for the primary forest, 26 were collected only in this lowland dipterocarp forest, and 15 of the 23 types of mosquitoes noted in the palm-mangrove swamps were exclusive to that habitat. Of 62 kinds of mosquitoes shown to feed on man in the field and to engorge to the point where the abdomen still visibly contained blood the morning after collection, 28 were found in the dipterocarp forest habitat, 23 in the nipah palm-mangrove swamps and 19 in scrub terrain.

The laboratory colonization of *Culex (Culex) gelidus* succeeded during the year, a significant step because this mosquito has been one of the major sources of isolation of Japanese encephalitis virus in Malaya and had not been colonized before. Living specimens were couriered to Washington and sub-cultures successfully established, and viable eggs and larvae successfully sent by airmail. Encouraging preliminary results have been obtained in attempts at colonization of *Aedes (Aedes) butleri* and *Culex (Lophoceratomyia)* species, both of which occur in the nipah-palm mangrove swamps and have yielded interesting viruses.

Relapsing Fever in East Africa

92. Dr. G. A. Walton and Mr. K. R. Cockings have continued their investigations at the East African Medical Survey and Research Institute, Mwanza, Tanganyika. Activities were concentrated on attempting to obtain pure cultures of what are suspected to be three recognisable biological variants of *Ornithodoros moubata*, Form A (man-feeder), Form B (chicken-feeder) and Form C (warthog). From recent observations of each of the three postu-

lated variants, it now appears that characteristic differences noted in shape and in coxal fluid excretion when fresh unmated ticks are feeding afford morphological criteria for each variant.

93. On crossing Form A with Form C a decrease in fertility and egg production is noted; and the offspring appear to inherit a tendency from the Form C parent to require 5 or 6 months to reach maturity, rather than 4 to 5, but to lose the ability of that parent to withstand desiccation.

Dr. Walton made extensive field surveys, in furtherance of these studies of biological varieties, in the Central Province of Kenya and the Central, Eastern and Lake Provinces of Tanganyika.

Identification of blood-meals

94. Mr. B. Weitz and Miss Lee-Jones of the Lister Institute of Preventive Medicine have continued their studies on the feeding habits of tsetse flies in conjunction with the staff of the East African Trypanosomiasis Research Organisation. The results of previous work (see this report 1955-56) required confirmation in several respects, particularly in regard to the effect of the method of collecting samples on the apparent host preferences of the fly. The old method of catching gorged flies by baiting or fly-round yielded only 3 per cent. females instead of the expected 50 per cent. Recent investigations made by Mr. P. Isherwood, Shinyanga, resulted in a new method of collecting gorged flies from their nesting site, where equal numbers of gorged males and females were found. It was desirable to check the validity of the previous results by collecting flies by both methods over a period of a year. Representative samples of the three components of the fly population of *G. swynnertoni* were obtained in this way for eight months of the year, viz., resting males, resting females, and active males (i.e. those caught by fly-round). These were all obtained from the same area near Shinyanga. The stomach contents of about 2,600 flies were identified. It was found that no real difference occurred between the feeding habits of resting flies and those caught on the wing, about 70-80 per cent. of all groups having fed on warthog and the remainder having obtained their meal from ruminants (about 10 per cent.) including kudu, eland and giraffe mostly, rhinoceros (3-4 per cent.) and some on a variety of mammals. This pattern resembles clearly the one observed in previous studies, and it can be concluded that earlier results reflected the real feeding habits of the tsetse population as a whole, in spite of the apparent bias in the sampling.

The proportion of flies which feed on Suidae was consistently higher among the resting females than among the males. Although the proportion fell in all groups during the height of the dry season, this variation was not correlated actively with rainfall.

95. Studies made in collaboration with workers abroad included a survey of feeding habits of culicoides in Uganda with Dr. M. C. Williams and G. H. McClelland of the E.A. Virus Research Institute. Dr. G. A. Walton submitted many ticks (*O. moubata*) for blood-meal identification in relation to his work on biological forms of this arthropod. Dr. M. T. Gillies and Dr. A. Smith from the East African Institute of Malaria and Vector-Borne Diseases sent many mosquito smears for identification. Among others from whom blood-meals were received from various blood-sucking insects were Dr. Heisch (Kenya), Dr. Willett (Uganda), Dr. Wharton (Malaya), Dr. Colless (Singapore), Dr. Lewis Davies (Durham), Dr. McMahan (Kenya), Dr. Symes (Fiji).

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WEITZ, B.—(1956) "Identification of blood-meals of blood-sucking arthropods. *Bull. Wild. Hlth. Org.* 15, 473.

Idem and GLASGOW, J. P.—(1956) "Natural hosts of some species of *Glossina* in East Africa." *Trans. R. Soc. trop. Med. Hyg.*, **50**, 593.

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Physiological and Nutritional Research

(a) *Uganda and Tanganyika*

96. At the East African Medical Survey and Research Institute at Mwanza, Tanganyika, Dr. E. G. Holmes has made much progress in building up the facilities required there for continuation of the nutrition research formerly directed by him at Makerere College, Kampala. Under Mr. Benton's supervision various rooms at the Institute have been adapted for biochemistry, and also for work with radioactive tracer substances on body composition, for which a technician (Mr. Read) specially skilled in isotope techniques has been added to the staff. A metabolic ward for eight patients has been erected in the Mwanza Hospital.

97. Despite pre-occupation with construction and adaptation it has been possible for Dr. Holmes and Dr. Sylvia Darke to study the absorption of foodstuffs by Africans, at first on prisoners in the prison hospital, and latterly in the metabolic ward. The prisoners, and some others, were found to absorb a smaller proportion of the total energy value and of the nitrogen of the food ingested than did the subjects used as controls. It remains to be decided whether this defect in absorption depends on the nature of the food consumed, or on other factors. Defects of absorption of the order found would have little practical importance where food intake depends only on need and appetite. If, however, food intake is limited, as in institutions, or among the general population from economic or natural causes, they will at once become significant.

In a collaborative study suggested by the Medical Research Council's Department of Human Nutrition in London, samples of human milk, absorbed on filter paper and dried in vacuo, have been sent for analysis to London.

Publications

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Idem, JONES, E. R., LYLE, M., and STANIER, M. W.—(1956) "Malnutrition in African adults. III. Effect of diet on body composition." *Brit. J. Nutr.*, **10**, 138.

THOMPSON, M. D., and HOLMES, E. G.—(1956) "Serum protein levels of African children." *Proc. Inter-African Nutrition Conference, Luanda, Portuguese West Africa*.

98. Dr. R. F. A. Dean, Director of the Medical Research Council's Infantile Malnutrition Research Unit at Kampala, has contributed the following brief summary of the Unit's activities.

The use of various diets in the treatment of kwashiorkor continues to be explored. Diets founded on milk protein and containing small amounts of sugar but fairly large amounts of vegetable oil have become the standard for use in the Unit's wards, even for the most severe cases. A commercial buttermilk preparation, of the kind extensively and successfully used against infantile diarrhoea, has been found to have only a limited value in kwashiorkor, as it has a tendency to produce loose stools, possibly because the butter fat is not well tolerated. Another commercial preparation, based on dried skimmed

milk from which much of the lactose has been removed, has also been tried, and appears to be more successful.

The rise in serum lipids that occurs soon after the beginning of treatment of kwashiorkor, even with a fat-free diet, has been confirmed. The partition of the lipids involves considerable technical difficulties, and until the difficulties have been overcome it will not be possible to establish with certainty the origin of the excess fat; the liver, however, continues to be the most likely source.

At the Unit's Child Welfare Clinic the average attendance is now over 100, and dried skimmed milk and protein-rich biscuits or biscuit meal, made from materials produced locally, are being tested as supplements to the diets of young children, especially at the time of weaning. It is hoped to extend the activity of the clinic soon by opening small nutrition centres in the periphery of the district from which the children come.

99. The work on growth has included a study of the effects of malnutrition on the skeleton. The retardation of development is marked, and its degree seems to be greater in the knee than in the hand, and less in the skull. The retardation must begin long before any sign of ill-health is noticed, and X-ray examination may provide the only means to which the beginning of malnutrition can be dated.

The neuro-muscular activity of the newborn African child has been studied by techniques evolved by Dr. André Thomas and other French workers. In comparison with European children there is nearly always much precocity, which is shown in the control of the head, and the absence of both "primitive" reflex activity and marked flexor tone. The results confirm those already obtained by clinical examination and by the use of Gesell tests in older children, and help to show that any suspected abnormalities of development, especially those that may be due to malnutrition, must be considered in relation to a pattern of development that may be considerably different from the European pattern.

Publications

DEAN, R. F. A.—(1957) "Some problems of the nutrition of the pre-school African child." *Central Afr. Med. J.*, **3**, 58.—(1957) "Digestion in kwashiorkor." *Mod. Probl. Paediat.*, **2**, 133.

Idem and WEINBREN, B.—(1956) "Fat absorption in chronic severe malnutrition in children." *Lancet*, **2**, 252.

SCHWARTZ, R.—(1956) "Alkaline phosphatase activity of the serum in kwashiorkor." *J. clin. Path.*, **9**, 333.

Idem and DEAN, R. F. A.—(1957) "The serum-lipids in kwashiorkor. (1) Neutral fat, phospholipids and cholesterol." *J. trop. Paediat.*, **3**, 23.

JONES, P. R. M. and DEAN, R. F. A.—(1956) "The effects of kwashiorkor on the development of the bones of the hand." *Ibid.*, **2**, 51.

100. Professor H. Heller, of the Department of Pharmacology of Bristol University, continuing work on weanling rats in which nutritional oedema was produced by feeding boiled African plantains (Matoke), showed that this diet, apart from being poor in protein, contained insufficient lipotropic substances, though it supplied adequate potassium. Dr. T. F. Hewer, Professor of Pathology in the University of Bristol, investigated the liver, kidneys and pancreas of rats which had been on this experimental diet for 3-4 weeks, and found fatty changes in the liver, the distribution being in most instances centrolobular, but no fibrosis. There was no microscopic change of any kind in kidneys or pancreas, except in 10 rats which showed the haemorrhagic

renal lesions of choline deficiency. Chemical estimation of total lipids in the livers and kidneys agreed with the histological findings.

101. Further "therapeutic" experiments showed that aminophylline, acetazolamide, Mictine, cortisone and prednisolone raised the urine output of the protein deficient animals, but only cortisone restored the impaired water diuresis to normal levels. When oedematous animals were treated with the diuretics and the steroids for three days, the total body water being estimated at the end of this period, it was found that only the steroids produced a significant decrease in the degree of body hydration. Moreover, cortisone reduced the body water of the rats to levels which were not significantly different from those of the untreated controls; that is, it freed the animals of oedema.

Jamaica

102. *Tropical Metabolism Research Unit, Jamaica.* The year has been one of transition. The new ward and laboratories were opened in October, 1956, since when until the end of the year 40 patients were admitted. Miss Helen Fox, B.Sc. (McGill), came to work in the Unit in October, 1956. Hitherto employed as a dietitian, the Government of Jamaica seconded her to its Applied Nutrition Research Unit. She also holds a Geddes Grant postgraduate scholarship of the University College of the West Indies. Dr. J. S. Garrow, after working in the Unit for nearly three years, left Jamaica in March, 1957, to do his National Service. The investigations have been concerned primarily with protein malnutrition in infants.

103. Dr. Garrow applied to infants the methods developed in his work on protein-depleted dogs in Dr. J. B. Allison's laboratory in the winter of 1955-56. He first showed that the dye Evans Blue cannot be used as a label for human plasma proteins, as it is broken down abnormally quickly. This was shown by comparison with I^{131} -labelled albumin (obtained through the kindness of Dr. A. S. McFarlane of the National Institute for Medical Research). The results do not agree with those of other workers in the U.S.A. The reason for this discrepancy probably lies in the nature of the radioactive albumin that they used for comparison. It had been hoped that by the use of Evans Blue it might be possible to measure the total circulating protein (intravascular + extravascular), a quantity that must be of much importance in relation to nutrition. A number of data had been collected, but Dr. Garrow's results now show that the method is not valid.

Studies in malnourished infants of the incorporation of radio-active methionine into plasma proteins gave qualitatively the same results as in protein-depleted dogs. In the malnourished organism, rather surprisingly, a larger proportion of the dose of tracer is taken up into pools of high activity. Garrow described this as a "contraction of metabolic frontiers," vital organs being protected at the expense of others less vital.

104. Work continued on the composition of tissues in malnutrition, especially of muscle. In specimens taken at autopsy a gross diminution was found in the ratio of nitrogen to deoxynucleic acid (DNA), and there was also a large loss of potassium. Rats on a simulated Jamaican diet show a similar fall in the ratio N/DNA in muscle, but with no loss of potassium. Studies are being made of the changes in DNA content during recovery; this gives an indication of the proliferation of cells.

105. Studies of enzyme activity in the human liver have been largely in abeyance. Some progress was made in the measurement of Krebs cycle oxidations. In malnourished infants there seems to be a considerable fall in liver succinoxidase; this is tentatively attributed not to loss of any one

enzyme, but to disorganisation of relationships in a multi-enzyme system. A beginning was made of nitrogen and electrolyte balance studies of patients in the ward. These form an essential background to measurements, such as those mentioned above, that are made on isolated fragments of tissue.

106. Dr. Wills has examined many hundreds of infants and pre-school children in various parts of the island, in an attempt to establish a correlation between different signs of malnutrition. No relation has been found between reddish discolouration of the hair and scaliness of the skin, both of which are very common, and diminution in either height or weight.

Cases of an unusual type of diabetes (the so-called J type) were admitted to the ward under Dr. J. A. Tulloch. He investigated the response to intravenous insulin, glucagon, and B255. This work continues.

107. *The Applied Nutrition Research Unit.* This unit of the Government of Jamaica works in close relation with the Tropical Metabolism Research Unit. It only recently reached full strength with the appointment of Dr. K. Standard, as Field Medical Officer. After consultation with agricultural officers, doctors and sociologists, he has selected areas for special study, where with the help of a public health nurse he has begun clinical surveys and the collection of dietary data. Mr. Mendes continued his work on the composition of muscle in malnutrition, which may prove of practical value for the diagnosis and assessment of protein depletion, and serve as a baseline for simpler tests, such as the measurement of serum enzymes. Miss Fox joined the Unit in a part-time capacity. She began by analysing and summarising the available information about the nutritional state and dietary intake of people in the Caribbean territories. The surveys agree in showing a shortage of protein—at least compared with recommended allowances. Her next task was to explore some of the ways of filling this gap, and she collaborated with Mr. N. W. Pirie, F.R.S., Head of the Department of Biochemistry, Rothamsted Agricultural Research Station, during his visit here, in the extraction of protein from local leaves. She has begun an analysis of amino-acids in various types of local bean that were not included in the study made by Jelliffe and Scrimshaw. She also collaborates with Dr. Standard in the analysis of dietary data collected during his surveys.

Publications

WATERLOW, J. C.—(1956) "The protein content of liver and muscle as a measure of protein deficiency in human subjects." *W. Ind. med J.*, **5**, 167.

Idem and VERGARA, A.—(1956) "Protein malnutrition in Brazil." *F.A.O. Nutritional Studies*, No. 14, F.A.O., Rome.

Idem, BRAS, G. and DEPASS, E.—(1957) "Further observations on the liver, pancreas and kidney in malnourished infants and children. II. The gross composition of the liver." *J. trop. Pediat.*, **2**, 189.

BRAS, G., WATERLOW, J. C., and DEPASS, E.—(1956) "I. The relation of certain histopathological changes in liver, pancreas and kidney." *Ibid.*, **2**, 147.

GARROW, J. and PIPER, E. A.—(1955) "A simple technique for counting milligram samples of protein labelled with ¹⁴C or ³⁵S." *Biochem. J.*, **60**, 527.

108. *Mechanism of action of hypoglycin.* Dr. J. Patrick, of the Faculty of Physiology at the University College of the West Indies, has continued his investigations on this and other research problems reported last year. The action of the "ackee" toxin, hypoglycin, on the concentrations of glycogen in the tissues of the rat and on various constituents of the blood,

and the effects of hypoglycin and insulin on the oxygen consumption and carbon dioxide production on the intact rat and on isolated tissues, have been studied. The general conclusion is that the pharmacological action of hypoglycin is confined to its effects on carbohydrate metabolism, mainly interference with carbohydrate production by the liver. Experiments with radio-glucose indicate that in rats treated with hypoglycin the "turnover" of liver glycogen is more rapid, the "glucose pool" decreases progressively in size, and the "turnover" of body glucose is slower than in normal rats. Much work remains to be done in localizing the defect in the hypoglycin-treated animals.

109. *Effect of diet on the carbohydrate metabolism of the liver.* More work was done on the effect of the composition of the diet fed to rats on the utilization of radio-glucose by liver slices in vitro. The protein content of the diets was kept at a constant optimal level and the effects of variations in the amounts of carbohydrate and fat in the diets were investigated; and it would appear that there is a critical intake of carbohydrate which, if exceeded, results in excess lipogenesis by the liver. The oxidation of glucose by the liver slices seems also to be roughly proportional to the carbohydrate intake of the rats. The study began of enzyme changes in the livers of the rats which have been fed diets producing excess lipogenesis.

110. *Constituents of the human liver in various diseases.* Many glycogen determinations were made with liver biopsy material from cases of various types of malnutrition and diabetes, before and after treatment. Typically, in kwashiorkor there is a large amount of liver glycogen which decreases on treatment, and in veno-occlusive disease and diabetes there are small amounts of liver glycogen which increase during treatment.

The glucose-6-phosphatase activity in the livers of human diabetic subjects was investigated before and after treatment. It was found that there is an increase in the activity of this enzyme in the livers of human diabetics as compared with non-diabetic subjects. Stabilization of the diabetes resulted in a decrease in the activity of the enzyme in each of thirteen cases, whether the diabetes was type I, II or "J", and whether insulin or BZ55 was administered. Much work was done on the development of a micro-assay for liver insulinase for the purpose of studying the changes in the activity of this enzyme which may occur in various human diseases. It has been shown that alloxan diabetes in rats results in a decrease in the activity of this enzyme. Despite the rather inconsistent results obtained from human biopsy material so far, the project deserves further study.

Nigeria

111. Dr. O. A. R. Bassir, Lecturer in Physiology at University College, Ibadan, continued his nutritional studies on the breast milk of Nigerian women, in particular on the quantitative assessment of its various constituents and their variations in certain circumstances. In estimating the total output of breast milk of 120 women, drawn by manual expression at random from the community, it was found that the statistical distribution of the 24-hour output approximated to the normal curve only in the period 3-26 weeks after delivery. The primiparae showed a regular increase in output from the 4th to the 20th week, and then a peak extending to the end of the first year of lactation. The proportion of total calories derivable from milk lipids also varied with the stage of lactation.

Changes in the major constituents during a single feed were also studied. Some 1,500 separate results obtained on serial samples of milk from 40 women showed a rise in the cream values throughout a feed; the concentration of protein nitrogen remained constant; the non-protein nitrogen

gave a variable pattern. The calcium and phosphorus results were closely parallel, but did not indicate a constant trend of variation during a feed. Lactose was unaffected.

Publications

BASSIR, O. A. R.—(1956) "Nutritional studies on breast milk of Nigerian women. 3. Variation in the output of milk with the stage of lactation." *W. Afr. Med. J.*, **5**, 88.—(1957) "Diurnal variation in the output of breast milk of Nigerian women." *J. trop. Med. Hyg.*, **60**, 137.

Investigations on sickle-cell trait and sickle-cell anaemia

112. These have continued, as a collaborative effort by workers in the field and in laboratories in Britain. Dr. J. C. White, of the London Post-Graduate Medical School, and Dr. G. H. Beaven, of the National Institute for Medical Research, assisted by Miss M. J. Ellis, B.Sc., have found that the use of a sensitive combined method of partial denaturation and ultra-violet spectrographic analysis has enabled foetal haemoglobin to be detected and estimated down to the 1 per cent. level with certainty. Falling rapidly from 70 to 80 per cent. at birth during the first 3 months of life, a few per cent. of Hb-F may persist in children under 5, but none is detectable in older children and in adults. Widely varying percentages of foetal haemoglobin are found in sickle-cell disease, thalassaemia, and in mixed conditions due to these genes operating together, or in the presence of genes for other abnormal haemoglobins. Paper electrophoresis and solubility measurements enable the investigation of the haemoglobin composition of these cases to be completed.

113. The presence of small percentages of Hb-F (1-6 per cent.) has been frequently, but not invariably, established in the parents of children with severe thalassaemia, and, taken in conjunction with normal or high serum iron, slightly hypochromic, osmotically resistant erythrocytes, and the presence of iron stores in the marrow, is a valuable sign of thalassaemia minor. Several families within the British Isles, of purely British stock, have been investigated in this way, and examples of moderately severe, resistant hypochromic anaemia shown to be familial disorders of thalassaemia-type. However, foetal haemoglobin is not always indicative of hereditary haemoglobin disorders, and children with leukaemia occasionally possess large amounts, and traces may occur in pernicious anaemia, but not in simple hypochromic anaemia.

114. A case of thalassaemia-like anaemia in a Trans-Jordanian with sub-acute leukaemia has been investigated and found to possess 20 per cent. of haemoglobin H, the remaining haemoglobin being normal. The properties of the Hb-H have been studied by combined spectrophotometric analysis and free-boundary electrophoresis, in co-operation with Dr. E. M. Shooter and Mr. E. B. Skinner (University College, London).

The results of analysis on over 1,000 samples of haemoglobin are now being classified for publication.

Publication

BEAVEN, G. H., ELLIS, M. J., and WHITE, J. C.—(1956) "Estimation of small proportions of foetal haemoglobin in blood." *Nature*, **178**, 857.

115. An investigation was undertaken by Dr. H. Lehmann, of St. Bartholomew's Hospital, London, with Dr. A. B. Raper in Uganda on the factors maintaining a high incidence of the sickling gene in the Baamba of Western Uganda. The sickle-cell gene can cause early death if it is inherited in the homozygous state, yet in spite of this constant depletion

it still exists at remarkable high frequencies in tropical Africa. A relatively lower mortality from malaria in sickling children is thought to balance the loss of sickling genes by death of sickle-cell homozygotes. To assess the extent to which malaria acts as a selective agent it is necessary to know how many of the sickling homozygotes do in fact die, and fail to transmit the sickle-cell gene to the next generation. A survey of the Baamba discovered 227 sicklers amongst 623 subjects. Of these, 191 sicklers were above the age of 5 years. No homozygotes were found amongst these 191. Therefore the survival of sickle-cell homozygotes plays no significant part in the maintenance of the high sickling-rate in the Baamba.

Earlier investigations and this survey indicate a sickling-rate in the Baamba of 39 per cent. If selective death of non-sicklers from malaria was responsible for the maintenance of this 39 per cent. sickling-rate, some 10-24 per cent. of all normal homozygotes (or some 7-16 per cent. of the whole child population) would have to die from malaria. Taking into account that malarial death occurs *after* the non-selective infant diseases have taken their toll, the actual death-rate for malaria would approximate to the lower of the two limits. A malarial death-rate of about 7 per cent. of all children born can reasonably be expected in Baamba.

116. Together with Dr. M. Aksoy sickle-cell thalassaemia in Turkey was investigated, as also was thalassaemia in Cypriots in collaboration with Dr. J. G. A. McSorley and Miss Mary F. Crowley at the Archway Hospital. The increase of the Haemoglobin A₂ fraction in thalassaemia was notable. Jointly with Dr. R. Bodley Scott a case of thalassaemia in an English woman was discovered, and evidence of the thalassaemia gene in her family collected.

With Colonel G. W. G. Bird, Poona, and Dr. A. E. Mourant, a notable incidence of haemoglobin D was found in North-West Indians; and, with Dr. A. B. Raper and Dr. Gillian Jacobs, a number of haemoglobin D carriers were found amongst Gujeratis resident in Uganda. A survey of Malaysian Malays with Dr. R. B. Singh revealed haemoglobin E at high frequency in North-East Malaya.

A condition not hitherto known, sickle-cell haemoglobin E disease, was discovered jointly with Dr. M. Aksoy in Turkey. Evidence suggests that the gene for haemoglobin E is either an allele of those for haemoglobins A, S and C, or is so closely linked with these genes that all four haemoglobins are inherited as if they were allelomorphs. The rare haemoglobin variant K was found in an Indian and his family resident in London (with Dr. J. A. M. Ager), and in three Dagomba from Ghana (with Dr. G. M. Edington). Jointly with Dr. Ager a new haemoglobin, haemoglobin L, was discovered in an Indian resident in London and its properties ascertained.

117. Animal haemoglobins were examined in geese in collaboration with Dr. G. V. J. Mathews of the Wild Fowl Trust, and in horses, mules, jennets, and donkeys with workers from the Agricultural Research Council, the Army, the Colonial Veterinary Services, the University College of Dublin, and others. Contrary to previous workers it was found that horses carry always 2 haemoglobins, donkeys one, and mules and jennets three haemoglobins, the latter being the two horse haemoglobins and the donkey haemoglobin.

Publications

LEHMANN, H.—(1956) "Haemoglobin and its abnormalities." *Practitioner*, 178, 198.

Idem and RAPER, A. B.—(1956) "The maintenance of a high sickling-rate in an African community." *Brit. med. J.*, 2, 333.

AKSOY, M., and LEHMANN, H.—(1957) "Sickle-cell thalassaemia disease in South Turkey." *Ibid*, **1**, 734.

WALTERS, J. H. and LEHMANN, H.—(1956) "Distribution of the S. and C. haemoglobin variants in two Nigerian communities." *Trans. R. Soc. trop. Med. Hyg.*, **50**, 204.

EDINGTON, G. M. and LEHMANN, H.—(1956) "Sickle-cell Trait and malaria in Africa." *Bull. Wld. Hlth. Org.*, **15**, 857.

118. Dr. A. C. Allison, a part-time member of the Medical Research Council's staff, studied at Oxford the physico-chemical changes that take place in sickle-cell haemoglobin solutions when they are deprived of oxygen. Under these conditions the molecules combine with one another to form fibrillar aggregates. This does not occur in the presence of urea, guanidine or agents combining with sulphhydryl groups. It is inferred that the combining site between the molecules is in the vicinity of the available sulphhydryl groups, and that the main force of combination is hydrogen bonding. Unfortunately, the agents that prevent sickling are too toxic to use therapeutically. Sickle-cell haemoglobin forms mixed aggregates with haemoglobin C very efficiently and with normal adult haemoglobin less efficiently. This accounts for the fact that persons who inherit both the sickle-cell and haemoglobin C genes are liable to disease whereas sickle-cell heterozygotes are not, with extremely rare exceptions.

The distribution and population genetics of the sickle-cell and haemoglobin C genes in West Africa were also studied. The results agreed with those of Edington and Lehmann that haemoglobin C is present from Nigeria to the Gambia, with maximum heterozygote frequencies (about 28 per cent.) in Northern Ghana. As the frequency of haemoglobin C rises, that of the sickle-cell trait falls. This is to be expected from natural selection if the sickle-cell: haemoglobin C heterozygote is at a disadvantage.

Publications

ALLISON, A. C.—(1956) "The sickle-cell and haemoglobin C genes in some African populations." *Ann. hum. Genet.*, **21**, 57.—(1956) "Observations on the sickling phenomenon and on the distribution of different haemoglobin types in erythrocyte populations." *Clin. Sci.*, **15**, 897.—(1957) "Properties of sickle-cell haemoglobin." *Biochem. J.*, **65**, 212.

119. Among the studies made by Mr. E. B. Skinner, B.Sc., and Dr. E. M. Shooter in the laboratories of Professor A. Baldwin at University College, London, the continued electrophoretic investigation of haemoglobins of sickle-cell trait individuals (in samples generously provided by Dr. N. A. Barnicot and Dr J. C. White), established that a buffer such as mixed phosphate at ionic strength 0.04 and pH 6.40, below the iso-electric point, gave good resolution of the two components in a relatively short time. Of buffers at pHs. above the iso-electric point which have been further investigated, tris (hydroxymethyl) amino-methane acetate, tris (hydroxymethyl) amino-methane barbiturate and triethanolamine at pH 8.76 and ionic strength 0.04 gave greater sharpening than any other, though still insufficient for the detection of possible minor components.

120. An attempt has been made to correlate conductivity and pH changes in these systems with boundary sharpening. In phosphate buffer these changes increased with decreasing ionic strength and lowering of pH. In the phosphate buffer at pH 6.40, giving adequate sharpening, the conductivity decrease was 17 per cent. while in tris (hydroxymethyl) amino-methane barbiturate at pH 8.76 the decrease was only 10 per cent. and insufficient sharpness was produced.

The reliability of the above system was good, eight determinations from a single trait individual giving mobilities for haemoglobins S and A of 2.94 ± 0.05 and 2.67 ± 0.06 respectively. The corresponding mobilities for seven different traits were 2.97 ± 0.05 and 2.72 ± 0.07 . Similar deviations were also found with haemoglobins from C-trait, sickle-cell anaemia and normal individuals. Furthermore, mixtures of the haemoglobins from two C-traits which gave greatest experimental variation of mobility showed only two components after prolonged electrophoresis. It is therefore unlikely that a variation occurs in the mobility of a particular haemoglobin species from different individuals.

This system has also been successfully applied to naturally-occurring mixtures of haemoglobins AE, AH, AF and SC, and to artificial mixtures in which any combinations of haemoglobins S, E and C with A were resolved, although S and E showed very close mobilities. Haemoglobins S, E and C were similarly resolved from A₂ and F.

121. The electrophoresis of different forms of normal adult haemoglobin has been studied in the above buffer. Methaemoglobin was found to migrate slightly ahead of carbonmonoxyhaemoglobin with a mobility difference of 0.1×10^{-5} . Carbonmonoxyhaemoglobin and reduced haemoglobin gave a difference of 0.2×10^{-5} . Hence in the analysis of haemoglobins by electrophoresis it must be ensured that all the haemoglobin is present in the same form.

122. Mr. G. V. F. Seaman and Dr. B. A. Pethica of the Department of Colloid Science at Cambridge have since September, 1955, undertaken research on the membrane characteristics of intact sickle red cells. Regular supplies of sickle-cell anaemia blood were generously provided by Dr. J. MacIver (University College of the West Indies, Jamaica), and occasional samples by American Air Force Hospitals. An examination of the electrophoretic characteristics of the human normal and sickle erythrocyte and a number of model systems has been completed. Part of the work was presented at the Second International Congress of Surface Activity in London (April, 1957) in a paper entitled "The Electrophoretic Characteristics of the Human Normal and Sickle Erythrocyte" by G. V. F. Seaman and B. A. Pethica.

123. The change in electrophoretic behaviour with the age of red cells in storage was examined. Sickle anaemia cells show a more rapid increase with age in copper ion binding than do normal red cells. Deoxygenated sickle cells exhibit within experimental error the same cation binding characteristics and pH mobility relationship as do oxygenated normal and sickle cells. The mobility of the normal and abnormal cells was examined over the pH range 1.6 to 10.8. Neither type of cell exhibits a true iso-electric point and on no occasion were positive mobilities observed down to pH 1.6. Readings could be taken after as little as 60 seconds from making up the suspensions. The pH mobility relationships indicate the presence of one dominant group with an intrinsic pK.ca.3.5. There is a rise in mobility at pH 9-10, indicative of another charge grouping. Formalin treatment does not increase the negative mobility over most of the pH range thereby suggesting the absence of free primary amines. The mobility increase at high pH could be produced by thiol or by hydroxyl groupings as in tyrosine.

124. Study of the time for 90 and 100 per cent. haemolysis for samples of oxygenated normal and sickle cells by various concentrations of butanol and dodecylamine hydrochloride shows no significant differences between normal and sickle cells. The source of water used in the experiments is important. Large differences (ca. 50 per cent.) were observed between experiments using water obtained from a mixed cationic-anionic resin column, a pyrex still and a quartz still.

125. At this stage, the membranes of the normal and sickle erythrocyte appear to be very similar. The principal difference shown up so far is in the more rapid ageing of the sickle-cell membrane.

126. Dr. A. E. Boyo, M.B., B.Ch., a young Nigerian research worker, is undertaking a field research project in Nigeria designed to test the validity of the contention that sickling protects in some degree against malaria, and that the high sickling-rate observed in parts of Africa results from a selective lower susceptibility of sicklers to malaria. In a biological survey an attempt will be made to assess the degree of variation, if any, in the growth, physique and fertility between normal and sickle-cell individuals in a malarious area. The existence of such differences, if established, might clarify this still contentious conception.

127. A preparatory period of five months training was spent at Oxford under Dr. J. S. Weiner, Reader in Physical Anthropology, and in London with Professor P. C. C. Garnham and Dr. H. Lehmann. A base laboratory was established at University College, Ibadan. A Yoruba village community with a sickling-rate of 25 per cent. has been chosen as the focus of the field work. The collection of anthropometric, malaria, sickling and fertility data has begun.

The project is financed jointly by grants from the Colonial Medical Research Committee, the University College of Ibadan and the Department of Anthropology of Oxford University.

Leprosy

Nigeria

128. Dr. T. F. Davey, Senior Specialist, Nigeria Leprosy Service, Uzuakoli, as provided the following summary of the work done by his Research Unit, which is administered as part of the Nigeria Leprosy Service, Eastern Region, and to which the Federal Government contributes financially.

129. *Therapeutic Studies.* The controlled pilot trial of diphenyl-thiourea (Ciba compound 15095E or S.U.1906) has now lasted 25 months. Six settlements are collaborating with the Research Unit in expanded trials on 140 patients. Findings have been uniform at all centres and are briefly that:

- (i) The drug has shown itself an effective treatment for all types of leprosy in a dosage of 1.0 to 3.0 g. daily; its activity at least equals that of diamino-diphenylsulphone (D.D.S.), and no evidence of drug resistance has appeared;
- (ii) it is remarkably free from toxic action;
- (iii) the complications of leprosy arising during treatment have not been severe;
- (iv) it combines effectively both with D.D.S. and with isoniazid.

On this experience, the drug already has a place in leprosy treatment. Its importance also lies in the fact that it introduces to therapy a new class of anti-leprosy drugs unrelated to the sulphones. Its continued study is directed to its suitability for outpatient treatment, and its wider use in combination with other drugs.

Diamino-diphenyl sulphoxide. This drug continues to show considerable promise, though how far this is due to its independent action and how far to its possible conversion to D.D.S. in the body remains to be seen. It has after 16 months' experience exhibited anti-leprosy activity on a dosage of 100 mg. daily comparable with that of D.D.S., and at the same time has shown only mild degrees of toxicity and little tendency to evoke undesirable complications.

Pyrazinamide. A small pilot trial on 11 patients was terminated after 12 months' experience with this drug, administered in a dosage of 250-500 mg. daily. Its action proved erratic; some individuals improved, others showed degeneration, and strong evidence of drug resistance developing in two patients indicated that in the dosage used it has little value in therapy.

130. *Immunology.* The relationship in immunology between tuberculosis and leprosy continues to be of interest. Extensive comparative studies of the tuberculin and lepromin reactions have been made among school children in rural and urban areas, in some of which the incidence of leprosy in recent years has been known, and in entire village communities. More than 5,000 individuals have been tested, and the results are being analysed.

Epidemiology. Studies have been made of the decline of leprosy now self-evident in the Eastern Region of Nigeria, particularly in relation to one group of villages where the incidence of the disease was formerly 170 per 1,000 and has now declined to 17 per 1,000. Among various contributing causes, co-operation in leprosy control measures appears to have been by far the most important.

Pathology. Laboratory facilities have been expanded, particularly for histology and photography, and a high standard obtained.

Publications

DAVEY, T. F. and CURRIE, G.—(1956) "Clinical trial of Diphenyl Thiourea Compound SU1906 (Ciba 15095E) in the treatment of leprosy. Progress during the first year." *Lep. Review*, **27**, 94.

Idem, ROSS, C. M., and NICHOLSON, B.—(1956) "Leprosy: A changing situation in Eastern Nigeria." *Brit. Med. J.*, **2**, 65.

Idem, KISSAUN, A. M., and MONETA, G.—(1957) "The treatment of leprosy with diamino-diphenyl sulphoxide. A progress report." *Lep. Review*, **28**, 51.

Uganda

131. At Makerere College Dr. R. F. Naylor, Lecturer in Chemistry, has studied the diffusion of D.D.S. into cells, using blood cells as a model. Equilibrium is rapidly established, but the relative roles of diffusion and adsorption in this is uncertain.

In studies on the enzymes of *Mycobacteria*, in particular the use of tetrazolium salts to detect dehydrogenase, satisfactory micro-methods have been developed and these give consistent results with cultured organisms (mainly *M. phlei*). A number of attempts made to apply the method to *M. leprae* taken straight from human lesions are still indecisive. The two principal problems in the direct study of *M. leprae* are the difficulty of clean separation of the bacteria from tissue (without damaging the enzyme systems) and the low order of activity of the bacteria themselves.

132. Dr. E. M. Brieger, Research Pathologist, Papworth Hospital, and attached to the Strangeways Research Laboratory, Cambridge, is making an electron microscope study of the fine structure of leprosy bacilli in collaboration with Dr. C. Becker, of the Leprosarium of the Africa Inland Mission at Oicha, Belgian Congo. In particular, information is being sought on the submicroscopical structure of bacilli in lepromatous lesions, the differences of bacillary structure in different types of cases at different stages of the disease, the influence of treatment of bacillary structure, and the fine cytoplasmic structure of the "foamy cells."

In view of controversial statements on the viability of bacilli in lepromatous lesions, and on their fate when grown on bacteriological media or

in tissue culture is attempted, organ cultures of fragments of lepromatous tissues were made and fixed at intervals in osmic acid for thin sectioning and in Susa's fixative for routine histology. As a control, lepromatous tissue juices were adsorbed on small squares of Dupont sponge on tantalum wire gauze, and cultivation in contact with a variety of fluid media attempted. Impression prints on coverslips and on electron microscope grids were made, and whole sponge fragments were fixed for thin sectioning.

133. At the National Institute for Medical Research, London, Dr. R. J. W. Rees and his colleagues, working mainly with rat leprosy as a model of the human infection, have made studies on the evolution of infection with *Mycobacterium leprae murium* in experimental animals, on experimental chemotherapy and on the behaviour of the organism in tissue culture.

134. The first objective was to devise quantitative bacteriological techniques in order to measure the multiplication rate of *M. leprae murium* in vivo. Experiments showed that the organisms divide approximately every 12-15 days in the mouse. The rat and mouse were equally susceptible. These quantitative methods permit an earlier and more precise measure of the progress of the infection than can be ordinarily obtained by macro- or microscopic examination, and have been used to study factors increasing the multiplication in vivo of the *M. leprae murium*, particularly in the early phase of infection. A number of factors, including cortisone, various diets, suramin and x-irradiation are under investigation. The most interesting result has been obtained with suramin, which markedly increases the susceptibility of mice to murine leprosy.

135. Using a standard mouse test, some current antituberculosis drugs have been tested against experimental leprosy. Of particular interest is the powerful antileprosy effect of Macrocydon (a surface-active polyoxyethylene ether), the least toxic member of a series of new antituberculous agents developed at the National Institute for Medical Research. Although Macrocydon has not as yet been administered to man, extensive toxicity tests in monkeys have been completed with entire satisfaction, and it will now be tested in man.

136. In attempts to grow *M. leprae murium* in tissue culture, since in vivo the bacillus is predominantly an intra-cellular parasite of the reticulo-endothelial system, macrophage type cells in particular were used. Various new media have been developed to make possible the long term maintenance of tissue cultures, and quantitative methods developed for accurate assessment of bacilli within these cultures. It has thus been possible to follow the behaviour of *M. leprae murium* in infected macrophage cultures and in cultures of other cell types and tissues for periods up to 80 days. There has been no evidence yet of multiplication of the bacilli in culture. But bacilli recovered from tissue cultures retained their infectivity. Furthermore, morphological studies (with the aid of electron microscopy, by which it is possible to distinguish degenerate, non-infective, from normal, infective bacilli) have revealed that while the bacilli degenerate equally rapidly in all the cell-free media tested, the intracellular bacilli in some of the same media degenerate far less rapidly. In more recent studies limited multiplication of bacilli has been obtained in cultures of infected spleen tissue.

137. In February, 1957, Dr. J. A. McFadzean of the National Institute for Medical Research, London, began a research project at the Sungei Buloh Leper Settlement near Kuala Lumpur, Malaya, financed jointly by the Medical Research Council, the Colonial Office and the Government of the Federation of Malaya. He will concentrate at the outset on chemotherapy. It is intended to undertake pilot trials of new drugs, either singly or in combination, following up these with larger trials, where merited, that would

be modelled as far as possible on those made by the Medical Research Council on tuberculosis. The newly developed anti-tuberculosis drug, "Macrocydon" (noted earlier) is to be tried, once current toxicity tests in Britain of man, monkeys, rats and mice have indicated its safety at the contemplated therapeutic dosage.

Tuberculosis

East Africa

138. *Therapeutic trials in pulmonary tuberculosis.* Professor A. W. Williams, of the Faculty of Medicine, Makerere College, Kampala, has provided the following summary. The results in the first trial in 65 patients with acute bilateral pulmonary tuberculosis treated at Mulago Hospital with isoniazid in combination with streptomycin or with PAS, without collapse therapy, were reported by Hutton and others. A comparison between progress in these patients and in a similar group of British patients on the same treatment has also been reported by Fox and others. Both these well established regimes were satisfactory under African conditions, as judged by bacteriological and radiographic improvement at 24 weeks. The African and the British patients fared similarly on the same treatment. No drug resistance was demonstrated in the culture obtained during this 24-week period.

In a two-year follow-up now being made, results so far analysed underline the now accepted view that 6 months drug treatment is not enough to ensure arrest or maintain quiescence in disease of this severity. Strains of bacilli resistant to all three drugs appeared in the sputa of patients who deteriorated. Nevertheless, considering the short duration of chemotherapy, the survival and working capacity at two years of the patients in this series was good.

139. A cooperative investigation on a larger scale, coordinated from the Tuberculosis Research Unit of the Medical Research Council in London, was undertaken in 1956 to test whether diamino-diphenyl sulphone (DDS) with isoniazid was an effective combination in preventing the emergence of isoniazid resistance, or as judged by clinical and radiographic progress. Bacteriology for this investigation was undertaken at the Government Medical Laboratories at Dar es Salaam, Nairobi and Kampala in collaboration with Dr. Mitchison's Laboratory at Hammersmith; the hospitals taking part were the Infectious Diseases Hospitals at Nairobi and Dar es Salaam, the Port Reitz Chest Hospital, Mombasa, Kibongoto Tuberculosis Sanatorium in Tanganyika, and Mulago Hospital in Uganda. A total of 146 patients were admitted to this series, between March and October, 1956. An interim analysis of clinical and bacteriological data at 3 months showed no significant difference between the group having the DDS/isoniazid combination and the control group having PAS and isoniazid in regard to clinical progress. However it was already clear at 3 months that DDS did not prevent the emergence of isoniazid-resistant strains of tubercle bacilli. A final analysis of results at the end of 6 months treatment is being made.

A pilot trial to find out whether a full-scale investigation on similar lines of a combination of thiosemicarbazone and isoniazid would be worthwhile was undertaken early in 1957. The results are not yet available.

140. Plans are mature for an assessment of isoniazid alone, both in a conventional low dosage regime and in high dosage given with pyridoxine, compared with a combination of PAS and isoniazid as control, continued for one year. This investigation aims to study the attenuation of virulence and the catalase activity of isoniazid-resistant organisms in relation to clinical progress or deterioration; the capacity of individuals to inactivate isoniazid rapidly; the clinical effectiveness of high and low dosage of isoniazid;

the prevention of toxicity by pyridoxine; and the bearing of all these on the prevention and interpretation of drug resistance and on correct dosage. A further aim is to secure data on the results of chemotherapy given under controlled conditions for a full year.

Participation by a number of hospitals in Kenya, Tanganyika and Uganda, and by the Medical Laboratories at Dar es Salaam and Nairobi with assistance from Dr. Mitchison's Laboratory at Hammersmith, is assured. The investigation will be coordinated from the Tuberculosis Research Unit of the Medical Research Council, through the Department of Medicine (Professor Williams and Dr. Hutton) at Makerere College, Kampala. The cost will be borne jointly by the Medical Research Council of Great Britain, the Colonial Office and the E. African Council for Medical Research.

West Africa

141. The West African Tuberculosis Research Unit referred to in last year's Annual Report has made its headquarters at Kumasi, Ghana, where two hospital wards, an outpatient clinic and other facilities have been placed at the disposal of Dr. W. J. Bell, who directs the Unit, by the Chief Medical Officer of Ghana. Its work during the first year has been largely organisation of coordinated studies of the most pressing problems of pulmonary tuberculosis in West Africa, viz. therapy and epidemiology. It is planned to study the chemotherapy of pulmonary tuberculosis to determine the most effective regime of drugs against the background of local geographic and socio-economic conditions and disease types, and to attempt to assess the prevalence of the infection in West Africa, particularly at the outset in Ghana.

142. *Chemotherapy trials.* Resulting from a conference of tuberculosis physicians convened at Lagos by the West African Council for Medical Research, during the next 12-18 months differing drug regimes will be studied in various areas throughout West Africa in the hope that the most effective regime for the outpatient treatment of pulmonary tuberculosis in the West African will thereby be indicated. The function of the Unit will be to aid in the planning, co-ordination, conduct and final analysis of the experiment.

Adjuvant therapy with cortisone. The present paucity of thoracic surgical facilities in West Africa, and the difficulty of ensuring adequate chemotherapeutic cover over prolonged periods of time, suggest that methods of potentiating drug therapy merit study, and therefore the role of cortisone as an ancillary to a standard regime of chemotherapy in the acute forms of tuberculous pneumonia will be explored.

143. *Epidemiological studies.* It is intended to investigate the extent of overt pulmonary tuberculosis and the pattern of tuberculin conversion in Ghana by the use of tuberculin testing and mass radiography in sections of the population in urban and rural areas. Should there be evidence of the presence of a non-specific tuberculin reaction, its extent and cause would be sought.

Research at the Medical Research Council Laboratories, the Gambia

144. The Director, Dr. I. A. McGregor, has furnished a summary of the activities of the Laboratories during the year. Excerpts from it pertaining to malaria have been given in their appropriate context earlier in this Report (para. 48). Other activities are noted below.

145. Observations on the long-term therapeutic effects of Hetrazan in *W. bancrofti* infections so far indicate that the maximal effect of non-toxic dosage levels is not discernible until approximately two years have elapsed from the time of treatment. These results tend to support the hypothesis put

forward by McGregor and Gilles that Hetrazan exerts, at the time of administration, a lethal or sterilising effect on mature filaria worms. At Keneba observations on the bionomics of the prevalent anopheline mosquitoes and on the efficiency and duration of potency of the residual insecticides Dieldrin, B.H.C. and D.D.T. have been continued. Simple anopheline room-densities obtained by morning space-spray catches in houses treated with residual insecticide yield little information on the lethal properties of the insecticide. Attention has therefore been directed to the determination of the proportion of half-gravid and fully gravid mosquitoes present in these morning catches.

Collections made from artificial resting shelters of the type described by M. T. Gilles sited close to breeding places, in zones intermediate between breeding places and villages, and in villages, have yielded considerable numbers of blood-fed mosquitoes of the *Gambiae-Melas* complex capable of survival to egg laying. Collections made in similar shelters situated within villages the houses of which have been treated with residual insecticide have also yielded blood-fed and viable mosquitoes of the *Gambiae-Melas* complex. Information on whether the blood-hosts were man or animal is awaited.

146. In May, 1956, to determine the effects of control measures in practice against malaria, filariasis and trypanosomiasis, 582 Keneba villagers were examined clinically and their health state compared with that of 423 inhabitants of the neighbouring and untreated village of Jali. Analysis of results showed that:

- (a) mean haemoglobin values of all age-groups were higher in Keneba ; the differences between the values in children and adult females of the two villages were statistically significant.
- (b) the incidence of hepatomegaly in children was significantly lower in Keneba than in Jali.
- (c) the incidence in adult females of certain mucosal lesions attributable to the deficiency of vitamins of the "B" complex was significantly lower in Keneba than in Jali.
- (d) no significant difference in the mean heights and weights of children or in the mean weights of adults could be demonstrated.

It is considered that these improvements in the health state of Keneba inhabitants resulted principally from the reduction in the incidence of malaria achieved by the control measures practised in Keneba over the preceding six-year period.

147. In December a brief ophthalmological survey was made in several villages of the Gambian Protectorate by a member of the M.R.C. Trachoma Research Group assisted by Laboratories' personnel. Evidence of past or existing eye disease was detected in approximately 60 per cent. of subjects examined. A high incidence of a virus infection, probably trachoma, was found in children ; conjunctival scrapings from many of the cases revealed inclusion bodies.

148. Other visiting workers made a variety of studies during the year. Mr. S. R. Smithers investigated schistosomiasis. Dr. O. D. Standen and Dr. L. Goodwin made clinical trials of the activity of different piperazine salts in the treatment of ascaris infestations.

Publications

BERTRAM, D. S. and MCGREGOR, I. A.—(1956) "Catches in the Gambia, West Africa, of *Anopheles gambiae* Giles and *A. gambiae* var. *Melas* Theobald in entrance traps of a baited portable wooden hut with special reference to the effect of wind direction." *Bull. ent. Res.*, **47**, 669.

DEEGAN, T.—(1956) "Some properties of different types of haemoglobin 0.5N sodium carbonate solutions." *Ann. trop. Med. Parasit.*, **50**, 187.

Idem and MAEGRAITH, B. G.—(1956) "Studies on the nature of malaria pigment (haemozoin) II: The pigment of the human species, *Plasmodium falciparum* and *P. malariae*." *Ibid.*, **50**, 212.

Idem, GILLES, H. M. and MCGREGOR, I. A.—(1956) "Observations on the erythrocyte sedimentation rates and blood protein patterns of Gambian Africans." *Ibid.*, **50**, 451.

GILLES, H. M.—(1956) "The development of malaria infection in breast-fed Gambian infants." *Ibid.*, **51**, 1.

Idem and SCOTT, J. G.—(1956) "Serum iron levels in Gambian Adults." *Ibid.*, **50**, 103.

McFADZEAN, J. A. and HAWKING, F.—(1956) "The periodicity of microfilariae." *Trans. R. Soc. trop. Med. Hyg.*, **50**, 534.

Idem, McCOURT, J. F. and WILKINSON, A. E.—(1957) "Treponematosis in Gambia, West Africa." *Ibid.*, **51**, 169.

MCGREGOR, I. A., GILLES, H. M., WALTERS, J. H., DAVIES, A. H., and PEARSON, F. A.—(1956) "Effects of heavy and repeated malarial infections on Gambian infants and children." *Brit. med. J.*, **ii**, 686.

MINNING, W. and McFADZEAN, J. A.—(1956) "Serological investigations in an area of endemic filariasis due to *Wuchereria bancrofti* and *Acanthocheilonema perstans* in Gambia, West Africa." *Trans. R. Soc. trop. Med Hyg.*, **50**, 246.

WRIGHT, C. A., and SMITHERS, S. R.—(1956) "A new echinostome trematode, *Pameileenia gambiensis* gen. et sp. nov. from the intestine of a colubrid snake in West Africa." *J. Helminth.*, **30**, 113.

East African Medical Survey and Research Institute

149. At this Institute at Wwanza, Tanganyika (Director: Ds. E. G. Holmes); four main research projects are in progress, viz., nutrition, schistosomiasis (Mr. W. F. H. McClelland), relapsing fever (Dr. G. A. Walton), and medical survey work. The first three have been summarized earlier in this Report in their appropriate context, *vide* paras. 96-97, 28-31, and 92-93.

150. *Haematology*. Dr. A. R. Moore is investigating the white blood count of Africans. He has confirmed the observation that the distribution of the white cells differs from that regarded as "normal" in Europe and America, in the sense that there is a preponderance of lymphocytes over neutrophils. He has found that the pattern shifts during pregnancy, the distribution in pregnant women approximating more closely to the conventional "normal" pattern, although the increase in total white cells in pregnancy elsewhere is not noticeable among the women whom he has observed. It has been suggested that altitude has an effect on the white blood count (Mwanza is 3,700 feet above sea-level), and Dr. Moore is making further observations at sea-level and at 8,000 feet.

151. *Rufiji Valley Survey*. An investigation was carried out in the Rufiji Valley of Tanganyika to determine the general health conditions there. This was of particular interest in view of possible plans for extensive irrigation in that area. The Rufiji Valley is an isolated district, with very poor communications, both internally, and with the rest of the territory. The investigating units, Dr. Moore, Mr. Roberts and an African technician, found a very high incidence of scabies, hookworm and malaria. Gross malnutrition was not observed, though heights and weights were low, and the weights were low for heights, judged by the formula for insurance companies of

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Odier and Mach. Haemoglobin determinations suggested a fairly widespread anaemia, as would be expected from the high incidence of malaria and hookworm. In spite of the large amount of rice cultivation, little bilharzia was found.

Research on the biology of sandflies in East Africa

152. Mr. D. M. Minter, B.Sc., based on the laboratory of Dr. R. B. Heisch in Nairobi, has begun an investigation of the highly complex problem of the identification of the vector of the recent outbreak of kala-azar in the Kitui area of Kenya. He reports that sandflies have been intensively studied in field and laboratory, especially those species found in the two principal foci of kala-azar. Much information on the biology and behaviour of the local sandfly fauna resulted, but is still largely fragmentary. Strenuous attempts have been made to establish colonies of important species, with only partial success; some bred through from egg to adult, but none have reached the second generation despite the use of methods old and new. Most of the species clearly are more difficult to handle than those of the Middle East and India, a conclusion shared by Professor O. Theodor, of the Hebrew University, Jerusalem, who during a four-months' collaborative study in Kenya met with equally disappointing results.

153. A hopeful exception was a sandfly of the *Phlebotomus major* group, *P. guggisbergi*, that occurs in caves near Nairobi. First noticed in February, 1957, to enter houses and bite man readily, a large colony was discovered in a nearby small cave and is being studied intensively, since the species is unusually large and robust and markedly anthropophilic. It has been reared in the laboratory with little difficulty, except that emerging females are reluctant to feed on man or the usual laboratory rodents. Members of the "major" group are frequently vectors of kala-azar. One out of about 20 specimens showed an anterior infection after being fed on an infected hamster. Attempts to infect this species continue. Even though *P. guggisbergi* has not yet been found in the two main kala-azar areas it is very useful having a *major* group sandfly so near Nairobi. Work with it may provide clues leading to the discovery of the real vector.

Professor Theodor found conditions in kala-azar areas in Kenya very different from those in the Middle East. Few if any anthropophilic species behaved like potential vectors. It would appear that failure to trace the local vector and to breed sandflies in captivity has not been due to faulty techniques or the wrong approach; the kala-azar problem in Kenya is just an exceptionally difficult one.

The kala-azar foci will be searched for *P. guggisbergi* and other species of the *P. major* group. It is thought that *P. martini*, a sandfly of that group which occurred in both kala-azar areas, might be a possible transmitter, and attempts are now being made to test its vector potential.

Miscellaneous projects aided by small research grants

154. A number of small grants have been given for a miscellaneous range of problems to make possible study of some facet that might otherwise be neglected. 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 of the varied biopsy and autopsy material available to his laboratory. Thus a steady stream of material has been sent to the Imperial Cancer Research Fund Laboratories in London, and to pathologists at Chicago, Yale and Dakar relating respectively to trypanosomiasis culture, a study of cirrhosis and cancer of the liver, and studies on Kaposi sarcoma.

**RESEARCH WORK UNDERTAKEN AND FINANCED BY THE
MEDICAL DEPARTMENTS OF COLONIAL TERRITORIES**

155. The following is a summary of relevant information provided by Colonial Governments. It is not possible to include it in full in a necessarily restricted report of this nature; the summary is therefore confined to selected items that illustrate the fields of medical investigation that are being explored.

Kenya

156. In the Division of Insect-Borne Diseases of the Medical Department of Kenya Dr. R. B. Heisch and his colleagues continued work on the epidemiology of Kala-azar; *P. martini*, a possible vector, has been fed in small numbers of infected humans and hamsters, but none became infected; spleens of a number of animals, which included gerbils, were emulsified and inoculated into hamsters, to be examined in six months' time.

Rickettsiae of the *R. conori* type have been isolated from *Haemaphysalis leachi*, *Rhipicephalus simus* and *Amblyomma variegatum* collected in Nairobi. A guinea-pig inoculated with the emulsified brains of a rodent (*Otomys* sp) developed a scrotal reaction.

Schistosoma mansoni and *S. haematobium* have been isolated in hamsters brought in contact with cercariae from *Biomphalaria pfeifferi* and *Physopsis globosa*, the latter a host of *S. bovis*.

157. Filariasis was investigated on the Island of Pate near the northern part of the Kenya Coast. In a village 32 per cent. were infected with *W. bancrofti*. A *Wuchereria* of the *malayi*-type was found in cats, dogs and genet cats. The vector of the former was *Culex fatigans*, while the vector of the latter was *Aedes pempaensis* which breeds in crab-holes and lays its eggs on the meri of crabs (*Sesarma* sp.) Cats and dogs were also infected with *Dirofilaria repens* and *D. immitis*. The *Wuchereria* of cats and dogs, which is probably a new species, was not found in humans.

The vector position was clarified by feeding experiments; *A. pempaensis* were fed on an infected cat and the *Wuchereria* developed rapidly in this mosquito, 3rd stage larvae appearing in the head and proboscis on the 8th day; *W. bancrofti* reached the proboscis of *C. fatigans* on the 12th day; *W. bancrofti* would not develop in *A. pempaensis*; the *malayi*-type *Wuchereria* would not develop in *C. fatigans*.

The inhabitants of the infected village (1,500 persons) were given Hetrazan. This greatly reduced the number of microfilariae in the blood of infected individuals but the general infection rate (32 per cent.) remained about the same.

Federation of Malaya

158. The Director of the Institute for Medical Research, Kuala Lumpur, Dr. T. Wilson, has furnished a summary of its activities throughout the year. Excerpts from it pertaining to two projects, on filariasis and the animal-borne diseases of Malaya, to both of which Colonial Development and Welfare research funds contribute, have been given earlier in this Report.

159. *Malaria*. Observations on patients with proguanil-resistant strains of *Plasmodium falciparum* confirmed that the gametocytes of such strains may be resistant to the sterilising effect of the drug, and can develop normally in suitable mosquitoes to the sporozoite stage.

160. *Malayan strains of Plasmodium vivax*. Three strains of *P. vivax* from Malaya were taken to Chicago late in 1955 by Dr. A. S. Alving, and established there in volunteer patients. His results indicate that in their

behaviour and life-history these strains resemble the Chesson strain of *P. vivax* from New Guinea, with a short incubation period and short intervals between attacks. It seems probable that radical cure can be achieved by treatment with chloroquine, 1.5 g. of base in 3 days, combined with primaquine, 0.10-0.15 g. daily for 14 days.

161. *Parasitology*. Study No. 24 from the Institute was issued during the year, viz. "The microscopic diagnosis of human malaria Part 2", by J. W. Field and P. G. Shute. This Study is in effect a text-book on the morphology of malaria parasites as seen in thin blood films, with 24 plates in colour and 35 in monochrome. It has been reviewed very favourably.

162. *Entomology*. Much of the entomological work has been noted earlier in this Report, under filariasis and animal-borne viruses. The long-overdue revision of the Malayan culicine mosquitoes is in hand, in collaborative work by the Institute's Research Fellow in Entomology (Mr. W. W. Macdonald), the U.S. Army Medical Research Unit, Mr. D. H. Colless (University of Malaya) and Mr. P. F. Mattingly (British Museum).

Catches of *Anopheles 'leucosphyrus'* by the U.S. Unit in hill forest provided the opportunity to study the characteristics of the two forms, *A.l. leucosphyrus* and *A.l. balabacensis*, which are important vectors of malaria in Borneo and elsewhere. The same catches produced an anopheline, *A. annandalei*, not previously recorded in Malaya.

163. *Phlebotomus in Malaya*. The true sandflies, *Phlebotomus* species, have rarely been encountered in Malaya hitherto, and their frequent appearance in boxes set out as artificial daytime resting places for *Mansonia* mosquitoes therefore came as a surprise. Specimens were sent to the Commonwealth Institute of Entomology, and Dr. D. J. Lewis identified four different species, two present in Pahang, and three in Selangor; *P. argentipes* is regarded as the vector of kala-azar in India and Assam, but there is no indication that it is of public health importance in Malaya; precipitin tests on specimens containing blood showed that almost all had fed on buffaloes and cattle.

Study No. 27 from the Institute, "The transmission of malaria in Malaya," by E. P. Hodgkin, was published during the year. Knowledge of the status of the different vectors of malaria in Malaya is largely based on the 90,000 mosquito dissections recorded therein.

164. In the Division of Bacteriology work has continued on moulds. From one of many sent to Britain, an antibiotic has been derived and patented as "Actinonin." Salmonella infections comprise one quarter of the enteric-like diseases in Malaya; 38 species have been found in recent years associated with disease.

165. In the Division of Biochemistry and Nutrition a study was made of the haemoglobin levels of Indian workers on rubber estates to whom rice enriched with iron was being supplied in place of highly milled rice. The enriched rice also provided additional thiamine and niacin. The results have now been analysed, and no beneficial effect of the additional iron could be demonstrated.

At the request of the Veterinary Department, investigations were undertaken of the calcium, magnesium and phosphorus content of the blood of Malayan buffaloes and Kelantan cattle, designed primarily to examine the effect of various mineral dietary supplements on the health of the animals, in which degrees of hypocalcaemia and hypomagnesaemia had been found—the latter for the first time in Malaya.

Colonial
Pesticides Research Committee
Tenth Annual Report
(1956-1957)

Commonwealth Institute of Entomology,
British Museum (Natural History),
Cromwell Road,
London, S.W.7.

25th September, 1957.

SIR,

I have the honour to enclose herewith the Tenth Annual Report of the Colonial Pesticides Research Committee for the year 1956-1957.

I am,

Sir,

Your obedient Servant,

(Sgd) W. J. HALL,

Chairman.

The Right Honourable Alan Lennox-Boyd, 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*).
- PROFESSOR G. E. BLACKMAN, M.A., Department of Agriculture, University of Oxford.
- BRIGADIER P. J. L. CAPON, M.D., Director of Army Health, War Office.
- DR. J. CARMICHAEL, C.M.G., D.Sc., M.R.C.V.S., late Colonial Veterinary Service.
- MR. W. F. DAWSON, M.B.E., Secretary, Tsetse Fly and Trypanosomiasis Committee.
- PROFESSOR P. C. C. GARNHAM, M.D., D.Sc., D.P.H., Director of Department of Parasitology, London School of Hygiene and Tropical Medicine.
- MR. G. V. B. HERFORD, O.B.E., M.Sc., Pest Infestation Laboratory, Department of Scientific and Industrial Research.
- MR. A. S. G. HILL, B.Sc., F.Inst.P., Chemical Defence Experimental Establishment, Ministry of Supply.
- DR. J. C. F. HOPKINS, D.Sc., A.I.C.T.A., Director, Commonwealth Mycological Institute.
- DR. H. G. H. KEARNS, 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.
- PROFESSOR J. W. MUNRO, C.B.E., M.A., D.Sc., Imperial College of Science and Technology.
- 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.

Ex-Officio Members

The Secretary of State's Medical, Agricultural, Animal Health and Forestry Advisers.

MR. C. A. KIRKMAN (*Secretary*).

MR. K. WILSON-JONES, M.Sc. (*Scientific Secretary*).

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.
- 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.
- SIR ERIC PRIDIE, K.C.M.G., D.S.O., O.B.E., F.R.C.P., Chief Medical Officer, Colonial Office.
- MR. R. MOWFORTH (*Secretary*).

SUB-COMMITTEE ON METHODS OF APPLICATION

- DR. H. G. H. KEARNS, 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, Ministry of Supply.
- DR. A. B. HADAWAY, D.I.C., Ph.D., Colonial Insecticides 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 Insecticides Research Unit, Porton.
- MR. E. R. HOARE, B.Sc., A.M.I.E.E., National Institute of Agricultural Engineering.
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- MR. C. A. KIRKMAN, Secretary, Colonial Pesticides Research Committee.
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MR. C. A. KIRKMAN (*Secretary*).

The Officer-in-Charge, Colonial Pesticides Research, the Scientific Secretary, and the Secretary of the Committee are ex-officio members of all sub-committees.

COLONIAL PESTICIDES RESEARCH COMMITTEE]

TENTH ANNUAL REPORT

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COLONIAL PESTICIDES RESEARCH COMMITTEE TENTH ANNUAL REPORT

PART I. GENERAL

1. A new joint sub-committee, called the Crop Protection Sub-Committee, has been set up with the Committee for Colonial Agriculture, Animal Health and Forestry Research, to study problems of mutual interest and to refer them to the main Committee considered most appropriate to deal with them. Membership of the new joint sub-committee consists of those who are already members of both Main Committees. The old Fungicide Sub-Committee has now been disbanded and its remaining functions taken over by the Crop Protection Sub-Committee.

2. Two meetings (Nos. 31 and 32) of the Main Committee were held during the year. Sub-committees met as follows:—Insect Vectors of Disease Sub-Committee, 3 meetings; Methods of Application Sub-Committee, 1 meeting; Crop Protection Sub-Committee, 2 meetings.

3. The following resignations from the Main Committee have taken place: the late Professor Sir John L. Simonsen, Dr. S. P. Wiltshire. The following appointment to the Main Committee has been made:—Dr. J. C. F. Hopkins.

4. On the sub-committees, Mr. G. H. E. Hopkins has resigned from the Insect Vectors of Disease Sub-Committee and Dr. S. P. Wiltshire has been succeeded on the Crop Protection Sub-Committee by Dr. J. C. F. Hopkins. The membership of the Main Committee and Sub-Committees as at 31st March, 1957, is shown at the beginning of this Report.

5. *Staff.* One mycologist (Mr. H. C. Hislop) and two chemists (Messrs. P. O. Park and M. A. Vickars) were appointed during the year to the Arusha Unit. Mr. J. A. Armstrong, Entomologist, from C.P.R.U., Arusha, visited Nigeria between July and November, 1956, to study the resistance of *Anopheles gambiae* to dieldrin in that country. Mr. G. F. Burnett, Entomologist, of C.P.R.U., Arusha, proceeded to Fiji in November, 1956, on secondment to take charge of the control of Filariasis Vectors. Mr. C. B. Symes, Entomologist, retired from Fiji in December, 1956. Mr. K. S. McKinlay, Entomologist, of C.P.R.U., Arusha, was on duty at the Swaziland Irrigation Scheme investigating problems of rice pests, from July, 1956, to April, 1957. Dr. G. W. Ivens, Botanist, of C.P.R.U., Arusha, visited Sierra Leone during his leave in March–May, 1956, to carry out arboricide experiments against the Mangroves, *Rhizophora* and *Avicennia* spp. Mr. R. T. Jarman, Physicist, C.P.R.U., Porton, visited the Sudan for microclimatic studies at the request of the Sudan Government during October, 1956–April, 1957, and paid a short visit to C.P.R.U., Arusha.

PART II. REVIEW OF RESEARCH WORK

Colonial Insecticides Research Unit, Porton

(Dr. A. B. Hadaway in charge)

6. *Susceptibility of Mosquito Larvae to Insecticides.* Experiments to study the effect of age on the vulnerability of mosquito larvae have been carried out. Some discrepancies were observed in the reactions of the larvae to DDT and dieldrin, probably because DDT is slightly less soluble in water than dieldrin. The third instar is considered to be the most satisfactory larval stage to adopt for standardising susceptibility tests, since only a relatively short exposure period (24 hours) is involved and a "recovery" interval is not needed. Other factors whose effects were examined were the proportion of insecticide solvent in the test medium, and the numbers of larvae per unit volume.

7. *Sorption of Insecticides by Soils.* Further aspects of this subject have been examined during the past year. It has been shown that:—(a) Repeated sprayings do not affect the sorption rate:—successive monthly applications of DDT and dieldrin at the rate of 100 mg/sq. ft. were sorbed at the same rate as the original application. (b) The loss of insecticide by chemical decomposition is not a significant factor:—dieldrin and lindane can be recovered quantitatively after sorption. (c) Increase of temperature accelerates the sorption of DDT and dieldrin; the inverse proportionality between relative humidity and sorption rate holds for all active soils so far examined. (d) A new commercial wettable powder formulation of dieldrin gives a much better residual action on active soils than the standard wettable powder.

8. *Persistence of Insecticides on the Surfaces of Various Materials.* A preliminary investigation has been made of the properties of residual DDT and dieldrin on some surfaces, other than dry soils, which are used in house construction. Bamboo, palm leaf and wood were compared with glass as a standard surface. Over six months there were negligible losses of DDT while dieldrin was reduced by about 60 per cent. due to evaporation. The only difference between the surface deposits was that from a given amount of both DDT and dieldrin about 40 per cent. was lost during the initial spraying by penetration of the spray particles between the loose fibres of which the wood was composed.

9. *Environmental Condition.* Environmental conditions, especially atmospheric humidity, have been shown to affect the distribution, and therefore the availability, of insecticides sorbed by some dried soils. It has also been shown that the effectiveness of a given dosage of insecticide is influenced by the post-treatment temperature. Before proceeding with experiments to determine the effect of the pre-treatment temperature on the susceptibility of insects to insecticides it was necessary to investigate any change in susceptibility with the age and nutritional status of the insects.

10. *Organic-Phosphorus Insecticides.* A number of phosphorus insecticides with a comparatively low degree of mammalian toxicity have become available, and the relative toxicities of three of them to houseflies and certain mosquito species have been determined. Diazinon, chlorthion and malathion were used in kerosene solutions. Median lethal doses for female houseflies were 0.077, 0.33 and 0.77 μg per fly respectively. Relative toxicities to mosquitoes varied considerably from one species to another. Thus, chlorthion was more toxic than diazinon to two culicines, *Aedes aegypti* and *Culex molestus*, whereas diazinon was more toxic than chlorthion to two anophelines, *Anopheles stephensi* and *A. quadrimaculatus*.

11. *Application of Molluscicides.* The following devices for controlling the rate of addition of molluscicides to water have been tried. (a) Briquettes made from a mixture of cement or plaster and the molluscicide. Their main disadvantage was that if the hardening properties of the carrier were not to be affected the percentage of molluscicide had to be kept low. This especially applied to an alkaline material like sodium pentachlorophenate. (b) Pellets made from the molluscicide bound with a thermosetting resin. These were easily made and were stable in water but the leaching rate of the chemical was dependent upon the concentration left in the pellet and therefore decreased with time. (c) Films of plastic separating the molluscicide from the water. These appear promising as their action in controlling leaching should be independent of concentration although the films so far tested have either been too porous or not porous enough.

12. *Wind Tunnel Studies.* The efficiency of droplet collection by some isolated spheres and a cascade impactor has been measured in a wind tunnel.

using droplets varying from 50 to 160 microns in diameter in winds ranging from 3 to 5 metres per second. The collection efficiencies of spheres were found to be similar to those computed by Langmuir and Blodgett, and the collection efficiency of the cascade impactor was found to be 70 ± 10 per cent. (CIRU/Porton/Report No. 119). Similar wind tunnel studies on the collection efficiency of various materials used for sampling sprays (e.g. siliconed glass plates, magnesium oxide coated glass plates, and filter papers) are being made.

13. *Performance of Spray Installations on Aircraft.* In an attempt to obtain finer sprays of insecticide than were given by the standard Auster equipment a new boom and nozzle type of equipment for aircraft use has been designed, manufactured and fitted to the aircraft. A description of the apparatus and the results of the assessment trials have been issued under CIRU/Porton/Report No. 124. A number of modifications have been incorporated in this aircraft to enable rotary spray devices to be assessed. A new type of rotary atomiser in the form of a wire gauze cylinder has been produced for use on aircraft by Messrs. Britten-Norman Ltd. A pair of these atomisers mounted on the lower wing tips of a DH Tiger Moth have been tested and found to produce a spray of droplets having a volume median diameter of 50 microns when spraying at the rate of 6 gallons per minute at an aircraft speed of 65 knots. The apparatus and the results of assessment trials with it have been described in CIRU/Porton/Report No. 125.

Imperial College Field Station, Silwood Park

14. *Olfaction in Insects.* Two promising new variations in olfactometric technique, concerned with the investigation of transient and prolonged stimuli respectively have been developed. The first consists of injecting brief pulses of odorous vapour of known concentration into the air flowing over an insect in a small tunnel. The intensity of response is noted for time of exposure and concentration. The other device, for examining the effect of prolonged exposures, is in effect a simplified choice chamber. It consists of a perforated partition leading into a narrow insect cage by means of a conical wind tunnel. The partition incorporates four removable perforated discs from which the stimulant evaporates at a constant rate into the airstream; the rate of evaporation of a formulation may be varied by partially masking discs with varnish. The use of such discs to provide controlled concentrations of vapour is a considerable simplification of the previous method which involved the use of multiple saturator and mixer circuits.

15. *Mode of Action of Insecticides.* Experiments are in progress on the absorption of hexadecane by blowflies and the effect of emulsifying agents on its subsequent translocation in the tissues. The hexadecane contained 1 per cent. of hexadecene with which radioactive iodine can be combined to allow of the detection of very small quantities.

Rothamsted Experimental Station

16. *Evaporation of Insecticides.* The rate of evaporation of insecticide deposits on glass plates has been measured in a wind tunnel constructed for this purpose. It is evident that the decay of deposits from both emulsions and suspensions of DDT is linear with time during the greater part of the life of the deposit. Two resins (Arochlor 5460 and Coumarone-Indene) added with a view to prolonging the life of the deposit actually caused a significant increase in the rate of loss of DDT.

17. *Toxicity of Emulsion Films.* Measurements have been made of the contact toxicity of deposits on glass plates (plain or wax coated) using a perspex cell in which houseflies are caused to walk over the insecticide deposit.

**Agricultural Research Council Unit of Experimental Agronomy,
Oxford**

18. *Field Studies.* Work has again been concentrated on field experiments with MCPB (4-chloro-2-methylphenoxybutyric acid) and 2,4-DB(4-(2,4-dichlorophenoxy) butyric acid) and, to a lesser extent, with dalapon (2,2-dichloropropionic acid), 3-amino-1,2,4-triazole and simazin (2, chloro-4-6-bis(ethaylamono)-S-triazinine). A small scale "logarithmic" sprayer has also been constructed.

19. *Laboratory and Greenhouse Studies.* Simazin was one of the most promising of about 20 new herbicides investigated for selectivity in greenhouse pot culture studies. The use of mixtures of substituted phenoxyacetic and phenoxybutyric herbicides in the control of mixed weed stands is being studied. Attempts are being made to propagate *Striga hermonthica* in the new greenhouse with a view to testing its susceptibility to various herbicides.

Studies of the phytotoxic and selectivity factors of herbicides have continued. It is found that under some conditions selective herbicidal action is influenced by differential spray retention. The absorption and elimination of 2,4-D by *Salvinia natans* and *Lemna minor* has been followed using radioactive tracer techniques. The translocation of substituted phenoxyacetic acids in excised segments of petioles and stems is being investigated.

Work on the physiological action of N,N-dimethyl-N¹-phenylurea (fenuron) and other substituted ureas, on the toxic action of nitrophenols to higher plants and on the identity of the metabolite found in plant material after indolyacetic acid (I.A.A.) treatment is in progress.

Attempts have been made to isolate the abscission-inducing factor discovered in senescent leaves.

Long Ashton Research Station

20. *Banana Leaf Spot.* A technique which supersedes the "mist application" used in Jamaica has been evolved for controlling leaf spot disease of Lacatan bananas. It comprises protecting the undersides of the freshly opened pair of top leaves by fortnightly sprayings with a copper fungicide, using lance and nozzles specially designed for this purpose. Complete coverage of the leaf surface, which is essential, can be obtained by adding a small quantity of wetting agent.

21. *Equipment.* Further improvements in equipment have been made: (a) the 80 cc small power spray machine, modified with a commercially developed centrifugal pump, is now considered more reliable. It is well suited for hard usage by unskilled labour and adaptable to many uses in the tropics. (b) More interchangeable parts, which permit a choice of swirl and fan spray patterns with a range of throughputs and droplet sizes are available for use in conjunction with the $\frac{1}{4}$ " Long Ashton spray nozzle. (c) A light-weight spray lance with a new type of trigger tap has been designed for numerous duties including mosquito control and tobacco spraying. (d) A small spray pistol for laboratory studies has been designed. It is operated by air from a reciprocating compressor and simulates the application of droplets by large "mist blower" sprayers.

22. *Spraying of Coffee.* Preliminary assay of spray deposits on *arabica* coffee showed considerable differences from those obtained on banana leaves. It is anticipated that further work will provide useful data for the efficient spraying of coffee.

Colonial Pesticides Research Unit, East Africa

(K. S. Hocking in charge)

23. *Experiments on Tsetse.* The Galapo experimental block of woodland was largely cut down in July/August, 1956, and observations have now been discontinued. This experiment has run for five and a half years and during the whole of this time the apparent densities on the hillside control have been about three hundred times those in the treated block. Another site of approximately 24 square miles near Chungai in the central province of Tanganyika is being surveyed as a preliminary to future field experiments. Reports have been issued on the susceptibility of tsetse flies and on the colony of *Glossina morsitans* which is being maintained as single tube cultures.

24. *Experiments on Mosquitoes.* On the Taveta Pare Scheme the second spraying cycle was completed in June, 1956, and the third cycle in March, 1957. The malaria parasite rate in young children and the vector mosquito house catches are very low now, although outside resting populations of *Anopheles gambiae* are still quite considerable. So far there is no evidence of any resistance to dieldrin developing, although it is now 18 months since the first applications were made. The sample paper technique is being retained for chemical assessments, in spite of its considerable disadvantages.

Dr. Armstrong, the entomologist principally concerned with resistance studies, carried out a survey of the pilot project and the extension zone of the Western Sokoto Malaria Control Scheme in Northern Nigeria, in September/October, 1956. In both BHC and dieldrin treated zones resistance to dieldrin had developed, even though one area had only been treated with BHC for two months. No indication was found of DDT resistance. Extension of the survey to include Sokoto Town and Kano City showed the existence of dieldrin resistant *A. gambiae* in both places, although neither of these areas had been given systematic insecticide treatment. Further extension of the survey to Southern Nigeria, which included Yaba and Ilaro, showed no indication of dieldrin resistance, despite the latter town having been included in a Malaria Control Scheme using BHC between 1949-53.

During April-June, 1956, an attempt was made at Dar-es-Salaam to prevent the seasonal increase in anopheline population which accompanies the long rains. Using aircraft, granules containing 2 per cent. w/w dieldrin were applied at a rate of 1 lb. per acre to the large seasonal breeding sites within the township; about five thousand acres were treated seven times during a period of approximately nine weeks, using 17 tons of granules. The experiment was carried out jointly with the East African Institute of Malaria and Vector-borne diseases, the Tanganyika Medical Department and the Medical Officer of Health, Dar-es-Salaam. During and immediately after the experiment no appreciable breeding of anophelines could be found in the treated sites, though the results as evidenced by house catches of mosquitoes were not so clearly apparent.

Preliminary investigations have been made into the possibility of carrying out field trials using the new formulations which are not sorbed by mud walls so readily as the older ones. Samples of the muds involved have been sent to C.I.R.U. Porton for assessment of their sorptive capacity.

During early 1957 intensive surveys have been made in various regions, including the Taveta-Pare area and Zanzibar in attempts to find insecticide-resistant individuals. In Taveta-Pare no resistance was found and in Zanzibar *A. gambiae* had the same susceptibility to DDT as in Tanga, but it was more susceptible to dieldrin and gamma BHC.

25. *Insect Pests of Cotton.* At Urambo an investigation of the possibilities of cotton as a cash crop is being carried out by the Tanganyika Agricultural Corporation. Concurrent tests were carried out using insecticides to protect the crop from the heavy infestations of bollworm (*Heliothis armigera*) and stainers (*Calidea*). It was found that successful control could be obtained by weekly sprayings of DDT at 1 lb. per acre with the addition of BHC at $\frac{1}{4}$ lb. per acre when necessary for aphid control. In spite of the heavy use of insecticides, the yields obtained (approximately 1,500 lbs. of seed cotton per acre) should be profitable. A report has been circulated.

The persistence of DDT and endrin on cotton leaves was also investigated at Urambo. Both insecticides were applied as emulsifiable concentrates. The disappearance of insecticide with time was followed by chemical methods, and regression equations for the loss of both these compounds have been calculated. The regression equations express the total residue loss, but it is probable that crop growth, by spreading the insecticide over a larger leaf area, caused greater reduction of deposit than did the weathering.

26. *Maize Stalk Borer.* A report has been issued on trials to date. There is little difference in the control obtained using sprays or dusts at equivalent rates of application, but so far endrin has proved the most powerful insecticide tried. Observations on the bionomics of *Busseola* and in particular on the correlation between rainfall and stalk borer infestation have continued. Chemical assessments have been made on the initial deposits of DDT and endrin required per plant for satisfactory stalk borer control.

27. *Miscellaneous Agricultural Pests.* Control of bean fly, *Agromyza* (*Melanagromyza*) *phaseoli*, has been obtained using seed dressings. The seeds were treated with small quantities of emulsifiable concentrates of aldrin, endrin and dieldrin which decreased germination to some extent and offered protection to the seedling for up to four weeks after germination. The rate of dressing was approximately 0.2 lbs. of active ingredient per hundred pounds of seed. Dry dressings likewise gave some protection. Studies have also been made of cerambycid borers of kapok and citrus in the Tanga area and of sugar cane borers.

The distribution obtained with spraying DDT to protect coffee trees against *Antestiopsis lineaticollis* Stal. has been investigated and a correlation between the deposits obtained on leaves and on sample papers is being worked out. A persistence study of DDT residue on coffee leaves is still in progress.

Investigations were carried out by Mr. McKinley at the request of the Colonial Development Corporation on means of controlling rice pests on the Swaziland Irrigation Scheme. A full report is in course of preparation. The principal pests of rice are the leaf beetle, *Trichispa sericea*, and two stalk borers, *Ampycodes pallidicosta* (Lepidoptera) and a diopsid fly. In addition studies were made on red (Sudan) and other bollworms, stainers, aphids and red spider of cotton under Swaziland conditions; on citrus scales; and on stalk borer and cutworms of maize.

In chemical studies, it was found that no vertical movement of aldrin occurred in irrigated soil over a four-month period. A simple apparatus which will simulate rainfall has been constructed from a design by Pereira; with this it is hoped to conduct leaching studies.

28. *Fungicides.* The Plant Pathologist commenced duties at Atusha during October, 1956.

29. *Herbicides.* A wide range of trees and shrubs which are undesirable in grazing land and in tsetse clearing operations has been covered in arboricide trials started in 1954 and 1955. Further trials have been started chiefly with

2, 4-D and 2, 4, 5-T against *Tarhonanthus camphoratus* (Leleshwa) and *Euclea divinorum* in Kenya and *Dichrostachys glomerata*, *Acacia zanzibaria* and *Lippia* sp. (sagebush) in Tanganyika.

The control of weed growth in maize is being investigated using "Simazin" (2 chloro-4, 6-bis ethylamino-S-triazine). Other experiments are planned on pyrethrum, coffee and sisal.

Preliminary trials have shown that *Eichornia crassipes* here as elsewhere is susceptible to 2, 4-D at about 2 lb./acre but it is extremely doubtful whether complete eradication can be achieved. Trials on *Pistia stratiotes* (Nile cabbage) are also to be undertaken.

30. *Miscellaneous*. Investigations on the performance of boom-and-nozzle systems on aircraft have continued. 1,769 samples were analysed for residues during the six months ending March, 1957.

Biting Fly Research Unit, Uganda

31. *Laboratory studies*. Facilities for entomological research have been extended and a laboratory colony of *Stomoxys calcitrans* has been established. Experiments are planned to determine the effect of temperature and humidity on its life cycle, egg laying activities and behaviour and to determine the median lethal dose values for various insecticides against adults and larvae.

Passaging of *Trypanosoma congolense* through rats has continued. It appears likely that biting flies of the group *Tabanidae* (e.g. *Haematopota brucei*) are responsible for the mechanical transmission of animal trypanosomiasis, since no evidence of this by *S. calcitrans* has been forthcoming.

32. *Field Investigations*. Numerous field investigations have been carried out in various parts of the territory including N. Busoga, Tororo, Kitale and Kawanda to study the breeding habits of the fly. More detailed bionomic studies are required and a permanent camp is being set up for this purpose in Bukomero.

Filariasis Research, Fiji

33. *Field experiments*. Residual sprays of DDT and dieldrin have given satisfactory control of mosquitoes resting in houses. Experiments being carried out at Makogai (island leper colony) in the control of vectors by sanitary measures have indicated that overlooking a very few breeding grounds can result in considerable localised infestations. The original sites surveyed for larger-scale experiments have proved unsuitable and others, where filarial transmission is higher, are being sought. Information is being collected to compare infection rates in mosquitoes caught in villages, gardens, bush, etc., to determine the potential infection range of the vectors *Aedes pseudoscutellaris* and *A. polynesiensis*. Sampling of mammal and bird blood continues, in search of micro-filariae which might confuse the identification of *bancrofti* vectors.

34. *Laboratory studies*. In transmission experiments, high infection rates (75/80 per cent.) were obtained with *A. polynesiensis* Marks. in feeding experiments. Attempts to feed *A. horrescens* on human blood or to infect *A. polynesiensis* and *A. fijiensis* Marks. on fruit bats were without success.

A start has been made on assessing the susceptibility of local vectors to insecticides using the modified Busvine-Nash technique for adults and using larval tests on Wharton's method (running acetone solutions into water and exposing 4th stage larvae for 20 hrs.) Results to date denote

some natural resistance in *A. pseudoscutellaris* to DDT. Work has been started on the settling time on treated surfaces of *A. fijiensis* and *Culex fatigans* in an attempt to assist the choice of insecticides for house spraying.

Western Sokoto Malaria Control Pilot Project

(D. M. Langbridge, Chemist)

35. *Persistence of Insecticides on Mud Surfaces.* An experiment has been designed to evaluate the effect of humidity on residual insecticides sprayed on mud walls. Blocks, prepared from local muds, ex. Birnin Kebbi, Argungu and Yaba respectively, are being stored at Kano and Lagos under humid conditions prior to spraying with insecticide. It is anticipated that reproducible dosage rates will be obtained by using an "endless belt machine", at present being constructed.

36. *Surface Sampling Methods.* An improved technique for sampling insecticide deposits on mud surfaces has been evolved. Previous methods relied upon the use of parchment paper (Alessandrini method) or spirit soluble adhesive (Barlow method). The present method employs a water soluble gum which, being insoluble in acetone and hydrocarbon solvents used to extract the deposit, will not interfere in the subsequent analysis. A solution containing 2 parts by weight of gum to one part by weight of water is spread thinly on a known area of non-absorbent paper. When the gum is on the point of setting the paper is pressed firmly to the surface and then removed after the gum has dried. The insecticide is extracted by washing with suitable solvents. Preliminary test results are in good agreement with the Barlow method.

The Imperial College of Tropical Agriculture, Trinidad

37. *Herbicide studies.* Weeds of rice cultivation are being collected and identified as a preliminary to larger scale control studies. Experiments are in progress to determine the effect of 2,4-D, DNBP, AMIZOL, TCA and a mixture of 2,4-D and DNBP sprayed post-emergence on *Fimbristylis miliacea* and *Sphenocles zeylanica*.

38. Box trials have been arranged to determine the response of maize, soya bean and groundnut to pre-emergence and post-emergence applications of MCPB. The response of yams to pre-emergence and post-emergence applications of a number of different herbicides is being studied. It has been found possible to stimulate the germination of yams with ethylene chlorhydrin.

Coconut Pest Research, Zanzibar

39. *Control of Pseudothrips wayi.* Effective economical control of *Pseudothrips wayi* on the 100 acre experimental plot at Kidichi/Mdo has been obtained with 10 DRDK formulation. The latter consists of about 10 per cent. DDT with 1 per cent. Coumarone Indene Resin dissolved in a mixed aromatic petroleum solvent. Applications were made with the Long Ashton Mist Blower and the rate, at first 1½ gallons per acre, was later reduced to 1 gallon per acre following modifications to the atomiser. Treatment every 2 or 3 months was necessary because of re-invasion by adult *Pseudothrips wayi*, and the growth of new inflorescences. It is estimated that about 90 per cent. by volume of the insecticide was present as particles between 70 and 90 microns diameter. The effectiveness of treatment was assessed in terms of the numbers of neanides found and the Vidaka Damage Rate, compared with the untreated control plot at Dole/Mdo. The total cost of spraying a 1 gallon per acre is estimated at under 10s. 0d. per acre.

PART III. PESTICIDES RESEARCH NOT UNDER THE AEGIS OF THE COMMITTEE

40. The Committee wishes to draw attention to some of the research which is being done in the Colonies without the assistance of the Committee. The following notes cover only those projects considered by Colonial authorities to be of special interest. Much other work is going on.

Aden

41. *Agriculture*. Insecticides. A preliminary survey has been carried out on the relative importance of the various pests of cotton. Sudan bollworm (*Diparopsis perditor*), first recorded in Abyan in 1952, has now become widespread throughout the delta and study and control of it is a first priority in the entomology programme. Insecticide trials have been initiated for the control of the cotton pest complex.

Barbados

42. *Agriculture*. Some measure of control was achieved in trials testing the effect of different insecticides on the sugar cane root mealy bug. Residual effects were also measured.

Bermuda

43. *Agriculture*. Experiments have been conducted during the course of the year in an effort to find suitable control methods for a variety of weeds. The land crab is of considerable importance in Bermuda, since tunnels made by the crabs ruin lawn areas and gardens and the crabs themselves cause damage by feeding on a variety of plants. Two baits showed excellent promise. Wild onion, *Northoscordum fragrans*, was effectively controlled by two applications, six months apart, of 2 per cent. aqueous Kuron (propyleneglycol butyl ether esters of 2-(2, 4, 5 trichlorophenoxy) propionic acid, 64.5 per cent). Kuron and sodium chlorate have been used very successfully against *Oxalis* spp.—kuron at 1 and 2 per cent. and sodium chlorate at the rate of 1 lb. per gallon of water. Sodium chlorate shows excellent promise as a means of controlling wire weed, *Sida carpinifolia*, which is very troublesome in local pasture lands.

British Solomon Islands Protectorate

44. *Agriculture*. Insecticides. Premature nutfall of coconuts in the British Solomon Islands is caused by the Coreid bug *Amblypelta cocophaga*. An account of this work is given in the Annual Report of the Committee for Agriculture, Animal Health and Forestry Research.

Cyprus

45. *Agriculture*. Insecticides. Experiments on control of Mediterranean Fruit Fly (*Ceratitis capitata*) begun in 1955, were continued and valuable information was obtained on the effectiveness of various concentrations of dieldrin. Further work with poison bait sprays containing protein hydrolysate showed that these sprays are effective against Mediterranean Fruit Fly when applied to large plots of trees.

Fungicides. In experiments on control of Olive Leaf Spot (*Cycloconium oleaginum*) using 10-1-100 Bordeaux mixture, one treatment reduced the incidence of the disease by 92 per cent. The indications are that a second treatment may not be necessary except in years of abundant rainfall.

Kenya

46. *Agricultural*. Insecticides. Experiments on the control of the larvae of *Leucoptera coffeella* Guer and *L. coffeina* Washb. in their mines have

continued. Diazinon has proved to be the most efficient insecticide so far tested. Dieldrin spray-banding proved its worth against *Anthores leuconotus* Pasè in the experiment mentioned in the 1955 report; the method will therefore be adopted for routine control of White Borer in coffee.

Coffee Berry Disease. Techniques for the study of the fungus and the disease under controlled conditions have been developed. Studies of the infection process, and its relation to both host variety and climatic factors are almost complete. As regards the distribution of the disease, there is evidence that it is increasing in hitherto free areas and at a lower altitude than previously recorded.

47. *Medical*. Bilharzia. Investigations into the probable vector responsible for the transmission of *Schistosoma mansoni* have been made in the Central Province area. Further investigations using the newer chemicals have been carried out in the field with a view to controlling the snail population.

Malaya

48. *Agricultural*. Insecticides. A new infestation of scale insects on *Hibiscus* sp. was killed by repeating six times at weekly intervals a treatment consisting of spraying with dieldrin and then three days later with Nicotox. Dieldrin and Gammexane continued to be used effectively against various crop defoliators. In one experiment on control of Rice Stem Borers, spraying with DDT at two weekly intervals resulted in a yield increase of 80 per cent.

Herbicides. Small-scale experiments were carried out on secondary growth at the Forest Research Institute to find a non-toxic arboricide that can replace sodium arsenite. Interim results indicate that water-borne emulsions of 2, 4, 5-T and 2, 4-D butyl esters applied to a frill girdle are ineffective in strengths which are economic to use. Nothing less than 5 per cent. 2, 4, 5-T in diesel oil has been found effective as a contact spray.

Mauritius

49. *Agricultural*. Fungicides. Further trials were made, utilizing an anti-biotic (Agrimycin—100) to effect control of bacterial wilt, especially the potato and tomato. Results so far have been inconclusive.

Nigeria

50. *Agricultural*. Insecticides. Following the results obtained by the use of BHC in 1955-56 cacao season, the West African Cacao Research Institute took over the main programme of capsid control experiments in Nigeria, namely the testing of the various rates and frequencies of application of BHC.

The reduction of infestation of groundnuts by *Trogoderma granarium* Everts has been proceeding very satisfactorily by routine fumigation. Several insecticides have been examined with a view to eliminating this pest from storage premises. Pilot scale tests are in progress.

Fungicides. The control of Blackpod disease has become a routine practice on many cocoa farms, particularly in Ondo Province. Investigation of the relative merits of proprietary fungicides is being carried out where it seems likely that a saving in cost or an increase in efficiency is probable.

Northern Rhodesia

51. *Agricultural*. Insecticides. In the area of Mulungushi sprayed against tsetse fly in 1954 with BHC in dieseline and left untreated in 1955, a very low density of *Glossina morsitans* persisted throughout 1956. Further treatment with BHC/dieseline aerosol was applied during 1956 to limited areas in which fly had been found, no conclusive result being apparent by the end of the year. The experiment has established that the threshold value of fly density,

as revealed by normal catching methods, which is necessary for the persistence of a *G. morsitans* population, is very much lower than had been anticipated.

At Chingola an area of 200 square miles of fly-infested country was subjected to discriminative clearing from 1953 to 1955, at the end of which year the residual infested area of 25 square miles was treated with BHC/dieseline aerosol, with a resultant 99 per cent. reduction in fly. A light infestation persisted in 1956, the limited areas in which fly were being caught being again treated by TIFA. Since July only one fly has been caught throughout the whole region and there is hope that the infestation has been successfully eradicated. It is an interesting point that the limited amount of game in the area has actually increased since operations started in 1953, due to the presence of control staff. It appears that the different response of the Chinola fly population from that experienced with the same treatment at Mulungushi is due to the different ecological, and particularly vegetational, factors which characterise the two regions.

Herbicides. Little success has yet been achieved with the use of 2, 4, 5-T as an arboricide, either basally sprayed or when applied to cut stumps to prevent regeneration. Towards the end of the year a new series of arboricide experiments were started in the Zambesi Valley in connection with the Kariba resettlement tsetse control scheme, using 2, 4, 5-T Ammate and CMU with varying concentrations, dosages and modes of application.

Sierra Leone

52. *Agricultural.* Fungicides. Preliminary trials were carried out with Carbide Bordeaux and Perepod to control "Black Pod" disease of cacao. Both sprays showed some effect with spraying intervals up to one month. *Mycosphaerella musicola*, the leaf spot disease of banana, which was suspected as occurring in Sierra Leone in 1955, was confirmed.

Herbicides. Arboricide trials are laid down on the Scarries areas, on the use of chemicals to kill *Rhizophora* and *Avicennia* mangroves and the grass *Raspalum vaginatum*.

Tanganyika

53. *Agriculture.* Insecticides. As a means of protecting young eucalyptus from termites several insecticides were tested by sprinkling them into the soil at the time of planting. Aldrin and gamma-BHC were the most effective, and gave adequate protection for at least a year, at a cost of about fifteen shillings an acre. Thorough mixing of the insecticide with the soil was found to be as important a factor as the amount used.

Research on white coffee borer, *Anthores leuconotus* Pasc., has now ceased as satisfactory measures for control using 0.5 per cent. dieldrin have been worked out. Work to determine losses due to leaf miners, *Leucoptera coffeella* (Guer) and *L. coffeina* Washbn., is planned. Endrin is proving promising for the control of Coffee Berry Borer, *Stephanoderes hampei* (Fern) in Bukoba.

The control of maize stalk borer (*Busseola fusca*) by 2.5 per cent. DDT has been shown to be economically successful only when the general standard of cultivation is high.

Trinidad and Tobago

54. *Agricultural.* Fungicides. The control of melanose on grapefruit was affected by low volume spraying. Low volume spraying of both water and oil based fungicides for the control of Black Pod Disease (*Phytophthora palmivora*) of cacao has been carried out. Evaluations have been made of the phytotoxicity of oil on foliage and flowers. The control of Banana Leaf Spot

Disease (*Mycosphaerella musicola*) with low volume oil based sprays has been investigated.

55. *Medical*. Insecticides. New colonies of *Aedes aegypti* mosquito were started from larvae brought in from Rio Claro, Biche and California. Several susceptibility tests using the more common chlorinated hydrocarbon insecticides were carried out during the year against 4th instar larvae from these colonies, to determine whether there were any differences in response from that of the Laventille strain which is highly resistant to DDT. Tests with malathion, diazinon and parathion, three organo-phosphate insecticides, were carried out against DDT resistant 4th instar larvae.

Several attempts were made without any success to establish colonies of normal non-resistant strains of *A. aegypti* from eggs obtained both from the London School of Hygiene and Tropical Medicine and U.S. Public Health Laboratories.

Uganda

56. *Agricultural*. Arborescences. About a dozen high forest species are now known to be resistant to the standard contact dose of 3 per cent. arboricide (D:T. 2:1 in diesel), but all are susceptible if frilled before the application. Work on individual chemicals and on seasonal sensitivity was continued.

57. *Medical*. Insecticides. A large scale field trial of the ground application of insecticide to vegetation along the edges of rivers and swamps as a means of eliminating *Glossina palpalis* from a network of tsetse infested rivers is being conducted. The latest technique developed has been successful in eliminating *G. palpalis* by a single spraying over limited parts of the waterside vegetation. A 5 per cent. wt/vol. solution of dieldrin is applied with a mechanical sprayer, the rate of application varying from 5 to 8 gallons per mile of river treated. This procedure gives a coating of insecticide which has remained fully lethal to tsetse for more than 90 days.

Zanzibar

58. *Insecticides*. The control of *Pseudotheraptus wayi* is described in detail in Section II above.

PART IV. APPENDIX

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Colonial Products Council
Fourth Annual Report
(1956-1957)

Courtauld Institute of Biochemistry,
The Middlesex Hospital,
Medical School,
London, W.1.
9th October, 1957.

SIR,

I have the honour to enclose herewith the Annual Report of the Colonial Products Council for the year 1956-57.

I am,

Sir,

Your obedient servant,

E. C. DODDS,
Chairman.

The Right Honourable Alan Lennox-Boyd, M.P.,
Secretary of State for the Colonies.

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The terms of reference of the Council are:

- “1. To consider how, by the application of research, greater use can be made of Colonial plant and animal products.
2. To advise the Secretary of State as to (a) the Colonial raw materials (plant and animal) which are likely to be of value to the manufacture of products required by industry and (b) the research and development which should be initiated on such products.”

COLONIAL PRODUCTS COUNCIL
FOURTH ANNUAL REPORT, 1956-57

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**COLONIAL PRODUCTS COUNCIL AND COLONIAL
PRODUCTS LABORATORY
FOURTH ANNUAL REPORT**

PART I. GENERAL

1. *Council Meetings.* There was one meeting of the Colonial Products Council during the year.

2. *Membership.* The membership of the Council has remained unchanged.

3. *Visits.* The Chairman, Sir Charles Dodds, and the Secretary, Mr. W. F. Dawson, visited Antigua, Barbados, Trinidad and Jamaica in May. The units in the West Indies for which the Council is responsible were inspected, and discussions were held with various other organizations whose interests are linked with those of the Council and the Colonial Products Laboratory.

At the Council's special request, the Director of the Microbiological Research Establishment, Porton, Dr. D. W. Henderson, visited Trinidad and Jamaica in November to survey the microbiological problems of the West Indies, to indicate which of them must necessarily or could best be examined locally, and to comment on the suitability of the Colonial Microbiological Research Institute for working on them.

Dr. R. A. E. Galley, Director of Research, visited Malta in August, to advise on the reorganization and expansion of the scientific work in the island to meet existing and future requirements.

Mr. R. W. Pearman attended the Symposium on Vegetable Tanning Materials held at Cambridge in April, organized by the Society of Leather Trades' Chemists.

Dr. W. D. Raymond, Head of the Oilseeds and Foodstuffs Section, attended the Conference on Yeast, held in Dublin in September, organized by the Food Group of the Society of Chemical Industry.

4. *International Meetings.* Dr. Galley attended the 7th Session of the World Health Organization Expert Committee on Insecticides at Geneva, in July.

Mr. H. T. Islip, Assistant Director (Advisory), led the United Kingdom delegation at a meeting of the International Standards Organization, Committee on Essential Oils, held in Oporto, in September.

Dr. R. H. Kirby, Head of the Fibres and Papermaking Materials Section, and Mr. A. E. Chittenden attended the second meeting of the European Group of the American Technical Association of the Pulp and Paper Industry, held in London in May.

5. *Committee Meetings.* A meeting of the Oil Palm Sub-Committee of the Laboratory's Consultative Committee on Oils and Oilseeds was held in June, at which the bleachability of palm oil was the main item discussed.

A special meeting of the Laboratory's Consultative Committee on Hides and Skins was held in October at which a number of overseas officers, including Veterinary Officers, Hide Improvement Officers and members of the East African Hides, Tanning and Allied Industries Bureau, were in attendance. The meeting was devoted to the discussion of problems connected with the hides and skins industry in East Africa.

Subsequent to the meeting, visits to a skin tannery and a hide tannery, both of which use East African raw material, and to the British Leather Manufacturers' Research Association were made by the overseas officers.

The Pyrethrum Research Committee (United Kingdom) held its second meeting in February, at which the problems discussed included the separation of the active constituents of pyrethrum and the action of synergists.

PART II. INQUIRIES, INVESTIGATIONS AND RESEARCH

6. This part of the Report is divided into three sections, covering (a) inquiries dealt with at the Colonial Products Laboratory, (b) investigations carried out in the Laboratory and (c) work, principally research and development, carried out elsewhere under the direction or with the assistance of the Council.

(a) INQUIRIES DEALT WITH AT THE COLONIAL PRODUCTS LABORATORY

7. The Laboratory has dealt with 745 inquiries during the year; 62 inquiries were in hand at the end of the period. Examples of those dealt with are given below:—

Essential Oils

8. *Cedarwood Oil*. In view of the demand from Kenya for information about East African cedarwood oil, which is distilled from *Juniperus procera* Hochst., the Laboratory prepared a memorandum on this subject which was sent to a number of inquirers. This dealt with the type of distillation material, methods of distilling, the quality and composition of the oil, and its uses. The memorandum embodied the results of the examinations of samples of East African cedarwood oil which had been carried out at the Laboratory over a number of years.

The demand for East African cedarwood oil declined in recent years, following the increased availability of American cedarwood oil from *Juniperus virginiana*. Producers were advised to improve the quality of their oils in order to place them in a better competitive position.

9. *Naval Stores*. Although at present no further tapping trials for oleo-resin are being undertaken in British Honduras, the information obtained as a result of these trials has been of value in considering the question of the production of naval stores in other Colonial Territories, notably Mauritius. A considerable amount of information has been assembled about the prospects for naval stores, having regard to the changes taking place in the industry in the United States, resulting largely from advances in the wood pulping industry, and to the development of new sources of naval stores in other parts of the world.

The products from the Aleppo pine, *Pinus halepensis* in Cyprus resemble those of the Greek industry, and it has been concluded that a limited market would exist for turpentine and rosin from this source, provided they could be produced economically.

Oilseeds, Oils and Fats

10. *Castor Seed*. Imports of seed into the United Kingdom over the past few years have diminished and this has caused anxiety to crushers in this country. This shortage, and the development of castor oil as a source of sebacic acid, a useful raw material for various industrial products including monofilament nylon, has stimulated an interest in castor cultivation

in several overseas territories. Attempts made in Jamaica and Kenya to encourage cultivation of new dwarf varieties, suitable for combine harvesting, have met with scant success. Possibly the older varieties are more suited to Colonial conditions.

Antigua is a new area experimenting with castor as a crop. Samples sent by the Director of Agriculture there were found to be of good quality and to have a satisfactory oil content. They would be readily marketable in the United Kingdom at current prices. The economics of extending cultivation in the island are now under examination.

Although the majority of Colonial-grown seed results from peasant cultivation, its production might be difficult to expand or even maintain with a rising standard of living. An important firm of chemical manufacturers is considering establishing plantations overseas in order to ensure supplies of seed. The Laboratory has provided considerable detailed information for their guidance including statistics, notes from overseas reports, cultural details and advice about processing castor seed in Colonial areas.

11. *Coconut Products*. Many inquiries concerning these products have been received, including those from the Agricultural Department, Tanganyika, the High Commission for the Western Pacific, the Director of Agriculture, British Guiana, the Biochemist, Fiji, the Director of Agriculture, Seychelles, and various firms. Some inquiries were connected with the briefing of the United Kingdom delegate to the FAO Coconut Working Party which met in Colombo, Ceylon, in January. Most inquiries reflect an increasing desire, both by buyers and producers, to improve the quality of the most important product, copra, and to find alternative outlets for the coconut. Advice has been given on the technology of drying copra, both to machine designers in this country and to the agricultural departments overseas. Information has been provided about expellers suitable for a variety of operating conditions which are available in the United Kingdom and overseas. The development of alternative methods of extracting the oil from the fresh coconut, well exemplified by the recently-developed Philippine process, has also attracted interest. Although several of these plants are operating in the Philippines, the Laboratory considers that caution is necessary in recommending their use to other overseas areas; pilot-scale operation in the first instance would certainly be advisable. Even the more orthodox oilseed expeller cannot always be operated locally in competition with more primitive devices and, in spite of the strong desire overseas for industrial development, it is usually economically unsound to export both oil and cake rather than the parent oilseed (in this case copra).

As an alternative to the production of copra, the manufacture of desiccated coconut might well receive serious consideration in Colonies which have ample supplies of good-quality nuts. A firm of confectioners in the United Kingdom is disturbed about the falling quality of supplies from Ceylon. It was suggested that the firm should contact and, if possible, visit Colonial Territories suggested as alternative sources of supply.

12. *Crambe abyssinica*. *Crambe* is a genus of the Cruciferae consisting of several species, of which at least two, the well-known sea kale and the Tartarian bread of Hungary, are edible. In reply to an inquiry concerning the suitability of developing *Crambe abyssinica* as an oilseed crop, the Director of Agriculture, Tanganyika, was informed that neither the seed nor the oil is known commercially in the United Kingdom. Some work on the development of the plant as an oilseed had, however, been carried out in Russia, where it has been claimed that trials have shown it to grow satisfactorily and give a good yield of seed. A trial of the plant had also been

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made in Venezuela, where it grows well. The oil from the seed is reported to be similar to rape seed oil in chemical properties and to be utilisable for analogous purposes. Although the market for rape seed and oil in the United Kingdom is not extensive, there is always a demand for them.

There is an indigenous species of *Crambe*; *C. kilimandscharicum*, in Tanganyika, and it has been suggested, therefore, that experiments should be made with this and also with *C. abyssinica* and that samples of both varieties of seed should be forwarded to the Laboratory for examination and commercial valuation.

13. *Melon Seeds*. In spite of the large-scale production in tropical countries of the better-known oil-bearing materials (e.g. copra, groundnuts and palm fruit), unusual materials are still utilized locally as a source of oil. An example is the water-melon seed of Nigeria, sold in Lagos as "egusi". The seeds may be consumed without further preparation as a masticatory or after roasting and grinding to pulp as an ingredient in sauces. The oil content of the seeds varies widely, from about 15 per cent. upwards, but is more usually in the range of 35-45 per cent. Melon seed oil has an agreeable odour and could be utilized as an edible oil; its fatty acids consist mainly of linoleic, together with oleic, palmitic and stearic acids. Advice has been given to the Governor of the Western Region, Nigeria, concerning machinery suitable for processing these seeds to yield products for local consumption.

Grain Crops

14. *Rice*. The Federal Rice Research Station in Nigeria is mainly concerned with the introduction of new varieties of rice into the Northern Region. The present production of rice in the Region is some 300,000 tons, including about 80,000 tons from *Oryza glaberrima*. This is a red variety unlike that usually utilized for rice production, *O. sativa*. Over the past twenty-five years *O. sativa* has been introduced into Nigeria in a rather haphazard manner: the aim now is to introduce one or two standard varieties, but, before replacing *O. glaberrima* by *O. sativa*, the Station wishes to have reliable information concerning the relative nutritional values of the two species. A search of the literature provided little assistance, and it was suggested that samples should be collected, both in Nigeria and in Sierra Leone, for further laboratory examination. For the satisfactory assessment of field samples, laboratory milling machinery is required. Information has been supplied on Italian, American and British machines, and arrangements made for a member of the staff from the Federal Rice Research Station to see equipment in operation in the United Kingdom. At present the majority of the rice consumed in the Region is parboiled, but certain mills in Kano are known to be operating a process in which parboiling is not included. The scientific principles underlying parboiling have been discussed and methods of overcoming difficulties such as smell nuisances were described.

Fruit, Nuts and Vegetables

15. *Canned Fruit Production*. A paper entitled "A Survey of World Production and Trade in Canned Fruit" has been prepared and circulated to those Colonial Governments whose territories are concerned with canned fruit production. In particular the Survey has guided the fruit canning industries of Kenya and Jamaica. It directed attention to the highly competitive nature of the trade in canned fruits and to the great expansion that has occurred in most of the chief producing countries in post-war years. It showed that the United Kingdom market is of major importance to exporting

countries, the main commercial demand being for a few favoured fruits of which peaches and pineapples are the most important. The difficulty of establishing new products on an appreciable scale was emphasised and a warning given against the possible danger of overproduction of canned pineapple.

16. *Nigerian Canning Industry.* In connection with a study of the possibility of finding alternative products for the fruit processing factory in the Western Region, Nigeria, observations have been made to the Department of Agriculture regarding the processing of and markets for a number of canned tropical fruit and vegetable products. It was recommended that the factory should undertake experimental work to widen the basis of the industry, and that the prospects of catering for the local trade in canned goods should be given special consideration.

17. *Standards for Fruit Products.* The Laboratory has kept in touch with the Adviser on Food Standards, Jamaica, in connection with the draft "Processed Fruit and Vegetable Regulations" which are under consideration for issue in that country under the "Processed Food Law". Sections of the draft regulations have been criticised constructively and suggestions have been made for modifications, with particular reference to the requirements of the United Kingdom as an important market for Jamaican processed fruit products.

18. *Fresh Mangoes.* Several Colonies are anxious to develop the export trade with this fruit. An experimental consignment of fresh mangoes from the Administrator, St. Vincent, has been examined with the co-operation of the Covent Garden Laboratory, Department of Scientific and Industrial Research. Commercial opinions on the suitability of the fruit for this market, and advice on the method of packing and transport have been supplied, although a serious handicap to the development of the trade is the difficulty of providing correct storage temperatures for the necessarily small commercial shipments involved in supplying the limited demand for this luxury fruit.

19. *Macadamia or Queensland Nut.* Although the tree is native to Australia, important commercial production of macadamia nuts has, hitherto, been largely confined to Hawaii. Interest has arisen in the crop both in Kenya and Tanganyika, and information on the preparation of the roasted kernels has been supplied to the Department of Agriculture, Kenya, and to the representatives of growers in Tanganyika. The crop may be capable of some useful development since at present the demand for the processed kernels in the United States exceeds the available supply.

Other Foods

20. *Nutritional Biscuits.* Dr. R. A. F. Dean, of the Medical Research Council, has been exploring the possibility of utilising in Uganda a high-protein biscuit made from locally-available ingredients for issue to school children. The groundnut has been used as the main source of protein but it is not entirely satisfactory, because of certain amino-acid deficiencies, and the nut has to be supplemented by a small amount of fish protein. The manufacture of such a mixture into a biscuit poses a technological problem. Advice concerning its solution was obtained by the Laboratory from a large firm of biscuit manufacturers in the United Kingdom, and the authorities in Uganda have been advised about this and about the availability of plant. The Laboratory does not consider that a proposal to erect a special factory in Uganda to make these biscuits would be as satisfactory as supply under contract during the development stage, particularly since a modern biscuit factory has recently started operation near Kampala.

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21. *Coffee*. Coffee is usually obtained from *Coffea arabica*, although other species, notably *C. robusta* and *C. liberica* which are more easily cultivated in many territories, are known in the trade. An inquiry was received from the Agricultural Department of the Northern Region, Nigeria, regarding the possibility of extending *robusta* coffee cultivation in that area. *Robusta* coffee has a neutral flavour and is useful for blending purposes where its price, which is lower than that of *arabica*, is an advantage. More recently, *robusta* has been widely used for the preparation of soluble coffee which is undoubtedly increasing in popularity. Trade circles in the United Kingdom anticipate that in about ten years' time the majority of coffee consumed in America will be of the soluble form. The Deputy Director of Agriculture, Northern Region, Nigeria, was introduced to various firms in this country for marketing discussions prior to the formulation of an agricultural programme for the Region. The prospects for developing *robusta* coffee were considered to be favourable.

22. *Fish and Fish Products*. Advice has been given to the Barbados authorities on their plans for the erection of a cold store-quick-freezing plant for fish, an abattoir and a by-products plant. Methods of preserving fish and of detecting fish unsuitable for human consumption, and the layout of the by-products plant were considered, and observations on the construction of the building and the salaries of the staff were included.

Views, based on the report of a survey carried out in 1948-49 by two Colonial Office scientists, were expressed on ways in which the Seychelles fisheries should be developed.

Details of modern methods of preserving fish and the applicability of those methods to the Caribbean area have been supplied to a United Kingdom inquirer. Information on electronic devices for detecting shoals of fish was also provided.

23. *Meat and Meat Products*. In response to a Kenya inquiry, advice has been given on the possible use of antioxidants in meat and bone meal to retard the development of rancidity, and suggestions have been made concerning methods of distributing antioxidants through large quantities of meal. Information has also been supplied on the value of stilboestrol in the fattening of beef cattle.

Tobacco

24. *Samples from Jamaica*. Qualitative assessment of a number of samples of Jamaican cigarette tobacco has been made and a report on the market prospects provided. Some of the grades were of reasonable quality, but in present circumstances there would be difficulty in finding outlets for such leaf on United Kingdom markets.

25. *Miscellaneous*. Particulars of electric moisture meters for tobacco testing have been collected on behalf of the Department of Agriculture, Nyasaland. Information on curing methods and equipment has been provided to trade inquirers. An account of manufacturing processes for twist tobacco has been prepared for the Solomon Islands.

Vegetable Insecticides

26. *Pyrethrum*. Information on the role of trace elements and other plant nutrients has been furnished to the Government Chemist, Tanganyika, in connection with field trials on the crop. Details of methods for the determination of small quantities of "pyrethrins" have been supplied to the Pyrethrum Board of Kenya.

Synthetic Insecticides

27. *Determination.* Inquiries on methods and apparatus for the determination of chlorinated insecticides and similar compounds have continued to be received, and appropriate details have been supplied to laboratories in Jamaica, Malaya and West Africa.

Vegetable Drugs

28. *West Indian Cherry.* This fruit (also known as "Acerola"), derived from *Malpighia punicifolia* and related species, is widely distributed in the Caribbean area and is an extremely rich source of Vitamin C (ascorbic acid), contents of up to 4 per cent. having been recorded. The possibility of extracting the pure vitamin for medicinal use has been examined for the Government Chemist, Jamaica. It was considered that the natural vitamin would not easily compete with the cheap and adequate supplies of synthetic ascorbic acid now available, but that the fruit might be used to produce syrups and concentrates for "vitamin" beverages.

29. *Miscellaneous.* Particulars relating to the preparation and marketing of aloes have been supplied to several of the smaller Caribbean islands. Other inquiries dealt with have concerned the distribution, cultivation and utilisation of *Dioscorea*, *Datura* and *Voacanga* species.

Vegetable Fibres and Canes

30. "*Crin vegetal*" Fibre. A firm of engineers in this country asked for information on the type of machine which is used for extracting "crin vegetal", the fibre from the leaf-sheath of *Chamaerops humilis* L. which is used in upholstery. Particulars were supplied of the hand-methods used and of the principles employed in machines which have been devised for use in the factories in Algeria where the fibre is extracted.

31. *Ramie Fibre.* Full information on the preparation of the fibre has been given to a firm in the United Kingdom who were contemplating making machinery for the degumming of ramie. They were given particulars of the various processes used for degumming the ribbons before spinning and observations were made on the type of plant and equipment which might be suitable for the process on a commercial scale.

32. *Coir Fibre.* An inquiry was received from the Tonga Copra Board with regard to the possible utilisation of coconut husks which are at present going to waste. The Board has been furnished with a memorandum on the preparation of coir fibre with details of the methods used in Ceylon and India. Particulars and quotations were also obtained from firms in the United Kingdom who make machinery for extracting and processing coir fibre and those making plant for the manufacture of rubberised coir mattresses.

33. *Bamboos and Rattans.* On behalf of the British Empire Society for the Blind, inquiries were made regarding machines for peeling, splitting and shaving rattans and bamboos, and the Society was eventually put in touch with firms in Japan who make such machines. Observations have been made regarding the possibilities of cultivating rattans on a small scale in various Colonies and a memorandum on the cultivation, harvesting and preparation of rattans in the Far East was supplied. Advice has also been given concerning local raw materials which might be suitable for use in native handicrafts.

Paper-making Materials

34. *Papyrus.* The Department of Trade and Industry, Northern Region, Nigeria, who were interested in the possibilities of using the papyrus in the

Lake Chad area for the manufacture of paper-pulp, has been given information on the technical problems associated with the pulping of papyrus. The suggestion was made that, if possible, other materials with good paper-making properties should be sought locally for admixture with papyrus. Observations were made on the economics of the harvesting and transporting of papyrus to the mill, and an offer was made to examine some of the papyrus from Lake Chad by the newer semi-chemical methods of pulping, as soon as the equipment ordered for the purpose has been installed at the Laboratory.

(b) INVESTIGATIONS CARRIED OUT IN THE COLONIAL PRODUCTS LABORATORY

35. During the year under review the Laboratory has completed 95 investigations; 45 investigations were in hand at the end of the period. Examples of those completed are given below:—

Essential Oils

36. *Oil of Leptospermum citratum*. The production of *L. citratum* oil in Kenya was developed on a limited scale by the late Gilbert Walker but no detailed examination of the oil was ever made. Captain Walker wished to exploit the oil to the best advantage, and wanted to know how it compared with the Australian oil which had been examined by Penfold (*Bulletin of the Technological Museum, Sydney*, No. 14, 1936, p. 13), particularly in regard to its citral content, and whether hydrogenation of the oil might yield a product of value in soap perfumery.

The Laboratory undertook this work, and has found that citral of over 97 per cent. purity and optically inactive could be readily obtained from the oil in a yield of 40 per cent. A detailed examination of *L. citratum* oil showed that it contained 45.5 per cent. of citral and 33.9 per cent. of \pm citronellal, together with smaller amounts of isopulegol, geraniol, citronellol, eugenol and hydrocarbons. It was considered that, apart from its use as a whole essence, the oil would be better utilised as a source of the isolates citral and citronellal, rather than by being hydrogenated to a mixture of alcohols (mainly citronellol) for use in soap perfumery.

37. *Oil of Cinnamomum pedatinervium bark*. No source of oils yielding safrole, which is a starting material for the manufacture of the important pyrethrum synergist piperonyl butoxide, has yet been developed in the Colonial Territories and, as part of the search for new oils yielding this isolate, it was decided to re-examine the oil from the bark of *C. pedatinervium* from Fiji which was reported on by E. Goulding (*J. chem. Soc.* 1903, **83**, 1093) over 50 years ago. Goulding stated that the oil contained 40-50 per cent. of safrole and 30 per cent. of alcohols, the latter being wholly or in part linalol.

A sample of the bark, obtained through the Forestry Department, Fiji, has been found on distillation at the Laboratory to yield 1.97 per cent. w/w of volatile oil, calculated on a moisture free basis, almost twice the yield reported in the earlier investigation. The oil contained 60.3 per cent. of safrole and 20.9 per cent. of total acetylisable constituents, calculated as terpene alcohols, $C_{10}H_{18}O$. Of these alcohols, linalol (8.5 per cent.), geraniol (9.3 per cent.) and borneol (approximately 0.5 per cent.) were isolated and identified.

The oil is thus promising as a source of safrole, but it is disappointing that the linalol content does not approach the value suggested by Goulding's work. Whether or not its production can be exploited will depend on availability of the bark and price trends for safrole.

38. *Patchouli from Sarawak.* Correspondence with the Department of Agriculture, Sarawak, revealed that certain farmers were taking an interest in growing patchouli and a good crop could apparently be raised if manuring was generous. As no information was available on the yield or quality of oil from this source, it was decided that samples of the leaves should be examined at the Laboratory.

On distillation of a sample of the leaves a yield of nearly 6 per cent. w/w of oil (on a moisture-free basis) was obtained; this compares favourably with the usual yields of 4 to 5 per cent. furnished by dried leaves imported from the Far East. The analytical constants of the oil were generally comparable with those of European distilled oils and the solubility in alcohol was much better than the average obtained for oils imported from Singapore. Trade comment on the oil was favourable and interest was expressed in the possibility of commercial production.

Spices

39. *Chillies.* As a result of advice previously supplied to the Department of Agriculture concerning the cultivation of chillies in certain development areas in Kenya, samples produced in two of these areas were forwarded for examination. One, from the Coast Province, consisted of fruits intended for seed purposes and was of reasonably good quality. The other, grown on the Perkerra Irrigation Scheme, had not been well prepared and was regarded commercially as of "ordinary low grade". In reporting on these samples it was noted that, whilst the Laboratory originally recommended the cultivation of the true chilli, i.e., the small, highly-pungent fruits of *Capsicum minimum* Roxb. and small fruited varieties of *C. frutescens* L., the samples submitted were, in fact, capsicums, which are larger and relatively non-pungent. This may have been due to the confusion which exists, unfortunately, in the naming of different forms of the spice. The true chilli, in official publications such as the *British Pharmaceutical Codex* and the *United States Pharmacopoeia*, is referred to by its generic name, *Capsicum*, whilst several of the larger, non-pungent fruits, which are really capsicums, are known commercially as chillies.

Oilseeds, Oils, Fats and Soaps

40. *Illipe Butter.* The kernels from a number of species of *Shorea* trees which grow in Borneo, Sarawak and the Malay Archipelago are sometimes called Illipe nuts, and the hard, brittle fat derived from them is known as Illipe butter or Borneo tallow. It is used for edible purposes and esteemed as a substitute for cacao butter, especially when the latter is high in price; for certain special chocolates (e.g. those consumed in the tropics) Illipe butter is often preferred. The nuts appear on the market in the form of broken kernels which are brown or black in colour; the trade prefer the black nuts, mainly on account of their higher oil content. In consultation with the Chief Research Officer of the Forest Research Institute, Kepong, Malaya, samples of nuts derived from *Shorea gysbertsiana* were processed locally in a variety of ways in order to determine the best procedure for preparing the kernels for market.

It was found at the Laboratory that, with the exception of the immersion of kernels in water for two weeks before drying, the various methods of treatment had had no appreciable effect on the physical appearance of the kernels, their fat content or the fatty acid composition. The sample which had been immersed contained 61.3 per cent. of fat, whereas the other samples contained from about 48 to 55 per cent. The germ fat, which was separately investigated, contained a slightly higher proportion of unsaturated

acids than did the fat from the cotyledons. However, the proportion of germ in the kernels was such that its presence or absence did not significantly alter the fatty acid composition of the Illipe butter.

41. *Croton megalocarpus*. The seed of this plant is collected by the indigenous population of Kenya and was mentioned in *Colonial Research* 1955-56. The composition of the oil has now been determined at the Laboratory and, as it contained about 74 per cent. of linoleic acid, a sample was sent to the Research Association of British Paint, Colour and Varnish Manufacturers for examination. The Association reported that the oil compared favourably with tobacco seed oil as regards its non-yellowing properties in paints, and with linseed oil and tobacco seed oil in its weather resistance and drying properties. However, in spite of these advantages it was doubtful whether the oil would command any premium over linseed oil and, in any event, the premium obtained would probably not exceed £10 per ton. The authorities in Kenya are now investigating the cost of collecting and marketing the seed in order to determine whether its production can be developed.

42. *Soap*. In the more backward areas of the world small quantities of soap are produced with the most primitive equipment, sometimes in batches of only a few pounds in weight. Such soaps fulfil a useful service in the local economy and are sometimes the pride of their manufacturers. Four samples of blue mottled laundry soap and one of toilet soap were received from the Director of Agriculture, Seychelles, with reference to the prospects of marketing such material other than locally. All the soaps, on examination at the Laboratory, failed to comply with the appropriate British Standard Specifications and did not attain a satisfactory grading by the Indian specifications. It was considered unlikely that such soaps would find a market outside the Seychelles.

Waxes

43. *Sugar Cane Wax*. Work on this material has continued, although it is unfortunate that, just when wax users in the United Kingdom were showing some interest, the pilot plant in Barbados manufacturing the wax should have closed down. One sample of wax (Carib 60) has been found to compare favourably with commercial sugar cane waxes from America and Australia in its gel strength and, to a lesser extent, in its solvent retention, and it was shown to be a suitable substitute for carnauba wax in commercial polishes. A less highly refined sample of sugar cane wax (Carib 20) has been freed from insoluble resinous material by extraction with hot *iso* propyl alcohol to yield about 85 per cent. of deresinated wax. The deresinated wax was found by chromatographic separation to consist of two main fractions, (a) a neutral wax (60 per cent.) of relatively simple nature comprising alcohols, simple esters, a ketonic substance and hydrocarbons, and (b) an acidic wax (30 per cent.) of more complex nature containing *n*-acids, ketones and hydroxy compounds. Consideration of the molecular weight of this latter fraction and the concentration of functional groups suggested that appreciable quantities of di- and tri-functional compounds were present.

44. *Sisal Wax*. The sisal plant (*Agave sisalana*) is cultivated in tropical countries for its fibre, and its leaf cuticle contains about 20 per cent. of wax. This wax can be recovered from the decorticator waste, and a sample, prepared by methods which were not disclosed, was submitted, by a firm operating in Kenya, for examination. The gel strength and solvent retention characteristics compared favourably with those of carnauba wax, indicating that the sample should prove a satisfactory substitute for carnauba wax in

polishes. A study of its composition showed that the unsaponifiable matter contained less *n*-alcohols and more hydrocarbons than carnauba wax and also contained an appreciable quantity of ketonic and unidentified substances. The acidic portion broadly resembled that of carnauba wax and consisted of *n*-acids and hydroxy acids.

Grain and Root Crops

45. *Processing of Rice.* The nutritional value of the products obtained by different methods of processing rice continues to excite interest in overseas territories, and samples have been received from the Agricultural Department of the main rice producing Colony, British Guiana, in connection with the proposal to process rice by a wet brushing technique. The aneurin content of samples of wet brushed raw rice has been found to be about one-third that of normally-milled parboiled rice and the appearance of the rice was marred by surface pitting. No great difference between the keeping qualities of the brushed and parboiled rices was noted. These findings were disappointing, and further work on the process has been discontinued.

Other samples, consisting of unpolished and polished rice, were received in connection with a treatment to minimise the smell nuisances associated with parboiling, which had been adopted following the recommendations of the Laboratory. It has been found that the use of a preliminary wash before treatment gave an unpolished rice of higher aneurin content than that obtained from unwashed paddy.

Starches

46. *Arrowroot and Sago.* The possibilities of developing starch supplies from the overseas territories continue to receive attention, studies of samples being related mainly to their purity and viscosity. The viscograph, which has proved valuable for continuous recording, has shown that *Maranta* arrowroot starch is outstanding for its high viscosity and for the manner in which it holds its viscosity when its starch paste is maintained at 92.5°C. The effects of soil and variety of the plant upon this property of arrowroot starch are under study. Starch from *Canna edulis* is prepared in St. Lucia, and a sample, received through a firm in the United Kingdom, has been found to have a higher viscosity than true arrowroot and, rather surprisingly, its viscosity continued to increase when its starch paste was held at 92.5°C.

The viscosity behaviour of carefully prepared sago starch is also promising. Unfortunately, the material reaching the United Kingdom market from Sarawak is often dirty, of low viscosity and unsatisfactory in other respects. The Laboratory, in consultation with the Sarawak authorities and the trade in this country, is endeavouring to lay down standards suitable for the control testing of exports from that Colony, and it is hoped that in due course the present "fair average quality" standard may be raised.

Fruit Products

47. *Tomato Paste.* The Laboratory has examined samples of tomato paste, representative of the products of five manufacturers in Malta, and has provided the Department of Trade and Industry with a report on the quality of the respective packs. As a result of this investigation, advice has been supplied concerning modifications in the methods of preparation, processing and packing which were shown to be necessary in order to enhance the competitive position of the commodity.

48. *Canned Pineapple.* A sample of canned pineapple, produced at a cannery in Tanganyika, has been examined on behalf of the Department of Agriculture. The results of the examination, together with commercial.

opinions, indicated that a marketable product is obtainable with local fruit, although, in connection with the possible development of the crop in Tanganyika, the highly competitive nature of the export market was emphasized. Advice was provided regarding directions in which the quality of the pack might be improved.

Animal Feedingstuffs

49. *Value of Waste Materials.* Following the visit of Dr. I. Mann, Veterinary Research Laboratory, Kenya, to the British West Indies, the Laboratory received samples of local waste products with a view to their utilization as animal feedingstuffs. These included arrowroot waste from St. Vincent, lobster meal from Jamaica and shrimp meal from British Guiana. The arrowroot waste was found to have a composition not unlike similar waste from cassava processing in Malaya and Indonesia, where the product is already esteemed as a feed for pigs. Its main value is as a source of carbohydrate. The lobster and shrimp meals were found to contain the non-protein, nitrogenous material, chitin. Approximately one quarter of the nitrogen in the lobster meal was present as chitin, so that the meal would be of little value as a protein concentrate. A much smaller proportion, one-twelfth, of the nitrogen in the shrimp meal was derived from chitin and the meal would therefore appear to be a useful protein concentrate, except that the salt content of the British Guiana samples was as high as 14 per cent.

Tobacco

50. *British Honduras.* Eleven further samples of cigarette tobacco, submitted by the Director of Agriculture, have been examined. Nicotine contents were lower than those of previous samples and there had been some improvement in smoking quality, although certain grades continued to be unsatisfactory as regards combustion and flavour.

51. *Antigua.* Five types of cigarette leaf, submitted by the Director of Agriculture, have been examined and found to show improvement in comparison with those submitted in 1954. Nicotine contents were lower and the composition characteristics of the ashes had become more normal, chlorides in particular being very much lower. As there had been difficulties in completing the flue-curing, proper assessment of smoking quality could not be made.

Vegetable Insecticides

52. *Pyrethrum.* Work has been continued, under the research scheme, on the examination and separation of the constituents of pyrethrum, using chromatographic and counter-current techniques. Small quantities of pyrethrin I and cinerin I have been prepared by displacement chromatography and the extension of this procedure to a larger scale and to the resolution of the mixed "pyrethrin III" fraction is in progress. A short communication on these aspects is in course of publication. Several non-pyrethroid substances have been isolated from the flowers but the exact nature of these has not yet been fully elucidated.

53. *Derris.* The popularity of this crop would be increased if the two-year maturation period could be reduced. Determinations of rotenone content of roots lifted after one year have been made for the Department of Agriculture, Zanzibar, and satisfactory rotenone contents in excess of the 7 per cent. regarded as a minimum have been found. The significance of these results can only be fully assessed when the results of later harvestings at 18 and 24 months become known.

Synthetic Insecticides

54. *Analysis.* Continuing assistance has been given to the Colonial Liaison Section of the Pest Infestation Laboratory in connection with storage experiments, by carrying out analyses of insecticide residues in various commodities from East and West Africa. Determination of the residual parathion contents of Cyprus olive oil samples (from a large-scale experiment on the control of the olive fly *Dacus oleae*) have been completed. Estimations of the active content of insecticidal preparations have been made for the Department of Agriculture, Kenya, and further samples of DDT, BHC, dieldrin and chlordane have been tested for the World Health Organization in connection with tropical storage trials.

Vegetable Drugs

55. *Corallopsis opuntia.* A further sample of this seaweed, submitted by the Director of Agriculture, Seychelles, has been examined. The jelling properties were good and it appeared that the material might replace Irish Moss (*Chondrus* spp.) in some applications. Commercial prospects would be dependent upon constant supplies being available at a competitive price.

Vegetable Fibres

56. *Abaca.* Several investigations have been carried out on abaca from Borneo, Sumatra and the Philippines, in order to ascertain how the fibre from Borneo compares in fineness with that from other sources. Abaca fibre is shipped in bales of standard weight but no allowance is made for any weight variation caused by changes in the moisture content which result from varying climatic conditions. In co-operation with the Colonial Development Corporation, bales of fibre have been tested for moisture content both in Borneo and in the United Kingdom. From the results obtained it is hoped to be able to draw some conclusions regarding reasonable gains or losses which might be expected in the weights of bales of abaca fibre.

57. *Urena lobata* L. Samples of *Urena lobata* fibre from fertilizer and other larger-scale trials carried out in the Gold Coast were examined in conjunction with the British Jute Trade Research Association. The samples were found to be most promising and among the best which have been examined at the Laboratory as regards quality.

58. *Fibre Identification.* Samples of fibre for identification have been submitted by a number of inquirers including the Textile Institute and the South Western Forensic Science Laboratory. Further additions were made during the year to the collection of authentic fibres.

Paper-making Materials

59. *Ricinodendron rautanenii* Timber. Pulping trials at the Laboratory on this timber from Northern Rhodesia have shown that the material might be useable for commercial pulp production. The yield of pulp obtained, however, was low and the pulp itself difficult to bleach, possibly due to the effects of sap-stain fungus on the timber. The work has been temporarily suspended pending the arrival of fresh unstained samples so that the effects of this fungal attack can be investigated.

60. *British Honduras Slash Pine.* Pulping trials on this pine, which is *Pinus caribaea* and not *P. elliottii* which is known in the southern United States of America as slash pine, have been carried out. It has been found that the results obtained with *P. caribaea* appear to differ appreciably from those published for the United States "slash pine" pulps and these differences are at present being actively investigated.

Hides and Skins

61. *Study of Faults.* Work on the correlation of diseases in the living animal with faults in the finished leather is continuing.

The four half hides from Nigeria, vegetable tanned in the United Kingdom, mentioned in *Colonial Research* 1955-56, together with samples of the raw hides preserved in formalin, have been examined microscopically by the British Leather Manufacturers' Research Association. The hides were from animals suffering from "kirchi", a rainy season disease, and some very interesting results have been obtained.

A number of goatskins have been supplied by Kenya showing demodex, streptothricosis, "scurf", "dimple", sarcoptic mange and nodular dermatitis. The skins have been tanned at the National Leathersellers' College and are now being examined microscopically, concurrently with samples taken from the raw skins preserved in formalin.

Publications

62. The following papers were published in the Laboratory's Journal, *Colonial Plant and Animal Products*.

"Oil of Turpentine". Pickering G. B., 1955, 5, 182.

"Six Species of Sedges and Rushes from Northern Rhodesia". Chittenden, A. E., and Morton, D., 1955, 5, 217.

"Gari from Nigeria". Spickett, R. G. W., Squires, Jean A., and Ward, J. B., 1955, 5, 230.

"*Aleurites fordii* Nuts from Swaziland". Raymond, W. D., Thorpe, E. F. J., and Ward, J. B., 1955, 5, 239.

"Cinnamon and Cassia: Sources, Production and Trade. Part 1. Cinnamon". Brown, E. G., 1955, 5, 257.

"The Differentiation of Jute and Some Jute Substitute Fibres Based on the Type of Crystals present in the Ash". Jarman, C. G., and Kirby, R. H., 1955, 5, 281.

"Second Report on Sage Leaves from Cyprus". Coveney, R. D., Matthews, W. S. A., and Pickering, G. B., 1955, 5, 322.

"Patchouli from Sarawak". Matthews, W. S. A., and Pickering, G. B., 1955, 5, 331.

(c) WORK CONDUCTED OUTSIDE THE COLONIAL PRODUCTS LABORATORY BUT UNDER THE DIRECTION OR WITH THE ASSISTANCE OF THE COLONIAL PRODUCTS COUNCIL

Colonial Microbiological Research Institute, Trinidad

63. *Curing of the Cacao Bean.* Controlled curing of cacao beans in "microfermentaries" and by various aseptic treatments continued during the earlier part of the period under review, but more recently efforts have been concentrated on testing an extremely simple small-scale method. Samples prepared by this method have scored as high as commercial controls on flavour assessment. The method is now being tested on clonal material. Added odiferous substances can be absorbed through the testa during the curing and detected in the finished chocolate.

In a commercial fermentation the beans die on or about the second day, owing, it is thought, to the combined action of heat and acid. However, no precise information is available on the conditions necessary to kill cacao beans. The conditions have now been determined by germination tests and it would appear that acidity rather than temperature is the major lethal factor in a normal curing.

The two cacao anthocyanin pigments have been isolated as pure crystalline hydrochlorides and their structures proved by synthesis. They are 3- β -D-galactosidyl and 3- α -5- arabinosidyl cyanidin salts.

The nature of the enzyme system concerned in the anaerobic conversion of the pigments during curing has been elucidated; a glycosidase liberates the sugars from the anthocyanin and other glycosides. The optimal conditions for this reaction have been determined. When air is available to the cotyledons later in the curing process, the polyphenol oxidase enzyme converts the astringent polyphenols into insoluble products. However the intermediates of this oxidation reaction destroy the glycosidase and other enzymes present so the anaerobic hydrolysis, if it is to take place, must precede the aerobic oxidation. A rationalization of the commercial practice can be based on these findings.

The structural investigation of the cacao leucocyanidin compounds continues.

64. *Plant Polyphenols*. In collaboration with the Chemistry Department of the University College of the West Indies, the accepted structure of peltogynol, for long the only known crystalline leucoanthocyanidin, has been shown to be incorrect and a 3 : 4-diol structure, in conformity with other leucoanthocyanidins, is indicated. A second leucoanthocyanidin has been crystallized from "purpleheart" wood and the corresponding anthocyanidin, peltogynidin, has also been prepared in crystalline form.

The results of an investigation of the oxidation of catechol in the presence of polyphenol oxidase, combining manometric and chromatographic methods, have been presented for publication. All the three possible dicatechols have been isolated and identified and their uptake of oxygen in the presence of the enzyme studied. Two other intermediates in the reaction are being studied; one is probably a dihydroxydiphenylene dioxide. Oxidations of mixtures of catechol and hydroxyhydroquinone were also investigated but no evidence was found that hydroxyhydroquinone was formed as an intermediate in the oxidation of catechol.

The isolation of the intermediates of the oxidation of substituted catechols is also in progress. Many catechol compounds occur naturally in plants, and it has been suggested that they may be an important factor in the resistance of plants to microbial infections. Further, the browning which frequently occurs in plant lesions caused by microbial infection is often the result of enzymic oxidation of phenols. The anti-microbial activity of the oxidation intermediates of substituted catechols is therefore being tested for possible systemic anti-plant-pathogen activity.

65. *Antifungal Antibiotics*. A long term, routine screening of tropical soils for actinomycetes which produce antibiotics active against plant pathogenic fungi has been started. Ten out of the thousand isolates so far examined have survived the weeding out and show promise of being producers of unknown antibiotics. Studies on variation of media to give increased antifungal titre have started on these ten isolates.

66. *The Hankey Culture Collection*. Throughout the year the provision of cultures and bacteriological examinations for local industries has continued; also, thirty-one cultures were sent overseas. The Collection now contains over 700 cultures (79 actinomycetes, 183 bacteria, 332 fungi and 144 yeasts).

67. *Miscellaneous Investigations.* As hitherto, the Institute has assisted various industries and organizations in different ways, and matters dealt with this year have included the following:—

- (a) *The Food Yeast Company (Pty) Ltd. (South Africa):* Maintenance and analyses of yeast cultures.
- (b) *The Department of Agriculture of Trinidad and Tobago:* The possibility of improving soil fertility in citrus orchards with nitrogen fixing bacteria (nodule bacteria on Kudzu) has been examined in collaboration with the Department.
- (c) *The Imperial College of Tropical Agriculture:* The gut microflora of the petroleum fly *Psilopa petrolei* Coq. is being examined at the request of the Department of Entomology. Soil samples from the Rupununi, British Guiana, have been analysed for their microflora at the request of the Soil Survey Section.
- (d) *The Commonwealth Bureau of Biological Control:* An investigation of the Green Muscardine fungus *Metarrhizium anisopliae* has begun.
- (e) *Forestry Department of Trinidad and Tobago:* Treatments of young teak sap wood to prevent moulding have been tested.
- (f) *Paint Manufacturers and Agents:* The subject of mildewed paintwork is still of considerable interest to local paint manufacturers and users. Scrapings of infected paint have been received from Jamaica and Barbados as well as Trinidad for identification of the infecting agent which invariably is a fungus of *Cladosporium*, *Curvularia*, *Alternaria*, or *Pullularia* spp. In one case the fungus itself was white, a *Sporotrichum* spp., but nevertheless caused a grey discolouration on cement walls.

68. *Visits.* During the year Dr. V. C. Quesnel read a paper at the Vth Meeting of the Inter-American Technical Cacao Committee at Bahia, Brazil. Two members of the scientific staff have been on long leave in the United Kingdom during 1956.

69. *Publications.* "Variations in Cacao Preparation". Forsyth, W. G. C., and Quesnel, V. C., *Proc. VI Meeting of the Inter-American Technical Cacao Committee, Brazil*, 1956.

"Cacao Polyphenolic Substances. 4. The Anthocyanin Pigments". Forsyth, W. G. C., and Quesnel, V. C., *Biochem J.*, 1957, **65**, 177.

"Cacao Glycosidase and Colour Changes During Fermentation". Forsyth, W. G. C., and Quesnel, V. C., *J. Sci. Food Agric.* (in press).

"Constitution of Peltogynol". Chan, W. R., Forsyth, W. G. C., and Hassall, C. H., *Chemistry and Industry*, 1957, (9), 264.

"Intermediates in the Enzymic Oxidation of Catechol". Forsyth, W. G. C., and Quesnel, V. C. *Biochimica et Biophysica Acta*, 1957, **25**, (1), 155.

British West Indies Sugar Research Scheme at the Sugar Technological Laboratory, Trinidad

70. *Director.* During the year under review, Mr. W. S. Wise was appointed Director of the British West Indies Sugar Research Scheme in succession to Professor L. F. Wiggins, who left Trinidad in October. Sir John Saint acted as Director during the inter-regnum. Mr. Wise has been a member of the scientific staff of the Sugar Technological Laboratory for the past five years.

71. *Experimental Sugar Factory.* Although the factory was not operated this year, further improvements were made to its equipment. It is hoped that sufficient money will be available for the factory to be run in subsequent years.

72. *Clarification.* A considerable amount of work has been carried out on the fundamental physico-chemical aspects of clarification; using one cane variety grown under normal field conditions. The samples of juice studied have been shown to be a suspension of spherical particles consisting of wax, together with small amounts of free fatty acids, alcohols, sterols, and unidentified resin. It has been shown that the surface properties of the particles in the raw juice are those of adsorbed layers of proteinaceous material and are altered by repeated centrifugal washing. Protein adsorption is maximal at the isoelectric point of the particles, pH 3.25.

A considerable quantity of protein remains in solution if the suspended particles are removed at a pH value at which protein adsorption is small. Fractions of these dissolved proteins have been obtained and are being studied by paper chromatography techniques.

Flocculation, as well as occurring at the isoelectric point, is also observed at pH values greater than 6 when it is associated with the precipitation of calcium and magnesium phosphates. An appreciable quantity of calcium and magnesium is bound to protein molecules in raw juice and is therefore not available for phosphate precipitation in the expected manner.

As a result of the investigations into the nature of clarification floc and its settling and thickening rates, it has been concluded that final mud volume is dependent on the total number of particles present and the total amount of calcium and magnesium phosphates precipitated. It is also dependent on the degree of close-packing of particles which, in turn, must govern the relative density of the settling floc and the floc size. It appears that the nature of the phosphate precipitate is the key factor.

Observations have been made of commercial clarification practices and the effects of treatment correlated with what is known of the physical chemistry of the process.

73. *Effect of Drought on Clarification.* These investigations, using cane grown in drought conditions out of doors and in the greenhouse, were suspended temporarily while the greenhouse was being reconditioned. It was decided to reduce the number of varieties to be tested to two, and experimental plots have now been laid out in the greenhouse and on adjacent land outside.

74. *Cane Juice Constituents.* Investigations were carried out following a report that lecithin had been found in cane juice, but the evidence for the presence of phospholipids was not conclusive. Leaf extracts were examined for polyphenols, using paper chromatographic methods. A polysaccharide, which appeared to be pectin, was extracted from raw juice.

75. *Tests on New Cane Varieties.* Samples of the juice from four new cane varieties, which are superior to the main variety grown at present in yields of sugar per acre and cane per acre, were examined and compared with juice from the older variety. Apart from the normal analyses of Brix, Pol per cent. and Apparent Purity, the juices were analysed for calcium, magnesium and phosphate. Special attention was given to the clarification and settling properties of the juices and it seemed that from this aspect all four cane varieties would be perfectly suitable for sugar manufacture.

76. *The Staling of Cane.* Two experiments, using six varieties, were conducted to investigate the changes taking place in sugar cane after it has been cut and topped and then kept for various periods of time before being milled. Evaporation losses occurred and it appeared that after the eighth day of storage there was a loss of solids also. It was found that the percentage of sucrose present decreased, while that of reducing sugars increased markedly,

although slightly less than would be expected from the disappearance of sucrose. The amino acid content of the juice rose during storage, probably due to hydrolysis of proteins. This may have some bearing on the suggestion that certain amino acids impede the growth of sugar crystals and that stale cane may give rise to difficulties in the pan station.

77. *Evaporator Scale Removal.* As has been described in previous reports, ethylenediaminetetraacetic acid (E.D.T.A. or Versene) is able to dissolve evaporator scale consisting of calcium and magnesium salts, but not of silica. Investigations have now been carried out on the rate of solution of calcium salts in E.D.T.A. under various conditions. It was found that the magnesium—E.D.T.A. chelate dissolved calcium sulphate more slowly than other compounds and since it is this which is formed in the regeneration process, the rate of cleaning by E.D.T.A. solutions would decrease after a number of regenerations had been carried out. It also appeared that E.D.T.A. solutions needed to be at a high pH to dissolve the less soluble scales, such as those of calcium oxalate.

Corrosion tests made with sulphamic and hydrochloric acids showed cleaning of evaporators with acids to be an unsuitable and destructive process.

Laboratory experiments showed that sodium citrate dissolved calcium sulphate readily and as its cost is about half that of E.D.T.A., it was tested under commercial conditions. The factory trial showed that sodium citrate was as effective as E.D.T.A. for removing scale consisting of calcium phosphate and sulphate with moderate amounts of silica. The economic feasibility of the process, including regeneration of the precipitated calcium citrate, is now being examined.

Several paints have been tested for their suitability in protecting the tanks containing hot acid or alkaline E.D.T.A. solutions during regeneration, and at least one type appears satisfactory. This could also be employed for tanks used in the citrate cleaning and regeneration processes.

78. *The Bach Polycell Clarifier.* As a result of tests with the clarifier it was found that the amount of juice it could handle varied with the settling characteristics of the juice. The relative capacity of the three elements was determined. It was found, however, not to be possible to form an opinion on the efficiency of the mud thickening compartment without operating the clarifier continuously on a 24-hour day basis.

79. *Lead Error.* The basis for the lead error corrections in sugar polarization is being investigated since it is thought there is some doubt about the reliability of the correction table normally used.

80. *Ammoniated Bagasse Pith.* Mixtures of 60:40 and 50:50 parts of ammoniated bagasse to molasses have been fed to cows, the 50:50 being most acceptable. Further trials with the 50:50 mixture with ruminants and chicks are to be undertaken. The chemistry of bagasse ammoniation is being investigated.

81. *Ammoniated Molasses.* Further work has been carried out on the chemistry of the constituents of ammoniated molasses. A study of the ammoniation reaction of glucose and fructose suggested that the formation of the toxic iminazoles could be minimised by adding the ammonia slowly to invert molasses so that the ammonia concentration in the reaction mixture is always low. Feeding trials using acidified ammoniated molasses carried out with heifers at the National Institute for Research in Dairying, Shinfield, suggested that ammoniated molasses is of no value when used as the principal source of nitrogen.

82. *Ammonia "Black Liquor"*. Interest has been shown in the use of ammonium hydroxide for pulping bagasse for paper-making, and so the value of the residual "black liquor" as an animal food rich in nitrogen is being investigated. So far the material has been fed to goats with no ill effects.

83. *Bagasse Hardboard*. Experiments have been carried out to make from bagasse a superior hardboard, preferably a material which is waterproof and could be drilled or nailed. One process has given good results on a laboratory scale and consists of ammoniating bagasse or bagasse pith and then heating the powdery product in a mould at a very high pressure. Another promising material has been made by hot pressing a mixture of bagasse and synthetic resin precursors.

84. *Filter Press Mud*. Work on the chemical utilization of sugar cane wax and fats has continued. In the isolation of constituents of the wax, particular attention has been paid to the sterol fraction.

85. *Laevulinic Acid*. Studies on the pilot plant production of laevulinic acid from molasses have now been carried out. It was found that the reasonable yield of 68 per cent. could only be obtained with an uneconomically low throughput, and if the charge of molasses were increased, the yield fell to as low as 40 per cent. and the reaction mixture was difficult to handle. Isolation of the laevulinic acid proved difficult on a pilot scale but a possible process was being evolved. However, it appears that the production of laevulinic acid in this way is unlikely to be economic and work on this project will probably be discontinued.

The reaction of carbohydrates in the presence of mineral acids to give laevulinic and formic acids has been studied, and analytical techniques for estimating these products have been developed.

Several possible processes utilizing laevulinic acid were investigated. The preparation of methyladipic acid which is used in the synthesis of a nylon was attempted but was not successful. Esters of laevulinic acid were prepared and their properties investigated. It was found that 2-methylpiperazine could be produced, but that although the price might be suitable for its use in the pharmaceutical industry it would not be made cheaply enough to be used as a basic material for the textile industry.

86. *Detergents from Sucrose*. A detergent similar to a sample received from the Sugar Research Foundation was produced by the reaction of sucrose with methyl stearate in the presence of dry potassium carbonate with dimethyl formamide as solvent. Although the production of these detergents is an interesting development, the present estimated cost compares somewhat unfavourably with that of established detergents. This will, of course, be the prime factor determining their use.

University College of the West Indies

87. *Monamycin*. Further progress has been made on the production, isolation and chemistry of this antibiotic. The work will be continued by Mr. K. E. Magnus at University College, Swansea, where his supervisor, Professor Hassall, is now working.

Makerere College, Uganda, Department of Chemistry

88. *Natural Products of East African Plants*. Dr. W. J. Peal is carrying out three main lines of research on the chemistry of local plants. A species of the Dioscoreaceae known as Kaama, probably *D. abyssinica*, is being grown on the University Farm to facilitate its examination. Three main fractions of an alcoholic extract have been obtained; an unidentified crystalline solid, a sapogenin mixture and β -sitosterol; the first two are being

investigated. Dodecandrol, a substance extracted from *Phytolacca dodecandra*, has been identified as α -spinasterol. Work on the improvement of the present technique for the conversion of diosgenin to progesterone has been completed.

Makerere College, Department of Agricultural Engineering

89. *Methane Fermentation*. Mr. W. Boshoff, a lecturer in Professor F. Wilson's department, is carrying out work on the methane fermentation of vegetable wastes. The effects of various factors on the progress of fermentation are being investigated on a laboratory scale and the results applied to experiments with pilot scale apparatus. Satisfactory digestion of elephant grass has been obtained on a small scale using decomposed cow dung as starting material. The apparatus, however, showed some defects and it is now being modified. It was found that, as might be expected, a higher feed rate of elephant grass was possible, without an increase in the volatile acid concentration, and a higher rate of gas output was obtained, at 32° than at 21°C. The yield of gas from a pilot scale digester based on the design of Boruff and Buswell was very low, and a simplified plant using a 44 gallon drum was developed. The first run with this was not successful, but a second trial, which is in progress at the time of writing, appears more promising. The results seem to confirm the opinion that satisfactory digestion of fibrous materials is far less easily achieved on a pilot scale than on a laboratory scale.

Forest Products Research Laboratory, Princes Risborough

90. *Production of Fibreboard*. The earlier work on the production of fibreboard from secondary Colonial timbers by a semi-chemical process has now been supplemented by investigations on the production of boards by a non-chemical process using the laboratory model Defibrator. The woods tested included morabukea and four Malayan species, namely, red meranti, keruing, kempas and balau, and boards meeting B.S. requirements were made from some of the individual woods and from a mixture of the Malayan species.

91. *Differences on Refining*. After treatment with steam alone in the Defibrator, pulps from all the species tested required further refinement in order to produce boards of adequate strength. Considerable differences in behaviour between the species were observed in this stage of the process. Pulps from morabukea and kempas could be refined to varying degrees without undue overall reduction in average fibre dimensions, the strength of the boards produced being proportional to the power consumed in the refiner. Meranti and keruing responded similarly, though within a more restricted range. Balau, however, showed a marked tendency to break down, with the production of excessive "fines", even at very low levels of power consumption. Similar, though less marked, differences in behaviour between these species had been observed using the semi-chemical process. With the more difficult woods, of which balau may be typical, some kind of chemical treatment is probably necessary in order to produce satisfactory boards.

92. *Density of Wood*. In either process, the two extremes were shown by morabukea and balau, which have similar bulk densities. Hence density alone cannot be taken as an indication of the suitability of any species for board manufacture.

Birmingham University, Department of Pharmacology

93. *Pharmacological Screening Unit*. A Unit has been established under Professor Frazer with the object of investigating the pharmacological activity of extractives from colonial plants and of other materials of interest and

importance to Colonial Territories. The examination of ammoniated molasses fractions and ingredients has been started with a view to learning more about the toxicity encountered with the material in feeding trials. A preliminary investigation of the pharmacological properties of 4-methyl-iminazole, one of the ingredients, showed that it was toxic to mice, apparently acting on the central nervous system.

94. *Anti-acetylcholine Activity*. Mr. A. R. Timms was awarded a Ph.D. degree, with warm commendation, for his study of drug antagonism upon the isolated ileum of the guinea pig. This work was completed during the year.

Birmingham University, Department of Chemistry

95. *Sugar Derivatives*. Mr. D. Horton has continued his work under the supervision of Professor M. Stacey. A pattern of incomplete acidic hydrolysis of D-glucosaminides resulting from the existence of two reaction pathways has been established. The series of oligosaccharides produced by the acid reversion of N-acetyl-D-glucosamine has been fractionated and two disaccharides were isolated pure. Their structure is being investigated and one of them is to be methylated in dimethylformamide solution and its hydrolysis products identified. This disaccharide is also being tested for growth factor activity for *Lactobacillus bifidus*, the predominant organism in the intestinal tract of healthy breast-fed babies.

Methods for extracting nitrogen-containing polysaccharides from the tissues of higher fungi have also been investigated.

Edinburgh University

96. *Aloe Species*. Mr. J. I. Henderson, supervised by Dr. L. J. Haynes has started work on the ingredients of aloe species.

Glasgow University

97. *Chemistry of Limonin*. The work on limonin, supervised by Professor D. H. R. Barton, is now being continued by Mr. S. K. Pradhan. New derivatives have been prepared and, in particular, compounds have been obtained from epi-limonol which are suitable for X-ray crystallography; so chemical and physical studies of the constitution of limonin are proceeding together. It has been found that seeds of grapefruit are by far the best source of limonin.

The Royal College of Science and Technology, Glasgow

98. *Steroids*. Mr. D. Savage, supervised by Professor F. S. Spring, has started the examination of certain colonial plants for steroids which might be of commercial importance. A new sapogenin, in low yield, has been isolated from sisal juice.

Nottingham University

99. *Hardwood Extractives*. Mr. J. D. White has continued his work on hardwood extractives under the supervision of Professor A. W. Johnson. The complete stereochemistry of arjunolic acid, derived from Abura (*Mitragyna ciliata*) has now been proved. A new diterpene acid has been isolated from the exudate of *Pterogopodium oxyphilium* and its structure investigated.

Work on Plant Material Supplied by the Council

100. *Hepatotoxic Agents*. Dr. R. Schoental of the Medical Research Council's Toxicology Research Unit has continued her study of medicinal plants which might contain hepatotoxic agents. Among the plants examined have been *Dichapetalum toxicarium*, *Entada gigans*, *Gossypium* sp., *Justicia*

ganderussa and *Momordica charantia*, but none of these produced significant liver damage or appeared very toxic to rats when administered in a normal diet. Alcoholic extracts of *Justicia ganderussa* and *Entada gigans* contained small amounts of alkaloidal substances which appeared to have a stimulating action on the animals and these plants might warrant pharmacological evaluation. The toxic agents in *Thylachium thomasi* and *T. africanum* have been identified as allyl-isothiocyanate compounds.

101. *Agave sisalana*. Dr. G. O. Aspinall and Dr. A. Canas-Rodriguez at Edinburgh University are working to obtain a more detailed knowledge of the composition and chemical structure of the pectic compounds of *Agave sisalana* flesh. Methods have been evolved for the fractionation of derivatives of pectic acid from the complex mixtures of polysaccharides found therein, and structural investigations are in progress.

102. *Dioscorea hispida*. The investigations on the constitution of the alkaloid dioscorine obtained from this species have been continued by Dr. A. R. Pinder at University College, Cardiff. A study has been made of the lithium aluminium hydride reduction of the base and the results suggest that dioscorine has not the formula formerly suggested for it; a new one has been proposed.

103. *Dichapetalum toxicarium*. Researches by Sir Rudolph Peters and his colleagues at the Agricultural Research Council's Institute of Animal Physiology, Cambridge, have shown that although a small amount of fluoroacetate has been detected in extracts of the seeds of *Dichapetalum toxicarium*, the main toxic component resides in the lipid fraction, and can be extracted by lipid solvents. A fraction was obtained which inhibits citric acid metabolism with kidney particles. Further investigation has shown that a major part of the active fraction behaves mainly as a C₁₈ fatty acid with one double bond and one fluorine atom. Other fractions separated did not contain fluorine and were not toxic. It is curious that the fluorine atom should be incorporated into only a small part of the seed fats and it is clearly of interest to search for the enzyme concerned with the synthesis and degradation of the C-F bond.

104. *Anona senegalensis*. Dr. A. Mackie, at the Heriot-Watt College, Edinburgh, has continued his chemical investigation of the leaves of *Anona senegalensis*. Several carbohydrates were found both in the free and combined states, though no tri-saccharides were present. The glucoside quercitrin and the aglycone quercetin were detected. A small amount of protein was obtained and a few free amino acids were also present. Palmitone and β -sitosterol, together with other sterol-like substances, were obtained from the unsaponifiable matter from the soft leaf wax.

Committee on
Colonial Road Research
Second Annual Report
1956-57

Road Research Laboratory,
Harmondsworth,
Middlesex.
1st August, 1957.

SIR,

I have the honour, on behalf of the Colonial Road Research Committee, to transmit to you the Second Report of the Committee covering the period from 1st April, 1956, to 31st March, 1957.

I have the honour to be,

Sir,

Your obedient servant,

W. H. GLANVILLE,
Chairman.

The Right Honourable Alan Lennox-Boyd, M.P.,
Secretary of State for the Colonies.

COMMITTEE ON COLONIAL ROAD RESEARCH

Membership

- DR. W. H. GLANVILLE, C.B., C.B.E., M.I.C.E., Director of Road Research
(*Chairman*).
- SIR GEORGE BURT, K.B.E., M.I.C.E., F.I.O.B., Messrs. J. Mowlem & Co., Ltd.
- R. L. FITT, ESQ., M.I.C.E., Sir Alexander Gibb & Partners.
- G. H. HARGREAVES, ESQ., M.C., M.I.C.E., Ministry of Transport and Civil
Aviation (to January, 1957).
- R. U. LAW, ESQ., M.I.C.E., Messrs. George Wimpey & Co., Ltd.
- J. S. MCNEIL, ESQ., B.Sc., M.I.C.E., A.M.I.Mun.E., Ministry of Transport
and Civil Aviation (from January, 1957).
- S. MEHEW, ESQ., O.B.E., M.I.C.E., M.I.Mun.E., A.M.T.P.I., County Surveyor,
Derbyshire.
- F. W. PARKER, ESQ., Messrs. Frederick Parker Ltd.
- J. L. PHIPPS, ESQ., M.B.E., Shell Petroleum Company Ltd.
- J. RAWLINSON, ESQ., C.B.E., M.I.C.E., M.I.Mech.E., M.I.Mun.E., County
Surveyor, London County Council.
- R. W. TAYLOR, ESQ., C.M.G., M.I.C.E., Engineer-in-Chief, Crown Agents and
Engineering Adviser to the Secretary of State for the Colonies.
- PROFESSOR GILBERT WALKER, D.Litt., Faculty of Commerce and Social Science,
University of Birmingham.
- SIR HUBERT WALKER, K.B.E., M.I.C.E., Adviser on Engineering Appointments,
Colonial Office.
- DR. R. S. MILLARD, B.Sc., A.M.I.C.E., Head of Colonial Section (*Ex officio*).
- F. H. P. WILLIAMS, ESQ., M.A., A.M.I.C.E. (*Secretary*).
- In addition to the above members, Colonial Governments are asked to
nominate delegates for each meeting. The following attended the 3rd meeting
held on the 17th June, 1957.
- G. C. W. BALDWIN, ESQ., O.B.E., Assistant Director, Public Works Department,
Northern Rhodesia.
- W. C. BELL, ESQ., A.M.I.C.E., Public Works Department, Hong Kong.
- A. G. BOORMAN, ESQ., M.Sc., D.I.C., A.C.G.I., M.I.C.E., M.I.W.E., Public
Works Department, Federation of Nigeria.
- K. L. HARDAKER, ESQ., M.A., A.M.I.C.E., Assistant Director, Public Works
Department, Aden.
- E. T. S. KING, ESQ., B.Eng., Director, Public Works Department, Western
Region, Nigeria.
- W. D. B. KINGSTON, ESQ., M.A., B.A.I., M.I.C.E., A.M.I.Mun.E., A.M.I.C.E.
(Ireland), Director, Public Works Department, Eastern Region, Nigeria.
- R. MILNE, ESQ., B.Sc., Deputy Director, Public Works Department, Sierra
Leone.
- F. SHARRATT, ESQ., A.M.I.C.E., Public Works Department, Kenya.

COLONIAL ROAD RESEARCH COMMITTEE
SECOND ANNUAL REPORT
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COMMITTEE ON COLONIAL ROAD RESEARCH**SECOND ANNUAL REPORT**

1. The period under review has seen the second meeting of the Committee and a gradual build-up in the staff and activities of the Colonial Section at the Road Research Laboratory. The Committee held its second meeting in June, 1956. It was attended by representatives of the following Colonial Governments: British Honduras, Brunei, Cyprus, Gold Coast, Kenya, Nigeria (Federal), Nigeria (Western Region), Nigeria (Northern Region), Northern Rhodesia, Nyasaland, Sierra Leone, Singapore, Tanganyika, Trinidad, and Uganda. A representative from Southern Rhodesia attended by special invitation.

2. In their report last year the Committee indicated their concern about the lack of means in some overseas territories to apply the results of research and thus to obtain full advantage from it. Successful application of research requires a sufficient number of trained and informed engineers who are able to devote their energies to the selection and exploitation of locally available road building materials and who are backed by the resources of materials testing and control laboratories. The Committee recommended that one means of meeting the need for such men which should be considered was the formation of a group of Materials Engineers based at the Road Research Laboratory and available to serve in different territories according to need. Enquiries of Directors of Public Works have shown considerable support for such a scheme; an estimate of the probable requirements from such a group during the next 10 years has been made and has been embodied in proposals which are now being considered by the Colonial Office.

3. The Committee is pleased to note that Nigeria (Federal) is proposing to establish its own central Road Research Laboratory and that Nigeria (Western) and Nigeria (Northern) are building up their Materials Testing Laboratories.

Staff and Accommodation

4. The build-up of the Colonial Section during the year under review has been slow but steady. At the end of March, 1957, the Section was short of complement by two scientific officers, five experimental officers and five assistants (scientific). It is hoped that a further improvement in recruitment will occur during the coming year, particularly of young scientific officers who are essential to the execution of experimental work in overseas territories.

5. The Section is still accommodated in the temporary premises provided at the Laboratory, and arrangements are being made for another temporary building to be erected to provide additional laboratory space, as there has been a further delay in the provision of the new laboratory buildings. These are now not expected to be completed before the middle of 1958. By then they will be inadequate for the needs of the Section, and further accommodation will be required. The restrictions and delays in new buildings affect the whole of the Road Research Laboratory; they bear particularly heavily on the Colonial Section, coming at a time when the Section is attempting to establish itself as a useful concern and when road transport is everywhere growing rapidly in importance and is vital to the development of the territories.

Visits

6. In May and June, 1956, Mr. Tresidder and Mr. Russam visited the Caribbean Territories to advise on local road problems and to collect information on the moisture conditions which exist in various types of soils under

sealed roads at the end of the dry season. During this visit contact was made with the Imperial College of Tropical Agriculture in Trinidad. A report on this visit has been written,⁽¹⁾ and also a note on the soil moisture conditions in Trinidad.⁽²⁾

7. Dr. Millard attended the Road Conference of West African Territories held in Accra, Gold Coast (now Ghana), in September, 1956. The Conference was attended by representatives from British and French territories in West Africa. Notes have been prepared summarising personal impressions of the Conference particularly as regards the needs for research, which were revealed and the extent to which the results of research are now being usefully applied.⁽³⁾ During the visit plans were made with the Director of Public Works for a co-operative investigation in the territory on the moisture conditions under roads and their effect on the bearing capacity of subgrades and bases. It has been concluded in Ghana that the lateritic gravels available are not adequate as bases for main roads, and soil stabilisation with cement has recently been introduced to provide bases of improved bearing capacity and which are less sensitive to the effects of increases in moisture content. Plans were made for full-scale experiments in Ghana and laboratory work in Ghana and at the Road Research Laboratory to determine the most economical methods of using soil-cement under West African conditions (see paragraphs 21-25).

8. Ghana is particularly suitable for these investigations. The range of climates and soil types will provide results which can be applied throughout West Africa and to other overseas territories. The organisation of the Public Works Department with its well-equipped Mechanical Road Construction Units and its established Materials Testing Laboratory provides some of the facilities necessary in the territories for the full-scale work. No less a material factor is an enthusiasm in the Public Works Department for these investigations. It is hoped that the new status of Ghana as an independent territory in the Commonwealth will not prejudice the completion of the programmes planned. As, however, it may take time for suitable arrangements to be worked out with the Government of Ghana, it is proposed meanwhile to initiate investigations of moisture conditions under roads in Kenya.

9. In the autumn of 1956, Dr. Millard made a two month tour of Singapore, Malaya, Sarawak, Brunei, North Borneo and Hong Kong, and visited the Central Road Research Institute, New Delhi, India, on his return journey.

10. Malaya is unique in the overseas territories in having a well-developed system of main roads nearly all with bituminous surfacings. One of the main problems confronting the Malayan Public Works Department is associated with impending independence in that a substantial number of engineers in the Department have signified their intention to resign. These are as yet few locally born engineers in the Department and it will inevitably be some years before these and other men now coming forward for training are able to fill the positions of greater responsibility. At present the Department contains a very efficient Roads Section and a Materials Laboratory, established during the past four years and already making an invaluable contribution to the work of the Department. The Committee hopes that in its activities it will be able to help Malaya in maintaining their road engineering works near the present level of efficiency.

11. Many of the main roads, particularly over the unconsolidated silts in the coastal areas, are proving inadequate in strength for the increasing traffic. This situation is being met in part by restricting the laden weight of vehicles. An outstanding requirement is for a method of pavement design applicable to local conditions, so that the amount of strengthening required on different roads can be determined in relation to the amount of traffic

wishing to use them. In particular, knowledge is required of the factors controlling moisture conditions in the soil under roads and of their effects on the form and thicknesses of construction required.

12. The use of rubber in bituminous surfacings is of great interest to Malaya. Two full-scale experiments and many of the simple road trials carried out by the Malayan Public Works Department during the past few years were seen during the visit. One experiment has demonstrated that rubber has potential value in promoting early stability in bituminous wet-sand-mix surfacings; a series of trials suggests that it may have value in semi-grouted construction. Proposals were made during the visit for further experimental work to examine the possible value of rubber in other forms of surfacing.

13. Singapore and Hong Kong have a common problem in the growing intensity of traffic and increasing congestion in the centre of the cities. These are problems in cities throughout the world but are particularly intense in these two cities because of the rapid development which is occurring, the mixed nature of the traffic and the very large numbers of pedestrians. It is proposed to build up a small group within the Colonial Section to study the special traffic problems of towns and cities in the overseas territories.

14. In Sarawak the main interest at the moment is in the planning and construction of the new road between Serian and Simanggang, a distance of approximately 80 miles through mountainous country. The Government is trying at the moment to recruit staff to undertake the work by direct labour. The heavy rainfall necessitates construction to bituminous surfaced standard from the start. As in Malaya there is a prime need for a method of pavement design which will enable the most economical form of construction suited to the expected traffic to be adopted. The work on this subject, referred to in paragraphs 29-35 will have direct application in these territories.

15. In the Third Division of Sarawak there are few sources of road aggregates; here, in Brunei and in North Borneo some aggregate is obtained from Hong Kong, a distance of over 1,000 miles by sea. There are deposits of sand near the coast in Brunei which are being exploited effectively for road construction by both bituminous and cement stabilisation. Farther from the sea there are deposits of sandy and gravelly clays, the products of decomposition of igneous rocks *in situ*, and arrangements were made for samples of these to be sent to the United Kingdom for detailed study, particularly to assess their suitability for stabilising.

16. This tour included the first visit of an officer from the Road Research Laboratory to Hong Kong and a note reviewing the road problems of that territory has been prepared.⁽⁴⁾ This contains proposals for specific researches which it is hoped may be pursued in co-operation with the Hong Kong Public Works Department and with other Road Authorities in South East Asia.

17. Reports have been written on the visits made by Mr. Williams to the Gambia, Gold Coast, and Sierra Leone in 1955 and Nigeria in 1956. A report on Roads and Road Problems in South East Asia and the Caribbean has been published by the Stationery Office (Colonial Research Publication No. 18).⁽⁵⁾

Research Activities

18. The research programme was reviewed by the Committee at their meeting in June, 1956. It contains five main items as follows:—

- (a) The economics of roads and road transport in underdeveloped territories.
- (b) Study of road-making materials available in colonial territories.

- (c) Pavement design.
- (d) Bituminous surfacings.
- (e) Machinery and labour.

19. During the year staff have been recruited to build up research teams to consider items (b) and (c) and the appointment of an economist towards the end of the year has made it possible to start on item (a). As a first step he has been examining existing sources of statistics on roads, road traffic and accidents. In particular the work has included a review of methods of reporting road accidents with the object of :—

- (i) Helping territories to adopt methods which are within their capacities and suited to their needs.
- (ii) Ensuring that the data collected are presented in such a way that they provide a reliable measure of the pattern of road accidents in the territories and of their economic importance.

20. *Road-making materials—earth and gravel roads. Corrugations.* A survey has been made of published information on corrugations, on theories which have been advanced to explain their formation, on methods of maintenance to keep them in check and on methods of alleviating or preventing them by selection and treatment of the road-making materials. No theory so far advanced to explain how corrugations form has been fully verified by experience or experiment. Hand labour has in the past been used extensively in maintaining corrugated roads but the growth of traffic and increasing cost of hand labour are both encouraging more extensive use of machinery. In the note summarising this information which has been prepared for publication⁽⁶⁾ methods of selecting and treating soils to render the road surface less prone to corrugate are discussed.

21. *Roads with sealed surfaces.* Over a large part of the overseas territories, crushed stone, the traditional road-making material, is not available and great use is made of naturally occurring soils and aggregates as road bases. The most important group of these are the lateritic soils (already referred to in paragraph 7) and decomposed rocks which occur extensively over the African territories, in the Far East and to a lesser extent in the Caribbean area.

22. Samples of representative materials have been collected for examination from Uganda, Northern Rhodesia and Gambia. Of the six samples of base material from Uganda, one, from the mountainous area near Fort Portal has been classified as a quartzitic gravel and the remaining five from the more low-lying area to the north of Lake Victoria, as ferruginous nodular gravels.

23. A study has been made of the bearing capacity of these soils at a range of densities and moisture contents using the California Bearing Ratio test. This has shown that their bearing capacity for use as bases under thin bituminous surfacings is critical and that it falls off rapidly, below the minimum required as the soils approach saturation. Soil stabilisation offers the prospect of improving these materials to make satisfactory road bases, e.g. the incorporation of small quantities of cement (of the order of 2–4 per cent.) provides material of improved stability which is considerably less affected by changes in moisture content.

24. An analysis of a survey by the Ghana Public Works Department of similar material in that territory has shown that with most soils within the group mixtures may be prepared having compressive strengths not less than

250 lb./sq. in. with cement contents up to 6 per cent. Soils from the rain-forest area in that territory showed anomalous properties, having a much slower gain in strength with increasing cement content than those from the savannah areas ; the reasons for this are being sought.

25. Further samples of soil from within the group are being obtained from Hong Kong, Kenya and Sarawak and information on similar and related soil groups is being sought in Malaya. Visits are being arranged by members of the Colonial Section to West, Central and East Africa to survey the occurrence of lateritic materials there, to collect samples and to study their performance in existing roads.

26. A second important group of naturally occurring road-making materials are in fine grained cohesionless sands occurring in coastal areas and in desert areas. Two opportunities have occurred during the year to investigate road construction problems with these materials, in connection with plans to build specific roads.

27. The first concerns the proposed Ado-Badagry road in Western Nigeria. The investigation was carried out during the secondment to the Laboratory of an engineer from the Western Nigerian Public Works Department (see paragraph 44). The investigation showed that for the traffic intensity expected, a thickness of road construction of 4 in. was desirable over the compacted sand and that this may be provided by stabilizing the soil on site with 5 per cent. of cement. Measurement of the bearing capacity of the sand on the section of road approaching Badagry suggested that, provided it is well compacted and adequately drained, it might possibly provide a suitable base for a thin bituminous surfacing, without the necessity for stabilizing. The provision of a stabilised base adds materially to the cost of construction ; this is an important issue in Nigeria and in other African territories where many of the naturally occurring road-making materials appear to have properties of this marginal character. It has therefore been suggested that the site be used for a full-scale road experiment to provide practical evidence on the suitability of the soil for use as a road base without stabilisation and to furnish data from which the laboratory criteria for unstabilised base materials can be more clearly defined.

28. The second concerns the Georgetown-Rosignol road in British Guiana. This road is to be reconstructed under the advice and supervision of a firm of consulting engineers and facilities have been given to the firm to examine samples of soil from the area in collaboration with the Laboratory. This investigation has added materially to the knowledge of the soils of the territory, their properties as subgrades and their suitability for stabilizing to provide road bases.

29. *Pavement design.* The cost of sealed road pavements is very high and it is of paramount importance to ensure that such pavements are adequately designed. The moisture condition within the various layers of material which comprise the road structure and foundation is one of the main factors affecting both the life and traffic-carrying capacity of the road. Under sealed road surfaces an approximate moisture equilibrium may exist. A method of determining this equilibrium condition under roads in the United Kingdom has been developed at the Road Research Laboratory. Field experience is necessary to determine the extent to which this method may be applied overseas and what further factors must be considered. A visit was paid to the West Indies from 18th May to 20th June to obtain first-hand knowledge of the climatic and soil moisture conditions in this area at the end of the dry season.

30. At several sites in Trinidad and Jamaica borings were made and the moisture contents of the soil at various depths under sealed road surfaces compared with those found at the same depths in the road verges. Undisturbed samples were taken for laboratory study of the soil suction and shrinkage properties. The main study of Trinidad soils suggests that the theoretical method of estimating the moisture distribution under roads from the suction properties of the soil and the position of the water table, as developed at the Road Research Laboratory for use in Great Britain, can be used in this area. It is also likely that the method can be used in other areas with similar climates. The road verges were not abnormally dry in comparison with the subgrades and it is unlikely that under these conditions drying from the edges will have a large effect on the moisture content of the subgrade as a whole. Seasonal volume changes will therefore not be large.

31. The suction and shrinkage characteristics of the Trinidad soils were very similar to those found for British soils of comparable plasticity indices and particle size distributions. It further appears that the clays tested had been subjected to similar consolidation or other structure forming processes as British clays. The report on the investigation of Trinidad soils has been issued⁽²⁾ and the examination of soil samples from Jamaica is continuing.

32. Soil suction measurements were made on the samples to determine what the critical moisture conditions were likely to be in the subgrades under the Ado-Badagry road and the Georgetown-Rosignol road, referred to in paragraphs 27 and 28. The thicknesses of pavement recommended were based on these predictions. The extension of the theory from conditions in Great Britain to these particular tropical conditions may be made with reasonable certainty, and the construction on both sites will provide the opportunity to determine more exactly the precision with which the method may be applied.

33. Data on the movement and distribution of moisture in soils under airfields in tropical and sub-tropical areas which has been collected by the Air Ministry and referred to in the first Annual Report of the Committee is being analysed. An analysis of the data from Khormaksar Airfield, Aden, has been carried out and a report issued.⁽⁷⁾ At this site where the soil is a medium/fine sand and the water table depth is approximately 3 feet the estimated moisture distribution using the method already referred to again gives good agreement with the measured values. Any changes of moisture content which occurred with time under the pavement were found to be due to fluctuations in the level of the water table and no evidence of any build up of moisture content due to vapour migration was found.

34. An examination of the data from two other sites, Khartoum (Sudan) and Abu Sueir (Egypt), has been carried out and laboratory tests are being made on soil samples from these airfields. Relevant moisture data and soil samples have also been received from Kai Tak airfield (Hong Kong), Habbaniya (Iraq), Heany, Kumalo and Thornhill (Southern Rhodesia).

35. The analysis of the Air Ministry data together with further field investigations enable a clearer picture to be obtained of the soil moisture conditions under impervious surfacings in various climatic conditions. It should then be possible to define the patterns of moisture movement in soil under roads in different conditions overseas, and to apply this knowledge in pavement design. A particular need in further work is to study the unsaturated permeability of soils and its effects on moisture conditions in the soil near the edges of roads particularly where there is a well-pronounced seasonal variation in rainfall.

36. The Committee notes with interest other investigations which have been in progress as part of the programme of the Road Research Board and

which are of special interest to the overseas territories. Some indication of these is given below.

37. *Rainfall and run-off studies.* Engineers are concerned with the design of surface water drainage systems for roads, and more particularly with the design of surface water drainage systems for the urban areas which are developing in many of the overseas territories. A large number of records of storms have been obtained during the summer at experimental sites covering different types of drainage area, and analysis of these records by the Lloyd-Davies and modified Ormsby and Hart methods is continuing. Run-off hydrographs have been calculated for the storms recorded at four sites by the unit-hydrograph method, which has formerly been employed for large undeveloped areas.

38. *Crushed stone bases.* In some oversea territories, crushed stone is used for the construction of road bases. During the summer of 1956 an experimental length of road has been completed on a trunk road in Nottinghamshire in which bases consisting of a wide variety of crushed rocks, gravels and industrial by-products were used. The following tentative observations can be made on the laying of the experiment. A report has been issued (RN/2947).

- (a) All the materials laid produced satisfactory bases.
- (b) When the materials were wetted and premixed, the effort involved in placing and compacting the base to achieve a uniform surface of good riding quality was much less than that required to place coarse aggregate dry, blinded with fines. This conclusion is of particular interest to engineers in the overseas territories where only light bituminous surfacings are used.
- (c) Bases containing limestone have shown evidence that they develop cementitious properties.

39. *Performance of compaction plant.* The value of compaction in increasing the strength of natural soil road bases makes the study of compaction equipment of great interest to overseas engineers. To add to information already published, during the year a report has been circulated describing the performance of a heavy rubber tyred roller (20 tons on 9 wheels) (RN/2861).

40. *The use of rubber in road surfacings.* The co-operative research which the Laboratory is engaged on with the Natural Rubber Development Board was referred to in the last Annual Report. A range of full-scale experiments is in progress to investigate the use of rubber in surface dressing, bitumen macadam and rolled asphalt. In laying the surface dressings it was noted that the immediate wetting and holding of the chippings by rubber-bitumen binders appeared better than by normal binders. This is possibly an advantage on heavily trafficked roads.

41. Some oversea territories have supplies of locally produced tars which are used for road-making and are interested in the possibility of improving the performance of these tars by the incorporation of rubber. It has so far proved very difficult to obtain stable mixtures of tar and natural rubber; a test for measuring the stability of the mixtures has been developed and is being used in the research to produce mixtures of adequate stability.

42. In some territories authorities are concerned with the provision of a resilient surfacing for school playgrounds. In this connection it is of interest to note that a number of small slabs using ground tyre tread rubber and sand as aggregates have been laid in the Laboratory grounds and subjected to heavy foot traffic.

Training and information services

43. At the courses on soil mechanics, bituminous materials and concrete, held at the Laboratory in the winter of 1956-57, 38 of the 224 places were taken up by colonial engineers. 47 colonial engineers were enrolled, but for sickness or other reasons, 9 did not attend. In the soil mechanics courses, extra lectures were included dealing with matters of overseas interest. 10 colonial engineers and one colonial police officer attended the courses on traffic and safety held in the spring of 1957.

44. The Western Region, Nigeria, sent a member of the staff of its Public Works Department to the Laboratory for a period of six months on secondment. During this period the officer received training in the various laboratory testing techniques, assisted on a full-scale experiment and attended the courses on materials given by the Laboratory. He also carried out tests on samples of soil taken from a road in the Western Region, Nigeria, which was scheduled for improvement, on which recommendations for the design of the road structure have been based. On his return it is proposed that this officer will set up and run a materials testing organisation in the territory.

45. This scheme provides one means of helping to put trained and informed Materials Engineers in the field and the Laboratory is ready within its capacity, to take officers from other territories for similar periods of secondment. Arrangements have been made for two further officers from Nigeria to be seconded to the Laboratory in this way, one from the Federal Public Works Department and the other from the Northern Region.

46. One of the characteristics of the scheme is that as part of his training the engineer studies a road problem from his own territory, and thus increases both his own and the general knowledge of road materials in the overseas territories.

47. The Laboratory has welcomed a large number of visitors during the year in consultation on particular colonial road problems, in addition to answering a growing number of technical enquiries by correspondence.

48. Public Works Departments are sent copies of Road Notes, notices of Technical Papers, Annual Reports and other publications of the Road Research Laboratory. In addition reprints of published articles on selected subjects by members of the Laboratory's staff and Summaries of Research Notes (unpublished reports) are also sent. Copies of Research Notes of particular interest to colonial engineers are sent out as soon as they are available. Research Notes on road traffic and safety are also sent to the police forces, and notes which have a bearing on policy are brought to the notice of Governments. A list of Research Notes which have appeared during the year and are of interest to overseas territories is given in Appendix 1.

49. *Overseas Bulletins*. A new series of notes, *Overseas Bulletins*, has been started with the object of disseminating information of particular interest to overseas territories. These will replace the Colonial Road Note series, and the two notes which were issued in that series will be *Overseas Bulletins* Nos. 1 and 2. Three further notes have been issued in this series as follows:

No. 3. Lime-stabilization of a nodular clay pea-laterite in Nyasaland.

No. 4. The use of aerial photographs in road construction in Nyasaland.

No. 5. Nyasaland laterites and their indications on aerial photographs.

It is intended to publish in this series a description of the use of lime stabilization in Northern Rhodesia and of cement stabilization in Brunei and Ghana.

References

- (1) TRESIDDER, J. O. Notes on a visit to the Caribbean area, 1956. *Department of Scientific and Industrial Research. Road Research Laboratory Note No. RN/3014/JOT.* (Unpublished.)
- (2) RUSSAM, K. An investigation into moisture conditions under roads in Trinidad, B.W.I. *Department of Scientific and Industrial Research. Road Research Laboratory Note No. RN/3011/KR.* (Unpublished.)
- (3) MILLARD, R. S. Notes on the Road Conference of West African Territories, September, 1956. *Department of Scientific and Industrial Research. Road Research Laboratory Note No. RN/2922/RSM.* (Unpublished.)
- (4) MILLARD, R. S. Roads and road problems in Hong Kong. *Department of Scientific and Industrial Research. Road Research Laboratory Note No. RN/3086/RSM.* (Unpublished.)
- (5) WILLIAMS, F. H. P. Report on roads and road problems in South East Asia and the Caribbean. Colonial Research Publication No. 18. H.M.S.O. (1957).
- (6) TANNER, J. S. Corrugations on earth and gravel roads. *Overseas Bulletin No. 6 (in the press). Department of Scientific and Industrial Research. Road Research Laboratory.*
- (7) RUSSAM, K. The movement and distribution of moisture in soils at overseas airfields. II, Khormaksar Airfield, Aden. *Department of Scientific and Industrial Research. Road Research Laboratory Note No. RN/3000/KR.* (Unpublished.)

Road Research Laboratory,
July, 1957.

APPENDIX I

LIST OF RESEARCH NOTES APPEARING BETWEEN APRIL 1956 AND
MARCH 1957 WHICH HAVE BEEN CIRCULATED TO THE COLONIES**Traffic engineering, road safety and economics of road construction,
maintenance and transport**

<i>RN No.</i>	<i>Title</i>	<i>Date of issue</i>
2728	Direction indicators	March, 1956
2756	A suggested specification for reflectorising materials used in traffic signs	March, 1956
2802	Notes on using the Sykes Traffic Counter No. 3 ...	May, 1956
2808	Traffic behaviour on a single track road in the Scottish Highlands	June, 1956
2854	International comparison of road accident statistics in 1954	August, 1956
2919	The effect on accidents of providing halt or slow signs	December, 1956
2988	A comparison of three types of reflectorised traffic sign	February, 1957

Road materials and methods of construction

<i>RN No.</i>	<i>Title</i>	<i>Date of issue</i>
2803	Recommendations for the construction of the Maiduguri- Bama road in Nigeria, B.W. Africa	June, 1956
2825	Notes for the guidance of engineers on sampling road making materials	June, 1956
2861	An investigation of the performance of a 20-ton pneumatic-tyred roller for compacting soils ...	September, 1956
2872	Laboratory experiments in the stabilisation of clays with hydrated lime	October, 1956
2953	An accelerated test for determining the strength of concrete	February, 1957

Colonial
Social Science Research Council
Thirteenth Annual Report
(1956-57)

London School of Economics and Political Science,
Houghton Street,
Aldwych,
London, W.C.2.
12th October, 1957.

SIR,

I have the honour, on behalf of the Colonial Social Science Research Council, to transmit to you the Thirteenth Report of the Council, covering the period from 1st April, 1956, to 31st March, 1957.

I have the honour to be,

Sir,

Your obedient servant,

ARNOLD PLANT,
Chairman.

The Right Honourable Alan Lennox-Boyd, M.P.,
Secretary of State for the Colonies.

COLONIAL SOCIAL SCIENCE RESEARCH COUNCIL

THIRTEENTH ANNUAL REPORT

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- 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., Fellow of Newnham College, University of Cambridge.
- PROFESSOR I. SCHAPERA, M.A., D.Sc., F.R.S.S.Af., Professor of Social Anthropology, London School of Economics and Political Science.
- PROFESSOR R. W. STEEL, B.Sc., M.A., Rankin Professor of Geography, University of Liverpool.
- PROFESSOR SIR RALPH TURNER, M.C., M.A., Litt.D., F.B.A., Director of the School of Oriental and African Studies, University of London.
- MR. A. F. COMFORT (*Secretary*).

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 Empire.

COLONIAL SOCIAL SCIENCE RESEARCH COUNCIL

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APPENDICES—Reports from the Regional Institutes:

- I. The East African Institute of Social Research
- II. The West African Institute of Social and Economic Research
- III. The Institute of Social and Economic Research, University College of the West Indies
- IV. The Rhodes-Livingstone Institute

COLONIAL SOCIAL SCIENCE RESEARCH COUNCIL

ANNUAL REPORT

I. INTRODUCTION

The Council held three meetings during the year 1st April, 1956 to 31st March, 1957. Six meetings of Committee, took place.

2. There were no changes in the composition of the Council since those noted in the previous report.

3. Mr. K. E. Robinson, of Nuffield College, Oxford, was compelled by his other commitments to resign from his membership of the Committee on Anthropology and Sociology. Sir Douglas Veale, the Registrar of Oxford University, also resigned from the Committee on History and Administration for similar reasons.

4. Dr. Eveline Martin, of the University of London, and Professor W. J. M. Mackenzie, of the University of Manchester, joined the Committee on History and Administration during the year.

5. There was no change in the composition of the Linguistics Committee.

6. A meeting of the Inter-African Committee on Social Sciences of CCTA was held in London in February, 1957. Professor Daryll Forde, of University College, London, attended as United Kingdom delegate and took the Chair at the meeting. Other members of the Council who were also present at the meeting were Dr. Audrey Richards, who represented the East African territories and Professor Schapera, of the London School of Economics.

7. Professor R. W. Steel, of Liverpool University, attended a meeting of Geographers, held at Brussels in July, 1956, to examine a CCTA proposal for the drawing up of population maps of Africa.

8. Professor Daryll Forde represented the United Kingdom at a meeting of specialists (also held under CCTA auspices) in July, 1956, in London to consider further research into migration in West Africa.

II. GENERAL

9. Issues against the allocation of £525,000 for Social Research to the end of the year totalled £204,309. Few new large grants were made in the year; decisions had already been taken in the year 1955-56 on the more important projects. An additional grant was, however, under consideration towards the end of the year to assist the Rhodes-Livingstone Institute in its building programme and with the cost of publishing both recurrent publications and books. The West African Institute of Social and Economic Research was wound up at the end of the year and the question of a grant for the new Nigerian Institute of Social and Economic Research was under consideration.

10. Work was begun on the project initiated by the Department of History, at University College, Ibadan, for a History of Benin (to be financed jointly with the Carnegie Corporation and the Governments of Nigeria) and on the study of family attitudes in Jamaica undertaken by the Conservation Foundation of New York, towards which the Council contributed in the previous year.

11. In accordance with the principle decided upon in 1955-56 of encouraging historical and administrative studies, the Council approved a number of grants to enable studies to be made of election procedures in

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Sierra Leone, Kenya and Eastern Nigeria. Grants were also made to assist individual historical studies in Uganda and Kenya. At the end of the year preliminary arrangements were well advanced on the proposed Regional History of East Africa which is to be in three volumes.

12. An increase was noted during the year in the numbers of American scholars working in British African territories on social science research projects with grants from the Ford Foundation. Three senior members of the Directorate of the Foundation visited African territories in the autumn of 1956.

13. A grant was made by the Leverhulme Foundation to Dr. Kaberry, of University College, London, to enable her to carry out a study of a Bamenda Chiefdom in the Cameroons. The Council agreed to provide a supplementary grant to cover additional expenditure.

III. REGIONAL INSTITUTES OF SOCIAL AND ECONOMIC RESEARCH

14. The full reports of the four Institutes will be found at the end of the present report.

15. Dr. Lloyd Fallers, who took over the directorship of the East African Institute of Social Research early in 1956, was unfortunately obliged by personal circumstances to resign the directorship as from July, 1957. He will be succeeded by Dr. Aidan Southall of the Institute. The constitution of the Institute will be remodelled so as to bring it into closer relationship with Makerere College, and Dr. Southall will hold the Chair of Sociology and Social Anthropology at the College in addition to the chairmanship of the Institute's Executive Committee.

16. The Rhodes-Livingstone Institute is proceeding with the recruitment of staff for its Research Programme, a large part of which has been generously financed from private sources in Northern Rhodesia in response to an appeal.

17. Dr. Huggins, Director of the Institute of Social and Economic Research at the University College of the West Indies, has been awarded a Guggenheim Fellowship and will be spending the academic year 1957-58 in the United States continuing his studies of capital expansion and economic growth in underdeveloped areas.

18. As is stated in paragraph 9 above, the West African Institute of Social and Economic Research was wound up at the end of the year. Its place will be taken by a new Nigerian Institute of Social and Economic Research, of which the post of Director will be combined with the Chair of Economics and Social Studies at University College, Ibadan. Professor R. H. Barback took up his duties at the University College in the Autumn of 1956 and recruitment of staff for the new Institute has begun.

19. The Educational Research Institute at Nasinu, Fiji, was wound up at the end of 1956. It is intended that the Institute's work will in time be taken over by the Teachers' Training College.

IV. RESEARCH IN THE COLONIAL TERRITORIES FINANCED INDEPENDENTLY OF COLONIAL DEVELOPMENT AND WELFARE FUNDS

20. *Hong Kong*. Research projects carried out by the University of Hong Kong are listed in the Hong Kong Annual Report for 1956.

21. *Cyprus*. The Director of Welfare Services published in 1956 an official study of deprivation, neglect and child care in the island. This was the first

survey of the subject to be held in Cyprus and comprised the results of an island-wide survey based on the work of social workers in the Department of Social Welfare from 1951 to 1955.

22. *West Indies*. Details of research studies carried on outside the regular programme of the Institute are given in the Annual Report of the Institute of Social and Economic Research in the University College of the West Indies. In addition, a Linguistic Survey is now being carried out by the College with a grant from the Carnegie Foundation. Dr. J. Berry, Reader in West African Languages at the School of Oriental and African Studies, visited Jamaica in 1956 to assist this study. His visit was financed with funds provided by the British Council.

23. *Malaya*. The Department of Economics of the University of Malaya have produced a report on the socio-economic survey of five villages in the Jasin district of Malaya carried out from 1955 to 1956. The survey was undertaken at the request of the Rural and Industrial Development Authority to provide a basis for development and resettlement plans in the area.

24. The Department of Broadcasting, with the assistance of funds provided by the Asia Foundation, are working on a collection of traditional music in Malaya.

25. The Department of Education, with the assistance of Mr. K. A. Spelling, a psychologist on loan from UNESCO, have continued their work on aptitude tests. Mr. Spelling has conducted a large scale investigation in non-verbal intelligence tests over the whole Federation.

26. *Singapore*. The Department of Social Welfare carried out surveys of the circumstances of old people and of the leisure needs of youth. Social research staff also participated in the Singapore Trial Census held in September, 1956. A study of trishaw riders in Singapore was also undertaken at the request of the Ministry of Communications and Works.

27. *Sierra Leone*. The results are being collated of research begun in 1953 on methods of selection of pupils in primary schools.

28. *Northern Rhodesia*. As in the last year, the Rhodes-Livingstone Museum has, in addition to its archaeological work, carried out research into the material culture of the indigenous peoples of the territory. The Commission for the Preservation of National and Historical Monuments and Relics has also assisted in research into local history.

V. COLONIAL DEVELOPMENT AND WELFARE PROJECTS IN PROGRESS

Projects undertaken by the International African Institute

Handbook of African Languages

29. The third volume of the four volume survey, *Non-Bantu languages of North-eastern Africa*—by A. N. Tucker and M. A. Bryan, was published in 1956, and the fourth volume—*Bantu Languages of Africa*, edited by M. A. Bryan—is now in the press. A special study of some of the languages of North-eastern Africa, including detailed linguistic analyses which could not be included in volume three of the survey for lack of space, is now being prepared for publication. This will complete the work carried out on this project.

Ethnographic Survey of Africa

30. Since the inception of this scheme, forty volumes have been published, including three prepared and published in Belgium under the auspices of

the Musée du Congo Belge, Terurven, and four in France financed by the Government of French West Africa. Further sections on peoples of East Africa and of Nigeria are in preparation. Four volumes are now out of print. More than 150 individuals and libraries have placed standing orders for all titles in this series, apart from bookshops and agents. Receipts from sales of volumes financed from C.D. & W. grants amounted to approximately £6,300 at June, 1957.

Linguistic Survey of the Northern Bantu Borderland

31. Volumes one, two and four of the report of this survey have now been published. The cost of publication of volume one is being defrayed from the Handbook grant, the costs of volumes two and four being borne by the International African Institute.

Other African Projects

Publication of Lord Lugard's Diaries

32. The first three volumes of the Diaries which have been prepared for publication under Miss Perham's direction have now been sent to the publishers, and the remaining volume is expected to be ready for printing in the Autumn of 1957.

Land Tenure in British Africa

33. Dr. Meek's volume on Nigeria and the Cameroons, which is being printed with the aid of contributions from the Nigerian Governments, is expected to be published very shortly.

Preparation of Ga-Adangme Dictionary

34. Dr. Berry has now completed the first half of the dictionary, which is expected to go to press shortly.

Field Study of the Nomadic Fulani, Northern Nigeria

35. Dr. Stenning's report is now to be published under the auspices of the International African Institute.

Study of the Mbembe People, Southern Nigeria

36. Miss Rosemary Harris has submitted regular reports on her study. She expects to return to the United Kingdom in August, 1957, to begin the writing-up of her material.

Study of the State of Gonja

37. Dr. Goody visited Gonja in June, 1956, for a period of seven months' field research. The Nuffield Foundation kindly agreed to provide a further grant to enable him to make a further visit in 1957 after Ghana became independent. Dr. Goody's book "Social Organisation of the Lowiili", which incorporated the results of the study he made with a CSSRC grant, was published in the Colonial Research Studies series during the year.

Sociological Research in Gambia

38. Mr. Gamble returned to London in October, 1956, in order to write up his field work. He has now submitted a Ph.D. thesis on the results of his research in the Kombo area.

Study of the Kikuyu Family, Kenya

39. Dr. Jeanne Fisher has now practically completed the revision of her report, which is to be duplicated.

Anthropological Study of the Kiga, Uganda

40. A final interim report has been received from Dr. Baxter, who has now returned to the United Kingdom after his period of study at the East African Institute of Social Research.

Survey of Land Tenure and Land Usage in Swaziland

41. It has not yet proved possible to recruit staff for this project, for which a grant has been made available from C. D. and W. funds. The University of Natal have agreed to administer the survey.

Study of the Indo-Mauritian Social Structure

42. Dr. Benedict has submitted a further progress report on his studies. He returned to the United Kingdom from September, 1956, to the end of February, 1957, when he left again for Mauritius. While in the United Kingdom, Dr. Benedict read a paper on "Factionalism in Mauritian Villages" which is expected to be published shortly.

Study of the Somali Tribes

43. Mr. Lewis continued his research into the social organisation of the Somali tribes. He returned from the United Kingdom and submitted a report shortly after the end of the year.

**Study of the Kenya Legislative Council*

44. A grant was made to Mr. G. Bennett, Lecturer in Colonial History at Oxford University, to enable him to visit Kenya in order to carry out a study of the history of the Kenya Legislative Council.

**Historical Research in Uganda*

45. The Council approved a grant to Mr. Low, Lecturer in History at the University College of East Africa, to assist him to complete his studies in the United Kingdom on the History of Uganda from 1862-1901. Mr. Low had previously worked on this subject while in Uganda.

**Study of Land-use in Uganda*

46. A grant was made from C. D. and W. funds to Miss Barbara Sloane, of the London School of Economics, to supplement an award made by the Goldsmiths' Company for a projected study of land-use in Ankole. Miss Sloane will be spending two years in Uganda.

**Election Studies*

47. In connexion with the projected volume of election studies, which it is planned to produce under the editorship of Professor Mackenzie of the University of Manchester and of Professor Kenneth Robinson of the University of London, grants were made to Mr. Scott, of the University of Manchester, to enable him to study the elections in Sierra Leone, to Mr. Price, of the University College of Ghana, to provide for a study of the Eastern Nigerian election, and to Mr. Engholm and Dr. Whitaker of Makerere College, who studied the Kenya African elections.

Caribbean*Crown Colony Government in Jamaica*

48. Mr. Fitzroy Augier submitted a thesis to the University of St. Andrews on his research and has been awarded the degree of Ph.D. He is now expected to edit one of the volumes of the large scale History of the West Indies, planned by the University College of the West Indies, under the general editorship of Professor J. H. Parry.

* Projects started in the year under review.

Amerindian Studies in British Guiana

49. Dr. Audrey Butt of the Pitt Rivers Museum was granted a further award to enable her to make a second visit to British Guiana, originally proposed for 1955 but deferred until she could obtain leave of absence from her present appointment. Dr. Butt left for British Guiana in March, 1957, and is expected to return in the Autumn.

Social Mobility in Jamaica

50. Dr. S. Collins' paper on Social Mobility in Jamaica was published during the year. He was awarded a further grant to enable him to return to Jamaica in the Summer of 1956 in order to complete a study on "the Teacher and Community in Jamaica" which is expected to be published in book form.

Study of the Working Class Movement in the British West Indies

51. Mr. Francis X. Mark has returned from the West Indies and is engaged on the writing-up of his research.

South East Asia and Pacific*Singapore*

52. Mr. Maurice Freedman's book, *Chinese Family and Marriage in Singapore*, was published in the Colonial Research Studies series at the end of the year.

Malaya

53. *Study of Visual Perception*. Mrs. Thornton presented a thesis to the University of Reading on the results of her research on differences in visual perception among various ethnic groups in Malaya, for which she was awarded a grant from C. D. and W. funds in 1953 as a contribution to the cost of her study. The degree of Ph.D. has been conferred on her. A copy of the thesis has been presented to the Colonial Office Library, where Dr. Thornton's field records are also being retained for consultation by research workers.

VI. THE STANDING COMMITTEES OF THE COUNCIL

54. The present composition of the Standing Committees is as follows :—

Committee on Anthropology and Sociology

Professor I. Schapera, University of London (*Chairman*).
 J. H. M. Beattie, Esq., University of Oxford.
 Professor Daryll Forde, University of London.
 Professor D. V. Glass, University of London.
 R. S. Hudson, Esq., C.M.G., Colonial Office.
 G. I. Jones, Esq., University of Cambridge.
 E. R. Leach, Esq., University of Cambridge.

Committee on History and Administration

Professor Vincent Harlow, C.M.G., University of Oxford (*Chairman*).
 Professor G. S. Graham, University of London.
 H. V. Hodson, Esq., Editor of "The Sunday Times".
 Professor W. J. M. Mackenzie, The Victoria University, Manchester.
 Miss Lucy Mair, University of London.
 Miss Eveline C. Martin, University of London.
 F. J. Pedler, Esq., United Africa Company.

Miss Margery Perham, C.B.E., University of Oxford.
 Professor C. H. Phillips, University of London.
 K. E. Robinson, Esq., University of Oxford.
 R. E. Robinson, Esq., University of Cambridge.

Linguistics Committee

Professor Sir Ralph Turner, M.C., F.B.A., University of London
 (*Chairman*).
 Professor J. R. Firth, O.B.E., University of London.
 Professor M. Guthrie, University of London.
 Rev. E. W. Smith.

Secretary of the Standing Committees

D. R. Willmott, Esq., Research Department, Colonial Office.

**PUBLICATIONS BY WORKERS ASSISTED FROM COLONIAL
 DEVELOPMENT AND WELFARE FUNDS**

55. 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:—

- Andrzejewski, B. W., "Some Problems of Somali Orthography" *Somali-land Journal*, 1, 1, 34-47. December, 1954.
- Ardener, Edwin, "Coastal Bantu of the Cameroons". International African Institute. (Volume in series *Ethnographic Survey of Africa*.)
- Berry, J., "Some Notes on the Pronunciation of the Krobo Dialect of Adangme". M.L.I.O., Band V, Heft 2, 1957.
- "Some Notes on the Phonology of the Nzema and Ahanta Dialects." Bulletin of the School of Oriental and African Studies. 17, 1, 160-5, 1955.
- Bohannan, P. J., "Justice and Judgement among the Tiv". O.U.P. for International African Institute, 1957.
- "Beauty and Scarification amongst the Tiv." *Man*, Vol. LVI, No. 129, September, 1956.
- Bradbury, Robert, "The Benin Kingdom and the Edo-speaking Peoples". International African Institute (Volume in series *Ethnographic Survey of Africa*). 1956.
- Burridge, K. O. "A Note on Tangu Dreams". *Man*. Vol. LVI, No. 130, September, 1956.
- Collins, S. "Social Mobility in Jamaica with reference to a Rural Community and the Teaching Profession". *Proceedings of the World Congress of Sociology, Amsterdam*, 1956.
- Cumper, G. E., "Population Movements in Jamaica 1830-1950". *Social and Economic Studies*, Vol. V, No. 3, September, 1956.
- "Working class emigration from Barbados to the United Kingdom—October, 1955." *Ibid.* Vol. VI. 1. March, 1957.
- Cunnison, Ian G., "Perpetual Kinship: a political institution of the Luapula peoples". *Human Problems in British Central Africa*, XX, pp. 28-48—1956.
- "History and Genealogies in a Conquest State (Kazembe's Lunda)." *American Anthropologist*, Vol. 59, No. 1, February, 1957.

- Dark, Philip, "The ETON of Southern French Cameroons". *Man*, Vol. LVI, No. 132, September, 1956.
- Freedman, Maurice, "Chinese Family and Marriage in Singapore". H.M.S.O. 1957.
- Goody, J. R., "The Social Organisation of the LoWiili". H.M.S.O. 1957. "Incest and Adultery ; a Comparative Approach". *British Journal of Sociology*, December, 1956.
- Gulliver, P. H., "The Teso of the Karamojong Cluster". *Uganda Journal*, Vol. 20-2, 1956.
- Gunn, Harold, "Pagan Peoples of Central Area of Northern Nigeria". International African Institute (Volume in series *Ethnographic Survey of Africa*). 1956.
- Kerr, Madeline, "Jamaican Rorschachs". Protocols published in the University of Kansas Microfilm Series—1957.
- Lewis, I. M., "La Comunita ('Giamia') di Bardera sulle rive del Guiba". *Somali d'Oggi*, Mogadishu, Anno II, No. 1, 1957.
- "The Somali Lineage System and the total Genealogy : a general introduction to basic principles of Somali political institutions." Secretariat, Hargeisa, Somaliland 1957 (duplicated).
- "Sufism in Somaliland : a Study of Tribal Islam." Bull. S.O.A.S., 17, 581-602, 1955 ; 18, 1, 145-60, 1956.
- Lloyd, P. C., "A Study of the Social Organisation and history of the Itsekiri people in Warri". International African Institute, *Ethnographic Survey of Africa* (Western Africa), Part XIII, 1957.
- Marwick, M. G., "The Continuance of Witchcraft Beliefs". *The Listener*, April, 1956. Abstracted in "The Colonial Review" and "Health Information Digest for Hot Countries". Copied in translation in "Mededelingen van Het Afriken Instituut".
- Milner, G. B., "Fijian Grammar", Govt. Press, Suva, Fiji, March, 1957.
- Mitchell, J. Clyde, "Africans in Industrial Towns in N. Rhodesia". H.R.H. the Duke of Edinburgh's Study Conference Background Papers No. I O.U.P. 1956.
- Morris, Stephen, "Indians in East Africa : a Study in a Plural Society". *British Journal of Sociology*, Vol. VII, No. 3, 1956.
- Prothero, R. M., "Population Patterns and Migrations in Sokoto Province Northern Nigeria" in Report of the Makerere Geographical Symposium, 1955—London, 1956.
- Smith, M. G., "Community Organisation in Rural Jamaica". *Social and Economic Studies*, Vol. 5, No. 3, September, 1956.
- "The Transmission of Land Rights by Transmission in Carriacou." *Ibid.* Vol. V. 2. June, 1956.
- "A Report on Labour Supply in Rural Jamaica." Government Printer. Jamaica. August, 1956.
- "The Social Functions and Meaning of Hausa Praise-Singing." *Africa*. Vol. 27. 1. January, 1957.
- "Ethnic and Cultural Pluralism in the British Caribbean." Incidi. 30th Conf. doc. II. March, 1957.
- Smith, R. T., "The Negro Family in British Guiana". Routledge & Kegan Paul. 1956.

- Southwold, M., "The Inheritance of Land in Buganda". *Uganda Journal*, 20, 1, 88-96, March, 1956 (Tables).
- Thornton, Peggie, "Visual Perception among the Peoples of Malaya". Abstract of paper read at British Psychological Society Conference in March, 1957. Published in the Bulletin. Pre-Bulletin off-prints March, 1957.
- West African Institute of Social and Economic Research, "Annual Conference Proceedings, March, 1956". W.A.I.S.E.R. 1956.
- Whiteley, W. H., "The Changing Position of Swahili in East Africa". *Africa*, Vol. XXVI, No. 4, Oct. 1956.
- Morton-Williams, P., "Cinema in Rural Nigeria". Federal Information Service, Govt. of Nigeria—1956.
- "The Atinga Cult among the South-Western Yoruba: a Sociological Analysis of a Witch-finding Movement." *Bulletin de l'IFAN*, T.XVIII, ser. B, Nos. 3-4, 1956.

Papers to be Published

- Berry, J. W., "An English Ga-Adangme Dictionary"—Part I. To be published by Macmillan & Co. Ltd. London.
- Clarke, Edith, "My Mother Who Fathered Me". To be published by Allen & Unwin (London).
- Wachsmann, K. P., "A Study of Norm in the Tribal Music of Uganda". To be published in *Ethnomusicology*.
- "Primitive Musical Instruments and Typology." To form part of a Penguin on Musical Instruments.

APPENDIX I

EAST AFRICAN INSTITUTE OF SOCIAL RESEARCH

DIRECTOR'S REPORT, 1956-1957

1. Publications

(a) Published:

Alur Society: A Study in Processes and Types of Domination, by A. W. Southall. Heffers, 1956.

Bantu Bureaucracy: A Study of Integration and Conflict in the Political Institutions of an East African People, by L. A. Fallers. Heffers, 1956.

An African Labour Force: Two Case Studies in East African Factory Employment, by W. Elkan. East African Studies No. 7.

Religion and Society in Buganda, by D. A. Low. East African Studies No. 8.

Townsmen in the Making: Kampala and Its Suburbs, by A. W. Southall and P. C. W. Gutkind. East African Studies No. 9.

(b) In Press:

Economic Policy and Labour in Uganda, by P. G. Powesland (edited by W. Elkan). East African Studies No. 10.

A Short Description of Item Categories in Iraqw (with material on Gorowa, Alagawa and Burunge), by W. H. Whiteley. East African Studies No. 11.

(c) In Preparation:

Methods of Selection of African Chiefs in Eleven East African Tribes, edited by A. I. Richards.

The Batoro, by B. K. Taylor.

The Economic Development of the Nyanza Province of Kenya Colony, 1903-1953, by H. Fearn.

Labour Problems in the Industrialization of an African Society: A Study in Industrial Employment in Uganda, by W. Elkan.

Kampala: A Study of a Multi-Racial Town, edited by A. W. Southall.

African Co-operation: A Study of African Co-operative Activity in the Nyanza Province, by H. Fearn.

Land and Population in Nyakyusa, by P. H. Gulliver.

Carnegie Studies in African Leadership

A Political History of Buganda.

Leadership in Buganda.

Leadership in Nyanza.

2. *Staff.* Two new members, Dr. Derrick J. Stenning and Mr. Malcolm J. Ruel, have joined the Institute staff during the past year. Dr. Stenning's previous research has been among the Fulani of Nigeria, while Mr. Ruel has carried out field work among the Banyang of the Cameroons.

Three former members of the staff have returned to take up new appointments. Mr. A. B. Mukwaya, having earned the Diploma in Anthropology at the University of London, rejoined the staff in July. He had been away from Uganda for two years. Mr. P. C. W. Gutkind also returned in July, having been away since June, 1955. During his absence from the Institute, he was successively a United Nations Fellow observing social welfare services for minorities in the United States, a Special Consultant to the Bureau of Social Affairs of the United Nations, and a post-graduate student at the London School of Economics. Dr. Walter Elkan returned to the Institute in September, having been awarded the Ph.D. by the University of London for the work on labour problems which he had carried out during 1953-1955.

Dr. W. H. Whiteley departed in September for a year's study leave in Belgium, France and the United Kingdom.

The staff at 1st April, 1957, was as follows:

Director	...	...	...	...	...	Dr. L. A. Fallers
Anthropologists	...	...	...	...	...	Dr. A. W. Southall Dr. D. J. Stenning Mr. A. B. Mukwaya Mr. M. J. Ruel
Sociologist	...	...	...	...	...	Mr. P. C. W. Gutkind
Economist	...	...	...	...	...	Dr. W. Elkan
Linguist	...	...	...	...	...	Dr. W. H. Whiteley (on leave)
Administrative Staff	...	...	...	...	...	Miss G. B. Hunter Miss B. O. Berrangé

3. *Associated Research Workers.* Three new Associates sponsored by the Ford Foundation have arrived during the year. Mr. Fred Burke of Princeton University has studied local government in Mombasa and in several districts of Uganda. Mr. Alan Jacobs of the University of Chicago is carrying out research into Masai social structure, while Mr. E. V. Winans is doing a study of the Shambaa of Tanganyika.

Mr. and Mrs. N. Dyson-Hudson of Oxford are continuing their research among the Karamojong with the aid of a grant from the Fulbright Programme.

Dr. David Apter completed his tour and returned to North-Western University in August.

4. *Work in Progress. The Leadership Project.* In December the Director travelled to Cambridge to meet with members of the study team to make final plans for the publication of the results of the study. Three volumes were planned (see Publications in Preparation, p. 1), and since the meeting substantial portions have been submitted in manuscript. These are being circulated among members of the team.

The Kampala Survey. The major part of the book, to be edited by the survey director, Dr. A. W. Southall, has been written and is expected to go to press shortly (see *Publications in Preparation*, p. 1). A preliminary account of the survey's findings has been published in the East African Studies series under the title *TOWNSMEN IN THE MAKING*. This has proved so popular among local readers that a reprinting has had to be undertaken.

Individual Projects. Dr. Elkan has begun an inquiry into the way imported goods are distributed. He is particularly interested in the economic reasons for and consequences of various types of import mechanisms.

Dr. Stenning is carrying out a study of the social structure of Ankole, with particular reference to the social background of cattle-keeping. He is also gathering data on political structure for comparison with that on the other Interlacustrine groups assembled by members of the Institute.

Mr. Gutkind is following up the work carried out in connection with the Kampala Survey with a study of housing needs in the Jinja area and a study of problems of urban development in Greater Kampala.

Mr. Ruel is carrying out field research amongst the Kuria on the boundary of South Nyanza District, Kenya and North Mara District, Tanganyika. He completed an initial general survey and is now making a sociological study of the past and present organization of one Kuria sub-unit.

Mr. Mukwaya has begun a study of African trading organizations. He is investigating the operation of such organizations in Uganda over the past several decades and is attempting to discover the conditions under which they arise and succeed or fail.

5. *Conferences.* As in past years, Institute conferences were held in July, 1956 and January, 1957.

The following papers were read at the July conference:

Some Implications of the Application of the English Committee System to Local Government in Uganda, by F. Burke.

Traditional Gusii Sanctions, Personality and Child Rearing, by R. LeVine.

Traditional Ganda Values as a Source of Current Politics, by L. A. Fallers.

The Establishment of British Administration: Two Examples from Uganda 1900-01, by D. A. Low.

One day of this conference was devoted to discussion of Comparative Nilotic Studies, led by Paula Hirsh, A. W. Southall and Dr. G. M. Wilson.

The following papers were read at the January conference:

Proposals for a Comparative Study of Nilotic Peoples of the Lwo Group, by A. W. Southall.

Padhola: Comparative Social Structure, by A. W. Southall.

The New Role of the Chief with special reference to the Jopadhola, by F. Burke.

Closer Union and Uganda, by K. Ingham.

Cotton and the Uganda Economy, 1903-1913, by C. Ehrlich.

The Role of Social Surveys in the Study of African Urbanization, by V. Pons.

The Theory of Urban Sociology, by A. W. Southall.

The Problem of Urbanization in Broad Sociological Terms, by P. C. W. Gutkind.

Agricultural Income and Labour Migration, by W. Elkan.

Nyakyusa Age-Villages in Transition, by P. H. Gulliver.

Ritual and Karamojong Groups, by N. Dyson-Hudson.

A Preliminary Account of the Shambaa, by E. V. Winans.

In November Dr. Elkan travelled to Salisbury, Southern Rhodesia to attend a C.C.T.A. advisory meeting on research into labour productivity.

6. *New Constitution.* During the coming year a new relationship between the Institute and the Social Studies Department of Makerere College will be inaugurated. Under its original constitution, the Institute was only administratively attached to the College and was separately financed from Colonial Development and Welfare funds. At that time, the social science fields were in an early stage of development in the College and it was felt that a clear separation between teaching and research would be of advantage to both. During recent years, however, it has become clear that a closer relationship could profitably be established. In a settled academic institution, it is felt, teaching and research should, to a substantial degree, be carried out by the same people. At the same time, it is recognised that the continuance of a strong research programme can best be insured by maintaining the Institute as a separate entity.

These objects will in future be achieved by maintaining the Institute as a separate organization within the College with its present buildings and present financial autonomy, but at the same time making the same people responsible for the direction of both teaching and research. Dr. Southall, who will become head of the Institute in July, 1957, will become Professor of Sociology and Social Anthropology and it is anticipated that a separate Department of Sociology will be set up. The present Head of the Social Studies Department and Professor of Economics, Dr. David Walker, will be head of a Department of Economics and Political Science (until such time as Political Science is able to become a separate department). The Institute will be headed by an Executive Committee made up of the Professor of Sociology and Social Anthropology, the Professor of Economics and one other, to be appointed by Academic Board. (Again, when Political Science achieves departmental status, it is envisaged that the third member will be the Professor of Political Science.) Until 1960, the Professor of Sociology and Social Anthropology (Dr. Southall) will be chairman of the Executive Committee. Thereafter the chairmanship will be reviewed.

Under the new scheme, the Institute will enjoy the financial stability which comes from being part of the regular College budget. At the same time, it will retain its separate identity. It will, for example, continue to have the advice of an Advisory Committee on which Governments and the public will be strongly represented. Indeed it is planned that the Advisory Committee be strengthened by more frequent meetings and perhaps by a revision of its membership and functions. Also, the Institute will, as in the past, be free to seek funds from outside sources to finance research. There will continue to be full-time research appointments from outside the College, though it is hoped that members of the teaching staffs for economics, sociology and political science will from time to time be seconded to the Institute for periods of full-time research.

7. *Visitors*

S.E. The Governor of Ruanda-Urundi.
 The Attorney-General of Malta.
 The Consul-General for the Sudan.
 The Consul-General in East Africa for the United States.
 Mr. S. Stackpole, Carnegie Corporation.
 Mr. J. B. Howard, Ford Foundation.
 Professor B. O. Brown, Ford Foundation.
 Mr. M. Fox, Ford Foundation.
 Mr. and Mrs. Huntington-Damon, U.S. Department of State.
 Mr. F. LaMacchia, U.S. Consulate-General, Nairobi.
 Mr. G. Hagberg, U.S. Information Service, Nairobi.
 Mr. J. H. Mower, U.S. Information Service, Nairobi.
 Admiral and Mrs. F. R. Dodge, Berkeley, California, U.S.
 Professor and Mrs. Newmark, Stanford University, U.S.A.
 Professor and Mrs. Coleman, University of California, U.S.A.
 Dr. and Mrs. Branscomb, Vanderbilt University, U.S.A.
 Mr. M. Friedman, Kalamazoo, Michigan, U.S.A.
 Mr. L. Ingles, New York Times, U.S.A.
 Mr. Hughes, Christian Science Monitor, U.S.A.
 Mr. and Mrs. Kellog, Florida, U.S.A.
 Mr. E. Munger, American Universities Field Staff, U.S.A.

Mr. J. George, Institute of African-American Relations, Washington, U.S.A.
 Mr. C. Brown, Haverford College, U.S.A.
 Professor W. J. M. Mackenzie, Manchester University, U.K.
 Professor Raeburn, London School of Economics, U.K.
 Miss M. Perham, Nuffield College, Oxford.
 Miss E. Gwynne-Jones, Nuffield College, Oxford.
 Mr. M. McWilliam, Nuffield College, Oxford.
 Mr. R. Gray, Chatham House, London.
 Miss K. Stahl, Institute of Commonwealth Studies, Oxford.
 Mr. Ingrams, Colonial Office, London.
 Miss P. Ady, St. Anne's, Oxford.
 Dr. G. Parrinder, Ibadan, Nigeria.
 Mr. R. Collings, Oxford University Press, Nairobi.
 Mr. A. D. Gallow, Hollerith, Nairobi.
 Mr. A. Tuden, Lusaka, Northern Rhodesia.
 Miss G. Sluiter, World Council of Churches, Nairobi.
 Dr. and Mrs. R. Gray, Tanganyika.
 Mr. H. Landon, Buwalasi College, Mbale, Uganda.
 Mr. P. K. Cavaye, Maseno, Kenya.
 Dr. G. M. Wilson, Department of African Affairs, Kenya.
 Dr. P. H. Gulliver, Arusha, Tanganyika.
 Dr. C. Mtawale, Bukoba, Tanganyika.
 Mr. J. Vinter, Secretariat, Tanganyika.
 Prince Stephen d'Arenberg, Buimba, Ruanda.

APPENDIX II

WEST AFRICAN INSTITUTE OF SOCIAL AND ECONOMIC RESEARCH
UNIVERSITY COLLEGE, IBADAN, NIGERIA

ANNUAL REPORT 1956-57 (1st APRIL-31st MARCH)

The operations of the Institute were allowed to run down during the year with a view to its replacement in Nigeria by a Nigerian Institute of Social and Economic Research.

Organisation and Staff

Dr. Saunders, Principal of the University College, Ibadan, who had assumed the functions of Acting Director of the Institute, retired at the end of the academic year 1955-56. A new Director was appointed as from 1st October, 1956. The Directorship is now held in conjunction with the new Chair of Economics and Social Studies within the University College, Ibadan. Mr. Ardener was re-appointed to a Research Fellowship in Anthropology to run from 1st October, 1956 to 30th September, 1957, to enable him to make a study of marriage-stability in part of the Southern Cameroons.

During the year the Research Staff of the Institute was:—

Research Fellows—

Mr. W. A. Warmington (Economics) Contract expired 30th April, 1956.
 Mrs. Ione Acquah (Sociology) Contract expired 30th September, 1956.
 Mr. P. Morton-Williams (Anthropology) Contract expired 31st August, 1956.
 Mr. P. C. Lloyd (Anthropology) Contract expired 30th September, 1956.
 Mr. E. W. Ardener (Anthropology).

Recipient of Grant:—

Dr. R. C. Abraham (Linguistics)

Research and Publications

(1) The Study of the *Social and Economic Problems of the Plantation Labour Force of the Cameroons Development Corporation*, by Messrs. Ardener, Warmington and others, has been written up. It is hoped to publish this study.

(2) Mrs. Acquah's "*Social Survey of Accra*", is in the press.

(3) Mr. Baldwin's study of economic and social aspects of the large-scale experiment in *agricultural development and resettlement at Mokwa, Niger Province* is soon to be published by Blackwell under the title "The Niger Agricultural Project".

(4) Mr. Hawkins' work on the *economics of the Road Transport Industry* in Nigeria is being revised to form a book which is likely to be published fairly soon.

(5) The economic study of "*The Gold Coast Cocoa Farmer*", by Mrs. Humphreys (Polly Hill) was published during the year by the Oxford University Press. This survey was carried out in 1954-55 with the aid of a W.A.I.S.E.R. Research Fellowship, after which Mrs. Humphreys became Research Fellow in the Economics Department of the University College of the Gold Coast, where the work was completed.

(6) Mr. Lloyd's study of the *social organisation of the Itsekiri people* in Warri, concentrating on the political system, is in the press as a volume in the Ethnographic Survey of Africa being published by the International African Institute and edited by Professor Daryll Forde. From the material collected during the tenure of his Fellowship Mr. Lloyd is now also writing a political history of the Itsekiri in the nineteenth century.

(7) Mr. Morton-Williams continued his ethnographic research in Oyo. His paper "The Atinga Cult among the South-Western Yoruba: a Sociological Analysis of a Witch-Finding Movement" appeared in *Bulletin de l'IFAN*, T.XVIII, ser. B, Nos. 3-4. (1956.)

(8) Mr. Morton-Williams' report on the results of the field study of the Audience Research Unit (to which he was seconded) was published by the Federal Information Service under the title "*Cinema in Rural Nigeria*". It deals with the impact of films about health, farming, village development, other parts of the world and the like, upon rural audiences among four Nigerian peoples.

(9) The following papers resulted from work done by Mr. Prothero during his Fellowship:—

"The Population Census of Northern Nigeria, 1952: Problems and Results". *Population Studies*, Vol. x, No. 2. (November, 1956.)

"Population Patterns and Migrations in Sokoto Province, Northern Nigeria", read to *International Geographical Union*.

A paper by Mr. Prothero on population migration in Sokoto Province is shortly to be published in *Africa*, and two maps of population distribution and density in Northern Nigeria, scale 1/1,000,000, together with an explanatory text, have been prepared for publication.

(10) Miss Martin's study of "*The Oil-Palm Economy of the Ibibio Farmer*" was published by the Ibadan University Press in July, 1956.

(11) Dr. Abraham has continued his work on an analysis and dictionary of the Ibo language. His study of Yoruba is in the press with Messrs. Hodder and Stoughton.

Visitors

The Institute continued to provide housing, library and other facilities for Dr. Tanya Baker and Miss Mary Bird of the Department of Social Anthropology, University of Edinburgh, until their departure in the early months of 1957. They had been making a study of the social role of leading women in the changing society of Western Nigeria.

Other visitors, who made brief visits, were:—Mr. C. P. Thompson, Deputy Secretary, Federal Council of Ministers (Economic Committee), Lagos; Mr. C. J. Mabey, Permanent Secretary, Ministry of Social Services, Lagos; Mr. P. C. Lloyd, Ministry of Lands, Western Region Government, Ibadan; Mr. P. Morton-Williams, Yoruba Historical Research Scheme, Oyo; Sir Stanley Unwin and Mr. C. Furth of George Allen and Unwin Ltd., London; Mr. D. M. Williams, Editor, "West Africa", London; Professor M. J. Herskovits, Northwestern University, U.S.A.; Mr. G. H. Nunn, University of Alabama, U.S.A.; Mr. K. D. S. Baldwin, Ministry of Natural Resources, Kaduna.

RONALD H. BARBACK,
Director.

11th April, 1957.

APPENDIX III

INSTITUTE OF SOCIAL AND ECONOMIC RESEARCH
UNIVERSITY COLLEGE OF THE WEST INDIES

ANNUAL REPORT

April, 1956—March, 1957

STAFF

Director—H. D. Huggins

M. G. Smith
L. E. Braithwaite
G. E. CumperD. T. Edwards
C. Jayawardena
C. O'Loughlin
R. T. Smith

Miss C. O'Loughlin, Research Fellow (Economics) and Mr. C. Jayawardena, Junior Research Fellow (Social Anthropology) joined the staff during the year.

CENTRAL RESEARCH PROGRAMME

Studies in Economics

The Institute is now working in four main fields of economics; the study of West Indian agriculture and agricultural development, the labour market, the analysis and supplementation of West Indian national accounts data, and the roll of investment in economic development.

Agriculture

The analysis of the results of the survey of small scale farming in Jamaica (D. T. Edwards) has continued. The associated study of the financing of small farm operations (C. S. McMorris, under Edwards' supervision) has been completed and is soon to be published. A paper, by Dr. Eric Back, of the Medical Department of the University College, on the health of the farm population covered in the main study, was published in the West Indian Medical Journal (September, 1956).

Prof. E. F. Nash of the University College of Wales, is now working at the Institute on a study of the marketing of export crops in the West Indies and on some aspects of Jamaican agricultural policy.

Labour

A number of small scale studies have been carried out or begun as ancillary material to the comprehensive analysis of the labour market in Jamaica and Barbados. These include a study of population distribution in Jamaica since 1830, a note on working class emigration from Barbados in 1955, a note on the external trade of Jamaica since 1830 and an analysis of labour utilisation in two types of Jamaican community (the first two published, the last two prepared for publication); and an analysis of expenditure data by income groups for a sample of families in Kingston, Jamaica, with the special aim of estimating the elasticity of imports on income. This later analysis may be extended later to a rural Jamaican and to a Barbadian sample. Work on the comprehensive analysis of the labour market has been begun.

The report on the Barbados employment survey of 1955 has been revised and will be published shortly by the Government of Barbados.

Dr. M. G. Smith's report on a study of rural labour supply in Jamaica has been published by the Government of Jamaica.

National Accounts

The Institute is collaborating with the West Indian governments in a scheme, partly financed by the Carnegie Corporation, to improve the coverage of national accounts in the region. In Barbados, Trinidad and Jamaica national accounts studies are part of the official statistical services; the aim of the scheme is to provide direct

help to other territories which find it convenient to make use of the Institute's services in completing national accounts, to help train government staff in national accounts work and to facilitate discussion among those in charge of this work and to encourage uniformity of procedures.

Miss C. O'Loughlin, the first Research Fellow appointed in connection with this scheme, visited the Eastern Caribbean and began work on the national accounts of British Guiana. A paper on the significance of agricultural sector statistics in national accounting was prepared for publication.

Economic Development

An empirical study of investment practices in a sample of Jamaican firms (H. D. Huggins and E. R. Chang) was completed during the year. The relation of the Institute's programme to the theme of economic development was discussed with Prof. A. R. Burns, who visited the Institute for this purpose.

Studies in Sociology and Social Anthropology

The Institute's studies in sociology and social anthropology fall into two groups—studies of communities and territorial societies on the one hand, and studies on the other which transcend territorial boundaries. The first group may be summarised here territory by territory:

British Guiana

A field study was carried out of East Indian communities in Demerara (British Guiana) (R. T. Smith) and preliminary analysis of the data has begun. Mr. C. Jayawardena, who was associated with this study, is now doing field work among the East Indian population of a sugar producing area in Berbice. These studies form part of the overall study of the social structure of British Guiana.

Dr. R. T. Smith's book "The Negro Family in British Guiana" was published during the year.

Grenada

The tabulation and analysis of data on family organization in Grenada and Carriacou has gone forward and further work has been done on papers based on data from these communities, including a monograph "Kinship and Community in Carriacou" which is near completion (M. G. Smith). A paper, "The Transformation of Land Rights by Transmission in Carriacou" has been published.

Jamaica

Data on family organization parallel to that for Grenada have been tabulated and are being analysed by M. G. Smith who also published "A Report on Rural Labour Supply" and a paper "Community Organisation in Rural Jamaica" and completed work on a sociological manual for Caribbean extension workers with Dr. G. J. Kruijer of the University of Amsterdam.

Of more general studies, three papers should first be mentioned which were delivered by members of the Institute staff at the meeting of the American Association for the Advancement of Science; "African Heritage in the Caribbean" (M. G. Smith), "Present Status and Prospects of Social Science in the Caribbean" (L. Braithwaite) (a summary of a monograph) and "The Family in the Caribbean" (R. T. Smith). L. Braithwaite has also prepared two papers on the history and sociological aspects of British West Indian Federation, M. G. Smith has in draft papers on "Ethics and Anthropology" and "Nature and Method of Applied Social Anthropology", and R. T. Smith has in draft papers on "Economic Aspects of Rice Farming in an East Indian Community in British Guiana" and "Hindu Marriage Customs in British Guiana".

COMPLEMENTARY RESEARCH PROGRAMME

Auxiliary Projects and their Financing

Migration. Mr. G. W. Roberts, in association with Mr. D. O. Mills, has undertaken a study of external migration affecting Jamaica (1953-55), a report on which has been

prepared. This project was undertaken at the request of the Chief Minister, Jamaica. Mr. Roberts, Vital Statistics Officer, Development and Welfare Organisation, was made available with all his costs (including his travelling, subsistence, emoluments) being met from D. and W. funds.

Housing. The Institute was asked to undertake a survey of two Housing Estates, Maverley and Tower Hill, in Jamaica by the Ministry of Housing with a view to investigating the unusual social and psychological relationships which seemed to exist between the authority and the householders. Dr. David Waddell (Lecturer in the History Department) has been associated with the Institute for this study. He has worked in close association with members of the Institute's staff, particularly Mr. Lloyd Braithwaite. The study was financed by the Jamaica Government.

Miscellaneous. The Institute has been asked to collaborate in several studies including a project on social aspects of the use of ganja, the social context of small scale fishing activity, social aspects of folk-lore and its role in the community.

Associate Studies

Dr. Wendell Bell, Professor of Sociology, Northwestern University came to the Institute for the summer of 1956 on a Social Science Research Council Faculty Research Fellowship. Prof. Bell's study related to social mobility and family life among the ethnic elite of Jamaica. Prof. Bell plans returning to Jamaica in 1957 and 1958 to continue his research.

Dr. Sydney Collins of the Department of Sociology, Edinburgh University, returned to Jamaica during the year to complete one aspect of his study on social mobility. He had carried out the field work in 1954.

Dr. David Lowenthal, a Fulbright Fellow and a historical geographer from Vassar College, has worked at the Institute for much of the academic year. Dr. Lowenthal is working on "A Comparative Study of the Lesser Antilles and the Guianas".

Mr. Colin Turnbull, social anthropologist attached to the Institute of Social Anthropology at Oxford, visited the Institute for a few weeks. He has worked for several years in the Congo on pygmy culture and is at present at the Natural History Museum in New York on some pygmy material.

Mrs. Margaret Katzin, cultural anthropologist from Northwestern University working under the direction of Prof. Melville Herskovits, visited Jamaica to study the role of the market-women in local communities.

Dr. Mordecai Ezekiel, the Acting Director of the Economics Division of F.A.O. came to Jamaica for a brief period and had discussions with the Institute on possible technical assistance with special reference to agriculture.

Columbia Research Programme

The Training Programme for the Study of Man in the Tropics providing for a programme of research and student training in the Caribbean has been initiated by the Department of Anthropology at Columbia in co-operation with several other eastern universities in the U.S. The field programme was scheduled to get under way in 1956.

ADMINISTRATION AND RELATED ACTIVITIES

Relations with the territorial units of the College

The Director, during the course of the year, visited other territorial units of the College to have discussions on those research projects which were under way. A second purpose of these visits was to discuss the Institute's programme as a whole with those organizations or government representatives in the area concerned with research relating to economic development and social change.

Prof. Arthur R. Burns of Columbia University was offered a State Department Grant for a period of three weeks, to visit the Institute in order to discuss the general programme of the Institute especially those studies relating to economic development and social change.

Library. The growth of a specialized social science research library is one of the Institute's activities from which the research programme has benefited. During the year talks took place between the Director and the College Librarian in regard to arranging the Institute's work in such a manner as to make possible complete integration of this branch library with the main library.

A start was made with the indexing of documents relating to labour and the labour movement in special reference to the Caribbean. Government Departments of Labour, Labour Unions and others interested in the field have been approached with a view to increasing the collection and indexing of material on the subject. The scheme had its origin in a labour seminar which was held at the Institute. It was then suggested that the better documentation of labour material would meet a need felt both by people in the academic world and others needing easy reference to arbitration and related material.

A Library Committee with Mr. L. E. Braithwaite as Chairman has helped materially in the running of the Library during the year.

Statistics Unit. The statistics unit, which has been organized from the outset to give help with the analysis of data, continues to be an essential part in the life of the Institute. Mr. G. E. Cumper has assumed responsibility for this unit.

Publications

The Journal, *Social and Economic Studies*, in its fifth volume, continues to be the main vehicle for the Institute's publications. The work on its circulation makes heavy demands but it is not possible to build up an international circulation for a professional Journal of this type without much endeavour.

An Editorial Advisory Board has been set up consisting of:

Prof. R. G. D. Allen, Prof. K. E. Boulding, Prof. R. W. Firth, Prof. P. Sargant Florence, Prof. M. Fortes, Prof. D. V. Glass, Prof. H. M. Gluckman, Prof. Sir Keith Hancock, Prof. W. A. Lewis, Prof. Robert Merton, Prof. E. F. Nash, Prof. Talcott Parsons, Mr. K. E. Robinson, Prof. Margaret Read, Mr. D. G. Seers, Prof. J. Tinbergen.

A list of publications for the year is attached. Special mention should be made of Dr. R. T. Smith's monograph *The Negro Family in British Guiana*, published by Routledge and Kegan Paul, London.

AWARDS

Mr. E. R. Chang (Statistical Assistant) was awarded a Ford Foundation Fellowship in order to undertake post-graduate work at Yale University. Mr. Chang's field of interest is economic analysis with special reference to problems of economic growth.

Dr. M. G. Smith, Mr. Lloyd Braithwaite and Dr. R. T. Smith were invited by the Department of Anthropology, Columbia University, to take part in a symposium on Caribbean research which formed part of the annual meeting of the American Association for the Advancement of Science in New York in December, 1956.

Dr. H. D. Huggins was invited by the International Economic Association to participate in a conference on economic development in Rio de Janeiro in August, 1957.

OTHER ACTIVITIES

Seminars were held on housing, labour problems, problems of communication and various sectors of the economy.

The Institute continues to act as a centre for visiting scholars. Among those who visited the Institute during the year were: Prof. Sidney Mintz, Mr. A. L. Nicholson, Dr. A. Curtis Wilgus, Mr. Colin Turnbull, Mrs. Margaret Katzin, Dr. Rudolph Dreikurs, Prof. George Taylor, Mr. Roy Chung, Prof. Wendell Bell, Prof. Frank Tannenbaum, Mr. S. A. Hammond, Dr. George Wythe, Mr. R. Llewelyn Davies, Dr. Gordon K. Lewis, Mr. J. K. A. Quashie, Mr. K. Bosomprah, Mr. A. P. Thorne, Mr. G. W. Roberts, Mr. F. X. Mark, Dr. Sydney Collins, Prof. A. R. Lindesmith, Mr. D. Seers, Mr. R. Snider, Mr. Louis Moss.

Members of the staff of the Institute also gave lectures for the summer schools held in 1956 at the College and have acted as consultants for persons in official and semi-official positions.

The Director and members of the staff have served on College and other committees.

Study Conference on Economic Development. The Extra Mural Department, the Economics Department and the Institute are collaborating on a Study Conference on Economic Development to be held at the College in August, 1957.

SOCIAL AND ECONOMIC STUDIES

quarterly journal

June, 1956—March, 1957

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| Social Security Problems with Special Reference to the British West Indies. | J. Henry Richardson |
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| Expansion of British Caribbean Trade with Europe ... | "Analyst" |
| The Segregation of Negroes in American Cities ... | Wendell Bell and
Ernest M. Willis |

Other Publications

A Report on Labour Supply in Rural Jamaica, by M. G. Smith. Government Printing Office, Kingston, 1956.

"On Segmentary Lineage Systems", by M. G. Smith. *Man*, Vol. LV, January, 1956.

The Negro Family in British Guiana, by R. T. Smith. Routledge and Kegan Paul, London, 1956. 28s.

APPENDIX IV

THE RHODES-LIVINGSTONE INSTITUTE FOR SOCIAL RESEARCH

DIRECTOR'S REPORT FOR YEAR ENDING 31st MARCH, 1957

Introduction

Last year's report described how Scheme R.370 was drawing to a close: financial provision ceased under this scheme as from the 31st March, 1956, though some workers remained on contract for several months, whilst much of the research work arising from the scheme remains to be published. The inauguration of the new scheme, R.698, involved by its very nature many radical changes. For the basis of the new

Colonial Development and Welfare grant is that U.K. funds will be available for the maintenance of the Central Office, provided that local resources make a commensurate contribution towards the cost of field research. This virtually reverses the previous ratio of 70 per cent. funds from overseas to 30 per cent. local.

With this change of policy in sight, Sir Arthur Benson, as President of the Trustees, launched an appeal to solicit increased support from the other Governments of the Federation, from our previous non-official supporters and from other sources. A satisfactory response to this appeal means that 10 field projects of from three to five years' duration can be financed under the present programme. With the broadening of the basis of the Institute's financial support, it was felt desirable to expand representation on the Board of Trustees, which has been increased by five new members. These represent the interests of the Federal Government, the Governments of Southern Rhodesia and Nyasaland, the University College of Rhodesia and Nyasaland, and finally, a representative of the general public. The last-named is the first African to serve on the Board.

Board of Trustees

His Excellency Sir Arthur Edward Trevor Benson, K.C.M.G. (President).	Governor of Northern Rhodesia.
*H. Franklin, Esq., O.B.E., M.L.C. (Vice-President).	Member for Education and Social Services, Northern Rhodesia.
*The Financial Secretary, R. A. Nicholson, Esq., C.B.E.	Northern Rhodesia.
*The Secretary for Native Affairs, D. B. Hall, Esq.	Northern Rhodesia.
F. M. Thomas, Esq.	Provincial Commissioner, Broken Hill.
L. Tucker, Esq., M.L.C.	Northern Rhodesia.
Col. Sir T. Ellis Robins, K.B.E., D.S.O., E.D.	Vice-President, British South Africa Company, Southern Rhodesia.
*W. C. Little, Esq.	Deputy Director of African Education, Northern Rhodesia.
H. N. Parry, Esq.	Secretary to the Prime Minister and Cabinet Office, Federation of Rhodesia and Nyasaland.
R. Howman, Esq.	Under Secretary for Native Affairs, Southern Rhodesia.
I. M. Ingham, Esq., C.M.G.	Secretary for African Affairs, Nyasaland Protectorate.
Professor B. A. Fletcher, M.A., B.Sc. ...	Vice-Principal, University College of Rhodesia and Nyasaland.
John Mwanakatwe, Esq.	Munali Secondary School, Lusaka, Northern Rhodesia.

* Indicates Member of Standing Committee.

It was with sincere regret that the resignation of Sir Ellis Robins was received in March, 1957, on his departure from the Federation. Sir Ellis joined the Board fourteen years ago, and by his wise counsel has contributed greatly to the development of the Institute.

Committees

It is apparent that this extended Board cannot be frequently summoned, so a Standing Committee was appointed to deal with day to day administrative matters, whilst a Projects and Priorities Committee deals with the more academic aspects of the Board's work. In the year under report, Trustees met twice, the Standing Committee on six occasions, and the Projects and Priorities Committee on three.

In addition, an Editorial Board was formed to assist the Director in editing the Institute's Journal "Human Problems in British Central Africa". Composition of the Standing Committee is indicated in the list of Trustees. The Advisory Committee on Projects and Priorities and the Editorial Board are as shown below:—

Advisory Committee on Projects and Priorities:

H. Franklin, Esq., O.B.E., M.L.C. (Chairman).	Member for Education and Social Services.
Desmond Clark, Esq., Ph.D., O.B.E. ...	Curator, Rhodes-Livingstone Museum.
*Elizabeth Colson, Ph.D.	Research Officer and Associate Professor, African Studies Program, Boston University.
Professor B. A. Fletcher, M.A., B.Sc. ...	Vice-Principal, University College of Rhodesia and Nyasaland.
W. C. Little, Esq.	Deputy Director of African Education, Northern Rhodesia.
*Professor J. Clyde Mitchell, B.A., D.Phil.	Chair of African Studies, University College of Rhodesia and Nyasaland.
C. A. L. Myburgh, Esq., M.Com., Ph.D.	Chief Statistician, Central African Statistical Office.
Roger Summers, Esq.	Keeper of Antiquities, The National Museum, Southern Rhodesia.

Consultant

*Dr. Max Gluckman	Professor of Social Anthropology, University of Manchester.
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*Indicates member of Editorial Board.

External Relations

The Projects and Priorities Committee provides a close link with the research work of the University College, which is represented by two members, the Vice-Principal (who is also a Trustee), and the Professor of African Studies, a previous Director of the Institute. In turn, the Director sits on the University College Social Science Research Committee, so that the risk of overlap in research work is obviated. Likewise, with other Governments of the Federation and other public bodies, in addition to their formal representation on the Board of Trustees, less formal contacts have been happy and productive. In Northern Rhodesia, the Director has been asked to serve on the Monuments Committee, the Council of the Munali Secondary School, the Editorial Board of the *Northern Rhodesia Journal*, and the Geographic Place Names Committee; he is also Chairman of the Lusaka Natural History Society.

Close contact has been maintained with the Nyasaland Government, both by personal visit and correspondence, particularly in relation to the social survey work in the Blantyre/Limbe area, to which the Nyasaland Government is making a generous financial contribution. The Government of Southern Rhodesia is planning similar survey work throughout the municipalities, and has enlisted the assistance of the Federal Department of Census and Statistics, who will undertake the demographic and economic research. It is hoped that the Southern Rhodesian Government will find itself in a position to increase its contribution to the Institute's funds, in which case it will be possible to conduct social research co-ordinated with the above project. The Director has visited Salisbury on two occasions, and attended several meetings, in this connection.

Visitors

Approximately two hundred people signed the visitors' book during the year; nearly all members of the Board of Trustees visited the Institute, including the President, Sir Arthur Benson, Mr. A. T. Williams, when acting President, and Sir Ellis Robins when he came to bid us farewell.

From overseas, we have been glad to welcome the following:—

Dr. and Mrs. E. B. Worthington, Scientific Council for Africa South of the Sahara.

Mr. Philip Mason, Mr. Richard Gray and Mr. E. Clegg, all the Royal Institute of International Affairs, St. James' Square, London, S.W.1.
 Col. J. B. George, a former Director of the Institute of African-American Relations, Washington, D.C.
 Judge and Mrs. Martin de Vries, of Long Beach, California, U.S.A.
 Dr. Emory Ross, of New York, U.S.A.
 Mr. Melvin J. Fox, Dr. W. O. Brown, Mr. John B. Howard, all of the Ford Foundation, New York, U.S.A.
 Sir Paul Sinker, Director-General of the British Council, London, W.1.
 Miss J. Eberhardt, Attaché de Recherches, C.N.R.S., College Franco-Britannique, Paris, France.
 Dr. J. Oscar Lee, National Council of Churches, Fourth Ave., New York, U.S.A.
 Dr. Paul Abrecht, World Council of Churches, Geneva, Switzerland.
 Dr. J. Karefa-Smart, M.D., World Council of Churches, Freetown, Sierra Leone.
 Sir Stephen King-Hall, The Penthouse, Buckingham Palace Rd., London, S.W.1.
 Lady King-Hall, Hartfield House, Headley Borddon, Hants.
 Mr. Wales Hood, Trades Union Congress, 23-28, Great Russell St., London, W.C.1.
 Mr. A. Hammerton, I.C.F.T.U., 24, rue du Lombard, Brussels.
 Sir J. A. Gray, on the staff of "South Africa," London.
 Sir Charles and Lady Ponsonby, The Royal Empire Society, London.
 Dr. and Mrs. D. Newmark, Food Research Institute, Stanford University, California.
 Mr. William Clark, B.B.C., London.

From neighbouring territories and towns in Africa, we have received visits from:—

Lord Malvern, Prime Minister of the Federation of Rhodesia and Nyasaland, Salisbury.
 Lt. Col. F. C. Hallier, formerly Provincial Commissioner, Tanganyika.
 Mr. R. Silcock, of the Agricultural Department, Lushoto, Tanganyika.
 Dr. Desmond Clark, Curator, The Rhodes-Livingstone Museum, Livingstone.
 Mrs. Desmond Clark, Secretary of the Rhodes-Livingstone Museum, and Treasurer/Secretary of the Northern Rhodesia Society, Livingstone.
 Mr. Peter Johnson, District Commissioner, Tikuyu, Tanganyika.
 Mr. M. J. B. Molohan, Provincial Commissioner, Arusha, Tanganyika.
 Mr. K. Balcomb, Provincial Education Officer, Broken Hill.
 Mr. A. G. Arbous, African Explosives and Chemical Industries Inst., Johannesburg, South Africa.
 Professor J. Clyde Mitchell, Chair of African Studies, University College of Rhodesia and Nyasaland, Salisbury, S. Rhodesia.
 Dr. C. A. C. Myburgh, Chief Statistician, Central African Statistical Office, Salisbury, S. Rhodesia.
 Mr. C. A. Collard, Commissioner for Labour, Zomba, Nyasaland.
 Mr. G. N. Burden, Nyasaland Government Representative, Salisbury, S. Rhodesia.
 Mr. Roger Summers, Keeper of Antiquities, The National Museum, Bulawayo.
 Professor D. T. Cole, Professor of Bantu Languages, University of Witwatersrand, Johannesburg, South Africa.
 Mrs. P. D. Cole-Benchmark, Lecturer in Bantu Languages, University of Witwatersrand, Johannesburg.
 Mr. Curtis C. Strong, American Consul, Salisbury.

Local residents take an increasing interest in the Institute; amongst numerous visitors, who included many African officials and students, we record:—

Sir T. S. Page, formerly Speaker, Legislative Council, Lusaka.
 Mr. T. Williams, Speaker, Legislative Council, Lusaka.
 Rt. Rev. Oliver Green-Wilkinson, Bishop of Northern Rhodesia.
 Rt. Rev. Adam Kozlowiescki, Roman Catholic Bishop of Lusaka, N. Rhodesia.
 Dr. Alexander Scott, Lusaka Federal Member of Parliament, Federal Assembly, Salisbury, S. Rhodesia.

Mr. E. I. G. Unsworth, Attorney General, Government of Northern Rhodesia.
 Mr. W. H. Wroth, Member for Agriculture and Natural Resources in the Government of Northern Rhodesia.
 Mr. and Mrs. J. A. Cottrell, Director of African Education, Lusaka.
 Mr. Norman S. Price, Provincial Commissioner, Secretariat, Lusaka.
 Mr. T. G. C. Vaughan-Jones, Commissioner for Rural Development, Lusaka.
 Mr. H. J. Roberts, Principal, Munali Secondary School, Lusaka.
 Lt. Col. N. O. Earl Spurr, of Lusaka.
 Mr. R. Philpott, Acting Commissioner of Labour, Lusaka.
 Mr. S. H. Chileshe, Member of Legislative Council, Lusaka.
 Mr. H. M. Nkumbula, President, African National Congress, Lusaka.
 Mr. L. G. Vincent, African Housing Board, Lusaka.
 Mr. C. M. N. White, Land Tenure Officer, Lusaka.
 Mr. G. M. Wilson, Director, Publications Bureau, Lusaka.

Research in Progress

Staff at the 1st March, 1957, was as under:—

Director	...	...	...	H. A. Fosbrooke, M.A.(Cantab.).
Administrative Secretary	...	...	...	Miss M. Marsden.
Librarian	...	...	...	Mrs. U. K. N. Stevenson, B.A.(Cantab.), F.L.A.
Assistant Librarian	...	...	...	R. M. S. Ng'ombe.
Research Officers	...	...	...	Elizabeth Colson, Ph.D.(Harvard), M.A. (Minnesota). D. G. Bettison, Ph.D.(Rhodes). T. Scudder, B.A.(Harvard). W. J. Argyle, B.A.(Oxon.), Dip. Soc. Anthrop.
Senior Research Assistant	...	...	...	S. C. Katilungu, Diploma in Social Welfare.

In addition, there are eight Research Assistants and Junior Research Assistants, and six central office staff, including the first African woman to be appointed, a girl who took her School Certificate in 1956.

The Institute was fortunate in securing the services of a previous Director, Dr. Elizabeth Colson, to conduct the enquiry into the Valley Tonga people, who are shortly to be moved to make way for the Kariba Lake. Assisted by Mr. Scudder, who is concentrating on the environmental side of the enquiry, Dr. Colson is recording the social and political organisation of these primitive people with a view to discovering, on a subsequent visit some years hence, the changes which their removal from the valley, and their establishment in a fresh environment, has brought about.

Arrangements were also made for Dr. Bettison, late lecturer at Rhodes University, to commence work in the Blantyre/Limbe peri-urban area in January, 1957, assisted by the African research teams which the Institute has built up and trained over the years. The other projects on the programme which finance permits us to tackle comprise:—

(1) two studies of European communities; one on the Copperbelt and one in Southern Rhodesia; it is only lack of finance which rules out a study of the Asians in the Federation; (2) two studies of the impact of modern conditions on rural communities, one a study of the economics of peasant farms, and the other of African education; (3) two urban studies, one of urban sociology and the other concerning the sociology of industry, which is complicated in the African setting by the intrusion of colour problem; and finally (4) two tribal studies. Likely candidates are available for the last named, whilst the other posts will be filled as qualified workers become available.

Affiliates

An important part of the work of this, as with other Institutes in Africa, is to provide facilities for affiliating workers. In the course of the year under report, Dr. W. B. Schwab, of Philadelphia, U.S.A., a previous C.S.S.R.C. worker, spent several

months in the study of urban problems at Gwelo, Southern Rhodesia; he was assisted by the Institute's African research staff, and is planning publication jointly with Dr. Epstein. Mr. Arthur Tuden, working under a Ford Foundation grant, was engaged from the 1st April, 1956, to the end of the year on a study of the Ila, of Smith and Dale fame; his field work will continue until April, 1957. Professor Coleman, of the University of California at Los Angeles, has been studying leadership in an urban setting in and around Lusaka since early January, and will remain at the Institute till the end of April, 1957.

At the moment the facilities which the Institute can offer are limited, but with the re-organisation of the office buildings, study space is available, with facilities for mapping and statistical work. It has also proved possible on numerous occasions to attach Institute African staff to our affiliates, which overcomes both the problems of language and local guidance. With the completion of our building programme, there may be occasions when living quarters are also available for such workers, whose affiliation in the future will be put on a more formal basis.

The Sir Gilbert Rennie Library

The membership of the Institute, which is dealt with by the Librarian, falls into the following categories: honorary members, official members, exchange members and paying members. The table set out below shows the changes in the membership during the past two years:—

	1955-56	1956-57			+ or -
		Resigned	Joined	Total membership	
Honorary	27	—	1	28	+ 1
Official	339	—	—	339	—
Exchange	78	1	8	85	+ 7
Paying	171	10	36	197	+26
Total... ..	615			649	+34

During the period under review, the library has been considerably re-arranged. A map room and a stock room have been added to it, and in the library itself there are now alcoves in which students may work undisturbed. Additional shelving has been erected, and this should meet the needs of the library for five or six years to come, if, as seems likely, the stock increases at the rate of about 250 books or pamphlets a year. During 1956-57, 290 books and pamphlets were added to the library. This is just over a hundred more books than were added the previous year, and is partly accounted for by the raising of the library vote from £150 to £250 per annum. The total of 290, however, includes books presented and books received on an exchange basis, as well as books purchased. It does not include reports received from the various government departments of the Federation, Northern and Southern Rhodesia, Nyasaland, Tanganyika, Uganda and Kenya; those are now coming in with greater regularity than formerly. Various sections of the library have been expanded, particular attention being paid to the reference section, and the section on language; which up to the present has been rather poor.

Eleven new periodicals were taken in the library during 1956-57, six of them on an exchange basis. Two hundred and seven periodicals are now taken altogether. Recently also various sections of the vernacular press have been received, and will continue to arrive regularly; these are being catalogued and classified, with a view to their providing a basis for future linguistic work and to enable a study of linguistic change and development to be undertaken.

In previous years, the number of books borrowed by the Institute staff has always exceeded those borrowed by ordinary members of the Institute; for the first time, however, during the past year, twenty more books were borrowed by ordinary members

than by the staff, and eleven more books were borrowed by ordinary members this year than last year. Most of the borrowing goes on by post, but there has been a slight increase this year in the number of those visiting and working in the library. The books are used by teachers, priests, welfare officers, and other government officials, by people engaged in individual research, and by Africans reading for degrees in their spare time.

The special bibliography, which aims to include all publications dealing with aspects of human relationships in the Federation and adjoining territories, continues to grow; it is hard to keep pace with all the available material, which is considerable, but the number and variety of subjects covered is steadily increasing.

Publications

It was hoped that the period under review would see a great number of publications issuing from the press, as during 1955 the Institute's officers were mainly employed in writing up the mass of material gathered in the field during 1954. Delays at various stages have caused the actual output to be slightly disappointing, but between April, 1956 and March, 1957, the following have appeared:—

No. XX of the Institute's Journal: "*Human Problems in British Central Africa*";

Rhodes-Livingstone Paper No. 26, *A Social Survey of the African Population of Livingstone*, by Merran McCulloch;

Rhodes-Livingstone Paper No. 27, *The Kalela Dance*, by J. Clyde Mitchell;

The Yao Village: a Study in the Social Structure of a Nyasaland Tribe, by J. Clyde Mitchell, a full length book which was published in June, 1956.

Dr. V. W. Turner's book, *Schism and Continuity in an African Society*, is now at the page-proof stage, and Dr. A. L. Epstein's *Politics in an Urban African Community* is also with the press; both these will probably be in print by the time this report appears.

Other full-length books which are expected to appear shortly are Dr. Elizabeth Colson's study of Tonga family structure and economic development; Mr. L. H. Gann's *Birth of a Plural Society*—an account of the development of Northern Rhodesia under the British South Africa Company; and Dr. Watson's book, *Tribal Cohesion in a Money Economy: a study of the Mambwe people of Northern Rhodesia*.

Buildings

With the build-up of greater facilities and intellectual stimulus in Central Africa it is the policy of Trustees to provide research workers with conditions enabling them to conclude their preliminary analysis and write-up locally. To this end, the existing office accommodation has been re-modelled, and a programme of additional living quarters embarked upon. The original layout comprised dwelling houses for the Director and the administrative secretary, and a rest house for field workers, as well as accommodation for research assistants, typists, drivers, etc. The present programme envisages four additional quarters for research personnel, and additional rest house accommodation, particularly for the interpreters, drivers and personal servants, who normally accompany field workers, but who had hitherto not been catered for. This programme is proceeding on a two-phase basis, Phase I, costing approximately £16,000, is being financed from the Institute's reserve, whilst the additional £8,000 required to complete Phase II is being sought from C.S.S.R.C., which body, we are assured, has earmarked a sum sufficient to complete the work.

The Institute is situated in pleasant rural surroundings six miles from Lusaka; this gives scope for the layout of the grounds, which have been extended from eight to fifteen acres, and planted with hedges, avenues and shrubberies—but it also poses problems of communication. These latter have been largely overcome during the year by the installation of a telephone, and the construction of a good road from the Great East Road to the Institute; the final link is electricity from the mains, which it is hoped will be effected in the coming year.

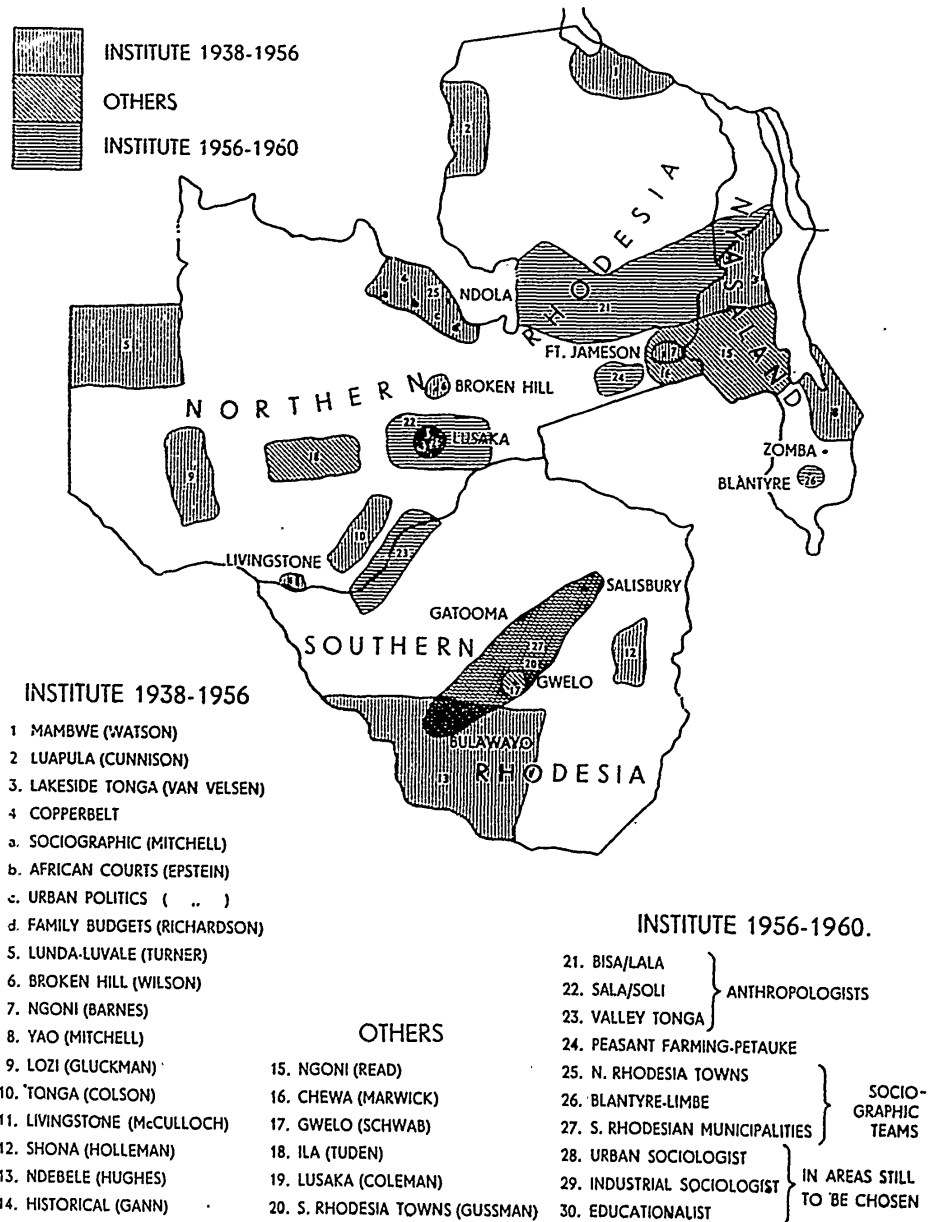
Conclusion

A perusal of this report reveals that the year under review has been one of winding up Scheme R.370, and of preparation for a fresh assault on the problems of social research amongst the indigenous and immigrant races in Central Africa. The material side of the work is now well in hand; all that holds up the full implementation of the research programme is lack of suitable staff, the task of recruiting which is currently in hand. It is a task not to be hurried, as only the best should be employed on work which demands not only technical competence but a delicacy of approach, without which results will fail to maintain the high standard which has come to be expected of this Institute.

H. A. FOSBROOKE,
Director.

Lusaka,
April, 1957.

RESEARCH BY RHODES-LIVINGSTONE INSTITUTE
PAST & FUTURE



Tsetse Fly and Trypanosomiasis Committee Report for 1956-1957

Colonial Office,
Sanctuary Buildings,
Great Smith Street,
Westminster, S.W.1.
10th October, 1957.

SIR,

I have the honour to transmit herewith the Report of the Tsetse Fly and Trypanosomiasis Committee for the year ended the 31st March, 1957.

I have the honour to be,

Sir,

Your obedient servant,

W. B. L. MONSON,
Chairman.

The Right Honourable Alan Lennox-Boyd, M.P.,
Secretary of State for the Colonies.

THE TSETSE FLY AND TRYPANOSOMIASIS COMMITTEE

REPORT FOR 1956-57

Membership

MR. W. B. L. MONSON, C.M.G., Assistant Under-Secretary of State, Colonial Office (*Chairman*).

CAPTAIN K. F. T. CALDWELL, formerly of the Kenya Game Department.

DR. J. CARMICHAEL, C.M.G., M.R.C.V.S., Dip. Bact., formerly of the Colonial Veterinary Service.

PROFESSOR T. H. DAVEY, O.B.E., M.D., D.T.M., Liverpool School of Tropical Medicine.

PROFESSOR P. C. C. GARNHAM, M.D., D.Sc., London School of Hygiene and Tropical Medicine.

PROFESSOR R. M. GORDON, O.B.E., M.D., D.Sc., F.R.C.P., Liverpool School of Tropical Medicine.

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

DR. C. A. HOARE, F.R.S., Wellcome Laboratories of Tropical Medicine.

DR. E. A. LEWIS, M.Sc., F.R.E.S.

DR. L. HARRISON MATTHEWS, M.A., F.R.S., Director and Permanent Secretary of the Zoological Society of London.

COLONEL H. W. MULLIGAN, C.M.G., M.D., D.Sc., The Wellcome Research Laboratories.

MR. W. H. POTTS, formerly of the East African Tsetse and Trypanosomiasis Research and Reclamation Organisation.

MR. W. F. DAWSON, M.B.E. (*Secretary*).

Ex-officio Members

The Directors of the East African Trypanosomiasis Research Organisation and the West African¹ Institute for Trypanosomiasis Research. The Secretary of State's Chief Medical Officer, and Advisers on Agriculture and Animal Health. The Director of Colonial Medical Research. The Secretary of the Colonial Pesticides Research Committee.

It is the practice to invite the Scientific Liaison Officer for the Federation of Rhodesia and Nyasaland to attend meetings.

Terms of Reference

“To consider and advise on the co-ordination of action, including research and reclamation, directed against human and animal trypanosomiasis.”

THE TSETSE FLY AND TRYPANOSOMIASIS COMMITTEE

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THE TSETSE FLY AND TRYPANOSOMIASIS COMMITTEE

I. THE COMMITTEE

1. One meeting of the main Committee and two meetings of the Chemotherapy Panel, recently set up by the Committee, were held during the period under review.

2. The Committee sustained a severe loss in the sudden death last summer of Dr. E. M. Lourie, one of the original members appointed when the Committee was first set up in 1944. His advice on chemotherapy of trypanosomiasis was always invaluable.

3. Professor P. C. C. Garnham of the London School of Hygiene and Tropical Medicine, and Professor R. M. Gordon of the Liverpool School of Tropical Medicine joined the Committee during the year.

4. The major field of activity during the year has been in chemotherapy, following the advent of a number of promising new trypanocidal drugs. The importance universally attached to chemotherapy in the treatment and control of animal trypanosomiasis was emphasised by the holding in the Colonial Office of a Conference attended by high-level veterinarians from all the British African territories and the Directors of the Regional Research Institutes to discuss the most efficient means of arranging and co-ordinating trials of the new drugs in Africa. In keeping with the Committee's policy of maintaining close liaison with the drug manufacturers, the various interested firms were invited to send representatives to the Conference for specific items. The Conference was successful in reaching agreement on procedures for the fullest co-ordination of full trials and the prompt dissemination of data about the behaviour of the drugs wherever tried out. These new procedures have already been implemented. Notable amongst the new prophylactic drugs that have come forward are the suramin complexes which have been developed at the West African Institute for Trypanosomiasis Research and which appear to offer a considerable increase in the period of protection as compared with drugs currently in general use.

II. FINANCE

5. An increase is being sought in the allocation of C. D. and W. money for tsetse and trypanosomiasis research over the five year period 1st April, 1955, to the 31st March, 1960, now standing at £560,000, in order to provide assistance towards new commitments e.g. assistance towards the cost of field trials of new trypanocides. The total expenditure against the allocation up to the 31st March, 1956, was estimated at £276,000.

III. GENERAL

6. The Sixth Meeting of the International Scientific Committee for Trypanosomiasis Research was held in Salisbury in September. The United Kingdom delegation was led by Dr. C. A. Hoare, F.R.S., who presented a paper entitled "Revision of the Classification of African Pathogenic Trypanosomes". His co-delegates were the Directors of the East and West African Trypanosomiasis Research Institutes. No less than sixteen observers from the dependent British African territories also attended. The next meeting of the I.S.C.T.R. is scheduled to be held in Brussels in 1958.

7. Encouraging results have been achieved by Mr. W. H. Potts, a member of the Committee, in an experiment to ascertain whether tsetse flies are susceptible to sterilization at the puparial stage by the application of gamma rays. This new method for the biological control of tsetse offers a possible means of eliminating any small residual fly population in reclaimed areas. Mr. Potts is now writing-up his results for publication.

8. A three years Colonial Research Fellowship was awarded to Dr. D. J. B. Wijers, a Dutch national, to enable him to undertake a study of human trypanosomiasis at the West African Institute for Trypanosomiasis Research.

IV. THE EAST AFRICAN TRYPANOSOMIASIS RESEARCH ORGANIZATION

General

9. With the exception of one vacancy for a Veterinary Research Officer, the Organization is fully established. The building programme at Tororo for European and African accommodation is nearing completion. In October, the Laboratory at Sukulu was formally opened by His Excellency the Governor of Uganda.

10. During the year, arrangements have been completed to place the Organization under the aegis of the East African Agricultural and Fisheries Research Council and its subsidiary Research Co-ordinating Committee. The programme of the Organization is also subject to review by the East African Medical Research Council.

11. Three officers attended the Salisbury Meeting of the I.S.C.T.R. and the Director attended the London Conference on Chemotherapy held at the Colonial Office in July.

Tsetse Research

12. An important study on the mechanism of water control in the pupa of *Glossina* contributes, not only to our understanding of the geographical distribution of tsetse flies, but also to our knowledge of how some current methods of reclamation may work and why they may be expected to succeed with one species and not with another.

13. The joint study with the Lister Institute of Preventive Medicine on the host animals of *Glossina* has continued. The great importance of wart-hog as a food supply for *Glossina morsitans* and *swynnertoni* is confirmed; but it is of interest to note that hippopotamus may under certain conditions replace wart-hog as the favoured source of food.

14. The feeding ground theory of Jackson has received confirmation from field observations which appear to demonstrate conclusively that the hungry tsetse fly actively hunts for its food, rather than sitting waiting for a host animal to appear.

15. An important field for investigation has been opened up by the study of resting places of the tsetse flies *Glossina swynnertoni*, *pallidipes*, and *morsitans*. This work is likely to lead to new ideas on the use of insecticides against these three species. To facilitate the discovery of the tsetse's resting places, an attempt has been made to develop a technique whereby flies are marked with fluorescent paints, released during the day, and then sought for at night using an ultra-violet lamp.

16. It has been possible to obtain an estimate of the availability of *Glossina morsitans* in South-West Uganda. Hitherto it has been assumed that the availability of this species generally is of the order of 10 per cent. Three

estimates made in Ankole suggest that there the figure lies between 0.5 and 1.0 per cent., indicating a type of behaviour much more like that of *G. pallidipes* and offering an explanation of the widespread cattle trypanosomiasis in an area in which tsetse can be found only with the greatest difficulty.

17. Two separate investigations have brought evidence that *G. pallidipes* populations contain a proportion of flies which, having attacked a man, have thereafter a greater tendency to attack men than the normal *pallidipes*. The presence of these "anthropophilic" flies may have a considerable importance in the epidemiology of *T. rhodesiense* on the north-east shores of Lake Victoria.

18. The use of traps as a means of studying field behaviour, particularly of *G. pallidipes*, has been revived, with interesting results on the diurnal activity of female flies.

Trypanosomiasis Research

19. The chief event at the Sukulu Laboratory has been the opening of a small hospital for reception of Sleeping Sickness patients from the Lake shore fly-belts. The purpose of the hospital is to permit detailed clinical and biochemical examinations of the disease to be made. It also allows for the careful examination and typing of trypanosome strains obtained from patients, with a view to further investigation of the relationship between *Trypanosoma gambiense* and *Trypanosoma rhodesiense*. It has been found that the majority of patients are suffering from a *rhodesiense*-like disease.

20. A joint investigation with the Kenya Medical Department in Central Nyanza has shown that *G. pallidipes* in that area is a carrier of *T. rhodesiense*. It has not yet been possible to demonstrate that *G. palpalis* is also a vector of human trypanosomiasis north of the Kavirondo Gulf. South of this Gulf where the disease occurs in *palpalis* areas without *G. pallidipes* there is little doubt about the matter, especially as there the disease appears to be of the Gambian type. The failure to implicate *G. palpalis* north of the Kavirondo Gulf is curious in that the foci of infection are almost always fishing camps and the victims either fishermen or fish-marketers. The problem is still under investigation.

21. An investigation into the epidemiology of *palpalis*-borne Sleeping Sickness in various parts of Uganda is also being undertaken. An attempt was made in Tanganyika to isolate a trypanosome infective to man from wild game. However, although one polymorphic trypanosome was obtained from a hartebeest, it would not infect a human volunteer. A number of other species of trypanosome were also obtained. The first part of the investigation into the infection rates of tsetse flies in the mixed *pallidipes* and *palpalis* fly bush of eastern Busoga has been completed. A shorter investigation into the infection rates and types of infection to be observed in *G. fuscipleuris* in western Uganda was also undertaken. It has been shown that the infectibility of tsetse to a strain of *Trypanosoma rhodesiense* does not differ from that to a strain of the morphologically identical *Trypanosoma brucei* from the same area. Polymorphism in *T. brucei* group trypanosomes of several strains in rats has been studied at Tinde. It seems very probable that the phenomenon is a response of the trypanosomes to antibody formation by the host. Studies on the early stages of *T. rhodesiense* infections in mammals, with Professor Gordon of the Liverpool School of Tropical Medicine, continue.

22. On the Veterinary side, much effort has gone into the organization of trials of new drugs and to the promotion of co-operation between the

various departments concerned on the lines recommended by the Veterinary Directors' Conference in London in July. At Shinyanga, where a field trial by the Tanganyika Veterinary Department is being carried out, the Organization is co-operating by provision of staff to allow somewhat more elaborate observations to be carried out than would normally be the case in the field trial. The data collected should be of considerable importance in reaching an understanding of the epidemiology of cattle trypanosomiasis. The chances of an individual cow becoming infected under a variety of conditions is the subject of a number of investigations. It has been shown that healthy cattle, uninfected by trypanosomes but treated periodically with antrycide pro-salt, acquire for some months a resistance to infection by *T. congolense*, which may persist for several months after treatment ceases. Efforts to improve present serological diagnostic techniques for cattle trypanosomiasis continue.

23. Laboratory trials of new trypanocidal drugs intended for treatment of human trypanosomiasis have been undertaken, using fly-passaged strains of *T. rhodesiense*. The results have been less favourable than those obtained by the manufacturers using needle passaged strains of the same species.

Publications

BAKER, J. R.—(1956). Studies on *Trypanosoma avium*, Danilewsky 1886. I. Incidence in some birds in Hertfordshire. *Parasitology*, **46**, 308.

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BAKER, J. R.—(1956c). Studies on *Trypanosoma avium*. I. Life cycle vertebrate and invertebrate hosts. *Ibid.* **46**, 335.

BAKER, J. R.—A new vector of *Haemoproteus columbae* in England. *J. Protozool.* (in press).

BAKER, J. R.—Preliminary trials of Stylomycin as a therapeutic agent in *Trypanosoma rhodesiense* infections in white rats, *Trans. R. Soc. trop. Med. Hyg.* (correspondence—in press).

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V. THE WEST AFRICAN INSTITUTE FOR TRYPANOSOMIASIS RESEARCH

General

24. Work during the year was upset by many staff changes; by the end of the year however all vacancies had been filled with the exception of one Field Officer post. New appointments were Mr. W. A. McDonald as Research Entomologist, Dr. D. G. Godfrey as Research Parasitologist, Dr. L. E. Stephen as Veterinary Research Officer, Mr. W. Petana and Mr. Killick-Kendrick as Laboratory Superintendents. With the staffing position at this high level the prospects for the coming year may be regarded as exceptionally good.

25. The Kaduna information bureau or museum has been overhauled and greatly improved by Mr. Steiner and Dr. Hutchinson and continues to attract many visitors.

26. Whilst on leave, Dr. J. Williamson, Biochemist, attended a course at the Isotope School, Harwell.

27. Papers were submitted to the 6th Meeting of the International Scientific Committee for Trypanosomiasis Research as follows; by Dr. Hutchinson on Clinical Trials with Melarsen and the use of the M.R.C. photometer in the estimation of cerebrospinal fluid protein, by Dr. Williamson on the prophylactic activity of suramin complexes in animal trypanosomiasis and by Drs. Watson and Williamson on experiments using therapeutic and prophylactic drugs in *T. simioe* infections in rabbits and pigs.

VETERINARY TRYPANOSOMIASIS

Chemoprophylaxis and Chemotherapy

28. The prophylactic experiments in small animals using a variety of trypanocidal drugs and their suramin complexes have continued. These complexes were developed by Dr. Williamson, the Institute's biochemist, following certain observations by the late Dr. Lourie. In the majority of cases, these insoluble complexes have shown considerable prophylactic activity while in addition it has been possible to give much larger doses of the basic drugs in combination without producing toxic effects.

29. The prophylactic properties of five of these complexes at different dose rates have been tested in cattle, other animals which had received some of the basic trypanocidal drugs alone being used as controls. In all cases only one injection of the drug was given at the start of the experiment.

30. These cattle were challenged mainly with *T. vivax* transmitted by laboratory bred *G. palpalis* in whom the infection rate had been raised to 90–100 per cent. by multiple feeds on animals heavily infected with this trypanosome. Batches of 100–150 such flies were fed on three consecutive days on each ox, and this three-day challenge was repeated every 10–14 days until break-through occurred.

31. As in the small animals, it was shown that the cattle would tolerate drugs in much larger doses when given in the suramin complex form; in the case of antrycide methyl sulphate the maximum tolerated dose was some eight times greater.

32. With regard to the prophylactic results, these must be viewed with caution at this stage as the number of beasts used for any one complex was small. In the case of antrycide pro-salt, the prophylactic drug in common use, when administered at 5 mg. per kg. the first break-through to trypanosomiasis occurred 2 months after injection. Of the various other drugs or drug-suramin complexes tested, the most promising appeared to be the ethidium bromide-suramin complex. At 5 mg. per kg. this drug complex protected for 7 months while at 10 mg. per kg. the first break-through in 3 animals occurred 13 months after the prophylactic injection. Experiments with Prothidium and RD. 2902 complexes are still under way and at 10 mg. per kg. both drugs have so far protected for over 8 months and at 20 mg. per kg. the latter drug is still protecting at 7 months.

33. The suramin complexes were so promising that with the agreement of the Colonial Office, patents have been taken out on behalf of the Institute by the National Research Development Corporation.

34. From the results of the pilot scheme it was clear that the ethidium bromide—suramin complex was outstandingly promising (especially since the cost of the basic ingredients for the single 10 mg. per kg. dose is only 5s. 9d.), and that therefore this complex should be adequately tested at the earliest opportunity; thanks to a Colonial Development and Welfare grant of £1,609

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extending from 1st November, 1956, to 31st March, 1958, such a further test has been made possible.

35. Some 24 animals have now been treated with the complex at three different dose rates, and 8 animals with antrycide pro-salt for comparison; in addition 9 animals are being used as untreated controls and will be left to die, thus indicating the acuteness of the challenge. No generalised toxic reactions have occurred amongst the animals treated with the complex; however, the local reaction at the site of the injection has been very much more severe than had been expected from the results of the pilot scheme. Investigations into the cause of this undesirable feature are being undertaken and means sought to overcome it.

36. The ethidium bromide—suramin complex is also being tested in the field by other organisations in both East and West Africa; it is hoped that by 1958 a proper assessment of the value of this drug will have been achieved.

37. Besides the work with *T. vivax* and, to a lesser extent, *T. congolense* in cattle, a quest has been made for drugs which will cure and protect pigs from *T. simiae* infections. Eight drugs were found to have little or no curative properties, but antrycide pro-salt, antrycide chloride and antrycide-suramin complex appear to be active curative agents. The very small investigation with drugs with prophylactic activity, when pigs were challenged with wild *G. morsitans* from an area where *T. simiae* occurs, have suggested that antrycide chloride at 50 mg. per kg. and antrycide-suramin complex at 20-40 mg. per kg. may protect for a period of 5-6 months.

Immunity Studies

38. Immunity studies on the local breeds of cattle and game animals are being continued and it is still too soon to assess the results.

HUMAN TRYPANOSOMIASIS

Laboratory Investigations

39. Strains of *T. gambiense* isolated from cases in the field have continued to be maintained in the laboratory and three new ones have recently been collected; in these the relation between change in morphology and alteration in virulence and transmissibility are being closely followed.

40. Investigations into the mechanism of acquired drug resistance have continued. In addition paper electrophoresis has been used to determine in a normal strain of *T. rhodesiense* the nature of the components present in trypanosome homogenates. Further experiments on the nature of the components and their mobility in resistant strains are being undertaken.

41. A close study has been made of the changes that occur in the saliva of tsetse infected with the *brucei* group of trypanosomes. It had been noted that with the development of these trypanosomes in the salivary glands of the fly, the saliva collected by the probe technique steadily lost its ability to take up Giemsa stain suggesting a change in composition. To ascertain the chemical composition of the saliva and to investigate those substances which were removed during the metabolism of the developing trypanosome, an extensive histochemical analysis of the saliva was undertaken. In addition to the identification of the substances present, the nature of the protein and carbohydrate elements in the saliva were examined by the use of paper partition chromatography. Specific stains for the identified chemical constituents in the clean saliva were then used to follow the reaction of the latter as infections

with *T. rhodesiense* or *T. gambiense* developed in infected flies. This work, which is still in its early stages, has cast considerable light on the metabolism of these trypanosomes at this crucial stage of their development in the fly and may eventually make it possible to produce an efficient medium for the culture of the trypanosomes and provide basic information of value in the synthesis of new trypanocidal drugs.

Diagnostic Methods

42. In the field the M.R.C. Grey Wedge Photometer has been used in the estimation of cerebrospinal fluid protein in over 300 cases. The advantages of this instrument, which were apparent when it was tested under laboratory conditions, were confirmed.

Chemotherapy

43. Clinical trials with malarsen have been concluded and the full results prepared for publication. These confirm that the drug is a valuable alternative weapon for the treatment under field conditions of *T. gambiense* infection, especially in the chemotherapy of late or relapsed cases.

44. A small trial with Berenil, recommended by the Tsetse Fly and Trypanosomiasis Committee, was undertaken using cases treated with pentamidine as controls. Patients were all in the early stages of the disease. It appeared that Berenil was well tolerated; apart from albuminuria in a few cases, there were no toxic effects. By the end of the course all patients were both gland and blood negative. All patients are being kept under observation throughout the year.

45. A further small trial with Stylomycin, which had also been recommended, was cancelled at the last moment at the request of the manufacturers.

46. All field trials were carried out in the closest collaboration with the Sleeping Sickness Service, Northern Region.

INSECT VECTOR

Laboratory Investigation

47. The full scale breeding of *G. palpalis* has been maintained and large numbers of pupae and flies have continued to be provided for research purposes both in the Institute's laboratories and elsewhere. A start has now been made to determine the optimum conditions for the laboratory breeding of *G. morsitans*.

48. Studies on the mating behaviour of *G. palpalis* have been completed and show that a proportion of females of this species will mate more than once especially during the first week of life, and it is suggested that this may affect the prospects of exterminating *G. palpalis* by swamping the wild male population with releases of laboratory bred males artificially sterilized by irradiation.

Field Investigations

49. It has always been a matter of speculation as to why human sleeping sickness is so rarely found in the forest belt of West Africa when it is so common in the savannah woodland. Following the pattern set at the W.A.I.T.R. Field Station in the Southern forest zone two years ago, a comparative experiment on man-fly contact was started near Kaduna during the rains.

50. At the southern station in the wet season out of 1,111 flies marked, only 0.36 per cent. were recaptured at the water-hole 18 days or longer after marking; but at Kaduna the figure was 3.8 per cent. of 1,942 flies marked.

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Hence even in the wet season the changes of the fly lingering at the water-hole sufficiently long after an infected feed to become infective are 10 times greater in the northern savannah woodland area as compared with the forest zone in which the high humidity makes it possible for *G. palpalis* to wander freely and not rely on man for its food.

51. A repeat dry season experiment is at present being undertaken near Kaduna when it is expected that the difference will be even more marked.

52. Research on the various forest species of tsetse has been continued at the Field Station and information regarding the habitats and ecology of these species is steadily being collected. It has now been proved that many of these forest species are of considerable economic importance, a high proportion being infected with the trypanosomes that cause bovine trypanosomiasis. Overall infection rates are as follows, the figures in brackets referring to the number of flies dissected which total 7,847.

G. nigrofusca 27 per cent. (99).

G. longipalis 21 per cent. (4,026).

G. Fusca 15 per cent. (485).

G. medicorum 14 per cent. (78).

G. tabaniformis 5 per cent. (1,594).

G. palpalis 2 per cent. (1,565).

53. The collecting teams have been making smears of blood on filter paper from any gorged flies which they may encounter in the field—a rare occurrence. These have been sent to Mr. Weitz of the Lister Institute for serological identification of the origin of the blood. Results from *G. palpalis* collected near Kaduna show that three quarters of the sample had fed on man, domestic animals or the usual reptiles such as monitor lizards, thus confirming the observation that both *G. palpalis* and sleeping sickness frequently occur in areas where game is very scarce or virtually absent. Among *G. morsitans* collected north-east of Kaduna, however, 83 per cent. of the sample had fed on wart-hog, demonstrating the importance of this animal as a source of food for this species of tsetse.

Control Measures

54. Colonial Development and Welfare Scheme R.552, which financed the pilot experiment to assess the value of obstructive clearing as a practical tsetse control measure, ended on 31st March, 1956, but observations continued until the end of the year.

55. Dealing with the stretch of stream cleared during the first season, fly disappeared during the dry season but there was some reinvasion by immigrant flies during the rains. Along the stretch cleared the second year, fly eradication was achieved in three months and not a single fly has been caught for over twenty-one months; here, where there has been no trouble from wet season immigrants, the method has been a complete success. Clearly the successful blockage of the tsetse's flight line by obstructive clearing does lead to eradication of *G. palpalis* provided isolation is complete.

56. Obstructive clearing is now being tested on a large scale by the Sleeping Sickness Service, Northern Region. In one northern hilly area, where the streams come down in spate, the obstruction was rapidly washed away and the method a failure; however, in a southern area, which is flat, results to date have been very satisfactory. It is felt that further investigations on this matter must now be left in the hands of those who have the resources to carry out large scale experiments.

Publications

Reports and scientific papers published, or prepared for publication, during the year are listed below by Authors in alphabetical order.

BUTLER, G. C., DUGGAN, A. J., and HUTCHINSON, M. P. Melarsen in the Treatment of *T. gambiense* Infection in Man. *Trans. R. Soc. trop. Med. Hyg.* Vol. 51, No. 1, pp. 69-74.

FAIRBAIRN, H. The Infectivity to Man of Syringe-passaged Strains of *Trypanosoma rhodesiense* and *T. gambiense*. *Ann. Trop. Med. and Parasitol.* Vol. 50, No. 2, pp. 167-171.

FAIRBAIRN, H. and WILLIAMSON, J. The Composition of Tsetse-fly Saliva. I—A Histochemical Analysis. *Ann. trop. Med. and Parasitol.* Vol. 50, No. 3, pp. 322-333.

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NASH, T. A. M. and STEINER, J. O. The Effect of Obstructive Clearing on *Glossina palpalis*. *Bull. Ent. Res.* Vol. 48, Part 2.

WATSON, H. J. C. and WILLIAMSON, J. Therapeutic and Prophylactic Experiments on *Trypanosoma simioe* infections in Rabbits and in Pigs (going to press).

WILLIAMSON, J. The Composition of Tsetse-fly Saliva. II.—Analysis of Amino Acids and Sugars by Paper Partition Chromatography. *Ann. Trop. Med. and Parasitol.* Vol. 50, No. 3, pp. 334-343.

WILLIAMSON, J. and DESOWITZ, R. S. Prophylactic Activity of Suramin Complexes in Animal Trypanosomiasis. *Nature.* Vol. 177, pp. 1074, 1075.

VI. ACTIVITIES OF TERRITORIAL DEPARTMENTS

57. The territorial departments of the African Administrations continue to play an important role in tsetse and trypanosomiasis research and much valuable work has been carried out during the year.

58. In Northern Rhodesia trypanosomiasis research has been almost entirely confined to drug trials and prophylaxis, using different drugs in marginal fly areas. Owing to serious side effects following the use of Dimidium Bromide, this drug is now being replaced by antrycide and Ethidium bromide.

59. Prophylaxis trials were continued at four stations in marginal fly sections of the territory. No breakdowns occurred during the year, using Antrycide pro-salt at two monthly intervals.

60. In tsetse control, research has continued in the use of insecticides. At Mulungushi in the area sprayed in 1954 by TIFA with BHC in dieselene and left untreated in 1955, a very low density of *G. morsitans* persisted throughout 1956. The average catch of fly by all means was 3.7 per month. Further treatments with BHC/Dieselene aerosol were applied during 1956 to limited areas in which fly had been found, no conclusive result being apparent by the end of the year. The experiment has established that the threshold value of fly density, as revealed by normal catching methods, which is necessary for the persistence of a *G. morsitans* population, is very much lower than had been anticipated.

61. At Chingola an area of 200 square miles was subjected to discriminative clearing from 1953 to 1955, at the end of which year the residual infested area of 25 square miles was treated with BHC/dieselene aerosol, with a resultant 99 per cent. reduction in fly. A light infestation persisted in 1956.

the limited areas in which fly were being caught being again treated by TIFA. Since July only one fly has been caught throughout the whole region and there is hope that the infestation has been successfully eradicated. It is an interesting point that the limited amount of game in the area has actually increased since operations started in 1953, due to the presence of control staff. It appears that the different response of the Chingola fly population from that experienced with the same treatment at Mulungushi is due to the different ecological, and particularly vegetational, factors which characterise the two regions.

62. The Veterinary Department of the Northern Region of Nigeria has been pursuing a vigorous programme of research into cattle trypanosomiasis. The trypanosome testing station at Kaduna has been chiefly concerned with the collection of field strains of *T. congolense* and *T. vivax* for the purpose of examining them for their therapeutic response. Briefly, strains of trypanosomes are being collected from areas where it is considered treatment of cattle herds has become too frequent for safety. These strains when established in mice and/or cattle are treated with the normal field dose, and field dose $\times 3$, of ethidium to test for drug-resistance. This work is considered to be of prime importance in view of the ever increasing demands of the Fulani for their herds to receive treatment.

63. Field trials have been undertaken using Boots new drug Prothidium. Severe local reaction at the site of injection and a high rate of delayed mortality have given some cause for concern. It is thought however that this may be due to the presence of an isomer in some batches of the drug and a series of comparative tests have been undertaken.

64. The Tsetse Control Unit has been fully occupied during the year in filling in the picture of general tsetse distribution in Northern Nigeria, in carrying out detailed investigations of tsetse populations in specific areas of economic importance, and in eradication schemes in four definite localities.

65. It was obvious, at an early stage, that the control of *Glossina morsitans* presented a different problem in the dry northern Sudan Vegetation zone from that in the Southern Guinea zone.

66. In the Sudan zone, *G. morsitans*, although widespread during the rains, retreats during the dry hot Harmattan season into the restricted evergreen forest islands along river flood plains. Eradication has been possible under these conditions by spraying the vegetation in the forest islands along the Kamaduga Gana river near Azare with DDT insecticide. The cost of eradication of 7 miles of river banks, equivalent to 7 square miles of territory, was £700 as against a possible total clearing cost of £7,000.

67. *Glossina Tachinoides* was eradicated from the Gongola valley in Adamawa Province, in the Sudan vegetative zone, by orthodox selective bush-clearing methods.

68. In the Guinea Zone there is no dramatic retreat of *G. morsitans* during the later Harmattans as seen in the Sudan zone although the association of the fly with drainage line, seen at all times of the year, becomes accentuated towards the late dry season.

69. In the Northern part of the Guinea zone, experimental clearings of drainage lines, on the system successful in Abercorn, Northern Rhodesia, were carried out in two localities, near Shika in Zaria Province and at Kontagora in Niger Province. The final results of these clearings are not yet apparent.

70. Detailed observations on *G. morsitans* in the Kadaru and Anchau corridor areas have given valuable data on the seasonal distribution of tsetse

in a vegetative zone intermediate in many respects between the Sudan and Guinea zones.

71. Detailed observation in the southern parts of the Guinea zone around Mokwa in Niger and in Benue Province have not yielded any results of value regarding control of *G. morsitans* but valuable records have been made on the distribution of *G. longipalpis*.

72. Routine examination of blood smears submitted from infected breeding herds has shown that *T. congolense* and *T. vivax* occur in about equal frequency.

73. The Department of Veterinary Services Tanganyika has a number of experiments in progress. Field trials have been undertaken to compare the length of protection afforded by prothidium, ethidium suramin complex, and RD2902 suramin complex in various doses, as compared with antrycide prosalt, under conditions of heavy fly challenge from *G. morsitans* and *G. swynnertoni*. A similar study is being made using ethidium suramin complex, prothidium and antrycide under conditions of moderately heavy challenge from *G. morsitans* and *G. swynnertoni*. A field trial has also been mounted using antrycide prosalt at two monthly intervals over long periods. In the Laboratory studies are in progress on the pathology of trypanosomiasis with particular reference to the lysing of trypanosomes in the blood stream at about the time of death of the host.

74. The Zoological and Tsetse Section of the Department of Veterinary Services, Kenya, has been active during the year in eighteen widely dispersed areas of the territory. The measures adopted to control trypanosomiasis have included various types of bush clearing, the use of insecticides, the use of protective and curative drugs or a combination of any of these methods of attack. The success can be measured in terms of considerable areas of country now safe for both man and beast and subsequently greater productivity.

75. Most, but not all, of the research carried out in 1956 has centred around the new trypanocidal drugs and a more detailed study of those already known. Extensive laboratory and field trials of several drugs have been carried out.

76. The most outstanding new prophylactic tested was Prothidium (Boots). Although giving severe reactions when administered by certain routes it was reasonably well tolerated subcutaneously, and, in Kenya at least, no delayed toxicity was observed. This drug gave protection against ordinary *T. congolense* for over four months in a laboratory trial, which compared very favourably with an antrycide prosalt protection period of 77 days under identical conditions. The drug however is not effective against strains which have become resistant to phenanthridine compounds.

77. Berenil (Farbwerk Haechst), a curative diamidine drug which was reported on last year, has proved to be extremely valuable in eliminating strains of *T. congolense* or *T. vivax* resistant to either antrycide and/or the phenanthridine compounds.

78. Preliminary trials with a Suramin in Prothidium complex in the molecular proportions 1:3 indicate a marked reduction in toxicity but challenge tests to assess protection periods under different conditions have not yet been carried out.

79. Many (twenty-nine in all) field trials have been carried out with different drugs under accurately assessed challenge conditions. It is not possible to summarize all the different results without referring to the actual protocols. However there is no doubt that the outstanding result has again been achieved with Prothidium. A single dose of this drug, at the rate

4 mg. per kg. has been shown to protect both Grade and Zebu cattle under high challenge conditions for more than six months, whereas three doses of Antrycide—at intervals—gave protection to only 80 per cent. of the test animals under similar conditions.

80. Much more information is now available about antrycide prosalt and methyl sulphate particularly the immunity periods which follow the use of these drugs. An immunity, capable of withstanding a low fly challenge, has been observed over a three year period in large numbers of test animals.

81. Observations have been made on the bionomics and ecology of *G. longipennis*. Although all the data so far collected have not yet been analysed it would appear that the activity of this fly is affected by both light intensity and temperature.

82. Work with insecticides has continued. Dioldrex (diluted to contain 1.8 per cent. dieldrin) is now used in all insecticide control schemes because of the longer residual effect. Several trials are under way to determine the cheapest method of eradicating lakeside *G. palpalis* with insecticides. Only one of these trials (Sifu Island) has been completed. Here after four treatments costing £40 per mile of habitat, *G. palpalis* was reduced from 85 to 0.1 per patrol. The use of attractants is being investigated to reduce costs further.

83. Further tests with herbicides and arboricides have been undertaken. Cutting, burning and spraying the important leleshwa (*Tarchonathus camphoratus*) did not succeed in killing but it transformed the trees into small shrubs enabling grass to grow where none existed before.

84. Tsetse infested land is now being ranched under drug protection as part of normal district development. In this way overstocking is being relieved in Native Reserves.

85. In some reclamation schemes discriminative clearing is adopted to reduce tsetse density to a level at which trypanosomiasis can be controlled by drugs. Much very valuable information on the comparative costs of the different operations has been obtained. With the rapid rise in costs it is essential to choose the most economical measures at present available and this knowledge is increasingly important.

Report of the Director,
Anti-Locust Research Centre,
on Locust Research and
Control, 1956-57

Anti-Locust Research Centre,
1, Princes Gate,
Kensington,
London, S.W.7.
29th April, 1957

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 1956-57.

I have the honour to be,

Sir,

Your obedient servant,

B. P. UVAROV

The Right Honourable Alan Lennox-Boyd, M.P.,
Secretary of State for the Colonies.

LOCUST RESEARCH AND CONTROL 1956-57

ANTI-LOCUST RESEARCH CENTRE

Personnel

1. As in previous years, research workers from overseas organisations have been attached to the Centre for varying periods in order to work out their field data and prepare papers for publication. They have included Dr. R. C. Rainey, Messrs. G. Popov, J. Roffey and D. J. McDonald of the Desert Locust Survey, Mr. J. T. Davey of the International African Migratory Locust Organisation and Mr. K. R. Bhatia of the Indian Locust Organisation.

Accommodation

2. The main offices of the Centre moved to the new quarters at 1, Princes Gate, Kensington, in January, 1956, but the installation of temperature control in the new Locust Laboratory was not completed until November. The whole organisation is now under one roof, except the Taxonomic Section which occupies one room at the British Museum (Natural History).

Locust information service

3. The current Desert Locust plague continued in 1956, when the heaviest infestations occurred in west and north Africa and in Arabia, while Iran, Pakistan, India and Eastern Africa remained relatively clear. In the course of the year the Centre received 984 reports of the Desert Locust situation from 32 territories. Monthly summaries and forecasts continued to be sent out regularly, and a special warning of possible serious plague developments was issued through radio, press and air-mail in October.

4. The information received at the Centre now includes also reports on low-density locust populations submitted by Desert Locust Survey officers in the Somali Peninsula, Ethiopia and parts of Arabia. The work of the Geographical Section included the plotting and summarising of these data and the preparation of standard report forms which may, in due course, be adopted on an international scale.

5. Abstracting of current publications progressed well, 516 abstracts having been issued during the year (as against 262 in the previous year).

6. A film illustrating swarm flight of the Desert Locust has been prepared from material obtained during field research in East Africa. A colour film "The Ruthless One" depicting the biology of the Desert Locust, some aspects of research on it and the activities of the information service of the Centre has been prepared by the Shell Film Unit, with the cooperation of the Centre.

Conferences, tours and lectures

7. At the 10th International Congress of Entomology at Montreal communications were made by Dr. Uvarov (on recent trends and needs of acridological research), Miss Z. Waloff (on the behaviour of locusts in migrating swarms), and Dr. R. C. Rainey (on the comparative assessment of locust control methods). A discussion on the aerodynamics of locust flight, between several members of the Centre's staff and research workers of the Atomic Weapons Research Establishment, Aldermaston, was held, by kind invitation of Sir William Penney. Dr. Uvarov attended meetings of the International African Migratory Locust Organisation in Paris in May and the Executive Committee in Brussels in December and the FAO Technical Advisory Committee and the Desert Locust Control Committee in Tehran in July, Dr. Taylor visited field research workers in Ethiopia and the Aden

Protectorates in May–June, 1956, and in Ethiopia and the Somaliland Protectorate in February, 1957; he also attended a meeting of the FAO Eastern African Desert Locust Control Committee in Addis Ababa in February, 1957. Dr. Rainey represented the Centre at the Council of the International Red Locust Control Service at Abercorn, Northern Rhodesia, in June. Dr. P. T. Haskell visited University laboratories at Durham, Glasgow, Liverpool, Birmingham, Cambridge and London in order to discuss research in progress and to stimulate new investigations. Dr. V. M. Dirsh visited the Belgian Congo Museum at Tervuren to study the type specimens and other material of African Acrididae. Mr. A. T. Thompson gave a talk on the locust problem to the West Kent Scientific Society, and Dr. Uvarov spoke on the Desert Locust and its control to a meeting of the Anglo-Arab Association.

Students and visitors

8. The meetings of the FAO expert panel (para. 35) and of the Desert Locust Survey Advisory Committee (para. 30) at the Centre provided opportunities for locust specialists from East Africa, Egypt, Ethiopia, India, Iran, Morocco, Pakistan, Spain and the Sudan to become personally acquainted with the staff and the work of the Centre. In addition, the Centre was visited by specialists from Madagascar, French Equatorial Africa, Germany, Belgium, China, Argentina, Australia and the United States. Visitors from Universities in the United Kingdom were frequent.

Locust research discussions

9. In order to enable research workers to exchange views on current research, afternoon meetings at the Centre have been organised for some time past. During 1956 the following topics were discussed: egg development in Acrididae in relation to water; the volume of the tracheal system in *Locusta migratoria*; developments in the aerial spraying of locusts; certain aspects of grasshopper behaviour; visual responses of locusts; laboratory work with insecticides against settled and flying locusts. These meetings are quite informal and in the discussions many useful suggestions for further investigation are made. They are attended not only by the staff of the Centre, but also by a number of outside research workers.

Locust Laboratory

10. The move of the Laboratory to the new quarters was accomplished without disruption of its work. The new accommodation is a great improvement, as there are two large constant temperature rooms, studies for personnel and some space for visiting research workers. A steady production of some 2,000 hatchlings and 600 young adults per week has made it possible to supply 21 laboratories in Great Britain and seven more in Italy, France, Austria, Germany, Canada, Gold Coast and South Africa. Requests for locust stocks from over 30 colleges and schools have also been satisfied. Apart from the routine stocks of the three main locusts several grasshopper species are being bred, and stocks have been established of an albino *Schistocerca gregaria*, and of the same species from South Africa; the latter may represent a distinct form.

11. Experimental work in the Locust Laboratory was continued by Mr. P. Hunter-Jones (phase variation and its inheritance); Dr. M. J. Richards (maturation and fecundity in the Red Locust); Mr. G. Cavanagh (weight and water content of the Desert Locust in relation to flight); Mr. A. Antoniou (life-cycle of *Eyprepocnemis plorans*); Miss V. K. Ward (life-cycle of *Gastrimargus africanus*); and Miss P. J. Miller (life-cycle of *Acrida bicolor*).

Extra-mural research

12. Dr. P. E. Ellis, working at the University of Oxford on marching and aggregation in the Desert Locust and the Migratory Locust has found important differences between the two species in their inherent abilities for acquiring gregarious habits.

13. Dr. R. H. Dadd, continuing his studies of locust nutrition at the Imperial College of Science and Technology, has elucidated the importance of ascorbic acid, carotene and vitamins in developing a satisfactory artificial diet, which is greatly needed for exact experimental investigations of growth and metabolism.

14. Dr. P. T. Haskell, with six students, carried out field studies on the behaviour of grasshoppers at the Imperial College Field Station, Silwood Park, near London.

15. Dr. S. R. A. Malek, of the Alexandria University, working at Manchester University on the integument of locusts, was unable to complete his studies before being recalled by his University, where, however, he is continuing this research.

16. Mr. D. A. H. Hearfield working at the University of Leeds concluded his studies on certain aspects of the metabolism of the fat-body, in relation to the biochemistry of locust blood.

17. The need for a better understanding of the sensory factors affecting locust behaviour led to the commencement of research on the visual responses of flying locusts by Miss L. Goodman at Queen Mary College, University of London; on the sense of smell in locusts by Dr. W. Loher at the Imperial College of Science and Technology; and on heat perception by locusts at Birmingham University by Dr. J. Weir. These projects started late in the year and the research is in its initial stages.

18. Dr. E. Slifer, of Iowa State University, working at the University of Birmingham under the Fulbright scheme on heat and humidity receptors in locusts, unfortunately had to interrupt her research for health reasons. Other researches on locusts, not supported financially by the Centre, but assisted by the supply of specimens, advice, etc., are actively pursued in a number of University laboratories in this country and abroad.

Taxonomic research

19. Keys to the African grasshopper genera are being constructed by Dr. Dirsh, and a beginning has been made in preparing illustrations. Miss J. B. Mason completed investigations of the tympanal organ in some 700 genera of Acrididae and analysis of the data is in progress.

Biogeographical research

20. In the Geographical Section, under Miss Z. Waloff, the annual and seasonal frequency maps of the incidence of Desert Locust swarms and hoppers were completed and maps of the major seasonal swarm movements were prepared. It was found that although breeding has occurred from time to time over a large part of the immense area over which swarms spread, the areas over which it has been frequent were much more restricted, and were confined to parts of India, Pakistan, Iran, Arabia, Somali Peninsula, Ethiopia, Sudan, Algeria and Morocco.

21. The study of swarm and hopper frequencies has demonstrated the markedly seasonal nature of infestations over most of the distribution area, and the analysis of plague developments has shown that the continuity of the plague is largely dependent on long-range movements between widely separated breeding areas. Reliable information on the full extent of such

movements has been obtained relatively recently with the improvements in reporting and in understanding of the mechanism of swarm displacements; it is now known that there is nothing unusual in displacements of 1,000–2,000 miles between breeding areas of successive generations. The entire Desert Locust distribution area was found to be inter-connected by these movements, and there is some evidence that the progeny of swarms produced, for example, in north-west Africa may, in a couple of generations, have a decisive influence on events in Pakistan and India and vice versa.

22. The seasonal distribution of swarms observed during the periods of plague recessions corresponded, in general, with those characteristic of the plague periods. This suggests long-range seasonal movements essentially similar to those during the plagues, and the continued inter-dependence in this respect of most parts of the total distribution area.

23. The analysis of historical data has been extended to the African Migratory Locust, and Miss E. Betts has prepared maps showing the annual frequencies of swarm incidence and of hopper infestations in different African territories during the 15-year plague period of 1928–1942. The most frequently infested territories (with infestations in 70–80 per cent. of the years) were found to lie in a wide belt extending from the west coast of Africa at Senegal, French Guinea and Sierra Leone eastwards through French West and Equatorial Africa and Nigeria to the Sudan, while in British East Africa and Northern Rhodesia the infestations occurred in 50–60 per cent. of the years.

Statistical investigations

24. Analysis of photographic data on the Desert Locust in natural flight and covariance analysis of fat content and wing length in the Desert Locust have been made for Miss Z. Waloff. Various other statistical analyses included those of data on the marching of Desert Locust hoppers, and on the distribution of egg-pods of the same species in egg-fields, and also data relating to the theory of aerial spraying of locusts.

Control investigations

25. Research at the Chemical Defence Experimental Station, Porton, under Mr. R. D. MacCuaig, included estimates of the pick-up of spray droplets by locusts flying in a wind-tunnel, and it was found that a flying locust collects nearly twice as much spray as a settled one. Investigations were carried out on the cumulative toxicity of DNC and diazinon sprayed over flying locusts. Relative toxicities of gamma-BHC and diazinon were studied.

26. Mr. R. D. Goodhue, working at the Imperial College of Science and Technology, was investigating the relative susceptibility to stomach poisons of locusts in different hopper instars.

Field research

27. Mr. D. J. Greathead continued his surveys of the natural enemies of the Desert Locust on the Eritrean coast of Ethiopia and in Arabia. Valuable data were obtained on the biology of *Stomorhina lunata*, an important egg-predator. Much additional information was collected on other natural enemies and the field material obtained in the last few years is now being studied in London.

Record of current research

28. A great increase in the number of workers in all branches of acridological research, as well as in general biological research in which locusts are used, has created a danger of overlapping and waste of effort. In the hope of reducing this danger, the Centre circulated to institutions and persons known to be engaged in such research a questionnaire asking them to state the

problems under current investigation. So far, over 100 replies have been received, indicating a very wide range of problems under current study. When the replies are sufficiently complete, it is intended to circulate a list of workers and of their problems. Apart from preventing duplication, the list should help workers on similar problems to establish direct contact with each other. It will also enable the Centre to know where co-operation in investigating some special problems could be obtained.

REGIONAL ORGANISATIONS

Desert Locust Survey

29. During the last few years most of the personnel of the Survey has been diverted to a greater or less extent to participation in control operations. The temporary regression of infestation in the Survey's area during 1956 made it possible to resume what should be the normal work of the organisation, that is, carrying out surveys designed to discover non-swarmling locust populations and to maintain a general watch on their development and movements. This has involved tests of the various survey methods and field training of technical officers in surveying and recording different types of locust populations. Research work was limited to the continuation of investigations on locust parasites and predators by Mr. D. J. Greathead of the Centre in cooperation with the staff of the Survey, the development of ground control techniques by Mr. J. H. Sayer and Mr. C. Ashall, and observations by Mr. J. Roffey on night flying by *Schistocerca*. Dr. W. J. Stower was engaged in preparing for publication the results of several years' field work on variation and behaviour of locusts.

30. The annual meeting of the Desert Locust Survey Advisory Committee, usually held at Nairobi, took place in 1956 in London at the Anti-Locust Research Centre, providing a closer link between the two organisations.

International Red Locust Control Service

31. Studies were continued on Red Locust populations in relation to vegetation dynamics and on control methods. Investigations on locust behaviour, particularly egg-laying and feeding habits, and on parasites and predators of eggs of locusts and grasshoppers are in progress.

International African Migratory Locust Organisation

32. This organisation has existed since 1937 under French administration and since 1947 under a provisional international agreement between France, Belgium and Great Britain. In 1956 it became a permanent international body under a 10-year convention between these three governments. This year has also seen the establishment of a Research Service, with Mr. J. T. Davey as its Director and Dr. B. Nickerson as one of its research officers. Research work has consisted mainly of the continuation of large-scale observations on seasonal displacements of the locust populations inside the outbreak area and beyond it. In addition, investigations were carried out on the ecology of oviposition and on the parasites and predators of eggs by Mr. G. Popov, loaned for the purpose by the Desert Locust Survey for a period of six months.

LOCUST CONTROL

33. No serious infestations and no escapes of swarms occurred from the outbreak areas of the African Migratory Locust in the French Sudan or those of the Red Locust in Tanganyika Territory and Northern Rhodesia, which are supervised by the respective permanent international organisations.

34. The Desert Locust situation improved somewhat during 1956, as far as Eastern Africa, Iran, Pakistan and India were concerned. However, extensive and heavy breeding occurred in the Sudan, and the French Chad Territory and the Niger Colony, where the local anti-locust forces were strained to the utmost, but were inadequate to achieve complete success. During the winter of 1956-57, north-western and western Africa were invaded on a serious scale. The international campaign in Arabia, sponsored by FAO has continued and the gap left by the withdrawal of British teams at the request of the Saudi Government has been partly filled by teams from other countries.

INTERNATIONAL COOPERATION

35. The FAO Technical Advisory Committee on Desert Locust Control, at their Fifth Session in August, 1955, at Damascus, accepted a suggestion by Dr. Uvarov, as consultant to the Committee, that a Panel of experts should be appointed to review present knowledge of the Desert Locust and to formulate long-range plans for investigating the problem on an international basis. The Director-General of FAO, accordingly, appointed a Panel of nine international experts which met at the Anti-Locust Research Centre under the Chairmanship of Dr. Uvarov on April 9-20, 1956. The Geographical Section of the Centre prepared for the Panel a series of memoranda on the distribution, frequency of infestation, and seasonal migration of the Desert Locust throughout its whole region. These documents served as a basis for the discussion, after which a series of conclusions and practical recommendations for long-range investigations and control were formulated. Of special significance were the conclusions that there was no evidence that plagues of the Desert Locust arise from definite outbreak areas, as in the case of other African species, and that surveys in the whole of the distribution area are essential for keeping watch both on swarms and on non-swarmling populations. This was followed by a recommendation that permanent surveys should be established by all governments concerned and that all information on the state of Desert Locust populations and on the relevant weather phenomena should be centralised. Recommendations of the Panel were endorsed by the FAO Technical Advisory Committee meeting in Tehran in July, when the Anti-Locust Research Centre was definitely requested to serve as the international information centre, subject to agreement on the conditions between the FAO and Her Majesty's Government.

36. An Eastern African Desert Locust Control Committee has been established, with FAO assistance, at Addis Ababa, its main function being to promote and facilitate cooperation between national anti-locust organisations in the region which comprises Ethiopia, the Sudan, French Somaliland, Somalia and Kenya.

World Meteorological Organisation

37. Mr. C. I. H. Aspliden, meteorologist in charge of the WMO Technical Assistance Mission for Desert Locust Control, spent some weeks at the Centre to co-ordinate plans for his work with that of the Geographical Section, and to attend meetings of the FAO Panel of experts. A year representative of the Desert Locust seasonal cycle has been selected for study by Mr. Aspliden and he is now engaged in assembling full synoptic data covering that year for the whole infestation area, with a view to a detailed analysis of the factors affecting locust movements and breeding in a typical year. His base is at Nairobi, but he will visit the Centre periodically.

APPENDIX I

ADVISORY COMMITTEE ON ANTI-LOCUST RESEARCH

Membership

- SIR GEOFFREY EVANS, C.I.E., M.A. (*Chairman*).
- DR. W. E. CHINA, M.A., Keeper of Entomology, British Museum (Natural History).
- MR. J. R. DOWNIE, M.A., Colonial Office.
- DR. A. G. FORSDYKE, Assistant Director, Climatological Research, Meteorological Office, Air Ministry.
- DR. W. J. HALL, C.M.G., M.C., Director, Commonwealth Institute of Entomology.
- PROFESSOR O. E. LOWENSTEIN, D.Sc., F.R.S., Mason Professor of Zoology and Comparative Physiology, University of Birmingham.
- MR. G. W. NYE, C.M.G., O.B.E., Colonial Office.
- MR. G. E. PATRICK, B.Sc., Ministry of Supply, D. Arm. R.D. Air.
- PROFESSOR O. W. RICHARDS, M.A., D.Sc., 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, Deputy Director, Anti-Locust Research Centre.
- DR. B. P. UVAROV, C.M.G., F.R.S., Director, Anti-Locust Research Centre.
- PROFESSOR G. C. VARLEY, M.A., Ph.D., Hope Professor of Zoology (Entomology) University of Oxford.
- 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.

APPENDIX II

List of publications

JOHNSTON, H. B., 1956. Annotated Catalogue of African Grasshoppers. Published for the Anti-Locust Research Centre. Cambridge, Univ. Press. xxii + 833 pp.

ANTI-LOCUST BULLETINS

ALBRECHT, F. O., 1956. The anatomy of the Red Locust (*Nomadacris septemfasciata* Serville). *Anti-Locust Bull.*, London, No. 23: 9 pp., 17 pls.

DAVEY, J. T. & JOHNSTON, H. B., 1956. The African Migratory Locust (*Locusta migratoria migratorioides* R. & F.) in Nigeria. *Anti-Locust Bull.*, London, No. 22: [4+] 91 pp., 7 pls., 13 figs.

ELLIS, P. E. & ASHALL, C., 1957. Field studies on diurnal behaviour, movement and aggregation in the Desert Locust (*Schistocerca gregaria* Forskål). *Anti-Locust Bull.*, London, No. 25: [2+] 94 pp., 9 pls., 27 figs.

NICKERSON, D., 1956. Pigmentation of hoppers of the Desert Locust (*Schistocerca gregaria* Forskål) in relation to phase coloration. *Anti-Locust Bull.*, London, No. 24: [2+] 34 pp., 7 figs.

JOURNAL PAPERS

ALBRECHT, F. O., 1956. Limitation des effectifs chez un Acridien: influence de la sécheresse du sol sur les oeufs de *Nomadacris septemfasciata* (Serv.). *Locusta*, Nogent-sur-Marne, No. 4: 1-21, 4 figs.

ALBRECHT, F. O. & VERDIER, M., 1956. Le poids et le nombre d'ovarioles chez les larves nouveau-nées de *Locusta migratoria migratorioides* R. et F. *C.R.Acad. Sci.*, Paris, 243: 203-205, 2 figs.

ANTONIOU, A. & HUNTER-JONES, P., 1957. The life-history of *Eyprepocnemis capitata* Miller (Orth., Acrididae) in the laboratory. *Ent. mon. Mag.*, London, 92: 364-368, 1 fig.

BACKLUND, H. O., 1956. Aspects and successions of some grassland vegetation in the Rukwa Valley, a permanent breeding area of the Red Locust. *Oikos*, Copenhagen, Suppl. No. 2: 132 pp., 35 figs.

BURTT, E. T. & CATTON, W. T., 1956. Electrical responses to visual stimulation in the optic lobes of the locust and certain other insects. *J. Physiol.*, London and Cambridge, 133: 68-88, 12 figs.

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CHOU DHURI, J. S. B., 1956. Experimental studies on the selection of oviposition sites by *Locusta migratoria migratorioides* (R. et F.). *Locusta*, Nogent-sur-Marne, No. 4: 23-34, 6 figs.

CHOU DHURI, J. S. B., 1956. Observations on the oviposition behaviour of the Moroccan Locust (*Dociostaurus maroccanus* Thunbg.) in Cyprus. *Saugor Univ. J.*, 1: 123-139, 5 figs.

DADD, R. H., 1957. Ascorbic acid and carotene in the nutrition of the Desert Locust, *Schistocerca gregaria* Forsk. *Nature*, Lond., 179: 427-428.

DAVEY, J. T., 1956. The seasonal migrations and dynamics of populations of the African Migratory Locust (*Locusta migratoria migratorioides* Reiche and Fairaire) in the outbreak area (Orth.). *Bull. Soc. ent. Fr.*, Paris, 61: 18-24.

DEMPSTER, J. P., 1956. The estimation of the number of individuals entering each stage during the development of one generation of an insect population. *J. Anim. Ecol.*, Oxford, 25: 1-5, 2 figs.

DIRSCH, V. M., 1956. A new species of the genus *Acrotylus* Fieber, 1853 (Orth., Acrididae) from South Africa. *Ent. mon. Mag.*, London, 92: 115-116.

DIRSH, V. M., 1956. The Phallic complex in Acridoidea (Orthoptera) in relation to taxonomy. *Trans. R. ent. Soc. Lond.*, 108: 223-356, 65 figs.

DIRSH, V. M., 1956. Results of the Lund University Expedition in 1950-51. Orthoptera Acridoidea. *S. Afr. Anim. Life*, Uppsala, 3: 121-272, 2 pls.

- DIRSH, V. M., 1956. The South African genera *Pachyphymus* Uvarov, *Xenotettix* Uvarov and *Duplessisia* gen.n. (Orthoptera, Acridoidea). *J. ent. Soc. S. Afr.*, Pretoria, **19**: 132-142, 24 figs.
- ELLIS, P. E., 1956. Differences in social aggregation in two species of locust. *Nature, Lond.*, **178**: 1007.
- GUNN, D. L., 1957. The story of the International Red Locust Control Service. *Rhod. agric. J.*, Salisbury, **54**: 8-24, 2 maps, 14 photos.
- HASKELL, P. T., 1956. Hearing in certain Orthoptera. I. Physiology of sound receptors. *J. exp. Biol.*, London, **33**: 756-766, 4 figs.
- HASKELL, P. T., 1956. Hearing in certain Orthoptera. II. The nature of the response of certain receptors to natural and imitation stridulation. *J. exp. Biol.*, London, **33**: 767-776, 3 figs.
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- SLIFER, E. H. & FINLAYSON, L. H., 1956. Muscle receptor organs in grasshoppers and locusts (Orthoptera, Acrididae). *Quart. J. micr. Sci.*, London, **97**: 617-620, 1 pl., 1 fig.
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RESEARCH MATTERS NOT COVERED BY THE ACCOMPANYING
REPORTS OF THE SPECIALIST ADVISORY BODIES

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A. BUILDING AND HOUSING RESEARCH

1. Building is one of the oldest human activities. And in almost every territory, long established local traditions of building are to be met with; some, like in parts of the African and Pacific territories, quite primitive in character; others, like in Malta and Cyprus, highly sophisticated. Changing building needs, and ever-present demands for economy and speed, have necessitated the introduction of new, often alien, techniques into almost every territory. Their introduction not infrequently sets new problems: the unexpectedly rapid deterioration of a new material; the dislike by tenants of new low-cost housing built in a novel construction; the inadequacy or unexpectedly high running cost of a new installation for air-conditioning.

2. Since its establishment in 1948, the Colonial Liaison Section, Building Research Station, Department of Scientific and Industrial Research, has spent the greater part of its time assisting builders overseas in the solution of such problems. This it has done largely by applying the results of the general work of the Building Research Station, and through experience gained from visits overseas. Less often it has been able to benefit from the results of scientific experiments in the field because, as yet, few such experiments have been attempted and fewer concluded. Lessons, of course, can be learnt from full-scale building of an experimental character; but they are costly. Seldom, moreover, is it possible to gain full benefit from such experiments overseas because complete information on what was done is usually lacking and skilled interpreters usually not at hand.

3. Much of the Colonial Liaison Section's limited resources have had to be devoted to the supply of information for builders overseas, a service which has been somewhat strengthened during the period by an increased provision from general C.D. & W. funds, rather than to experimental research. However, as noted in subsequent paragraphs, a study is being made of the natural ventilation of building in low latitudes; it is proposed to follow this with experimental work in the field. The Paint Research Fellow has also started his programme of work.

Visits

4. The Colonial Liaison Officer concluded in June, 1956, his visit to Fiji and the Far Eastern territories. He will be visiting Aden, Somaliland Protectorate and the East African territories from April to July, 1957.

5. Other visits by members of the Section included a tour of the Caribbean territories, and a visit to Nigeria and the Gold Coast (Ghana). Visits are being planned to Malta and West Africa.

Enquiries and Technical Investigations

6. *Climatological studies.* Though the Section's interest in the effect of climate on building continues, owing to staff changes half way through the period interest is now being concentrated on a few more limited aspects. A joint report, with the Colonial Products Laboratory, on the World Symposium on Applied Solar Energy held in Arizona in November, 1955, has been completed. Studies of the short wave radiation on inclined surfaces based on data from fifteen tropical Stations are in the course of preparation; the studies should help in such problems as determining the cooling load in an air conditioned building.

7. *Natural ventilation.* A study has been commenced on the natural ventilation of buildings in low latitudes, and at the end of the period under review two notes on this topic were in preparation. One set forth a possible basis for a tropical ventilation standard. Some typical examples of the ventilation of buildings known to be satisfactory, or unsatisfactory, are being studied.

8. *Air conditioning.* A note on air-conditioning practices in the Far East, based on experience gained during the Colonial Liaison Officer's tour, has been prepared. Further information is being collected in the forthcoming visit to Aden and East Africa.

9. *Cooking facilities in low-cost housing.* A number of enquiries have been received on the design of kitchen fireplaces in low-cost tropical housing. In the past, firewood has been the usual fuel. Fireplaces tend to smoke and attempts to provide smoke canopies have frequently been unsuccessful. A review of the problems involved was made. It showed that firewood in the larger towns is becoming scarce and increasingly costly. Some families are spending as much on fuel as on rent. In many places, increasing use of kerosene is reported. At the same time, a number of authorities are developing cheap stoves for burning firewood. Further information is being sought during the Colonial Liaison Officer's visit to East Africa. In the meantime, information collected to date is being assembled in a forthcoming Colonial Building Note. The subject has a bearing on the ventilation of kitchens in low latitudes.

10. *Food crop storage buildings.* Work has continued, in collaboration with the Pest Infestation Laboratory, on aspects of the design of buildings for the storage of food crops. In particular, buildings for storage of cocoa beans have received attention. Existing stores have not been entirely satisfactory. Improvements need to be made when new stores are built, in particular, to prevent the growth of moulds and attack by insects. Within the limits of present knowledge of the behaviour of stores under different temperature and humidity conditions, it has been possible to advise on the design of new buildings.

11. *Behaviour of materials in use.* Under damp, warm conditions, a variety of building materials used externally are attacked by mould growth. One of these materials is asbestos cement roofing sheets. The mould growth, besides being unsightly, blackens the surface of the sheets, which consequently absorb a great proportion of solar radiation. It is known that copper sulphate is a deterrent to growth; it will also partially remove existing growth. The co-operation of a United Kingdom manufacturer in treating sheets with fungicides during manufacture has been sought. Sheets, treated alternatively with copper sulphate and copper-8-quinolinolate, are to be exposed to tropical weathering conditions in West Africa.

12. Since the Colonial Liaison Officer's visit to Malta in 1955, the Section has been in correspondence with the Admiralty on the problems of deterioration of the local globigerina limestone used for most building on the island. The degree of deterioration varies. It is more noticeable in buildings, such as those in the Dockyard, close to sea level. A review of the quite extensive literature on Malta building studies has been made. Suggestions for a simple laboratory test which it is thought will distinguish between satisfactory and unsatisfactory stones have been made to Malta. It is proposed to visit the island shortly to follow up this work.

13. *Use of local materials for building.* The prospect of utilising locally the St. Vincent pozzolanas, mentioned in the previous report, has now diminished on the grounds that the initial capital expenditure and annual operating costs are likely to be higher than the local government can afford. The possibility of their use for the proposed deep-water harbour in Barbados is, however, being examined.

14. Preliminary advice has been given on the possible uses for building of Somaliland's gypsum deposits. The matter will be taken further during the Colonial Liaison Officer's forthcoming visit to the Protectorate.

15. *Architectural housing and town planning matters.* Assistance has been given to governments and others on a variety of matters relating to tropical and overseas building. These have included a review of standards for labour housing in Malaya and advice on school building in a number of territories, including the Somaliland Protectorate. Advice has also been given in connection with the proposed West Indies Federal Capital.

16. In recent years in the field of low cost housing, much attention has been given to cheaper building and improved house designs. Less attention has been given to the layout of housing schemes, both from the standpoint of cost and of appearance. A study of alternative housing layouts has been started. It is hoped eventually to issue the results in the form of a guide for those responsible for developing new housing areas.

Dissemination of Technical Information

17. The sixth course for architects and civil engineers in H.M. Oversea Civil Service was held in September 1956, the engineer in charge of building research in French West Africa was among those attending the course. The Section again assisted with lectures at the London School of Hygiene and Tropical Medicine, the Architectural Association School of Tropical Architecture, and elsewhere. In February, the Colonial Liaison Officer gave a Henry Morley lecture on "Housing and Building in the Commonwealth" to the Royal Society of Arts.

18. The demand for Colonial Building Notes is still increasing. Nearly 1,000 copies are distributed to government departments and others overseas and in this country. During the period four issues were published, others are under preparation. Proposals for a series of publications on tropical building problems with a wide circulation are under consideration. The Colonial Building Notes issued during the period are listed below:

- No. 39. Resistance of Timbers to Termite Attack. Durability of Plywood Adhesives in the Tropics. Analysis of Water Used or Encountered in Construction.
- No. 40. The Singapore Master Plan. Recent Developments in Town Planning and Land Legislation, etc.
- No. 41. Aspects of Housing and Planning in Africa: I. Housing and Town Planning in Nigeria, 1953-54. Housebuilding Traditions of the Bantu of North Kavirondo, Kenya. Housing in South Africa: A recent publication.
- No. 42. Aspects of Housing and Planning in Africa: II. Development of Peri-urban Areas in Uganda. Housebuilding in East Africa: A review of "The Home Builder's Guide for East Africa", etc.

Paint research

19. The Colonial Paint Research Fellow started work in March 1957. Based on the Colonial Liaison Section, Building Research Station, he is working in co-operation with the Paint Research Station. A first meeting of the Advisory Panel on Colonial Paint Research will shortly be held.

B. FALKLAND ISLANDS DEPENDENCIES SURVEY

20. The number of Bases manned on the coast of Graham Land and its offlying islands has been increased to eleven, the last to be established being Base J on the Graham Coast. Owing to an altogether abnormally open ice-year less winter and spring sledging has been possible but during the summer much more use than usual has been made of boats; hydrographical survey has been stepped up and advantage of the presence of

H.M.S. Protector has been taken through the landing of survey and geological parties by motor launch and helicopter. Refuge huts have been established to minimise the effect of any prolongation of the open conditions that have prevailed for the last two years. The visit of R.Y. Britannia with H.R.H. The Duke of Edinburgh who visited seven Bases in January was a noteworthy event of the year.

21. The outstanding feature of the survey work during this year and last has been the air survey carried out by Huntings Aerosurveys under the title Falkland Islands Dependencies Aerial Survey Expedition. During the two seasons 35,000 square miles have been covered from the air and many ground control points accurately fixed by parties landed from helicopters or operating from Falkland Islands Dependencies Survey Bases. The Geological survey of Anvers Island has been completed this year and the detailed survey from the other Bases continued by boat, sledge and man-packing parties. The Survey provided a biologist to do a year's investigation as Sealing Inspector in South Georgia and the problem of Seal Conservation is under review. A new dog ration is being tried out as the result of investigations in dog physiology carried out during the year. Liaison with the Medical Research Council has enabled the three Medical Officers at the Bases to take part in the programme of research into cold acclimatisation.

22. A feature of the year was preparation for participation in the International Geophysical Year. The programme of ionospheric research at Port Lockroy has been intensified and at the Argentine Islands a seismological station has been set up, and ozone measurements are also being undertaken. Glaciologists are working at South Georgia (where Falkland Islands Dependencies Survey have undertaken to maintain two of the Royal Society's International Geophysical Year teams) and at Admiralty Bay, King George Island.

23. The establishment of a geological unit in the Geological Department of the University of Birmingham should facilitate considerably the working up of past and current geological results.

24. In addition to the eleven stations maintained by the Survey, the Director of the Falkland Islands Dependencies Scientific Bureau has been seconded while acting as leader of the Trans-Antarctic Expedition now stationed at Shackleton Base on the Weddell Sea coast and preparing to cross the continent to the Ross Sea. Falkland Islands Dependencies Survey has also contributed to the supply of the Royal Society's International Geophysical Year base at Halley Bay, also on the coast of the Weddell Sea.

C. GEODETIC AND TOPOGRAPHIC SURVEYS

Staff

25. Recruitment of qualified surveyors remained difficult, but the intake of cartographic draughtsmen showed a big improvement. Despite the loss of twenty-six, there had been an overall gain of forty-six in this grade at the end of the year. This was the first time for many years that recruitment more than replaced losses.

26. The total staff in post on 31st March, 1957, was 390, including eight Officers and Senior Other Ranks seconded from the Royal Engineers (Survey).

Geodetic Surveys

27. The first order chain in south-eastern Tanganyika was almost completed apart from observations for the quadrilateral joining this work to the Nyasaland first order chain.

28. Observations of the Kenya first order chain were recommenced and measurement of the base line near Isiolo was almost completed. Some observations were also made for the chain north of Nairobi.

29. Complete primary observations for Swaziland were passed to the Trigonometrical Survey Office of the Union of South Africa who have undertaken to do the adjustment.

30. In Uganda, observing of the first order chain from the Arc of the 30th Meridian to the Karamoja chain was completed in addition to reconnaissance and some observing of the chain north of Lake Victoria.

31. The network of primary triangulation from Livingstone to Lusaka, in Northern Rhodesia, was completely observed.

32. Progress in North Borneo, where conditions for this work are exceptionally difficult, was slow although some observations were completed east of Jesselton.

33. Precise traversing of the second Gambia loop was completed.

34. Reconnaissance of a first order chain of triangulation in the Cameroons was commenced.

Minor Triangulation and Photo Control

35. In Tanganyika, control was supplied for the area between Dar es Salaam and the Kenya border and work continued in the Kilosa-Dodoma area.

36. Secondary and minor control was completed in the Mombasa-Malindi area of Kenya and westwards to Voi.

37. In Nyasaland, secondary control was undertaken for the area between 13°S and 14° 30'S.

38. Secondary triangulations were completed for Swaziland and for eastern Bechuanaland and astro-fixes were observed for the flat area of Bechuanaland.

39. Work in Somaliland continued throughout the year.

40. The triangulation of the Virgin Islands and of Anguilla was completed and an additional control was established in Dominica.

Air Photography

41. The contractors in the Caribbean claimed about 10,000 square miles of British Guiana and almost complete cover of Anguilla, Barbuda, St. Kitts-Nevis and Tobago. About 630 square miles of cover was obtained for British Honduras.

42. Photography was received for about 15,000 square miles of the Kilombero Valley in Tanganyika and claimed for 3,000 square miles of the West Nile District of Uganda, while sorties were also flown over Aden and Kenya by the Royal Air Force.

43. In Bechuanaland about 16,000 square miles were photographed.

44. Claims amounting to about 12,000 square miles of Nigeria, 1,700 square miles of Sierra Leone and 2,000 square miles of the Gambia were received.

45. Complete cover of the Falkland Islands and of about 35,000 square miles of the Dependencies was claimed.

Mapping

46. Production of the by now well known "Preliminary Plots" was discontinued and replaced in most cases by printing in at least two colours

in the first instance, thereby making for easier map reading. Improved methods maintained production, most of which was at 1:50,000, or larger scales.

47. Part of an extensive programme, including many contoured sheets, was completed for Kenya (Ethiopia Boundary Commission), Tanganyika (irrigation) and southern Uganda.

48. Preparation of contoured editions at 1:50,000 for Basutoland, N. Rhodesia and Swaziland continued, together with mapping of Nigeria, N. Borneo and Sarawak.

49. The series covering Somaliland and Viti Levu (Fiji) were completed and further sheets were published at 1:200,000 of the Falkland Islands Dependencies.

50. Contouring at larger scales included progress with Mauritius and the Caribbean islands and completion of the 1:10,000 map of Barbados.

51. New blocks of mapping were taken up for Aden, eastern Bechuanaland, Malta and Vanua Levu (Fiji).

52. Production of print laydowns (uncontrolled mosaics of air photographs) continued to meet the increasing demands which came particularly from geologists working in areas as yet unmapped.

53. The post of Land Use Officer was filled and assistance was given to agricultural research in the Caribbean islands and the Gambia, while land use maps were prepared for Grenada and Mauritius.

54. Special productions included fully coloured geological maps, forestry sketch maps, and illustrations for reference books on Africa.

55. (A full account of this work is given in the Directorate of Colonial (Geodetic and Topographical) Surveys Annual Report for the year ended 31st March, 1957.)

D. GEOLOGICAL SURVEYS

56. The Director of Colonial Geological Surveys and members of his staff visited East, Central and West Africa, the Federation of Malaya, the United States and Mexico, in order to examine developments, give specialist help and attend conferences.

57. During the year geological surveys continued in 20 territories. The number of geologists, geophysicists and geochemists overseas, rose to 211, but there were still a number of vacancies which could not be filled.

58. Progress was made in investigating mineral resources, further developing underground water supplies, solving geological problems encountered in engineering projects, and in geological mapping.

59. In Uganda, extensive pitting at Namekara and Busumbu has proved 100,000 tons of medium grade vermiculite and more than 1 million tons of phosphate ore. More than 200 million tons of phosphate and niobium-bearing material have been proved at Sukulu.

60. In Tanganyika, five carbonatite deposits are being examined by mining companies.

61. Carbonatites are also being investigated in Northern Rhodesia, and some 25 to 30 million tons of coal have been discovered and prospected in the main seam of the Kandabwe coalfield.

62. In the Gold Coast, progress has been made in evaluating alluvial diamond deposits. Important work has been done in determining the source-rock in the Birim diamond field.

63. In Sierra Leone, rutile has been found in the alluvial deposits of the Lanti River.

64. Aeromagnetic and air-borne radiometric surveys are being carried out over one-third of the territory of the Federation of Malaya, by arrangements made under the Colombo Plan.

65. The Geological Survey has found phosphate occurrences in the British Solomon Islands Protectorate and the possibility of deposits of economic value is being examined.

66. The Mineral Resources Division in London carried out extensive laboratory investigations on coal from Northern Rhodesia and Nyasaland, gypsum from Somaliland Protectorate, chromite-bearing sands from North Borneo, and tin ore from Nigeria. Complete chemical analyses were made of rocks from Cyprus, Nigeria, Sarawak, Sierra Leone and Swaziland. About 700 inquiries were dealt with.

67. A small geophysical section based in London has begun operations. It has carried out seismic work on the Lupa goldfield in Tanganyika and on hydrological problems in Malaya.

68. The photogeological section has been engaged on mapping to assist the geological survey departments of Nyasaland, the Gold Coast, Somaliland Protectorate; and the territories in North Borneo.

69. During the year research by geologists of university staffs, has been carried out in British Guiana, the British Solomon Islands Protectorate and Fiji, and valuable field help by the Geochemical Prospecting Research Centre of the Imperial College of Science and Technology has been given in Tanganyika, Northern Rhodesia and Sierra Leone.

Vulcanological Research in the Caribbean

70. The seismograph stations in Trinidad, Grenada, St. Vincent, St. Lucia, Barbados, Dominica and Antigua have been in operation throughout the year. In all 820 earthquakes were recorded, 165 of these being distant ones originating more than 100 miles from the seismograph network. During the year the seismologist visited the Seismological Division of the United States Coast and Geodetic Survey, the Seismological Observatory at Lamont of Columbia University and the Canadian Dominion Observatory at Ottawa.

E. INDUSTRIAL AND ENGINEERING RESEARCH

East Africa

71. In East Africa, the most welcome development has been the building of new laboratories and offices in Nairobi and a metallurgical laboratory in Entebbe for the East African Industrial Research Organization.

72. Investigations into coffee processing, particularly drying, have been continued and pilot scale equipment has been installed on estates where experimental trials have been undertaken.

73. Attention has been directed towards a study of the fermentation of sisal waste to produce methane gas.

74. Technical assistance has been sought by the ceramics industry, particularly in developing brick and tile works in Uganda and in encouraging pottery making as a village industry in African areas in Kenya.

75. The Crown Agents' Engineering Advisory Service has continued to give advice and assistance to Overseas officers in technical matters, and has arranged visits to works as required. An increasing demand has been met for study or training courses varying in duration between a week and twelve months.

76. Close relationship has been maintained with the Colonial Liaison Officers for Road and Building Research, and with the Water Pollution and Hydraulics Research Laboratories.

77. "The Crown Agents Review" continues to include articles of technical interest. In the year under review the journal published articles on buildings designed and supplied by the Crown Agents' office for Antarctic service, Road Construction in Tanganyika and the construction of Ijora "B" Power Station, Nigeria.

F. METEOROLOGY

78. The year under review saw the first of a series of visits to Colonial territories by Dr. A. G. Forsdyke of the Meteorological Office who is conducting a survey of the research requirements for tropical meteorology with special reference to Colonial territories. After preparatory correspondence with Colonial meteorological services Dr. Forsdyke visited West Africa in November, 1956, and the Caribbean and East Africa in May/July, 1957. He hopes to produce a report before the end of 1957-58. This project is being undertaken in pursuance of a resolution of the 1955 Conference of Commonwealth Meteorologists and is financed mainly from C.D. and W. funds.

79. Local research in Colonial territories was again hampered by shortage of staff. However, work has continued in East Africa on the use of cetyl alcohol to reduce evaporation losses from reservoirs and lakes and on the use of rockets in order to stimulate the production of rainfall from rain bearing clouds. Papers were produced on the reduction of evaporation losses.

80. The evaporation work in West Africa mentioned in last year's report has also continued and three papers have been produced on different aspects of the subject in relation to the Volta River project. In connection with the survey of the Niger and Benue a network of evaporation tanks has now been installed in Nigeria.

81. In Mauritius studies on the effect of rainfall on sugar cane have been pursued for some time and are near the stage when a paper may be produced. Two simple linear equations have been derived correlating the quantity of cane with summer rainfall and the quality with winter rainfall.

82. A number of papers were published by members of the Hong Kong and Malayan Meteorological Services, some appearing in the Quarterly Journal of the Royal Meteorological Society.

83. The British Caribbean Meteorological Service is participating in a hurricane research programme which was started during the year under the auspices of the United States Weather Bureau, and most of the Colonial meteorological services had, by the end of the year, made arrangements for extensive participation in the meteorological programme of the International Geophysical Year.

G. WATER POLLUTION RESEARCH

84. During the year the Water Pollution Research Laboratory has been in touch with the Colonial Products Council concerning the use of cetyl alcohol for reducing the rate of evaporation from reservoirs. The Laboratory has shown that cetyl alcohol is susceptible to breakdown by biochemical oxidation, and that the natural contamination of water surfaces may reduce the effectiveness of the method.

85. As usual information concerning the Laboratory's work was sent to correspondents in the Colonies. Specific enquiries to which answers were provided concerned methods for chlorinating water supplies and for disposing of waste waters from tanning and from a rubber factory.