

1956-57 Cmnd. 52 Colonial Office. Colonial research 1955-1956. 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



1

COLONIAL OFFICE

COLONIAL RESEARCH

1955-1956

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 by the Secretary of State for the Colonies to Parliament
by Command of Her Majesty
November, 1956*

LONDON

HER MAJESTY'S STATIONERY OFFICE

TEN SHILLINGS NET

Cmnd. 52

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Colonial Research Council Annual Report on Colonial Research (1955-1956)

Colonial Office,
The Church House,
Great Smith Street,
London, S.W.1.
15th October, 1956.

SIR,

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
1955-56.

I have the honour to be,

Sir,

Your obedient servant,

LLOYD.

The Right Honourable Alan Lennox-Boyd, M.P.



COLONIAL RESEARCH COUNCIL

Membership

THE PARLIAMENTARY UNDER-SECRETARY OF STATE FOR THE COLONIES
(*Chairman*).

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

SIR CHARLES DODDS, F.R.S., D.Sc., M.D., F.R.C.P., F.R.I.C. (Chairman,
Colonial Products Research 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. (Chairman, Colonial Insecticides, Fungicides
and Herbicides Committee).

SIR HAROLD HIMSWORTH, K.C.B., M.D., F.R.C.P., F.R.S., Q.H.P. (Chairman,
Colonial Medical Research Committee).

SIR BEN LOCKSPEISER, M.A., K.C.B., D.Sc., M.I.Mech.E., F.R.Ae.S., 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 EDWARD SALISBURY, C.B.E., D.Sc., F.R.S. (Secretary, The Royal Society).

SIR WILLIAM SLATER, K.B.E., D.Sc., F.R.I.C. (Chairman, Committee for
Colonial Agricultural, Animal Health and Forestry Research).

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 1955-1956

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Table I: Lists of schemes approved for Research grants under the Colonial Development and Welfare Acts during the period 1st April, 1955, to 31st March, 1956.

Table II: Allocations for Research under the Colonial Development and Welfare Acts, 1940, to 31st March, 1956.

Table III: Actual issues in respect of Research Schemes, 1940-1956.

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

Agriculture, 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.

COLONIAL RESEARCH COUNCIL (1955-1956)

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, formerly under the title (" Insecticides, Herbicides and Fungicides ") ; 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. The first report of the Committee newly appointed by the Secretary of State to advise him on colonial road research matters now appears as a separate report.

2. During the year, Sir Ben Lockspeiser retired from the public service and from membership of the Colonial Research Council. The Council desire to place on record an expression of their sincere appreciation of the valuable assistance which Sir Ben Lockspeiser gave to the Council during his period of membership, particularly in the furtherance of co-operation between the Department of Scientific and Industrial Research and the Colonial Office.

3. A number of visits were made by members of the Council and Committees during the year under review. Two meetings of the East African Agriculture and Fisheries Research Council were held and members of the Committee for Colonial Agricultural, Animal Health and Forestry Research attended on each occasion. At the second meeting a member of the Colonial Office Research Department was also present. As in previous years the opportunity was taken to visit research establishments in East Africa. One member of the Committee visited the West African Cacao Research Institute to advise on plant breeding techniques and another member visited Singapore and Malaya in connection with soil problems in the rice fields. The Agricultural Adviser and Deputy Agricultural Adviser made visits to East Africa, West Africa, Mauritius, Cyprus and Malta. The Adviser on Animal Health visited East Africa, Somaliland, Cyprus and the Far East. The Forestry Adviser visited West Africa and the Fisheries Adviser made visits to Central Africa, Malta and the Far East. Members of the Colonial Medical Research Committee and the Director of Colonial Medical Research attended meetings of the East and West African Councils for Medical Research and visits were made by other members of the committee to West Africa, Malaya and Fiji. In addition a member of the Tsetse Fly and Trypanosomiasis Committee visited Bechuanaland under the auspices of the World Health Organisation. The Officer-in-Charge of Colonial Pesticides Research visited East, Central and West Africa and his deputy, who took up his appointment as Scientific Secretary to the Colonial Pesticides Research Committee in 1955, also visited East Africa. The Director and Deputy Director of the Anti-Locust Research Centre and members of the Colonial Office Research Department attended international meetings on Locust Control. An Inter-African Conference on the Social Sciences and other special meetings convened by the Commission for Technical Co-operation in Africa South of the Sahara were attended by members and the Secretary of the Colonial Social Science Research Council and Colonial Economic Research Committee. Attendance of the Scientific Secretary of the Colonial Products Council at the World Symposium on Applied Solar Energy was combined with visits to scientific establishments in the United States of America and to British Caribbean territories.

4. As stated in paragraph 5 of our report for 1954-55 the total provision of Colonial Development and Welfare funds for Colonial Research during the period 1955-60 is approximately £8m. and thus calls for an average annual

expenditure of £1,600,000. The expenditure during the year ended 31st March, 1955, was £1,173,381 and expenditure on research schemes for the year under review, viz. the year ended 31st March, 1956, was approximately £1,364,320. While this increase over expenditure in the previous year is to be welcomed, and a further increase is expected during the year 1956-57, it is obvious over the field as a whole that expenditure will require to be stepped up if the whole of the amount available is to be spent during the current quinquennium. The Council and the Advisory Committees will review research schemes and research expenditure in detail during the year 1956-57 and will make such re-allocations among the various fields of Colonial Research as may seem to be desirable.

GENERAL

Colonial Development and Welfare Research Schemes made in 1955-56 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. Eighty-eight new schemes and 66 supplementary schemes were made, involving grants totalling £1,889,486. These compare with 52 new schemes and 48 supplementary schemes made during the previous year entailing grants totalling £533,548, 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, 1955. 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 £15,389,486. The net commitment, after allowing for revision of schemes and unspent balances, was on the 31st March, 1956, of the order of £14·60 million of which some £12·5 million 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 £10,563,866.

6. About 32 per cent. of the gross allocation of £15·3 million has been for agricultural animal health and forestry schemes, 15·5 per cent. for medical research, 12 per cent. for fisheries research, 9 per cent. for tsetse and trypanosomiasis research, 10 per cent. for social science and economic research, 8 per cent. for insecticides research, 5 per cent. for research sponsored by the Colonial Products Council, 3·5 per cent. for anti-locust research, and 5 per cent. for miscellaneous schemes including building and road research. Approximately 36 per cent. of the gross allocation has been for schemes to benefit the East African territories, 19·5 per cent. for the West African group, 10 per cent. for the South-East Asian territories and Hong Kong, 10·3 per cent. for the West Indian colonies, British Guiana and British Honduras, 5·6 per cent. for the Central African territories (Northern Rhodesia and Nyasaland) and 18·6 per cent. for other territories and for schemes of general interest. The policy of creating pools of United Kingdom-based staff has been continued. Further expansions have taken place in the existing pools and new pools have been established. Increased assistance to Colonial research projects (other than financial assistance) was given by extending the arrangements for visits overseas by specialists from the United Kingdom.

7. The new schemes made during the year include : in the United Kingdom, a contribution to research on animal physiology under tropical conditions at the Hannah Dairy Research Institute ; establishment of a colonial pool for stored products research ; research on colonial paint problems ; trachoma research in Jordan ; in East Africa, leprosy research at Makerere College ;

schistosomiasis research at Mwanza, Tanganyika ; short-term survey of the incidence of insect pests of cereal crops ; research on the biology of sandflies : in West Africa, a study of aphids and white flies ; sociological research in the Kombo districts of the Gambia ; agricultural improvement schemes in the Gambia ; a study of the Mbembe people of Nigeria ; preparation of a social, political and economic history of Benin : in Swaziland, a study of land holding and land usage among the Swazi : in Malta, a preliminary survey of economic research possibilities : in Mauritius, research on the social structure of the Indian community : in Malaya, research on virus and other diseases transmissible from animal to man ; filariasis research at the Institute for Medical Research, Kuala Lumpur : in North Borneo, an investigation of diseases of Manila hemp : establishment of a Fundamental Nutrition Research Unit at the University College of the West Indies ; in British Guiana, a soil and land use survey ; investigation into the possibility of cotton production (also in British Honduras) : in Trinidad, contribution towards the cost of maintaining the Rockefeller Foundation Regional Virus Research Laboratory. Supplementary schemes include further financial assistance for : provision of research studentships and research fellowships ; the Agricultural Research Council's unit of Experimental Agronomy at Oxford ; the Anti-Locust Research Centre ; the East Africa Desert Locust Survey ; the various colonial pools established in the United Kingdom ; the various research institutes in East and West Africa conducting medical, agricultural, veterinary, fisheries and forestry, and social science and economic research ; preparation of Florae of East Africa and Central Africa ; the West and East African Institutes for Trypanosomiasis ; preparation of a Flora of Cyprus ; research on certain virus diseases and emergency yellow fever vaccination methods in Malaya ; the Regional Research Centre at the Imperial College of Agriculture, Trinidad and sugar technology research in Trinidad.

Research Branch of Her Majesty's Oversea Civil Service

8. During the year 39 new appointments were made to the Research Branch. There are two Research Fellows pursuing research on behalf of the Colonial territories. Sixteen research studentships were awarded to train candidates for research appointments : four for agriculture, four for stored products, four soil science, two veterinary and two medical.

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

9. The Sixth and Seventh meetings of the Council took place during 1955-56 ; the former at Luanda, Angola, in September, 1955, and the latter at Yangambi, Belgian Congo, in July, 1956. Among the research activities in Africa South of the Sahara reviewed by the Council at these meetings were maps and surveys, geology, geophysics, the use of radio isotopes, climatology, physical hydrology, soils, forestry, public health, oceanography, sea fisheries and social sciences. The function of the Council is to promote inter-African scientific co-operation in these fields. During the year a number of specialist meetings have been held ; these were on the subjects of quelea, the bird pest of Africa which devours crops of small grains ; the use of irrigation and drainage in agriculture ; the Second Inter-African Symposium on Hydrobiology and Inland Fisheries ; the Specialist Meeting on Phyto-Geography. A specialist meeting on stored food products is to be held later this year.

10. Progress has been made on the Council's two special projects undertaken with the Commission for Technical Co-operation in Africa, South of the Sahara (C.C.T.A.). The preparation of a climatological atlas for Africa (Joint Project No. 1) is nearing completion. Joint Project No. 2, the revision by Dr. Worthington of his book on " Science in Africa ", is expected to be completed this year.

11. The Scientific Secretary of C.S.A., Mons. Bredo, resigned during the year ; his successor has not yet been appointed. Professor G. Leduc, Professor Daryll Forde and Dr. E. W. Russell have been appointed members of the Council in place of Professor F. S. Frankel, Dr. Audrey Richards and Dr. H. H. Storey who have resigned.

12. Further C.S.A. publications appeared during the year. No. 14 is a directory of scientific institutes, organisations and services in Africa South of the Sahara ; No. 15 contains a list of topographical maps of Africa ; No. 16 is a list of scientific societies in Africa South of the Sahara ; No. 17 contains a list of topographical maps and of special maps (geology, climatology, demography, etc.) ; No. 18 is the report of the Sixth Meeting 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 Report No. XII in this volume. Officers in the service of Colonial Governments have made visits to the hydraulic research station during the year.

Technical Assistance

14. The two American pasture specialists made available under the Mutual Security Agency completed their survey in West and Central Africa during the year. The Food and Agriculture Organisation continued to provide specialists for the Ebini Livestock Experiment Station, British Guiana and the Gold Coast Pilot Irrigation Scheme.

Colonial Research Publications

15. In addition to the reports listed in the Reports of the Specialist Advisory Committees, "Iban Agriculture" by J. D. Freeman (12s. 6d.) was published in the Colonial Research Studies series as No. 18.

APPENDIX

TABLE I

LIST OF SCHEMES APPROVED FOR RESEARCH GRANTS UNDER THE COLONIAL DEVELOPMENT AND WELFARE ACTS DURING THE PERIOD 1ST APRIL, 1955 TO 31ST MARCH, 1956

Scheme No. (Prefix "R")	Benefiting Territory	Description of Scheme	Amount
			£
375B	General	Continuation of appointment of Colonial Road Liaison Officer. (Supplementary provision.)	1,200
375C	do.		3,250
430E	do.	Contribution towards the cost of the Unit of Experimental Agronomy, Oxford 1956-1960. (Supplementary provision.)	6,036
435A	do.	Colonial Agricultural Research Studentships. (Supplementary provision.)	1,000
494C	do.	Maintenance of the Anti-Locust Research Centre 1955-56. (Supplementary provision.)	40,100
494D	do.	Removal of the Anti-Locust Research Centre to new premises at Princes Gate. (Supplementary provision.)	9,926 253 1,275
581A	do.	Social Science and Economic Publications (Supplementary provision.)	2,500
647	do.	Sickle cell investigations by Dr. H. Lehmann. Provision of deep freeze box.	100
656	do.	Research on animal physiology under tropical conditions at the Hannah Dairy Research Institute.	60,350
657	do.	Part-time appointment of Dr. A. C. Allison to the staff of the Medical Research Council for sickle cell work.	3,950
665	do.	Full-time assistance by Mr. E. R. Skinner on sickle cell blood investigations at the Department of Biochemistry, University of London.	1,500
667	do.	Publication by the Royal Entomological Society of London of a paper "The Anopheles Lencosphyrus".	150
669	do.	Research on leprosy by Dr. Graham Weddell.	4,680
672	do.	Trachoma research in Jordan	40,586
674	do.	Sickle cell investigations by Dr. H. Lehmann. Provision of electrophoresis apparatus and accessory glassware.	100
677	do.	Establishment of a Colonial pool for stored products research.	18,500
683	do.	Contributions towards the cost of delegates expenses at the Symposium on the Endemiology of Primary Hepatic Carcinoma.	333

Scheme No. (Prefix "R")	Benefiting Territory	Description of Scheme	Amount
685	General	Research on Colonial paint problems ..	£ 10,000
689	do.	Continuation of appointment of Secretary etc., to the Colonial Social Science Research Council and the Colonial Economic Research Council.	9,060
691	do.	Timber borer research at the Forest Products Laboratory.	5,800
695	do.	Visit of Dr. H. Lehmann to East Africa in connection with "sickle cell" investigations.	525
696	do.	Contribution to the maintenance of the British Commonwealth Scientific Offices (London) 1956-1960.	900
700	do.	Visits etc. by members of the Committee for Colonial Agricultural, Animal Health and Forestry Research and its sub-Committees.	4,400
701	do.	Colonial Pool of Spraying and Dusting Machinery at Silwood Park.	2,475
702	do.	Appointment of Secretary etc. to the Committee for Colonial Agricultural, Animal Health and Forestry Research 1956-1960.	15,000
704	do.	Fundamental research on insecticides at Rothamsted Experimental Station.	3,000
705	do.	Purchase of semi-diesel marine engines for trial in Colonial Fisheries.	1,250
707	do.	Continuation of Colonial Pool of Entomologists 1956-1960.	8,000
708	do.	Continuation of the Colonial Pool of Plant Pathologists 1956-1960.	8,800
709	do.	Colonial Pesticides Research Unit, Porton. 1956-1960.	36,300
713	do.	Visits abroad by members of the Colonial Medical Research Committee 1956-1960.	11,500
714	do.	Agricultural and allied studentships 1956-1960.	24,000
715	do.	Continuation of appointment of assistant to Professor Macgraith at the Liverpool School of Tropical Medicine.	1,000
716	do.	Secretariat of the Colonial Medical Research Committee. 1956-1960.	16,120
717	do.	Colonial Medical Research Studentships. 1956-1960.	12,000
719	do.	Colonial Research Fellowships 1956-1960.	14,000

Scheme No. (Prefix "R")	Benefiting Territory	Description of Scheme	Amount
722	General	Assistance on statistical matters by Rothamsted Experimental Station 1956-1960.	£ 8,000
723	do.	Abstracts and news summaries 1956-1960..	16,920
724	do.	Headquarters staff of the Colonial Pesticides Research Committee 1956-1960.	14,520
726	do.	Continuation of the Termite Research Unit. 1956-1960.	18,160
729	do.	Continuation of appointment of Tropical Soils Adviser at Rothamsted Experimental Station.	11,575
730	do.	Continuation of appointment of Colonial Liaison Officer and staff at the Pest Infestation Laboratory.	34,084
733	do.	Anti-Locust Research Centre 1956-1957 ..	50,200
734	do.	Colonial Products Council—Extra-mural activities 1956-1960.	25,000
735	do.	Maintenance of Headquarters Unit of Colonial Products Council 1956-1960.	21,200
28J	Africa General	Publication of North Bantu Borderland Linguistic Survey. (Supplementary provision.)	470
41F	do.	Publication of Ethnographic Survey of Africa. (Supplementary provision.)	3,000
472A	do.	Fact finding survey of Literature of African fauna. (Supplementary provision.)	2,430
668	do.	Investigation into the growth of chlorophora excelsa in plantations. Visit of Dr. Jones to East, West and Central Africa for preliminary survey.	650
678	do.	Studies connected with the control of Quelea grain eating birds in Africa.	2,300
712	do.	Contribution towards the costs of the activities of the Commission for Technical Co-operation in Africa South of the Sahara (C.C.T.A.) and the Scientific Council for Africa South of the Sahara (C.S.A.).	15,000
732	do.	Experiments on the sterilization of tsetse flies.	400
354G	East Africa General	Desert Locust Survey. (Supplementary provision.)	19,215
355C	do.	East African Institute of Malaria and Vector Borne Diseases. (Supplementary provision.)	3,070

Scheme No. (Prefix "R ")	Benefiting Territory	Description of Scheme	Amount
395A	East Africa General	Maintenance of East African Virus Research Institute. (Supplementary provision.)	£ 38,100
409H	do.	Economic research at Makerere College, Uganda. (Supplementary provision.)	16,619
452A	do.	East African Tsetse and Trypanosomiasis Research and Reclamation Organisation. (Supplementary provision.)	3,730
523B	do.	Colonial Insecticides Research Unit. (Supplementary provision.)	20,600
527A 527B	do.	East African Agriculture and Forestry Research Organisation. (Supplementary provision.)	30,914 3,253
568A 568B	do.	East African Veterinary Research Organisation. (Supplementary provision.)	22,596 904
642A	do.	Employment of an Assistant to Professor J. N. P. Davies at Makerere College, Uganda. (Supplementary provision.)	900
658	do.	Visit of Miss Ballantine to the East African Marine Fisheries Research station, Zanzibar, to assist in culture research on phytoplankton.	110
659	do.	Purchase of equipment and cost of transport for leprosy research at Makerere College, Uganda, by Dr. R. S. Naylor.	1,120
666 666A	do.	Investigation of snail vectors of schistosomiasis at Mwanza, Tanganyika, by Mr. W. F. J. McClelland. (And supplementary provision.)	3,220 370
676 676A	do.	Investigation of Aedes Aegypti at the East African Virus Research Institute, Entebbe. (And supplementary provision.)	4,000 325
682	do.	Tuberculosis chemotherapy trials in East Africa.	1,250
688	do.	Preliminary short term survey in East Africa of the incidence of insect pests of cereal crops.	7,360
690	do.	Establishment of a Research Section in the East African Meteorological Department.	1,250
692	do.	Visit of Mr. Weitz to Kampala to attend the Scientific Conference on Zoonosis.	330
693	do.	East African Institute of Social Research, Makerere College, Uganda, 1956-1960.	82,329
706	do.	Desert Locust Survey 1956-1957	18,312
721	do.	Continuation of preparation of a Flora of East Africa.	34,000

Scheme No. (Prefix "R")	Benefiting Territory	Description of Scheme	Amount
684	Kenya	Research on the biology of sandflies ..	£ 4,935
583A 583B	Uganda	Social anthropological research at Makerere College. (Supplementary provision.)	435 134
632A	Somaliland Protectorate	Study of the Somali. (Supplementary provision.)	913
530B	Tanganyika	Control of agricultural pests by insecticidal methods. (Supplementary provision.)	3,013
643A	do.	Inquiry into the national income of Tanganyika. (Supplementary provision.)	330
629A	Central Africa General	Flora Zambesiaca. Visit of Mr. Exell to Central Africa. (Supplementary provision.)	14
698	Northern Rhodesia..	Rhodes-Livingstone Institute	32,770
311C	West Africa General	West African Building Research Institute. (Supplementary provision.)	43,100
322E	do.	Capital expenditure for additional accommodation at the Helminthiasis Research Unit. (Supplementary provision.)	5,105
424B 424C	do.	West African Institute for Trypanosomiasis Research. (Supplementary provision.)	2,750 4,000
471B	do.	West African Maize Rust Research Unit (Supplementary provision.)	1,700
524A 524B	do.	West African Timber Borer Research Unit. (Supplementary provision.)	380 870
703	do.	Visit of Taxonomist to West Africa to study aphids and white flies.	6,180
725	do.	Extension of Work of the Termite Research Unit to West Africa.	11,000
727	do.	Visit of mission to West Africa to review and submit proposals for fisheries research.	2,150
597A	Gambia	Investigation into the control of insects damaging growing groundnut crops in the Gambia. (Supplementary provision.)	3,400
644A	do.	Appointment of an Entomologist to the Medical Research Council Laboratories, Fajara, Gambia. (Supplementary provision.)	243
645	do.	Sociological research in the Kombo districts of the Gambia.	3,325
680	do.	Visits to Gambia by United Kingdom experts to advise on agricultural research.	1,250
686	do.	Agricultural improvement scheme	43,100

Scheme No. (Prefix "R")	Benefiting Territory	Description of Scheme	Amount
397C	Nigeria	Research on guinea worm at the University College, Ibadan. (Supplementary provision.)	£ 1,280
575A	do.	Provision of Research Chemist for Sokoto Malaria Control Pilot Project. (Supplementary provision.)	772
636A 636B	do.	Nutritional research in Nigeria. (Supplementary provision.)	160 200
694	do.	Study of the Mbembe people of Nigeria ..	1,820
699	do.	Study of water and electrolyte metabolism in clinical and experimental nutrition by Dr. H. Schnieden at University College Ibadan.	250
728	do.	Preparation of a social political and economic history of Benin.	20,000
585A	Sierra Leone ..	Investigation into the Control of infestation of stored rice. (Supplementary provision.)	1,716
	South Africa High Commission Territories		
661	Swaziland	Study of land holding and land usage among the Swazi.	6,895
	Mediterranean		
720	Cyprus	Preparation of a Flora of Cyprus	5,655
679	Malta	Preliminary survey of economic research possibilities in Malta.	300
	Indian Ocean		
655	Mauritius	Research on the social structure of the Indian community in Mauritius.	3,700
	South East Asia		
593A	Federation of Malaya	Social Science Research Unit. University of Malaya. (Supplementary provision.)	162
626A	do.	Research on certain virus diseases and on emergency yellow fever vaccination methods in Malaya. (Supplementary provision.)	200
648	do.	Contribution towards the cost of preparation of a "Flora Malesiana".	100
718	do.	Research on virus and other diseases transmissible from animals to man.	19,100
731	do.	Filariasis research at the Institute for Medical Research Kuala Lumpur.	27,946

Scheme No. (Prefix "R ")	Benefiting Territory	Description of Scheme	Amount
710	North Borneo ..	Cost of appointment of a Plant Pathologist investigating diseases of manila hemp.	£ 13,904
711	do. ..	Cost of appointment of a soil Scientist ..	7,305
Western Pacific			
533B	Solomon Islands ..	Investigation into the control of coconut pests in the Solomon Islands.	564
251F	West Indies.. General	Continuation of the Institute of Social and Economic Research 1956-1960. (Supplementary provision.)	113,569
462C	do. ..	Seismic investigations in the West Indies. (Supplementary provision.)	300
576A	do. ..	Institute of Social and Economic Research, University College of the West Indies. Land utilisation investigation. (Supplementary provision.)	1,317
639A	do. ..	Visit to Europe by Professor Hassell to attend two conferences. (Supplementary provision.)	300
652	do. ..	Establishment and maintenance during 1955-1958 of a Fundamental Nutrition Research Unit at the University College of the West Indies.	42,570
654	do. ..	Capital expenditure for the setting up of the Fundamental and Applied Nutrition Units at the University College of the West Indies.	59,905
671	do. ..	Regional Research Centre for Agricultural Research in the Caribbean area.	362,000
673	do. ..	Histochemical nutritional research at the University College of the West Indies.	7,270
681 681A	do. ..	Visit of Dr. Sheila Sherlock to the University College of the West Indies. (And supplementary provision.)	70 7
687 687A	do. ..	Study of the working class movement in Jamaica and Trinidad. (And Supplementary provision.)	500 100
697	do. ..	Establishment of seismic recording stations in the West Indies.	9,740
454C	British Guiana ..	Investigations into leaf scald of sugar cane. (Supplementary provision.)	1,521
664	do. ..	Investigations into the possibility of cotton production in British Guiana.	6,625
670	do. ..	Soil and Land use survey	25,300

Scheme No. (Prefix "R")	Benefiting Territory	Description of Scheme	Amount
662	British Guiana and British Honduras	Investigation into the possibility of cotton production in British Guiana and British Honduras—Expenses of Cotton officer.	£ 5,730
663	British Honduras ..	Investigations into the possibility of cotton production in British Honduras.	7,125
651	Jamaica	Research on the levels of living in Jamaica	675
653	do.	Contribution towards the cost of an Applied Nutrition Research Unit, University College of the West Indies.	3,109
660	do.	Visit of Mr. Stearn to Jamaica in connection with the preparation of a "Flora of Jamaica".	275
175D 175E	Trinidad	Sugar Technology Research. (Supplementary provision.)	1,320 3,700
236G 236H	do.	Colonial Microbiological Institute. (Supplementary provision.)	8,397 4,850
573B	do.	Appointment of a Senior British Laboratory Technician at the Rockefeller Foundation Regional Virus Research Laboratory in Trinidad. (Supplementary provision.)	420
675	do.	Contribution towards the cost of maintaining the Rockefeller Foundation Regional Virus Research Laboratory, Trinidad.	21,960
Total£			1,889,486

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*

* These figures include expenditure totalling £136,978 incurred up to the 31st March, 1953, 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, 1940-1956

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	1,233,362
1952-53	1,268,562
1953-54	1,287,972
1954-55	1,173,381
1955-56	1,339,524
	£ 10,563,866

Committee for Colonial
Agricultural, Animal Health
and Forestry Research
Eleventh Annual Report
(1955-1956)

Agricultural Research Council,
Cunard Building,
15, Regent Street,
London, S.W.1.
18th October, 1956.

SIR,

I have the honour, on behalf of the Committee for Colonial Agricultural, Animal Health and Forestry Research, to transmit to you the Eleventh Annual Report of the Committee covering the period 1st April, 1955, to 31st March, 1956.

I have the honour to be,

Sir,

Your most obedient servant,

W. K. SLATER,
Chairman.

The Right Honourable 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., 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.
- PROFESSOR W. I. B. BEVERIDGE, M.A., D.V.Sc., Professor of Animal Pathology, Cambridge University.
- DR. J. CARMICHAEL, C.M.G., D.Sc., M.R.C.V.S., Dip. Bact., formerly Colonial Veterinary Service.
- SIR GEOFFREY CLAY, K.C.M.G., O.B.E., M.C., Adviser to the Secretary of State on Agriculture.
- MR. F. S. COLLIER, C.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.
- PROFESSOR J. W. MUNRO, C.B.E., D.Sc., M.A., Professor of Zoology and Applied Entomology in the University of London.
- DR. E. W. RUSSELL, Ph.D., M.A., F.Inst.P., Department of Agriculture, University of Oxford (*Resigned August, 1955*).
- PROFESSOR A. B. STEWART, M.A., B.Sc., Ph.D., F.R.I.C., Department of Agriculture, Aberdeen University (*from August, 1955*).
- SIR EDWARD SALISBURY, C.B.E., D.Sc., Sec.R.S., Director, Royal Botanic Gardens, Kew.
- MR. R. J. SIMMONS, C.M.G., C.B.E., M.R.C.V.S., Adviser to the Secretary of State on Animal Health (*Resigned August, 1955*).
- MR. R. S. MARSHALL, C.B.E., M.R.C.V.S., D.V.S.M., Dip. Bact., Adviser to the Secretary of State on Animal Health (*from August, 1955*).
- DR. S. P. WILTSHIRE, M.A., D.Sc., Director, Commonwealth Mycological Institute.
- MR. D. RHIND (*Secretary*).
- MR. K. D. LAW (*Assistant Secretary*) (*to October, 1955*).
- MR. R. MOWFORTH (*Assistant Secretary*) (*from October, 1955*).

COCOA RESEARCH SUB-COMMITTEE

- MR. D. RHIND, O.B.E., Secretary for Colonial Agricultural Research (*Chairman*).
- DR. F. H. BANFIELD, M.Sc., Ph.D., F.R.I.C., British Food Manufacturing Industries Research Association.
- DR. E. C. BATE-SMITH, M.Sc., Ph.D., Low Temperature Research Station, Cambridge.
- MR. F. C. BAWDEN, M.A., F.R.S., Rothamsted Experimental Station.
- DR. E. E. CHEESMAN, D.Sc., A.R.C.S., Agricultural Research Council.
- SIR GEOFFREY CLAY, K.C.M.G., O.B.E., M.C., Adviser to the Secretary of State on Agriculture.
- MR. F. S. COLLIER, C.M.G., C.B.E., Adviser to the Secretary of State on Forestry.
- SIR FRANK ENGLEADOW, C.M.G., M.A., F.R.S., Drapers' Professor of Agriculture, Cambridge.
- SIR GEOFFREY EVANS, C.I.E., M.A., formerly Economic Botanist, Royal Botanic Gardens, Kew.
- PROFESSOR F. G. GREGORY, D.Sc., F.R.S., Imperial College of Science and Technology.
- DR. W. J. HALL, C.M.G., M.C., D.Sc., Director, Commonwealth Institute of Entomology.
- MR. A. NORTON, Rowntree and Company, Limited.
- DR. A. F. POSNETTE, M.A., Ph.D., East Malling Research Station.
- MR. R. V. WADSWORTH, Cadbury Brothers, Limited.
- MR. O. J. VOELCKER, C.B.E., formerly Colonial Agricultural Service (*from May, 1955*).
- DR. S. P. WILTSHIRE, M.A., D.Sc., Director, Commonwealth Mycological Institute.
- MR. K. D. LAW (*Secretary*) (*to October, 1955*).
- MR. R. MOWFORTH (*Secretary*) (*from October, 1955*).

SOILS SUB-COMMITTEE

- DR. E. W. RUSSELL, Ph.D., M.A., F.Inst.P., Department of Agriculture, Oxford University (*Chairman*) (*Resigned August, 1955*).
- PROFESSOR A. B. STEWART, M.A., B.Sc., Ph.D., F.R.I.C., Department of Agriculture, Aberdeen University (*Chairman*) (*from August, 1955*).
- SIR GEOFFREY CLAY, K.C.M.G., O.B.E., M.C., Adviser to the Secretary of State on Agriculture.
- DR. W. DAVIES, D.Sc., Grassland Research Institute.
- DR. F. DIXEY, C.M.G., O.B.E., D.Sc., F.G.S., M.I.M.M., Director of Colonial Geological Surveys.
- 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.
- DR. A. MUIR, Ph.D., Rothamsted Experimental Station.
- 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 Station, Bristol.
- MR. K. D. LAW (*Secretary*) (*to October, 1955*).
- MR. R. MOWFORTH (*Secretary*) (*from October, 1955*).

STORED PRODUCTS RESEARCH SUB-COMMITTEE

- MR. G. V. B. HERFORD, O.B.E., M.Sc., Director, Pest Infestation Laboratory, Department of Scientific and Industrial Research (*Chairman*).
- MR. W. L. BLOOMFIELD, Nigerian Produce Marketing Company Limited.
- MR. W. H. CASHMORE, National Institute of Agricultural Engineering, Silsoe.
- DR. J. A. FREEMAN, Ph.D., A.R.C.S., Infestation Control Division, Ministry of Agriculture, Fisheries and Food.
- DR. W. F. JEPSON, O.B.E., Ph.D., A.R.C.S., Imperial College of Science and Technology.
- MR. D. D. JONES, Unilever Limited.
- MR. L. LORD, O.B.E., Assistant Agricultural Adviser to the Secretary of State.
- MR. T. A. OXLEY, Pest Infestation Laboratory, Department of Scientific and Industrial Research, Slough.
- MR. L. W. PHILLIPS, C.B.E., Chairman, National Federation of Corn Trade Associations.
- MR. D. RHIND, O.B.E., Secretary for Colonial Agricultural Research.
- DR. I. THOMAS, Ph.D., M.Sc., Infestation Control Division, Ministry of Agriculture, Fisheries and Food.
- DR. E. E. TURTLE, M.B.E., Ph.D., M.Sc., F.R.I.C., Infestation Control Division, Ministry of Agriculture, Fisheries and Food.
- MR. K. D. LAW (*Secretary*) (*to October, 1955*).
- MR. R. MOWFORTH (*Secretary*) (*from October, 1955*).

COMMITTEE FOR COLONIAL AGRICULTURAL, ANIMAL HEALTH
AND FORESTRY RESEARCH

ELEVENTH ANNUAL REPORT

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COMMITTEE FOR COLONIAL AGRICULTURAL, ANIMAL HEALTH AND FORESTRY RESEARCH

ELEVENTH ANNUAL REPORT

I. GENERAL

The Committee held three meetings during the year. Reports of Sub-committees dealing with Soils, Cocoa Research and Stored Products are recorded in Section VII.

2. Dr. E. W. Russell left the Committee on his appointment as Director of the East African Agriculture and Forestry Research Organization, and Professor A. B. Stewart was appointed in his stead. Professor Stewart also took over the Chairmanship of the Soils Sub-committee relinquished by Dr. Russell. Mr. R. S. Marshall replaced Mr. R. J. Simmons on the latter's retirement.

3. Overseas visits by members of the Committee, advisory officers of the Colonial Office and other scientists were again a prominent feature of the effort to co-ordinate research between territories, to bring to them the most up-to-date information on research and to strengthen links between research overseas and that in progress in Europe. Dr. Bell and Mr. Rhind attended the Fourth Meeting of the East African Agricultural and Fisheries Research Council, and Dr. Wright and Mr. Rose attended the Fifth Meeting. Mr. Rhind attended the International Horticultural Congress in Holland and also took the Chair at the UNESCO Preparatory Meeting in Ceylon on Humid Tropics Research. He also made a tour in the British West Indies, visiting Jamaica, Trinidad, British Guiana, British Honduras and Barbados. Sir William Slater visited Nigeria and the Gold Coast and attended the first meeting of the West African Standing Advisory Committee for Agricultural Research. Sir Geoffrey Clay attended the Conference on the Mechanisation of Agriculture (CCTA) in Uganda. Mr. Collier toured Sierra Leone, the Gold Coast and the Northern Region of Nigeria. Mr. Marshall made extensive tours in East Africa and South East Asia. Sir Frank Engledow visited Trinidad and Jamaica. Dr. Russell, before proceeding to Kenya as Director of EAAFRO visited New Zealand, the Federation of Malaya and the Sudan. Dr. H. Greene attended the UNESCO Conference on Arid Zone Research in Mexico, visited the Aden and Central African regions, the Sudan and the British West Indies. Dr. Jepson attended a meeting of the West African Stored Products Research Unit Reviewing Committee in Nigeria and toured that country. Visits by scientists not members of the Committee or its Sub-committees included one by Dr. Webb to the Gambia, Dr. Jones to Nigeria, Kenya, Uganda, Tanganyika, Belgian Congo and Nyasaland; Dr. Kearns to Kenya, Zanzibar and Jamaica, Mr. Duffy to Nigeria and the Gold Coast; Mr. Exell to the Central African region and Moçambique, Mr. Nye to Cyprus, Malta and West Africa, Mr. Harris to West Africa and South-east Asia; Mr. Hall to Nigeria and the Gold Coast.

4. In addition to visits from scientists in the United Kingdom there were also visits arranged between scientists in overseas territories, as, for example, by Dr. Ivens of the Colonial Insecticides Research Unit, East Africa, to Sierra Leone, by Mr. MacKenzie, Director of Agriculture, British Guiana to the International Rice Commission meetings in Penang and Rome, and by Mr. Dawkins of the Forest Department, Uganda to the British West Indies.

5. The Committee recommended grants towards research amounting to a total of £819,495 during the year. A review of the schemes in progress has been made. A few small schemes have been closed and the work, where not completed,

taken over by local Governments. In some other cases, a tapering of C.D. & W. support has been introduced with agreement of the recipient territory with the object of reducing the United Kingdom contribution gradually during the current C.D. & W. Act. Territories having restricted financial resources have continued to receive undiminished support and in no case have funds been curtailed to the detriment of the research work.

6. A restrictive feature which has much exercised the Committee is the difficulty of finding and retaining good research workers in overseas posts. Though recruitment has not slackened there continue to be serious losses of young scientists with from two to six years' overseas experience; that is they seek other employment at a time when their training and experience are beginning to bear full fruit. Salary revisions and in some cases special allowances, have been given but money alone is not the answer to the problem. The Committee will continue to watch this problem, because provision of staff is fundamental to the research programme and staff are proving more difficult to provide than the money.

7. United States Technical Assistance provided a team for soil survey of the coastal areas of British Guiana, and a rice expert for the Muscle Creek Rice Project, also in British Guiana. Assistance on Drainage and Irrigation in Trinidad, and special training for an entomologist were also provided from United States sources. Assistance in a survey of helminths infesting cattle in Malaya was given and a check list of parasites prepared.

II. SUMMARY OF PRINCIPAL RESEARCH DEVELOPMENTS

8. The termination of one Colonial Development and Welfare Act in March 1956, and the start of a new quinquennial period led to the revision of a number of research schemes and to the introduction of a gradual tapering off of United Kingdom contributions in appropriate cases. Since 1946 research schemes totalling £M14.75 have been made. Agriculture has received grants amounting to £M5.02 (34 per cent.) but to this must be added part of the sums allocated to research on Insecticides (£M1.08), Tsetse and Trypanosomiasis (£M1.34) and Research Fellowships (£M0.08) which in some degree relate to problems of agriculture, forestry and animal health. None of these figures include contributions from local sources nor work undertaken by territorial Governments on their own initiative and they therefore indicate only a part of the research effort now being made toward the betterment of agriculture in general.

9. In September 1955 the three research schemes at the Imperial College of Tropical Agriculture, Trinidad, for work on cocoa, bananas and soils were combined and a Regional Research Centre created under the Principal of the College as Director of Research. The Regional Research Centre will, in future, embrace all fields of research appropriate to it and not only the three subjects of the original separate schemes. In order to make better known the work of this Research Centre in the Caribbean and to link its work with the needs of the region, a Technical Co-ordinating Committee has been set up under the British Caribbean Advisory Council on Agriculture, Animal Health and Husbandry, Forestry and Fisheries. The Committee for Colonial Agricultural, Animal Health and Forestry Research will be represented on this Committee.

10. In West Africa, the long-awaited West African Standing Advisory Committee for Agricultural Research has been established and has met for the first time with the Chairman of the Committee for Colonial Agricultural, Animal Health and Forestry Research in attendance. It is apparent that there is a fruitful field for research co-ordination in which it is expected this body will play an important rôle.

11. In East Africa, work at the East African Agriculture and Forestry Research Organization on soil moisture relationships made much progress and this research is becoming increasingly valuable. Studies on the sulphur cycle in soils are revealing information of fundamental importance. Cassava breeding for virus disease resistance has made progress and resistance to wild pig damage by the breeding in of bitterness in the raw roots may be of much value. The transmission of mosaic virus in cassava by white flies was observed in Nigeria.

12. At the Joint Animal Industry Division of EAAFRO work on the digestibility of nitrogenous compounds led to the discovery of a fairly close relationship between the total nitrogen content and its apparent digestibility, a relationship which holds good for all published feeding trials examined from all parts of the world.

13. Cocoa research, which is principally done at the West African Cacao Research Institute and the Imperial College of Tropical Agriculture, confirmed the close dependence of mineral nutrient uptake on degree of shade. The interaction of nitrogen status of the plant and liability to attack by thrips was also demonstrated. In West Africa, despite shortages of staff, important information was gained, particularly on the tolerance of certain Iquitos strains of cocoa to Swollen Shoot viruses and on the insecticidal control of capsids.

14. The South American maize rust disease which has caused so much concern in the hot, humid parts of Africa, continued its eastward spread, being reported from Malaya, North Borneo, Siam and intervening islands in the Indian Ocean. Resistant varieties are being issued to growers in West Africa, where research work is now being directed to breeding for resistance to other pests and diseases. Of particular importance is the discovery of some degree of resistance to stem boring insects.

15. The damaging Coffee Berry Disease which has been serious in parts of Kenya is the subject of study by a special team. Preliminary results suggest possible control using a mercurial fungicide.

16. Damage to produce in store is now recognised as a serious source of loss in the tropics. A Pool of Stored Products Research Workers has been set up based at the Pest Infestation Laboratory of the D.S.I.R. and several investigations are under way. A large number of enquiries continue to be received on storage problems.

17. A large part of the veterinary investigations relates to the testing of biologicals and other drugs and to the detailed study of well-known diseases in relation to local conditions and breeds of cattle. Of particular interest is the observation that calves born of dams immune to rinderpest are susceptible before suckling, but that they develop immunity one to two days after suckling. This colostral immunity seems to decline fairly rapidly and to disappear in about six months.

18. By the use of antrycide it has been possible to hold large numbers of cattle in areas of Kenya infested with tsetse fly with quite low rates of infection by sleeping sickness. Field trials suggest that dieldrin may be a more effective and cheaper insecticide than DDT against tsetse flies.

At the Malayan Forest Research Institute it has been found possible to produce excellent hardboards from mixtures of common Malayan woods and high quality paper was made from padi straw.

19. In the Caribbean trials with tropical pines have in a number of places shown the importance of small doses of phosphatic fertilizers in the early stages of growth, the response of the trees being phenomenal in some instances.

· III. LIAISON WITH RESEARCH INSTITUTIONS

20. The Committee continued to receive much valuable help from research institutions in the United Kingdom. So closely has overseas research become linked with that in progress in England that it would now not be possible to progress without this aid. Of particular value is the close association with the Agricultural Research Council, and the Experimental Stations under its control.

Commonwealth Institute of Entomology

21. Much of the work of the Commonwealth Institute of Entomology is concerned with colonial problems. In 1955-56, some 29,000 specimens of insects were submitted for identification from 22 Colonial territories, and nearly 3,000 identifications were sent out, amounting to 41 per cent. of all those given by the Institute during the year. Volume 46 (1955) of the Bulletin of Entomological Research contained 28 papers, occupying over half the volume, reporting the results of entomological work carried out in or concerned with the Colonies.

22. Mr. E. A. J. Duffy, of the staff of the Institute, concluded in May, 1955, a successful three months visit to the Gold Coast and Nigeria, undertaken primarily to obtain additional material and biological information for a monograph on the Cerambycid beetles infesting timber in Africa. His visit also yielded useful information on several problems of economic importance, including the discovery of the insect (*Symmerus tuberculatus* Chap., a Plytaypodid beetle) responsible for an obscure but serious form of damage to one of the hardwoods (*Triplochiton*).

Commonwealth Mycological Institute

23. The *Commonwealth Phytopathological News* has made a good beginning and it is hoped it will serve a useful means of keeping Colonial Plant Pathologists, Agricultural Officers, and others, in touch with the latest developments in plant pathology within the Commonwealth.

24. Specimens for identification were received from 18 Colonial Dependencies, notably from Malaya, Northern Rhodesia, and the Gold Coast. A list of diseases in Northern Rhodesia was completed and is now in the Press. Other *Mycological Papers* published in 1955-56 were "A preliminary list of Jamaican Uredinales" by W. T. Dale and a monograph on "The genus *Cerebella*" by J. Langdon. Two valuable publications in the Press at the end of the year were "Losses caused by Plant Diseases in the Colonial Dependencies" by Dr. G. Watts Padwick and a handbook of "Diseases of Tobacco, with special reference to Africa" by Dr. J. C. F. Hopkins. A monograph on "Witches' Broom of Cocoa" by the late Professor Baker and Mr. P. Holliday is almost ready for printing.

25. An outstanding feature of the year's work was the identification of maize rust, *Puccinia polysora*, on specimens from Agalega Island, Christmas Island (heavily infected specimens), North Borneo (two specimens), and Malaya. The spread of this rust into the South East Asia region is now an accomplished fact and the distribution of the disease in that area has now to be worked out. Its occurrence is not very new, as the earliest collection from Malaya dates from 1950. Happily resistant varieties are available and it will be interesting to discover whether the South East Asia race is the same as either of those in Africa.

Adviser on Tropical Soils at Rothamsted Experimental Station

26. Dr. H. Greene visited the Gold Coast and the Gambia, Swaziland, Basutoland and the British West Indies. In the Gold Coast members of the Department of Soil and Land-Use Survey, directed by the late Mr. C. F. Charter,

have observed a pronounced lack of magnesium in strongly acid soils which have failed to support cocoa. On the other hand cocoa has survived on less acid soils having a higher content of magnesium. That young cocoa plants grown in containers need magnesium had been demonstrated in the Belgian Congo by Professor M. V. Homés. These observations throw a welcome light on the nutritional needs of this important crop. After attending meetings of the UNESCO Advisory Committee on Arid Zone Research, Dr. Greene visited irrigation and drainage projects in California and Utah.

27. Dr. Greene accompanied Mr. G. Murdoch, a member of the recently constituted pool of soil surveyors, at the start of the Swaziland soil survey. Dr. Greene also discussed the extension to Swaziland of fertilizer experiments that have been so fruitfully initiated in Basutoland by Mr. Venn. In Mr. Venn's experiments with maize on solodized solonetz, marked responses to lime, phosphate and dung were obtained. Mr. Venn will now begin rotation experiments probably including legume and cereal crops. This work will effectively support and supplement progress in soil conservation.

28. When at work overseas soil scientists are liable to lack easy contact with professional colleagues. To alleviate this isolation the Adviser on Tropical Soils issues occasional circulars containing notes on books, equipment and items of soil news. Among the news items circulated were notes on soil surveys carried out near Ilesha (Nigeria), Mbozi (Tanganyika), Lower Rufiji (Tanganyika), the Trans-Perak Swamp (Malaya) and on the Land-Use survey in British Honduras.

Colonial Statistical Assistance at the Rothamsted Experimental Station

29. A final comprehensive report on "The Responses of Sugar-cane to Fertilizers" has been completed. Average standardized responses of plant-canes and ratoons to nitrogen, phosphate and potash were estimated from the results of over 1,000 experiments conducted in British Colonial and Commonwealth Territories since about 1930. The responses (in terms of sugar) were examined in relation to ecological regions within each territory. Responses to organic manure, by-products and lime were also summarized. Nitrogen responses were observed everywhere. Under irrigation they were usually larger while the ratoons generally responded more than the plant-canes. No residual response was observed. The sugar percentage was consistently reduced. Sulphate of ammonia appears to be the most effective form of nitrogen. With phosphate, the responses tended to be associated with soil types. They were generally rather small and similar with successive crops. The effect on the sugar percentage was small and irregular. Responses to potash were also associated with soil types and to some extent with rainfall. The ratoons tended to give somewhat higher responses than the plant-canes. There was no evidence for interactions between fertilizers and varieties.

30. In the course of this work a study was also made of response curves of exponential form, their applications in the analysis of series of experiments and the information provided by experiments of fixed size with different numbers of levels of the factors on the response curves and standardized responses.

31. With the departure of Mr. G. E. Hodnett to take up a post at the Imperial College of Tropical Agriculture new arrangements have been agreed with the Director of the Rothamsted Experimental Station. The provision of help in Colonial statistical problems will in the future be given by members of the Statistical Division staff on a part-time basis towards which the Colonial Office will make a C.D. and W. Research grant.

Publication

The Responses of Sugarcane to Fertilizers. G. E. Hodnett. *Emp. J. exp. Agric.*, 24, (1946) 1.

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IV. REGIONAL RESEARCH

(a) EAST AFRICA

East African Agriculture and Forestry Research Organization

32. Dr. H. H. Storey, C.M.G., F.R.S., was Acting Director until October when the new Director, Dr. E. W. Russell, took up his duties. Dr. H. C. Pereira was appointed Deputy Director in June, and acted as Director from then until August.

33. The Physics Division is primarily concerned with the soil-water relationships in East African soils, and increasingly with the effect of land management practices, and changes in land-use, on the ease with which water can enter a soil. This work is developing along two lines, both being undertaken in very close co-operation with the Departments of Agriculture and when relevant the Departments of Forestry, Public Works and the Ministries of Natural Resources in the Territories. One line concerns the suitability of the soils for irrigation and the most efficient method of irrigation to use, and the other the influence of vegetation and change of land-use on the amount and uniformity of stream flow out of catchment areas. Increasing attention is being given to developing improved methods for calculating the amount of water transpired by different types of vegetation from meteorological observations.

34. The Chemistry Division has mainly been concerned with improving methods for predicting the responsiveness of crops on different soils to fertilizers. This is being done in close co-operation with the Departments of Agriculture of Kenya and Tanganyika, the Department staff carrying out field fertilizer trials and this Division doing the analytical work on the soils and crops. In addition a short study was made on the factors causing the poor breadmaking qualities of some Kenya wheat flours, in co-operation with the Department of Agriculture and Unga Ltd. Although the cause of the trouble had not yet been found, it has been shown that it chiefly occurs in wet years. The Spectrographic Section is undertaking a systematic study of the trace element content of crops grown at Muguga. Finally, a study of the sulphur cycle in forest soils has shown that most of the readily available sulphur entering the soil from forest trees does so as water-soluble sulphates leached from the foliage and only about 10 per cent. comes from organic sulphur compounds in the litter.

35. The Soil Survey Division has been concerned with detailed soil surveying in parts of Kenya for the Department of Agriculture, and with a reconnaissance survey in parts of Tanganyika as part of the general programme for collecting material for a revised Soil Map of East Africa.

36. The Plant Physiologist has continued work on rainfall reliability, and is now preparing maps to show the reliability of seasonal rainfall. In addition he has studied the effect of the distribution of rainfall on the yields of maize and wheat in the Kenya Highlands and has been able to determine the rainfall distribution to give optimum yields for these two crops.

37. The Plant Breeding Division is continuing its programme for producing varieties of cassava resistant to virus diseases along the following lines: continuation of breeding work for increasing resistance, breeding in bitterness to make the roots less palatable to wild pig, and developing quarantine methods against latent Brown Streak virus, so the clones can be introduced into those parts of the Territories where Mosaic is common but Brown Streak is absent. Work with groundnuts has been confined to an attempt to produce interspecific hybridisation using artificial embryo culture methods.

38. The Plant Pathology Division has been mainly concerned with two problems: the breeding of maize resistant to the Central American maize rust, *Puccinia polysora*, and the identification of some viruses in sweet potatoes. In

early 1955 a new strain of the maize rust appeared in the Muguga glasshouses, against which no control was given by the gene which confers strong resistance to the original strain. But a second gene has been found which confers considerable resistance against both strains, though it is not quite so efficient as the original gene for the original strain. Seed containing these genes has been distributed to the Territorial plant breeders so they can transfer them into their local varieties. The work with sweet potato viruses is concerned with determining the insects that transmit the viruses and separating out what appear to be two distinct diseases, one of which causes much more damage than the other.

39. The Forestry Division is divided into a silvicultural and an entomological section. The forest entomologist is continuing the survey of the forest insects of East Africa, now in its sixth year. The survey covers all forest insects whether apparently important or not ; all available biological information is recorded and insect species likely to be of economic importance are marked for special attention. An authoritatively identified reference collection of forest insects is being built up with the active co-operation of the Commonwealth Institute of Entomology. One difficulty is that about 40 per cent. of the insect species concerned are new to science or at least not represented in the collections of the British Museum.

40. The silvicultural section, in co-operation with the horticulturist, have continued work on improving the nursery practices prevalent in East Africa. This work involves experimental work in the Muguga nurseries, helping to organise co-operative experiments in the Territories, running an annual forestry course at Muguga, and paying advisory visits to the Territorial nurseries. One example of these co-operative experiments is a progeny trial of plants from seed from the same tree of *Cupressus lusitanica* but selected for different size of seed and different numbers of cotyledons. Another is an experiment on the effect of season of pruning on the rate of wound occlusion, which is of importance in the control of wood boring insects of the genus *Oemida*. The silvicultural section also contains a Forestry Information Bureau, which issued during the course of the year "An East African Forest Bibliography". This contains as complete a record as possible of the older published work on East African forest experiments and observations. Much of this work was done by the Germans before 1914 and many of the papers are rare and very inaccessible to the forester. Six Forestry Technical Notes have also been issued.

41. The East African Herbarium, situated in the grounds of the Coryndon Museum continued work identifying collections of plants received from all over East Africa and Arabia. It is also closely co-operating with the Royal Botanic Gardens, Kew, in the preparation of the Flora of Tropical East Africa. The amalgamation of the Coryndon Museum Herbarium with that of the East African Herbarium is almost completed.

42. The East African Plant Quarantine Station is situated in the Muguga Estate and is in the charge of Dr. F. M. L. Sheffield, a pathologist on the E.A.A.F.R.O. staff. So far its work has mainly been with the quarantine of sugar cane, but it has also handled other economic plants and will increasingly be called upon to handle ornamentals.

43. The work of the E.A.A.F.R.O. Section of the Joint Animal Industry Division falls into the following lines : a study of the techniques for estimating the productivity of pastures either by cutting the herbage or by live weight increase of the grazing animals, the effect of climate and stage of maturity on the constituents of grasses and clovers, the digestibility of the nitrogen constituents of the fodder, and the growth rates and grazing habits of cattle at Muguga. The problem that has arisen in estimating the productivity of pastures

is that fairly uniform production, as between different plots on the same paddock, can be obtained during the rainy season at Muguga, but the variability in the herbage growth during the dry season can be so large that few useful experiments can yet be made on assessing the value of new methods for improving dry season grazing. Further, the digestibility of natural grasses can drop very rapidly during quite short spells of dry weather, and the work on the constituents of grasses is designed to establish the causes of this rapid drop. The principal result that has emerged in the work on the digestibility of the nitrogen compounds of grasses is the discovery that there is a fairly close relationship between the total nitrogen content, the crude protein, of a hay or grass and its apparent digestibility which holds for all the published feeding trials from different parts of the world which have been examined. The existence of this relationship implies that there is little if any difference between the various breeds of sheep or cattle in their ability to digest the nitrogen compounds present in natural fodders.

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East African Veterinary Research Organization

44. The year 1955–56 was characterised by substantial progress in the establishment of E.A.V.R.O. as a major research institute and progress in the spheres of research and the production of biological products was encouraging. The development of the farm has continued with the provision of additional fencing, water supplies, cattle crushes, hay barns and further isolation buildings. Another substantial area of land has been reclaimed from bush and scrub.

45. During the first half of 1956, the Director was awarded a Carnegie Corporation Travel Grant which enabled him to spend some five months in the United States of America and Canada visiting a great number of veterinary and medical research institutions where valuable information was obtained on research problems of mutual interest. Dr. S. E. Piercy acted as Director during this period.

46. A very successful training course in Rabies was held at Muguga in July, 1955, initiated jointly by the World Health Organization and the Commission for Technical Co-operation in Africa south of the Sahara. This was attended by nearly forty veterinary and medical research workers from most parts of Africa and the Middle East. The training was given by a number of scientists of international repute, namely Drs. Habel and Koprowski of the U.S.A., Dr. Lepine of France, Dr. Komarov of Israel, Dr. Gallardo of Spain and Dr. Kaplan of W.H.O., Geneva. In March, 1956, a Conference on Bilharzia, attended by veterinary and medical delegates from the three East African territories, was also held at Muguga. Several members of the Organization were invited to present papers at the Kampala Conference on Zoonoses in January, 1956, and the Director was honoured by being appointed President. An important scientific endeavour, based on the Organization's laboratories, commenced in June, 1956. This was the Scientific Working Party on Ectoparasites and Arthropod-borne Diseases. Initiated by the Director and Dr. H. Hoogstraal of the United States Naval Medical Research Unit, Cairo, expert workers from Cairo, the United States of America, London, South Africa, Southern Rhodesia and East Africa assembled to begin work on a two months' project designed to elucidate many problems on ectoparasite ecology, classification and disease-transmission.

47. The production of caprinised and lapinized rinderpest vaccines proceeded without serious interruption throughout the year. 5,349,490 doses of the former and 216,350 doses of the latter were prepared, tested and issued to the vaccine store. These vaccines were used in the three East African territories, the Sudan, Gambia and the Somaliland Protectorate. A considerable amount of research into improved and alternative methods of production was also carried out.

48. Considerable progress was made in virological research. With the assistance of Mr. M. A. Witcomb, encouraging results on a laboratory scale were achieved in the preparation of an avianised rinderpest vaccine. The immunising ability and storage properties of this product compare favourably with lapinized rinderpest vaccine. The technique of production is considerably simpler and the cost is appreciably less. There are good prospects that avianised vaccine may prove at least a useful alternative to lapinized vaccine and, in some cases, a product to be preferred. Mr Witcomb also persevered throughout the year in attempts to adapt rinderpest virus to the mouse with erratic but sometimes encouraging results.

49. Mr. R. D. Ferris made considerable progress in the field of tissue culture but many attempts to grow the rinderpest virus in this medium failed. Complete success, however, was achieved with the virus of Rift Valley Fever and it is hoped to elaborate a technique that will be simpler and more economic than the present use of mice for neutralisation and viral titration procedures. Encouraging results were also obtained with the virus of East African Swine Fever and virus was recovered in pigs after four direct passages through pig kidney monolayer tissue cultures.

50. Mr. R. D. Brown continued his work on rinderpest serological research. The early promise of a successful conglutination test was not fulfilled and Mr. Brown concentrated on the development of a rabbit neutralisation test. By this means he showed that calves born from immune dams are susceptible before suckling, but that after suckling the serum antibody titre rises to about that of the colostrum within 30-48 hours. The colostrum titre is usually 2-4 times that of the immune dam's serum. Calves born from susceptible dams were able to form antibodies in response to lapinized vaccination at the age of one day. Titres were low, however, and varied between one calf and another. Preliminary results suggest that the colostrum immunity of calves born from dams

immunised with caprinized vaccine declines steadily a month after birth and is no longer demonstrable after 6 months. This type of information is badly needed for the proper immunisation of calves in field campaigns.

51. Mr. G. J. Knight made substantial progress towards improved techniques for the preparation of avianised Pleuropneumonia vaccine and the testing of this product under laboratory conditions. His work has recently been largely directed towards the possibility of using a stronger type of vaccine capable of stimulating a more solid and durable immunity. This may necessitate the tail-tip method of inoculation rather than the subcutaneous route so as to avoid undesirable reaction.

52. Mr. C. R. Newing, assisted by Mr. A. K. Macleod, concentrated on the elaboration of a more precise and sensitive Pleuropneumonia complement-fixation test for the diagnosis of infected animals and for the study of the immune response to vaccination or artificial infection. This test is extremely delicate and demonstrates the presence of complement-fixing bodies in amounts which would escape detection by the commonly used complement-fixation test of Campbell and Turner. He also carried out further work to show that the slide agglutination test is capable of application in the field. A satisfactory technique for producing high-quality Pleuropneumonia antigen has now been worked out using a new tryptose broth medium, and a modified Lister separator for concentrating the organisms. An improved technique for the growth of the Pleuropneumonia organism and other organisms such as the *Pasteurella* group has been devised by means of cultures aerated with the aid of magnetic stirrers.

53. With the arrival of Mr. Brocklesby, the Protozoology Division is now at full strength. Dr. Barnett and his staff are engaged upon a very substantial programme of work which includes a continuation of a field survey of East Coast Fever and calf mortality in an enzootic area, a long-term investigation of the susceptibility of Zebu calves to E.C.F. under experimental conditions at Muguga, studies on the duration of immunity of cattle which have recovered from E.C.F., a study of the life cycle of the parasite *T. parva* in the tick and the identification of these parasites in tick salivary glands, efforts to attenuate the parasite of E.C.F. by passage through unusual hosts, the mechanical transmission of E.C.F., the adaptation of *T. parva* to laboratory animals and the chemotherapy of E.C.F.

54. Outstanding amongst a number of important results are the findings that a considerable resistance to E.C.F. exist in Zebu animals from immune stock and that this resistance decreases with age, that colostral immunity plays little or no part in this resistance, that the outcome of infection can be varied by the number of infected ticks to which a calf is exposed, that a solid immunity for at least a year is established after recovery from an attack of E.C.F., and that E.C.F. may be suppressed by the continuous oral administration of "Aurofac", the by-product of the manufacture of aureomycin.

55. Mr. Brocklesby commenced the difficult task of propagating *T. parva* in tissue culture in the hope that a successful outcome would provide a cheap alternative to the use of cattle for screening drugs. Partial success was achieved in that the parasite was made to survive in migrant cells for a period of five days.

56. 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*. Assistance with the identification of numerous specimens collected for the tick survey of the Arusha district has been given to the Veterinary Officer in charge.

57. Dr. and Mr. J. A. Dinnik continued their researches into the systematics, distribution and life-histories of the stomach-flukes of ruminants and carried out extensive and detailed examinations into the identification, ecology and life-cycle of African liver-flukes. Investigations on the development of an African liver-fluke in molluscan and mammalian hosts with a view to gaining the basic knowledge essential for planning measures of control have commenced. As a result of their studies, a new conception of the way in which the rediae of *Fasciola gigantica* are generated has been submitted. Preliminary experiments with *Fasciola gigantica* in cattle and goats indicate that the parasite requires at least 100 days to develop to maturity and commence to lay eggs in the bovine liver. Other experiments showed that all large *Lymnaea* snails occurring in East Africa can serve as intermediate hosts for the African liver-fluke.

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Flora of Tropical East Africa

58. Accounts of the following families have gone to press and are awaiting publication: *Canellaceae*, *Caricaceae*, *Caryophyllaceae*, *Connaraceae*, *Menispermaceae* and *Rhizophoraceae*. In addition, the families *Alangiaceae*, *Orobanchaceae* and *Resedaceae* have been completed.

59. The sad death of Miss E. A. Bruce in the autumn of 1955 left her research into *Loganiaceae*, especially the important and difficult genus *Strychnos*, incomplete. The task of finishing her work on this family has been undertaken by Mr. J. Lewis.

60. Messrs. E. Milne-Redhead and P. Taylor, of Kew, have left on a botanical expedition to the highly interesting but little-known southern part of Tanganyika. The results of this expedition, which is due to last until well on in 1956, should be of the utmost value for the Flora of Tropical East Africa.

61. Active research continues on *Leguminosae*. Mr. Milne-Redhead, before starting for Africa, had started work on *Crotalaria*, Mr. J. B. Gillett has finished a revision of the large and difficult genus *Indigofera*, and Mr. J. P. M. Brenan is working on *Acacia*.

62. Other families or groups upon which work for the Flora is being done include *Amaryllidaceae* (Mr. J. Sealy), *Capparidaceae* (Miss J. Elffers), *Celastraceae* (Mr. R. A. Blakelock), *Convolvulaceae* (Mr. B. Verdcourt, East African Herbarium, Nairobi), *Cyperaceae* (Mr. E. Nelmes), *Ericaceae* (Mr. R. Ross, British Museum, Natural History), *Gramineae* (Mr. C. E. Hubbard), *Gymnospermae* (Dr. R. Melville), *Orchidaceae* (Mr. V. S. Summerhayes), *Podostemaceae* (Dr. G. Taylor, British Museum, Natural History), *Polygonaceae* (Mr. R. A. Graham), *Sapotaceae* and *Cucurbitaceae* (Mr. J. H. Hemsley). In

addition to those mentioned above, thanks are due to Mr. I. H. Burkill for his continued help in *Dioscorea*, to Mons. G. Troupin for his work on *Menispermaceae*, and to Mr. B. Burte for undertaking the *Gesneriaceae*.

Survey of the Aphids of East Africa

63. Dr. V. F. Eastop spent several months working at the British Museum (Natural History) on the concluding stages of his study of the Aphids of East Africa, carried out during the tenure of a Colonial Research Fellowship, of which the previous two and a half years had been spent in East Africa, attached to the East African Agriculture and Forestry Research Organization. His report, which is to be published as a Colonial Research Memoir, takes the form of a systematic account of the aphids of East Africa, with keys, including for each species a brief description, its distribution, and notes on host plants, biology, economic importance and taxonomic position. Dr. Eastop, who is now on the staff of the British Museum (Natural History), has been seconded to the Colonial Office for eighteen months in order to carry out a similar survey of the aphids of West Africa.

(b) *MEDITERRANEAN*

Flora of Cyprus

64. The appointment of two assistants (scientific), Mr. J. L. Gilbert and Miss P. Z. Scammell, has considerably aided the progress of work on the Flora. A draft account of the family *Malvaceae* has been completed and circulated amongst correspondents in Cyprus for advice and comment. An account of *Ranunculaceae* is now almost complete, and work will proceed systematically from this point, following the sequence of families adopted in the Kew Herbarium.

65. The card index of plant records is now approaching completion ; a detailed bibliography of Cyprian botany has been prepared.

(c) *WEST AFRICA*

West African Standing Advisory Committee for Agricultural Research

66. With the appointment of a Secretary for West African Agricultural Research (Mr. A. Pickles) it has been possible to set up the West African Standing Advisory Committee for Agricultural Research. This Committee held its first meeting in April, 1956. The Secretary made extensive tours in West Africa, visiting the principal research stations with a view to co-ordinating research. The West African Inter-territorial Secretariat continued to play a large part in the administration of research which is organised on an inter-territorial basis, notably the West African Cocoa Research Institute, the West African Institute for Oil Palm Research and smaller projects for research on maize, rice and timber borers. This research is reported separately.

West African Cocoa Research Institute

67. Mr. J. Lamb, O.B.E. assumed duty as Director on 1st November, 1955, and the Acting Director, Mr. A. Pickles transferred to the post of Secretary for West African Agriculture and Forestry Research.

68. Studies on the host range of Swollen Shoot viruses have shown that the baobab tree (*Adansoniadigitata* L.) while frequently carrying viruses in areas North and South of the cocoa belt, has not been found infected within the cocoa area of the Gold Coast. Laboratory tests have shown that a number of species not indigenous to West Africa can carry S.S. viruses. Among these are *Abroma augusta* L., *Sterculia laevis* Wall., *S. appendiculata* K. Schum. ex. Engl. *S. rubiginosa* Vent., *S. alata*, three varieties of jute (*C. olitarius*), and *Theobroma bicolor* Humb. and Bonpl.

69. Protection tests using mild strains of virus against lethal types have shown that though mild strains of virus may suppress the symptoms of virulent strains "back tests" yield both types of virus and there is a breakdown of the protection in some cases resulting in the appearance of virulent symptoms. As a practical control measure protection with mild strains, at any rate against the New Juaber strain, is dangerous in that the protected plants constitute reservoirs of virulent virus which can be transmitted and further, the protection may break down.

70. The resistance to Swollen Shoot viruses apparently shown by Iquitos cocoa has shown varying degrees of tolerance. Some were as severely affected as West African Amelonado, many showed swellings and/or mild though distinct leaf symptoms, five showed no symptoms while the rest showed faint or transitory leaf patterns. There is obviously segregation for tolerance within these Iquitos progenies, though whether this is related to resistance to infection or low availability of virus to vectors is uncertain.

71. Studies on capsids have in the past been hindered by lack of a satisfactory method for mass rearing of the insects. A method has been developed for laboratory rearing of *Distantiella theobroma* Dist. and *Sahlbergella singularis* Hagl. in which adults caged on basket seedlings oviposit and the nymphs, when hatched, are transferred to unripe pods suspended in ventilated glass cages. Preliminary tests show that BHC has a higher toxicity for capsids than DDT Using 0.25 per cent. BHC *D. theobroma* suffered 50 per cent. knockdown in one hour compared to five hours for 2.5 per cent. DDT. Studies on capsid populations show a peak density for both species in September. For *D. theobroma* a density of 28 capsids per 100 trees was recorded which declined to 21 per 100 trees in December. For *S. singularis* the September peak density was 11 per 100 trees. It was found that mercury vapour lamps rich in ultra violet were effective in trapping *S. singularis* but *D. theobroma* was not attracted. Studies on the fungi associated with capsid lesions continue.

72. Cultural studies have shown a number of interesting results. Comparison of yields under dense oil palm shade with light forest shade showed 2.7 times the yield as wet beans under the light shade compared to dense shade. In a trial of shade effects on seedlings lightly-shaded plants showed much greater dry weights (83 per cent.) than those under normal shade. Mulch under light shade gave a positive response but not under normal shade.

73. Plant breeding work was curtailed by staff vacancies. Upper Amazon types were the highest yielders followed closely by hybrids.

74. Four catechins have been identified in studies on cocoa fermentation. The distribution of the polyphenols of Amelonado cocoa has been found to be similar to that described by Forsyth for I.C.S.I. Two principal anthocyanins have been isolated from purple beans, both derived from cyanidin. There appear to be no pigments other than the two reported.

West African Institute for Oil Palm Research

75. Building at the Main Station, near Benin City in Nigeria, will be completed by the end of the year. The buildings recently completed include a Nutrition Research Unit for the study of deficiency and toxicity symptoms. The equipping of this Unit is expected to be completed during 1956/57. Good progress is being made with the establishment of a Sub-Station at Njala (near the Agricultural Department headquarters) in Sierra Leone. Many of the buildings required have been erected and some field experiments have been laid down. At the Eastern Nigeria Sub-Station at Abak good progress is being made with palm grove improvement experiments. In a replanting experiment there are early indications that complete felling of the old stand is desirable.

76. At the Main Station the Agronomy Division has been active with practical planting problems. For several years attempts have been made to devise methods of transplanting seedlings without having to lift and transport a large ball of earth. While this is a sound plantation practice it is difficult to carry out when distributing seedlings from nurseries to farmers who may have to travel long distances. Two promising new methods have been developed: firstly, pruning roots a month before planting; secondly, dipping the roots in clay. A comprehensive experiment including these methods and manuring was laid down in 1955. Both methods have proved useful, but so far the combination of the two has shown no added advantage. Attention is also being given to nursery selection and nitrogen manuring of young palms. An experiment planted in 1955 has been designed partly to test the recent theory of Devuyt on methods of seedling selection.

77. Nursery work itself is also receiving a great deal of attention. Oil palm nurseries in West Africa continue to be uneven and to suffer losses from various diseases. A good deal of the experimental work being carried out lies in the sphere of plant pathology, but work has also been carried out on the purely cultural aspects of nursery work. In the first place experiments continue on the cultivation and manuring of seedlings on permanent nursery sites. Secondly the value of shade and watering, already proved under the climatic conditions at Benin, have been tried out at the Abak Sub-Station in the heart of the palm belt in Eastern Nigeria. Thirdly trials have started with the use of three types of irrigation for dry season use. As far as nursery diseases are concerned, investigations have continued on Blast disease and on the leaf diseases Anthracnose and Freckle. Surveys have shown that Blast is not randomly distributed in the nurseries and therefore may be assumed to be caused by a pathogen. Isolations from infected roots have shown that one probable pathogenic fungus is present and it has been possible to isolate this fungus from the transition zone of roots of newly infected seedlings though pathogenicity has not yet been established. Anthracnose has been shown to be caused by three distinct fungi and control has been obtained by spraying with Thiram and Ziram creams. Although a fair control of Freckle has been obtained with Perenox, a really satisfactory fungicide remains to be discovered.

78. Good progress has continued with work on the physiology of germination. The slow germination of fresh nuts and kernels has been shown to be due to a combination of two factors, mechanical resistance and lack of oxygen. Kernels have shown accelerated germination when set to germinate in pure oxygen at 38–40° C. Progress has also been made in determining the optimum moisture content of the shell for germination and practical results are expected.

79. The Institute's plant breeding programme has suffered greatly from lack of staff. An attempt has, however, been made to summarise past work, to take stock of the present position, and to outline a future policy. Concentration areas of good material from the Aba and Ufuma Selection Stations have been laid down at the Main Station and the Sub-Station at Abak. Large-scale inheritance studies which were planted in 1952 are expected shortly to give results of practical importance. At the present time, however, it is considered that the Institute's breeding programme is not sufficiently ambitious and proposals for a new programme entailing a policy of line or strain selection have been put forward.

80. The Institute's present seed for distribution (known as E.W.S.) is produced by a process of mass selection and production is being continually increased. Large areas at the Main Station are being exploited and production in the 1955–56 year is expected to be around 1,600,000 seeds.

81. Much interest has been taken in possible reasons for the wide differences in yield between plantations in West Africa and the Far East. Evidence has been accumulating to show that light intensity in West Africa may be insufficient to produce the growth and yields commonly attained in the Far East and elsewhere. A study of the performance of the Deli palm in West Africa gives no reason to believe that the high yields of the Far East are due primarily to the planting of this strain. Differences in climate between West Africa and the Far East also influence methods of germination and arrangements for nursery and field planting. These climatic and cultural differences were discussed in a paper presented at the recent International Horticultural Congress in Holland.

Publications

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J. D. ALLEN and R. A. BULL—Recent Severe Attacks on Oil Palms by two new Caterpillar Pests belonging to the Limacodidae. *J. W. Afric. Inst. Oil Palm Res.*, 2, (1954) 130-137.

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J. M. WATERSTON—Observations on the influence of some ecological factors on the Incidence of Oil Palm Diseases in Nigeria. *J. W. Afric. Inst. Oil Palm Res.*, 1, (1953) 24-59.

ANONYMOUS—Notes on Establishing an Oil Palm Nursery. *J. W. Afric. Inst. Oil Palm Res.*, 1, (1953) 88-91.

ANONYMOUS—The Cost of Establishing an Oil Palm Plantation. *J. W. Afric. Inst. Oil Palm Res.*, 1, (1953) 92–94.

ANONYMOUS—The Production and Distribution of Improved Seed by the Institute. *J. W. Afric. Inst. Oil Palm Res.*, 1, (1953) 95–97.

ANONYMOUS—The Rate of Germination of Large Lots of Seed. *J. W. Afric. Inst. Oil Palm Res.*, 2, (1954) 138–140.

ANONYMOUS—Notes on the Botany of the Oil Palm : 1. The Seed. *J. W. Afric. Inst. Oil Palm Res.*, 3, (1955) 73–74.

West African Maize Research Unit

82. The title of the Unit has been changed to that of “ West African Maize Research Unit ” to permit its programme to include more extensive investigations on other problems of maize breeding and pathology which have emerged in the course of the initial investigations.

83. The incidence of rust during 1955 was moderate and a system of survey plots has given evidence that both the incidence and the severity of damage is continuing to decline with time. The distribution of rust resistant varieties is being undertaken by the Nigerian Departments of Agriculture.

84. Differential seedling reactions have been obtained between rust stocks from the Gold Coast and Nigeria. Only derivatives from one Mexican variety differentiate the two rust forms and the possibility of the existence of a new strain of rust will be further investigated when more typing lines have been found. No change in reaction types has been observed on assay plots in Nigeria where all derivatives of the differential host have been planted in the field. The relationship between seedling reactions in West Africa and those obtained by Storey and Ryland in East Africa is not fully elucidated. Difficulty has been encountered due to differences in the environment in comparing results of inoculations. However, a controlled environment chamber has now been received and will be used to analyse this problem.

85. When field tested, a number of imported maize lines which had been selected for rust resistance became severely attacked by *Helminthosporium turcicum* Pass., particularly those from the original selections from the Rockefeller Research Centre, Mexico City. Further investigations showed that this pathogen might be severe on local maize. Plots of rust resistant maize treated with “ Nabam ” (disodium ethylene bis-dithiocarbamate) at seven day intervals, from the five leaf to the milk ripe stages, showed an increase in yield of 18 per cent. over the control. Similarly treated local, rust susceptible varieties showed an increase in yield of 7 per cent. *Helminthosporium* resistant varieties have been found in a collection of lines from Turrialba received via Dr. H. H. Storey. Some *Helminthosporium* resistant lines from Gainesville, Florida, were disappointing in their resistance in West Africa.

86. Stem borers of the genera *Busseola* and *Sessamia* are of great economic importance on maize in West Africa. Using semi-in-vitro methods of testing stem borer resistance developed by Mr. Bowden in the Gold Coast it has been found that some in-breds from Minnesota, supplied by Dr. E. H. Rinke and selected originally for resistance to the Pyralid stem borer (*Pyrausta nubilalis*) lower the rate of larval development of *Busseola fusca*. This resistance is transmitted to the F' in crosses with Mexican lines.

87. In conjunction with the West African Stored Products Research Unit (University College, Ibadan sub-station) storage tests are being conducted on selected maize lines in relation to their spoilage by *Calandra oryzae*. The variety Tsolo encouraged growth of these insects more than the local varieties

(although the latter are soft flour maize). Different lines from Mexico 1 showed variation in acceptability to *Calandra* of as wide a range as that of the differences reported above.

88. Synthetics of the varieties "Sicaragua" and "Mexico 1" have now been produced from partial in-breds of these two varieties. Two synthetics have been made from Trinidad material supplied originally by Dr. W. L. Brown, and these are under trial at present. Selections from the Central American Collection are being in-bred for resistance to specific pathogens including rust, with the object of keeping a broad base to the source of resistance in the hope that more than one gene will be retained as a safeguard against the appearance of new races.

89. Some 700 samples and data sheets have been received in connection with a survey of the indigenous maize types of West Africa. The help of the French authorities in this has been appreciated, not only in the supply of samples, but also for general data on the environment and anthropology.

West African Timber Borer Research Unit—Investigations in West Africa

90. Work has to date been confined largely to the Gold Coast. However, it is planned that an officer will be posted shortly to open a Sub-Station in the main forest area of Nigeria.

91. During the past year, the emphasis has been on a study of the life histories of the ambrosia (pinhole borer) beetles of the families Platypodidae and Scolytidae. Detailed studies of the life cycles, habits and gallery patterns of several species have been made. Some sixty species of Platypodidae and Scolytidae have been collected and the Commonwealth Institute of Entomology have identified forty.

92. Several insecticide trials have been conducted to find a mixture that will remain effective for a long period under the conditions of high evaporation and heavy rainfall prevailing in West Africa. The gamma isomer of benzene hexachloride formulated in a water-soluble paint and applied as a spray has given the best protection. The paint on drying becomes more or less water resistant and has afforded good protection to both logs with the bark intact and logs with the bark removed for periods up to ten weeks from felling. These insecticide trials have revealed that fuel oil acts as an attractant for the beetles and should therefore not be used in insecticide mixtures. It has been established that the attractant effect of the fuel oil is greater when applied to logs with the bark intact than when applied to those from which the bark has been removed. It is believed that bark on a log affords some measure of protection for a short period against ambrosia beetle attack, probably by masking the natural attractant of the log. It seems probable that the fuel oil, in addition to its own attractiveness, acts on the bark in a way which destroys this masking effect and thereby releases the logs' natural attractiveness. Further studies along these lines are planned to attempt to isolate the attractant factor of fuel oil in the belief that its determination may lead to the development of better methods of control.

Investigations at Princes Risborough

93. The work at Princes Risborough continues along three main lines :—

- (i) *Studies of the biology and life-history of the beetle.* Observations made on the progress of attack by *Platypus cylindricus* Fab. in oak logs and stumps initially attacked at known times in the summer were continued. At any time during the autumn and winter eggs are found in the tunnels, and dissection has shown that throughout this period sperm are present in the spermathecae of the females and the ovaries remain in an active

state. Some data on the egg-laying capacity have been obtained. The gut of the larva differs from that of the adult in not possessing a well-developed grinding gizzard ; this can be correlated with differences in their feeding habits. The tunnel is lined with wood particles finely comminuted by their passage through the gut of the adults and this wood forms a substrate for the spore-bearing portions of the ambrosia fungi. The larvae ingest the lining of the tunnel, wood fragments together with fungus, and pass the wood fragments through their guts and back to the tunnel lining.

- (ii) *Studies on the fungi.* Further isolations have been made from fresh and old tunnels of *Platypus*, and some very interesting results are appearing. A species of a genus near *Endomyces* always occurs in inhabited tunnels. Very often a species of *Cephalosporium* is also isolated jointly with *Endomyces*. The two fungi grow very well together in culture, with the *Cephalosporium* masking the Endomycete. The Endomycete is now in pure culture but the *Cephalosporium* is not and further attempts to obtain single spore cultures of this fungus will be made. The opportunity has been taken to culture fungus from the tunnels of *Trypodendron domesticum*, and from tunnels of several ambrosia beetles in imported woods. It is of great interest that in all these instances the pattern of an Endomycete growing in association with a fungus of the form genus *Cephalosporium* is maintained. The form of the fungi in culture differs from that in the tunnels and beetle gut, in particular a large spore, provisionally termed an A-spore, found under natural conditions has not yet been obtained in agar culture but appears to be produced by the Endomycete. Attempts are being made to grow the fungi on sterile sap and heartwood of English and Turkey oak. The *Cephalosporium* has been grown thus but not the Endomycete.
- (iii) *Relationships of beetle and fungi.* The relative importance of the different fungi as food for the beetle is not known, and feeding experiments are being started but their success will depend on whether cultures of the fungi on the wood substrates described above can be obtained. Meanwhile last-stage larvae have been induced to feed on agar cultures of the Endomycete, but although they have gained weight they soon die, becoming embedded in the vigorously growing fungus.

Flora of West Tropical Africa

94. The manuscript for Volume I, Part 2, of the revised edition has been completed by Mr. R. W. J. Keay and is now being printed ; it will be published during 1956. It has been almost completely rewritten and will be considerably larger than the first edition ; 53 families are dealt with ; numerous new species have been recognised and described.

95. Work on Volume II, Part 1, is now in progress. Mr. Keay has started on the *Rubiaceae*, one of the largest families in West Africa. Mr. V. S. Summerhayes of Kew is revising the *Orchidaceae*. Mr. C. D. Adams and Dr. J. K. Morton of the University College of the Gold Coast are working on the *Compositae* and *Labiatae* respectively. Mr. F. White of the Imperial Forestry Institute, Oxford has nearly finished the *Ebenaceae*, and various smaller groups are being tackled by other specialists. The new Fern Supplement by Mr. A. H. G. Alston of the British Museum is nearly complete.

Publications

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R. W. J. KEAY and J. MIÈGE—*Neostachyanthus occidentalis* Keay et Miège, nouvelle espèce d'Icacinacée d'Afrique occidentale. *Bull. Jard. Bot. Brux.*, **25**, (1955).

The West African Rice Research Station, Rokupr

96. There was an improvement in the staff position despite the resignation of the Botanist, as two new Botanists were appointed towards the end of the year.

97. Investigations on control of crabs have continued. A year's readings have shown the main breeding periods to be at high spring tide in the dry season. Spraying with technical BHC just after these periods and until planting has given effective control of crabs and treatment of special seedlings in the nursery with technical BHC prior to planting reduces crab damage. This work is therefore completed.

98. Botanical work has been confined to examination and recording of existing selections and hybrids, the complete recording of all characters of the one hundred local and two hundred introduced rices in the collection and the preparation for the expansion of the programme in the coming year. This programme includes statistical investigations of the experimental methods which will show yield differences best on the rather variable Rokupr soils.

99. In the Chemistry section, analytical techniques have been developed for the examination of mangrove soils and a survey made of the soil characters in an area of mangrove swamp at Mapotolon, which was empoldered in 1954. Levels of various ions, and of acidity, have been mapped and correlated with the growth of rice. Fluctuations in acidity and ion levels have also been recorded on Rokupr farm for areas under different water regimes, and an investigation made into the effect of the changes that occur in some mangrove soils on drying on the growth of rice. These investigations are not yet complete, but a considerable amount of basic information has been obtained.

100. Trials were again carried out by the Agricultural Officer in the Bonthe area on the effects of arboricides on *Rhizophora* mangrove. The chemicals used in 1955 were 2, 4-D, 2, 4, 5-T, and MCPA. All the chemicals were effective but the 4 per cent. solutions took up to four months longer to take effect than those of 8 per cent. 2, 4-D and 2, 4, 5-T appeared about equally effective in killing mangrove and slightly better than MCPA. 2, 4-D reacted more quickly and more effectively when painted on than when applied through cuts. As the results have been promising, further detailed trials are to be undertaken by the Rice Research Station.

University College, Gold Coast

Soil Science

101. Study continued on the distribution of the different forms of soil phosphorus in the main soil types of the Gold Coast. It has been shown that phosphorus deficiencies in the country are related to a lack of total phosphorus in the thoroughly weathered soils rather than to any irregularity in the proportions of the different forms, which are remarkably similar to those in soils of temperate climates. The organic phosphorus fraction is stable, and unlikely, except as freshly incorporated organic matter, to have any significance for crop growth. Partial regressions of crop responses to superphosphate on the different soil fractions indicate that none of the fractions can be used to predict responses

to the fertilizer, and the cropping history of the land provides a surer guide. A study of the distribution of superphosphate applied annually over the last seven years reveals that the acid soluble soil phosphorus has been significantly increased but there has been little change in the other fractions.

102. Dr. Foster continued his studies with P^{32} on the ability of plants to take up the less available forms of phosphorus on an acid soil with high phosphorus-fixing capacity. Although there are marked differences in vigour between the different species tested, they all appear to be utilizing the same fraction of the phosphorus in the soil.

103. A survey was made of the composition of typical examples of natural fallow species and planted fallows in the coastal savanna, the forest, and Southern Guinea savanna, and the corresponding soils. Forest fallows at the West African Institute for Oil Palm Research, Nigeria, as well as in the Gold Coast, have been studied. The object is to determine from the standpoint of the important soil nutrients how natural bush fallows compare with planted fallows, and how a broad-leaved fallow compares with a grass fallow in their influence on the soil.

104. Dr. Greenland has commenced an investigation of the gains and losses of nitrogen occurring in Gold Coast soils. As a first step the basic data on the fluctuations in the level of mineral nitrogen throughout the year on soil, vegetation and cropping systems typical of different regions of the country are being collected.

105. A new semi-micro procedure has been devised for the rapid analysis of plants for the major nutrient elements, which requires one digestion only for N, P, K, Ca and Mg. The work has involved a number of modifications in the standard technique of flame photometry.

Ecological Land-Use Survey

106. A survey of the vegetation and soils on about 50 square miles of country adjacent to the University Farm was made. From this and other studies advances in technique and procedure have emerged.

Pasture Ecology Management

107. Useful advances were made in the study of problems of analysis, composition and ecological status of vegetation on the Agricultural Research Station and elsewhere on the Accra plains. Among features of especial interest were the establishment of seven large protection plots on different soil types and including various plant communities; the working out of a method of transect analysis likely to be sufficiently rapid to suit the requirements of pasture management in West Africa; root studies of several species of grass by means of the monolith method, and identification of grasses by vegetative characteristics.

Soil and Water Conservation

108. Attention was paid to technical matters arising from the several dams and from the systems of soil and water conservation being tested at the Agricultural Research Station. These included the determination of the yields of catchments large and small; run-off intensities; the maximum permissible velocities in open channels of the types used in conservation practice; evaporation from impounded water; and the design of spillway to deal with flood discharge.

Animal Production

109. Investigations have been focussed principally on sheep. Work undertaken earlier on the measurement of basic growth potential and other features connected with the local Dwarf Forest sheep has continued at the Government

farms at Asuansi and Pokoase, by courtesy of the Director of Agriculture. Data of like kind are also being obtained at Nungua, which, together with those from the other centres mentioned, should prove of value in the cross-breeding programme under way at the Agricultural Research Station. Despite losses from various causes thriving lambs were produced from local ewes sired by Blackhead Persian rams imported from South Africa, live-weight of the hybrid lamb being significantly greater than that of the local dwarf sheep. An important feature of the work on sheep is the regular sampling of worm burden under a variety of environmental and feeding conditions, a large number of animals at the three centres being kept under observation in this regard. Pigs have continued to thrive under conditions of controlled open range.

Veterinary Science

110. A haematological survey of the blood of Fulani Zebu and West African Shorthorn cattle, under tsetse-free conditions at the Veterinary Farm, Nungua, was undertaken, blood from West African Shorthorn exposed to fly at Pokoase being studied for comparison. The West African Shorthorn exposed to fly suffered from severe anaemia, although the mortality from trypanosomiasis was slight.

Agricultural Engineering

Mechanisation of Agriculture

111. An investigation was commenced into the machinery requirements of cassava processing. A standard ensilage crop shredder proved unsuitable for preparing cassava for the making of "gari" because the resultant product was too coarse. By courtesy of a well-known firm of machinery manufacturers, the construction was commenced of a new type of tiller-planter, recently introduced in South Africa. It is hoped this planter will overcome many of the troubles associated with the operation of present types of equipment on rough, trashy and wet land.

Agricultural Zoology

112. Under the guidance of Professor Edwards, Mr. F. C. Peacock continued his study of the biology of the root-knot eelworm. Experiments to show the limits of tolerance of different stages of the organisms to moisture content of the environment suggest that below 10-12 per cent. of saturation all stages are killed; and that above, say 75 per cent. of saturation, root-knot populations are appreciably reduced.

Publications

P. H. NYE—Some soil-forming processes in the humid tropics Pts. II, III and IV. *J. Soil Sci.*, 6, (1955) 51.

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*, 7, (1955).

University College, Ibadan

Crop Production

113. Research on the influence of plant hormones on the flowering and fruit-size of pine-apples was continued. Studies were made on the heredity of abnormal pine-apple fruits including band faciations. Crosses were made in paw-paw to get true breeding hermaphrodite strains. Research on *Crotalaria juncea* as a source of fibre was done in collaboration with the Department of Commerce and Industries, Lagos.

Entomology and Grain Storage

114. Surveys of ticks and flies on cattle, lice on poultry and tsetse flies have been completed. A routine survey of insects on crops grown on the Faculty Farm continues and 50,753 insects were collected and recorded during 1955. Work on the biology of *Callosobruchus maculatus*, the major pest of cowpea, continues. Preliminary study of the problems associated with maize storage in Southern Nigeria continues and investigation of the relative merits of different types of grain dryer and storage bin is to be made.

Pastures and Pasture Plants

115. A study of the chemical constituents of the indigenous and exotic grass species in relation to their stages of growth, frequency of cutting, seasonal effects etc., continues. The effects of nutritional requirements on chemical constituents of pastures were also investigated.

Agricultural Economics and Farm Management

116. A comprehensive study of the rural economy of Nigeria designed to determine the impact of technology on peasant production, and to ascertain the economics of plantations and mechanisation in the further development of the country's agriculture is in progress. Work continues on the collection of market prices of the basic agricultural products. These will furnish the basic data for a projected study of the trend of agricultural prices and incomes in the Western Region of Nigeria.

Publications

D. H. HILL—Some Clinical and Serological Observations on an outbreak of Contagious Pleuropneumonia in a dairy herd of zebu cattle in Nigeria. *Brit. Vet. J.*, **112**, (1956) 63–70.

V. A. OYENUGA—The Composition and Nutritive Value of Certain Feeding-Stuffs in Nigeria : 1. Roots, Tubers and Green Leaves. *Emp. J. exp. Agric.*, **23**, (1955) 81.

V. A. OYENUGA—The Composition and Nutritive Value of Certain Feeding-Stuffs in Nigeria : 2. Concentrates. *Emp. J. exp. Agric.*, **23**, (1955) 171.

(d) WEST INDIES

Regional Research Centre at The Imperial College of Tropical Agriculture, Trinidad

Banana Research

117. In Jamaica, the male parents mentioned in the last report have now been largely superseded by later selections of which 3940 C(35), 3020 (203) and 3940 C(19) are the most promising and have priority as pollen parents. (Numbers of the last two were miscited in the previous report.) All three are complex hybrids derived in part from the Malayan edible diploid Pisang lilan, in part from Burmese strains of *Musa acuminata* and (3020 (203)) in part from a Samoan strain of *Musa acuminata* subsp. *banksii* (= *Musa banksii*). Several very promising selections have been made among the progeny of an edible diploid, Sikuzani, which was collected by Baker and Simmonds in Zanzibar in 1948 and pollinations by these selections of Gros Michel in Jamaica will start this year. A congener of Sikuzani, Paka by name, promised even better but its use in crossing was delayed by a strong suspicion that it was susceptible to Panama Disease ; if it is not, then it will certainly be used extensively for it has a better bunch than Sikuzani and is more resistant to Leaf Spot. It is planned to combine these African edible diploids with the *banksii* strains from the south-west Pacific which are referred to below, if the latter prove to have vigour and disease resistance under West Indian conditions.

118. The tetraploid progeny of Gros Michel that are presently under test in Jamaica contain no outstandingly promising types but standards of selection are rising steadily and there is no doubt that the average quality of bunches seen in the tetraploid nursery has risen markedly over the past five years.

119. The tetraploid banana 1877 which was mentioned in para. 101 of the last report has not in fact been abandoned. It passed two years in trials on thirty different estates scattered through Jamaica and performed very well on some of them, rather poorly on others. The assessment of the results was a complex matter that left much room for individual opinion; furthermore, the decision of whether to keep or to abandon the variety rested also on opinion of future trends in the banana trade and banana research. It was eventually decided that it should be kept for extended trials on certain hilly lands under natural rainfall where it had shown up best in comparison with the standard variety, Lacatan.

120. Fundamental studies of the botany of the wild bananas and their related cultigens has been continued. Especially interesting is the study of the various subspecies of *Musa acuminata* and their cytogenetic interrelations; and the genetics of certain intersectional crosses which may be expected to throw much light on the evolutionary history of *Rhodochlamys* since its divergence from Eumusoid ancestors. An exciting moment in the recent banana expedition came with the discovery (in the field in Assam) of natural hybrids identical with one of those made and studied at the I.C.T.A. The banana expedition provided a mass of valuable taxonomic data which are now being worked up; several new species were discovered and we believe that *Musa* is now rapidly becoming one of the best understood of widely ranging tropical genera.

121. The banana collecting expedition mentioned in para. 103 of the last report ended on 23rd May, 1955. Some of the results have been indicated above; for banana breeding the most important undoubtedly were the collection (a) in Samoa and New Guinea of stocks of *Musa acuminata* subsp. *banksii* which bore large bunches of large fruit and (b), in New Guinea and Malaya, of several promising edible diploids. The former are now in cultivation at the I.C.T.A., having been introduced as seed; the latter are under quarantine at Kew. The *banksii* stocks are superficially very promising but a word of caution is necessary here: *banksii* has never in the past thriven under West Indian conditions and we yet know very little of its reaction to Panama Disease and Leaf Spot. Promising as these collections are, then, they must be extensively tested before they can be admitted as breeding stocks and even then it may be necessary to use them only in hybrid combinations if a practical level of vigour is to be maintained. On the scientific side the expedition made collections of great taxonomic interest and added much to our knowledge of the cultivated bananas. Particularly interesting in the latter connection was the discovery in New Guinea of botanically primitive edible diploid cultures of a type which we supposed had died out some thousands of years ago; the bananas in fact, match the primitive technologies of the indigenous people.

122. For the successful conclusion of the banana collecting expedition our most grateful thanks are due to the Governments of Western Samoa, Queensland, the Territory of Papua and New Guinea, the Federation of Malaya, Thailand, India and Sikkim for their most generous help and advice.

Cocoa Research

123. *Plant Breeding.* The programme involves studies of the genetics of various characters of cocoa, evaluation of single trees for superior clones for a sexual propagation, and studies of techniques and methods of seed production.

Comparisons are being made among progeny arising from crosses between high-yielding trees. Experiments are being conducted to solve some basic problems of cocoa breeding.

124. Experiments were laid down to determine the distances at which cross-pollination occurs and the amount of self-fertilization that takes place in individual trees. A set of crosses among trees of first-generation inbreds was planted to determine the use of such crosses to develop more uniform hybrid populations and to study the inheritance of combining ability in cocoa.

125. Inoculation of a large number of young seedlings with spores of *Marasmius pernicius* Stahel (Witches' Broom disease) by a technique developed at the College, was carried out as part of a study of the inheritance of resistance to the disease and to obtain plants resistant to it.

126. Large-scale cytological investigations into the nature of self-incompatibility are being carried out. The collection of species of *Theobroma* and *Herrania* was maintained and several new inter-specific hybrids were obtained.

127. *Plant Physiology and Biochemistry.* A generalised theory having been developed on the interaction of shade and mineral nutrition in the early growth and cropping of cocoa, attention has now been turned to a study of growth in relation to water requirements. This will cover both the effects of excess water in the rainy season leading to soil water-logging and water-strain in the dry season.

128. A technique for the biological assay of plant growth substances under tropical conditions has been developed. The growth substances extracted from the plant are separated by paper chromatography and estimated by the *Avena* straight growth method. The presence of indole-acetic acid in the young expanding flushes and buds of seedlings has been demonstrated.

129. Study of the nitrogen metabolism of fermenting cocoa has shown that during fermentation a continuous loss of protein occurs by hydrolysis and other processes. Under certain unfavourable conditions, the changes are slowed down so that an appreciable part of the protein is left intact at the end of the fermentation and such cocoa shows a high purple bean content.

130. *Entomology.* The entomologist continued his study of environmental conditions associated with the fluctuation of mealybug populations on cocoa.

131. In a study of the bionomics of cocoa thrips data were collected on their abundance in Trinidad in relation to time of year, leaf flushing and yearly weather, and to the genetic constitution, yielding performance and growth characteristics of individual cocoa trees, as well as to its spatial distribution within a single field of known history. The conclusion was reached that outbreaks of cocoa thrips in the area studied are obligately dependent on intrinsic factors in the cell solutes of the leaves used as food, and that these factors are intimately related to seasonal changes in the soil environment. There is a relationship between cocoa thrips incidence and the genetic constitution of the tree, and this is an expression of the relative tolerance by the tree of unfavourable soil conditions during the wet season. The data lend no support to the view that the major differences in growth and yield between "heavily infested" and "lightly infested" trees are attributable primarily to the effect of feeding by cocoa thrips.

132. *Soils.* Results of cocoa field experiments on shade, spacing, fertilizers, mulching and inter-row cultivation for the crop year 1953-54 were published during the year. Detailed analyses of soil and tree factors made evident the complex interactions between shade, spacing, mineral nutrition and tree performance. Large tree-to-tree yield variation in mulch experiments were

mentioned in last year's report and it was stated that soil factors had so far provided no ready explanation. A possible causative soil factor is however still being studied. Justification for this emphasis is additionally upheld by a study of an area in the Central Range of Trinidad where enormous tree-to-tree variations occur and appear to be associated with very localised soil heterogeneity.

133. Regular soil moisture measurements in the shade and mulching experiment at River Estate commenced at the beginning of the 1955 wet season. There are indications that during the rains aeration conditions in this soil cannot be considered satisfactory for cocoa roots despite drainage and regardless of mulch or other treatments.

134. The detailed soil and ecological survey of an area in the Trinidad Central Range, mentioned in last year's report, has continued and the field work of most of the area was completed. Mapping and correlation of results are now in progress.

135. *Soil Science and Soil and Land-Use Surveys.* Using data from the College Meteorological station, the theories of Penman have been applied to calculate plant-water requirements under Trinidad conditions. Results so far enable irrigation requirements to be calculated in the immediate vicinity of the College. Irrigation equipment has now been installed and is initially being used in a co-operative project with the Sugar Research Department for a study of droughted sugar-cane. A small portable meteorological station has also been equipped which will be erected at selected sites over the whole colony and which will be staffed by volunteer workers. In this way, and again based on the theories of Penman, it is hoped to compile a tentative map of irrigation requirements in Trinidad.

136. Suspicions of "whiptail" in cauliflowers grown on a soil type (pH 5.5) in the vicinity of the College initiated an investigation and was found on experimental plots to be partially corrected by application of lime, but all traces of the disease were removed by application of 1 lb./acre of ammonium molybdate.

137. An investigation was started (in conjunction with the Agricultural Department of the College) using chromium oxide as an index in digestibility trials of animal diets. The oxide was incorporated in the feed and analysed in the faeces. Spectrochemical analyses of blood, urine and milk showed that uptake of chromium was insignificant.

138. A series of pot tests has been initiated to follow up the field work of the soil survey, and based on the technique followed by Webb in establishing nutrient deficiencies of Gambia soils. Spectrographic analyses of soil and indicator crop from the pots will in time also provide valuable data on the total and "available" trace element status of the soil types identified in the field.

139. Approximately 25 per cent. coverage of Jamaica has now been achieved by the soil survey team and reports for publication are in preparation. The final map of the soil survey of St. Vincent is complete and with its accompanying report is being prepared for publication.

140. The soil survey of the Rupununi savannahs, British Guiana, was started in September, 1955. By the end of the year 1,200 square miles had been mapped in the field. This was considered as being representative of approximately double the area and would therefore provide considerable acreage on which to base experimental work towards possible improvement of the productivity of the region. Final soil survey maps are under compilation and it is hoped to issue a report on the work in the near future.

The Imperial College of Tropical Agriculture, Trinidad

Department of Entomology.

141. The biology of *Nausibius clavicornis* (Kug.) (Col. Cucujidae), infesting raw sugar, was investigated. A study of the hygroscopic equilibrium of paddy at 25° C. was completed.

Department of Agriculture

142. *Rice.* Investigations with irrigated rice to assess optimum cultural practices continue. Experiments are in progress to determine the optimum population and pattern of planting for transplanted rice and comparisons are being made between various ways of direct seeding and of transplanting for establishing the crop. Results so far obtained suggest that, under Trinidad conditions, yields from directly seeded swamp rice can equal or surpass those obtained by the traditional transplanting method provided attention is paid to the following factors which are the subject of investigation :—

- (a) control of weeds, by herbicides, in rice directly seeded on dry land,
- (b) the influence of variety when pre-germinated seed is broadcast into standing water,
- (c) the influence of the oxygen content of irrigation water on the germination of rice seed,
- (d) control of snails.

143. *Herbicides.* The main investigations are with :—

- (a) herbicides for weed control in irrigated rice and in maize,
- (b) the maximum concentration of selected herbicides which these crops will tolerate under various environmental conditions,
- (c) testing new chemicals to ascertain their value under tropical conditions.

It has been shown that the response of rice to post-emergence applications of 2, 4-D and related compounds is essentially the same in Trinidad as in other regions where they have been tested. In particular these chemicals are of value in Trinidad for the control of *Fimbristylis miliacea* Vahl. Work with DNBP for both pre-emergence and post-emergence application to swamp rice continued ; promising results have been obtained from experiments with this herbicide ; it gives good general control of weeds when applied pre-emergence to directly seeded crops and has a specific value for the control of *Sphenoclea zeylanica* Gaertn. when applied post-emergence. Investigations with Amizol (3-amino-1 : 2 : 4 triazole) and pentachlorophenol are in progress. Work with Delapon and CMU in rice has been discontinued since these chemicals have not fulfilled their early promise.

144. *Yam Storage.* Experiments dealing with the storage of the Lisbon yam (*Dioscorea alata*) with the object of inducing prolonged dormancy using growth regulating substances are continuing. Promising results have been obtained using the methyl ester of naphthalene-acetic acid.

145. *Pasture and Grassland.* During 1955 a number of additions were made to the collection of grasses of which the most promising appears to be *Acroceras maorum* Stapf. Studies on the production of grass seed for the establishment of leys have been continued. Grasses which are free-seeding in the drier tropics often fail to produce seed under the wetter conditions of Trinidad or, if seed is produced, it is usually of low viability. Because of the difficulties of production of viable seed in bulk under local conditions, more attention is being paid to those grasses which can easily and cheaply be propagated by vegetative means and in this respect both *Ischaemum timorense* and *Digitaria decumbens* have given encouraging results. Of the grasses so far used in

grazing trials the following are, at this stage, the most promising :—*Ischaemum timorense* Kunth, *Digitaria decumbens* Stent, *Paspalum notatum* Flugge, *Dichanthium aristatum* (Poir) C. E. Hubbard, *Dichanthium caricosum* (L.) A. Camus. Other possible useful grasses which are being studied in detail are :—*Bothriochloa pertusa* A. Camus, *Echinochloa pyramidalis* Hitchcock and Chase, *Setaria sphacelata* (Stapf) Hubbard, *Panicum coloratum* L. var. *makarikariensis*, *Andropogon gayanus* Kunth, *Ixophorus unisetus* (Presl.) Schlecht, and *Paspalum dilatatum* Poir.

146. *Animal Nutrition.* Grazing behaviour studies have been continued, the 1955-56 series of observations being conducted with cross-bred Holstein-Zebu cattle grazing on six different species of grasses. The determination of the digestibility of tropical grasses continued using sheep and goats in specially designed digestibility crates. Guatemala grass (*Tripsacum laxum*) was the first grass so studied. Work on the digestibility of various ammoniated sugar by-products has been maintained and, in conjunction with the Department of Sugar Technology, the lack of palatability of ammoniated molasses has been investigated. Preliminary feeding trials with molasses-ammoniated-bagasse have begun. Individual pig feeding trials with dried citrus pulp and with cull bananas have been started.

147. Other current investigations include :—

- (a) A determination of the reasons for the low palatability of bamboo grass (*Paspalum fasciculatum* Willd.)
- (b) The cause of a taint in milk from cows fed on *Ischaemum aristatum* L.
- (c) The feeding of low grade sugar to chicks.
- (d) Studies designed to measure the feed (fodder and concentrate) intake of various types of livestock maintained under Trinidad conditions. Work with sheep, goats, cattle and poultry has been undertaken.

148. *Animal Physiology.* An investigation of the low fertility of Rhode Island Red poultry showed this to be due to the use of the two-year-old males and females. It appears that fertility is seriously reduced, under Trinidad conditions, in birds after their first year. Long term projects designed to assess the effects of season and time of hatching on fertility and hatchability and the effects of season on reproductive phenomena in dairy cattle have continued. A preliminary study using artificial lighting for laying poultry indicates that an extension of the day length to fourteen hours is remunerative and economic.

149. Heat tolerance physiological work continues, a termistor being used for skin temperature studies on dairy heifers kept under both covered and open conditions. With poultry the project designed to determine the effect of time of hatching on lifetime production continues.

Publications

W. G. C. FORSYTH and N. W. SIMMONDS—A Survey of the Anthocyanins of some Tropical Plants. *Proc. Roy. Soc. B*, **142**, (1954) 549-564.

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N. W. SIMMONDS—Wild Bananas in Malaya. *Malay. Nat. J.*, **10**, (1955) 1-8.

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A. L. JOLLY—The Philosophy of Unit Farms. *The Caribbean*, **8**, (1955) 105-108.

A. L. JOLLY—Peasant Experimental Farms. *Trop. Agric. Trin.*, **32**, (1955) 257-274.

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British West Indies Central Sugar Cane Breeding Station

150. Further improvements in the design of the hybridisation lanterns were made, and a satisfactory type which is less costly to construct and more easily portable than the standard Barbados type was used on a considerable scale. The use of a series of organic oxidase inhibitors was investigated in experiments to devise a method by which normal flowering could proceed in cut arrows: none of these proved in any way superior to the organo-mercurial "Aretan", which at 0.01 per cent. permits of normal flowering and pollen-shedding for 4-5 days. Experiments with marcotting, using a rooting medium of composted bagasse in pliofilm covering, indicated that canes showing early signs of arrowing could be easily rooted, removed from the stools and transferred in good condition to pots, but that further experiments are necessary to ensure normal arrow emergence in such canes under Barbados conditions.

151. For the control of arrowing, it was shown that for a normally heavy arrowing variety, spraying with a 1 per cent. solution of maleic hydrazide about 8 weeks before the normal date of arrow emergence resulted in a significantly lower percentage of arrows per stool. Arrowing was, however, not completely inhibited, nor was it appreciably delayed.

152. In the general breeding programme, the most notable change was the introduction of a considerable proportion of inbred-crosses. With the large-scale use of inter-specific hybrids in the breeding work, a sufficient degree of variation is obtained in such inbred crosses without loss of vigour, and the method has particular value in special breeding lines, as for instance, in developing varieties resistant to mosaic and leaf scald. The first close inbred to be recommended for commercial cultivation in Barbados, B.49119, continued to give exceptionally promising results in its trials, particularly as a ratoon. Though unfortunately rather liable to damage by high winds, this variety will undoubtedly be planted on a large scale in the Caribbean in the near future: indications are that it might increase sugar yields by as much as ten per cent.

153. Good progress was made in the development of pure lines in the cyto-genetics research programme. Contrary to expectations expressed in some quarters, fertility has been well maintained in most of the inbred lines, and with a few notable exceptions, flowering has been sufficient for continuation of the lines by selfing. The expected loss in vigour after several generations of selfing has become evident in all lines: the conclusion to be drawn, however, from observations on flowering in such material is that genetic characters, rather than vigour, control the degree of flowering in sugar cane, at least so far as differences in one environment are concerned. Top crosses (between proven parents and inbred derivatives) and interline crosses between inbreds were made in order to evaluate the lines as breeding material. Satisfactory germinations were obtained in most of these crosses, and the performance of the seedlings is awaited with interest.

154. Two populations of second-generation self from B.4362, which is a tri-species hybrid, showed an interesting reversion to the growth-characters of the *spontanum* ancestor. This is interpreted as an example of a cytological mechanism which tends to avoid dilution of characters differentiating between species, and in which only gametes with certain gene arrays are viable. Similar examples have been reported for other genera.

155. Useful information on the heredity of resistance to mosaic and leaf scald is becoming available from resistance testing at the sub-stations in Jamaica and British Guiana, respectively. As a result of this, some 75 per cent. of seedlings recently sent to Jamaica have shown mosaic resistance, and complete control of the disease in commercial plantations is now in sight by the use of resistant varieties. The breeding of leaf-scald-resistant varieties for British Guiana is not so far advanced, but is being tackled energetically: basic information on resistance of many parental types and seedling progenies is already available to guide the selection of parents.

156. In the laboratory, further experiments in the technique of preparation for counting of chromosomes showed that root-tip squashes, reported as successful in Taiwan and Queensland, show no promise in Barbados owing to difficulties in hydrolysis of the material. This experience is similar to that reported from South Africa, Hawaii and Florida. On the other hand, the use of embryonic leaf tissue from germinating buds shows considerable promise, and it is hoped that a more rapid and convenient method than that with embedded and sectioned root-tips will be worked out shortly.

Publications

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(e) SOUTH-EAST ASIA

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Forest Botany

157. Acquisitions to the herbarium amounted to 2,636 (3,276) of which 1,152 (729) were from Malaya, while the remainder were mostly duplicates received for identification from the Borneo territories. A few came from the Royal Forest Department, Thailand. The total number of specimens in the herbarium reached 49,319 (46,681). The study of the species of the family *Dipterocarpaceae* represented in the Commonwealth territories in Borneo (North Borneo, Brunei and Sarawak) was continued, and papers on *Anisoptera* and *Dryobalanops* were published. The arboretum now contains 109 species of dipterocarps and this is probably the finest living collection of the family in the world.

158. A number of experiments were made in tree killing by basal sprays and application to frill-girdles of 2,4,5-T butyl ester (80 per cent. acid equivalent) in diesel oil. The chemical is expensive and solutions which compare in price with sodium arsenite at 2 lbs. per gallon of water, appear ineffective as a spray but show some promise in a frill-girdle. The saving of labour in spraying compared to frill-girdling is only approximately 20 per cent., or half a man/day per acre, when doing a full tree-killing treatment after exploitation, which is the normal Malayan practice.

Ecology

159. The 20-acre plantation of *yemane* (*Gmelina arborea* Roxb.) in Sungei Buloh Forest Reserve, Selangor, proved a failure. Even in the blocks where

initial eradication of lalang was followed up for some months by forking or treatment with Sovacide P.Y.D., the *yemane* did not grow vigorously enough to close canopy or prevent the re-establishment of lalang. The 20-acre plantation of *batai* (*Albizia falcata* Back.) in fire-protected lalang continued to thrive. Other species that are showing promise are *Araucaria cunninghamii* Sweet, *Pinus caribaea* Mil., *P. insularis* Endl. and *P. merkusii* Jungh. and De Vries. Of the species planted the previous year on tin tailings at the 9th mile, Kuala Lumpur-Rawang Road, *Eucalyptus multiflora* and *gelam* (*Melaleuca leucodendron* L.) are showing promise. *Batai* was used for manuring experiments in this area and initial response to phosphate was very marked.

Entomology

160. Mortality from termite attack on the roots of young trees of *Eucalyptus* spp. was reduced from 15 to 2 per cent. by application of Dieldrin to the soil. It also eradicated carton-building ants (*Crematogaster* sp.) from young trees. D-D soil fumigant was found unsuitable because it kills the trees as well as the termites.

161. Of three promising proprietary insecticides tested for protection of freshly felled logs against ambrosia beetle attack, only one, containing Endrin, gave significant protection. One of the others (which both contained BHC) appeared to attract attack, although it has been reported to be very effective in some other countries. Half-inch Jelutong boards, treated with boric acid, were still free from powder-post beetle attack after nearly two years.

Chemistry

162. Excellent samples of hardboard made from mixtures of common Malayan woods were received from the laboratories of A.B. Defibrator, Stockholm, Sweden. Resin-bonded chip-board, made from sawmill waste and rubber wood by International Plastics Ltd., London, was also of high quality, although incorporation of rubber wood was shown to lower the strength and resistance to water-absorption. Hand-sheets of laboratory-made paper, made by the Cellulose Development Corporation, Middlesex, England, from padi straw by the Celdecor-Pomilio process, showed that it is likely that high quality printing and writing paper can be made from this material. These trials were arranged with the co-operation of the Rubber Research Institute of Malaya and the Agricultural Department.

Timber Research

163. In collaboration with the Public Works Department, a start has been made in preparing a series of standard roof-truss designs suitable for Malayan timbers, and modern developments in timber construction methods are being examined with a view to applying them locally. It is intended to set up a new research section to cover this type of work when staff permits.

Wood Technology

164. Investigation of the cause of brittle-heart formation in some of the local timbers continued, and more than a hundred fresh specimens of *Meranti sarang punai* (*Shorea parvifolia*) and *Meranti tembaga* (*Shorea leprosula*) were collected from various localities of Kinta, Ulu Selangor and Kuala Lumpur Districts. Microscopic examination provided no clue to the cause or origin of this condition, which in some localities and in some circumstances, e.g. in fast-growing plantations, may affect almost the whole cross-sectional area of many stems, although the wood appears to be sound when initially laid down. The Mycologist of the Department of Agriculture, who helped in the investigation, did not succeed in isolating any possible fungus from any of the "infected" timber that he examined.

*The Botanic Gardens, Singapore**Taxonomy*

165. It was possible to carry out more field work in 1955 than in recent years and collecting trips were made to Bau, the Lundu area and the Pueh Range in western Sarawak and to Fraser's Hill, Malacca, Pulau Pisang, Pulau Sauh, Kuala Trengganu and Pangkor Island in Malaya. Plants hitherto unknown to science have been collected, the Sarawak collection of some 500 numbers proving particularly rich in new species.

166. Mr. Sinclair continued his study of Malayan Myristicaceae and hopes to complete the work during visits to European herbaria on his present leave. Dr. Furtado continued his study of the genus *Calamus*. Mr. Burkill has begun a collection of Malayan marine algae, while Dr. Prowse of the Malacca Fish Culture Research and Training Institute, who is working temporarily at the Botanic Gardens, has made interesting discoveries among the fresh-water algae.

The Ridley Centenary

167. In December, 1955, the Gardens celebrated the hundredth birthday anniversary of Mr. H. N. Ridley, C.M.G., F.R.S., who now lives in retirement at Kew. Mr. Ridley, who was Director of the Singapore Botanic Gardens during 1888-1912, played the vital role in the founding of the Malayan rubber industry and made outstanding and voluminous contributions to our knowledge of the natural history of South-East Asia.

Publications

G. H. ADDISON—Cactus and Succulents in Malaya. *M.A.H.A. Mag.*, XII (1955), No. 1, 13-15; No. 2, 21-23; No. 3, 22-23.

G. H. ADDISON—New Orchid hybrids raised and flowered in Singapore. *M.A.H.A. Mag.*, XII (1955), No. 2, 14-16; No. 3, 14-15.

J. W. EWART—Saintpaulias. *M.A.H.A. Mag.*, XII (1955), No. 1, 16-17.

University of Malaya

168. Dr. Kiang Ai Kim and Mr. Alfred S. C. Wan are working on the alkaloids of *Rauwolfia perakensis*, King and Gamble. Dr. Kiang is continuing work on the extractives of sawdust of *Dryobalanops aromatica* and is also engaged, in collaboration with Dr. W. D. Crow of C.S.I.R.O., Melbourne, on the investigation of *Kopsia singaporensis*. Mr. I. Enoch has commenced a study of the genus *Aglaiia*, Mr. J. Carrick continued his study of the respiration of *Aspergillus niger*, and Dr. P. B. Tomlinson is studying the anatomy of palms. Miss Gloria Lim presented a thesis entitled "Morphology, Anatomy and Pathology of *Carica papaya* Linn. in Malaya".

V. OTHER RESEARCH PROJECTS UNDERTAKEN WITH ASSISTANCE FROM COLONIAL DEVELOPMENT AND WELFARE RESEARCH FUNDS*ADEN**Abyan Research Scheme*

169. Studies on crop rotations and soil preparation continued. New selections of cotton made from within the commercial crop were released for general cultivation with good results. Selections for improved staple and evenness are under multiplication for next season's crop. Backcrosses (wilt susceptible x resistant) strains are in the fourth backcross. Selections of maize, sorghum and tomato are under multiplication. The soil chemistry investigations relate principally to salinity within the delta associated with the rising water table.

BASUTOLAND*Soil and Plant Research*

170. The 32 exploratory fertilizer experiments previously reported were repeated for the third successive year. The dressings were of NPK in various doses and combinations applied to maize, wheat and sorghum. The response of maize to phosphate was again large, being on average slightly over half a ton per acre for a 200 lb./acre dressing, a mean increase of 367 per cent. The only nitrogen response (40 lb. N. per acre) was at Leribe as occurred before, where there was also an NP interaction. There were no responses to potash. Sorghum showed large responses to phosphate (except on fertile alluvium at Fort Hartley). The mean response to 50 lb. P_2O_5 /acre was 730 lb./acre. Wheat trials, where not subject to various accidents, showed a mean increase to P at 200 lb./acre of 378 lb./acre. Nitrogen and potash had little effect. On the fertile mountain black clays neither fertilizers nor dung had appreciable effects. Residual responses on wheat were substantial for dung and phosphates. There were no significant responses to trace elements (Cu, Mg, Zn, Mn, B.).

171. Weed control with chemicals in comparison with hand and implement cultivation showed that hand weeding gave the highest yields followed by implement cultivation. Chemicals did nevertheless effect a good degree of weed control, a pre-emergence spray of 2,4-D more than doubling the yield over no weeding.

172. Variety trials with maize showed yields varying from 714 to 1,778 lb./acre, the South African hybrids being outstandingly good. Wheat trials showed very good performance by some Spitzkop varieties recently bred in the Union for the High Veld.

GAMBIA

173. Previous pot trials had shown that soils at Yundum Farm were deficient in N, S, P, K, Cu, Zn and Mo, the deficiencies varying from severe to slight. Under high leaching boron was also deficient. These tests were followed by field trials using the subtractive technique which allowed the deficient elements to be tested in 13 plots using groundnuts, maize, sunn hemp and green gram. Green gram showed a high interaction between P, K and S but no response to P or KS alone. Sunn hemp gave a significant response to PCa but there was also an interaction with KS. With maize PCa had no effect but there was response when P, Ca, N and S were applied though symptoms of K deficiency appeared late in the season.

174. Further pot trials indicated that in the early stages of growth N, S, P and Mn were deficient ; at intermediate stages only N and P deficiencies were pronounced and after three months S and K were also markedly deficient with lesser symptoms indicating shortages of Ca, B, Cu, Zn and Mo.

FIJI*Biochemical Investigations*

175. Successful use was made of the Wadsworth-Howat technique for small-scale cocoa fermentation and beans from 55 selected trees were fermented separately for flavour assessment. First reports were generally satisfactory.

NORTH BORNEO*Forestry Research*

176. 1955 was memorable for an exceptionally heavy flowering and fruiting of forest trees of all sizes and the Forest Botanist spent about six months in the field making botanical collections. Most of the 200 or so North Bornean species

of the most important timber-producing family, Dipterocarpaceae, flowered and particular effort was made to make good collections of the lesser known species. A total of 1,625 botanical specimens, mainly woody species, was collected during the year and seven sets of most of these were distributed to major herbaria including Kew, Leiden, Arnold Arboretum, Brisbane, Singapore, Kepong and Bogor. In addition four sets of the better material of Dipterocarpaceae were sent to Manila, Oxford, Kuching and Florence. A list of preferred vernacular names was revised as North Borneo Forest Records No. 6 "Check List of the Forest Flora of North Borneo". A preliminary ecological survey was made in the Balong area near Tawau and a 5 acre virgin jungle plot established in Sepilok Forest Reserve near Sandakan. Limited investigations were made on *lobang pusing* damage (caused by *Hoplocerambyx spinicornis*) and needleworm borer attack (caused by species of the family Lymexilidae).

BRITISH GUIANA

Livestock Investigations

177. At the Ebini Livestock Station fertilizer, burning and mowing trials were continued on the minerally deficient savannahs. Phosphate and nitrogen responses are very pronounced. Promising grasses for fertilized pastures are : Bahia grass (*Paspalum notatum*) and Carpet grass (*Axonopus compressus*). Pangola Grass (*Digitaria decumbens*) showed disappointing growth after a promising start. Tropical kudzu (*Pueraria phaseoloides*) and Pigeon peas (*Cajanus indicus*) grow well. *Stylosanthes gracilis* shows promise. Carrying capacity on improved paddocks has been many times greater than the open range. The feeding of a mineral mixture to the cattle has greatly improved the general health of the herd and increased calf production.

Nutrition of Rice

178. Fertilizer trials on rice continued and phosphate was found to be deficient on most soils. Its importance in suppressing exchangeable aluminium toxicity was confirmed. Sulphate of ammonia was of value in promoting early growth to suppress weeds.

Soil Surveys

179. The United States Operations Mission provided two soil surveyors who carried out a survey of 27,000 acres on Blocks I and II, Corentyne, which are to form part of a drainage and irrigation scheme. The soils found were most fertile with 80 per cent. suited to rice cultivation without the use of fertilizers. A reconnaissance survey of the coastal strip was being carried out with the use of a helicopter. A soil survey of the Rupununi area was commenced under the technical supervision of the Regional Research Centre at the Imperial College of Tropical Agriculture, Trinidad.

Cotton Investigations

180. American, Sudan-Egyptian and Sea Island types were grown. Satisfactory growth was obtained on all soil types except pegasse (tropical peat). Promising yields were obtained from some plots. Stainers and jassids were the main pests. A collection of perennial cottons was made.

Pool of Entomologists at the Commonwealth Institute of Entomology

181. Mr. E. S. Brown has completed his second year of studies of *Amblypelta cocophaga* China, the cause of nutfall of coconuts in the Solomon Islands, and of the ants that determine its prevalence. Detailed observations are being made of the insect populations of the palm crowns and of the possibility of favourably adjusting the balance of these by means of insecticides. Mr. C. R. Wallace is

studying pests of the groundnut crop in the Gambia, where he finds that the Lygaeid, *Aphanus littoralis* Dist., appears to be of substantial importance at and after harvest. Dr. I. W. B. Nye spent seven months working at the British Museum (Natural History) on the taxonomy of stem-boring Lepidoptera before leaving, in February 1956, for East Africa, where he is to survey the incidence of these and other pests of tropical cereal crops.

Pool of Plant Pathologists at the Commonwealth Mycological Institute

182. Mr. R. A. Altson went to Sarawak in May, 1955 to investigate a serious disease of pepper (*Piper nigrum*) estimated to be causing damage of about £100,000 a year. The presence of eelworms in considerable numbers points to a possible factor in the etiology of the disease. The crop is so valuable that it has been difficult to find plants for experimental work. Mr. P. Holliday joined the Pool in September and proceeded to Sarawak to work with Mr. Altson. The investigation may be an arduous one as more than one causal agent may be involved.

183. Dr. J. C. F. Hopkins of the Institute staff was loaned to the Nyasaland Government for a period of six weeks in early 1955 to make a preliminary investigation of tobacco leaf spot caused by *Alternaria longipes* and to initiate further research by Dr. B. E. J. Wheeler. He made field surveys of the several outbreaks in the Kasungu area of Nyasaland and visited the Fort Jameson district of Northern Rhodesia. He also supervised preliminary field experiments performed by Dr. Wheeler in Nyasaland and arranged for him to carry on more detailed research at the station of the Tobacco Research Board of Rhodesia, outside Salisbury, during the period between crops. Dr. Hopkins has reviewed the principal causes of the distinctive outbreaks of *Alternaria* leaf spot and has made recommendations for control, which include changes in methods of cultivation, particularly early harvesting, and modifications of fertilizer mixtures. Dr. Wheeler has made considerable progress in assessing the factors which initiate infection of the crop and affect the etiology of the disease and the determination of the toxicity of a number of fungicides to *A. longipes*.

Colonial Pool of Soil Surveyors

184. The strength of the Pool has been increased to a sanctioned cadre of six. Soil surveys have been undertaken in Aden Protectorate and Somaliland (Mr. Hodge), in Northern Rhodesia (Mr. Ballantyne) and a survey has been started in Swaziland (Mr. Murdoch). Arrangements have been made for a survey in Hong Kong and requests for assistance have been received from Northern Nigeria, Jamaica, Dominica, Grenada, Malta, Uganda, North Borneo and the Seychelles.

Termite Research Unit

185. One member of the team continued work in East Africa while the others worked on collections in the Natural History Museum. Seventy-one identifications have been made, based on 194 tubes of materials, other than those of our own collecting or already in the Museum collection. The larger collections were from the Solomon Islands (Mr. Brown) and Nigeria (Dr. MacNulty). A large collection from Southern Rhodesia awaits examination.

186. Two cases of termites reaching this country alive in imported timber came to notice this year. *Zootermopsis angusticollis* was in some North American soft wood and *Kalotermeis jouteli* was found in considerable quantity in Lignum Vitae from Santo Domingo. Flourishing laboratory cultures of the last named have been established.

187. Mr. Sands has completed his account of the East African representatives of the sub-family Nasutitermitinae, together with a study of the soldier mandibles of the sub-family as a whole. Mr. Wilkinson is engaged on the systematics of the East African Kalotermitidae.

188. Information has been obtained on the relationship between species of *Cubitermes* and soils of different kinds, inter-relations with ants and other termites, and by means of laboratory colonies observations have been made on feeding methods and life-history.

189. Mr. Harris visited Sierra Leone, Gold Coast and the three regions of Nigeria.

Economic

190. A field test of polyvinylchloride (P.V.C.) sheet carried out in Kenya showed that this substance had no apparent influence on the termites attacking wood, and was certainly no deterrent.

Publications

W. V. HARRIS—The Prevention of Termite Damage to Buildings. *Colonial Building Notes*, No. 26.

P. B. KEMP—Termites of North-Eastern Tanganyika. *Bull. Ent. Res.*, **46**, (1955) 113.

W. V. HARRIS—Termites and Forestry. *Emp. For. Rev.*, **34**, (1955) 160–166.

W. V. HARRIS—Termites and the Soil, in *Soil Zoology*: London. *Butterworths*, pp. 62–72.

W. V. HARRIS—American Termites in Imported Timber (in the press).

W. V. HARRIS—Termites in and around Aden. *Port of Aden Annual, 1955–56*.

W. A. SANDS—A new species of *Mineutermes* from the Gold Coast. *Proc. R. Ent. Soc.*

W. A. SANDS—Some factors affecting the survival of *Odontotermes badius*. *Insectes Sociaux*.

W. V. HARRIS—Termite Mound Building. *Rept. II Cong. Int. Union Study of Social Insects*.

W. V. HARRIS—Isoptera of the Danish Expedition to the French Cameroons. *Bull. de l'IFAN*.

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

191. A steady flow of enquiries has come from the Colonies, over 1,000 having been answered by the Colonial Liaison Group of the Pest Infestation Laboratory, Department of Scientific and Industrial Research. The third annual meeting of the West African Stored Products Research Unit Reviewing Committee was held in January, 1956, in Lagos and the Colonial Office was represented by Dr. W. F. Jepson, a member of the Stored Products Research Sub-Committee. Mr. D. W. Hall, Colonial Liaison Officer, also attended this meeting.

192. Insect infestation of West African cocoa has assumed greater economic importance and full-scale practical control schemes have been drawn up for Nigeria and the Gold Coast. The Pest Infestation Laboratory is collaborating with the Cocoa Scientific Advisory Committee of the Cocoa, Chocolate and Confectionery Alliance, the Gold Coast and Nigerian authorities, and the Colonial Products Laboratory in carrying out experiments to determine the toxicity and taint hazards when bagged cocoa is treated with DDT and lindane insecticides in certain prescribed manners.

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193. At the request of the East Africa High Commission, Mr. T. A. Oxley, of the Pest Infestation Laboratory, visited Uganda and Kenya to advise on the erection of additional storage for maize in Uganda and suitable for wheat in Kenya. Whilst in East Africa Mr. Oxley paid a very short visit to Tanganyika to see the experimental underground pit at Morogoro which had recently been opened.

194. A large silo in Southern Rhodesia, has had each bin fitted to enable disinfection to be carried out by circulatory fumigation. At the opening of this silo, Mr. W. Burns Brown and Mr. H. K. Heseltine, of the Pest Infestation Laboratory, were present to undertake the initial trials with the circulatory fumigation plant. Mr. Burns Brown also visited Northern Rhodesia at the request of the Maize Control Board to advise on circulatory fumigation plants for two silos at Lusaka and Monze.

195. Mr. A. A. Green, of the Pest Infestation Laboratory, has paid a return visit of one month's duration to the Gambia to determine the degree of control being achieved in practice with the control measures recommended on his previous visit.

196. The results from a number of territories of storing dry grain, i.e. with a moisture content below 13 per cent., in experimental pits have shown this method to be entirely satisfactory for tropical conditions provided care is taken locally to choose the site properly and to construct the floor, walls etc. in such a way as to render them impervious to gases and to water vapour. Difficulties in Tanganyika and other territories with commercial sized pits are being investigated in collaboration with the D.S.I.R. Building Research Colonial Liaison Section.

197. The effect of insect attack on the chemical composition of maize and groundnuts is being investigated in collaboration with the Colonial Products Laboratory. This has shown that heavy insect infestation increases the acidity of these products, especially the fat acidity, and reduces the amount of protein, oil and carbohydrate present.

198. A quick, simple method of determining the moisture content of a bag of produce, without removing a sample from the bag, has been developed at the Pest Infestation Laboratory, specially for Colonial needs. This moisture tester, known as the Scotmec-Oxley meter, is now available commercially.

Publications

D. W. HALL—Stored Product Problems in British Guiana (Colonial Office).

D. W. HALL—Report on Food Storage in Gold Coast (Colonial Office).

D. W. HALL—Report on Food Storage in East Africa (Colonial Office).

D. W. HALL—The Quality of Gambian Groundnuts 1954-55 (Report).

D. W. HALL—Problems of Food Storage in Tropical Territories. *Ann. Appl. Biol.*, **42**, (1955) 85.

R. W. HOWE and J. A. FREEMAN—Insect Infestation of West African Produce imported into Britain. *Bull. Ent. Res.*, **46**, (1955) 643.

T. A. OXLEY—Grain Storage in Tropical Climates. *World Crops*, **7**, (1956) 473.

E. A. PARKIN—The Insecticidal effect of Nigerian Diatomite. *Colon. Pl. Anim. Prod.* 1956.

E. A. PARKIN and G. T. BILLS—Insecticidal Dusts for the Protection of Stored Peas and Beans against Bruchid Infestation. *Bull. Ent. Res.*, **46**, (1955) 625.

E. A. PARKIN—A Comparison of Chemical and Biological Assays of three Samples of Pyrethrum Flowers from Tanganyika. *Pyrethrum Post*, 3, (1955) 18.

E. A. PARKIN—Stored Product Entomology. The Assessment and Reduction of Losses Caused by Insects to Stored Foodstuffs. *Ann. Rev. Ent.*, 1955.

W. O. STEEL and R. W. HOWE—A new Species of *Cryptolestes* (Coleoptera : Cucujidae) Associated with Stored Products in Africa. *Proc. R. Ent. Soc. Lond. B*, 24, (1955) 117.

Studentships

199. Fourteen Colonial Research Studentships tenable for from one to two years were awarded, covering training in Agriculture (4), Soil Science (4), Veterinary (2), and Stored Products Entomology (4). One Colonial Research Fellowship for work on nematodes in East Africa was awarded.

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

BARBADOS

Agronomy and Agricultural Chemistry

200. The programme of field research is, at present, being undertaken jointly by the Agricultural Chemist and the Agronomist. The following experiments have been completed or are in progress :—

201. Results of trials to test the effect of differing intensities of subsoil cultivation suggest that on the lighter calcareous soils little benefit results from more intensive cultivation. Modifications of current planting practice on the camber bed system of cultivation for heavy Group IV soils indicate that furrowing or cane-holing on the camber bed exercised slight but non-significant beneficial effects upon yield.

202. Early results of bagasse application indicate positive yield increments. There were indications that these effects were independent of any mulch effect or of the manner in which the bagasse was applied to the soil. A trial on sweet potatoes has shown over 100 per cent. increase in yield by using furrows as opposed to the current practice of planting in "cane holes" on heavy black clay soils.

Irrigation

203. A comprehensive scheme of drilling has been carried out in St. Lucy and will be extended to all appropriate areas in Barbados. As a result of this work, elevated sheet water basins have been found and tested in St. Lucy, St. Peter, and Sweet Vale, St. George. The establishment of the three pilot irrigation areas at the Hope, Pine and Sandy Hill has opened up an entirely new field of agronomic research. During 1955, the mean evapo-transpiration per day has been calculated from meteorological data using Penman's formulae. This data will be used in controlling irrigation applications. Growth measurements have been found to be a valuable guide in assisting irrigation control. The maintenance of growth measurement stations at the irrigation centres is an important aspect of the experimental programme undertaken during 1955 and this work will be expanded in 1956 if staff permits. Experiments to determine the effects of closer spacing, earlier planting, variations in fertilizer practice and early versus late reaping on irrigated cane have all either been established or are scheduled for establishment.

BECHUANALAND

Fertilizer and Manurial Trials

204. A critical analysis of data obtained from fertilizer and manurial trials conducted in the Southern Protectorate have enabled general recommendations based on these results to be made for the area. The trials have been discontinued but co-operative experiments to supplement the available information are being conducted throughout the area. No significant results have been obtained from trials conducted at Mahalapye on soils derived from old granite and gneiss except in wet seasons when there is a significant response to nitrogenous top dressings.

Agronomic Investigations

205. Spacement trials with maize, sorghum and cowpea were continued and, during the present season, these have been combined with variety trials in split plots designed so that interactions between varieties and spacings can be determined. Promising local and introduced varieties of both grain and fodder varieties of cowpeas were tested. Several homozygous lines of pearl millet have been fixed but further pure lines are required. Further introductions of grain and sweet sorghums have been made following damage by aphids and fungus diseases to the varieties already available. Systemic insecticides were very effective in controlling aphids on sorghums.

Pasture Research

206. The long-term grazing experiments to determine optimum carrying capacity of natural pastures and to test out different systems of grazing were continued. A trial to determine the effect on carrying capacity of veld following almost complete debushing was commenced. Preliminary results indicate that a very considerable increase in carrying capacity can be achieved. A sampling technique to provide data on the comparative changes in sward composition has been evolved. Good results have been obtained in the propagation of *Eragrostis curvula* from seed and *Panicum maximum* var. *makarikariensis* from roots.

BERMUDA

Biological Control of Insect Pests

207. Biological control work during 1955 was centred on the two scale insects attacking local oleanders, the oleander scale, *Pseudalacaspis pentagona* and the green shield scale, *Pulvinaria psidii*. Dr. F. J. Simmonds, of the Commonwealth Institute of Biological Control, paid three visits to Bermuda to investigate the position of these two scale insects with regard to their natural enemies.

1. *Oleander Scale : Pseudalacaspis pentagona*. Two factors may have affected the abundance of this scale in recent years. (1) The possible alteration of microclimate of oleander bushes brought about by the elimination of the junipers. (2) The gradual spread of the Argentine ant, *Iridomyrmex humilis*, may have affected the population by reduction of parasites of the scale. Data on seasonal variation in the incidence of oleander scale indicates that it increases in the summer and decreases towards November, this variation following closely the changes in parasitism by *Aphytis* sp., *Aspidiotiphagus lounsburyi* and *A. citrinus*. Lady-birds are unimportant in checking oleander scale. Sowbugs, millipedes and particularly cockroaches, *Periplaneta* spp. destroy a number of scales at night; the mites, *Hemisarcoptes mali* and *Tydux* sp. destroy a limited number of scales locally, and the mite *Pediculoides ventricosus* attacks a seasonally variable number of large larvae and pupae of the parasite *Aphytis* sp. The scale does not appear to be generally on the

increase in Argentine ant-free areas, but where the Argentine ant is present—and the distribution of this pest has now been mapped and its spread watched—the oleander scale position is more complicated. In heavy infestations the ant appears to effect a considerable lowering of parasitism, possibly by mechanical and incidental interference with ovipositing female *Aphytis*, and may prevent the decline of an infestation once it has built up. It seems that where there are severe infestations in areas where Argentine ant is present, elimination of the latter by means of insecticides produces a subsequent diminution of oleander scale.

2. *Pulvinaria psidii*. In 1954, a parasite *Microterys kotinskyi* was successfully introduced, and appeared in April, 1955, to be most promising. However, a secondary parasite, *Cheiloneuris* sp., attacks *Microterys* and from investigations made this year, would seem to be preventing *Microterys* from exerting control of the green shield scale. No other parasite is at present of any importance against this scale in Bermuda. The Lady-bird, *Cryptolaemus montrouseri*, was again liberated in Bermuda—this time against *Pulvinaria*, and became initially successfully established. However, it seemed obvious that something was destroying the adults, and experiments showed that the tree lizards *Anolis* spp. were partly responsible, and may be the reason for the failure of other species of Coccinellids to become established in Bermuda.

Propagation of Citrus

208. There has always been great difficulty in successfully budding citrus in Bermuda. In 1955 a budding technique was perfected which proved most satisfactory, resulting in a high percentage of successes. A rectangular bud was used from which the wood was removed. This bud was then inserted into an "I" slit in the stock. A series of tests carried out have indicated that July and August are the best months in which to bud citrus in Bermuda. Prior to the perfecting of this budding technique, it was almost impossible to induce more than 20 per cent. of the budded citrus to develop. Figures for 1955 showed that 80 to 90 per cent. successes were not uncommon in many varieties, while the average for all varieties attempted was approximately 60 per cent.

Weed Control

209. CMU proved to be by far the best general weed killer for use in lily fields. Tolerance tests indicated that lilies were unaffected by CMU at rates up to five pounds to the acre, applied either as a pre- or post-emergence treatment. Recommendations can now be made to farmers with complete certainty as to the safety of various materials and the degree of weed control which can be expected. Nearly all the major lily growers in the Colony treated their fields with pre-emergence spray of CMU, using 2½ lb. of the active material to the acre. This treatment resulted in the virtual elimination of all weeds (wild onion, *Nothoscordum fragrans* and *Oxalis* spp. being the exceptions) for a period of at least three months.

210. Investigations into the control of *Oxalis* spp. and wild onion, *Nothoscordum fragrans*, two very persistent weeds, were carried out by Mr. A. G. Dustan. Such non-selective herbicides as CMU, Ammate, 2, 4-D ester and Kuron were tested. Prime interest is in ridding an area of these troublesome weeds even if it means sterilizing the soil for a year or two. Kuron has given encouraging results.

Iron Chlorosis of Lilies

211. Iron sequestrane was found to be very effective in correcting yellowing in lilies when used as a soil application at the rate of 30–40 lb./acre. Solutions of sequestrane were found to be quicker acting than the soil treatments, but

sequestrane applied as a spray at the rate of 10-30 lb./acre, caused some burning to lily foliage. Sprays at rates of 5 lb./acre gave little or no burning and corrected yellowed lilies in 3-4 weeks.

Control of Mites on Lily Bulbs

212. The bulb mite, *Rhizoglyphus solani*, is commonly found in association with the Easter lily bulbs. Fumigation with naphthalene and methyl bromide were tested in different strengths in addition to dips containing malathion, Dow 645, Demite, Ovatron and mercuric chloride. Fumigation with methyl bromide and dipping in mercuric chloride gave the most promising results.

BRITISH GUIANA

Central Agricultural Station

213. The 1,000-acre property of Mon Repos on the East Coast, Demerara was purchased for the development of the Central Agricultural Station. Central laboratories will be built. Crop and fertilizer trials, rice breeding, crop rotation experiments, etc. are planned for the station.

Sugar Cane

214. The three diseases, Leaf Scald, Chlorotic Streak and Ratoon Stunting, received attention. Routine resistance testing was carried out on new varieties and a field resistance technique developed, to assess spread by cutlasses and rats. Chlorotic Streak is of widespread occurrence, but the heat treatment for control gave initial difficulties. A survey of the occurrence of Ratoon Stunting was carried out. There is some doubt as to its existence in the colony.

215. Variety trials of canes from Barbados and the raising of seedlings from "fuzz" continued. Data from first ratoon reapings of B.47258 and B.47225 which gave promise of becoming commercial canes in the plant cane trials, showed that B.47258 ratooned satisfactorily, but B.47225 did not maintain its promise. B.45137 and B.43413 have been recommended for moderate trial on a commercial scale. Foliar diagnosis for determining the nutrient requirements of sugar cane under local conditions has been adopted by the industry for guiding fertilizer practices.

Rice

216. Three locally bred families suited to mechanisation have been developed to F₂ and hopes are high that a non-lodging variety with yield superior to the local lodging types will soon be available for use. Raised fertilized nurseries for rice seedlings were found to be less suitable than wet nurseries for local varieties and conditions. A survey of rice borers in one area showed an overall 6-7 per cent. of bored stems. The main species concerned were *Rupela albinella* Cram. and *Diatraea saccharalis* F.

Coconuts

217. Trials confirm that nicotine sprays around the heart of palms were effective in controlling *Castnia daedalus* Cram.

Forestry

218. A successful nursery technique was evolved for raising seedlings and transplants of *Pinus caribaea*. The small experimental plantations of this species established on brown sandy soil in 1954 and 1955 indicate that growth is likely to be moderately fast. At the end of 1955 a small plot was established on white sand.

BRITISH HONDURAS

Agriculture

219. The factor which influenced the whole pattern of agricultural work for 1955 was the prolonged drought during which only 15½ inches of rain fell in the first six months. The 19·81 inches of rain for July was the heaviest monthly total recorded at Central Farm since 1949 and the resultant floods added to the farmer's worries. The Hurricane "Janet" on the night of September 27th was responsible for heavy crop losses throughout the Northern, Central and Western Districts.

Livestock

220. A poultry feeding trial to assess the corn-sparing effect of liver-meal was completed. The birds were average local stock of mixed origin and 20 per cent. of pullets were included after the first 15 weeks. For every 100 birds, by replacing 1,387 lb. of corn per annum with 188 lb. of 72 per cent. liver-meal, the saving in feed cost was \$18 (14 per cent. of the corn-group feed cost), egg production was increased 44·5 per cent. and the feed cost per egg was lowered from 2·79c. to 1·70c. The liver-meal eggs were significantly heavier. The saving in corn represents a 22-month ration for a person in an area where corn land is being lost to sugar-cane.

221. A feeding trial involving 18 local cross-bred pigs in two groups was carried out for 14 weeks to assess the effect on growth rates and feed economy of a supplement of 2 oz. per head daily of liver-meal to a corn-roots-greens-banana ration. Results show a weekly live weight increase of 4·41 lb. for the group receiving liver-meal compared with 2·56 lb. for the control group.

222. A trial on young coconuts growing on the notoriously infertile Consejo soil showed significant ($P = 0\cdot01$) growth increase to phosphate with potash after 18 months and two fertilizer applications. Laboratory analysis of these soils had previously shown a very high chemically-available potash content, but in this present trial there was no response to phosphate without potash. Thus the infertility of these soils may well be due to interference with major nutrient uptake by excess free calcium, and not to boron toxicity as was formerly believed from leaf analyses. A further 12 months study of coconuts at Paraiso has shown that mulching alone was as effective as a complete fertilizer treatment, and considerably more economic.

223. Ramie (*Boehmeria nivea*) ceased to be a fibre crop of interest to the Colony after the C.D.C. closed its project. Selections of the material held by the C.D.C. were transferred to Central Farm and kept for observation as a likely source of protein-rich pig and cattle feed. One variety of U.S. origin—Rosario—has proved to have a much higher leaf/stem ratio than any of the other 14 varieties and is being bulked. Hairiness of the leaves is important from a stock feed point of view and seems to be correlated inversely with palatability. Several varieties of American Upland Cotton were planted in isolation plots in 1954 and harvested in February 1955. Yields of seed cotton were very high, averaging 1,500 lb./acre and quality was good. Some aphids in the early stages and stainers were the only insect pests noted, and boll weevil was absent. Spinning samples were sent to U.K. for a trade report and the bulk of the crop was saw-ginned and sold locally. The variety C50/20 proved most promising.

224. Pangola grass (*Digitaria decumbens*) from Jamaica has done very well and promises to be a rapid-growing dry season feed, but difficult to establish from sprigs in the wet season when most grasses are established. Jaragua grass (*Hyparrhenia rufa*) was successfully established from seed at 20 lb./acre on newly cleared bush-land and the seed is easily gathered. The indigenous sweet

grass (*Ixophorus unisetus*) was found to give good cover with as little as 9 lb./acre broadcast with phosphate. This is a good forage, the seed of which has no resting period and local belief that it is cyanogenetic proved unfounded with both young calves and pigs. Its low fibre content makes it an excellent source of greens for pigs and poultry.

225. A detailed soil survey of 3,500 acres was completed and blocks for small-holders sited on the basis of the land capability map. Semi-detailed survey of 4,000 acres led to demarcation of cocoa land in a hilly area of erodible granitic soils. A survey of 1,000 acres of river terraces showed that there was no correlation between poor drainage and the incidence of a die-back disorder in grapefruit.

Forestry

226. A trial plot of Balsa (*Ochroma lagopus* Sw.) was established in cleared and burnt hardwood forest in Silkgrass Forest Reserve near Stann Creek in June. By November a dense crop of balsa saplings 10-12 feet high had resulted. This was taller and more even than the plentiful natural regeneration of balsa in adjoining mahogany plantations formed at the same time.

227. In February an acre of dense natural regeneration of Pine (*Pinus caribaea* Morelet) on the Mountain Pine Ridge was early burnt. The early burning successfully removed the inflammable dry grass and 95 per cent. of the pine trees quickly recovered. In May an accidental fire swept through this area. The previously unburnt control plot and the well-stocked surrounding area suffered very heavy mortality of young pine in places. But the early burnt plot, through which this accidental late fire also passed, showed 95 per cent. survival.

228. The rosin produced from distillation of the two-ton sample of pine oleo-resin sent to the United Kingdom for test in 1954 was very dark in colour, owing to contact with rusty iron collecting tins and containers. A small sample was obtained in 1955, using glass collecting cups and containers and sent to the Colonial Products Laboratory. This oleo-resin was of good colour and the Laboratory has given a preliminary favourable report on the quality both of the rosin and turpentine produced from it. No sound conclusions about the economics of resin-tapping in British Honduras can yet be drawn from work done so far. Distillation tests on pine sawdust, sawmill waste and sample logs showed that the yields of oil and rosin from these materials were negligible.

CYPRUS

229. Wheats introduced from Australia, Kenya and South Africa have shown promising results. In dry years a low seed rate of 50 lb./acre has given the best results. The most prevalent race of stem rust was 14 but races 17, 24, 53 and 117 were also present. Trials have shown that safflower can give satisfactory yields in Cyprus and has considerable drought resistance.

Plant Protection

230. In large scale experiments in the control of Mediterranean Fruit Fly (*Ceratitis capitata* Wied.) on citrus excellent control was obtained with one spray of 0.1 per cent. dieldrin during early October. Against Olive Fly (*Dacus oleae* Rossi) trials with parathion in various concentrations applied at different stages of fruit development gave satisfactory control in some cases. Cereal Leaf Minor (*Syringopais temperatella* Led.) was well controlled with one application of 1.5 per cent. parathion dust at $7\frac{1}{2}$ lb./acre.

Pasture Improvement

231. New methods of pasture establishment to avoid competition between perennial and annual species were successful. Several new species of perennial

grasses having a different time of availability from those now in use were sufficiently promising to justify field-scale trials. Three year old stands of grass/legume mixtures sown on cultivated soil cleared from bush are looking well.

Livestock

232. In a pig fattening trial the conversion ration with an animal protein ration was 1 : 3.72. With a vegetable protein ration plus penicillin supplement the conversion ration was 1 : 3.68. Investigational work continued on Newcastle Disease vaccine, coccidiosis in goats and on *Oestrus ovis* in sheep and goats.

Forestry

233. In the semi-arid lowlands extensive species trials were laid down in the search for suitable exotics to plant, particularly on the poorer sites available to the peasant farmer. Many new species have been introduced chiefly of *Eucalyptus* and *Acacia*. In the coniferous natural forests of the mountains, two lines of approach to the problems of regeneration have been followed: the observation of the incidence and survival of natural seedlings throughout the year, and of the seedlings arising from artificial sowings under different site treatments.

234. The survey of the forest insects was completed and a provisional report submitted by the Forest Entomologist, Dr. R. N. Chrystal. Further studies on his more important findings have followed, particularly on the life-cycles of the *Eucalyptus* and Cypress Borers, the Cedar seed-fly and the cone-moth, and the natural control of Bark Beetle populations by *Crypturgus*.

235. In the field of Forest Ecology, Mrs. E. Chapman completed her phyto-geographical survey of the forest vegetation of Cyprus and submitted a report. The grazing and fodder investigations resulted in a promising interim report on the feeding value to livestock of the seeds of *Acacia cyanophylla*.

236. At the new Forest Utilization Centre, Morphou, a small-scale experiment on the control of sap-stain in coniferous timber indicated that air-drying of box-shooks in a special rack for a period of 72–96 hours might eliminate “blue-stain” as effectively as chemical treatment.

237. Climate studies were extended by another Forest Meteorological Station and the further use of Piche evaporimeters on field experiments. The Fire Hazard system was modified by last year's experience to give a more accurate warning of forest fire danger to the public by daily radio broadcasts throughout the summer.

Publications

E. CHAPMAN.—A phyto-geographical Survey of the Forest Vegetation of Cyprus. 1953–1955 (Report).

R. N. CHRYSAL.—Provisional Report on a Survey of the Insect Fauna of the Cyprus Forests and Plantations. 1954–1955 (Report).

J. V. THIRGOOD.—A note on the testing of Eucalyptus Seed (*Emp. For. Rev.*—in press).

FIJI

Plant Introduction

238. In Fiji, during the year, 494 introductions were made including several valuable collections of cocoa, black pepper, arabian coffee and a number of grasses, legumes and fruit trees new to the region. Distributions of economic species were made to all the associated territories. The station is collaborating with research workers in several directions: Dr. R. Cooper's collection of

Pacific edible aroids has been established at Nadurololou, and nucleus plantings of all cocoa clones have been established for observation and propagation locally. Valuable collections of local food plants have been assembled.

Animal Husbandry

239. The animal husbandry work has made marked progress. Reports on pig and goat husbandry, fish-pond culture and pasture improvement have been published locally and overseas. The further study of dairy cattle management in the tropics is temporarily postponed pending the arrival from New Zealand of identical twin heifers.

Crop Research

240. Research has been concerned with rotation trials for bananas and sugar cane, rice and other food crop variety trials, and fertilizer trials for banana, rice, pastures and root crops. Recently introduced rice varieties from Malaya have proved superior and distribution to growers is in hand.

Entomology

241. Local investigations on the control of the coconut beetle, *Oryctes rhinoceros*, have been continued. By arrangement with the Commonwealth Institute of Biological Control, large importations of predatory beetles of the families *Histeridae* and *Elateridae* were made from Trinidad. More than 9,000 *Leionota* spp. and 2,700 *Pyrophorus* spp. were liberated. The successful introduction from Hawaii of the fruit fly parasite, *Opius oophilus*, was confirmed. Breeding and liberation of the moth, *Blepharomastix acutangulalis*, a leaf roller which defoliates the weed *Lantana*, continued throughout the year. Six hundred adults and 2,000 larvae of this moth and small numbers of adults and larvae of a second moth, *Diastema tigris*, were liberated. Cockroaches parasitized by the wasp, *Ampulex compressa*, were imported from Hawaii. Arrangements were completed for a search to be made in Papua-New Guinea by an experienced entomologist for parasites of *Nacoleia octasema*, the scab moth pest of bananas. Further attention has been given to the egg parasites (*Paranastatus* spp.) of the coconut stick insect (*Graeffea crouanii*) and two trials for control of rats by means of aluminium strip bands were undertaken. A number of different predatory and parasitic species were sent overseas to assist biological control measures and 107 species of insects were collected for the Commonwealth Institute of Entomology.

Chemistry

242. Field work of the soil survey has been completed for Vanua Levu and a final report for all Fiji, complete with maps, is being prepared. Major soil types have been assessed for their power to fix phosphate. The conditions necessary for increasing the present low production of paddy soils have been defined.

243. Laboratory-scale fermentation of cocoa beans is assisting in the selection of good quality planting material. Cocoa is also being studied in the field on acid and phosphate-deficient hill soils: so far lime and superphosphate have not increased growth rate.

244. Work is being continued with copra drying research, with particular reference to conditions of high temperature and artificially elevated humidity. Analyses of copra have been undertaken as part of an experiment to determine the amount of deterioration in various grades of copra when stored and shipped overseas.

GAMBIA*Groundnuts*

245. The investigations undertaken by kind arrangement with the Director of the Pest Infestation Laboratory of the D.S.I.R. were continued when Mr. A. A. Green paid a second visit to the Gambia in March, 1956. The degree of damage caused by insects to stored groundnuts in the Gambia can reach very serious proportions. Infestation of unshelled groundnuts (of which there are between 6-7,000 tons annually stored for seed purposes) by *Caryedon fuscus* can be reduced to a negligible level by the application of suitable insecticides (5 per cent. DDT or 1 per cent. Lindane) within the prescribed health limitations. The major damage to decorticated nuts by *Tribolium castaneum* can best be prevented by rapid shipment following decortication. As a result of this work Government is to consider the introduction of legislation.

Veterinary Research

246. The percentage of reactors to the agglutination test for brucellosis has been much higher than expected. Tuberculin testing of local herds has produced a number of non-specific reactors but no positive reactors to mammalian tuberculin.

GOLD COAST*Entomology*

247. The success of the 1954-55 extension trials for control of borer in late maize justified the expansion of control measures as a Departmental project. A thousand acres were dusted in 1955, the Division of Entomology acting in a supervisory capacity. In other borer studies, evidence has been obtained of resistance to attack by *Sesamia botanophaga* Tams and Bowden, in two American lines imported by the West African Maize Research Unit. Investigations into the biology and control of borers in the Savannah areas of the North have been intensified. The species concerned are *Sesamia poephaga* Tams and Bowden and *Busseola fusca* Fuller, in Sorghum, and *Coniesta ignefusalia* Hampson and *Heliothis* sp. in Pennisetum millets. The most fruitful line of investigation appears at present to be that into the aestivation habits of the various species in relation to different crops and localities.

248. Work on Sorghum midge, *Contarinia sorghicola*, has been largely confined to infestation assessment in varietal trials. There is some evidence of resistance in varieties other than the Nunaba type.

249. An extensive programme of work on cocoa capsids has been initiated. The most important findings are that the fan is the major breeding site, that oviposition sites are definitely connected with feeding sites, and that over 90 per cent. of all eggs are laid at levels below about 16 feet, whether on fan tissue or chupons. Studies of the relation of alternate hosts and capsids are under way. In this connection it is of interest that *Distantiella theobroma* has been recorded from *Ceiba* sp. from localities well within the northern Savannah zone.

250. Maize which was harvested in July (rainy season) with a heavy infestation of *Calandra oryzae* and several species of Tenebionids, was machine-shelled, dried on an in-sack drier, treated with lindane BHC (0.45 per cent. gamma) at the rate of 1 oz./cwt., and stored in plywood silos for a period of three months. Although the results obtained were excellent, the capital costs for expanding such a project are high and thus make extension work difficult. Preliminary trials on dusting cob maize in farmers' cribs with 0.45 per cent. gamma BHC (lindane) against *Calandra oryzae*, *Tribolium castaneum*, *T. confusum*, *Gnathocerus maxillosus*, *Palorus* sp. and *Carthartus quadricollis* have given promising results and further trials are being laid down.

251. Dusting the heart leaves of 5 year old coconut palms with 0.65 per cent. BHC at 14 day intervals gave little control of attack by Rhinoceros beetle (*Oryctes monoceros*). Scoring based on the number of leaves showing beetle damage showed only a slight reduction in the treated over control palms after 17 months treatment.

Plant Breeding

252. Maize breeding and selection work for resistance to rust attack (*P. polysora*) combined with high yields has been continued on material provided by the West African Maize Research Unit. Further observations and selections have been made both on tall and dwarf sorghums. The objectives include high yielding dwarfs which can be mechanically harvested and are palatable, and high yielding tall suitable for peasant production. A high degree of disease and pest resistance is also aimed at.

Plant Pathology

253. Investigations into Black Pod disease in Cocoa (*Phytophthora palmivora*) are proceeding to determine whether one or various strains of this fungus are present. Further attempts to determine the causes of the disease known as Bronze Leaf Wilt of coconut palms grown in the coastal area have been unsuccessful. No likely pathogen has yet been isolated and all attempts to transmit the disease artificially have failed. Trials involving the use of fertilizers, farm yard manure, trace elements and various cultural practices gave no control. Salinity readings of the ground water measured as total chlorides showed palms to be thriving in water containing as much as 12,000 p.p.m. and revealed that the disease was epidemic in areas of both high and low salinity.

254. Experiments on Lime dieback have not yet shown whether the *Fusarium* isolated from dying seedling limes in the nurseries is pathogenic, or that the "little leaf" symptom can be transmitted by grafting. The Mealy bug *Ferrisia virgata* was shown not to be an efficient vector of the disease.

255. Preliminary trials using various seed dressings on rice, groundnuts and maize showed that significant germination increases resulted from these, though there was little variation in effect between the various seed dressings themselves. A collection of Gold Coast plant diseases is well under way and of some new diseases recorded it is of interest to note the appearance of *Cercospora musae*, Banana leaf spot.

Crop Husbandry

256. The programme of fertilizer field trials continued to be a large one. Nearly every agricultural station in the country has a permanent 2⁵ factorial trial which measures the responses to N, P, K, lime and organic manures under conditions of continuous cropping. In general N and P have had the best effects for the first few years, while later organic manures and potash tend to become more important. Ten half replicate 2⁶ trials were started this year to measure the responses of food crops to the trace elements boron, copper, zinc, manganese, iron and magnesium. Twenty simple observational trials were also laid down using the same elements on indicator crops of cauliflower and tomato. The trials are not yet completed, but the indications are that there will be no significant responses to trace elements.

257. A series of trials comparing different types of N and P fertilizers and various methods of application came to an end this year. Complete results are not yet to hand, but it seems fairly certain that triple superphosphate and single superphosphate are as good as or better than rock phosphate, ammonium phosphate or gypsum, while sulphate of ammonia is probably better than urea,

ammonium nitrate or cyanamide. The time of application of 1 cwt. sulphate of ammonia per acre was not critical provided it was applied to the crop, i.e. with mixed crops, only applications after the harvest of the early crop benefited the late one.

258. Three long-term trials comparing various lengths of grass and pigeon pea fallows and two N.P.K. trials on coconuts were continued. They yielded no outstanding results this year. Extension trials on farmers' land were once again carried out in many parts of the country, and in general they confirmed previous results. One surprise, and an unwelcome one, was the poor showing of triple superphosphate on groundnuts in the North : it appeared to be much less effective than single super.

Irrigation

259. The first crops to be grown on the Kpong Station were planted in March, 1955. In every instance the growth of first season crops was most irregular and the early planted maize a complete failure. The response to phosphorus was striking on all crops. Comprehensive fertilizer trials are planned for 1956.

Cocoa (Field Insecticidal Trials)

260. Field trials continued with a view to ascertaining the minimum rate and frequency of application of gamma BHC which will give satisfactory control of capsids on mature cocoa. Since the peak period of capsid populations, and hence, damage, is experienced in January/February it is not at present possible to report results. Three large-scale spraying trials were started each involving approximately 100 acres of mature cocoa. Each area was completely sprayed twice in successive months followed by 50 yd. wide perimeter spray monthly. The central part of the plots sprayed has remained free from capsid damage for a period of up to five months by the end of the year. Trials involving the use of BHC dusts continued and frequency was reduced to monthly application and in some cases application at $\frac{1}{2}$ oz. gamma BHC/acre (5 lbs. dust). Results are promising.

Soil, Vegetation and Land-Use Surveys

261. The field work of the detailed preliminary regional surveys initiated last year has been completed. These are :

- (i) The Nasia Basin (3,200 sq. miles) in the interior tree savannah overlying Voltaian sediments ;
- (ii) The Togoland Cocoa Region (2,200 sq. miles) in mixed savannah and forest, overlying Akwapimian and Buem formations ;
- (iii) The Lower Tano Basin (2,900 sq. miles) comprising much forest hitherto unexploited for cocoa, overlying Upper Birrimian, Lower Birrimian, Granite, and Appollonian formations.

Survey work in the Ho-Keta Plains Region (2,800 sq. miles) in the coastal tree and grass savannah zone, was initiated at the end of 1955 and is progressing. Special surveys of four agricultural stations have been carried out for the Department of Agriculture and of a Veterinary Station of the Department of Animal Health, where it is hoped shortly to commence systematic studies of methods of improvement of natural grasslands for livestock grazing purposes.

Grassland Ecology

262. The collection of grasses, sedges and associated leguminous and non-leguminous herbs of the savannah and forest zones has continued. Several grass species not previously recorded in the country have been noted and certain unidentified specimens may prove to be new species. The first steps in a general

survey of the different grassland associations of the interior and coastal savannahs have been undertaken and a preliminary map of the associations occurring in the Gold Coast, grouped together under the headings of high, tall, medium and short grassland, has been prepared.

Analytical Investigations

263. *Methods.* The necessity to elaborate methods specially adapted to Gold Coast requirements has recently arisen and efforts have therefore been made to develop rapid and accurate procedures, capable of revealing small differences with accuracy in routine work. The main emphasis was put on cation exchange, and investigations have yielded much valuable fundamental information about the nature of the exchange complex and differential leaching of exchangeable cations in the red and yellow soils of the forest area of the Gold Coast.

264. *Fertility Studies.* An attempt has been made to assess the fertility value of the soils on a statistical basis. Reaction (pH), organic matter, total nitrogen, cation exchange capacity and the amounts of exchangeable Ca, Mg, and K were the variables used, in conjunction with different types of vegetation. The statistical examination has been extended to the study of the decrease of organic matter upon the destruction of the forest, which with regard to subsistence land rotation agriculture, is a matter of prime importance. Attempts are also being made to assess the phosphate status of the forest soils, but none of the methods employed appeared to give significant results. The mechanism of the phosphate supply of the ferruginous forest soils appears to be governed by specific factors hitherto not considered and the amount of total phosphate seems to be much more important than in the soils of the temperate climates.

Publications :

C. F. CHARTER.—The Mechanization of Peasant Agriculture and Maintenance of Soil Fertility with Bush Fallows. Commission for Technical Co-operation in Africa, Conf. on the Mechanization of Agriculture, Entebbe, June, 1955.

C. F. CHARTER.—The nutrient status of Gold Coast forest soils, with special reference to the manuring of cocoa. Cocoa Conf. London, September, 1955.

J. B. WILLS.—The application of the World Land-Use Survey Scheme in the Gold Coast. Internat. Geographical Union Symposium on Natural Resources, Food and Popn. in Inter-Tropical Africa, Kampala, 1955.

Forestry

265. Natural regeneration experiments continued. The Tropical Shelterbelt System is now being used in the Bobiri Reserve on a field scale. Prolific regeneration of desired species including mahogany has been obtained and experiment is now directed to the treatment required by pole-stage regeneration. Elsewhere with this system, regeneration has also been satisfactory, *Entandrophragma utile* proving particularly well suited to the system. In the wetter areas of the southwest, the system has not produced good results even where the stocking of mature mahogany seed-bearers has been good.

266. In experiments of line planting valuable species more drastic opening of the canopy gave better results and this is now being done by poisoning along the lines six months ahead of planting. In order to reduce nursery work experiments in direct spot sowing of *Terminalia ivorensis* were started. Results so far have been only moderately successful.

267. Stratified random sampling of such Forest Reserves as will be opened to controlled utilization was continued, 5 per cent. enumerations being completed in seven of them with a total area of 315 sq. miles. In some types of forest it was found necessary to increase the size of the sample unit to 16 acres (*i.e.* a strip 80 chains by 2 chains) to ensure an adequately representative sample.

268. With the appointment of a Utilization Officer in February 1955, work on a Research Programme was initiated. This includes the collection and publishing of basic information on different species, e.g., their weight, strength and durability, their characteristics, e.g., ease of conversion in sawmills, and veneer mills (particular attention has already been given to the use of stellite-tipped saws for converting the harder timbers), ease of seasoning, and impregnation with preservatives, etc. The chemical analysis of timber and minor forest products has in some cases already been put in hand thanks to the collaboration of the Government Chemist but most of the programme awaits the arrival of machinery and laboratory equipment which will be installed in, or near, the new offices and laboratories at Takoradi. The building is almost complete.

Animal Health

269. It has now been established that Wet Lapinised Rinderpest Vaccine used in the Gold Coast West African Shorthorn is producing a solid immunity in these animals which lasts for at least four years, and is probably for all practical purposes, a life immunity. A study of the pathological changes induced in the rabbit by Lapinised Rinderpest Virus, is being made.

270. Investigation into the incidence and character of *Brucella abortus* infection in the Gold Coast are in hand.

271. The treatment of clinical Haemorrhagic Septicaemia with antibiotics has been studied and cures effected under both field and laboratory conditions.

272. A survey of the incidence of latent trypanosomiasis in sheep and goats is being undertaken and its importance in relation to other reservoirs of trypanosomes is being studied. It has already been established that *Trypanosoma vivax* is harboured by these animals without clinical disease. Simultaneous administration of Dried Goat Rinderpest Virus and Antrycide Prosalt to Zebu and "Sanga" cattle showed no interference with immunity or protection and no undue reaction to joint administration.

273. A trial was made to establish the curative and prophylactic effect of "Berenil" (Amidinophenyl-triazene-diacetate 3H₂O) in Bovis Trypanosomiasis and Babesiosis. A cure was effected in two natural clinical cases of *B. bovis* in three days. A definite Trypanocidal effect against *Trypanosoma vivax* and *T. congolense* at a drug rate of 3.5 mgm./kilogram was established. Prophylactic effect against artificial infection with *T. vivax* and *T. congolense* was not of more than 21 days duration. No toxic effects were observed.

274. A controlled experiment was carried out in pigs using Piperazine adipate and oil of chenopodium in castor oil to compare efficiency of the two as ascaricides. The use of Piperazine adipate produced at least three times the number of ascarides in the faeces as was produced by oil of chenopodium.

275. An investigation was made into the use of Dieldrin Lacquer Spray as an Ascaricide in cattle. It was found that the residual effect of the lacquer was no more prolonged than aqueous sprays.

HONG KONG

Insect Pests

276. Considerable damage to the first rice crop in 1955 was caused by the rice stem borer (*Schoenobius incertellus*). In some areas losses were as high as

30 per cent. Organised control was undertaken by the Department of Agriculture in co-operation with the farmers themselves. A reduction in loss to 10 per cent. was found possible by the application of an endrin spray used in the rice nurseries and later on the growing crop, two or three applications being used.

277. Much damage to cruciferous crops is caused by several species of the flea beetle (*Phyllotreta vitata*). Effective control has been obtained over a number of years by the application of proprietary products containing BHC and DDT but latterly these insecticides would appear to have lost their effectiveness. A parathion product has given very good results but owing to its dangerous nature its use has had to be discontinued except under strict control. The best results now seem to be obtained with an endrin spray, 1 in 300, to which has been added a copper fungicide, the latter having some repellent effect. This treatment is widely used. Chlorthion 1: 600 and malathion 1: 500 have also been used against flea beetle with good effect.

Livestock

278. With the recent establishment of a diagnostic laboratory at the main agricultural station, a survey of disease incidence has been commenced. In the field of disease prevention the main activity has been the implementation of a programme of hatchery inoculation against Newcastle Disease of poultry and Swine Fever using the F Strain virus intranasally on day-old chicks and the Hudson lapinised Swine Fever virus respectively. A marked decrease in the incidence of both diseases is apparent.

JAMAICA

Pasture Development

279. There was intensification of investigational work for the improvement of pasture land and as a consequence of the positive results being obtained, farmers showed more enthusiasm in applying some of these improved methods. The search to find suitable tropical legumes for grass-cum-legume mixtures was continued. Mixtures of *Pueraria phaseoloides* and various strains of *Panicum maximum*, *Melinis minutiflora*, *Digitaria decumbens* and *Cynodon* sp. were established and subjected to grazing, but no definite results have yet been obtained. A number of strains of Lucerne were also tested and indications were that some of these could be intensively cultivated locally. The major problem appeared to be control of weeds in the early stages of establishment, but once this was overcome yields of up to 23 tons per acre per annum of green material have been harvested from eight to ten cuttings.

280. The promise shown by *Digitaria decumbens* (Pangola) as a species suitable to a wide range of conditions was maintained and several more acres were established for commercial grazing. *Cynodon* sp. (Coastal Bermuda) also gave indications of being suitable to low rainfall areas.

Livestock

281. Work on livestock continued to demonstrate that in the tropics it is possible to obtain yields of beef and milk comparable to those obtained in temperate climates. The main factors contributing to this are a high-producing breed adapted to tropical conditions, and development of pastures and their proper utilization. As a dairy breed the Jamaica Hope is now satisfying the first factor, and the 305-day yields of some of the highest producers have averaged over 8,000 lbs. of milk. The best cow gave 18,860 lb.

Agricultural Chemistry

282. The analysis of banana leaves as an index of the nutrition of banana plants indicated that when less than 2.6 per cent. of N was found in the leaf, a response to nitrogen dressings could be expected. For phosphate and potash, results were less precise but indicated threshold values for phosphate of 0.45 per cent. and for potash of 3.3 per cent.

283. The second reaping of a fertilizer and spacing trial with sisal on a shallow limestone soil showed that a yield increase of 4 cwt. of fibre per acre was obtained in 2 years from the annual application of $1\frac{1}{2}$ cwts. of muriate of potash per acre. Phosphate resulted in a slight increase in the fibre content of the leaf.

Bananas

284. Spraying experiments for control of leafspot gave conclusive evidence of the value of Triton as a spreading and wetting agent to increase the efficiency of Bordeaux spraying. Preliminary trials were begun on the possibility of low volume spraying of bananas along the lines which have been successfully applied in Guadeloupe.

Coconuts

285. The research team under Dr. J. Nutman completed its investigations into the "Unknown Disease" or "Lethal Yellowing Disease" of coconuts and a report on the work indicated that the disease might be due to an insect-transmitted virus. It was not considered necessary to carry the investigations any further since such trials would be expensive to maintain and there was a possibility that the results would ultimately be of doubtful value. It was recommended that an intensive search should be made for varieties of coconuts which are immune or highly resistant to the disease, and it seemed that the St. Lucia dwarf variety would come into this category.

Citrus

286. As a result of complaints of blemishes on the fruit, a series of spray trials were initiated. The results show that copper sulphate and lime sulphur gave a 50 per cent. increase in clean fruit when rust mite attack was severe.

287. Investigations were begun to find out whether there is a relationship between factors in the field and "Brown Stem" or "Brown Spot" in the fruit. Normally, this condition becomes evident only after fruit has been reaped and shipped for some time.

Plant Protection

288. Trials with insecticides to control Banana Weevil Borer included Dieldrex 15, Aldrin 40 per cent. wettable powder, Dieldrin 50 per cent. wettable powder and Endrin. The results showed that substantial value is derived from the application of any of the above insecticides but the emulsified form of the concentrate gave superior results.

289. Extensive insecticide trials were conducted for the control of the Fiddler Beetles of citrus, *Prepodes* spp. and *Pachneus* spp. Results suggest that Dieldrin 50 per cent. wettable powder will give a large measure of control up to about a year for seedlings and Dieldrex 15 has a similar value for older trees but the latter insecticide is not safe to use on seedlings owing to the phytotoxic nature of its solvent.

290. Experiments are being conducted to find the insect vector of Chlorotic Streak of Sugar Cane which has become increasingly prevalent on several estates in Jamaica. It is suspected that the cane fly, *Saccharosydne saccharivora* may be the agent.

Publication

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Forestry

291. Exotic conifers have given promise in some areas and trials are being extended. Growth of *Melia composita* have been very good. Under adverse conditions most success has been with species of *Eucalyptus*. For matchwood "Bitter damsel" (*Simaruba glauca*) has been found suitable.

*KENYA**Coffee*

292. Research on tillage and weed control in coffee was begun in 1947 and the results of the first seven years' work were published in two papers in the Empire Journal of Experimental Agriculture in 1954. The modified Rotovator developed as a result of this work has proved highly satisfactory and is now used extensively on estates on the Kikuyu Red Loam soils. Manurial and mulch trials extending over six years have shown that generally no increase in yield is obtained from dressings of farmyard manure or phosphate; some increase is obtained from nitrogen and heavy increases from grass mulching. "Tonic copper spraying", through its fungicidal effect in reducing leaf-fall and die-back, has been shown to increase yields by more than 300 per cent. in some cases. In the early stage of the investigations on Coffee Berry Disease, the fungicide Verdasan shows promise as a possible means of control. In the Chemistry Section work continued on the nitrogen nutrition of coffee and on chemical weed control.

Grassland

293. After five years of plant introduction work, it is becoming apparent that the main species in general use are not very likely to be replaced by entirely new ones though they may eventually be supplemented by a few new species. The genus *Paspalum* seems to be the most promising source of new grass species at present. Among the legumes, 30 varieties of Kenya White Clover (*Trifolium semipilosum*) were scrutinised and from 120 varieties of Lucerne selections were made for productivity and resistance to leaf diseases. Work continued on the evaluation of species and strains for leys and on ley establishment and management. A pilot scheme was started for the production of certified seed of the Nandi strain of *Setaria sphacelata*. The isolation and testing of cultures of indigenous strains of *Rhizobium* was continued. An examination of the factors affecting nodule formation was completed and a series of pot experiments to measure the nitrogen fixed by indigenous legumes was initiated.

Soil Surveys

294. The major effort of the Soil Chemistry section was devoted to soil surveys in connection with irrigation development. Detailed field surveys of 100,000 acres in the Mwea/Tebera and Tana Delta areas were undertaken and 2,000 samples from 700 profiles were analysed in the laboratory. A further 1,800 soil and water samples were analysed in connection with the survey of irrigation potential in the Nyanza Province.

Horticulture

295. Work was concentrated on crops of interest to the developing canning industry. This included spacing and fertiliser trials on pineapples, trials of tomato varieties for *purée* production, variety trials of canning peas and canning tests on youngberries.

Other Research Work

296. With sisal, studies were in progress on planting material, spacing, time of cutting, fertilisers, the use of sisal waste as a manure and the control of "couch" by chemical weedkillers. On pyrethrum, work continued on the selection of high-toxic strains, systems of picking, fertiliser trials and the control of Bud Disease. The wheat breeding programme was continued: a new physiologic race of black stem rust arose and there was a severe and widespread outbreak of stem rust in commercial wheat crops. Hybrid maize breeding has not yet been successful in Kenya but two synthetics have been produced.

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T. R. BROOK.—Soil and Water Conservation. *Coffee Board Monthly Bull.*, **20**, (1955) 65.

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C. C. WEBSTER.—Research Plans. *R.A.S.K. Quart. J. No. 7*, p. 21.

Forestry

Silviculture

297. *Pruning*. Studies of the incremental losses involved in pruning cypress to various fractional heights continued. While a few more years must elapse before completion, there is evidence that the optimum fraction that combines low exposure of tissue with low volume loss is between one-half and two-thirds, the latter being suitable only for first-quality sites. Under low quality crops, slower canopy closure results in excessive ground vegetation competition when trees are pruned much above one-half. An East African interterritorially replicated experiment on pruning seasons was laid down.

298. *Plant Production*. The use of nursery lines and semi-naked rooted plants of exotic softwoods in cooler, high rainfall areas continued successfully. The larger plants are less liable to browsing by buck, an important consideration. Survival is but slightly lower than that of boxed plants.

299. *Chlorophora excelsa*. Two facts emerged from pilot experiments on stump planting of this species. The first confirms findings elsewhere in favour of large stumps, and the second that gall (*Phytolyma lata*) incidence is roughly proportionate to plant height in the first year following planting.

300. The field survey of Cypress Heart Rot has been continued and the data now indicate that *Cupressus lusitanica* types are probably less susceptible to this disease than *C. macrocarpa* types. Overall rot incidence is low, showing a gradual increase with the age of tree. Various nursery studies of damping-off in pines have been continued during the year. Mvule in the Coast region has been found attacked by *Melicobasidium purpureum* in the root, and by a *Cercospora* sp. on the leaves. Observation plots will be laid down to determine the relative susceptibility of *C. macrocarpa* and *C. lusitanica* types to canker on a year-to-year basis.

301. Studies of the life history and control of the Cerambycid timber borer *Oemida gahani* continued. The survey of the importance of ambrosia beetles as timber pests, and investigations of control measures continued. Entomological research is done in conjunction with the Forest Entomologist, E.A.A.F.R.O.

*Veterinary Research**Foot-and-Mouth Disease*

302. Vaccination was practised on a large scale to combat widespread outbreaks of foot-and-mouth disease. Imported Waldmann-Schmidt type vaccine was used against the 'O' and 'A' strains encountered. In the latter part of the year a two-man commission visited institutes in Europe and America and reported on the use of vaccines for control of this disease and on the feasibility of producing vaccine in Kenya.

Newcastle Disease

303. The disease occurred for the first time since 1941, and 44 outbreaks were confirmed in widely separated districts and mostly in small flocks. Research determined that Komarov vaccine would be suitable in Kenya poultry and large amounts of such vaccine were produced but have not yet been used in the field. Survey work has shown that a chronic type of the disease is replacing the acute syndrome.

African Swine Fever

304. Work showed that specific African swine fever antibodies were seldom demonstrable in the blood of convalescent pigs. Attempts to produce an active immunity by various vaccines were also unsuccessful. An asymptomatic infection was established in a warthog by contact with affected domestic pigs. Further contact transmission from the warthog to other warthogs did not occur.

Brucellosis

305. A survey was carried out using the brucella ring test on bulked cream and milk samples at creameries. An overall average of 19 per cent. of samples were positive. Investigation of the proportion of positive tests caused by strain 19 vaccination will give a clearer indication of the colony incidence of this disease.

Johne's Disease

306. Use of the complement fixation test for diagnosis of Johne's disease has yielded encouraging results and attempts are being made to eliminate the disease from several herds using periodical testing to identify reactors.

Hides and Skins

307. Conditions causing lesions on goat skins and resulting leather have been identified and classified. A similar study of hides is in progress.

Mineral Deficiency

308. Chemical analysis of natural pastures and of the blood of grazing cattle has demonstrated widespread moderate aphosphorosis. Extremely low sodium levels and border-line concentrations of copper have also been found in grazing.

Zoology

309. Work on the temporary use of tsetse-infected areas for relief grazing of cattle protected by various drugs was continued. Previous experiments suggested that the degree of prophylaxis afforded by antrycide prosalt might depend upon the "challenge" which the drug had to withstand, i.e. the virulence of the trypanosomes and the frequency of infested bites. As a result, a further series of experiments was conducted in order to ascertain when antrycide resistance would develop under different fly densities and if a more economical method of dosing could be evolved. A thousand native-owned cattle were placed in the Simba district in a low fly density, and treated with antrycide prosalt at two-monthly intervals. A final dose of antrycide methyl sulphate was given before return to the reserve at the end of six months. At the beginning

of the experiment 0·06 per cent. of the animals were infected before the first treatment. No trypanosomes were detected by blood and gland smear examination in any of them at the end of the second and fourth months but by the end of the six-month period, before the final treatment with the methyl sulphate, 0·24 per cent. had become infected.

310. At Makindu 900 native-owned cattle were admitted for six months to an area, the boundary of which was only one mile away from bush, with a *G. pallidipes* density reaching 500 at certain times of the year. These animals were given antrycide prosalt before entry and at two-monthly intervals. At the end of six months they were all treated with ethidium bromide and returned to the reserve. Before the first injection with antrycide prosalt the infection rate in the herd was 0·12 per cent. At the end of two months the infection rate was 0·58 per cent., by the end of the fourth month it was 0·41 per cent., and it reached 2·0 per cent. by the end of the sixth month. Further experiments are now being conducted in a light fly area, using antrycide methyl sulphate at two-monthly intervals, to investigate whether in light fly densities the cost of treatment cannot be reduced by using the methyl sulphate only.

311. Experiments on the use of dieldrin as a spray against tsetse flies have indicated that this insecticide may be more effective in the field than DDT at a similar or even lower cost.

312. Studies on the ecology of *G. austeni* have shown that it can be controlled by merely cutting out the undergrowth until the light intensity and temperatures are so increased that it finds its habitat is no longer congenial and does not deposit pupae. Also it has been demonstrated that in selecting sites for larviposition *G. austeni* favours the densest types of forest and chooses areas where light in the undergrowth is less than 10 per cent. of that outside it.

313. Experiments on testing new dip compounds have been carried out. It has been shown that diazinon is an efficient tick-destroying agent. It is particularly deadly against *Palpobothrius decoloratus*, but is slightly less effective than toxaphane, and its residual effect is not as prolonged as toxaphane.

314. Experiments with arboricides have been carried out in collaboration with the Colonial Insecticide Research Unit using 2,4,5-T on various types of vegetation and on 'sodom apple' (*Solanum iucanum*) in pasture lands but so far with no great success.

Animal Husbandry

315. Upgrading to the Sahiwal was continued at eight of the departmental Breeding Centres. The pure-bred stud was reinforced by the importation of a further three Sahiwal bulls. The small Red Sindhi stud made good progress at the Coast Breeding Centre at Mariakani. A half-bred Masai-X-Sahiwal cow produced the record total of 8,010 lbs. of milk in 295 days at 5·3 per cent. butterfat. Seven other half-bred and three-quarter-bred Sahiwal cows produced milk yields of over 7,000 lbs. in a normal lactation period. Indigenous native cattle are maintained at most Centres. Two cows, half-sisters, have produced milk yields of over 5,000 lbs. at 5·8 per cent. butterfat in a normal lactation period.

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MALAYA

Rice

316. Pure line selection in 13 local varieties, commenced in 1946–47, is approaching completion and improved strains have been released, capable of increasing production by 2,500 tons of milled rice over 17,000 acres in coastal Malacca, and some 3,000 tons over 30,000 acres in Negri Sembilan. Rapidly expanding interest in taking two rice crops a year has led to an intensive search for very short term varieties both among the local varieties and in new hybrid populations.

317. Progenies of 48 *indica* × *japonica* crosses supplied under the International Rice Hybridization Project are now under selection in generations from the F₂ to F₆. These are expected to give rise to useful short term varieties either directly or after backcrossing. Sterility in this material has now largely been eliminated by selection.

318. Lack of fundamental information on the physiology of the rice plant is proving an increasingly serious barrier to progress towards greater production. Studies have therefore been commenced on the physiology and inheritance of photosensitivity, seed dormancy, nutrient uptake in relation to fertilizer application, and the effects of toxic elements and major and minor nutrient deficiencies and excesses on the plant.

319. Work relating to the control of rice stem borers has been intensified with ecological studies in the Krian District of Perak on distribution and fluctuation of borer population and varietal susceptibility. Tests with organo-phosphorus insecticides, though effective, have been terminated owing to their high human toxicity, and with endrin owing to its toxicity to fish. Field trials with DDT, BHC and dieldrin are promising, but the time of application appears to be critical.

Cocoa

320. Selection is proceeding in progenies of eight groups of imported varieties and a number of promising parents have been isolated. An exploratory but comprehensive hybridisation programme has been undertaken using all available varieties with a view to selecting a self-compatible and reasonably homozygous commercial type. As an aid to selection for quality a micro-fermentation process for dealing with the contents of single pods has been devised and satisfactory chocolate samples can now be prepared in the laboratory from locally grown cocoa.

Oil Palm

321. With the promised co-operation of the industry the scope of the breeding programme has been greatly expanded and is aimed at the eventual replacement of the existing Deli *dura* by Deli and Dumpy *tenera* types.

322. Increasing kernel acidity has proved to be primarily an engineering problem as it depends on the rate of heat penetration during bunch sterilisation.

Arising from investigations on bronzing of oil palms, which revealed marked cation antagonisms, a nutritional survey of palms on various soil types by analysis of leaf samples for N, P, K, Ca and Mg has been undertaken.

Pineapple

323. Intra-clonal selection in the varieties Singapore Spanish and Sarawak has revealed genetic variation in vigour, maturation period and vegetative characters but few characters of economic value have appeared. Analytical studies have shown that sugar content and acidity of Singapore Spanish can be raised to the level found in Smooth Cayenne by potash manuring. Similar studies are in progress to relate fruit analyses to quality of resultant juice. The development of "paraffin off-flavour" in the can has been found to be conditioned by prolonged exposure of the cut fruit prior to processing, and the presence of an off-flavour precursor.

Soil investigations

324. During 1955 soil surveys of some 300,000 acres of land have been carried out, half of which was in jungle and half in rice. In 140,000 acres of forest in Trengganu some 70,000 acres suitable for cocoa development have been located; similar areas have been mapped in Pahang. The survey of 150,000 acres of alluvial rice land in Kedah has revealed eight soil associations subdivisible into eighteen series, the classification of which has proved to be closely correlated with the results of chemical analyses and with fertility. Other studies in hand are related to improving methods of determining available potassium, cation exchange capacity and exchangeable acidity in rice soils, particularly in relation to iron toxicity.

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Veterinary Research

325. As in previous years much of the work of the Veterinary Research Institute was concerned with the production of viral and bacterial vaccines for use on local livestock. Ranikhet (Newcastle) disease vaccine was distributed to Singapore (4 million doses) and to other neighbouring territories (1.4 million doses), whilst over 7 million doses were prepared for use in the Federation. An experimental Ranikhet disease vaccine for intranasal inoculation of day-old chicks showed promising results. Research into an emaciation syndrome in local cattle and buffaloes, characterised by marked anaemia, was continued. The specific cause has not yet been determined. Lapinised swine fever vaccine was produced in experimental quantities and conferred a satisfactory immunity in local pigs. The virus of infectious canine hepatitis and pleuro-pneumonia-like organisms from poultry were isolated.

326. Further progress was recorded in the up-grading of local Zebu cattle by using imported Red Sindhi bulls primarily, and a small number of Sahiwal bulls. Over 5,000 crossbred calves have now been bred under the scheme, and their numbers are increasing rapidly. A few half-bred heifers produced their first calves during the year but data on milk yields are insufficient for general comparisons to be made with those of local cows.

327. Breeding of pure-bred Red Sindhi and Sahiwal cattle, of Indian dairy-type Zebu cattle, of Sindhi local cross-bred cattle, and of Indian Murrah and Malayan swamp buffaloes continued at the two Federal Animal Husbandry Stations. Promising results have been obtained by the crossing of imported Indonesian male goats with local goats, and of Malayan buffalo cows with Murrah buffalo bulls. A small sheep-breeding scheme based on imported Dorset Horn rams crossed with local ewes was initiated in Kelantan. A pilot artificial insemination scheme, using Red Sindhi semen, was started for dairymen in the area around the Federal capital, Kuala Lumpur. It is thought that the service will be of advantage to those owners whose herds are too small to justify hiring or purchasing a bull of their own.

Forestry

(See under Forest Research Institute, paragraphs 156 to 163.)

Agriculture

328. Attention has been given to the improvement of grass and to an attempt to treat it as a crop. This is being done both in the well-watered uplands and in the drier coastal areas where sugar-cane cannot be grown. The grasses which at present appear most likely to give useful results are *Setaria* sp. and Molasses-grass (*Melinis minutiflora*). Elephant grass is as promising as *Setaria* in the wet districts.

329. A programme for the development of citrus growing has been initiated, material resistant to *tristeza* being introduced from Trinidad in a determined attempt to create anew an industry for which there is a good market in the Island where at one time citrus was flourishing.

330. The breeding of *Puccinia polysora* resistant varieties of maize continued with some success. Considerable progress has been made towards the production of hybrid maize which will be ready for planting next year.

331. The modification of implements, especially for cutting cultivated grasses and *Leucaena glauca*, has met with a considerable measure of success. Arrangements have been made to train an officer—already a qualified Chemical Engineer—in Agricultural Engineering in the United Kingdom in 1956.

Mauritius Hemp

332. The outstanding development of the year has been the successful operation of a pilot mechanical feeder for the standard raspadors which are in use for the decortication of leaves of *Furcraea*. This is the culmination of many years of trial and error. With it one unskilled operator can feed up to 50 leaves per minute giving ten tons of leaves per working day or a capacity three times greater than that of an ordinary raspador. It has already attracted the attention of fibre producers who are now carrying out a full-scale operational test.

Tea

333. A new seed garden has been established in a more isolated area to prevent cross fertilization. All efforts to obtain seeds of an Assam high yielding strain having failed, recourse was had to the vegetative propagation by layering of plants of that type already existing in Mauritius but in very small quantity. As it is planned to open up and plant 3,000 acres of tea in the scrubby uplands within the next few years, the supply of good strain seed is important and special measures have been taken to tide over the time until 1958-60 when the Colony will be able to provide its own seed in adequate quantities. A survey has been made to select high yielding bushes from imported Nyasaland and Malayan types for vegetative propagation. New hedge-planting of tea bushes has made possible the use of a small Ransome M.G. 6 tractor for interrow cultivation in the early stages of bush development.

Tobacco

334. Planting in soil blocks with a modified John Innes mixture was done on a field scale and resulted in giving the plants a rapid start, a total gain to maturity of about 15 days and a marked reduction in suckering. It was also accompanied by a very small production of seed probably due to the more rapid growth. Overhead irrigation resulted in a full and uniform stand with all the ensuing advantages. Trials with farmyard manure and fertilizer compared with fertilizers only have confirmed, after three years, the view that with the proper type of manure the risk of greater incidence of Black Shank disease was so small as to be negligible.

Pests and Diseases

335. Experiments with chlordane to control the sugar-cane grub, *Clemora smithi*, still popularly known as the *Phytalus*, have given a highly significant reduction of larval infestation. Several consignments of the two new parasites of the cane spotted borer against which parasites have been introduced every year since 1947 were received from the Commonwealth Institute of Biological Control. The Institute has also been of great assistance in forwarding ten consignments of a useful parasite of *Maruca testulalis*, one of the worst pests of the pigeon pea. In view of the menace to the Island's economy which the presence in Madagascar of the Fiji disease of sugar-cane constitutes, an investigation was made of the biology and bionomics of the two principal insect vectors of the disease which exist in Mauritius.

Livestock

336. The vigorous implementation of the long-term policy of improving the "indigenous" breed of milch cattle known as the "Creole", which is descended from and closely related to the Bretonne, has been unavoidably delayed, but milk recording has continued. The most interesting feature of work with cattle during the year has been the carrying out of feeding trials with urea at 2-3 per cent. mixed with molasses (69 per cent.) and coarse bagasse (30 per cent.). This is well tolerated in moderate quantities by both store cattle and the Creole milch cow and when all the results are available may prove of great value in the feeding of the Indian-owned cow.

Publications

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L. A. MOURIA.—The commoner insect pests of orchards, foodcrops, vegetables, flower gardens and households in Mauritius. *Bull. No. 91, Dept. of Agric., Mauritius.*

G. ORIAN.—La maladie de Fidji de la Canne à Sucre. *Rev. Agric. et Sucriere (Mauritius)*, 1, (1955) 28-34.

*NIGERIA—Federal Research**Agriculture*

337. The main efforts of the Federal Department of Agricultural Research have been devoted to the improvement of food crops, particularly with respect to cassava and yams which provide the bulk of the carbohydrate food of Nigeria. Practically all the cassava plants in Nigeria are infected with virus, causing the widespread mosaic disease which is regarded as of major importance in the research programme. This virus disease has been successfully transmitted to healthy seedlings through the white fly vector (*Bemisia* sp.), and also by grafting. Now that techniques for production and germination of cassava seed have been satisfactorily developed, tests for possible resistance can proceed. Yields and quality of yams (*Dioscorea* spp.) are seriously affected in some areas by the yam beetle (*Heteroligus* spp.). It is now known that damage caused by this pest can be considerably reduced by treatment of "seed" yams with BHC dust before planting, but adequate monetary returns could not be demonstrated in all experiments. Further experiments are proceeding with the purpose of developing economic control of yam beetle.

Publications

J. T. DAVEY.—A method of marking isolated adult locusts in large numbers as an aid to the study of their seasonal migrations. *Bull. ent. Res.*, 46, (1956) 797-802.

T. A. RUSSELL.—The Kola of Nigeria and the Cameroons. *Trop. Agric.*, **32**, (1955) 210.

T. A. RUSSELL.—The Kola nut of West Africa. *World Crops*, **7**, (1955) 221.

J. R. G. SUTHERLAND.—Gall Midges infesting grain sorghums and grasses in Nigeria. *FAO Plant Protection Bull.*, **3**, (1955) 168.

C. A. THOROLD.—Observations on black-pod disease (*Phytophthora palmivora*) of cacao in Nigeria. *Trans. Brit. Mycol. Soc.*, **38**, (1955) 435.

Forestry

Silviculture

338. In the west research is still mainly concerned with natural regeneration, though line planting and sowing are also receiving attention. Investigations started three years ago continue but it is too early to obtain definite results.

339. Among the many problems concerning natural regeneration which have to be solved three are receiving particular attention now. Firstly it is hoped to avoid the dense climber tangle which so quickly develops once the canopy of the forest is considerably opened. Secondly large uneconomic trees left after an area has been regenerated and exploited must be removed, and thirdly better and cheaper methods of poisoning unwanted trees are being sought. It is hoped that the first problem may be solved by obtaining as quickly as possible a canopy of young economic trees mixed with small uneconomic trees and shrubs. It is believed that this canopy will prevent the formation of climber tangles and investigations with this end in view have been started this year. For the second and third problems investigations are in progress with contact arboricides and sodium arsenite.

340. In the north investigations are concerned both with the small areas of high forest on low-lying land and with the savannah areas. In these areas it may be possible to obtain good fuel either by thickening the natural forest or by plantations. A new investigation has recently been started comparing the two. Work continues at Jos on nursery and planting techniques and with trials of exotics, especially Eucalypts. Experiments have been started with tractors and mechanical methods of cultivation and planting.

Botany

341. Study of the ecology of the low acacia tangle in Benin was started. These tangles, which are a feature of the Benin high forest, present a special problem in silvicultural treatment. It is hoped that this series of studies by indicating the natural sequence of development from tangle to high forest and the changes of flora associated with this development, will throw light on the silvicultural problem.

NIGERIA—NORTHERN REGION

342. *New Stations.* As a result of the accession of new staff, it was possible to initiate the staffing of three projected sub-stations; the groundnut breeding sub-station at Kano, and two grassland sub-stations at Katsina (for the Sudan Zone) and Mokwa (for the Southern Guinea Zone). At Katsina the programme is to be dovetailed into the Veterinary Department's livestock improvement centre, and at Mokwa into the work of a general investigation programme on crops of the zone.

343. *New Work.* New work in hand includes expansion of cereal breeding and investigations (mainly sorghum and millet), of pathological investigations (particularly the cereal head smuts and groundnut rosette disease), of grassland and range management problems, and of vegetables and other non-staple food crops. A small start has been made on a general soil survey of the Region, and

two limited ecological surveys carried out by a Federal ecologist have indicated that ecological studies are likely to provide a most useful method under Northern conditions of expanding the findings of the soil surveys.

344. *Continued Work.* Cotton breeding has continued, and bulk tests with the new Samaru 26J strain, which has entered the first stages of multiplication for general distribution to replace Samaru 26C, have shown that it is equally acceptable to the trade, and that its yield superiority and slight improvement in quality over 26C have been maintained. Fertilizer investigations on the main staples and cash crops have covered wider areas, and it has been possible during the year to make positive recommendations for certain crops in limited areas and tentative recommendations over wider areas. There is still far to go however, before positive recommendations for all the main crops in all areas can be made. Seed dressing trials, previously almost confined to cotton were continued with millet, sorghum and groundnuts in co-operation with Plant Protection Limited, who posted an officer for several months. Some positive results were obtained but have not yet been fully analysed.

NIGERIA—WESTERN REGION

Agriculture

Soil Survey and Crop Nutrition

345. Nearly two thirds (6,500 sq. miles) of the main cocoa growing area of the Region has been covered by the Reconnaissance Soil Survey and detailed reports on Ibadan and Oyo Provinces are almost complete. The extension of field work to Abeokuta Province has necessitated naming a large number of series for the soils derived from the Eocene sediments but further North and West in Ondo Province the soils are very similar to those mapped in Ibadan and Oyo Provinces.

346. Simple nitrogen and phosphate trials have been carried out on a further 950 farmers' plots of maize and yams. Economic responses to the application of 1 cwt. of sulphate of ammonia to yams in savannah areas have continued but elsewhere though responses have frequently been statistically highly significant to both nitrogen and phosphate the treatments are not profitable. Pot experiments have recently indicated a marked deficiency of boron in soil from around Eruwa in Oyo Province and this has been supported by some field trials which included a trace element mixture containing this nutrient.

347. Fertilizer experiments on coppiced cocoa have been initiated and the treatments include the minor nutrient elements zinc and iron which, as a result of preliminary spray and injection trials, appear to be supplied in sub-optimal amounts in some of the main cocoa soils. A study of nitrate fluctuations under mature cocoa is providing useful data for comparison with similar studies under annual crops made on Moor Plantation in recent years.

348. Economic responses to the application of 1 cwt. of sulphate of ammonia per acre on upland rice have been obtained in parts of Abeokuta Province. The investigation was made using simple trials on 71 farmers' plots and it appears that economic responses are confined to certain soil types. This aspect is receiving further study by the Division as a whole.

349. Results are now available from a fertilizer experiment on pineapple (Smooth Cayene variety) carried out on heavily farmed land in an area of derived savannah near Eruwa in Oyo Province. Nitrogen gave highly significant responses and appeared to induce a higher percentage of fruiting during the main cropping season. Significant responses to phosphate and potash were not recorded.

Maize

350. The early maize crop continues to be the subject of a series of detailed experiments on varieties, spacing, manuring, etc. A variety known as Mexico 1 which is being distributed to farmers has been shown to be 46 per cent. higher yielding than local maize over the drier part of the region. In wetter areas, where maize is not such an important crop, Mexico 1 does not do so well, and it is inferior to local maize in Delta Province. The storage qualities of this variety are inferior to local maize, so farmers are advised to plant trial areas only. Other varieties from Central America have proved to be appreciably better than Mexico 1 in preliminary tests. In weed control trials in early maize a 2, 4-D herbicide has shown promise particularly for pre-emergence spraying.

351. The production of maize hybrids using Mexico 1 as the male parent top crossed with Lagos White, Tsolo and Nicaragua resulted in hybrids which out-yielded the parents by 12 per cent.

Cotton

352. The application of 10 lb./acre of water soluble DDT to control pests resulted in an increased yield. Further investigation into the economics of cost of application of DDT is needed as it seems that the cost of the treatment exceeds the value of the extra cotton.

Giant Star Grass

353. This grass has been found to be an excellent pasture grass (particularly in association with *Centrosema*) and its cost of establishment is lower than that of other species. Fears have however been felt that if introduced into an arable and ley rotation it might prove difficult to eliminate at the end of the ley. It has now been proved that under a mechanized farming system and provided cultivations are adequately carried out at correct seasons that there is no such danger.

Poultry

354. In a comparison of imported balanced poultry food with the "Standard Agricultural Department Poultry Ration" it was found that poultry fed on the imported ration achieved maturity earlier and are laying more and larger eggs than those on the Nigerian ration. Experiments are now planned to try to improve the local ration.

355. For some years it has been Departmental policy to issue pure bred Rhode Island Red poultry to farmers and 15,000 have been so issued since 1952. There has however been a high mortality of these after issue to farmers who rarely feed or otherwise care for them properly. In 1955, half the fowls issued were pure Rhode Island Reds and the others were $\frac{3}{4}$ Rhode Island Red \times $\frac{1}{4}$ Selected Nigerian. Preliminary reports from Provincial Agricultural Officers indicate that the cross-bred birds may find favour everywhere except near Lagos where there is a number of large scale professional poultry keepers who look after their birds well and expect a high level of egg production and no broodiness. The cross-bred fowls may be hardier and better foragers.

Pigs

356. A comparison of a balanced pig ration imported from the United Kingdom with the "Standard Agricultural Department Pig Ration" showed that pigs gained weight equally with both rations. The carcass quality was better in the case of pigs fed on the imported ration. The latter is however much more expensive as the Standard Agricultural Department Ration is composed entirely of Nigerian products. In another series of trials in which the standard ration was compared with three other local rations it was found that pigs attained killing weight (200 lbs.) between 2 and 12 weeks earlier on the standard ration than on the others.

*NIGERIA—EASTERN REGION**Agriculture*

357. A series of trials of new maize varieties and hybrids originated by the West African Maize Research Unit were carried out with the object of isolating high-yielding rust resistant lines. Some vigorous, white flour, rust-resistant types were selfed for further selection.

358. Trials with varieties of yams collected from Owerri and Calabar Provinces were carried out at different spacings and with varying sizes of setts. Other trials were on groundnuts and on tobacco, the latter to bring the crop to maturity at the end of the rains. A collection of local rice varieties was made.

Forestry

359. Research in the Eastern Region has hitherto been restricted to a series of *ad hoc* experiments, designed to answer simple questions. For instance, a series of experiments designed to ascertain the best type and optimum size of planting stock of various species have produced results, which are now being used in nursery practice. Other experiments have consisted in the laying down of establishment plots of the different mixtures used in plantations.

360. In January, 1956, a full-time Federal Research Officer was appointed to the Eastern Region and has taken over all existing experiments, and will also initiate a programme of investigations which have hitherto been held up for want of staff. Among this officer's immediate items of work, and probably the most important, is the disposal of unwanted uneconomic trees and their replacement by planting stock of economic species on the line planting or some allied system.

*NORTH BORNEO**Rice*

361. Varietal trials comparing introduced selections with local unselected varieties have shown that local varieties have generally surpassed the exotics in yield. A selection programme for local rices has therefore been started. The selection from material derived from the International Rice Hybridization Project was continued, lines in F_5 showing considerable uniformity. Fertilizer trials have generally given economic responses to nitrogen but smaller increases from phosphates.

*NORTHERN RHODESIA**Agricultural Chemistry*

362. The results of maize fertilizer experiments conducted since 1951 reveal widespread nitrogen deficiency, limited phosphate deficiency, and adequate potash in the wide range of soils studied. Marked responses to nitrogen were obtained on the reddish brown or dark brown clays and leached sands of the Central Province, some of the latter giving increments of up to 2,000 lbs. dry maize grain per acre per 200 lbs. application of ammonium sulphate. The better red clay soils of the Eastern Province and the grey brown loamy sands of the Southern Province gave smaller responses but still of the order of 450 lbs. grain per acre per 200 lbs. fertilizer. There are indications that the recommended time of application of sulphate of ammonia by side dressing at the six-week stage may require modification under certain circumstances. With vigorous growth the application may be better applied at an earlier stage.

363. Analysis of maize leaf showed that, under conditions of a single experiment, the nitrogen content of the leaf is positively correlated with yield and is also at all times a good indicator of soil nitrogen status.

364. Severe phosphate deficiency was found only on the loamy sands of the Southern Province where 200 lbs. superphosphate gave increments of the order of 800 lbs. grain per acre.

365. Maize population experiments suggest that high plant populations of 15,000-20,000 plants per acre can be carried by soils of good inherent fertility suitably dressed with NP fertilizers, and yields increased proportionately.

Soil Survey

366. The Land Use Survey of the Copperbelt was completed in November, 1955, and a comprehensive report is now in preparation. The greater part of this area is unsuitable for agricultural development owing to the presence of outcropping laterite, laterite at shallow depths or very impoverished soil. Clearing in such areas could lead only to rapid deterioration of whatever soil is present and subsequently to extensive erosion under the climatic conditions prevailing in the region. Of the land considered worthy of further attention, the greater part must be regarded as marginal, requiring careful and skilful handling and much capital investment if it is to be brought into economic production.

367. A comprehensive survey of the Kambowa Experiment Station has shown that all Copperbelt soils are represented there and a preliminary series of experiments to investigate suitable crops, fertility levels, manurial requirements, pasture management, etc., are now being conducted by the Ecologist as a follow-on from the Land Use Survey findings.

368. The preliminary stages of a further Land Use Survey in the Ngoni Reserve were carried out in the dry season and the survey will be continued after the present rains. This area is over-stocked and through over-grazing has deteriorated by erosion to such a state that it is now incapable of supporting its present population.

Ecology

369. In the light of experience gained in the initial stages of the Copperbelt survey, methods of vegetation classification were modified. By greater use of indicator plants it has been found possible to obtain quite a close correlation between vegetation and soil types in the Konkola area of the Copperbelt. Studies of the potentialities of aerial photography for the assessment of vegetation and soil types have continued, and suggest that it can be used to define the limits, with very reasonable accuracy, of good, bad, and indifferent soils without preliminary ground survey. The application of this method of mapping in relation to soil and ecological surveys is being investigated further.

Plant Pathology

370. Fungicidal tests for the control of anthracnose in tobacco seed beds were continued. "Maneb" (manganese ethylene bis-dithiocarbamate) while highly phytotoxic to tobacco at normal rates, gave excellent control of this disease at low dosages.

371. Further experiments in the suspected boron deficiency in tobacco in the Eastern Province, though giving statistically insignificant results, suggested that 8 lbs. borax per acre, coupled with high levels of NPK fertilizing, gave better quality tobacco and increased yields.

372. Excellent control of *Eleusine indica* and fair control of *Rottboellia exaltata* was obtained in lucerne, using CDEC at 3 lbs. active ingredient per acre, the lucerne being unaffected at this rate. In similar trials with MCPB and 2,4-D formulations, germination of the lucerne was reduced from 80 per cent. to 30 per cent. 2,4,5-T gave good control of several shrubby species in a

veld paddock at 2 per cent. concentration when applied to the stem bases. The principal species involved were *Acacia* spp. and *Trichodesma* spp. The estimated cost of the treatment of £40 per acre was prohibitive.

373. A heavy attack of *Puccinia polysora* on maize again occurred in the Eastern Province but was again too late to cause serious losses of yield. The rust was found to be heavily hyperparasitised by *Eudarlucia australis*.

Pasture Research

374. A number of introductions of pasture legumes and grasses have shown promise in the nursery stages and will be investigated further. These include *Stylosanthes* spp. *Indigofera tettensis*, *Indigofera subulata* and *Alysicarpus glumaceus* and various strains of Rhodes grass, *Cenchrus ciliaris* and *Eragrostis curvula*. Hairy Peruvian lucerne has proved remarkably persistent after a severe dry season and the study of dryland lucerne as a pasture legume will receive more intensive investigation. Seed production and establishment studies are being continued and expanded. Weed growth, particularly of *Eleusine indica* has proved to be a major problem in all establishment experiments and will require a separate series of experiments to investigate methods of control.

Plant Breeding

375. Varieties of wheat, groundnuts and kidney beans assembled in observation plots are now being subjected to trial for yield, disease resistance and optimum planting times. Wet season trials of wheat varieties indicated that several were worthy of further investigation and selections from these are now under test. Grass weeds were a major problem in the wheat trials as in pasture work.

Forestry

376. One more attempt has been made to type the *Brachystegia-Isobertinia* woodlands of the Copperbelt and rate the types for timber production. These woodlands are usually rated at 50–100 cu. ft./acre. Stands have been measured with over 1,000 cu. ft./acre. In general the best timber is found on deep red soils with a lot of *Landolphia* and *Paropsea* and odd colonies of *Aframomum* and *Smilax*.

377. Treated paper pots were tested on an extensive scale as containers for transplants, mostly Pines, but also Eucalypts. Early results indicate that their use had led to an increase in the number of days upon which planting can successfully be done. The development of conifer transplants was good in the pots but for an unexplained reason Eucalypts transplanted into pots suffered severe check. Preliminary trials indicate that the use of NPK mixtures in the nursery can increase height growth of pine transplants very appreciably and also causes the early development of secondary needles. Several Eucalypts new to the territory were planted out in tenth acre trial plots this year. They include *E. triantha*, *E. phaetrocha* and *E. drepanophylla*.

Veterinary Research

378. Extensive clinical trials of a wide range of preparations in the treatment of Streptothricosis were undertaken. Studies were made of cross drug resistance in trypanosomes between Dimidium, Ethidium and Antrycide. Work was continued on tick bionomics and control.

379. Nucleus breeding of indigenous and Boran cattle, in conjunction with response to nutrition, was continued and further observations were made on the physiology and heat tolerance of Zebu cattle.

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NYASALAND

Agriculture

Maize

380. *Breeding.* This work continues using local material, and some top-crosses are now equal in yield to the best imported hybrids and at the same time have a type of grain better suited to local conditions. Progress is being made towards producing a synthetic variety of good type which will not require fresh stocks of cross-bred seed each year.

381. *Diseases.* *Puccinia polysora* was widespread in a mild form and local strains are being combined with EAAFRO resistant types for distribution if the disease should ever become severe. Leaf blight (*Helminthosporium turcicum*) is common and spraying trials showed losses in yield from different varieties varying from 5-28 per cent. Resistant strains are being isolated for breeding work.

Tobacco

382. *Dark.* Variety trials show that locally selected strains have a higher yield and quality than imported varieties. Nitrogen is the greatest fertilizer need and phosphate gives varying responses. There was no indication that any minor element tried is a limiting factor in yield but the addition of magnesium may improve the quality. In cultural experiments it was shown that the early removal of the lower leaves improves the quality and closer spacing does not alter the total yield of long leaf per acre but reduces the proportion of this long leaf in the crop.

383. *Burley.* The local standard variety proved to have a higher value per acre than all imported types. A fertilizer trial showed that nitrogen was the main limiting factor to high yield ; phosphate increased the yield slightly and gave better quality while potash had no effect.

Groundnuts

384. A large number of varieties have been tried and below an elevation of about 2,500 ft. the early maturing bunch varieties do best while at higher elevations the longer term varieties yield as well as or better than the bunch. Early planting gives considerably increased yields for both early and late types, and early or late lifting reduces the yield of non-dormant varieties.

Tung

385. The classical experiment comparing budded trees with seedlings continues to show that the budded clones outyielded the best selected seedlings. Some new clones at eight years of age are proving higher yielders than the older selections. Nitrogen is the most important fertilizer requirement and there is no response to phosphate or potash. Among the minor elements, zinc improves the health of the trees and while an apparent deficiency of copper has been noted, no response to this element has been recorded. There has been an interesting examination of the cause of biennial bearing. Various cultural treatments such as extra nitrogen, pruning, and hormone sprays have given no response, but it has been found that there is a significant correlation between the rainfall in the winter, or "dry season", and the yield in the following summer. Although the total rainfall during the winter is not more than 3 inches (out of the annual total of about 45 inches) it occurs during the time of bud formation and has a marked effect on the crop.

Tea

386. Pruning experiments have shown that a three-yearly clean prune gives a higher yield than a shorter cycle. This effect only shows up after the cycle has been repeated several times and is more marked with Indian than local jat.

Fertilizer experiments show that nitrogen gives a large increase in yield but there have been no responses to phosphate or potash. An examination of the soils of tea gardens planted 25–35 years ago has shown a considerable depletion of the amount of potassium in the soil but so far this has not been reflected in leaf analysis which continues to show a reasonably high percentage of potash. There are indications that the best time to apply the nitrogen is October or November. Increasing the number of bushes per acre has given an increased yield in the fifth year after planting.

Chemistry

387. A comprehensive examination of the Chilwa area showed that the soils were generally suitable for irrigation but that the water from Lake Chilwa generally had too high a salt concentration for use as irrigation water at the time of year when it is required. One feature of the Shire Valley Project would be the reclamation of land now subject to flooding. An examination of this area showed that the soil is likely to be suitable and that there will not be salinity problems. An investigation of the soils in the Central Province showed that there was some correlation between phosphate response and the percentage saturation of the base exchange capacity and also to the water soluble silica content of the soil. Root washing studies showed that maize and groundnut roots explored the soil to a depth of over 6 feet while tobacco roots went down for little more than half that depth.

Pastures

388. It has been established that the most generally suitable grasses for use in Nyasaland are *Chloris gayana*, *Panicum coloratum* var. *makarikariensis* and *Cynodon dactylon*. The *Panicum* is especially suitable in the drier and less fertile areas and gives more yield in the winter than the others and is very palatable. *Pennisetum purpureum* besides giving a high yield of grass for silage is also most valuable for grazing in the winter giving a greater yield of green material at this time than any other grass. Responses to nitrogen manuring were high but there was little response to phosphate. The most economical application of sulphate of ammonia was between 200 and 400 lb. per acre and this was better than nitromoncal though the former may lead to excessive acidity if used continuously for many years.

Rotations

389. Rotation experiments are showing that the yield of maize falls slightly in the second year after bush fallow and to a much greater extent in the third successive year. Groundnuts help greatly to restore the yield probably acting largely through the added nitrogen. Velvet bean as a green manure had a greater effect than sunn hemp and after velvet bean was ploughed in there was no response by maize to added nitrogen.

Forestry

Experimental Plantations and Trial Plots

Indigenous Species

390. On Zomba plateau three acres of indigenous evergreen forest were underplanted with Mlanje cedar, and a quarter-acre plot of *Pinus patula* was also underplanted with cedar. The object of this trial is to obtain information on the conversion of evergreen forest patches of low timber value to cedar, and also the effect of underplanting exotic pine stands with an indigenous conifer. At Chikangawa, the growth of cedar planted in cleared rows within a four-year old *Pinus patula* stand is exceptionally good, and provides a most interesting comparison with plots of the same species planted in the open without shelter or side shade. Growth is faster and the young trees are taller, straighter and less

branchy. At Kalwe and Nkuwazi Hill in Nkata Bay Districts, the *Pterocarpus angolensis* baton-planting plots established during the previous year showed a fair percentage take which was better at Nkwazi than at Kalwe. Percentage take did not appear to be affected by size, since both large and small batons sprouted equally well. The trial plots of *Entandrophragma stolzii* in the ever-green forest at Nchisi are surviving, but the trees are making very slow growth. Further removal of overhead and side shade is to be carried out. At Cholomwani in the Southern Province a trial plot of *Entandrophragma caudatum* was established.

391. At Nkuwazi Hill, a plot of *Chlorophora excelsa* (*mvule*) planted in 1954 is making excellent growth, the tallest tree being 12 feet in height and the plot average about 6 feet. At Kalwe, very good but less spectacular growth was made, an interesting feature being the vigorous shooting from large stumps and the rapid occlusion of the cut end. Sowing of *mvule* in the nurseries at Sosole, Mua-Livulezi and at Cholomwani have made excellent growth and provided planting is done on really good soils, it would appear from results so far obtained that planting of *mvule* can be carried out in Nyasaland without the difficulties experienced elsewhere in Africa.

Exotic Species

392. At Massenjere and Cholomwani in the Southern Province the Department is carrying out trials with teak with very interesting results so far. After one season's growth, trees at Massenjere (altitude about 500 feet) averaged 4½ feet, and those at Cholomwani (altitude about 2,800 feet) averaged 3 feet in height. Teak plots were also established at Kalwe and at Mua-Livulezi, but growth on the poorer soils there was not comparable with that at Massenjere and Cholomwani.

393. Excellent nursery stock of the exotic mahoganies, *Khaya grandifolia*, *K. anthotheca*, *K. senegalensis*, and *Entandrophragma utile* and *E. angolensis* has been raised at Kalwe and at Cholomwani. Trials of these will be established, using striplings, in the 1956 and 1957 seasons. It is felt that the possibilities of growing African mahoganies other than the indigenous *K. nyasica* in the high and medium rainfall areas of Nyasaland are worth exploring. Further softwood trial plots were established at Champila, Luwawa Dam, Luafwa and Lusangadzi, all on the Vipya. Nursery stocks of *Pinus caribaea*, *P. khasya*, and *Araucaria cunninghamii* were raised at Kalwe, Likabula and Cholomwani for trials at the lower altitude where *Pinus patula* does not thrive. Seed of *Pinus ayacahuite* and an alleged straight form of *Pinus leiophylla* were obtained from Mexico, and nursery stock was raised on the Zomba plateau. Trial plots of the following eucalypts were established at Chikangawa:—*E. maideni*, *saligna*, *fraxinoides*, *microcorys*, *fastigata*, *globulus*, *camaldulensis* and *muelleriana*.

394. Fertilizer trials were laid out at Ndirande and Chambe Forests in the Southern Province in order to study the response of pine plantings on poor soils during the first year of growth. Applications were made of ammonium sulphate and superphosphate alone and in various mixtures and concentrations, but no significant response was observed.

Veterinary Research

395. Little original research was undertaken, the efforts of the Laboratory being directed to the production and standardization of fowl typhoid, black-quarter and S. 19 vaccine and to routine diagnosis and *ad hoc* investigation. Initial work on the production of phenolised rabies vaccine was also undertaken. As a result of the high incidence of low-grade avian coccidiosis in the Territory's flocks experiments were carried out on the effects on live weight gains of prolonged treatment with various coccidiocidal drugs.

SEYCHELLES

396. A study of the Sooty Tern (*Sterna fuscata*), whose eggs are an important commodity in the islands, was carried out by Lord Richard Percy and the Hon. Matthew Ridley, with particular reference to the conservation of the bird population in relation to the crop of eggs which may be taken annually.

ST. VINCENT

397. Further studies on the treatment of cotton land during the close season have confirmed that cotton yields were higher following sweet potatoes, maize, green dressing and bare fallow, than yields from cotton which followed weed fallow. The relative effectiveness of the treatments was in direct relation to the degree of weed control which they afforded. The result of the previous season, when a dressing of ammonium sulphate depressed yields of cotton following all treatments except sweet potatoes, was reversed in the 1954-55 season when sulphate of ammonia gave the expected increase in yield over all treatments. The value of early ploughing for cotton planting was again confirmed. In two trials, phosphate, potash and nitrogen fertilisers applied below the seed at planting and followed five weeks later by a top dressing of ammonium sulphate, gave increased cotton yields over treatments where NPK was all applied at the five weeks stage.

398. In fertiliser trials on arrowroot the application of 0, 300, and 600 lbs. ammonium sulphate gave increasingly significant responses in all trials, 200 lbs. muriate of potash increased yields of arrowroot rhizomes at only two sites, but generally tended to improve the effect of nitrogenous fertilizer. There was no effect on the starch content of the rhizomes. Yields of rhizomes were very greatly improved at close spacings.

SARAWAK

Forestry

399. Apart from much routine work, mainly botanical and silvicultural, the principal research projects now being undertaken are :—

- (1) A general study of the composition and ecology of peat-swamp forests.
- (2) Studies in the management of mixed swamp forest, lowland Dipterocarp forest and *kerangas* forest by means of selective girth-limit fellings.
- (3) A study of *kerangas* soils, with particular reference to their variation and potential use. For this purpose, a soils expert was seconded under the Technical Assistance plan of the Food and Agricultural Organization of the United Nations for a period of twelve months, and began his investigations late in the year.
- (4) Spot tests of the suitability of various timber species for planting on very poor *kerangas* soils. Species now on trial are *Agathis alba*, *Albizzia falcata*, *Araucaria cunninghamii*, *Dacrydium elatum*, *Dryobalanops ? fusca*, *Dryobalanops rappa*, *Durio zibethinus*, *Eucalyptus siderophloia*, *Gonystylus bancanus*, *Hymenaea courbaril*, *Melia excelsa*, *Pinus caribaea*, *Pinus merkusii*, and *Shorea albida*.

Zoology

400. Research relating to agriculture being undertaken through the Sarawak Museum includes an investigation in conjunction with the Department of Zoology, St. Bartholomew's Medical College, London, into the breeding habits of *Munia* birds (the Java Sparrow, main pest of rice cultivation) with special reference to their migrations and feeding habits.

*SIERRA LEONE**Animal Husbandry*

401. Work continued on the selection and breeding of a beef type of animal which matures early with a good carcase weight and breeds regularly. Bull progeny testing indicates that the useful life of a bull may not be so long as was first believed. Since using S. 19 vaccine against *Brucella abortus*, little trouble has been experienced with this disease. Investigation is being made into the problem of establishing fodder crops more easily.

Systematic Botanist and Ecologist

402. Numerous collections were made in conjunction with the Forestry Department in the Kambui hills reserve and full details of all timber trees felled in flower and fruit recorded. Collections were made of two species of *Raphia* which are little known botanically but of economic importance.

Agricultural Chemistry

403. Field experiments at Njala have confirmed a calcium deficiency which severely reduces groundnut yields. Applications of lime disturb the K/Ca and Ca/Mg ratios and, although higher yields are obtained, it is beneficial to use sulphate of potash and magnesium sulphate at the same time. With this combination of fertilizers, yields can be trebled in the year of application but whether these elements alone will maintain yields on a gravelly red latosol has yet to be investigated. For groundnuts, the results obtained in these experiments suggest that the value of superphosphate lies almost entirely in its calcium content, the crop having a very low demand for phosphate. In order to discover nutrient deficiencies in Sierra Leone soils a routine pot test is being developed to determine which elements need to be added to the soil to produce maximum yields. For this, the standard is a plant grown in soil and watered with a complete nutrient solution. Macronutrient deficiencies have been discovered with ease but micronutrients have presented considerable difficulties.

Forestry

404. In the absence of a specific research branch the Forest Department carried out a good deal of practical trials. These were directed towards evolving a silvicultural system suitable for natural high forest, using arboricides. The development of a "dry nursery" technique shows promise of reducing the costs of shading and watering while maintaining or improving the quality of nursery stock.

Veterinary

405. Experiments with Wet Lapinised Rinderpest virus now indicate that it confers immunity on Ndama cattle for at least 33 months.

*SOLOMON ISLANDS PROTECTORATE**Coconut*

406. 1955 saw the completion of a series of experiments and long-term observations on plots to investigate the relation between *Anoplolepis longipes* (the "Crazy ant") and *Amblyopelta* nutfall. It had been known for a long time that another ant, *Oecophylla*, protected coconut palms against attack by *Amblyopelta*, and there was some evidence that *Anoplolepis* did likewise, but the matter stood in need of confirmation. These experiments and observations show beyond doubt that *Anoplolepis* gives protection almost, if not quite, equal to that given by *Oecophylla*, and that if therefore an attempt is made to control nutfall indirectly through the agency of ant-control, there is no necessity to try to control this ant, but rather there are grounds for encouraging it. The evidence

for this conclusion comes from various sources and is very strong. Further tours were made to different parts of the Protectorate to survey and evaluate the status of *Amblypelta* nutfall in the islands as a whole ; among other things it was found that in San Cristobal nutfall on a minor scale is caused by an undescribed species of *Amblypelta*, distinct from *A. cocophaga* which is the species found on most other islands. During the same year a start was made on experiments with insecticides to control *Brontispa*, a serious pest of young palms. These experiments, although as yet incomplete, have given very encouraging results.

SOMALILAND PROTECTORATE

Agriculture

407. *Date Cultivation.* The annual mortality count suggests that a position of stability has now been reached among the imported date shoots. It was formerly thought that when a daughter shoot does not show some signs of vigorous life within the first few months it is not likely to survive. The converse now appears to be true : that when a shoot is well and truly established it is likely to flourish although it is too early to say whether it will not only thrive but produce in abundance. At the end of October a number of daughter shoots of the Hadhra-maut importation were severed and planted direct into blank holes. This is the first time that daughter shoots from imported palms have been thus utilized and their progress, at present encouraging, will be watched with great interest. Much time has also been devoted to the investigation of crops to grow in date gardens while the palms are in the early stages of development. Lucerne from the Yemen and Egyptian Clover are both promising, but citrus has proved disappointing.

Experimental Farm

408. A very promising central experimental farm is now fully established at Aborein. Study of cockchafer and smut control on sorghum were carried out besides a comprehensive artificial manurial trial. The experiment in cockchafer control was combined with a method of cultivation trial. Full results are not available but it is evident that in a year of drought any seed dressing, such as Fernasan, which, combining an insecticide with a fungicide, controls cockchafer attack will result in a markedly more prolific stand and an increased yield. In a correctly banded field where moisture is conserved to the full, the effect of seed treatment, as far as cockchafer control is concerned, is not likely to be so pronounced.

Forestry

409. Further observations in the juniper forests seem to confirm that it is destruction of the habitat by over-grazing which results in these forests failing to maintain themselves, and in the paucity of regeneration. Any stands of new regeneration found have all been in areas comparatively free from stock.

410. The method of establishing *Conocarpus lancifolius* in a plantation on the arid coast with only about two inches annual rainfall, but with ground water, is of interest. Six to eighteen inches below the ground surface there occurs a rocklike gypsum layer which has to be broken with crow-bars. A hole four to six feet deep is dug, down to the water table, for each plant. Striplings long enough to stick out of the holes are planted at the bottom. The holes are not filled in, but this occurs naturally by windblown sand in a year or so, by which time the trees are established.

411. Initial success (95 per cent. germination and survival after two years) has been obtained with the dom palm (*Hyphaene thebaica*) in the same locality as *Conocarpus*. No nursery work is required ; the seeds are simply sown in the pits which are kept free of blown sand until the plant has developed enough to escape being covered.

*SWAZILAND**Agriculture*

412. Results of yield trials of 18 strains of hybrid versus local varieties of maize indicated that certain double hybrids, bred at Pietermaritzburg, Natal, should be of importance in increasing food production in the Territory. Variety trials with cotton strains from Barberton Experimental Station have been laid down in different ecological areas as a preliminary to efforts at standardization of planting material. Seven varieties of rice are being tested for yield at Mdutshane Experimental Farm.

413. Investigations on nutrient requirements of maize, rice and potatoes indicate that N, P and K plus a light dressing of Ca for maize, are necessary to give maximum response. A survey of the lower Usutu basin is being carried out to assess the irrigation potential of the area. Methods of establishment and management of pasture leys continue to be investigated, and the collection, propagation and study of promising fodder plants is being carried out.

Animal Husbandry

414. At the Mpisi Cattle Breeding Experimental farm the indigenous Swazi cattle, known as the Nguni, are being improved by selection within the breed for beef production, early maturity and milk production. The breed is also being compared with the Afrikaner cattle, indigenous to the Union of South Africa, as well as the Afrikaner upgraded by using pure bred registered Afrikaner bulls on Nguni cows and the resultant crossbreeds. The Nguni bulls, after careful selection, are made available to African cattle farmers in an endeavour to improve the indigenous African cattle in native areas. Careful records are being kept of breeding, fertility, milk production and monthly weights of cattle on the station.

*TANGANYIKA**Agriculture*

415. *Cashew Nuts.* Two species of Mirid bugs, *Helopeltis anacardii* Miller and *H. bergrothi* Reut., have caused considerable damage to cashew nut trees and to the fruit. Dusting trials, using 5 per cent. DDT or 0.5 per cent. gamma BHC showed, in the case of DDT, a considerable reduction in damage to flowering shoots.

416. *Coffee.* Dieltrin, painted round the foot of the tree, can now be confidently recommended to control the White Coffee Borer (*Anthores leuconotus*). A coffee washing machine was imported from America, designed to remove the mucilage of freshly pulped coffee without the necessity of fermentation. Tests show that this can be done efficiently, but the liquoring quality is depressed and further tests are being made to obviate this.

417. *Cotton.*

(a) *Lake Province.* The yield was only 36 bales per 100 acres, compared with about 42 for each of the previous three years, on account of a high proportion of late planting and the lack of moisture to develop the top crop. Another type of seed, U.K. 55, has been produced from the segregates of Mwanza "local" cotton and is being bulked. Work continues in attempting to breed resistance to bacterial blight into the best of the Ukiriguru strains.

(b) *Eastern Province.* Further re-selections of 47/10 are being undertaken at Ilonga Research Station and some very promising types with a high lint out-turn and better jassid resistance are at present undergoing trial at Ilonga and on District plots. Dusting trials for the control of

American Bollworm in Cotton have confirmed the effectiveness of 10 per cent. DDT and 3 per cent. BHC at 8 lb./acre, but the increases in yield are only economic on early planted, well cultivated, cotton.

418. *Groundnuts*. A prostrate variety "Mwitunde" which is resistant to Rosette Disease has been produced by the Tanganyika Agricultural Corporation.

419. *Maize*. Two breeding projects based on local "Katumbili" have made good progress. At Nachingwea rust-resistant strains with an increased potential yield will be used on a farm scale in 1956 and at Ilonga the final stage in evolving an open pollinated, improved flint type has been reached. A high degree of control of the stalk borer has been achieved in the Western Province by the timely application of 5 lb./acre of DDT dust, but this is only an economic practice where crops have been well cultivated.

420. *Potatoes*. Of the several varieties of seed being tested at Kungului Farm, Lushoto, for blight resistance, 1521c(3) imported from the Scottish Plant Breeding Station is still outstanding and is being bulked in many parts of the Territory.

421. *Pyrethrum*. A series of identical experiments on eight different soil types has shown a remarkable variation in the inherent fertility of soils. Most of them show a significant response to superphosphate, but a rate of 200 lb./acre is often no better than 100 lb./acre. Farmyard manure has given significant responses, but neither nitrogen nor mulching have had any effect.

422. *Sisal*. Now that problems relating to plant density and cutting practice have been satisfactorily solved, increasing attention is being paid to plant nutrition in relation to the maintenance or restoration of fertility during later planting cycles. Two spectrographs, of large and medium sizes, have been installed and are proving invaluable in elucidating these problems.

423. *Sorghum*. The Botanist, Ukiriguru, continued the programme for breeding a short-term, palatable, weevil- and bird-resistant variety. "SUK 1", a segregate from the first cross of B.C.27 (3½ months, poor grain) x Wiru (5-6 months, palatable, weevil-resistant grain) was bulked. The resulting grain was palatable and weevil-resistant, but the yield was below the standard required. There are, however, two very promising lines from the first back-cross, B.C. 27 (2) x Wiru, which are being developed to remedy this defect. A useful range of breeding material is now available with various combinations of characters such as "goose neck", large glumes and long awns, which may confer a measure of bird resistance. Counts have shown that "goose-necked" varieties suffer less damage than straight-headed varieties.

Publications

G. SWAINE, A. C. EVANS, and J. B. WARD—The Cotton Red Bollworm Problem in Southern Tanganyika. *E. Afr. Agric. J.*, **20**, (1954) 183.

M. M. WALLACE—The Bark Diseases of Coffee. *E. Afr. Agric. J.*, **21**, (1955) 1.

G. B. WALLACE and M. M. WALLACE—Sudden Death Disease of Cashew Trees in Tanganyika. *E. Afr. Agric. J.*, **21**, (1955) 1.

Applied Pedology

424. Pilot irrigation of an immature alluvial fan soil off the Uluguru Mountains has proved successful. Various small areas of saline soils at the foot of the West Usambara Mountains have been successfully reclaimed. A large piece of country in the Handeni district has been reconnoitred for West Usambara expansion. A fairly intricate soil pattern, generally related to topography, was found. A well-developed normal catena, however, does not occur, the highest

lying soil being a deep red clay loam developed on an old peneplain with the slope soils below it rather immature and rocky. The soils generally, however, are sufficiently favourable for pilot development. A number of irrigation projects have been reconnoitred in the Central Province. The soils of this semi-arid region are largely relics much affected by the various materials (clayey, siliceous, ferruginous, calcareous) deposited under past peneplain conditions. Some subsoil salinity is generally found. All the available information on the soils of Tanganyika has been brought together and a revised soil map prepared for the third edition of the Tanganyika Atlas.

Plant Deficiencies

425. Evidence has been obtained that the "dieback" condition of coffee at Mbosi is a boron-zinc deficiency and that the "dieback" of wattle at Njombe is a boron deficiency. Unthrifty young pines at Mbeya have shown marked growth responses to boron-zinc spray.

426. A study of the infertile "rweya" soils of Bukoba has shown with micro-plots of grass and millet marked responses to N, Ca, P, K and some response to micro-nutrient mixtures. Laboratory nitrification tests with these soils have given responses to Mo, Cu, Mn and Fe while Webb pot tests using cauliflowers have given indications of Ca, P, Mo, Mn and Mg deficiencies. Plant tissue analyses of coffee and banana leaves have given indications of various micro-nutrient deficiencies and small scale exploratory spraying trials with these crops are now in hand. It would appear that the deficiencies studied are primarily the result of intense soil leaching and that the deficiencies most likely to be found are those of the normally anionic or amphoteric elements—P, B, S, Mo, Zn, with Ca, a macro-nutrient not strongly held by clay minerals, also of considerable importance.

Publication

W. E. CALTON, G. E. TIDBURY and G. F. WALKER—A study of the more important soils of Zanzibar Protectorate. *E. Afr. Agric. J.*, **21**, (1955) 53.

Forestry

Silviculture

427. The main lines of research concerned nursery problems, softwood planting, and the replacement of four indigenous species. Subsidiary investigation dealt with insect pests and tree diseases. Measurements of rates of growth of indigenous and exotic trees were made. Although checking of *Pinus patula* can be induced by delayed transplanting and omission of NPK fertilizer, neither is the sole answer to the problem. It was found that Swaziland beds six to eight inches deep produced markedly larger plants in the same time than standard five-inch boxes. Experiments in softwood areas dealt with degrees of ground preparation and weeding, effects of wind, trace element deficiencies, fertilizer applications and effects of different degrees of pruning on growth and occlusion of wounds.

428. Insect pests studied included *Oemida gahani* and *Androemi* sp. on cypress, *Tragoceplala pretosa* on cinnamon, *Icerya purchasi* on Black Wattle and *Achatina fulica* attacking *Chorophora*. Heartrot was discovered in *Ocotea* root suckers, *Fomes senex* being isolated and other fungi suspected.

Bee Keeping

429. The subject which received maximum attention was bee botany, based on pollen analysis. Most of the pollens collected have been described, and 400 photomicrographs have been taken of the principal pollen types represented in the collections. Experiments with frame hives confirm that the Langstroth brood chamber (single storey) is too small and that the modified Dadant type is more satisfactory for brood nest development and dry season reserves.

Utilisation

430. The research unit, comprising sawmill, wood-working shop, preservation plant, seasoning kiln, seasoning shed, logging unit, laboratory and herbarium, was completed and opened at the end of the year.

Investigations included :—

- (a) *Timber*. Tests of durability to insect and fungal attack, of methods of preservative treatment, and air and kiln drying. Investigations into wood-working properties of local timbers and the equipment required to deal with them, were also made.
- (b) *Sawmilling*. Tests were made into most suitable types of blades ; mill conversion studies ; investigation into organization and working of sawmills.
- (c) *Logging*. Costings of felling, logging and hauling were undertaken.

Game Department

431. The Senior Game Ranger, C. J. P. Ionides, continued his study of reptiles and amphibians in the Southern Province, discovering a number of new fossorial species. Mr. Ionides, in conjunction with Mr. A. Loveridge of the Museum of Comparative Zoology, Massachusetts, contributed a paper on reptilia in Tanganyika published in the Journal of the East African Natural History Society.

Animal Diseases

432. Studies included :—

- (a) The continued observations on the immunity conferred by Adjuvant Rinderpest vaccine and K.A.G. vaccine on calves of various age groups born of immune mothers.
- (b) Trials of new prophylactic drugs against *T. congolense* in Zebu cattle. These drugs were supplied by Messrs. Boots Pure Drug Co. Ltd., and of the compounds tested, one showed great promise.
- (c) Studies on the pathology of the disease caused by *T. congolense* in Zebu cattle.
- (d) Feeding trials using pods of *Acacia spirocarpa* and *Acacia albida*.
- (e) An attempt to discover whether Sulphaquinoxaline treatment in relation to the protein percentage in the ration is associated with chronic nephritis and liver dysfunction in poultry.
- (f) Investigation into the efficient use of acaricides and attempts to produce a dip-side test for BHC dips.
- (g) Work on mineral imbalance in stock in various parts of the Territory.
- (h) The investigation of bovine fluorosis in the Northern Province of the Territory.

Pasture Research

433. Investigations included bush eradication and soil conservation studies, the establishment of grass leys under semi-arid conditions, studies on grain crops, grasses, legumes ; fodder grasses under irrigation and under dry land conditions ; investigations in connection with the making of grass, grain and legume silage and the evaluation of arboricides.

Livestock Research

434. The recording of Departmental livestock was continued and heat tolerance studies involving variations in normal rectal temperatures and the inter-relationship between rectal temperatures, skin and dewlap temperatures were developed. Study of the normal suckling habits of calves was started and studies on the anatomy and physiology of the bovine hump were continued.

Publications

R. M. MABON—A simple method of assessing the moisture exuded through the skin of cattle. (In the Press.)

A. H. MILNE—An Outbreak of Tuberculosis in Goats in Tanganyika. *Vet. Rec.*, **67**, (1955) 374.

A. H. MILNE, J. ROBSON and T. LWEBANDIZA—The Efficiency of Berenil against *T. congolense* in Zebu Cattle. *Vet. Rec.*, **67**, (1955) 280.

A. H. MILNE and J. ROBSON—The Late Treatment of *T. congolense* Infection in Zebu Cattle with Ethidium Bromide. *Vet. Rec.*, **67**, (1955) 452.

G. W. WALKER—Removal of Excess Fluorine from Drinking Water for Stock. *E. Afr. Agric. J.*, **22**, No. 4, April, 1955.

G. W. WALKER and A. H. MILNE—Fluorosis in Cattle in the Northern Province of Tanganyika. *E. Afr. Agric. J.*, **21**, No. 1 July, 1955.

*TRINIDAD AND TOBAGO**Agriculture*

435. Evaluation of the performance of selected cocoa clones on various soil types ; shade, spacing and fertilizer trials ; selection and hybridisation for resistance to witches' broom disease were continued. Sugar cane variety sorting trials, lime-fertilizer trials and observations on new hybrid varieties were made. Citrus studies included rootstock investigations, management and nursery trials with oranges and grapefruit. Investigation of Dying Out disease of limes was continued.

436. Coconut studies included an assessment of the high-yielding selections with observations on precocity. Control of Red Ring Disease by the use of phytocides was attempted. Control of palm weevils, *Rhyncophorus palmarum* and *Rhina barbirostris*, which are proven vectors of Red Ring disease caused by *Aphelenoides coccophilus* were also the subject of control experiments.

437. *Bananas*. Spraying trials were continued for the control of Leafspot Disease caused by *Mycosphaerella musicola*, Leach, by the use of the conventional water-based copper fungicides and the more recently developed technique of low volume spraying with oil-based sprays. Indications are that the latter is far more effective in controlling the disease. The ascospore stage of the fungus was observed for the first time in Trinidad, although it is highly probable that it has been present here for some time. Moko disease caused by *Pseudomonas solanacearum* is being investigated by cultivation and soil treatments for its control.

438. The banana weevil borer, *Cosmopolites sordidus*, Germ., continues to be troublesome. Control is being achieved by soaking suckers before planting in aldrin solution and spraying around the base of the plants with dieldrin solution every six months.

439. *Rice*. Pure lines of Sughandi, D.52/37 and D.110 have been produced for distribution. Five variety trials and one uniformity trial were laid down. A biological study was made of the two moth borers, *Rupela albinella*, Cr., and *Diatraea saccharalis*, F., found attacking rice at the Central Experiment Station.

440. *Grasses and Fodder*. Pasture management and observations on the grazing of Elephant Grass, *Pennisetum purpureum*, continued. Tropical Kudzu, *Pueraria phaseoloides*, grown in a 12 acre block during the past four years gave good grazing throughout the year at approximately six week intervals, an average of 200 cow days per acre per annum. Pangola, *Digitaria procumbens*, and Lucuntu, *Ischaemum timorense*, two promising pasture grasses were extended at the three principal livestock centres of the Department and planting material

was distributed to sub-stations and to stock keepers. Toco grass, *Ischaemum aristatum*, also promises to be a useful pasture cover for dry cows and beef cattle.

441. *Soil Survey.* A detailed survey of the Caroni Swamp to assess its suitability for rice cultivation was completed. Approximately 8,000 acres were completed in the survey of southern Trinidad. The soil survey of Tobago was resumed. It is planned to have an aerial survey early in 1956.

Soil Conservation

442. Trials for the assessment of run-off and soil loss under different types of vegetal cover have been established, and data collected over the past two years are being analysed. A land-use demonstration for steep slopes is in process of development.

Forestry

443. The pine (*Pinus caribaea*) research programme was brought to a successful close and the work on the formation of pine plantations handed over to the divisional officers who will expand the rate of planting. Growth continues to be fast, five feet height growth per year in the better plots; the colour of the foliage is good and there have been very few deaths from any cause. Four year old trees bore cones but no fertile seed.

Growth Increment Studies

444. During a visit by H. C. Dawkins, Ecologist, Uganda, a sampling and thinning programme to study growth in Arena mixed hardwood forest was worked out and surveys were commenced in November. Forty acres of a thirteen year old pole crop are being used and divided into twenty-five squares of 1.6 acres each.

Arboricides

445. Contact arboricides were tried out in primary and secondary forest growth. They killed secondary growth species such as *Cecropia*, *Erythrina* and *Castilloa* rubber within a month but after five months the effect on climax species has been negligible.

Soil Erosion Studies

446. Three small valleys, two under natural forest and one under teak ten years old, form the basis of research into run off and soil erosion. Later one of the forest-covered valleys will be converted into teak when sufficient data on their comparability have accumulated. Records were kept throughout the year but the data have not been analysed so far.

UGANDA

Maize

447. A series of maize variety trials was organised throughout East Africa by E.A.A.F.R.O. to test the possibility that the land races which have developed in different areas might be redistributed to better advantage. These trials were not completed by the end of the year because the seasons are not the same in all places, but there was some indication that certain types developed in Tanganyika might be useful in Uganda. The transference to local maize varieties of resistance to *polysora* rust proceeded at Kawanda, but the programme was modified in the light of the knowledge gained by Dr. Storey at E.A.A.F.R.O. headquarters that two races of the rust exist (potentially many more) and that two genes for resistance are available for transfer. Work also proceeded on the production of synthetic maize varieties by Lonnquist's method.

Sorghum

448. A review was completed at Serere of the place of sorghum in different agricultural systems. The main problems in the crop were short-listed as (a) birds, (b) stalk borers, (c) storage pests. Uganda is therefore interested in breeding radically improved varieties to take the place of maize or finger millet in marginal areas.

Finger Millet

449. Interesting light was thrown on the wild head ("ekitu") problem. Information kindly provided by the Director of the Royal Botanic Gardens, Kew (personal communication), suggested that there are two important wild species in Africa, a diploid species *Eleusine indica* in the coastal and humid areas, and a tetraploid species *Eleusine sp. nov.* in the savannah areas. Both occur in Uganda, the latter being "ekitu". Only the former occurs in India, where wild heads are not reported as a problem in the crop. If the tetraploid species is postulated as the progenitor of the crop, *E. coracana*, which is a tetraploid, then Africa and not India emerges as the centre of origin of the crop, and the occurrence of a range of hybrids in the crop in Africa is explained. The practical importance of this hypothesis in Africa may not be great, but it becomes important to avoid making an unwitting introduction of the tetraploid species into Asia.

Rice

450. Fifteen varieties selected for resistance to blast disease at Kawanda have been forwarded to Mbale for testing in the area where most rice is grown.

Bananas

451. Panama disease was reported from two new areas, Toro in the west, and Bugisu in the east. It is now unlikely that any banana growing area is sufficiently free from this disease to warrant any special precautions concerning the internal movement of material for planting. The relative susceptibility of the sweet and roasting types as compared with the green banana has been noted on a number of occasions, but as yet no formal data can be presented.

Coffee

452. The E.A.A.F.R.O. Specialist Committee discussed at length the important question of self-incompatibility in the diploid species, and its bearing on the breeding of *Coffea canephora*. At the end of the year a coffee research unit was set up within this department, with the task of framing a new and more vigorous programme of research. The new station for robusta coffee in Kyagwe has to establish a water supply before building can start, and that for arabica coffee on Mt. Elgon awaits a solution to the local problem of *Simulium neavei*, which is being pursued by the Medical Department.

Cotton

453. The variety BP 52/NC 54 bred by the Empire Cotton Growing Corporation at Namulonge offers the promise of a remarkably good yield on some 200 acres of land at the Bunyoro Agricultural Company's farm at Kigumba in the western province. In the eastern and northern provinces this department's variety DE 715/6 has achieved yield, resistance to blackarm and wilt, and freedom from seed-coat neps, but its spinning quality is in question. The Empire Cotton Growing Corporation will post an officer to Serere in 1956, when the responsibility for cotton breeding in this area will be handed over.

454. All twelve seed dressing stations were in operation and for the first time all seed for planting throughout Uganda was dressed with *Perecot* or *Armasan* dust. The annual survey did not reveal any main-stem infection rate higher than 15 per cent., whereas formerly figures of 50 per cent. or more were frequent.

Sugar Cane

455. An enquiry into the origin of the varieties which have proved to be commercially successful in Uganda revealed a very close relationship between them and suggested that breeding for a 12-hour day may be an important consideration.

456. By the end of the year stocks of material free from ratoon-stunting disease had been built up at Kawanda to the point where it could be released in bulk to the estates. It has been arranged that all new varieties released from the E.A.A.F.R.O. Plant Quarantine Station are sent to Kawanda for heat treatment against ratoon-stunting disease. This material raised at Kawanda is made available to all research centres in East Africa.

Entomology

457. Most types of sprayer and duster which show any promise have been tested. Definite recommendations for machines for use in tropical conditions can now be made.

458. It has again been confirmed that *Lygus vosseleri* can be controlled and cotton greatly improved by low-volume spraying with DDT. This work is passing the research stage and is going into practice. Pyrethrum dusting against *Antestia* on arabica coffee is becoming normal practice in certain areas and is being extended to the Coffee Lace Bug, *Habrochila ghesquierei*.

459. Various kinds of seed produce have been sampled in order to measure the extent of insect damage and other defects. The information gained has been used to help in drawing up quality standards, most of which have been adopted by the trade in Kenya as well as Uganda.

460. *Chilo zonellus* has been proved to be the most serious of the cereal stem-boring caterpillars, but *Busseola fusca*, *Sesamia calamistis*, *S. poephaga* and *S. ?botanephaga* also do considerable harm. Sorghum and maize are often heavily damaged, finger millet, bulrush millet, rice and sugar-cane much less so. All species appear to breed continuously, no sign of a dry season resting stage having been found. Preliminary work has been done on the various species of Dipterous stem-borers and on the Sorghum Midge *Contarinia sorghicola*, and other pests of heads.

Publications

A. P. G. MICHELMORE—Food Storage Problems in Uganda in relation to Insect Pests. *E. Afr. Agric. J.*, **21**, No. 2, 1955.

T. E. T. TROUGHT—Preliminary Tobacco Eelworm Investigations in Uganda. *E. Afr. Agric. J.*, **21**, No. 1, 1955.

Chemistry

461. On the more fertile red soils of Southern Uganda considerable responses are sometimes obtained by applying nitrogen and phosphate on old, heavily cropped land. Thus the basic yield of an area under cotton has been approximately doubled by a combined treatment with sulphate of ammonia, double superphosphate and sulphate of potash at planting time. On new land in a similar situation a marked increase in yield was observed due to mulch and sulphate of ammonia but it is noted that continued mulching with no applied nitrogen eventually produces very late, nitrogen-deficient cotton. Application of nitrogen to a permanent grass ley produced a nearly fourfold increase in green matter. Pot tests on soil from two of the trial sites have indicated a need for trace elements which may mask the response to nitrogen and phosphate.

462. Pot culture techniques have been used extensively to detect deficiencies of major and minor nutrients. A number of deficiencies of nitrogen, phosphorus, sulphur and of the trace elements have been found. The beneficial effects of small dressings of farmyard manure in maintaining fertility in N.E. Uganda are probably due largely to overcoming the acute shortages of nitrogen, phosphorus and sulphur of these soils. Pot experiments on red and brown volcanic soils from areas surrounding Mt. Elgon have also revealed deficiencies in nitrogen and sulphur. The infertility of acid soils in certain areas of Buganda has been found to be due to nitrogen and phosphorus deficiencies as well as to acidity.

463. Investigations have now commenced on the relative contributions of bacterial nitrification and capillary transport of nitrate towards the nitrate status of the topsoil. Results so far indicate that bacterial nitrification plays the more important part during a period of light, intermittent rains. The active population of nitrate-producing organisms declines markedly with the fall in total nitrogen and pH consequent upon continued cropping. Soils from different areas have indicated contrasting populations of nitrifying and nitrogen-fixing organisms. Experiments will be continued on the mineralization of organic nitrogen and its dependence upon the total nitrogen status in each soil type.

Publications

E. M. CHENERY—Rapid method for the determination of total Aluminium—in A. Thompson and A. M. Raven: "Soil Contamination of Herbage Samples". *J. Sci. Food Agric.*, 6, (1955) 776.

G. H. S. WOOD and E. M. CHENERY—Regeneration of *Chlorophora excelsa* (Mvule) in Uganda in Relation to Soil-Root Conditions. *E. Afr. Agric. J.*, 21, (1955) 34.

Forest Research

Natural Forest Silviculture

464. Four-year old factorial experiments testing the effects of various treatments on regeneration have now produced significant results. Interactions have proved to be greater than individual effects, and a practicable combination of pre-exploitation treatments has emerged. It has been found that ordinary "regeneration counts" are not satisfactory for assessment of results and that some form of basal area enumeration must be used.

Arboricides

465. Experiments in seasonal sensitivity were started as there is some evidence that certain weed trees are more resistant to contact arboricides during the rains. In the dry-country thorn-scrub, most species were found to be highly sensitive to basal sprays of 2,4,5-T in diesel oil.

Natural Forest Increment

466. It has been found that very large differences of growth-rate between individuals of a species occur even when crown position, form, height, girth and site have been accounted for. Some individuals can remain "inert" for at least four years while others, apparently comparable, grow fast. A method of girth measurement giving readings accurate to ± 0.03 inch of girth has been evolved, requiring no apparatus beyond a steel tape. By using this method it is hoped to discover relatively quickly how phenology, treatments, climate and cyclical fluctuations may account for the so-far inexplicable growth behaviour.

Utilisation

467. General tests were completed on four of Uganda's more abundant timber trees including *Drypetes* and *Celtis* which were new to the trade. Further tests were started on seven other species.

Publications

H. C. DAWKINS.—The Refining of Mixed Forest ; a new Objective for Tropical Silviculture. *Emp. For. Rev.*, **34**, (1955) 188.

J. E. M. STEPHENS.—Tree Growth in a Seasonally dry swamp in Eastern Uganda. *E. Afr. Agric. J.*, **20**, (1955) 232.

Veterinary Research

468. Investigations into the incidence, life history and control of liver fluke in Uganda were undertaken throughout the year. Studies were commenced on the virus of fowl pest following outbreaks of the disease in Uganda.

469. Research continued into the bionomics of biting flies other than tsetse. Collection and identifications of flies were made and a laboratory breeding unit of *Stomoxys calcitrans* was successfully established.

470. Work continued upon the evaluation by chemical analysis and digestibility trials of local fodders and concentrates. Particular attention was paid to the preparator, composition, and feeding value of silage. Several types of pit silo were used. Studies on the habits of Zebu cattle were extended to include sexual behaviour and recording of heat periods. Further trials were made of artificial insemination in indigenous cattle and an experimental pilot insemination unit was in action for about two months.

Publications

K. W. HARKER, J. I. TAYLOR and D. H. L. ROLLINSON.—Studies on the Habits of Zebu Cattle. V. Night Paddocking. *J. Agric. Sci.* (in the press).

J. M. S. LUCAS.—Transmission of *Trypanosoma congolense* in Cattle under Field Conditions in the absence of Tsetse Flies. *Vet. Rec.*, **67**, (1955) 403.

D. H. L. ROLLINSON, K. W. HARKER and J. I. TAYLOR.—Studies on the Habits of Zebu Cattle. III. Water Consumption of Zebu Cattle. *J. Agric. Sci.*, **46**, (1955) 1.

D. H. L. ROLLINSON.—Oestrus in Zebu Cattle in Uganda. *Nature*, **176**, (1955) 352.

D. H. L. ROLLINSON.—Hereditary Factors Affecting Reproductive Efficiency in Cattle. *Animal Breed. Abs.*, **23**, (1955) 215.

J. I. TAYLOR, D. H. L. ROLLINSON and K. W. HARKER.—Studies on the Habits of Zebu Cattle. II. Individual and Group Variation within a Herd. *J. Agric. Sci.*, **45**, (1955) 3.

J. I. TAYLOR.—The Rearing of an African Elephant in Captivity. *Vet. Rec.*, **67**, (1955) 301.

J. I. TAYLOR.—East Coast Fever in Uganda. *Bull. Epizoot. Dis. Afr.*, **2**, (1955) 391.

ZANZIBAR

Clove Disease Research

471. In Zanzibar Island, young clove trees which are established in areas where trees have been killed by sudden-death are frequently affected by a disease known as slow decline when they reach the age of 10–12 years. Experiments aimed at preventing slow decline by deep cultivation, field sanitation, and delayed planting are in progress. In Pemba, sites are being selected for experiments to arrest the progress of active sudden-death in privately-owned plantations.

Cattle

472. Milk production records of the Zanzibar herd at the Government stock farm continue to improve, and the culling standards have again been increased. Two cows have now given over 400 gallons in their first lactation (305 days). The success of the herd established for the production of beef in a tsetse area on the thin soils overlying coral has led to the establishment of a second herd with much greater possibilities for expansion.

Soils and Fertilizers

473. Fertilizer experiments on rice in both islands were continued. In Zanzibar nitrogen and phosphate again increased rice yields, and efforts to get rice growers to purchase fertilizers are being continued. Soils in Pemba are more variable but one or two also respond well to nitrogen and phosphate. Fertilizers applied to cassava in Zanzibar have so far produced no significant effects. Manurial experiments are also being carried out with derris, coffee, cocoa, and other crops.

Plant Testing

474. Investigations on the suitability of various forest trees on soils in Zanzibar and Pemba continue. Trials of hybrid cassava bred for resistance to virus infection and issued by the East African Agriculture and Forestry Research Organization were continued, three of the third back crosses of *M. glaziovii* with cassava giving higher yields than the best local variety in trials over three years. Observations were made on growth, yield and resistance to *Puccinia polysora* of 14 maize types believed to be pure for the hypersensitive gene supplied by the East African Agriculture and Forestry Research Organization.

Pasture Research

475. *Stylosanthes gracilis*, *Pennisetum purpureum*, *Panicum maximum*, *Melinis minutiflora*, *Digitaria* sp. and *Pueraria phaseoloides* were under test both for yield and palatability, while *Digitaria* sp. was also compared with *Stenotaphrum dimidiatum* and *Paspalum notatum* under grazing. Sulphate of ammonia was shown significantly to increase yields of *Digitaria* sp.

Publication

G. E. TIDBURY—Response of Rice to certain Fertilizers in Zanzibar. *Trop. Agric. (Trinidad)*, 33, (1956) 113.

VII. REPORTS OF STANDING SUB-COMMITTEES*(a) Cocoa Research Sub-Committee*

476. The Sub-Committee did not meet but a special Panel met to consider cocoa fermentation problems. Mr. O. J. Voelcker, C.B.E., joined the Sub-Committee and Dr. C. B. Williams, F.R.S., retired.

477. Attention was directed chiefly to the problems of cocoa fermentation, both laboratory studies on small-scale aseptic processes and on the glucoside and enzyme systems involved in changes in cocoa-beans during fermentation. The need for reliable small-scale methods of cocoa preparation for taste assessment of new varieties and hybrids is particularly urgent as an aid to the extensive cocoa breeding programmes now under way. Fuller information on this problem is given by the Colonial Microbiological Research Institute in the Annual Report of the Colonial Products Council.

(b) *Soils Sub-Committee*

478. The Sub-Committee held one meeting. Dr. E. W. Russell relinquished the Chairmanship on his appointment as Director of the East African Agriculture and Forestry Research Organization and was succeeded by Professor A. B. Stewart. Overseas visits were made by Dr. Russell to New Zealand, Malaya, the Sudan and East Africa ; by Dr. Greene to New Mexico, U.S.A., Central and West Africa, and the British West Indies ; and by Dr. Osmond to Cyprus.

479. The Sub-Committee paid particular attention to the conduct of soil surveys notably that of British Guiana, and to assignments by members of the Pool of Soil Surveyors. Consideration was also given to the needs of Caribbean territories for soil research and to the part to be played by the newly constituted Regional Research Centre in Trinidad.

(c) *Stored Products Research Sub-Committee*

480. The Sub-Committee held one meeting. Dr. Jepson attended the Reviewing Committee meeting of the West African Stored Products Research Unit.

481. The Sub-Committee was specially concerned with co-ordination of the work of the West African Stored Products Research Unit, the code of practice in the use of DDT and BHC, with insect control in Gambia groundnuts and the use of insecticides on cocoa in store in West Africa. Members of the Sub-Committee were called on to a large extent for advice on the control of storage pests not necessarily involving research.

Colonial Economic Research Committee Ninth Annual Report (1955-1956)

London School of Economics and Political Science,
Houghton Street,
Aldwych,
London, W.C.2.
6th December, 1956.

SIR,

I have the honour, on behalf of the Colonial Economic Research Committee, to transmit to you the Ninth Report of the Committee covering the period from 1st April, 1955, to 31st March, 1956.

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 ¹¹⁷

NINTH ANNUAL REPORT
(1955-56)

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 Economics, with special reference to
Banking and Currency, University of London.

PROFESSOR J. R. N. STONE, C.B.E., Professor of Finance and Accounting,
University of Cambridge.

PROFESSOR R. C. TRESS, Professor of Political Economy, University of Bristol.

MRS. E. M. CHILVER, (*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

ANNUAL REPORT 1955-56

I. INTRODUCTION

1. Three meetings of the Committee were held during the year and a Working Party was set up to examine proposals for economic research in Malta, which will be referred to below.

2. Professor J. R. N. Stone tendered his resignation to the Secretary of State at the end of the year owing to heavy pressure of work. Professor R. C. Tress attended the Inter-African Conference on Social Sciences at Bukavu in August/September, 1955, at the invitation of the Secretary of State. He also visited the East African Institute of Social Research during his trip.

II. GENERAL

3. Issues against the Economic Research Allocation of £70,000 were £7,570 at the 31st December, 1955.

4. The Committee invited the views of Colonial Governments on the expenditure of the uncommitted balance and these were being considered at the end of the year in the light of staffing and financial considerations.

5. Work at the Institutes and Social Research Units of Economic interest is fully recorded in the annual reports of the Institutes. Its volume is increasing and several interesting publications by Institute staff are in the press or ready for publication, notably Mrs. Humphreys' study of Gold Coast Cocoa Farmers' Incomes, Mr. Baldwin's account of the Mokwa Scheme, Dr. Kaye's study of a slum street in Singapore and Mr. W. Elkan's study of factory labour in Kampala and Jinja. Miss Martin's study of the Oil Palm Economy of the Ibibio was about to be issued by the Ibadan University Press.

6. New publications in the East African Studies series included Dr. Winter's account of the economy of a small tribe in western Uganda, Doctors C. and R. Sofer's description of the social and economic changes in Jinja brought about by the construction of the Nile dam, and Dr. Gulliver's report on labour migration in Southern Tanganyika.

7. The University College of the West Indies' Institute of Social and Economic Research continued to publish its Journal "Social and Economic Studies" and a forthcoming issue will contain a symposium by a number of economists on the Hicks' report on taxation in Jamaica, and Mr. Thorne's study of the National Income of Jamaica.

III. RESEARCH FINDINGS PUBLISHED

8. Dr. Fergus Chalmers-Wright's report on African consumers in Tanganyika and Nyasaland was published in the Colonial Research Studies series in the course of the year.

IV. RESEARCH COMPLETED

9. Professor Gilbert Walker's monograph *Nigerian Transport in 1950* was received and is now being studied by the Nigerian Federal Government and by the Colonial Road Research Committee.

10. Mr. G. A. Petch had at the end of the year circulated his report on the agricultural economy of Sierra Leone with special reference to the oil palm industry. A summary of it had been forwarded to the Sierra Leone Government for comments.

11. The fiscal survey of the British Caribbean by Dr. A. R. Prest, assisted by Mr. W. G. Demas, had been completed in draft by the end of the year and circulated to the Governments concerned. It is now being prepared for publication in the Colonial Research Studies series.

12. Mr. F. H. H. King's *Money in British East Asia* is now printing and will be published in the Colonial Research Studies series. Copies of the final draft were submitted before publication to the Governments interested.

V. RESEARCH IN PROGRESS

13. Mr. C. A. Moser of the London School of Economics will be completing his report very shortly on levels of living studies in Jamaica.

14. Mr. D. T. Edwards, attached to the Institute of Social and Economic Research, University College of the West Indies, is now at work on the last stages of the analysis of the results of the economics of small farms in Jamaica, carried out in close association with the Jamaican Department of Agriculture. This study, which has received considerable financial and other assistance from the Government of Jamaica, was prolonged by means of a supplementary grant to enable an unexpectedly large volume of findings, due to the excellent co-operation of the farming community, to be analysed.

15. Mr. A. T. Peacock and Mr. Douglas Dosser started work on the national income inquiry in Tanganyika. The purpose of the inquiry is, in particular, to lay the foundations for further national income accounting work in the territory. The inquiry is being energetically pursued in close collaboration with the Government, which has contributed funds towards it. It is being planned on rather similar lines to the national income inquiry in Nigeria carried out with the assistance of the Department of Applied Economics at Cambridge.

VI. NEW PROJECTS

16. The Committee recommended that a grant of £5,000 should be made to a joint investigation by the Royal University of Malta and the Durham Colleges of the agricultural economy of Malta. The object of the investigation is not only to provide information on the structure of Malta agriculture and its place in the national economy but to suggest new lines of development to the Malta Ministry of Agriculture, which will be kept closely in touch with the work of the team. The investigation will be organised by a joint committee of the two Universities.

17. A grant of over £16,500 was made to Makerere College to enable the East African Institute of Social Research to continue its work in the field of industrial and labour economics in East Africa, and to expand along lines suggested by the Report of the East African Royal Commission.

VII. ECONOMIC RESEARCH UNIT, UNIVERSITY COLLEGE OF THE GOLD COAST

18. The Economic Research Unit of the University College of the Gold Coast made two new appointments during the year: Mrs. Polly Humphreys and Miss C. McGlade, who are cooperating in an investigation into certain economic aspects of cocoa farming with special reference to the relations between farm owners and tenants. Their work has been designed to continue the preliminary research already undertaken by Mrs. Humphreys in 1954-55 under a grant from the West African Institute of Social and Economic Research, and to fit in with the budget inquiries already undertaken by the Government Statistician's office.

An investigation into the problems of food supplies to the Sekondi-Takoradi area and the neighbouring urban areas was undertaken by the Unit under the direction of B. M. Niculescu, at the request of the National Food Board, to facilitate the formulation of a feeder road policy. This investigation was carried out along the lines worked out over the past three years in the preliminary work for the supply of foodstuffs to Accra. A dot map of the population distribution of the Gold Coast on the basis of one dot for each 500 people and on a 1 : 400,000 scale was drawn up by B. M. Niculescu and printed at the Government Printing Department in connection with the final report to the National Food Board.

The investigations into the problems of African entrepreneurship continued with the help from voluntary workers from outside the Research Unit.

Mr. E. Rado concentrated on the problems of the African contractors.

The fairly heavy lecturing programme undertaken, as in past years, by part of the staff of the Research Unit enabled the teaching members of the Economics Department of the University College to continue with their own research work as well as with similar work undertaken at the request of the Government.

VIII. CONFERENCES

19. The joint Conference of the University College Ibadan and the University College of the Gold Coast, organised by W.A.I.S.E.R. took place in the Spring of 1955 and the Conference proceedings are being duplicated for circulation. A final Conference organized by W.A.I.S.E.R. took place at the end of the year pending the re-organization of the Institute as a Nigerian body. There is every hope that the social and economic conferences, which are now attended by scholars from many territories in West Africa, will become a regular feature of inter-collegiate activity in West Africa.

20. As a result of recommendations made at the meeting of the Inter-African Committee on Social Sciences in Bukavu, the Scientific Council for Africa South of the Sahara is convening a meeting of economists in Nairobi to discuss the preparation and regular issue of a register of economic research in tropical Africa both of work in progress and in the planning stage. Dr. P. Ady of St. Ann's College, Oxford, is the rapporteur to the meeting and has already prepared a draft register for consideration.

IX. PUBLICATIONS BY WORKERS ASSISTED FROM COLONIAL DEVELOPMENT AND WELFARE FUNDS

21. 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 Eighth Annual Report) are :—

Cumper, G. E., *Report on Employment in Barbados*, Report submitted to Minister of Trade and Labour, Barbados, March, 1956.

Elkan, W., *An African Labour Force : Two Case Studies in East African Factory Employment*, East African Studies, No. 7, E.A.I.S.R., 1956.

Is Mr. Padley Right about the Missing Millions? "Uganda Argus", 17th August, 1955.

- Fearn, H., *Marketing and Distribution*, "East African Economics Journal", January, 1956.
- Review articles : V. C. R. Ford, *The Trade of Lake Victoria*, "Uganda Argus", December, 1955 and "Uganda Journal", March, 1956.
- The Diverse Pattern of African Agriculture in the Nyanza Province of Kenya*, paper read at International Geographical Union Symposium, September, 1955.
- The Gold Mining Era in Kenya Colony*, "Malayan Journal of Tropical Geography", 1956.
- Ford, V. C. R., *The Trade of Lake Victoria*, East African Studies, No. 3, E.A.I.S.R., 1955.
- Hawkins, E. K., *Nigeria : une année de transformations*, "Civilisations", Vol. 2, May, 1955.
- Transport in Nigeria : 3*, "West Africa", 3rd December, 1955.
- Huggins, H. D., *Regional Differentials in Wages : Some Considerations*, "Social and Economic Studies", Vol. 4, No. 3, September, 1955.
- Population and Migration*, "New Commonwealth" (special Caribbean supplement), 31st October, 1955.
- King, F. H. H., *Notes on the History of Currency in Sarawak*, Hong Kong University Press, "Journal of Oriental Studies", II, July, 1955.
- Sterling Balances and the Colonial Monetary Systems*, Royal Economic Society, "Economic Journal", LXV, December, 1955.
- Chapter on Malaya and British Borneo in the annual E.S.A.F.E., *Economic Survey of Asia and the Far East*.
- Prothero, R. Mansell, *The Sample Census of Nigeria, 1950-51*, "Geographical Journal", Vol. CXXI, 2, June, 1955.
- Turner, E. L. B. and V. W., *Money Economy among the Mwinilunga Ndembu: a Study of some Individual Cash Budgets*, "Human Problems in British Central Africa", Vol. XVIII, 1955.
- Wolfson, F., *The Krobo Oil Boycott—a price Agreement on the Gold Coast*, "Economic History Review", Vol. VI, 1953.
- Chalmers-Wright, F., *African Consumers in Nyasaland and Tanganyika*, Colonial Research Studies, No. 17, H.M.S.O., 1955.

Colonial Fisheries Advisory Committee Annual Report on Fisheries Research (1955-1956)

The Church House,
Great Smith Street,
Westminster, S.W.1.
13th November, 1956.

SIR,

I have the honour, on behalf of the Colonial Fisheries Advisory Committee, to transmit to you the Committee's Report on Fisheries Research for the year 1955-56.

I have the honour to be,

Sir,

Your obedient servant,

LLOYD,
Chairman.

The Right Honourable Alan Lennox-Boyd, M.P.,
Secretary of State for the Colonies.

COLONIAL FISHERIES ADVISORY COMMITTEE

Membership

THE PARLIAMENTARY UNDER-SECRETARY OF STATE FOR THE COLONIES (*Chairman*)

W. B. L. MONSON, C.M.G. (*Vice-Chairman*)

J. CROFT-BAKER, C.B.E.

G. E. R. DEACON, C.B.E., D.Sc., F.R.S.

C. F. HICKLING, C.M.G., Sc.D. (*Fisheries Adviser to the Secretary of State*)

T. S. LEACH, M.C.

C. F. A. PANTIN, Sc.D., F.R.S.

G. A. REAY, O.B.E., Ph.D., F.R.I.C.

F. S. RUSSELL, C.B.E., D.S.C., D.F.C., F.R.S.

MISS E. TREWAVAS, D.Sc.

R. S. WIMPENNY, M.Sc.

PROFESSOR C. M. YONGE, C.B.E., D.Sc., Ph.D., F.R.S.

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
 (1955-56)

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COLONIAL FISHERIES ADVISORY COMMITTEE
ANNUAL REPORT ON FISHERIES
RESEARCH 1955-56

I. STAFF

1. It is expected that existing vacancies will be filled by transfer.

II. FINANCIAL POSITION

2. Of the £930,000 made available under the Colonial Development and Welfare Act 1955 for Colonial fisheries research during the period 1st April, 1955 to 31st March, 1960, a total of some £730,000 has been committed. Further funds totalling £190,000 have already been earmarked for additional schemes, leaving only some £10,000 in reserve.

III. REPORTS OF INDIVIDUAL COLONIAL FISHERIES
RESEARCH STATIONS

The Inter-Territorial Fisheries Research Station at Jinja on Lake Victoria

3. The work of this station covers a wide range, and shows how the study of fisheries, and of fish, draws in as essential corollaries studies of the water they inhabit, and bacteria and plants present in the water, the soil and its chemical constituents and bacteria, and the invertebrates, especially insects, which are probably the most important food of fish, taken as a whole, in the Lake.

4. It is shown that the quantity of dissolved salts cannot be used as a general indication of potential fertility in the lakes of East Africa, because these may contain considerable quantities of sodium bicarbonate. If values for alkalinity, expressed as units of electrical conductivity, are subtracted from values for total conductivity, it is found that the remaining electrolytes are present in remarkably low concentrations. In other words, the content of biologically valuable electrolytes is much lower than might at first appear.

5. Yet plant nutrients occur in vast quantities in the deposits of organic matter lying on the lake bottom. Many analyses of these muds have been carried out, and it is clear that they constitute a vast store of valuable organic matter, derived from precipitated plankton, detritus of higher plants, and faecal remains from all the animals living in the lake. Dried samples of this mud appear to be quite edible, and might prove to be a useful supplement to the food of cattle, pigs and chickens. It has been shown to be effective in stimulating the growth of plants.

6. This mass of organic matter is almost odourless, contains few bacteria, and shows little tendency to decompose either under aerobic or anaerobic conditions. If boiled, however, it subsequently decomposes rapidly, and if dried and returned to the water, it produces a solution which supports a dense growth of bacteria, and later protozoa and algae.

7. A tentative explanation, which remains to be confirmed, is that antibiotic substances associated with freshly precipitated phytoplankton inhibit the growth of the bacteria. Under tropical conditions one might expect decomposition to proceed rapidly, but under a continuous rain of phytoplankton, carrying with it some antibiotic substance, the bacteria may never be able to establish themselves in the same way as they may do under temperate conditions where a

winter brings about a cessation of growth. If ways can be found to accelerate in situ the decomposition of these deposits, the fertility of the lake would be increased.

8. Snails may play some part in bringing back some of this material into circulation, for they not only secrete sulphuric acid as part of their digestive process, thus making available this essential plant nutrient, but they harbour bacteria in their gut, which are shed with the faeces, and probably assist in the decomposition of bottom deposits. It seems, therefore, that if molluscs were more abundant, the lake might be rendered more fertile.

9. This apparent antagonism between bacteria and algae may explain why iron bacteria are more abundant in some part of Lake Victoria than in others. It is found that iron objects corrode rapidly in lake water near Jinja, and that bacteria are associated with the products of corrosion. Yet corrosion is much less in other parts of the lake, for example at Kisumu. This recalls that the steel hull of the Lake Victoria Fishery Board's fishing craft stationed at Entebbe was severely corroded, while no observable corrosion had occurred to the similar vessels stationed at Kisumu and Mwanza. Moreover, the engineers responsible for the Owen Falls construction, and the new steel viaduct which carries the railway, have necessarily become interested in the corrosive effect of lake water.

10. Experimental work showed that little or no corrosion occurred in lake water which had been sterilised ; that a small amount of a commercial antibiotic preparation containing Streptomycin and Penicillin, when added to lake water, reduced the rate of corrosion very considerably ; and that the addition of a solution containing phosphates, nitrate, and sulphate caused an increase in the rate of corrosion.

11. The impression was gained that the iron bacteria are inhibited by the presence of algae, and that in this respect diatoms are probably more effective than green or blue-green algae. The density of phytoplankton is very much lower at Entebbe, in the region of Jinja, than at Kisumu or Mwanza.

12. Yet another possible illustration of this apparent antagonism between bacteria and algae may be seen in the rate of survival of very young *Tilapia* fish. These are, in nature, incubated in the mouth of the parent ; but successful experiments were made in incubating and hatching them *in vitro*. The mortality is low, when the young fish are incubated by the parents, because not only are the eggs well aerated, but by being rolled about in the parent's mouth, and probably because the buccal mucus contains some antibiotic substances, they are protected from bacterial and fungus attack. But *in vitro*, a high rate of mortality occurs when the small fish are between ten and twelve millimetres long, death being due to bacterial infection of the gut. So the young fish must be kept in water containing very few bacteria ; and in lake water they live in a medium containing considerable quantities of algae, but relatively few bacteria.

13. It seems clear that this apparent algae-bacteria antagonism deserves further study, affecting, as it seems to do, so many different facets of life in Lake Victoria.

14. This research station now has a wide programme of entomology, since nearly every species of fish at some stage of its life feeds on insects, and many species do so throughout life. Named collections of several groups are now available in the laboratory for reference. Adults are being correlated with the larvae. Besides the Chironomids, whose importance as food for Mormyrids has been noted in earlier reports, the Ephemeropteran *Povilla adusta* swarm at monthly intervals, usually on the second day after full moon.

At the time of the emergence of the adults, certain species of fish abandon their normal feeding habits to exploit the larvae and adults congregating at the surface. Also several fish feed extensively on the larvae during their pre-swarming period of growth, on or in the lake bottom. Hemiptera may be important as predators on young fish.

Some study has been made of the freshwater crab (of little importance to fish) and the freshwater prawn, which is at times important as food for fish.

15. An analysis of the records of Tilapia fish caught by African fishermen in Lake Victoria has been completed for a period covering three years. This analysis throws light on the variable density and distribution of the fish populations occurring round the shores of the lake, and is based on statistical records collected at 34 stations by the Lake Victoria Fisheries Service.

16. Although much information can be derived from such records, it is necessary for the Laboratory to collect regularly samples of fish from particular habitats, using nets covering a wide range of mesh-sizes, and at all seasons of the year, including seasons when the commercial fishermen may not be active. Useful information has been obtained not only on the occurrence of different species of fish present in various habitats, but knowledge has been gained on the movements made by certain species during the course of their lives. Although in general terms the outline of the life-history of Tilapia fish is known—that the young fish inhabit water lily swamps; that as they grow larger they move into open water before they start to seek suitable breeding grounds—this knowledge has still to be integrated with the records of fish caught commercially. Furthermore, though much is now known of the rate of growth of these fish, very little is known of their mortality rate, so that it is still not possible to predict future catches.

17. Investigations to date indicate that stocks of Tilapia have in many areas been seriously depleted, and that there are few areas where the fishing effort can be much increased without endangering the future. A memorandum entitled “The Danger of Overfishing Existing Stocks of Tilapia, with particular reference to Lake Victoria and the Kavirondo Gulf” was sent to the Lake Victoria Fisheries Board and to other interested parties.

18. As a possible counter to the depletion of the native stocks of Tilapia, and because its habits themselves add to the fertility of a lake, the experiment of introducing the weed-eating *Tilapia Zillii* into Lake Victoria was recommended. It has since been found that these fish grow more rapidly than the native Tilapias, and some have grown to a length of 27 cm. It still remains to be seen, however, whether they will reproduce in sufficient numbers to form a significant part of the commercial catches in the future. This same species, introduced into Lake Kioga, has attained a weight of 6½ lb.

19. The most important discovery among fish other than the Tilapias (and their relatives) is that of the breeding habits of the valuable *Clarias mossambicus*, a discovery which may enable this fish to be farmed. The eggs are laid in seasonably-flowing streams, so that the eggs and young fish have well oxygenated water. The adults have an accessory air-breathing organ, and can and do live in habitats where there is little or no dissolved oxygen.

New data have been collected on the breeding of the Lung-Fish *Protopterus*, an important food-fish. One nest in papyrus was found to contain 5,192 young fish, and the nest was so made as to give the young access to the air, which they can breathe, thanks to their lungs, when the water in which they live is deoxygenated.

East African Marine Fisheries Organisation

20. The work of this station continues to be a study of the big pelagic fishes of the Western Indian Ocean, the principal bottom fishes (snappers and groupers) and the oceanic circulation and the variations in the layering of the waters with the changes of monsoon.

21. The research-vessel, the 69 ft. wooden motor-drifter "Research", has given good service, having steamed some 26,000 miles since she came to East Africa in 1951, and spent some 339 days at sea. She has paid eight routine visits to the dockyard in these years, totalling some 76 days. Her record has therefore been good; but she is now 18 years old, is too small for the extended cruises which are now required by the programme for a full staff, and is due for replacement.

22. On 16th June, 1955, when the "Research" was off Mafia Island, and to windward of the reefs, the primary timing chain on the main engine broke and put that engine out of action. The Master, Captain Slater, skilfully extricated the ship from this dangerous situation, and succeeded in sailing her home to Zanzibar, a distance of 165 miles.

23. There is now a full staff, consisting of a Director and four scientific officers. The Director is dealing with the Lethrinid fishes and also with sharks; Mr. Talbot with the Lutianids (snappers), assisted by Mr. Morgans, who also deals with the Serranids (groupers); Mr. Williams continues his work on the big pelagic (surface) fish, with particular attention to the Carangids (jacks or crevallys). Mr. Newall is the hydrographer, and studies the distribution and movements of the oceanic waters.

24. A study of the plankton has begun, as throwing some light on the movements of the big pelagic fishes. Fine nets towed at midnight, or during the early hours of the morning, produce a quantity and variety of planktonic forms in striking contrast to the meagre catches of the daytime; yet the plankton is there below the surface, and it is quite likely concentrated at a level where light conditions are at an optimum in relation to other factors.

25. The descent of surface plankton forms may be checked by a thermocline or abrupt change in temperature. Could it be shown that plankton concentrations occur at the level of this thermocline, and that pelagic fishes remained at this level in the daytime to feed, new and extensive grounds for both commercial and sporting fishing might be opened. So work is being directed toward a device which will carry towed lures down to the level of the thermocline.

26. The size of these big pelagic fishes may be judged from the fact that, among the fishes caught by the research vessel by trolling, the average weight was 15 lb. It would have been higher but for the fact that the very big fish break the lines, no shock-absorbing device having yet succeeded in coping with the sudden strain of the strike of a big fish while the ship is at speed.

27. The bottom-living fish are less susceptible to local hydrographic changes, and their average size is smaller (average weight $5\frac{1}{2}$ lb.). Work on the food and life histories of these fish continues, the principal means of capture being hand-lines. Trawls have not been effective, and gill nets and trammel nets have had only a limited success, owing to the strong currents. Fish traps have given better results.

28. Direct observation of the habits of bottom-dwelling fishes is now possible by the acquisition of an Aqua Lung.

29. The marine fishponds at Chukwani are being used to observe the rates of growth of particular species.

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Joint Northern-Rhodesia Nyasaland Freshwater Research Station

30. The research team which consists of Mr. Jackson, Scientific Officer in charge, and Messrs. Fryer, Harding and Iles, with Mr. Gilbert as technical officer, left Nkata Bay, on Lake Nyasa, in November, 1955, at the end of the two-year survey of the northern part of the lake. One officer, however, has remained on the lake to continue observations.

31. The team spent the rest of the year in unpacking equipment and organising the new permanent headquarters at Samfya, on Lake Bangweolo. The Laboratory was not complete when the team arrived, and although all the rooms were available for use, there was a lack of facilities, furniture and space.

32. Subject to these handicaps, work was started on Lake Bangweolo, with visits to Lake Mweru.

33. Most of the year under review, however, was spent on Lake Nyasa. The lines followed by the survey consisted firstly of a general survey of the area from an ecological standpoint and with special reference to fish, in order to discover as much as possible about their preference of habitat, feeding and breeding habits, distribution and abundance, all of which knowledge is essential to the understanding and proper management of the fisheries. It was found that the fishes of Lake Nyasa, which are in great and complex variety, are in nearly all cases very narrowly confined to certain habitats.

34. In addition to the general survey, a more detailed study along these lines was undertaken of the lake littoral, in particular of a small section of the shore near Nkata Bay.

35. Another detailed study was undertaken of the Utaka, a group of species of cichlid fishes mostly of close and complex relationship, which are one of the most important economic groups of the deep and rocky Northern Lake. The Utaka, which were known to be Zooplankton eaters, and of shoaling habit, are unfortunately not very abundant in the open waters of the lake, but are associated generally with rocky areas close to the shore. Though thousands of square miles of open water are thus relatively lacking in Utaka or other fish life, a great deal was done on the fishery for them, an improved version of the "Chilimila" or open-water seine giving much better catches than the African net.

36. Despite the absence of Utaka from the offshore waters, there is a large potential fishery for these fish in the Northern Lake, and it is to be hoped that the African fisherman will develop this to the full.

37. During the year, work also continued on the setting of deep gillnets for Bagrus, Clarias, and other fishes which occur in numbers in deep waters down to the limit of dissolved oxygen. This development of gill netting, started by this research team, is a valuable and useful commercial fishery.

38. Studies of the Crustacea of the area, both free-living and parasitic, were continued and are being prepared for publication. Animals of this group are very important as food for fish. The plankton of the southern part of the lake seems, in general, to be quantitatively and qualitatively richer than in the north, especially at certain seasons.

39. Work also continued on the collection of limnological data, and on echo-sounding records of fish. The chemical analysis of the water showed that few nutrients can be detected in the surface waters, these presumably being used as soon as available, and that the deeper waters of the lake are completely deoxygenated, may contain a considerable quantity of sulphuretted hydrogen, are therefore unable to support fish life, and have no fishery potential.

West African Fisheries Research Institute

40. This Institute has a staff of six, namely, a Director, Mr. A. G. Taylor, and five scientific officers, one of whom is on detached duty at a field station at Birnin Kebbi, in Northern Nigeria.

41. The station's research vessel, the motor-trawler "Cape St. Mary", was at her builder's yard at Aberdeen from March to December. Her refit was completed by early September, when an outbreak of fire resulted in damage which delayed her return to West Africa until January. She arrived in Sierra Leone on the 9th of February.

42. The station's two 31-ft. research launches, the "Cape St. Paul" and the "Cape St. Ann", have also, after a long period of excellent service, given trouble with cylinder heads and crankshafts, and in both the engine has been replaced.

43. Owing to the absence of the research vessel, work has again mainly depended on the launches; trawling investigations in the sea and estuary have been continued, and show the usual increase in demersal fish during the first quarter of the year, and, in particular, the appearance of younger age-groups.

Preliminary analysis of records of catches at varying depths with a 62 ft. otter trawl indicates that the best fishing grounds covered up to date lie within the depths of 5-25 fathoms. It also seems, from past records of the research vessel, that along the west coast of Africa the best average fishing with the trawl is off Guinea, at about 500 lb. of fish per hour's fishing, that the lowest average fishing is off Liberia and in the Bights of Benin and Biafra, with averages of 150 to 200 lb. per hour, with Sengambia and the Gold Coast intermediate.

44. A study of the pelagic African Shad, *Ethmalosa dorsalis*, the Bonga, has continued, correlating its food and chemical composition with the plankton in the water.

45. Identification of fishes, planktonic organisms and invertebrates has continued, and type collections of named species are being built up.

46. Important work has been done on the invertebrate bottom-fauna, especially as it constitutes food for fish, and this is being prepared for publication. The first results indicate that the biomass of the Sierra Leone benthos is considerably lower than that of comparable communities in European waters; but it is possible that this low biomass gives an inaccurate impression of the productivity of the benthos in view of the very rapid growth rates of marine organisms in warm tropical water.

47. Transects across the continental shelf off Freetown indicate that a complete change of fauna occurs at 30-50 metres in association with the thermocline, and that the biomass of the deeper bottom fauna may be considerably higher than that of the communities of shallower water. But the increase appears to be due to the presence of large numbers of animals of doubtful value as fish food.

48. The routine plankton survey of the Sierra Leone River estuary is nearing completion, and the results are being prepared for publication. Collections of Mysidacea and Amphipoda from the plankton samples have been sent to specialists for identification, and sufficient systematic data have now been accumulated to warrant re-examination of the plankton samples collected by the "Cape St. Mary" in 1952 from widely separated parts of the West African coast.

49. The seasonal changes in the hydrography of the Sierra Leone estuary over a three-year period are being worked up. A paper on the bottom deposits is also in preparation.

The Singapore Regional Fisheries Research Station

50. The staff of this Station still consists of a Director, Dr. F. D. Ommanney, and two scientific officers, Messrs. Hall and Wickstead. The Laboratory at Changi Point has been completed, but the supply of electricity had not been made available by the close of the period under review. It was therefore impossible to work at the Station after nightfall, and the air-conditioning plant and aquaria were inoperative. Nevertheless the staff moved in to the Laboratory in November, 1955, and had at all events the convenience of having their own research accommodation, and proximity to their quarters.

51. The thanks of the Station are rendered to Professor R. D. Purchon, of the University of Malaya, for the hospitality which enabled the staff, in the two years before the move to Changi, to carry on their work in the Department of Zoology.

52. The 213 gross tons research vessel "Manihine" arrived in Singapore on 12th August, 1955, after her refit in Gosport. She had met with very heavy weather while on passage across the Indian Ocean, for example, having to lie-to in a 70 miles per hour gale off Cape Guardafui. The Captain was extremely pleased with her sea-keeping qualities, and she has proved an excellent sea-boat and economical to run. She has since put in the maximum sea time, namely, eleven major cruises in ten months.

53. During her cruises, the "Manihine" has tried out the following types of fishing gear :—

- (1) Otter trawl.
- (2) Long lines.
- (3) Drift nets.
- (4) Trolling lines.
- (5) Lampara net.
- (6) Blanket lift net with lights.

Of these, the otter trawl has, so far, proved to be the only certain and efficacious means of catching fish in commercial quantities available to a ship the size of the "Manihine" in offshore waters.

The cruises made by this vessel cover a wide network in the South China Sea and through the Malacca Strait North, and north-west of Sumatra and between Penang and the Thailand coast.

The best trawl catches were made in the South China Sea, where fishing was frequently at a rate higher than 200 cwt. per 100 hours' fishing, a rate comparable with that of many remunerative British trawling grounds.

All fish taken, or in the case of very large catches, an aliquot part, were measured, weighed, and examined for breeding condition and food-organisms. In this way, a picture is beginning to emerge of the distribution of the principal bottom-dwelling fish and prawns, their feeding and breeding habits. Trawl catches have frequently included useful numbers of the pelagic mackerel *Rastrelliger*, and important food fish.

54. The remaining methods tried were not successful. Long-lines of European practice have so far given negative results, while drift nets, again of European practice, caught little, and proved difficult to handle.

Trolling lines again yielded little, only six fish and three "strikes" being recorded in 375 line-hours. The lampara net and blanket net were rendered ineffective by the strong tides.

55. The research on prawns, begun in the Singapore prawn ponds, and continued in inshore waters by the research launch, has been extended into offshore waters by the catches of the "Manihine".

This prawn research is being conducted along the following lines :—

- (1) Determination of the variety and distribution of species of Malayan Penaeid prawns.
- (2) Identification of the more important economic species in the Singapore prawn ponds and in the fisheries of the Federation of Malaya.
- (3) A study of the biological and other factors which influence them.
- (4) An analysis of factors with a view to improving fishing techniques.

Some 40 species of prawns have been identified, of which several are new to science. Samples of prawns from the commercial prawn ponds show that there are about a dozen species which may be taken in commercial catches, but only five are of economic importance.

56. The majority of the catch in the commercial pond nets consists of immature prawns. A small proportion is made up of prawns approaching maturity but, so far, there is no indication that spawning ever occurs in the ponds.

Migrating prawns probably move eastwards against the prevailing westerly current off Singapore Island, shedding their eggs, which, developing into planktonic larvae, drift into the prawn ponds and surrounding mangrove areas where they settle down on the bottom and begin to grow. An increase in the catches of prawns in the ponds might be obtained if a greater number of these young stages (larvae) could be held in the ponds. At present, some are swept into and out of the ponds at each rise and fall of the tide. If the water were allowed to enter the ponds through the lower half of the sluice gates, and leave by the upper half, then :—

- (a) Larvae which are at the end of their drifting (planktonic) stage and are about to settle on the bottom will be swept into the ponds.
- (b) Larvae which have just settled on the bottom, will be more likely to be held there because there will be no sweep of water close to the bottom to dislodge them.

The prawns appear to grow at a rate of about 0·01 mm. increase in carapace length per day. So most of the prawns of all species caught in the ponds are less than six months old.

57. *Plankton Research.*—This has been continued, together with hydrological investigations, in the Singapore Straits. It is confirmed that plankton animals show a definite periodicity in these waters. Fluctuations in the numbers of fish eggs and larvae in the catches indicate that there is a definite breeding season for fish. There is evidence that at least one plankton animal is an indicator species, which helps to identify water of a certain origin.

With the arrival of the "Manihine" these observations are being extended, using the same types of collecting nets, into the open sea.

Fish Culture Research Station, Batu Berendam, Malacca

58. Work on the construction of this station is well advanced, and two of the quarters were built and occupied by the Resident Engineer, Mr. S. F. Owen, and his Assistant Engineer. The date of completion is still likely to be March, 1957. Piped water and electricity are now on the site.

59. Two staff have been appointed. Dr. G. A. Prowse, botanist, has been in Singapore and at Malacca, working up and identifying the aquatic plants, including diatoms, desmids, and flagelletes, of the region. He has a paper on the Desmids of Malaya in the press.

Dr. G. R. Fish has been working at Nottingham University, on the digestive enzymes of fish, preparatory to his departure for Malaya.

Fisheries Research Unit at the University of Hong Kong

60. This unit continues, with its research vessel "Alister Hardy", routine hydrographic observations in the waters around Hong Kong. It is also, in collaboration with the Fisheries Department, carrying out trawling and Danish seining experiments, and market observations.

61. Some promising results are being got in research on the oyster fishery in Deep Bay. The usual method of collecting oyster spat is to scatter old shells over the bottom; but the Research Unit is experimenting with the "hanging drop" method, where the collecting shells are threaded on wires and suspended in the water from bamboo frames. When they are well covered with spat, the collecting shells are re-threaded on wires, but now separated by bamboo distance-pieces. It appears that the growth of the oysters by this method is much increased, since they are less congested and can use the whole column of water for their feeding, and not the bottom layers only.

62. A small freshwater station has been set up in the New Territories to study fish culture.

IV. PUBLICATIONS

63. Besides many papers published in the recognised scientific journals by members of the staffs of the Colonial Fisheries Research stations, there are four papers in the press for publication in the Colonial Fisheries Publication series, namely, "The Pelagic Fish of East Africa", by Frank Williams, "Recent Developments in the Barbadian Flying-Fish Fishery, and a Contribution to the Biology of the Flying Fish", by D. N. F. Hall, and "A Seiche Movement and its effect on the Hydrology of Lake Victoria", by G. R. Fish, and "Preliminary Survey of the Hydrography of British East African Waters", by B. S. Newell.

Colonial Medical Research Committee Eleventh Annual Report (1955-1956)

Medical Research Council,
38, Old Queen Street,
London, S.W.1.
2nd August, 1956.

SIR,

On behalf of the Colonial Medical Research Committee, I have the honour to transmit to you the Eleventh Annual Report of the Committee, covering the period 1st April, 1955, to 31st March, 1956.

I have the honour to be,

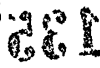
Sir,

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

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- 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.

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SICKLE-CELL ANAEMIA

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- 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
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- DR. H. LEHMANN, M.D., Ph.D., F.R.I.C., St. Bartholomew's Hospital, London.
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COLONIAL MEDICAL RESEARCH COMMITTEE
ELEVENTH ANNUAL REPORT

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COLONIAL MEDICAL RESEARCH COMMITTEE

ELEVENTH ANNUAL REPORT

GENERAL

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

2. By the death of Professor P. A. Buxton, C.M.G., F.R.S., towards the end of the year the Committee sustained a grievous loss. A man of outstanding calibre, originality of thought and uncompromising scientific integrity, he had long given unsparingly invaluable assistance to the Committee, particularly in the field of insect-borne diseases. The Colonial Office was indeed fortunate to have had his guidance in ensuring that during the post-war years the rapid scientific progress achieved under the spur of war continued to be applied and extended in Colonial territories. Yet perhaps pre-eminent amongst his contributions to research in Colonial Territories were the zeal and purpose with which he imbued his students, and the solicitude with which he followed their careers overseas.

WORK OF THE COMMITTEE

Development of Research Schemes

3. Thirty-nine research schemes were under the 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.

Personnel

4. The Personnel Sub-Committee has continued to advise on all medical appointments to the Research Branch of Her Majesty's Oversea Civil Service, to scrutinise annually the emoluments of all medical members of that Service, and to make recommendations accordingly. During the year two officers resigned on receiving other appointments. Seven new oversea postings were made, two to existing vacancies and five to newly-created ones. One Colonial Medical Research Student was posted overseas ; four continue their specialised two to three years' training in Britain.

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.

6. *Extension of the research field.* As new problems in certain research fields have obtruded, and as research workers experienced in those fields have become available either for oversea assignments or for relevant basic research in home-based laboratories, or as younger workers have completed appropriate specialised training, the Committee has recommended and undertaken the extension of its scientific sponsorship into certain aspects of these problems.

Thus the digression into the field of the *sickle-cell trait* and *sickle-cell anaemia*, noted last year, has been extended by additional grants to oversea and home-based experts. Research on *tuberculosis*, hitherto supported by research funds only in East Africa, has been extended to West Africa, where a unit staffed and financed from Britain and West Africa has initiated a comprehensive research project under the guidance of Professor F. R. G. Heaf, the Scientific Adviser on Tuberculosis to the West African Council for Medical Research. The challenging problem of *Onchocerciasis*, which leaves so much residual blindness, has led to the maturing of plans for placing in the field in West Africa a research unit comprising three appropriately trained young scientists and one or more scientists of experience who will be partly home-based. It will be under the scientific supervision of the West African Council, to which Professor R. M. Gordon, of the Liverpool School of Tropical Medicine, is the Scientific Adviser in Helminthiasis. In *Schistosomiasis*, as noted last year, the need to clarify much obscurity in fundamental knowledge is urgent, and the recruitment of two young zoologists to undergo comprehensive basic training in its many malacological aspects before embarking on field investigations is in hand. In the meantime work proceeds in Tanganyika, Uganda and the Gambia in one or other aspects of the problem.

In *Leprosy*, the Committee felt that the advances made in recent years in the study of acid-fast bacilli *in vitro* provided the opportunity to attack again the laboratory approach to leprosy. A Leprosy Sub-Committee has, therefore, been appointed and this, in turn, has appointed a Laboratory Panel. These two bodies will include, or co-opt where necessary, a number of scientists whose research activities can contribute to the elucidation of the diverse problems confronting the leprologists, in chemotherapy, epidemiology, tissue-culture, morbid histology, electronmicroscopy, immunology, bacterial resistance and the like. During the year five research grants were made for leprosy research to aid investigators abroad and in British universities. Again, the need for effective incursion into the field of *Trachoma* has been recognised. In consultation with Sir Stewart Duke-Elder, Director of Research at the Institute of Ophthalmology, University of London, and Hospitaller of the Venerable Order of the Hospital of St. John of Jerusalem, a substantial research grant has been contributed towards a concerted research project to be initiated in Jordan, where a Trachoma Research Institute has been built and will be associated with a new ophthalmic hospital that will serve the large number of "displaced persons" in that region in whom the disease is rife. A unit comprising a clinician, a bacteriologist and ancillary staff will work there, and studies have indeed begun. The unit will be closely linked with virologists at the Institute of Ophthalmology, London, and the Lister Institute. Large contributions have been received from benefactors in Britain and the Levant, especially from the Order of St. John, thanks to the advocacy of Sir Stewart Duke-Elder. It is hoped that from the unique material available to the unit advances will come that can be applied to satellite research projects that would then be initiated in those Colonial territories most afflicted by the disease.

Oversea Visits

7. Fifteen members of the Committee and its Sub-Committees visited various research units in the field during the year. In addition, the facilities of the oversea units continue to be much used by research workers from Britain for the short-term study of specific problems.

REGIONAL ORGANISATIONS FOR MEDICAL RESEARCH IN COLONIAL TERRITORIES

East Africa

(a) East African Council for Medical Research

8. This Council, the development and functions of which were noted at length last year, held its second meeting at Nairobi in February, 1956. It was preceded a month earlier by a meeting in Kampala of its Standing Advisory Committee which followed immediately a very successful four-day Scientific Conference on "The Zoonoses : Diseases of animals communicable to man" which some 80 scientists from the medical, veterinary, trypanosomiasis and other cognate scientific fields attended each day. 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.

Dr. Alan Howell, formerly the Director of Medical Services, Tanganyika, has been appointed Secretary to the Council for a period of two years. Sir Gordon Covell and Professor P. C. C. Garnham attended all meetings as delegates of the Colonial Medical Research Committee.

West Africa

(b) West African Council for Medical Research

9. The second meeting of this Council was held in Accra in March, 1956, and was attended by two delegates from the Committee, Professor A. W. Woodruff and Dr. W. P. H. Lightbody, the latter nominated for this meeting by the Liverpool School of Tropical Medicine in place of Professor B. G. Maegraith. It was preceded by a meeting of the 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.

West Indies

(c) Standing Advisory Committee for Medical Research in the British Caribbean

10. The favourable reaction evoked in the Caribbean region by proposals for the initiation there of a regional organisation for medical research, as noted last year, has led to the inception of a Standing Advisory Committee for Medical Research, which held its inaugural meeting in April, 1956, at the University College of the West Indies. It is intended that the Advisory Committee shall ultimately develop into a "Council for Medical Research in the British Caribbean", with semi-autonomous powers, following thus the procedure that has proved effective in East and West Africa.

The delegates of the Colonial Medical Research Committee were Professor A. C. Frazer and Professor Robert Platt ; the Chairman (Sir Harold Himsworth) and Dr. R. Lewthwaite also attended. The Chairman of the Standing Advisory Committee was the Comptroller of the British West Indies Development and Welfare Organisation (Sir Stephen Luke), whose Medical Adviser (Sir Joseph Harkness) and Dr. John Waterlow were responsible for the excellent arrangements made and will continue to act as secretaries of the Committee, aided by a small panel. The membership of the Committee comprises the Directors of Medical Services and Senior Medical Officers of the larger British territories of the region, representatives of the University College of the West Indies,

two delegates from the Colonial Medical Research Committee, and the Director of Colonial Medical Research (Dr. R. Lewthwaite). In addition, the meetings will be attended by three "Observers", Dr. G. Giglioli of British Guiana, Dr. Wilbur G. Downs (Director of the Trinidad Regional Virus Laboratory and a Rockefeller Foundation staff member) and Dr. John Waterlow (Director of the Tropical Metabolism Research Unit of the Medical Research Council).

The meeting was formally opened by the Chief Minister of Jamaica, the Hon. Norman Manley, Q.C., who welcomed the inception of this regional organisation.

11. It was preceded by a two-day Scientific Conference at the University College, over which Sir Harold Himsworth presided. Papers on current medical research projects, noteworthy for their variety and excellence, were read and discussed. About eighty medical scientists attended and some twenty senior medical students from the University College. The Committee and Scientific Conference will meet in Trinidad next year, when the main theme of the latter will be "Communicable Diseases of the Caribbean". It was recommended that every third year the meetings should be held in Jamaica, in recognition of the role of the University College as the main focus of medical research in the region.

REVIEW OF THE WORK IN PROGRESS

12. 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

13. *Entomological aspects.* The seasonal variations in the biting density of *Chrysops silacea* at Kumba, now plotted for three years, indicate that the flies are most numerous at the beginning and end of the rains. A comparison of the biting-cycles, seasonal variation in numbers and biting habits of *C. silacea* and *C. dimidiata* is being made. A year's study of the biting densities and infection rates of *C. silacea*, *C. dimidiata*, *C. langi* and *C. centurionis* taken at a canopy platform in the rainforest during day and night catching has been completed and awaits analysis. An area near the coastal creeks of the Cameroons has recently been discovered where *C. longicornis* is commonly found biting during the dry season and it is hoped later to study the habits of this potential vector of loiasis; it has hitherto proved a most elusive species. With a view to attempting soon to control *Chrysops* by anti-larval measures, a survey of all the larval breeding sites within a mile of Kumba is being made, and a similar survey is planned for the swamp forest country where *Chrysops* breed near Sapele Rubber Estate in Southern Nigeria. In one large breeding-site a year's study of the numbers and distribution of the larvae is being made and will include observations on the very early instars which can only be found by magnesium sulphate flotation methods.

14. Laboratory studies on the effect of insecticides on *Chrysops* larvae kept in trays full of mud indicate that both Dieldrin granules and 5 per cent. D.D.T. emulsions will kill the larvae but that the concentrations necessary are very high

(3 to 5 g. of Dieldrin granules per sq. ft., and 4 to 10 pints of 5 per cent. D.D.T. emulsion per 100 sq. ft.). *Tabanus* larvae have been shown in the laboratory to be as susceptible as *Chrysops* larvae to insecticides, and it may therefore be possible to employ them as additional indicators of the efficacy of these measures in the field. Preliminary field trials of insecticides and of vegetational clearing as anti-larval measures are in progress at certain selected forest breeding sites 20 miles from Kumba. Experiments with paint-marked adult flies have begun in order to discover the flight range of *Chrysops* through the rain-forest and the range of their dispersal to and from the breeding-sites, and to throw some light on the length of life of the fly. A new method of trapping *C. silacea* and *C. dimidiata* in umbrella traps has been devised, which may be of use in sampling the density of the fly population.

For the first time a naturally deposited egg mass of *Chrysops* has been found in the rain-forest near Kumba, on the underside of a leaf some four feet above the ground over a breeding site.

15. *Parasito-pathological aspects.* In work on monkeys infected with *Loa*, five naturally infected drills (*Mandrillus leucophaeus*) were obtained, and all showed microfilariae of *Loa* with a nocturnal periodicity; whereas *L. loa* from man, when passaged into drills, invariably gave rise to infections with a diurnal periodicity, and the adult worms found at post-mortem were considerably smaller than those which produce nocturnal microfilariae in naturally infected drills. A single *Cercopithecus nictitans martini* monkey, which was infected by transplanting adult *Loa* worms from a wild monkey of the same species, also showed a nocturnal microfilarial periodicity. Infective forms of *Loa* naturally acquired by wild *Chrysops* species caught in the forest were injected into drills to determine the periodicity of the infections. So far two *C. langi* have been found carrying nocturnally periodic *Loa* presumably of monkey origin, and two *C. silacea* and one *C. dimidiata* carrying diurnally periodic *Loa* presumably of human origin. A monkey has been inoculated with infective forms from a wild *C. centurionis*; the infection is still incubating.

16. Attempts are being made to passage the nocturnally periodic type of *Loa* of monkeys into man, and two European and three African volunteers have been inoculated with infective forms. No positive results can be expected for some months to come. The possibility of hybridising the diurnally and nocturnally periodic types of *Loa* in monkeys is being investigated.

The fate of the parasite during the early stages of its life history in the vertebrate host was studied, and in monkeys the young adult worms were found in the usual sites, in loose connective tissue, two months after the inoculation of infective forms. It is hoped to elucidate the whereabouts of the earlier stages by the study of serial sections of tissues of monkeys inoculated with large numbers of infective forms. It has been observed that in monkeys microfilariae first appear in the peripheral blood some five to six months after infection. The microfilarial counts usually rise for a few months and then fall to a very low level, at which they remain. At this stage, however, microfilariae can still be found in very large numbers in the blood from the lung at post-mortem, although they are apparently not released into the peripheral circulation during life. Adult worms from monkeys with "lung-bound" microfilariae were transplanted into clean monkeys and in them the microfilarial count was observed to build up normally in the peripheral blood and later to become depressed in a similar manner. Experiments are now in hand to determine the effect of re-infecting monkeys in which microfilariae have become "lung-bound".

17. Work on the morbid histology of infected monkeys is yet at an early stage but the only organ which presents a macroscopic pathology is the spleen. The effect of diethylcarbamazine on nocturnal and diurnal monkey infections has

been tried in two individual monkeys. After a three weeks' course on doses of 50–150 mg/kg. per day the blood of a monkey with diurnally periodic microfilariæ was completely clear of microfilariæ, but post-mortem examination revealed all the worms except one to be alive and to have active microfilariæ *in utero*. In a monkey with nocturnally periodic microfilariæ the count in the peripheral blood was reduced almost to zero, but the lung blood was still heavily infected and none of the adult worms was affected.

18. *Studies on onchocerciasis*. A follow-up for one year of the number of *Onchocerca volvulus* microfilariæ in the skin of 10 African volunteers who had been treated with diethylcarbamazine (total dosage 7.0–7.7 g. of Banocide) has now been completed. In two, the pre-treatment concentration of microfilariæ had been built up within a year; in the others, by extrapolation it appeared that the pre-treatment concentration would have been reached within two or three years. The pattern of distribution of the returning microfilariæ in the skin corresponded to the pre-treatment pattern, and in the upper parts of the body and in the region of the eye the microfilariæ were liable to accumulate, in proportion to their pre-treatment concentration, as rapidly as those in the lower parts.

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(b) Filariasis

East Africa

19. Dr. P. Jordan, of the East African Survey and Research Institutè at Mwanza, Tanganyika (Director: Dr. E. G. Holmes), has initiated a pilot scheme for the eradication of Bancroftian filariasis with diethylcarbazine on Ukara Island in Lake Victoria. The population (3,500) of three villages will be treated for the first year, a second blood survey will then be made and the situation re-assessed. Three treatment schedules are projected, one for each village, viz. (a) a single monthly 200 mg. tablet of diethylcarbazine, (b) a 50 mg. tablet every month, (c) a 200 mg. tablet every two months. General medical treatment is also given.

The condition of the lymphatic vessels in elephantiasis is being studied by the injection of patent blue dye into the foot. Following its absorption the lymphatics can be seen and injected with diodone and x-rays taken. Some technical difficulties remain to be solved. In collaboration with Miss Margaret Lyle, B.Sc., the fluid from filarial hydrocoeles is being investigated by electrophoresis in an endeavour to differentiate filarial and non-filarial hydrocoeles. The total protein has been found to range from 2.77 mg. per cent. to 5.78 mg. per cent. The A/G ratio is usually approximately 1.6 in spite of the serum A/G ratio being about 0.5. Fluid from elephantiasis cases is also being studied.

Histological preparations of testes from cases of genital filarial disease indicate that spermatogenesis is frequently depressed, due perhaps to a higher temperature in the scrotal mass and not to pressure on the testes.

20. Entomological studies have continued with *Culex fatigans* and *Aedes aegypti*. A new colony of *Cercopithecus* sp. monkeys, infected with *Dirofilaria*

aethiops, has been started. Investigations into the minimal microfilarial levels in blood which are capable of producing infective larvae in mosquitoes have shown that late developmental forms of *Wuchereria bancrofti* in *C. fatigans* may follow the ingestion of blood from a patient in whom only one microfilariae was found in 40 ml. of blood. A similar study using *Anopheles gambiae* is projected. The results indicate the necessity of treating all persons with diethylcarbamazine in Bancroftian control schemes, lest persons with very low microfilarial counts who may be missed in evening surveys are overlooked and jeopardise success.

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Malaya

21. *General.* Three visiting scientists spent several months with the filariasis research unit at Kuantan, in East Pahang, investigating filarial infections in animals; Lt.-Comdr. L. A. Jachowski, Jr., U.S. Navy, and Captain D. L. Price, U.S. Army, during March and April, 1955, and Professor J. J. C. Buckley, London School of Hygiene and Tropical Medicine, from July to October, 1955. In December, 1955, a World Health Organisation Study Group on Filariasis met at the Institute for Medical Research in Kuala Lumpur, and later spent three days in Kuantan, visiting the endemic areas and seeing the work in progress. After the meeting, Dr. F. Hawking spent several days in Kuantan investigating microfilarial periodicity in *Wuchereria malayi*.

22. *Epidemiology.* Field surveys by the unit were limited to the areas in which control experiments were in progress. Blood films sent in by various Health Officers, however, revealed three hitherto unreported foci of *W. malayi* infection, two in Kelantan and one in Trengganu.

Microfilarial periodicity. Periodicity curves from 20 patients infected with *W. malayi* in East Pahang have now been compared with those from 26 patients in Penang. The almost completely nocturnal periodicity in the Penang patients is in sharp contrast with the presence of many microfilariae in the daytime blood films from the East Pahang patients.

23. *Treatment of microfilaria carriers in hospital.* The method of administering diethylcarbamazine which promises to be most useful for mass treatment of populations infected with *W. malayi* is a dose of approximately 5 mg/kg. (of citrate) given once weekly or monthly for six doses. Almost everyone with microfilariae in their blood experience a sharp febrile reaction after the first dose, but the proportion having a reaction to the second dose is much lower, and the severity of the reaction is much reduced; while very few have any symptoms after the third or subsequent doses. Of 25 microfilaria carriers treated with such doses once a month for six months, none showed microfilariae when examined six months after the final dose, and only 3 out of 22 showed microfilariae (in small numbers) twelve months after it.

24. *Control experiments in rural areas.* In two villages the whole population was given six doses of diethylcarbamazine at weekly or monthly intervals. In a third village the houses were sprayed with Dieldrin at 100 mg/sq. ft. at intervals

of six months, a dose which had given good results in window-trap hut experiments against *Mansonia longipalpis*, the main vector. Although there was a marked fall in the human microfilarial reservoir in the two drug-treated areas, none of the three areas showed any reduction in the proportion of mosquitoes carrying the infective stages of *W. malayi*-type larvae.

25. *Filarial infections in animals.* Some results from East Pahang have recently been published. Sheathed microfilariae resembling those of *W. malayi* have been found in monkeys (*Macaca irus*; *Presbytis melalophos*), the slow loris (*Nycticebus coucang*), the domestic dog, and the domestic cat. Examination of adult worms recovered from the macaque monkey, the dog and the cat, shows that all belong to the genus *Wuchereria*, but that at least two species are involved; one is clearly distinct from *W. malayi*, the other is much closer to it. Experimental mosquito feedings showed some difference in developmental pattern, but for all practical purposes the mature larvae were indistinguishable from those of *W. malayi*. Whatever may prove to be the relationship of these infections to human ones, their presence in this area confuses the interpretation of dissection results in wild-caught mosquitoes.

26. *Feeding habits of the vectors.* Precipitin tests were made on a small series of blood specimens from *M. longipalpis* and *M. uniformis* caught resting by day in undergrowth near houses. Nearly all the mosquitoes had fed on cattle or buffaloes, and only a few on man, which may explain the great difference between the total natural infection-rate in these mosquitoes (1-2 per cent.) and the high microfilaria-rate in the human population (around 50 per cent.). In view of the ease with which *M. longipalpis* can be infected, one would expect it to have a total infection rate very much higher than 2 per cent. if it fed predominantly on man in these areas.

Colonising Mansonia mosquitoes. A successful attempt was made to establish a laboratory colony of *M. uniformis*, following the method of Jayewickreme and Niles. Water hyacinth (*Eichornia crassipes*) has been found easier to manage than water lettuce (*Pistia stratiotes*); although suitable conditions for the larvae and the host plant are somewhat critical, large numbers of adults have been produced. The life-cycle is a slow one; from emergence of adults of one generation to emergence of those of the next is about a month, the aquatic stages occupying about 25 days. *M. longipalpis* and *annulatus* have proved much more difficult to colonise, and only a few *longipalpis* have been raised so far.

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(c) *Schistosomiasis*

27. Mr. W. F. H. McClelland, B.Sc., began in September a research project 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. Beforehand he spent a few weeks observing relevant research in snail control directed by Dr. Elmer G. Berry in Egypt, and that being undertaken in the Gazira Irrigation Area of the Sudan by the Ministry of Health of that country.

28. At Mwanza an investigation of the snail vectors of schistosomiasis was a necessary preliminary, especially those which are likely to transmit *Schistosoma haematobium*, and is under way, as is also the identification of schistosomes causing natural infections in snails. Studies are also in progress to investigate whether fluctuations occur in the size of snail populations of different habitats, and in the rate of infection of snails throughout the year, factors that may be of importance in planning control by the use of molluscicides.

29. In the Gambia the investigations of Mr. S. R. Smithers, B.Sc., were in abeyance throughout most of the year owing to leave, during which he prepared a report of his eighteen months' study of the transmission of schistosomiasis in the Gambia and the related earlier studies there of Duke and McCullough, and suggested appropriate control measures. He has now resumed his investigations, to be concentrated primarily on a more detailed study than hitherto of the limiting ecological factors of the four vectors of bilharzia in the Gambia, each of which has its own preferential and separate habitat. Recently he has found a focus of *S. mansoni* in the Western Division, the first such record in the Gambia.

(d) *Guinea-worm*

30. Dr. S. D. Onabamiro continued his investigations on guinea-worm at University College, Ibadan, largely on determining the location of the parasite during the first two months after being fed to puppies one to two months old. To obtain the guinea-worm larvae in the infective stage large numbers of *Cyclops* (*Thermocyclops nigerianus* Kiefer and *Mesocyclops leuckharti* Kiefer) from neighbouring ponds were collected into shallow earthen pots to which were added some quantities of green water plants, e.g. *Spirogyra* sp. Guinea-worm larvae were obtained from school-children from villages near Ibadan where the incidence of dracontiasis is very high, particularly in the dry season, and were mixed with the *Cyclops* in appropriate quantities. The infected *Cyclops* were kept in pots for two weeks and then fed to puppies; these were killed and dissected at graded intervals. Immature male and female specimens of the guinea-worm were recovered which were 43, 45 and 48 days old, some of them observed to be going through the last ecdysis.

31. These results led to the following conclusions:—

- (1) The route of the larval worms from the alimentary canal to the subcutaneous tissue is most probably through the lymphatic system.
- (2) The worms have reached the subcutaneous tissue of the mammalian host by the 43rd day, possibly a little earlier.
- (3) The two sexes emerge into the subcutaneous tissue in about equal numbers, and sexual differentiation is distinct at that stage, though the males have not started to develop spicules.
- (4) The last ecdysis takes place in the subcutaneous tissue.
- (5) The worms have not developed to the fertilisation stage by the 48th day.
- (6) The hook-tailed larvae obtained from some specimens of adult guinea-worms in India probably represent a mere anatomical abnormality of no specific significance, and, contrary to the views expressed by those who reported their discovery, probably do not represent a sexual differentiation in the early larval forms.

32. In addition to the work reported above, routine visits to various guinea-worm infested areas were made to examine the *Cyclops* species and populations in the village ponds in order to work out the breeding seasons of the guinea-worm's intermediate hosts in the different parts of South-West Nigeria. A visit to Offa and Ilorin in Northern Nigeria was made to initiate an investigation on the identification of the species of *Cyclops* transmitting the guinea-worm there.

*Malaria**East Africa*

33. Investigation of age groups of adult anopheles by the East African Institute of Malaria and Vector-Borne Diseases has continued. If an adequate method of determining the age of a mosquito population could be found, it might be much more feasible to assess with precision the efficacy of control methods against adults. Some great differences between drier areas in East Africa and those nearer the coast, concerning anopheline survival, feeding habits and resting places, were revealed.

A comprehensive examination has been made of the anopheles in the Pare lowlands, to establish a baseline from which the effects of residual house spraying can be measured. Adult house populations and those outside, as revealed by catches on trees and in artificial shelters, have been recorded, with their infectivity, feeding preferences and times of feeding, their age and, by inference, their survival. These data on normal anopheline behaviour in the Pare area and, earlier, in the coastal area should clarify the mechanism of the success or failure of this essay in residual control. In the more difficult study of anopheline behaviour in the larval stage, the importance of food carried as dust to the surface of the water has been demonstrated. A method devised for observing the movements and behaviour of mosquito larvae in containers without disturbing them has given interesting results.

Another investigation, deriving from an examination of those swamps in Uganda that do not breed vector anopheles, seeks the reasons for their absence ; one may be the lack of oxygen in the water. It is a collaborative study with the Department of Biology of Makerere College.

34. The preliminary period of assessment in the Pare area has included the early stages of chemical and biological tests of insect susceptibility to Dieldrin, now being sprayed on house walls there. While much of this work is being done by the Colonial Insecticides Research Unit at Arusha, joint studies that will reveal the development, or otherwise, of resistance to Dieldrin are being shared by the Institute. They concern both the Chemist, in that the effective dosage is the amount of insecticide on the actual surface of the walls, and the Entomologists, since the mosquito's susceptibility can, in the last resort, only be ascertained by exposing it to the treated surface. Methods based on Busvine's work, but applicable to much larger numbers, have been developed by the Chemist, and are being used as a routine.

The majority of human studies have also been made in the Pare area, and are designed to assess the effects on man of the results of spraying. Thus the degree of malaria infection in man over the whole area has been measured ; and, in certain selected areas of high endemicity, much more detailed measurements have been made of some 2,000 people on two occasions. These have included height and weight, skin-fold thickness, physical measurements, presence of pyrexia, estimation of haemoglobin, parasites in stools and urine, and a dietetic survey. A general medical examination is also made, and the people in the whole area were counted as their houses were being enumerated preparatory to spraying, and will be re-counted at regular intervals.

Other human malaria surveys were made elsewhere, notably in Uganda, and on the Nandi plateau of Kenya.

The assistance of the group from the World Health Organisation has been valuable. Dr. Holstein has initiated some studies on chromosome patterns in anopheline larvae ; Dr. Press has made a varied range of chemical estimations, including many on haemoglobin and benzene hexachloride.

Publications

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GILLIES, M. T.—(1955) "Notes on the eggs of some East African *Anopheles*." *Ann. trop. Med. Parasit.*, **49**, 158.—(1955) "The pre-gravid phase of ovarian development in *Anopheles funestus*." *Ibid.*, **49**, 320.—(1955) "The density of adult *Anopheles* in the neighbourhood of an East African village" *Amer. J. trop. Med.*, **4**, 1103.

WILSON, D. B.—(1955) "Trials of residual insecticides on a sugar estate." *E.A. Med. J.*, **32**, 315.

Nigeria

35. Although the Committee is not directly concerned with the work of the Federal Malaria Service, Nigeria, some account of it is included here. Points in the report of its Director, Dr. L. J. Bruce-Chwatt, are summarized.

36. *The Malaria Control Pilot Project in Western Sokoto, Northern Nigeria.* The Malaria Service is responsible for the scientific guidance and research content of this pilot project, now at the end of its second year, undertaken jointly by the World Health Organisation, U.N.I.C.E.F. and the Government of Northern Nigeria. An entomologist from W.H.O. and a chemist from the Colonial Research Service supplement the staff provided by the Federation of Nigeria. Details of the area and intended measures were given last year. In the first half of the year malaria declined; the infant parasite-rate of 43 per cent. in peripheral unsprayed areas contrasted with 20 per cent. in controlled areas, and some reduction was evident in the 1-2 years age-group. But later, especially at the end of the rainy season, the decline was less, due most probably to re-infection. Room density indices for *Anopheles gambiae* were reduced by 99, 98 and 90 per cent., in the B.H.C., D.D.T. and Dieldrin zones respectively, although transmission continued in all. Some 60 per cent. were found resting on the thatch of ceilings, 20 per cent. on the walls, and 20 per cent. on pots, furniture, etc. Some were taken biting out-of-doors, with a probable peak of activity at 3 a.m.-6 a.m. Precipitin tests confirmed that it feeds indiscriminately on man, horse and cattle.

37. Chemical tests showed that the loss of all three insecticides from sprayed mud walls was 40-60 per cent. during the first few weeks. D.D.T. and Dieldrin residues showed a high loss in the first two weeks, and then a more gradual decline; the loss of B.H.C. was uniformly high, amounting at the end of the fifth week to 90 per cent.

Insecticide resistance tests, prompted by the disappointingly high room density index of *A. gambiae* towards the end of the second year, especially in the Dieldrin area, revealed a Median Lethal Concentration for Dieldrin of at least 2 per cent. in contrast with the figure of 0.25 per cent. for *A. gambiae* from a Lagos colony or from unsprayed areas in Western Sokoto. Incidentally, similar tests on houseflies from the Dieldrin zone showed a sevenfold resistance to Dieldrin, a twofold and threefold cross-resistance to D.D.T. and B.H.C., and a threefold resistance to Malathion, a totally unrelated chemical compound.

38. The biometric study of spleen and liver weights in Africans and Europeans, with special reference to malaria, has been completed, with the following salient results: (1) In Africans of all age-groups, including the neonatal, the spleen weighed 1.5-2.5 times more than in those from a comparable reported series of Europeans and American Negroes. (2) A similar but much smaller difference in mean liver weights was found during the first two years of life only. (3) Holoendemic malaria was the main if not the sole cause of the high spleen-weight in the African series.

39. Other investigations include studies of the relation of sickling to malaria, the influence of malaria infection of the placenta on the incidence of prematurity in Southern Nigeria, comparative chemotherapeutic trials of chloroquine and amodiaquine, the prevalence of *Plasmodium ovale* infections in a forest area near Lagos, cross-mating of two colonies of *Culex fatigans* from Lagos and British Guiana respectively, the effect of smoke on insecticide residues, the uptake of radio-active phosphorus by larvae and adults of *Aedes aegypti*, and auto-radiography for the detection of mosquitoes labelled with radio-isotopes.

Publications

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Idem and GIBSON, F. D.—(1956) "Transplacental passages of *Plasmodium berghei* and passive transfer of immunity in rats and mice." *Trans. R. Soc. trop. Med. Hyg.*, **50**, 47.

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Idem and RAMAKRISHNA, V.—(1956) "Insecticide resistance in *Anopheles gambiae* Giles." *Nature*, **177**, 532.

Gambia

40. At the Medical Research Council's Laboratories at Fajara, the Gambia, the permanent staff have had under observation two groups of Gambian children, one of which from birth has been protected from malaria by weekly doses of either chloroquine or Daraprim, the other group remaining unprotected. The objectives were to assess (i) the effect of repeated and heavy malaria infection on Gambian children, especially any resultant change in liver histology and serum proteins, and (ii) the efficiency of long-term malaria prophylaxis with chloroquine and Daraprim. The results of the first three years have yielded the following data.

- (a) The mortality-rate in the malarious group was five times greater than in the protected (i.e. non-malarious) group; all deaths occurred in the first 16 months of life.
- (b) The malarious children gained weight more slowly for the first 30 months of life than did the protected, but more rapidly from the 30th-36th month, and by the mean age of 161 weeks were slightly heavier, though slightly smaller, than the protected.
- (c) Although the malarious children rapidly became much more anaemic than the protected, by the mean age of 161 weeks no significant difference in the average haemoglobin levels could be detected.
- (d) Whereas the malarious children developed marked enlargement of the liver, only one protected child did so, and his serum was strongly positive to the Wasserman, Kahn, and allied tests. No clinical evidence of hepatic insufficiency was found.

- (e) Assessment at 161 weeks revealed, firstly, no marked difference in nutritional status, as assessed clinically, or in mental or physical agility, between the groups; secondly, a significantly higher total serum protein level in the malarious group. The mean serum albumin level was almost identical in both groups; but in the malarious group the mean serum globulin level was significantly higher, and (by electrophoretic methods) the gamma globulin 50 per cent. higher than in the protected group.
- (f) By the 30th month Gambian children appear to have developed a good functional resistance to malaria.
- (g) No evidence was found of toxic effects attributable to long continued administration of chloroquine or Daraprim.

41. The possible protective influence that a purely breast-milk diet affords Gambian infants against malaria has been studied. It has been shown that heavy malarial infection frequently develops in Gambian infants receiving only breast milk even as early as in the first month of life. Analysis of the breast milk of Gambian mothers by chemical estimation and by biological assay has shown that the para-aminobenzoic acid content is low. An experiment during an entire rains period revealed that four of seven infants receiving a breast milk diet with a daily supplement of para-aminobenzoic acid (4 mg/kg.) developed malaria, as did two of seven receiving only breast milk. The most virulent infection, producing the most severe clinical illness of all, occurred in one receiving only breast milk. These findings suggest that, in the Gambia at least, breast milk offers but little protection against infection with malaria.

42. Study of the effects of malaria upon the health of a rural African community has continued at Keneba. Considerable health improvements, notably in mean haemoglobin levels, have resulted from those antimalarial measures practised in earlier years.

In an investigation of the bionomics of anopheline mosquitoes in the Keneba area, the use of specially constructed portable catching-huts has shown that throughout the wet season enormous fleeting fluctuations develop in the outdoor mosquito population. This finding has led to radical alteration in the techniques used in the investigation of the efficiency of the insecticides, B.H.C., D.D.T. and Dieldrin.

43. *Studies on Plasmodium knowlesi.* These were continued by Mrs. B. Glockling, B.Sc., in the laboratory of Professor B. G. Maegraith at the Liverpool School of Tropical Medicine.

44. *The metabolism of Plasmodium knowlesi.* The investigation indicating that glucose metabolism occurs via the Krebs tricarboxylic acid cycle has been completed. The parasitised blood from 24 Rhesus monkeys was used and the effects of two specific inhibitors studied. Since others have suggested that the effect of inhibitors may be upon the host red cell rather than the parasite, specific anti-monkey erythrocyte serum in rabbits was used to free the parasites; the results of experiments then repeated differed only in the smaller oxygen uptake, and the time-lag before malonate showed its inhibitory effect on freed parasites.

The metabolism of leucocytes. Since there was a slight rise in the white cell count of a few of the monkeys used for this work, the oxygen uptake of white cells was investigated, and found to be small in comparison with that of the parasite; there was therefore no need to correct the figures obtained for the respiration of parasitised blood.

45. *Haemolysis during Plasmodium knowlesi infection.* Since there is a regular and drastic reduction of erythrocytes during *P. knowlesi* infections, it was thought possible that the presence of the parasite stimulated the production of an autohaemolytic factor. Using recognised serological techniques, and also a sensitive photometric method for the detection of small degrees of haemolysis, such a factor could not be detected; nor could an anti-autohaemolytic factor in the blood of immune monkeys which showed no response to repeated parasite infections.

46. *The adenosine triphosphate content of parasitised blood.* By chromatographic separation of the adenosine phosphates, preliminary results showed conclusively that the red cell reserves were readily utilized by the infecting parasite. The ATP content of the host cell-parasite combination was therefore measured in all experiments. For parasitaemias of up to 30 per cent. the ATP content was found to fall linearly with increasing numbers of parasites. This was demonstrated clearly in *P. knowlesi* infected monkeys in which the parasitaemia was repeatedly "damped down" with small doses of mepacrine. In uninhibited infections the ATP content fell regularly until the 24 hours before death, when there was a sudden accumulation along with other intermediate metabolites. Throughout a single life cycle there is a fall in the adenosine phosphate content in the absence of any change in the number of parasites. The exact point at which energy changes occur prior to the formation of schizonts is being sought.

47. *The citrate content of normal and parasitised blood.* By assaying this in monkey blood before and during *P. knowlesi* infections figures were obtained showing the rate of metabolism of the parasite throughout the infection. Thus when the parasite is most active the accumulation of intermediate metabolites, e.g., citrate, is at a minimum; whereas, towards the end of an infection when lysis is occurring and the blood as a whole provides a deficient medium for the parasite, there is a sudden accumulation of citrate. These figures closely parallel those obtained for ATP assays on the same samples. This is to be expected, for when the expenditure of energy is greatest intermediate metabolites do not accumulate.

48. *The in vitro cultivation of Plasmodium knowlesi.* Although cultures could be kept alive for five days using Geiman's techniques, no active multiplication occurred after two days. Experiments with different ingredients continue; in particular, a substance which will prevent the escape of half-grown schizonts from the red cells is being sought. This work is a preliminary to the problem of the relationship between malaria and sickle-cell anaemia.

The effect of the parasite on the red cell enzyme complexes is being further studied.

Virus Diseases

(a) The West African Council for Medical Research Laboratories, Lagos, Nigeria

49. *Epidemiology of yellow fever.* Epidemiological studies on yellow fever and the antigenically related but relatively innocuous viruses, Uganda S, Zika and West Nile, have revealed problems of great complexity. The antibody studies have employed both the haemagglutination-inhibition reaction (HAI) and the intra-cerebral mouse protection test (P.T.). The results so far obtained are summarised below:—

- (1) In Abeokuta, a large town in the rain-forest belt of Southern Nigeria, where clinical yellow fever has never been recognised in the African population, 70 per cent. of the population give a positive P.T. by the age of 15 years.

- (2) In Ilobi, a large village closely invested by forest 40 miles from Lagos, from which yellow fever has never been reported, only 20 per cent. remain P.T. negative at the age of 15 years ; H.A.I. antibody studies on Zika virus here revealed an even more intense endemicity of this virus than of yellow fever.
- (3) In the Gambia, human surveys in two widely separated localities suggest that an agent which immunizes to yellow fever occurs in frequent waves. Some blood specimens obtained from colobus and cercopithecus monkeys and from dog-faced baboons contained yellow fever antibodies.
- (4) While in the forested zones of Southern Nigeria and the Gold Coast the results of yellow fever P.T. and H.A.I. reactions are in good accord, in sera obtained in the dry savannah country of the Northern Gold Coast there is a significant discrepancy. Although P.T. antibodies are only found in the over 30 age-group, H.A.I. antibodies were demonstrated in over 70 per cent. of the children in the 10-14 age groups.
- (5) Experiments on rhesus monkeys have shown a degree of serological cross-relationship between yellow fever, Uganda S, Zika and West Nile viruses. Tests for H.A.I. antibody proved a more sensitive index of these reactions than the production of neutralising antibodies ; with either test the rise in titre of yellow fever antibody evoked by a heterologous virus was more intense and longer sustained in an animal already possessing some degree of yellow fever immunity. These experimental results must obviously have an important bearing on the interpretation of the results of human antibody surveys. They do little as yet to clarify the picture.

50. *Experimental Zika virus infection in man.* This was investigated by Dr. W. G. C. Bearcroft, who inoculated himself subcutaneously with 265 mouse LD50 of an Eastern Nigerian strain isolated by Dr. Macnamara in 1953. A mild fever of 4 days duration followed an incubation period of 3 days ; no evidence of damage to any organ could be found, and recovery was rapid. Zika virus was isolated from the blood on the 4th and 6th days after inoculation, and a rise in titre of homologous antibodies was demonstrated after the 7th day by both P.T. and H.A.I. techniques. The titre of yellow fever H.A.I. antibody showed a steep sustained rise ; the neutralising antibodies likewise. Attempted mosquito transmission through *Aedes aegypti* failed. No virus could be recovered from the stools.

51. *Hepatic pathology.* The evolution of the hepatic lesion of yellow fever has been studied by Dr. Bearcroft in rhesus monkeys. Serial liver biopsies were taken prior to infection and at frequent intervals thereafter until death. Small focal degenerative lesions appeared on the 3rd day, each surrounded by a contiguous zone of viable liver cells the nuclei of which contained inclusion bodies. These foci enlarged slowly until 12 hours before death ; thereafter the degenerative process spread with great rapidity to give rise to a typical confluent midzonal necrosis some 3 hours before death.

Following a challenge with 400,000 mouse LD50 doses of the Asibi strain of yellow fever virus, an animal hyperimmunised to Zika virus survived twice as long as non-immunised animals, and at death the characteristic lesions of yellow fever, though large, remained focal.

52. *Field expeditions.* Five such were made :—

- (1) Dr. Macnamara and Lt.-Col. Walters visited the Gambia to investigate the epidemiology of yellow fever in the Colony and Protectorate. They could find no evidence that the virus in Serekunda and Brikama,

situated in the Colony and the immediate hinterland, had been present since the epidemic of 1934. Local monkeys showed no immunity. But they did find evidence of small localised waves of infection recurring at intervals of between 5 and 10 years in villages of West Kiang and Upper River Division. Many cercopithecus and colobus monkeys and baboons (*Papio anubis*) in the middle and upper regions were immune.

- (2) Dr. Porterfield and Mr. Boorman visited Kintampo in the middle belt of the Gold Coast to investigate a suspected outbreak of yellow fever. They isolated yellow fever virus from a woman of 22, who survived. Her syndrome was typical of the disease in a moderately severe form. They confirmed the histological diagnosis made in Accra on 3 fatal cases which had occurred prior to their arrival. Re-survey of Punpuano, a village near Kintampo visited in 1954, showed that 4 of 7 subjects who were non-immune in 1954 had become P.T. positive, while 2 doubtful positives in 1954 had now become positive. All *Aedes* species of mosquitoes were rare, but *Aedes africanus* were taken feeding on man in small numbers both near and remote from habitation. It was inferred that these subjects and others whose disease was inapparent had been infected individually from the forest cycle.
- (3) Dr. Macnamara visited Maidiguri and the Plateau to investigate an outbreak of jaundice in Maidiguri town, to test for antibodies in the blood of baboons living on the Nigerian Plateau, and to search for potential vectors of yellow fever on the Nigerian Plateau. He found no serological evidence of recent yellow fever at Maidiguro. Blood of 4 of 5 baboons shot near Pankshin on the southern escarpment contained neutralising antibodies to yellow fever. Larvae of *Aedes vittatus*, a potential yellow fever vector, were obtained from rock pools in the same district.
- (4) Dr. Bearcroft visited Udegi Beki at the foot of the southern escarpment of the Plateau to investigate an outbreak of jaundice in a columbite mining camp, where 100 cases, with 8 deaths, had occurred in 3 months. The active and convalescent cases seen suggested a diagnosis of infective hepatitis. Convalescent sera tested for yellow fever H.A.I. antibody showed no constant positive reaction. Sera are being examined for leptospiral antibodies. Despite a thorough search, the only mosquito larvae found were culicines.
- (5) Dr. Macnamara visited Katsina to collect sera from young children for poliomyelitis antibody examination by Dr. Gear in Johannesburg, a portion of each serum specimen being retained for antibody tests at Yaba. The results are awaited.

53. *Poliomyelitis*. At the General Hospital, Lagos, 26 sera were collected from patients in December, 1955, for dispatch to Dr. Gear.

His results were :—

Type I		Type II		Type III	
Pos.	Neg.	Pos.	Neg.	Pos.	Neg.
23	3	19	7	24	2

Of the 26 specimens one only, from a child aged 2 years, was completely lacking in immune bodies.

54. *Entomological studies.* The investigation of insects which bite man in Ilobi has now been in progress for a full year. The results may be summarised thus :—

- (i) Catches on human bait in the village and its environs show *Taeniorhynchus africanus* to be the most common human biting mosquito. A pox virus was isolated from a batch of these.
- (ii) *Aedes aegypti* bites man freely between 17.00 and 20.00 hours ; its habitat and breeding sites are limited to the village and its investing zone of bushes and scrub ; generally it does not enter or breed in the forest. The resting site of engorged females has not yet been discovered.
- (iii) The following species of *Aedes* have also been taken : *A. apicoargenteus*, *A. luteocephalus*, *A. simulans aedomorphus*, *A. longipalpis*, *A. grahami* and *A. simpsoni*. Of these, *A. simpsoni* does not bite man in this region.

Publications

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PORTERFIELD, J. S.—(1956) “ The serological cross-relationships of yellow fever and other arthropod-borne viruses as revealed by the haemagglutination-inhibition reaction ”. *Proc. VII Internat. Congr. Comparative Pathology*. Lausanne.

(b) The East African Virus Research Institute, Entebbe, Uganda.

55. *Rift Valley Fever virus.* Work on this virus (R.V.F.) has been a most important activity this year. The systematic studies on cycles of virus multiplication in the laboratory mouse and the actual pathogenic effects of the virus on the host have been concluded. Among the more interesting findings were those concerned with the cause of death. The virus attacks the liver, and it was felt that hypoglycaemia or toxæmia might be the main cause of death, but this has not proved to be the case. On the other hand, it has been shown that prothrombin virtually disappeared from the infected animal following on the liver damage, and this is the obvious explanation of the clotting defect and consequent hæmorrhages so common in the latter stages of R.V.F. infections. The same was found in monkeys with yellow fever, once again liver damage being the main feature, and the hæmorrhagic nature of the later phases being attendant on a virtual disappearance of prothrombin.

Another important study on R.V.F. has been the demonstration of “ incomplete ” virus in the mouse, previously studied only in the embryonated egg ; the fact that it can be shown in the intact mammal is of great interest. Further, it bears on another main project, a group of studies on the ability of viruses to infect only certain species of mosquitoes and only certain individuals of these species ; to date, most of the work had been of a genetical nature, but this year a switch has been made, as it appears that this matter may be bound up with the production of “ incomplete ” virus. The investigation continues, *Aedes aegypti* being used, with R.V.F. and yellow fever viruses. Other work has demonstrated that R.V.F. will, like many other viruses, agglutinate chicken red cells ; and present findings place it in a group by itself where hæmagglutination is concerned.

56. *Encephalomyocarditis virus.* It was known that this virus (which probably extends throughout the tropics, and has been isolated at Entebbe from animals, mosquitoes and man) damages heart muscle. A visiting American scientist,

studying its effects on various African mammals, has shown that the degree of damage is of a previously unsuspected order, and that in some animals a fulminating myocarditis is the actual cause of death. Mongooses may die in as little as two and a half days after infection. The study is being continued by the Institute's staff.

Complement fixation and haemagglutination tests by the Rockefeller Foundation have clarified the status of the viruses isolated some time ago during a large epidemic of dengue-like disease in Southern Tanganyika. The virus of the epidemic, formerly known as Chikungunya B. and later as Chikungunya, is almost certainly a new Group A virus, closely related to Semliki Forest virus. The other virus, first known as Chikungunya B. and later as Makonde virus, appears to be a strain of Uganda S. virus, which was first isolated from mosquitoes caught in Bwamba County, Uganda.

57. Attempts to isolate new viruses continue. One which is probably new was isolated from *Aedes circumluteolus* mosquitoes caught on the Entebbe peninsula. It may prove important, as it causes liver damage in mice. Only one of the liver-damaging viruses, R.V.F., will "go" in mice (the most inexpensive laboratory animal), and it is not admitted by most countries as it is very infectious. Another virus has been isolated from *Culex* mosquitoes caught in the same area; it is too soon to say whether it is new, or previously encountered.

58. Work on yellow fever continues to centre on the part played by the bush-babies (*Galago* spp.) in the maintenance of the virus in the drier areas. The most important work undertaken was an immunity survey of bush-babies in Northern Rhodesia and Nyasaland, with financial support from W.H.O.; specimens showing protective antibodies against yellow fever virus were found in both areas. It has been felt for some time that for bush-babies mosquitoes could not be the vectors of the virus, and studies in Karamoja suggest most strongly that infection occurs in the nest. Attempts to transmit virus by the mites which infest bush-babies and their nests continue, and the more serious technical difficulties have now been overcome. Transmission has not yet been achieved, but it is now known that the mites can maintain the virus for some time.

59. During field survey work, many cattle from North Karamoja were tested for R.V.F. virus; all were negative.

A study of local wild birds as possible hosts has begun. Blood samples are tested and material is also inoculated into laboratory animals. Mosquitoes are being collected by means of 24-hour and other catches, with birds as bait, to find which species are important. Much the same species come to bite as when human bait is used, but *Culex* spp. makes up a much larger proportion of the total catch, while *Aedes* spp. are relatively scarce.

Work also continues on the biting habits of the arboreal forest mosquitoes, and still other mosquito studies are concerned with the seasonal abundance of some common species, mainly in the genus *Taeniorhynchus*.

A most important finding has been that behaviour differences exist between different strains of *Aedes aegypti*, and may have a direct bearing on epidemiological problems. It is already known that in the case of *Aedes simpsoni*, a vector of human yellow fever, the differences in biting habits between different strains may play a large part in determining the distribution of this disease in East Africa.

Publications

GILLETT, J. D.—(1955) "Further studies on the biting behaviour of *Aedes (Stegomyia) simpsoni* Theobald in Uganda". *Ann. trop. Med. Parasit.*, **49**, 154—(1955) "Behaviour differences in two strains of *Aedes aegypti*". *Nature*,

176, 124—(1955) "Variation in the hatching-response of *Aedes* eggs : (Diptera : Culicidae)". *Bull. ent. Res.*, **46**, 241—(1955) "The inherited basis of variation in the hatching-response of *Aedes* eggs. (Diptera : Culicidae)". *Ibid.*, **46**, 255.

HADDOW, A. J.—(1956) "Observations on the biting-habits of African mosquitoes in the genus *Eretmapodites* Theobald". *Ibid.*, **46**, 761—(1956) "Rhythmic biting activity of certain East African mosquitoes". *Nature*, **177**, 531.

(c) *The Trinidad Regional Virus Laboratory, Port of Spain.*

60. The research project for the study of viruses in man, animals and arthropods in the Caribbean region, and the pattern of virus survival and spread, initiated by the Division of Medicine and Public Health of the Rockefeller Foundation in 1953 with the co-operation of the Trinidad Government, has again had a most successful year. The Director, Dr. Wilbur G. Downs, has contributed the following summary (paragraphs 61–66).

61. The most important administrative event in 1955 has been the grant approved jointly by the Government of Trinidad and Tobago and the Colonial Office, whereby they contribute equally to assume the salaries of all the 48 locally employed personnel. This scheme is to continue for 3 years and will total £17,000 annually. The Rockefeller Foundation continues to pay the salaries of three senior professional staff members and the operating expenses of the laboratory.

62. *Ilheus virus*. Technical activities were focussed upon further study of *Ilheus virus* infections in Trinidad. High immunity rates had earlier been noted in forested areas of eastern and central Trinidad and, in 1954, two strains were isolated from mosquitoes. Accordingly, in 1955, a clinic was established at Sangre Grande to study fever cases. Between July and December 321 fever cases were seen ; 85 (26·5 per cent.) had positive malaria smears ; the remainder are recorded as "undiagnosed fevers". *Ilheus virus* has not been isolated from any of these, nor is there serological evidence (neutralization test and haemagglutination-inhibition test) of any cases. Mosquito captures were made in the nearby Melajo Forest, and during 1955 31 viruses as yet unidentified (but none *Ilheus*) were isolated by inoculating mosquito suspensions intracerebrally into two-day old mice. However, in December, 1955, and January, 1956, three strains of presumed *ilheus virus* were isolated from ground-captured mosquitoes from the region ; two came from mixed pools of mosquitoes and the third from a pool of seven *Psorophora ferox*.

Ilheus virus was recovered from the blood of a human encephalitis case of unusual interest seen in Port-of-Spain in August, 1955, being the first isolation of this virus from man in nature. The individual was seriously ill, and if the encephalitic reaction may be considered as due to the virus, which was recovered from the blood during a febrile period several days prior to the onset of the encephalitis, *Ilheus virus* then stands incriminated as an agent capable of provoking serious illness in man.

63. *Yellow fever*. The outbreak of 1954 died down in the latter months of that year. On 19th January, 1955, a dead young male red howler monkey was brought into the laboratory from the Nariva Swamp region. Yellow fever virus was isolated from its liver. This is the last evidence of yellow fever activity which has been noted on the island. This also was the seventh dead howler monkey from which virus was thus isolated. Three more strains were isolated in 1955 from human blood specimens taken during the active period of 1954, increasing to 17 the total of yellow fever strains recovered from man during this

outbreak. Serological studies continue on over 2,000 serum collections made before the onset of the vaccination programme, as well as on a group of 150 pre- and post-yellow fever vaccination sera.

Dengue. No new strains were isolated during 1955. Two previously isolated strains stand confirmed as dengue, and two more strains are presumed to be dengue and are undergoing further study.

64. *Mayaro virus.* An entirely new virus agent, tentatively named Mayaro Virus, was isolated in 1954 from a human patient in Trinidad. The New York Laboratory of the Rockefeller Foundation carried out identification work. Retrospective study of virus strains obtained from human cases seen in 1954 has added four additional isolations of Mayaro virus. Aside from indicating that this virus may produce clinical illness of several days duration, with fever as high as 104·5° F. and a leucopenia, it is not possible as yet, with inadequate clinical data, to attempt to synthesize a disease picture.

65. *Unclassified viruses.* Of unknown (or at least, as yet unidentified) virus agents there is a surfeit. A virus was isolated from a woodcutter, working in the Melajo Forest. It is pathogenic to infant and adult mice on intracerebral inoculation. An attempt to prepare a haemagglutinating and complement fixing antigen failed. None of immune sera tested give any indication of protective action against this virus. However, the patient did develop neutralising antibodies to the virus in his convalescent serum. Another virus was isolated from another woodcutter in the Melajo Forest, apparently not related to the agent remarked above ; and yet a third agent was recovered from the blood of one of the mosquito-catching boys who was afebrile before, during and after the day of isolation of virus. An agent suspected to belong to the lymphogranuloma-psittacosis group was isolated from the sputum of a human suspected of having psittacosis.

Very little can yet be reported on the identity of the 31 agents isolated during 1955 from mosquitoes. Efforts are being made to divide these strains into groups of likes and unlikes by the preparation of immune sera for serological and neutralisation tests. Three are affected more by St. Louis immune serum than by any other immune serum tried, and all three produced a haemagglutinin against baby chick red cells, in the general range of a " Group B " virus.

66. A serological survey of 153 residents in Tobago was made. Dengue appears to have been endemic and yellow fever present over forty years ago. The situation with regard to Ilheus is not completely resolved, but it would appear to be either uncommon or absent.

A serological section, prepared to make antigens according to the method of Casals, and to run complement-fixation and haemagglutination-inhibition tests, has been established.

Over 280,000 mosquitoes were identified during the year in the course of field studies, and about 50 per cent. of these were inoculated into mice.

Publications

ANDERSON, C. R., and DOWNS, W. G.—(1955) " The isolation of yellow fever virus from the livers of naturally infected red howler monkeys". *Amer. J. trop. Med. Hyg.*, **4**, 662.

Idem and WATTLE, G. H.—(1955) " The isolation of yellow fever virus from human liver obtained at autopsy". *Trans. R. Soc. trop. Med. Hyg.*, **49**, 580.

DOWNS, W. G., AITKEN, T. H. G. and ANDERSON, C. R.—(1955) "Activities of the Trinidad Regional Virus Laboratory in 1953 and 1954 with special reference to the yellow fever outbreak in Trinidad, B.W.I." *Ibid.*, 4, 837.

Idem, ANDERSON, C. R., and SPENCE, L.—(1955) "Isolation of yellow fever virus from a human patient on the twelfth day of illness". *Trans. R. Soc. trop. Med. Hyg.*, 49, 577.

Animal-borne diseases in Malaya

67. *The yellow fever hazard in South-East Asia.* The lines of investigation noted last year have continued. *Aedes* surveys by Mr. W. W. Macdonald have provided a basis for recommendations on mosquito control. *Aedes albopictus*, one potential vector, is almost ubiquitous in association with man, is practically ineradicable, and provides a direct link between man and the forest assemblage. Surveys have included species of *Armigeres*. Breeding colonies of three species of culicines have been established; the Malayan samples of *A. aegypti* sent to the Virus Research Institute at Entebbe were found to transmit virus efficiently. Serological surveys of human and animal groups, and vaccination trials, are reported below. Available information about Malayan primates has been collected and published.

68. *Serological surveys of arthropod-borne viruses in Malaya. Human.* Five rural communities have been studied, including Aborigines from hill-forest fringe and from forest at 5,000 feet, and Malays from coastal and inland rice growing areas and from a coastal swamp. The incidence of dengue antibodies is about the same in all; 25 per cent. of those aged less than 11, 50 per cent. of those aged 11–20, and 100 per cent. of those over 30 have antibodies to type 1 dengue. The incidence of antibodies to Japanese encephalitis (JE) varied from almost nil in Aborigines at 5,000 feet, and about 20 per cent. in those on the forest fringe, to 60 to 80 per cent. in the agricultural communities.

Animal. Neutralising antibodies to JE were found in 70 to 80 per cent. of cattle, buffaloes, and pigs, and in lesser proportions of dogs, cats, and goats, in that order. In forest animals, neutralising antibodies to JE were found in very few, but neutralising antibodies to dengue have been found in monkeys (29/40), lorises (7/12), squirrels (7/35) and civets (2/28). Appearances therefore suggest that JE is mainly an infection of domestic animals with which man is in close contact, whereas dengue may have a reservoir in tree-dwelling forest animals.

Yellow fever. The human sera referred to above were tested for neutralising antibodies to yellow fever. Some, with antibodies also to JE and dengue, were positive. There is evidence that these are cross-reactions, and the phenomenon is under study. A pilot experiment to assess the effect of yellow fever vaccination on persons with antibodies to JE and dengue has been made and the response shown to be variable. Attempts to make a full-scale experiment, hitherto abortive, continue.

Dengue. Studies of diagnostic techniques for dengue based on serial specimens of human sera have continued. The neutralisation test on serial sera is necessary for clear-cut diagnosis, but the haemagglutinin-inhibition test is valuable for screening. The complement-fixation test gives no additional information and is more difficult.

A dengue-like virus accounts for one-third of the undiagnosed fevers at the Kuala Lumpur General Hospital, where the patients are mainly townfolk, and for about one-twentieth of those contracted by soldiers in the jungle. There is evidence that some of the fevers are due to a related virus yet unknown.

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69. *Rickettsioses*. Q-fever complement-fixing antibodies have been found in dogs (4/49), goats (17/283), cats (2/40), buffaloes (6/142), cattle (11/428), and pigs (2/207). To unravel the epidemiology, a survey of wild animals was made with several rickettsial antigens. Q-fever antibodies were found in house and forest rats, murine typhus antibodies only in house rats, and rickettsialpox antibodies mainly in forest rats. The study continues.

Leptospirosea. Animal Reservoirs. From over 2,200 animals, 107 strains (59 identified so far) have been isolated. Many forest rats yielding leptospirae have had no agglutination-lysis antibodies, even to their own strain; this important finding is being followed up.

70. *Zoological studies*. The number of animals examined during the year was 5,259, including 1,096 birds of 102 species. Apart from biological and taxonomic work, these were used for serological studies and to provide information about ecto- and endo-parasites. Much work on birds has been occasioned by the serological survey of JE by the U.S. Army Unit at the Institute. Mark-recapture experiments on ground mammals have continued. It has not been possible to separate ecologically the rats of the *Rattus rajah* group, distinguishable morphologically; but the three rats usually regarded as subspecies of *Rattus rattus*, namely the house-rat, *diardii*, the wood-rat, *jalorensis*, and the field-rat, *argentiventer*, behave as distinct species, and appear to be the result of three separate introductions into Malaya.

Mark-recapture experiments also give information of value in the biology of trombiculid mites. The burning of grass had a trifling effect upon the populations of the vectors of mite-typhus, but the removal of rats from an area appeared to increase the chance of infestation of a casual host, and hence increase the typhus risk; experimental evidence for this has hitherto been lacking. The distribution of vector mites suggests that *Trombicula akamushi* is an introduced species, here practically confined to the field-rat, *R. argentiventer*, and to birds such as quail in grassland; it is patchily distributed. But *Tr. deliensis* is much more widespread, and occurs in relatively small numbers on giant-rats in the forest edge. Taxonomic revisions and biological studies on trombiculids are being completed.

Publications

HARRISON, J. L.—(1955) "The Apes and Monkeys of Malaya", *Malayan Mus. pop. Pamphlet No. 9*.—(1955) "The age of a monitor lizard". *Malay. nat. J.* 9, 134.—(1955) "Data on the reproduction of some Malayan mammals". *Proc. zool. Soc. Lond.*, 125, 445.

Idem, LIM BOO LIAT and WILLIAMS-HUNT, J.—(1955) "Aboriginal names of mammals". *Malay. hist. J.*, 2, 53.

I.M.R. REPORT No. 47—(1955) "An *Aedes aegypti* survey in Singapore City".

MACDONALD, W. W.—(1956) "A mosquito survey at Kuala Lumpur airport with special reference to *Aedes aegypti*". *Med. J. Malaya*, 10, 232.

71. The following paragraphs (72-74) summarise the studies of the U.S. Army Medical Research Unit in Malaya undertaken in collaboration with the staffs of the Institute for Medical Research, Kuala Lumpur, the nearby British Military Hospital and the Walter Reed Army Institute of Research, Washington. During the year primary emphasis has been focussed upon search for the aetiology of pyrexiae of unknown origin.

72. *Pyrexiae of unknown origin in adults*. The aetiological classification of these fevers in adult patients in and around Kuala Lumpur were concluded after 614 military and 238 civilian patients were studied. No essential change

in the prevalence of various diseases was observed in the additional 400 patients seen during the past year. Leptospirosis, dengue, malaria and scrub-typhus continued to be the most common sources of such illness ; no specific diagnosis could be made in 30 per cent. of the patients.

Pyrexiae of unknown origin in children. Recent investigations of undiagnosed fevers have been confined almost exclusively to the search for the causal agent in acutely ill children, in the belief that virus infections were less likely to be complicated in children than in adults, and prompted by the acquisition of a small pediatric ward in the General Hospital in Kuala Lumpur. Of more than 100 patients studied in this ward since October, 1955, and excluding enteric and upper respiratory disease, almost two-thirds have not been demonstrably related to known aetiological agents. Thus so far the inoculation of acute phase blood from these sick children into suckling mice has yielded 3 transmissible agents. The relation of these agents to apparent disease, while not yet clear, is being investigated ; the newly isolated viruses are being characterised.

73. *Leptospirosis.* The systematic study of leptospirosis was terminated after 244 patients had been investigated ; *Leptospirae* were isolated from the blood of 108 of them. The 73 isolates which were characterised serologically fell into 12 serogroups.

74. *Arthropods as reservoirs and vectors of viruses.* The search for the natural vector or vectors of Japanese encephalitis has continued to result in the isolation of virus agents ; of 22 such isolates obtained since the last report, 6 have been identified as Japanese encephalitis, 4 appear to be new agents, and others are still being studied. Of the 19 species of Malayan mosquitoes inoculated into mice, viruses were obtained from 4 : *Culex gelidus*, *C. tritaeniorhynchus*, *Anopheles philippinensis* and *Mansonia uniformis*. Although the data do not yet provide a sufficient basis for estimating the relative frequency of viral infection in these mosquitoes it is evident that *C. tritaeniorhynchus* and *C. gelidus* are involved.

Publications

PRICE, D. L., and JACHOWSKI, L. A.—(1955) “ Notes on animal filarial parasites in Malaya, with special reference to *Macaca cynomologus* ”. *J. Parasit.*, **41**, 46.

WALTON, B. C., TRAUB, R., and NEWSON, H. D.—(1955) “ Efficacy of the clothing impregnants M.2065 and M.2066 against terrestrial leeches in North Borneo ”. *Amer. J. trop. Med. Hyg.*, **5**, 1950.

University of Malaya

75. Professor James Hale, of the Faculty of Bacteriology, reports that in collaboration with the Department of Parasitology at the University large numbers of mosquitoes have been caught and suspensions passed into mice to detect the presence of the virus of Japanese encephalitis. The virus was isolated from *Culex tritaeniorhynchus siamensis*. Further work established the fact that the virus multiplies in this mosquito which remains infective for the rest of its life. Experiments are in progress to attempt to demonstrate the ability of the mosquito to transmit the infection and determine its role as a vector of this disease. Search for the reservoir of the infection continues.

An extensive investigation is in progress to establish the position of poliomyelitis in Malaya. The laboratory is now equipped for the isolation and typing of strains, and for serological surveys, using the trypsinised dispersed monkey kidney cell culture technique.

Trinidad (Health Department)

76. *Measures against yellow fever.* The Malaria Division, Health Department, Trinidad, has undertaken an island-wide programme for the elimination of

A. aegypti, consequent on the occurrence of several cases of *yellow fever* in 1954. The Malariologist, Dr. H. P. S. Gillette, reports that the Division had for many years conducted a D.D.T. residual house-spraying programme as a malaria control measure, and this has been supplemented by residual spraying of water-containers and by larviciding measures, using D.D.T. suspensions or emulsions. It was soon found that D.D.T. applied to water containers at the recommended dosage of 1 p.p.m. failed to give total mortality in 24 hours, a finding confirmed by the Pan-American Sanitary Bureau which undertook tests in Trinidad later in 1954.

The Division therefore initiated a series of tests to determine the optimum dosage for total kill in 24 hours, and to find if resistance had developed. A colony of *A. aegypti* was started with larvae obtained from water-containers in an area which had had eight residual treatments with D.D.T. over the previous eight years. (Owing to the widespread use of D.D.T. in Trinidad over 10 years it was not possible to obtain *A. aegypti* from any place free from previous contact with D.D.T.) Five series of 28 tests have been completed, with the following summarised results.

77. *D.D.T. suspensions.* In one series, 1,000 larvae in 40 separate containers were treated in 10 tests with 1 p.p.m. D.D.T. The average mortality was 0·1 per cent. after 6 hours, 2·8 per cent. after 24 hours and 12·7 per cent. after 48 hours' exposure, indicating that even under controlled laboratory conditions a concentration of 1 p.p.m. of D.D.T. applied as a suspension is inadequate for the control of *A. aegypti* larvae.

The results at concentrations higher than 1 p.p.m. were progressively better ; but the average mortality at 20 p.p.m. was only 1 per cent. after 6 hours, 46·4 per cent. after 24 hours and 69·1 per cent. after 48 hours exposure, suggesting that even at the concentrations used in the field (20 p.p.m.) total mortality could not be achieved in a reasonable time with a single treatment. Further, higher concentrations were disappointing ; 200 p.p.m. were used in one series and up to 500 p.p.m. in another. In none was 100 per cent. mortality obtained after 48 hours.

In addition to those larvae found dead, there were several larvae which, though not dead, were visibly affected by the D.D.T. and were unable to swim to the surface but lay wriggling on the bottom of the bowl. The number of those "sick" larvae was usually higher at 6 hours and 24 hours than at 48 hours. Other larvae in all the concentrations appeared normal even after 48 hours, and some pupated.

78. *D.D.T. Emulsions.* In another series, emulsions replaced suspensions ; 1 p.p.m. gave no significant results, but total mortality was obtained in several of the tests even though the highest concentration contained only 50 p.p.m. Comparative tests with Xylene-Antarox-D.D.T. and Xylene-Antarox showed that while the solvent and emulsifier played some part in causing mortality, D.D.T. as an emulsion was vastly more effective at the same concentration than a suspension. The quantity of emulsion required to ensure total mortality within 48 hours of *A. aegypti* larvae is large, viz. 50 p.p.m. Tests continue, seeking confirmation and more information. Meanwhile the present programme has been modified. Now that the whole island has had one treatment with D.D.T. by the "perifocal" method without the desired effect on the *Aedes* index, intensive treatment will be given in several short cycles to small areas, and, when the index in these has been reduced to 1 per cent. or less, will be applied to new areas.

Relapsing Fever in East Africa

79. At the laboratory at Kerugoya Mr. K. R. Cockings, the Field Assistant, has continued the studies of variation in *Ornithodoros moubata*, in particular the

long-term experiments on cross-breeding, longevity and natural history. Dr. G. A. Walton, while on leave in Britain, made a final analysis of the data accumulated in the field, from which it would appear that there are three distinct biological forms which he has termed tentatively as *Form A*. (*man-feeder*), *Form B*. (*chicken-feeder*), and *Form C*. (*wart-hog*).

80. Briefly, *Form A* occurs in African dwellings in cool wet country, lays large numbers of eggs, shows a marked preference for human blood while ignoring domestic fowls, and withstands starvation poorly. *Form B* also occurs in African dwellings, but in drier and hotter country, feeds on domestic fowls in preference to man, lays significantly smaller numbers of eggs, is tolerant to a much wider variation of microclimate and is more resistant to starvation. *Form C*, which is found in the burrows of wart-hogs and porcupines, possesses morphological characters more easily appreciated than those displayed by the others, is extremely resistant to starvation, and differs from the others significantly in certain of its egg-laying characteristics.

All these forms are capable of producing viable adult offspring when crossed. Crosses between the offspring will shortly be attempted.

The findings on the culture originally chosen to represent the *Form B*, coming as it did from the Usambara Mountain area of Tanganyika where both hut-haunting forms appear to mix, need confirmation on pure cultures. To undertake this, the Unit has moved to the East African Medical Survey and Research Institute at Mwanza, where cultures of each of the free forms, taken from individual huts or burrows in widely separated sites, will be established and studied.

Publication

WALTON, G. A.—(1955) "Relapsing fever in the Digo District of Kenya Colony." *E.A. Med. J.*, 32, 377.

Identification of blood-meals

81. The investigations of the last few years made by Mr. B. Weitz and Miss F. Lee-Jones of the Lister Institute have culminated in a comprehensive study of the feeding habits of tsetse flies in Eastern Africa. Through the co-operation of the staff of the East African Trypanosomiasis Research Organisation over 1,500 blood smears from seven species of *Glossina* have been collected from about twenty different areas including the Sudan, Uganda, Tanganyika, Kenya, Southern Rhodesia. The blood smears were identified by a preliminary screening test using the precipitin reaction, followed by the more specific test, viz. the inhibition of agglutination of tanned red cells. By various improvements in the technique, the species of the host of over 80 per cent. of the blood-meals was determined. Ten per cent. were not identifiable, and the remainder were identified as belonging to specific groups of hosts.

82. No significant variations were noted in the feeding habits of *G. morsitans* and *G. swynnertoni* in ten different areas from which the blood-meals were obtained. These flies showed a marked preference for warthog, from which they obtained about half their food supply. About 30 per cent. of the blood-meals were from various ruminants (chiefly kudu, bushbuck, roan antelope, reedbuck, buffalo and giraffe), but no single species of ruminant provided more than 5 per cent. of all the blood-meals. Only very few blood-meals contained impala and none contained hartebeest, topi or wildebeest blood, although these animals were common in some of the areas studied. Elephant was a sporadic source of food; but rhinoceros, on which only 3 per cent. of the flies had fed, was a more constant source, as at least a few blood-meals containing

rhinoceros blood were invariably found when this animal was present in the area. A few feeds were obtained from monkey, baboon, jackal, hyaena, cats (probably lion or leopard), porcupine, and birds.

However, in areas where hippopotamus resided, the flies showed a marked preference for this host. As much as half the feeds which were normally derived from warthog in other areas were from hippopotamus. This is surprising in view of the habits of the hippopotamus which normally spends most of the daylight hours under water.

83. It is not possible to generalise about the feeding habits of other species of tsetse, because different habits and preferences were noted in different areas and because of the relatively smaller number of blood-meals identified. In the Lambwe valley, Kenya, *G. pallidipes* was feeding almost exclusively on bushbuck, although other animals (including buffalo) were present; a few (8 per cent.) had fed on bushpig. *G. palpalis* in one area on the West shores of Lake Victoria had fed exclusively on reptiles (presumably monitor lizards) while no reptilian feeds were found in other areas where the main hosts were bushbuck and birds. Some feeds from Uganda in areas where game had been partly destroyed showed that *G. brevipalpis*, *G. morsitans* and *G. pallidipes* largely fed on hippopotamus which had been left undisturbed. Here this animal was presumably responsible for the survival of the fly populations after the game was partially eliminated. A very few blood meals from *G. longipennis* obtained from a focus in Tanganyika were all found to contain rhinoceros blood at two different seasons of the year.

Investigations are being made to establish if these results were influenced by such factors as seasonal variations, the possibility of bias in the samples in favour of certain hosts, and differences in the habits of flies associated with age or sex. A survey of *G. swynnertoni* blood-meals collected from Shinyanga is in progress and may provide the answer to some of these points.

The work on mosquito feeds has continued to help field workers with local problems. As an example, Dr. Gillies in Amani, Tanganyika, has started a survey of the forest mosquito, *A. machardyi*, and the identification tests have established the importance of duiker as the chief source of food of these insects. This will help to narrow down the search for the origin of the sporozoites found in the glands of *A. machardyi*. Other surveys of blood-meal identification have been made as part of malaria eradication schemes and in preliminary spraying experiments. The studies undertaken for Dr. A. Smith in relation to the bionomics of *A. gambiae* and *A. funestus* in the Pare district have continued. The schemes organised by Dr. Halcrow in Mauritius and Dr. Gillette in Trinidad ended during the year. Further blood-meal tests were done on *Phlebotomus* species caught by Dr. Heisch in his search for the carrier of the causal organisms of kala-azar in Kenya. Other research workers assisted include Dr. Colless from Singapore, Mr. Symes from Fiji, and Dr. Wharton from Malaya.

Publications

WEITZ, B. and JACKSON, C. H. N.—(1955) "The host-animals of *Glossina morsitans* at Daga-Iloi". *Bull. ent. Res.*, 46, 531.

Physiological and Nutritional Research

(a) *Uganda and Tanganyika*

84. In June, 1955, Dr. Eric Holmes, formerly Professor of Physiology at Makerere College, was appointed Director of the East African Medical Survey and Research Institute at Mwanza, Tanganyika, and took with him the

Physiological and Nutritional Research Unit, of which he was the Director, at Makerere. Administratively it has been merged with the staff of the Institute at Mwanza.

In Tanganyika a unit detached from the Institute undertook for six months a diet survey in the Taveta-Pare area as a contribution to the physiological assessment of the effects on the population of the attempted mitigation of malaria by residual house-spraying with Dieldrin. The results are being analysed.

In Mwanza the diet of the residential boys' school has been examined, and a series of balance experiments (nitrogen, sulphur, calcium, phosphorus and calories) undertaken. As a result, modifications have been made in the diet.

Publication

THOMPSON, M. D.—(1956) "The serum protein pattern of African infants in Uganda". *Trans. R. Soc. trop. Med. Hyg.*, **50**, 77.

85. Dr. R. F. A. Dean, of the Medical Research Council, the Director of the Group for Research in Infantile Malnutrition at Mulago Hospital, Kampala, Uganda, has contributed the following brief summary of the activities, mainly on kwashiorkor, undertaken by the Group.

Although ample calories must be provided if the synthesis of new protein is to continue at the optimum rate, diets intended for the treatment of kwashiorkor are usually low in caloric value; sugar must be restricted because a small excess causes diarrhoea, and fats are also believed to be badly tolerated. The Group has, however, recently found that considerable quantities of vegetable oil can be added with good effect to the usual high-protein diets. The oil causes neither vomiting nor diarrhoea, even to a very ill child in the first days of treatment. Studies of the utilisation of the oil, and a comparison with butter fat, are being undertaken.

The biochemical work has included an investigation of the serum lipids. It has been found that shortly after treatment begins there is a large increase in the total lipids, due chiefly to increases in the neutral fat and esterified cholesterol. These substances are thought to be released from the liver and not to be derived from the diet: they appear whether the diet contains fat or is fat-free. Work has also been done on the fraction of serum cholinesterase remaining after activity has been inhibited by physostigmine, and it has been found that in the acute stage of the disease an abnormally large proportion of the enzyme escapes inhibition.

86. The activities of the Group outside Kampala have been extended. A Child Welfare Clinic has been started that is intended to provide information on the possibilities of introducing supplementary foods useful about the time of weaning, and a biscuit made of local materials that are cheap and highly nutritious is under trial in a school feeding scheme.

The studies of growth and development have also been continued, and those on newborn children have included the making of electro-encephalographic records and the determination of the extent of reflex activity. The results confirm the precocity in the first months of life already demonstrated in the African child by the use of Gesell tests.

Publications

DEAN, R. F. A.—(1955) "Protein requirements and their satisfaction". *E.A. med. J.*, **32**, 79.—(1956) "Undernutrition in East Africa: a description of a Group for Research in Infantile Malnutrition of the Medical Research Council, Mulago Hospital, Kampala, Uganda". *Pediatrics*, **17**, 121.

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SCHWARTZ, R., and DEAN, R. F. A.—(1955) "An investigation of the daily intake of individual boys at a boarding school in Uganda". *Brit. J. Nutr.*, **9**, 230.

GEBER, M.—(1956) "Developpement psycho-moteur de l'enfant Africain". *Courrier*, **5**, 17.

Idem and DEAN, R. F. A.—(1955) "Psychological factors in the aetiology of kwashiorkor". *Bull. Wld. Hlth. Org.*, **12**, 471.—(1956) "The psychological changes accompanying kwashiorkor". *Courrier*, **5**, 3.

TROWELL, H. C., DAVIES, J. N. P., and DEAN, R. F. A.—(1955) "Kwashiorkor and malnutrition". *Acta paediat.* (Uppsala), **44**, 487.

87. Professor H. Heller, of the Department of Pharmacology of Bristol University, has contributed the following summary of the investigations which he and his colleagues are making at Bristol, deriving from his earlier observations in Kampala.

Work on weanling rats kept in a psychrometric room at the mean temperature humidity of Kampala and fed on a diet of boiled African plantain (Matoke) has been continued by Professor Heller and Mrs. Hughes (Dr. H. Schnieden, a collaborator in the earlier work, is making parallel experiments with cassava in the Department of Physiology at the University of Nigeria, Ibadan). It could be shown that the food intake of such animals is about twice that of litter mate controls on a diet rich in protein. In spite of that the mean plasma protein level of the "Matoke animals" after 3-4 weeks was 5.4 g/100 ml. as compared with 7.9 g. in the controls. The figures for plasma albumin were 2.0 g. and 3.8 g. The plasma sodium and potassium in the protein-deficient weanlings was comparable to that of the controls. This agrees with results reported last year, obtained in African infants with kwashiorkor. The haematocrit in the "matoke animals" was low (27 as against 44 in the controls) and their ability to excrete an oral water load was significantly impaired. Preliminary experiments suggest, however, that the sensitivity of such animals to the antidiuretic hormone is unchanged.

88. Since oedematous infants suffering from kwashiorkor respond inadequately to conventional diuretics, it seemed interesting to investigate the effect of diuretics on the protein-deficient weanling rats. The results so far indicate that, concerning water diuresis, they do not react to aminophylline but do respond to large doses of cortisone. Experiments with other diuretics and hormones are being continued.

(b) Nigeria

89. *Hot Climate Physiological Research Unit.* Dr. W. S. S. Ladell, the Director, reports on the three principal projects of the Unit.

90. *Effect of wind on reaction to heat and on sweat-gland fatigue.* The investigations begun in 1954 were continued. The same subjects have now been exposed twice to the same "climates" but to different degrees of air movement, once working two hours and then resting, and once in the reverse order. The detailed observations recorded are to be found in the annual report of the unit. In both climates the heart rates were greater than those observed elsewhere in tests of the same severity on European subjects, suggesting that the African subjects were less fit; but the rate of increase in heart rate, both at work and at rest as the body temperatures rose, was less than had been found in Europeans. There also appeared to be a lower limiting maximum heart rate in the Africans.

The apparent tendency for sweat production during work to be lower when the subject had had a prolonged rest in the heat before working was found not to be a fatigue phenomenon, but was entirely attributable to the higher rectal

temperatures (R.T.) reached under these conditions. The sweat response (ratio of sweat produced to rectal temperature rise) was found to fall logarithmically as the R.T. rose; the same sweat response for a given R.T. was found irrespective of whether the observation was late or early in an exposure.

91. *Effect of climate on the performance of minor skilled tasks.* Soldiers were subjected to three psychomotor tests of increasing mental complexity in different climates. The first was a simple motor co-ordination test, involving high speed and moderately delicate, simple repetitive movements, requiring little or no thought; the second involved vigilance, some forethought and little or no skill; the third was of wireless telegraphy reception and involved no motor component beyond writing, but considerable mental activity. The same battery of tests has been used on British service personnel. Exposure to hot climates, up to 97° F. Effective Temperature (E.T.) made no difference whatsoever to performance and efficiency in the first test, nor did the subjects show any deterioration in performance during successive tests repeated throughout a morning. In the second test performance fell away when the E.T. reached 87° F. and at 92° and 97° F. E.T. considerably deteriorated, independently of body temperature; again there was no deterioration in repeated tests during a morning. In the third test the results were complicated by variations in skill and motivation; with skilled operators there was a definite deterioration of performance at 97° F. E.T.; efficiency did diminish during a succession of tests.

92. *The use of ground nut flour in human nutrition.* An analysis of ground nut flour showed that it contains approximately 50 per cent. protein. It may be mixed with gari in proportions of 1 : 2 or even higher without interfering with the palatability or flavour of the prepared gari. Three metabolic trials were made on six subjects over ten days at intervals of several months, using different ground nut/gari mixtures in each, viz. : 1 : 2, 1 : 3 and 1 : 5. The mean protein intakes on these mixtures were 146.7, 111.4 and 77.8 g/day respectively. All did well and none showed gastro-intestinal upset, even on the 1 : 2 mixture. Digestibility was as good as, and in some cases better than, that of gari either alone or with an animal protein "soup," for each of the major nutrients. Nitrogen retention occurred at all levels of protein intake, increasing with a slope of 30 per cent. as the mixture became richer in ground nut flour and protein intake was increased. Extrapolation downwards showed that nitrogen balance would have been obtained for the group with a protein intake from the ground nut flour/gari mixture of 53 g./day; this is only 10 g./day higher than the amount required on a gari/animal protein mix. There were considerable differences between subjects; the larger subjects had greater protein and calorie intakes, in proportion to their size, than the smaller, and retained more nitrogen at a given level of protein intake. "Correcting" the nitrogen intakes and balances to a standard creatinine excretion, on the assumption that the creatinine is an indicator of lean body mass, reduced the differences between the protein intakes but emphasised those between the nitrogen retentions.

Publications

BARNICOT, N. A., and HARDY, R. H.—(1955) "The position of the hallux in West Africans". *J. of Anat.*, **89**, 355.

LADELL, W. S. S.—(1954) "Some observations on the nitrogen and calorie balance in indigenous West Africans". *C.R.Vmes. Congr. Internat. Med. trop. Palud., Istanbul*, **2**, 528.—(1955) "The influence of environment in arid regions on the biology of man". *UNESCO Arid zone programme, Paris*—(1955) "The effects of water and salt intake upon performance of men working in hot and humid environments". *J. Physiol.*, **127**, 11—(1955) "The decline in sweating with raise. rectal temperature". *Ibid.*, **128**, 8—(1955) "Physiological

classification of climates, illustrated by reference to Nigeria". *Proc. Internat. West African Congr., Ibadan, 1949*, publ. by *Nig. Dept. Antiquities*, 1955, page 1.—(1955) "The myth about the Tropics". *UNESCO Courier*, No. 8-9, 58.—(1955) "Physiological observations on men working in supposedly limiting environments in a West African gold-mine". *Brit. J. industr. Med.*, 40, 283.

Idem and KENNEY, R. A.—(1955) "Some laboratory and field observations on the Harvard Pack Test". *Q.J. Exp. Physiol.*, 40, 283.

THOMSON, M. L.—(1955) "Relative efficiency of pigment and horny layer thickness in protecting skin of Europeans and Africans against solar ultra-violet radiation". *J. Physiol.*, 127, 236.

Jamaica

93. *Tropical Metabolism Research Unit, Jamaica.* This unit, of which the Director is Dr. J. C. Waterlow of the Medical Research Council, was brought up to establishment by the arrival of Dr. V. G. Wills, M.B., M.R.C.P., and Dr. J. M. L. Stephen, Ph.D., to join Dr. Waterlow and Dr. J. B. Garrow. Mr. C. Mendes, B.Sc., the biochemist appointed by the Government of Jamaica to the Applied Nutrition Scheme of that Government, was attached to the Unit in January, 1956. The new laboratory and metabolic hospital ward near completion. In the meantime laboratory work has been carried on in the Department of Physiology, through the hospitality of Professor I. F. S. Mackay, and clinical investigations have been done on patients under the care of Dr. E. Back in the paediatric ward of the University College Hospital. Initially it has been desirable to concentrate mainly on laboratory work and the development of methods. Investigations on patients have been of a preliminary nature; they will be expanded when the special facilities of the new ward become available.

94. Work has continued on the gross composition of the tissues in malnutrition, on both biopsy and autopsy material. For these studies it is necessary to use deoxynucleic acid as a basis of reference, and more work was undertaken on analytical methods for its estimation. The investigations on the liver are being extended to muscle by Mr. Mendes, and progress, though slow, is being made in a study of the enzyme activity of liver tissue obtained at biopsy.

Measurements were made of total body water, thiocyanate space, and plasma volume in malnourished infants. In patients in a poor state of nutrition but without oedema no increase of total body water was found, contrary to the suggestion put forward by workers in Uganda and by Waterlow at the Jamaica Conference on Protein Malnutrition that there may be an increase of intracellular water in malnutrition. Plasma volumes were relatively although not absolutely increased. Measurements were also made of the total exchangeable albumin, which includes protein outside as well as inside the circulation. This "total albumin space" was relatively much larger in the child than in the adult, a new observation which has important implications in studies of protein reserves and exchanges within the body, and is being explored further.

95. Measurements of potassium in post-mortem tissues show a severe depletion, which may be even greater than that of nitrogen. This is in keeping with the observations of Hansen and Brock in Cape Town, but not with the experimental work of McCance in Cambridge. Preliminary measurements of total exchangeable body potassium with isotopic ⁴²K also suggest a considerable depletion in some subjects.

Early in the year Dr. J. S. Garrow began work with ³⁵S-methionine, designed to test the ability of the malnourished patient to synthesize new protein. The first results were difficult to interpret, and it was therefore arranged that he should spend four months in the U.S.A. under Dr. J. B. Allison at the Bureau of

Biological Research, Rutgers University, working on protein-depleted dogs. Valuable experience was gained thereby that affords a firm background for study of the problem in man.

Publications

WATERLOW, J. C. (Editor)—(1955) "Protein Malnutrition. Proceedings of a Conference convened in Jamaica by the Food and Agriculture Organisation of the United Nations, the World Health Organisation and the Josiah Macy, Jr. Foundation". F.A.O., Rome, June.

Idem and WEISZ, T.—(1956) "The fat, protein and nucleic acid content of the liver in malnourished human infants". *J. clin. Investig.*, 5, 346.

96. Dr. J. Patrick, of the Faculty of Physiology at the University College of the West Indies, has continued his investigations. His objectives are threefold : (1) the mechanism of action of the "ackee" toxin, hypoglycin, now considered responsible for the occasionally fatal "vomiting sickness" of Jamaica ; (2) the effects of diet on the utilisation of glucose by the liver of the rat ; (3) the glycogen content and various enzyme activities of the human liver in diabetes and other diseases.

97. *Action of hypoglycin.* New evidence was obtained on why a fall in liver glycogen follows the administration of hypoglycin. Cortisone is found to delay that fall and also the fall in blood glucose, suggesting that hypoglycin decreases liver glycogen synthesis, while cortisone antagonises that effect. Adrenaline and insulin also decrease liver glycogen, but have effects on the blood sugar quite unlike hypoglycin. Other findings have suggested that whereas insulin favours the anabolic reactions of glucose at the expense of the catabolic reactions, hypoglycin has the reverse effects, and appears to decrease the blood glucose by decreasing input rather than by increasing utilisation.

98. *Effect of diet on the utilisation of glucose.* This project seeks information on how the synthetic abilities of the liver are influenced by the proportion of carbohydrate, fat and protein in the diet, in view of the low protein diets and the liver disease of nutritional origin that are common in the West Indies. Particular points investigated have been the utilisation of radio-active glucose by rat liver on various purified diets containing adequate vitamins, minerals and choline, and measurement in incubated liver slices of the percentage conversion of glucose to carbon dioxide, fatty acid and glycogen. It was found thus that a diet of bread, or a purified diet low in protein, produced a four-fold greater conversion of the radio-active glucose to fatty acid, and to carbon dioxide, and decreased conversion of glucose to glycogen.

Glycogen content and enzyme activities of human liver. This is a collaborative investigation with Dr. Waterlow's unit and the Department of Medicine, and is concerned primarily with studies of changes in substances and enzymes connected with carbohydrate metabolism in liver biopsy material from human diabetics, and designed to reveal if there are differences between "insulin sensitive", "insulin resistant" and "Jamaican" types of diabetes. Results are awaited.

99. Dr. G. Bras, Reader in Pathology at the University College of the West Indies, has initiated studies on the histological features of the liver, pancreas and kidney in malnourished children. In the liver, fatty change was found to be an important feature in kwashiorkor ; but fibrosis was not. In a series of 22 newly-born infants, no relation could be demonstrated between fatty change in the liver and kwashiorkor, contrary to reports from elsewhere ; other explanations could be adduced. Lesions were found in the pancreas in

kwashiorkor, but also in marasmus and in a miscellaneous control group of children who had fatty changes in the liver. It was concluded that morbid changes in the pancreas are associated with malnutrition irrespective of the presence of fatty changes in the liver; they may also be associated with severe degrees of fatty liver in the absence of clinical symptoms of malnutrition. Histochemical techniques will be applied to further elucidation of these features.

100. Dr. O. A. R. Bassir, Lecturer in Physiology at University College, Ibadan, began a survey of the output and composition of milk of African mothers in Lagos, following up his investigations in England in 1953. The clinical studies were made at the Infant Welfare Clinic in Lagos, at the General Hospital and at other clinics in the Lagos area. On some 200 mothers, drawn indiscriminately from the community and all in the first year of lactation, the milk output was estimated, both by test-weighing the baby before and after feeding and by weighing the milk manually expressed from both breasts. The amount of milk obtainable by either technique proved variable. When "test-weighing" and manual expression were alternately followed on the same subject, at regular intervals throughout the day, rather large differences in output were observed in some cases.

Chemical analysis of the early morning specimens of expressed breast milk was undertaken for most of our subjects. The results showed no significant difference between the mean values of the concentrations of lactose, total nitrogen, and cream, respectively, in the Lagos mothers' milk and the published values for European and North American women. The results for calcium and phosphorus were, however, much lower than the European and North American averages; yet the Ca : P ratios were not different. Another interesting but tentative finding on breast milk was the lower daily output (about 500 g.) than that of European and North American mothers, so that the absolute amounts of the nutrients available daily to the suckling are inadequate for nourishing a baby over four months old. The study is being extended.

Publication

BASSIR, O. A. R.—(1955) "The effect of low calcium diet on tissue metabolism". *J. trop. Med. Hyg.*, **58**, 210.—(1956) "Nutritional studies on breast milk of Nigerian women". *Ibid.*, **59**, 139.

Investigations on sickle-cell trait and sickle-cell anaemia

101. These have continued, as a collaborative effort by workers in the field and in laboratories in Britain. Dr. G. H. Beaven, of the National Institute for Medical Research, and Dr. J. C. White of the London Post-Graduate Medical School, assisted by Miss E. Ellis, have combined the Singer 1-min. alkali-denaturation method for the estimation of foetal haemoglobin (Hb-F) in blood with their ultraviolet spectrographic methods, seeking to increase the sensitivity of detection of Hb-F below the 10 per cent. level. Whereas the simple Singer method gave increasing quantitative errors as the proportion of F-Hb fell below 10 per cent., the combined method enabled identification and estimation down to 1 per cent.

102. Dr. H. Lehmann, Dr. A. E. Mourant and Miss Ikin, investigating foetal haemoglobin, have collaborated in two projects, firstly search for the presence of haemoglobin F in a number of blood diseases and haemoglobinopathies, and, secondly, the correlation of chemical findings concerning haemoglobin F with the behaviour of cells when tested with rabbit anti-human foetal red cell serum. The distribution of haemoglobin S has been examined in Mediterranean countries, and found to be restricted to distinct foci, in which there were always both a high malaria rate and an opportunity of African blood admixture. Jointly with Dr. G. M. Edington, Accra, the distribution and mode of

inheritance in Africa has been studied ; likewise with haemoglobin C, found (in collaboration with Lt.-Col. J. H. Walters) in some Nigerian tribes. New instances of the rare haemoglobin D were recorded, all in Asiatics, and also of haemoglobin E and G.

103. Dr. A. C. Allison, a part-time member of the Medical Research Council's staff, has pursued three main lines of research.

- (a) *Chemistry of sickling.* The behaviour of oxygenated and deoxygenated solutions of various pure human haemoglobin types and mixtures of human haemoglobin types *in vitro* has been analysed, and has led to a new interpretation of the sickling phenomenon involving aggregation of the deoxygenated sickle cell haemoglobin molecule into helices which attract one another into a parallel orientation to produce a paracrystalline phase. Molecules of normal adult haemoglobin and haemoglobin C can specifically replace some sickle-cell haemoglobin molecules in the helices, the latter more efficiently than the former. Aggregation of the sickle cell haemoglobin molecules can be prevented by addition of urea and p-chloromercuribenzoate in relatively low concentrations. It is inferred that hydrogen bonding between the molecules is the main force in combination and that sulphhydryl groups are located near the combining sites.
- (b) *Conditions under which susceptible cells become sickled.* The exact conditions under which erythrocytes from sickle-cell trait carriers and from patients with sickle-cell anaemia and its genetic variants are transformed into the sickle shape have been studied. The proportion of haem groups that must lose oxygen before sickling can occur has been calculated. It is shown that these conditions are very similar to those required for the formation of a paracrystalline phase in haemoglobin solutions *in vitro*, so that the two processes must be the same. The cell membrane and stroma play very little part in sickling, although their properties are affected by it. The importance of the time factor in sickling is emphasised. Sickling takes more than a minute to complete, but the blood is deoxygenated in the capillaries and veins for about ten seconds. This time-lag helps to explain the precarious equilibrium of sickle-cell anaemic patients between crisis periods and the suddenly increased haemolysis of crisis periods. The distribution of haemoglobin types in erythrocyte populations is not uniform but varies significantly from cell to cell.
- (c) *Genetics of haemoglobin types.* Quantitative observations on the proportion of abnormal haemoglobins in sickle-cell trait carriers have been recorded. During a visit to the Gambia, Sierra Leone, the Gold Coast, Uganda and Tanganyika, blood specimens were collected from 729 infants between 2 months and 1 year of age and from 3,602 adult Africans. Tests for sickling and electrophoresis of haemoglobin specimens made on these specimens extended present knowledge of the distribution of the sickle-cell and haemoglobin C genes in West Africa and of the relative viabilities of the various genotypes. There is no evidence of selection in foetal or early neonatal life. Between the third month and adult life, however, more than 80 per cent. of sickle-cell homozygotes, 60 per cent. of sickle-cell : haemoglobin C heterozygotes, and 40 per cent. of haemoglobin C homozygotes, die. The frequency of sickle-cell trait carriers is significantly greater in the adult African population than in the infant population, which accords with the calculated selective advantage of about 25 per cent. There seems to be no significant difference in the number of offspring of matings between various genotypes.

104. *The electrophoretic analysis of haemolysates of red cells of individuals with sickle-cell trait.* This study has been made by Dr. E. M. Shooter and Mr. E. B. Skinner, B.Sc., in the laboratories of Professor A. Baldwin at University College, London. They report that the purpose of the research is to seek improved conditions for the electrophoretic analysis of mixtures of human haemoglobins such that the protein boundaries remain sharp and adequate resolution of the haemoglobins is achieved after a relatively short time, qualities which earlier conditions lacked. The investigation has been particularly concerned with a mixture of adult and sickle-cell haemoglobins, as found in sickle-cell trait individuals. It has been found that satisfactory and rapid resolution can be obtained by accentuating the boundary anomalies, i.e. the conductivity and pH changes across the protein boundaries which occur in all electrophoresis experiments. These anomalies depend on the pH, ionic strength and relative mobilities of buffer and protein ions.

105. The magnitude of the boundary anomalies below the iso-electric point decreases as the mobility of the buffer cation decreases and thus the addition of slow moving lithium ions caused blurring of the peaks. As was expected, the relative mobility of buffer anions had only a minor effect below the iso-electric point. The pH required to achieve the same mobility in these different buffers showed that anion binding of the two haemoglobins decreases in the order phosphate, chloride, cacodylate.

With uncharged acid-type buffers above the iso-electric point the conductivity and pH effects work in opposition, giving diffuse boundaries, and thus barbiturate buffers gave poor resolution. With uncharged base-type buffers, e.g. trihydroxymethylaminomethane, the effects are combined to sharpen the boundaries but boundary instability occurred at 0.04 ionic strength. The instability disappeared at 0.08, but here the sharpness was lost. The degree of sharpening of the haemoglobin boundaries has been correlated with measurements of the pH and conductivity changes occurring across them.

The most satisfactory analysis was thus obtained in phosphate buffer at pH 6.4 and ionic strength 0.04, and under these conditions excellent resolution of the haemoglobins from sickle-cell anaemia, C-trait and normal bloods besides that of the sickle-cell trait was achieved.

106. *Research on sickle-cell membrane properties.* Dr. G. V. F. Seaman and Dr. B. A. Pethica of the Department of Colloid Science (University of Cambridge) have begun research on the membrane properties of intact sickle-cells. Adequate supplies of sickle blood for laboratory work were obtained from a number of sources. A survey of Negro students in the University yielded four persons with sickle-cell trait, all co-operative. Further trait and anaemia specimens were generously supplied by others. The first group of experiments has been concerned with characterising the membrane charge of intact normal and sickle-cells, done by measuring the reversal of charge concentrations of heavy metal ions in a microelectrophoresis apparatus. The results with a variety of cations indicate that the surface charge of both sickle and normal cells is due to phosphate groups. The charge densities of sickle and normal cells differ significantly, and differences of charge pattern are indicated by the fact that sickle-cells adsorb trypsin more effectively than do normal cells. The character of the phospholipid groups causing the negative charge of the normal and sickle membranes is being investigated with model phospholipid and cholesterol dispersions using the adsorption of mercuric ions as an indicator. Mercuric ions adsorb differently on normal and sickle-cells, and also exhibit unusual adsorption on cholesterol and phospholipid dispersions, due possibly to presence of HgCl_4^{2-} ions. The phenomenon of sphering of erythrocytes by passage over

glass beads has also been examined. Oxygenated sickle-cells are more resistant than normal cells to sphering, but no alteration in electrophoretic properties was detectable in either case after sphering had occurred. It was found that the differential sickle-cell count obtained in sterile smears sealed with vaseline and incubated at 25° from 1 to 7 days decreased markedly with the thickness of the smear. This points to the participation of the glass surfaces in the sickling process.

Publications

WHITE, J. C., and BEAVEN, G. H.—(1955) "Detection and estimation of abnormal human haemoglobins." *5th Internat. Congr. Blood Transfusion*, Paris, 1954. *Reports*, Sept. 1955.

Idem, BEAVEN, G. H., and ELLIS, M.—(1955) "Analysis of human haemoglobins by paper electrophoresis." *Ciba Foundation Symp.*, July, 1955. [Publ. Churchill, 1956.]

LEHMANN, H.—(1955) "Human haemoglobin variants." *J. clin. Path.*, **2**, 178.

EDINGTON, G. M.—(1955) "The pathology of sickle-cell disease in West Africa." *Trans. R. Soc. trop. Med. Hyg.*, **49**, 253.

Idem and LEHMANN, H.—(1955) "Expression of the sickle-cell gene in Africa." *Brit. Med. J.*, **1**, 1308.

Idem, LEHMANN, H., and SCHNEIDER, R. G.—(1955) "Characterisation and genetics of haemoglobin G." *Nature*, **175**, 850.

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Idem, IKIN, E. W., and MOURANT, A. E.—(1955) "Further observations on blood groups in East African tribes." *J. Roy. Anthropol. Inst.*, **84**, 158.

SHOOTER, E. M., and SKINNER, E. R.—(1955) "The electrophoretic analysis of haemolysates of red cells of individuals with sickle-cell trait." *Biochem. J.*, **60**, XXVIII.

Leprosy

Nigeria

107. Dr. T. F. Davey, Senior Specialist, Nigeria Leprosy Service, Uzuakoli, has 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.

108. *Therapeutic Studies.* Laboratory and clinical studies of "Avlosulfon Soluble" have shown it to be a suitable and convenient preparation for administration by injection; its activity may be due in part, not to its breakdown in the body to D.D.S., but to the release of more soluble metabolites. A comparable study of D.D.S. itself suggests that the action of the parent substance may also in part be due to its breakdown to such substances in the body.

Diphenyl-thiourea, Ciba compound 15095E (or SU 1906), also reported as giving encouraging short-term results in tuberculosis, has been used in a clinical trial in leprosy for the past year. Dosage was empirical, and was increased slowly to a maintenance dose of 3 g. daily. Evidence appeared early that the drug was active, clinical improvement in every patient being associated with degenerative changes and reduction of numbers of bacilli in routine smears. Toxic signs were absent, as also was evidence of hepatic insufficiency or blood dyscrasia for which the drug could be held responsible. So far it may be said that at the dosage tested this drug is comparable in activity with D.D.S., and its lack of toxicity makes it especially promising. Expanded trials are continuing, to study dosage more thoroughly, to observe progress during the second year, to

watch for signs of drug resistance, and to assess the drug in combination with other agents. Trials are in progress on Diamino-diphenyl sulphoxide, related chemically to D.D.S., and showing much promise, producing a rapid therapeutic response, but displaying some evidence of disturbance of blood cell formation. Pyrazinamide is yet another substance possessing powerful chemotherapeutic activity in tuberculosis, though potentially of rather high toxicity. It has only recently been tried in leprosy.

109. Miscellaneous activities have included a study of lepromin and tuberculin in urban and rural areas, many hundreds of blood estimations on "Avlosulfon Soluble" which have raised doubts on the efficiency of benzene as an extractant of D.D.S. from body fluids, and the training of workers in the more technical aspects of leprosy, including two W.H.O. Fellows and several other medical men and technicians.

Uganda

110. At Makerere College Dr. R. F. Naylor, Lecturer in Chemistry, has initiated projects on the solubility of D.D.S. and on the enzymes of *Mycobacteria*. A simple apparatus has been devised for routine determinations of the solubility of D.D.S. in water and other solvents, and the concentration of the solute determined by a modification of the colorimetric method of Bratton and Marshall. The influence on its solubility of certain factors, viz. temperature, pH and small percentages of ethyl alcohol, has been investigated. In a study of the hydrogen transfer capacity of the enzymes of *Mycobacteria*, research on the Tetrazolium method has begun. It is known that reproducible results, showing with *M. lepraemurium* a good correlation with infectivity, are obtainable by conventional methods, and it is hoped to obtain satisfactory results on a microscopic scale so that the method may be applied to *M. leprae*. Using drop quantities of *M. phlei* and *M. ranae* on a microscope slide enclosed in an anaerobic system at 37° C. for periods of 2-4 days, development of the formazan colour (the reduced tetrazolium compound) is obtained within the bacteria. The applicability of microchemical methods will be investigated.

Publications

DAVEY, T. F.—(1955) "The effect of treating lepromin with lepromatous serum." *Lep. Review*, 26, 65.—(1956) "Experience with 'Avlosulfon Soluble'". *Ibid.*, 27, 6.

FISHER, B. C.—(1955) "Experience with the treatment of trophic ulcers by plaster casts." *Ibid.*, 26, 107.

Research at the Medical Research Council Laboratories, the Gambia.

111. 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 (paras. 40-42). Other activities are noted below.

112. All those subjects in Keneba found infected with *W. bancrofti* and treated with Hetrazan (25 mg. base/kg. body weight) in February, 1951, were again examined in December, 1954. In certain respects these results, four years after treatment, were superior to those obtained ten months after treatment. Evidence suggests that small doses of the drug may sterilise mature parent worms at the time of administration and thus terminate microfilaria production. It is therefore possible that small doses of Hetrazan repeated at prolonged intervals might in several years depress the microfilarial reservoir of a population below the level necessary for the infection of mosquitoes without causing the severe reaction that large doses of the drug produce by mass destruction of

microfilaria. To test the validity of this hypothesis Hetrazan at the dosage level of 12.5 mg. base/Kg. of body weight was given to infected subjects. Few ill effects were observed, and results so far are most encouraging. At this dosage level the simultaneous administration of an antihistamine drug to half the experimental group did not further reduce the incidence of ill-effects of hetrazan.

The incidence of sickle-cell trait in the various tribes of the Gambia has been established. Its relationship to the malaria parasitisation is being studied.

113. Visiting workers made a variety of studies during the year. As reported earlier Mr. S. R. Smithers throughout the year investigated schistosomiasis. Dr. J. A. McFadzean completed his observations on treponematosiis and on the incidence of leprosy in Gambian villages. Dr. J. H. Walters and Dr. F. N. Macnamara, of the Virus Laboratories in Lagos, spent four weeks investigating the incidence of yellow fever antibodies in Gambian indigenes. Professor A. W. Woodruff, Dr. F. D. Schofield and Dr. S. Bell spent some weeks assessing the incidence of the anaemias prevalent in the Gambia. Dr. Kingsley Saunders made a short study on the preparation of monkey kidney tissue suspensions for use in poliomyelitis research. Dr. A. C. Allison made studies for four weeks on the treatment of sickle-cell anaemia with ethyl biscoumacetate ("Tromexan") and on the distribution of haemoglobin in Gambians, especially haemoglobins S and C. Dr. L. Goodwin and Dr. O. Standen for two months undertook trials of different piperazine salts in ascariasis and trichuris infections, and of antigen testing in schistosomiasis.

Publications

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DUKE, B. O. L. and MCCULLOUGH, F. S.—(1954) "Schistosomiasis in the Gambia. II. The epidemiology and distribution of urinary schistosomiasis". *Ibid.*, **48**, 287.

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Idem and MCCOURT, J. F.—(1954) "Treponematosiis". *Brit. Med. J.*, **11**, 1270.—(1955) "Leprosy in Gambia, British West Africa". *Leprosy Rev.*, **26**, 57.

MCGREGOR, J. A. and GILLES, H. M.—(1956) "Diethylcarbamazine control of Bancroftian filariasis". *Brit. Med. J.*, **1**, 331.

JONES, E. S.—(1954) "A note on the photometric measurement of plasma pH". *J. Med. Lab. Tech.*, **12**, 71.

WRIGHT, C. A.—(1956) "Bulinus (*Pyrogophysa*) forskali (Ehrenberg) as vector of *Schistosoma haematobium*". *Nature*, **177**, 43.

East African Medical Survey and Research Institute

114. As stated earlier, the activities of this Survey and Institute at Mwanza, Tanganyika, now directed by Dr. Eric Holmes, have been widened in scope. The nutritional studies were reported at paras. 84–85.

115. A series of observations on the local population are in progress. A long-term one is on the health of children at local schools, viz. a primary non-residential school and a secondary residential school with a training college attached. Records are kept of heights, weights, enlargement of spleen and liver, and parasites. The haematology, stools and urine of a section of the local European population have been examined. Several were found to have bilharzia,

and their red blood cell counts were appreciably lower than the known figures for Makerere College students. Another study is on the white cell counts of Africans (including pregnant women) and of Europeans. This confirms the fact, previously noted, that there is an appreciably lower percentage of polymorphonuclear cells in the African white cell count than is found in Europe. The work is in an early stage, but may well open opportunities for further investigation.

Dr. P. Jordan has begun an investigation on filariasis on Ukara Island, which has been recorded earlier at paras. 19-20.

The studies recently initiated by Mr. W. F. H. McClelland on the snail vectors of schistosomes have also been noted earlier, at paras. 27-28.

Miscellaneous projects aided by small research grants

116. A number of comparatively small additional 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 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. Much of this is sent by request to British and American pathologists for the comparative study of various features such as (a) the normal weights of organs, in particular of the heart, spleen, liver, kidney and endocrine glands, (b) morbid changes in relation to endocrinology, nutritional disease including kwashiorkor, and diseases of the cardiovascular system and the significance of the latter in hypertension in the African, (c) the endomyocardial fibrosis described by Ball, Williams and Davies in Uganda, and (d) the incidence and variety of neoplastic disease in East Africa, especially of primary carcinoma of the liver.

Another such grant was made, jointly with the Medical Research Council, towards chemotherapy trials in tuberculosis in East Africa, centred on Mulago Hospital, Kampala, under the direction of Professor A. W. Williams and Dr. P. W. Hutton, with the collaboration of other hospitals and bacteriological laboratories in Kenya and Tanganyika. It provides for the collaboration of the M.R.C. Tuberculosis Research Unit in London by oversea visits and comparative studies in London of biological assessments and bacterial sensitivity tests.

**RESEARCH WORK UNDERTAKEN AND FINANCED BY THE
MEDICAL DEPARTMENTS OF COLONIAL TERRITORIES**

117. 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.

Federation of Malaya

118. The Director of the Institute for Medical Research, Kuala Lumpur, Dr. J. W. Field, has furnished a summary of its activities during 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.

119. *Malaria.* During the year therapeutic trials confirmed that chloroquine and amodiaquine are the most effective remedies for acute malaria in Malaya. Strains of *P. falciparum* resistant to proguanil and pyrimethamine were still encountered ; and the earlier indication that resistance to proguanil in the

blood forms extends also to the gametocytes and pre-erythrocytic forms was confirmed. Three Malayan strains of *P. vivax* were sent in mosquitoes and blood to America for study by Dr. A. S. Alving, University of Chicago.

The factors affecting the transmission of malaria by *Anopheles maculatus* were investigated during a three-month visit by Mr. G. Davidson, of the Ross Institute of Tropical Hygiene; the observations were planned to give data similar to those already obtained in Africa and thus provide a standard for the comparison of malaria transmitted under widely differing conditions.

120. *Pyrexiae of unknown origin.* As noted earlier (paragraph 71) the American Army group at the Institute have undertaken the isolation of viruses from hospital patients with undiagnosed fevers, and from wild-caught mosquitoes. In a complementary study the staff of the Institute have investigated the incidence of virus antibodies in man and in domestic and forest animals. Tests on Malayan sera, done mainly in America, have revealed antibody trails of viruses that occur in the African and American forests. Ntaya, Ilheus, Zika and Semliki Forest virus antibodies were common, and some evidence suggested the presence in Malaya of Uganda S. and Bunyamera viruses, and that infections with type I and type II dengue viruses were widespread. The relation of some of these viruses to disease in man is still unknown.

121. In 1954 three strains of influenza virus of type A Prime were isolated. During 1955 strains of type B were recovered from an epidemic in a boys' boarding school; another outbreak was proved serologically to be due to type B.

122. In the Department of Bacteriology work has continued on moulds from various sources, including soils, and selected strains sent to Britain for refined study. Phage typing of the typhoid bacillus was begun. On one of four strains of *Pf. whitmori*, *in vitro* tests suggested that a combination of Chloromycetin and Aureomycin might be effective in therapy.

123. In the Division of Biochemistry and Nutrition, 238 cases of severe anaemia were investigated. Serum iron levels and iron stores in the bone-marrow suggest that most had a severe iron deficiency upon which various degrees of megaloblastic anaemia might be superimposed. A study of the pattern of iron metabolism has begun, using the radio-active isotope Fe⁵⁹, the equipment having been provided by a grant recommended by the Committee. In an investigation of the significance of hookworm infestation as a cause of anaemia, at the higher haemoglobin levels the incidence was 15 per cent., but at the lowest levels the incidence rose steeply to 65 per cent.

Work has continued on the enrichment of rice with thiamine and iron supplements, on palatability trials with parboiled rice, and on the effect of the parental administration of supplementary thiamine on the milk thiamine levels in pregnant women of the three racial groups in Malaya. In analyses of fish meal the protein and calcium content was found to be fairly high; but the optimal conditions necessary for safe storage under local conditions call for much investigation.

Kenya

124. From the Division of Insect-borne Diseases of the Medical Department, Dr. R. B. Heisch and his colleagues report further observations made in the Kitui kala-azar area. It was at first believed that an anthropophilic species of sandfly, provisionally designated *Phlebotomus (Sergentomyia)* sp. nov. 2 and now named *P. garnhami*, was the most likely vector of the epidemic. Not only does this species bite man in large numbers, but specimens have been found naturally infected with leptomonads, and last year a number were artificially infected by feeding them on cutaneous lesions containing *Leishmania*. However,

the infection rate (5 per cent.) was rather low for a potential vector, and now two more anthrophilic species are under suspicion. These are two *Synphlebotomus*, one of which is *P. martini*, which also occurs in the southern Sudan and Abyssinia, and the other a closely related new species named *P. vansomereni*. Both are fairly closely related to the *P. major* group, and their vector potential will be tested by feeding experiments. Another focus of kala-azar has been found at Marigat in the Rift Valley of Kenya, and *P. martini* is quite common in the termite hills of this new locality. Another species caught biting man at Marigat is *P. schwetzi*. Thus the vector problem is highly complex and will be difficult to solve. The search for an animal reservoir continues.

125. Much work was done on the so-called "negative phase" of spirochaetes in lice. It was found by using a new technique, which entails examining the haemocoelic fluid of lice instead of smearing them on slides and staining with Giemsa, that a true "negative phase" does not exist, small numbers of spirochaetes being present in the haemocoelic fluid 6-8 days after an infective feed, the period being suddenly terminated by the appearance of numerous spirochaetes in the body fluids of the louse. It is suggested that the early phase, which is really an incubation period, should be called the "*pseudo-negative phase*". The possible role of the nephrocytes in the development of spirochaetes in lice deserves consideration; curious granules have been observed in these cells on the 6th day, the significance of which is uncertain.

Over 400 *O. savignyi* from the Northern Province have been emulsified and inoculated into white rats. No spirochaete was isolated, and it is unlikely that this species is a vector in nature.

There was a small outbreak of plague in a village on the forest edge of the escarpment overlooking the Rongai Area. An interesting find was *Pulex irritans* (regarded as rare in East Africa) on skins worn by the villagers. Large numbers of *Dinopsyllus lypusus*, a possible transmitter of campestrial plague in Kenya, were sent to Dr. Baltazard in Teheran who will test their vector potential.

Work continued on the elephant shrew parasite *P. brodeni*, but the tissue stages have not yet been found.

Fiji

126. The important investigation by Mr. C. B. Symes into the possible uses of insecticides as an aid to the control of the mosquito vector, or vectors, of filariasis are reported in the corresponding Annual Report of the Colonial Pesticides Research Committee. The salient findings have been that the one hitherto accepted vector, *Aedes pseudoscutellaris*, is now known to include a second species, *A. polynesiensis*; both species appear to be good carriers in the field and in the laboratory. Further, two other vectors have been incriminated, *Aedes fijiensis* and *Culex fatigans*, the relative importance of which is now being studied.

As one of a series of trials with Hetrazan in 1954, almost the whole population of Lakeba Island received 50 mg. once monthly, irrespective of whether they had microfilariae in their blood; of the 1,582 recipients of the drug, 322 (i.e. 20.3 per cent.) were proved positive. One year later, of these 322 positives, 211 were available for re-examination; and it was found that 142 (i.e. 67.3 per cent.) had become negative. It was also found that of the 1,153 islanders recorded as negative in 1954, 47 showed microfilariae in their blood on re-examination after their one-year "treatment" with Hetrazan; presumably a formerly cryptic infection had become demonstrable.

Further trials are now projected in which a larger dosage than 50 mg. at monthly intervals will be used.

Colonial
Pesticides Research Committee
Ninth Annual Report
(1955-1956)

Commonwealth Institute of Entomology,
British Museum (Natural History),
Cromwell Road,
London, S.W.7.
19th October, 1956

SIR,

I have the honour to enclose herewith the Ninth Annual Report of the Colonial Pesticides Research Committee for the year 1955-1956.

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. H. G. H. KEARNS, Ph.D., Department of Agriculture and Horticulture, University of Bristol.
- DR. R. LEWTHWAITE, O.B.E., D.M., F.R.C.P., Joint 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.
- PROFESSOR SIR JOHN L. SIMONSEN, D.Sc., F.R.S.
- DR. S. P. WILTSHIRE, M.A., D.Sc., Director, Commonwealth Mycological Institute.

Ex-Officio Members

The Secretary of State's Medical, Agricultural, Animal Health and Forestry Advisers.

MR. J. ROSE, M.B.E., D.F.C. (*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.
- MR. G. H. E. HOPKINS, O.B.E., M.A., Zoological Museum, Tring, Herts.
- DR. R. LEWTHWAITE, O.B.E., D.M., F.F.C.P., Joint 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*).

FUNGICIDES SUB-COMMITTEE

- DR. S. P. WILTSHIRE, M.A., D.Sc., Commonwealth Mycological Institute (*Chairman*).
- SIR GEOFFREY CLAY, K.C.M.G., O.B.E., M.C., Agricultural Adviser to the Secretary of State.
- DR. G. WATTS PADWICK, M.Sc., Ph.D., D.Sc., Imperial Chemical Industries Ltd.
- DR. A. F. POSNETTE, Ph.D., M.A., East Malling Research Station.
- MR. D. RHIND, O.B.E., F.L.S., Secretary, Committee for Colonial Agricultural, Animal Health and Forestry Research.
- MR. G. SAMUEL, M.Sc., Agricultural Research Council.
- 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.
- MR. J. E. MAYNE, Colonial Liaison Officer, National Institute of Agricultural Engineering.
- MR. A. C. PEACOCK, B.A., A.R.I.C., Chemical Defence Experimental Establishment, Ministry of Supply.
- MR. J. ROSE, M.B.E., D.F.C., Secretary, Colonial Pesticides Research Committee.
- MR. K. WILSON-JONES, M.Sc., Scientific Secretary, Colonial Pesticides Research Committee.
- MR. R. MOWFORTH (*Secretary*).

COLONIAL PESTICIDES RESEARCH COMMITTEE
NINTH ANNUAL REPORT

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Circulated to the Committee.

COLONIAL PESTICIDES RESEARCH COMMITTEE NINTH ANNUAL REPORT

PART I. GENERAL

1. At the 30th meeting of the Committee held on the 25th November, 1955, the recommendation was made that as the old title of "Colonial Insecticides, Fungicides and Herbicides Committee" was cumbersome and inadequately described some of the present activities under its aegis, it should be changed to "Colonial Pesticides Research Committee". This has now been approved.

2. The Herbicides and Arborescences Sub-Committee was disbanded. A new Sub-Committee on Methods of Application was formed which will be responsible, through the main Committee, for advising the Secretary of State on the technical aspects of the application of pesticides. This Sub-Committee will include in its terms of reference the application of liquid sprays, dusts, dispersible powders, aerosols, mists and fogs from the ground and from the air, thus incorporating the work formerly undertaken by the Aircraft Trials Sub-Committee.

3. Two meetings of the main Committee, but no meetings of the Sub-Committees, were held during the year.

Membership

4. The following resignations from the main Committee have taken place :—

Dr. E. A. Perren, on his appointment as Chief Superintendent (now Director) of the Chemical Defence Experimental Establishment of the Ministry of Supply.

Brigadier A. E. Campbell, on his taking up a new appointment.

The following appointments to the main Committee have been made :—

Mr. A. S. G. Hill (replacing Dr. Perren).

Brigadier P. J. L. Capon (replacing Brigadier A. E. Campbell).

Mr. K. Wilson-Jones (to the new post of Scientific Secretary to the Committee), on his appointment as Assistant to the Officer-in-Charge, Colonial Pesticides Research.

5. Mr. K. D. Law was succeeded by Mr. R. Mowforth as Secretary to the Sub-Committees. Two new members were appointed, Dr. F. Hawking and Dr. J. R. Busvine, both to the Sub-Committee on Insect Vectors of Disease.

The membership of the main Committee and Sub-Committees as at 31st March, 1956, is shown at the beginning of the Ninth Annual Report on Pesticides Research.

PART II. SUMMARY OF ACTIVITIES

6. Among developments during the year has been the decision to make Arusha the main centre of overseas Colonial Pesticides Research activity by the amalgamation of the Unit lately at Ilonga and by the later inclusion of other detached units. From the new combined Unit it is proposed to detach scientists, either singly or in small balanced teams as necessary, for the investigation of particular problems. The advantages which it is thereby hoped to gain will include the availability of more experienced officers for these tasks, their close connection with the main centre of research at Arusha, and the opportunity of using the "combined approach" of biological and physical sciences, so necessary in research of this kind.

7. Included in the activities at the Colonial Insecticide Research Unit, Porton, the mechanism of sorption of insecticides into mud blocks has been further studied, and is now better understood. The influence of water vapour on

insecticide mobility has been observed, and is being further studied at high priority. Work on U-F lacquer formulations has now been temporarily discontinued, having been carried as far as practicable with the resources available. The physics section has carried out wind tunnel studies on the "collection efficiency" of objects placed in an air-stream of droplets of various diameters, and a number of aircraft assessment trials made. At the Imperial College Field Station, Silwood Park, the studies on olfactory stimulation of insects, on the pick-up of insecticides from surface deposits, and on the penetration of the insect integument by insecticides, have continued. At Rothamsted Experimental Station work continues on the toxicity of insecticide films.

8. Overseas, at the Colonial Insecticide Research Unit, Arusha, work has continued to find the optimum conditions under which tsetse and mosquitoes may be killed, aircraft spray assessments have been carried out, and work on arboricides continued. The Colonial Agricultural Insecticides Research Unit, Ilonga, has reported large increases in cotton yield from the use of various insecticides to control mainly American Bollworm and jassids. Work on maize pests, and on seed dressings, has continued.

9. Among the smaller Units, the Biting Fly survey work in Uganda has continued, and the work of the Entomology Research Unit in Mauritius has now been closed down and the officer withdrawn. Work has continued at the Western Sokoto Malaria Control Project in Northern Nigeria on the behaviour of insecticide deposits on mud surfaces in native huts, and in Zanzibar on *Pseudotheraptus wayi*. The survey of filariasis vectors in Fiji has continued, and preliminary experiments in control of its vectors was begun.

10. Overseas visits were made by Dr. R. A. E. Galley, who, in company with Mr. J. W. Wright, Secretary of the World Health Organisation Expert Committee on Insecticides, visited East, Central and West Africa in February and March, 1956, to study particularly the problems arising in malaria control projects caused by the development of insecticide resistance in anopheline vectors. Mr. K. Wilson-Jones made a brief visit to East Africa in June and July, 1955, before commencing his duties at Headquarters. Dr. H. G. H. Kearns visited Jamaica in connection with the programme of research on banana Leaf Spot in November and December, 1955, and East Africa in February and March, 1956.

PART III. REVIEW OF RESEARCH WORK

Colonial Insecticide Research Unit, Porton (England)

(Dr. A. B. Hadaway in charge)

11. *Sorption of Insecticides by Soils.* Investigations of the effect of atmospheric humidity on the sorption of insecticides by soils have been carried out. Results from this work indicate that the rate of disappearance of insecticides from the sprayed surface of mud blocks is inversely proportional to humidity, but once adsorbed, the rate of diffusion of insecticide away from the surface is directly proportional to humidity, and increase in humidity results in an enhanced mobility of adsorbed insecticide, which, while increasing the rate of diffusion farther into the mud, thereby decreasing the surface insecticide concentration, will also produce an increase in the rate of diffusion on to and into resting insects on the surface.

12. *Insecticidal Surface Coatings*

- (i) Work on the crystallization of insecticides from urea-formaldehyde resin films has been completed during the year.
- (ii) The effects of temperature upon the behaviour of the films have been investigated, and the weights of crystals produced from standard

laboratory-prepared lacquers containing DDT or pure dieldrin were found to increase with rising temperature, over the range 16° C. to 30° C.

- (iii) The effects of the relative humidity on the amounts of induced crystallization of insecticides on the surface of films have been investigated, and have been found to be directly proportional to the humidity conditions. Further work has shown the complete reversibility of the interchange of water between the films and the air surrounding them. In addition, the conditions under which films are stored before stimulation have little or no influence upon the subsequent crystal growth, suggesting that the equilibrium between water in the air and in the film is rapidly regained after a change of humidity.

13. *Residual Deposits on Vegetation.* Work has continued on this subject, the object being to provide further information concerning the behaviour of residual deposits from low-volume sprays on leaves of different types.

- (i) Comparison of DDT and dieldrin deposits on bean leaves and glass plates kept in a greenhouse with a daily maximum temperature often over 40° C. has been made, the greatest persistence being shown by dieldrin oil solution on bean leaves.
- (ii) Oil solutions and emulsions were compared, but no evidence of any difference in the persistence of these two types of formulations could be found.
- (iii) The persistence on leaves and glass plates was investigated, and it was found that, irrespective of the insecticide or the formulation used, leaves kept in the greenhouse during the summer remained toxic longer than similarly-treated glass plates. A possible explanation for this appears to be connected with the higher temperatures which the glass plates attain when exposed to sunlight.
- (iv) The toxicity of both plates and leaves was found to decline more rapidly in the greenhouse than in the constant-temperature room. This difference was partially attributed to differences in temperature, since although the mean temperature in the greenhouse was not always above that of the constant-temperature room, the daily maximum was almost always higher.

14. *Insecticide Formulations.* Some of the properties of insecticidal formulations affecting their toxicity have been investigated.

- (i) The toxicity to mosquitoes of dusts, made by impregnating inert materials with solutions of insecticides, was determined, and it was concluded that impregnated dusts have no advantages, from the toxicity point of view, over dispersible powders.
- (ii) In studies on solution formulations, the effect of the solvent on the toxicity of insecticide solutions was investigated by allowing insects to remain in contact with oil films for a limited period, and in other experiments a definite dose of insecticide solution was applied to the thorax of the insect.

Solutions of DDT in various solvents were in the same general order of toxicity to house-flies as they were to mosquitoes. Solutions of prolan, dieldrin, endrin or malathion were in the same order of toxicity as were solutions of DDT. The extent to which the solvent affected toxicity varied considerably, from one insecticide to another.

15. *Cumulative Effect of Sub-Lethal Doses.* In order to obtain information concerning the effects of repeated small doses of insecticides on insects, experiments were carried out, using DDT, gamma-BHC, dieldrin and diazinon.

The conclusions from the tests which have so far been made were that houseflies from a normal strain have the ability to eliminate, metabolise or store in a harmless condition, to a greater or lesser extent depending on the insecticide, a proportion of the absorbed insecticide provided that the dosage was sufficiently low.

16. *Wind Tunnel Studies.* Measurements of the efficiency of droplet collection by a number of objects have been made in a small 1 ft. perspex wind tunnel, in order to obtain basic information on the deposition of spray droplets and to develop improved methods of field assessment of aircraft sprays.

17. *Spraying Installations on Aircraft.* Field trials have been carried out with the Auster J5G aircraft and using a variety of liquids, sprays with volume median diameters ranging from 200 to 500 microns have been obtained. The performance of Spinning Disc Spraying Units fitted to another Auster has been assessed at the request of the Desert Locust Control, and it was found that the volume median diameter was 110 microns. The hydraulically-powered insecticide pump installation has been fitted to the Westland S-51 helicopter, and has been tested out in a series of functional and field trials.

Imperial College Field Station, Silwood Park (England)

18. *Penetration of the Insect Integument by DDT Solutions.* Investigation of a method of assessing the degree of intoxication during the early stages of nerve poisoning by DDT is being carried out. The method depends on the responses of treated insects to graded stimulation of sense organs. The ability of an insect to become habituated to a stimulus appears to decrease as DDT takes effect.

19. *Contamination of Insects Exposed to Deposits.* In comparative studies the weights of material picked up during the first few steps on a standard deposit have been determined for five species of insect, viz. *Dysdercus fasciatus*, *Notostera erratica*, *Feronia modida*, *Rhagonycha fulva*, and *Vespa vulgaris* (workers). The quantity picked up per step was unaffected by the speed of movement but varied with the area of contact with the surface and the weight of the insect, thus females of *Dysdercus* were twice as heavy as males and picked up 20 per cent. more particles per step. The structures of the tarsi of the above species have been described and the distribution of particles contaminating the tarsi observed. The "collecting efficiencies" of different legs and segments are considered to be functions of pressure on substrate associated with structure. The effect of cleaning movements on the distribution of particles has also been investigated.

20. *Olfactory Stimulation of Tsetse Flies.* The present series of experiments on the responses of tsetse flies to the vapours of organic compounds has been completed.

21. The final tests were made with four mixtures of compounds. The activity of *Glossina morsitans* in each mixture of acetic acid and n-hexanol, amyl acetate and ethyl valerate, ethyl caprate and di-n-butylamine, and n-butanol and ethyl acetate equalled the sum of the activities of the flies in the individual components; no synergistic effects were found.

22. The concentrations of vapours to which *G. morsitans* and the blowfly *Protophormia terraenovae* would respond were found to be related to the physical properties of a considerable number of compounds in a partial regression analysis. From the calculation, compounds of low vapour pressure and low dielectric constant were shown to be good olfactory stimulants. A mechanism of olfactory stimulation compatible with this result will be suggested in a final report on this work which is now being completed.

Rothamsted Experimental Station (England)

23. *Toxicity of Emulsion Films.* The effect which small quantities of non-volatile oleophobic additives produce on the physical nature and toxicity of films obtained from DDT emulsions is being studied. The effect of additives on the appearance of the films is very great when the insecticide is sprayed on to glass, but less when the glass has received an initial wax coating.

24. In further studies on the effect of sunlight on DDT deposits, an attempt has been made to distinguish between possible photo decomposition and losses due to evaporation, caused by the heating effect of sunlight. The results indicated that most of the losses occurring from deposits exposed to the sun could be prevented if a matt black metal surface cooled by circulating tap-water was used as the support for DDT-bearing glass plates.

25. The method of testing the toxicity of the deposits, using *Tribolium castaneum* Herbst. as the test insect, has some unsatisfactory features, and is being investigated further.

26. *Persistence of DDT on Foliage.* Work on this subject was continued, and investigations have been carried out to determine the site of storage in the leaf. The experiments were repeated using the plant *Graptopetalum paraguayense* a succulent with leaves from which the cuticle can be entirely stripped. When leaves were stripped as soon as the deposit was dry, the DDT was confined to the cuticle, and could be removed completely by washing with carbon tetrachloride before stripping. Leaves kept for 12 days showed penetration of DDT. It seems, therefore, that DDT in the form of a crystalline deposit is capable of penetrating right through the cuticle into the underlying tissue. The proportion penetrating in this way is, however, too small to have any important bearing on the life of the deposit as a contact poison.

Agricultural Research Unit of Experimental Agronomy, Oxford (England)

(Director, Professor G. E. Blackman)

27. Work on the testing and evaluation of new chemicals for the control of undesirable vegetation has continued. Although much of this work has been concerned with temperate crops and their associated weeds, special tests using *Chrysanthemum cinerariaefolium*, the source of Pyrethrum insecticide, have been carried out. Experimental techniques and spraying equipment have also been studied.

28. Studies have continued on some of the factors concerned in phytotoxicity. The action, upon whole plants, of the α -substituted phenoxybutyric acids and the corresponding phenoxyacetic acids, has been compared, using a variety of plant species, growth stages, formulations and types of application.

29. Physiological and biochemical investigations have followed (a) the effect of B-indole-acetic acid (I.A.A.) on cell metabolism, especially amino-acid metabolism, (b) the movement of growth substances in the plant, particularly methods of polar transport, and (c) the physiology of leaf abscission, with special reference to its regulation by natural and artificial means. The results of some of this work have been published (Osborne, D. J. *Nature*, 176, pp. 1161–1163, 1955). It is postulated that leaf abscission is controlled not only by endogenous auxins but also by some substance or substances produced by the mature or senescent leaf.

30. Close liaison has been maintained with the Botanist, C.I.R.U., Arusha, who interrupted his leave in March, 1956, in order to visit Sierra Leone and carry out experiments in the control of mangroves (*Avicennia* and *Rhizophora* spp.) on lines proposed by Professor Blackman following his visit in 1953.



Long Ashton Research Station (England)

31. During the year special-purpose spraying equipment and spray materials were made for Jamaica, Zanzibar, Tanganyika, Kenya, the British Solomons and North Borneo. The investigations in Jamaica on the control of Leaf Spot of bananas by copper fungicides, commenced in 1953, have been completed and a new technique of spraying has been adopted throughout the Island. The results of the experimental work will be published.

32. Whilst in East Africa, Dr. H. G. H. Kearns visited Zanzibar to demonstrate the use of a specially-designed Airflow "Mist Blower" and of an observation ladder required for investigations on *Pseudotheraptus* "nutfall" of coconuts. Preliminary investigations were made at Lyamungu, Tanganyika, on the factors involved in the retention and distribution of copper fungicides on *Arabica* coffee for the control of *Hemeleia* rust. A detailed specification was prepared for spraying equipment required for the plantations of the Research Station. The performance of a stirrup pump spraying equipment made for use by African growers of the Kilimanjaro Native Co-operative Union was examined. Nairobi was visited in connection with small power sprayers supplied for experimental work.

33. Kawanda in Uganda was visited to discuss the use of spraying equipment and techniques for use by African growers. Arrangements were made for testing a standardised spray nozzle and for comparative trials of a DDT emulsion of high wetting properties on cotton. A spray machine suitably modified was supplied to the British Solomons and spray materials for experimental work on the control of *Amblypelta* "nutfall" of coconuts. A high wetting gamma-BHC spray was compounded and supplied to North Borneo for experimental work on the control of aphids on hemp.

Colonial Insecticide Research Unit, East Africa

(K. S. Hocking in charge)

34. *Experiments on Tsetse.* Observations have continued on the experimental area at Kikore. Numbers of fly are still very small, and *G. morsitans* barely maintains itself, though recent native settlers in the block have left again allegedly on account of "fly". *G. swynnertoni* has shown a small but steady increase since 1952. The highest apparent densities in the treated block of 3.8 for *G. swynnertoni* and 2.0 for *G. morsitans*, are still well below the A.D. of *G. morsitans* of 239 on the hillside control, for the first quarter of 1956.

35. In the South Nyanza area of Kenya, experiments are being carried out in the control of *G. palpalis* by residual spraying of riverine vegetation. Samples of treated leaves have been collected at regular intervals for chemical and biological examination in the Arusha laboratories. Both DDT at 5 per cent. emulsion, and dieldrin at 5 per cent. and 1.7 per cent., have been used. The former gave deposits of unexpectedly poor life, but the latter, even at the lower strength, proved satisfactory. New spraying schedules, based on those findings, have been proposed for use by the Kenya Veterinary Department and the Uganda Department of Tsetse Control.

36. A re-examination of the results of experiments in the use of non-persistent insecticides for insect control has been carried out, from which it appears that the percentage kill per treatment constitutes the over-riding factor in reduction in tsetse numbers, and that variations in intertreatment interval are of relatively less importance. The relatively higher resistance of very young and very old tsetse, allowing for recovery from sublethal contact with the insecticide, offers an explanation of the cases when the control attained has been below reasonable expectation.

37. In connection with the chilling of tsetse for purposes of handling and transport, experiments have been carried out to delimit the conditions for maximum efficiency. It was found that *G. palpalis fuscipes* became more susceptible to cold (2 hours at 2° C.) as they aged, but that under less rigorous conditions the correlation became less ; even so, mortality at 10° C. for 3 hours was 9 per cent. It is concluded that low night temperatures may be of considerable importance in limiting tsetse breeding.

38. A portable aerosol apparatus, based on a design by M. M. Christie (E. A. Malaria Institute), has been built. The first model was lost in a bush fire, but a second is now in operation. It is possible to vary both the " deposit " and the droplet size. Results so far obtained show that susceptibility to DDT aerosols varies with the species, age and hunger state of the fly.

39. The laboratory culture work has been concentrated principally on *G. morsitans*. A partially successful colony had to be terminated in the first quarter of 1956 principally on account of the difficulties of maintaining standard condition in the absence of a mains electric supply, but not before full details had been worked out to produce a regular weekly increase in numbers of 5-7 per cent. Flies are kept separately in 3 in. × 1 in. specimen tubes at 73°-79° F. and 60-70 per cent. R.H. and fed on sheep at 3-day intervals. A full report is to be issued later.

40. *Experiments with Mosquitoes.* On the Taveta-Pare Malaria Scheme, the second spraying cycle commenced in February, 1956. The rate of application in the first cycle rose considerably towards the end and precautions are being taken to control the rate of application. Intended nozzle dosage has been reduced to 0.5 g/m² to give 0.4 g/m² deposit of dieldrin. As a result of the first treatment the number of mosquitoes caught per house by flitting has fallen greatly, especially in the Taveta area. Work on the acquired resistance to insecticides of *A. gambiae* has been concerned mainly with dieldrin. Using the Busvine technique, the natural level of susceptibility has been measured in a number of parts of East Africa, including the Taveta-Pare area. Attempts are being made to produce a resistant strain in the laboratory.

41. *Work of the Physics Section.* Experiments with granular insecticides containing dieldrin have been carried out, and a suitable installation for the dissemination of the granular insecticide by aircraft has been devised. Further assessments have been made of the drop spectra produced by various nozzles fitted to a conventional boom-and-nozzle installation used with an Auster aircraft. Brief tests have been carried out with rotary brush equipment fitted to a Cessna 180 aircraft. Using three brushes per unit, and a liquid BHC formulation, volume median diameters of 250 and 300 microns were obtained for emission rates of 6 and 12 gallons per minute respectively. In collaboration with other organisations, the unit has organised and carried out a large-scale attempt to control the seasonal peak of Anopheline breeding in Dar-es-Salaam, using aircraft applications of dieldrin granules. A series of experiments, using aircraft applications of insecticides, was carried out in Mafia to investigate methods of controlling *Pseudotheraptus wayi*, a pest of coconut palms. Calculations have been made of the effect of introducing sterile male tsetse flies into a natural wild population, and calculations have also been made of dosage distributions from smoke generators.

42. *Work of the Chemistry Section.* Over 8,000 samples were examined during the year, the largest number being spray deposits from aircraft trials. The principal independent investigation was the assessment of individual operators engaged in the Taveta-Pare Scheme. A method of checking during the spraying cycle, based on quality control charts, has been worked out.

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Work upon the persistence of insecticides in soils and in the bark of coffee trees has continued, and studies have started of their persistence and distribution upon cotton plants. A modification of the Stepanow method for determining dieldrin has been worked out, and a paper has been submitted for publication.

43. *Arboricides and Herbicides*. No further aerial spraying experiments have been undertaken, since March, 1955. Observations on ground spraying experiments have continued and a number of new trials have been started. It appears probable that many of the more troublesome tree and shrub species in Tanganyika can be killed and regeneration either prevented or inhibited for some time, by spraying with oil solutions of 2,4,5-T or 2,4-D esters. Some species of *Lansea* (*L. triphylla* and *L. humilis*) and of *Commiphora* (*C. schimperi* and *C. subsessifolia*) are also susceptible to 0.5 per cent. concentrations of 2,4,5-T. Some *Combretum* species, however, appear to be more resistant. *C. zeheri* has been killed by a basal spray of 2.5 per cent. 2,4,5-T with little regeneration after 10 months. Large *Acacia senegal* have been killed by 3 per cent. 2,4,5-T applied to frills. Two trees of particular importance at higher altitudes in Kenya are *Euclea divinorum* and *Tarchonanthus camphoratus*, and present results indicate that the former is relatively resistant to 2,4,5-T and 2,4-D; further experiments on this species are in progress. Experiments have been reported at different times of the year on a number of species, to determine the best season for spraying. Spraying experiments on Sodum apple (*Solanum incanum*) suggest that this weed may be controlled with an ester formulation of 2,4-D at 1.2 lb./acre.

Colonial Agricultural Insecticides Research Unit, East Africa

(K. S. McKinlay in charge)

44. *Control of Cotton Pests*. A series of field trials was carried out during the 1955 cotton season, with the object of investigating the extent to which the use of insecticides is influenced by other factors such as planting times, and method of crop formation of the cotton plant. The high yields obtained from these trials indicated not only the importance of using effective insecticides but also of early planting and good cultivation. Since the problem has now become one of extension rather than research, experiments at Ilonga finished during August, 1955, and the Unit moved to Urambo at the end of the year, where experiments have commenced on the control of Cotton Stainers.

45. *Maize Pests*. In trials against the maize stalk borer, *Busseola fusca*, the somewhat greater efficiency of 2 per cent. endrin dust over DDT was apparent. Another trial where emulsion sprays of endrin, DDT and gamma BHC were used has shown the superiority of endrin at less than half the rate of DDT. Malathion and diazinon have also proved to be highly effective but without the residual effect of the chlorinated hydrocarbon insecticides. DDT formulated with resins appears more effective than the standard DDT emulsion.

46. *Other Pests*. Two trials have been put down in the Arusha area, one on the effect of aldrin on chafer grubs in the soil, and the other on beans is designed to assess the effect of different seed treatments. Field and laboratory tests have been carried out with various insecticides on the Cerambycid Kapok Borer *Tragiscoschema*.

Biting Fly Research Unit, Uganda

(H. C. M. Parr, Entomologist)

47. Work in Entebbe has been hampered by delays in recruiting a field officer for the survey work, but the vacancy has now been filled. Survey and collection is now proceeding, and a number of hitherto unidentified types have been

submitted to the British Museum. The C.T. and H. room has now been completed and methods worked out for breeding of *Stomoxys*. The colony of this latter insect is now well established and reproducing at a high rate. No insecticide applications have so far been carried out, as emphasis has been throughout on the survey and bionomics of the biting flies.

Entomology Research, Mauritius

(J. G. Halcrow, Entomologist)

48. The one-man unit consisting of Mr. J. G. Halcrow was withdrawn on completion of the study of the bionomics of *A. gambiae*. No further work is contemplated. A final report has been prepared for circulation.

Filariasis Research Centre, Fiji

(C. B. Symes)

49. It is now clear that of the 15 species of mosquitoes occurring in Fiji, *Aedes pseudoscutellaris*, *A. polynesiensis*, *A. fijiensis*, and *Culex fatigans* must be regarded as the principal vectors of filariasis, on the grounds of (a) close contact with man either in the bush or in houses or both, (b) their high infection rate in nature, and (c) the ease of their infection with *W. bancrofti* in the laboratory.

50. Infection has been found in Indians, Europeans and persons of mixed blood living in coconut plantations, but no adequate surveys of races other than Fijian have yet been made.

51. Recent work has shown that normal microscopical diagnosis is unsatisfactory in the case of slight infections. The diurnal fluctuations in parasite numbers are well known, but even blood counts made simultaneously may show serious variations from finger to finger of the same patient. It is probable that blood samples actually taken are too small, for surveys based upon larger blood samples show a higher infection rate. In the present studies the incidence of filariasis, based upon microscopical diagnosis, is 20·8 per cent. A further 5 per cent show clinical symptoms but no microfilariae. In view of the above it is not improbable that the real incidence is around 30 per cent., but this can only be confirmed by improved sampling technique.

52. During observations on the effect of Hetrazan on numbers of microfilariae, a few mosquitoes (*A. pseudoscutellaris*) have become infected after feeding upon men with blood counts of 24, 14 and 0 microfilariae in 1 cc. Infection from a blood count of 0 occurred in two mosquitoes of a batch of 112, and in one of a batch of 49. These are the lowest recorded degrees of infection known to have infected mosquitoes, in the Pacific region.

53. The search for filariae in animal bloods, referred to in the previous report, has proceeded slowly. Filariae have been found in (in addition to dogs and cattle) one of a few mynah birds and a fruit bat (*Pterous hawaiiensis*). It is unlikely, however, that these are normally carried by the vectors of *W. bancrofti*.

54. Small village experiments in vector control have been carried out. Attempts at mosquito control by classical methods in 2 villages failed on account of local apathy. Experimental hut applications of wettable powders of DDT, dieldrin and BHC have been made in four other villages, where internal walls and roofs were sprayed, but the results are not yet available.

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Western Sokoto Malaria Control Pilot Project

(D. M. Langbridge, Chemist)

55. The insecticide chemist has completed his first tour, and arrangements have been made for the laboratory to be moved to Lagos. A very large number of investigations have been carried out during this first tour, and the main conclusions are as follows :—

- (a) The majority of DDT, dieldrin and BHC water-dispersible powders delivered to the project have satisfied the minimum requirements of the respective W.H.O. specifications. In one or two cases a low suspensibility has been found although this has not affected the spraying of the formulations.
- (b) The dosages of the three insecticides have been very variable, but most of the variation has tended to be in excess of the required dosage.
- (c) DDT residues from sprayed surfaces can be estimated rapidly by the Alessandrini technique with results equivalent in accuracy to those of more refined techniques.
- (d) Dieldrin and BHC residues containing from 0.5 to 5 mg. of the insecticide can be determined rapidly and accurately by a semi-micro Stepanow method followed by amperometric titration of the chloride ion produced.
- (e) The persistence of the three insecticides on mud walls is characterised by a rapid loss from the surface half millimetre during the first two weeks after spraying. The loss amounts to between 40 per cent. and 60 per cent.
- (f) DDT and dieldrin, at both 25 and 50 mg./ft.², show a more gradual decline after the first two weeks. BHC continues to disappear from the surface at the initial rate and 5 weeks after application only 10 per cent. of the original deposit remains.
- (g) The loss of DDT and dieldrin from the surface is due primarily to diffusion into the wall and consequent inactivation biologically.
- (h) The diffusion of DDT and dieldrin into the wall slows down the rate of loss of succeeding applications provided that there is a sufficient reservoir of the chemical inside the wall.
- (i) BHC deposits show no enhancement of residual life through superimposition of successive dosages.
- (j) There is no evidence of any appreciable enhancement in the residual life of the insecticides on white-washed surfaces.
- (k) The fate of insecticide deposits on thatch, which constitutes half the sprayable surface, is a major topic which requires further investigation.

During the year the chemist attended the W.H.O.-sponsored Second African Malaria Conference in Lagos, and contributed two papers which were introduced at the Conference.

Coconut Pest Research, Zanzibar

(F. L. Vanderplank)

56. Research into the control of *Pseudotheraptus wayi*, chief cause of nutfall in Zanzibar, has been continued. Two formulations of DDT were applied by means of a power sprayer using various dosages and droplet sizes, in plots varying from 2 to 8 acres. Best results were obtained with a formulation of 10 per cent. DDT and 1 per cent. coumarone indene resin in oil, and 30 per cent. DDT in Sovacide F. The former was applied as an 80 micron droplet spray at a density of 52×10^6 droplets per cu. ft. of air with an output of 2,000 cu. ft. per minute, and a total application of 2 gallons per acre.

57. The 268 bearing palms of this area yielded 53·6 nuts per palm as compared with 12·7 nuts per palm in a comparable untreated area. The DDT/Sovacide formulation was applied at about the same density with a 50–60 micron droplet, using 1 gallon per acre. The 800 bearing palms from this experiment yielded 48·1 nuts per palm in comparison with 8·8 nuts per palm in the untreated area.

PART IV. PESTICIDES RESEARCH NOT UNDER THE AEGIS OF THE COMMITTEE

58. 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

59. *Abyan Research Scheme*. Pests. The life cycles of economic crop pests are being observed with a view to ultimate control.

Barbados

60. *Medical*. Eradication of *Aedes aegypti* has continued satisfactorily on an island-wide basis.

61. *Agriculture*. Sugar-cane root mealy bug. Trials are being continued to test the value of chemical insecticides as a possible economic means of controlling the sugar-cane root mealy bug.

British Guiana

62. Trials of nicotine against *Castnia daedalus* Cram., on coconuts, mentioned in the last report, were repeated on ten palms at Cane Grove with eight palms kept as controls. Remains of dead larvae were found in the borings of eight of the sprayed palms, pupation having occurred in the remaining two. In the eight controls, living larvae were found in the borings of six, pupation having occurred in the remaining two. The Land Settlement Authority at Cane Grove has since sprayed several hundred infested palms, and progressive deformation of the leaf canopy usually associated with this species has been checked.

63. Trials against *Atta laevigata* were continued, and aldrin applied to the nests as an emulsion at the rate of 0·5 g. aldrin per entrance hole has continued to control this pest on the sandy soils of the intermediate savannahs.

64. BHC has controlled *Dysdercus ruficollis* and *D. fusco fasciatus* on cotton at 1 lb. of the gamma isomer per acre, although the minimum dosage has not yet been found. For small plots surrounded by wild host species, indications are that fortnightly dusting will be necessary during the bolling period.

65. *Scapteriscus didactylus* was controlled by aldrin at 4 lbs. technical aldrin per acre, applied as a 0·25 per cent. emulsion at 160 gallons per acre. This was applied after 24 hours of dry weather, but lower dosages would probably be effective on a dry soil.

66. At Providence, Berbice, an outbreak of *Arsenura erythrinae* completely defoliated Erythrina used as shade for cacao, before damaging the cacao itself. Control was rapidly obtained by spraying the boles of the tees to run-off point with a suspension of 50 per cent. DDT dispersible powder containing 2·5 per cent. DDT.

67. A general insecticide trial on rice, using six treatments and control, has been carried out at Mahaicony—Abary Rice Development Scheme, but has not yet been analysed.

British Honduras

68. *Haricot Beans*. Early sowings were completely destroyed by powdery mildew and aphids, and later planted beans suffered severely from flea beetle attack but appeared more promising.

69. *Seed Cotton*. Some aphids in the early stages and stainers were the only insect pests noted, and boll weevil was absent.

70. *Johnson Grass (Sorghum halepense)*, present in a small area in the north of the Colony, was effectively controlled with 3-(p-chlorophenyl)-1-1-dimethyl-urea. Sodium chlorate and 2 : 2-dichloro propionic acid were unsatisfactory.

Cyprus

71. *Plant Protection*. In large-scale experiments with citrus excellent control of the Mediterranean fruit fly *Ceratitis capitata* Wied. was obtained with one treatment of 0.1 per cent. actual dieldrin applied as a cover spray during the first week in October. Satisfactory control of the Olive fly (*Dacus oleae*, Rossi) was obtained with parathion in large-scale trials. Oil samples from the treated trees are being analysed to determine the parathion residue accumulated. Other insecticides tested were diazinon, malathion, chlorthion and metasystox. 1.5 parathion dust applied at 7.5 lb./acre gave excellent control of Cereal Leaf Miner (*Syringopais temperatella* Led.). BHC, DDT, diazinon and dieldrin gave inferior results, whilst chlordane proved ineffective.

Gold Coast

72. *Cocoa*. Experiments were continued at the West African Cacao Research Institute, Tafo, on the control of cacao mirids, *Distantiella theobroma* Dist., and *Sahlbergella singularis* Hagl., by a combined cultural and insecticidal treatment. A low canopy is maintained by pruning, followed by applications of 5 per cent. DDT dust to trees on which damage is found. This treatment is being compared with the application of an aqueous emulsion of 1.25 per cent. DDT, to pruned and unpruned trees. The toxicity of BHC and DDT to laboratory-reared mirid nymphs and adults is being investigated, and preliminary results have shown that at concentrations used in the field, BHC has a much higher toxicity to mirids than DDT.

73. Persistence of DDT deposits on cacao foliage is being investigated using the flour beetle, *Tribolium castaneum* Hbst., as the test insect. Present indications are that the toxicity, after spraying cacao leaves with 2½ per cent. DDT emulsion, persists for about a month. Two proprietary insecticidal lacquers are being examined for persistence on hardened cacao stems and on plates under controlled conditions. The effect of low-volume spraying using an aqueous emulsion of BHC on the eggs of cacao mirids is being investigated.

74. Two trials to investigate the possibility of controlling black-pod disease, *Phytophthora palmivora* Butl., using copper fungicides with more frequent harvesting, have continued. It was found that weekly harvesting gave only half as many infected pods as monthly harvesting, and also enabled more cocoa to be salvaged from pods which were attacked. The mean incidence of pod infection for the combined weekly and monthly harvested, unsprayed plots during the latter half of 1955 was 30 per cent. Sprays applied at monthly, fortnightly or weekly intervals, using Bordeaux mixture made with calcium carbide, ordinary Bordeaux, and Perenox (cuprous oxide) reduced the numbers of infected pods to 5, 10 and 10 per cent. respectively. In a smaller trial, the mean incidence of infection for the combined weekly and monthly harvested, unsprayed plots was 24 per cent. Regular fortnightly spraying with Perenox reduced this to 12 per cent., although monthly applications of this fungicide or of Blitox (copper oxychloride) at either level had less effect.

75. Based on recently completed field trials to control Capsids, a standard treatment of 4 ozs. gamma-BHC/acre in 5 gallons wash applied twice with a four-weekly interval has been recommended. Yield increases up to nine times have been recorded on plots where Capsids have been controlled for two seasons. Gamma-BHC dust applied at monthly intervals was effective on test plots at 10 lb./acre (equivalent to 1 oz. gamma-BHC per month). Further tests are being planned.

76. *Agriculture*. Stem Borers in Maize. Over 1,000 acres of late maize were treated with 5 per cent. DDT dust at 14 and 28 days after planting. Yields so far available indicate a 23 per cent. increase.

77. Storage Pests. Disinfestation of maize showing *Calandra oryzae* and several species of Tenebrionids after harvesting was accomplished by machine shelling and in-sack drying. Protection of the residues was afforded by treatment with lindane BHC. (0.45 per cent. gamma) at the rate of 1 oz. per cwt. prior to storage in plywood silos. Excellent results are reported for a three-months period, but notice is given of the high capital costs for developing this procedure.

78. Following initial promising results further tests are being laid down to assess the effectiveness of dusting cob maize in farmers' cribs with 0.45 per cent. lindane to control *Calandra oryzae*, *Tribolium castaneum*, *T. confusum*, *Gnathocerus maxillosua*, *Palorus* spp. and *Cathartus quadricollis*.

Jamaica

79. *Citrus*. After extensive trials with soil insecticides against the grubs of Fiddler Beetles (*Prepodes* spp. and *Pachnaeus* spp.) the following recommendations were possible for the 1956 season: for established trees the insecticide Dieldrex 15 will, in general, give control approaching 100 per cent. for one year if applied at the rate of one gallon of the concentrate per acre of 100 trees. Owing to the phytotoxic nature of its solvent, however, Dieldrex 15 is not recommended for use at the time of planting. Dieldrin 50 per cent. dispersible powder is recommended for use at the time of planting, and will give control approaching 100 per cent. for one year if applied at the rate of 2 lbs. of concentrate per acre of 100 seedlings. In the large-scale replacement of unthrifty trees which the Industry proposes to carry out in the immediate future, it is recommended that all replacements be "puddled in" with Dieldrin 50 per cent. dispersible powder at a dosage of 2 lbs. per 100 gallons of water, each replacement receiving one gallon of the mixture. The trials are continuing in order to ascertain the duration of residual effect and to determine the minimum effective dosages of all insecticides likely to prove effective.

80. *Banana Leaf Spot*. Further experimental work on the control of Leaf Spot was carried out during the year. Results indicated that the wetter dioctyl sodium sulphosuccinate greatly improved the efficiency of cuprous oxide and copper carbonate. An alkyl aryl polyether alcohol wetter which is compatible with Bordeaux was tested in a number of field trials all over the Island. These trials showed that it effectively improves the efficiency of Bordeaux and the Banana Board of Jamaica has decided to distribute it to growers for use in their spray mixtures.

Kenya

81. The Division of Insect-Borne Diseases commenced the spraying of about 38,000 huts with dieldrin in the Nandi Reserve. This work was carried out in an effort to control the severe seasonal epidemics of malaria which sometimes occur.

82. A few experiments using diazinon were carried out, with the object of controlling the larvae of *Culex fatigans*. At Malindi, a Kenya coastal town, *C. fatigans* was controlled by spraying pit latrines with Gammexane P.520.

83. Mambrin, another coastal town, sprayed with DDT in 1949, is still free of *Aedes aegypti* and attempts to re-introduce the species artificially have failed, for reasons unknown.

84. In the Tiwi coastal area, where 163 huts were treated with Gammexane P.520 in 1953 in an attempt to control *Ornithodoros moubata*, the ticks at first completely disappeared. This was not permanent, however, and in 1955 ticks re-appeared in several huts. In spite of re-spraying, ticks were still present in some of the huts a month later.

85. An attempt is being made to control *Glossina palpalis* at Waturi in the Lambwe Valley of Kenya by using small dummy animals treated with a dieldrin lacquer preparation. It is too early yet to reach any conclusions regarding the effectiveness of this treatment.

Malaya

86. Though effective, testing of organo phosphorus insecticides has been terminated owing to their high human activity, as have tests with endrin owing to its toxicity to fish. Field trials with DDT, BHC and dieldrin are promising, but the time of application appears to be critical. Work is proceeding on control of pests and diseases on cloves, bananas, tomato, cruciferous and other vegetables in addition to crops mentioned previously.

87. *Agriculture.* Mortality from termite attack on the roots of young trees of *Eucalyptus* spp. was reduced from 15 to 2 per cent. by application of dieldrin to the soil. DD soil fumigant was found unsuitable because it kills the trees as well as the termites. Dieldrin also eradicated carton-building ants (*Crematogaster* sp.) from young trees.

88. Of three promising proprietary insecticides given a full-scale test for protection of freshly-felled logs against Ambrosia beetle attack, only one, containing endrin, gave significant protection. One of the others (which contained BHC) appeared to attract attack, although it had been reported to be very effective in some other countries. Preliminary tests on several other insecticides did not show any to be worth a full-scale test. Half-inch Jelutong boards treated with boric acid were still free from powder beetle attack after nearly two years.

Mauritius

89. *Pests and Diseases.* Experiments with chlordane to control sugar-cane grub *Clemora smithi*, popularly known as the *Phytalus*, have given a highly significant reduction of larval infestation. Several consignments of parasites of the cane spotted borer have been introduced, including *Maruca testulalis*.

Nigeria (Northern Region)

90. *Cotton.* Insecticide trials were continued at Kontagora Farm Centre and on the Kontagora Land Settlement Scheme, using a DDT/BHC spray mixture. At Samaru, insecticides are being used in an attempt to determine the actual loss of cotton due to pests. Further trials of a mercurial seed dressing to control bacterial blight of cotton have again failed to demonstrate a yield increase after treatment. It is probable that the strain of cotton grown possesses a considerable degree of resistance, and the loss of yield from this disease is not great enough to be measurable under the trial conditions. It has also not been found possible to maintain through the season the initial striking difference in infection between plots from disinfected and untreated seed in spite of the use of screens of sorghum.

91. A small observational spraying trial was carried out on onions affected with a leaf disease. Both seedlings and older plants were sprayed using Perenox (cuprous oxide) and Spersul (dispersible sulphur) separately and combined.

These two fungicides combined appeared most effective, and the Spersul alone almost as good. It was concluded that spraying of seedlings might be economical since these were more frequently killed by the attack.

92. In tobacco seed-beds, damping off occurred, and this was at first controlled by spraying Bordeaux, although considerable trouble was experienced from choked nozzles. Some of the larger seedlings developed early symptoms of Frog Eye Spot, and the larvae of an unidentified insect appeared within some of the stems. A mixture of Perenox and Gammalin 10 (gamma BHC) in the proportions of 1 oz. and 5 ml. per gallon respectively proved fairly successful, and also controlled the damping off as well.

93. Seed dressing trials on millet, sorghum and groundnuts were carried out at various stations in the region. Dressings used included Fernasan A (tetra-methyl thiuram disulphide), Fernasan D (tetra-methyl thiuram disulphide and gamma BHC) and several experimental formulations. Dressed seed produced a marked improvement both in establishment and final yield of millet at Sokoto, as compared with untreated seed, though there was little to choose between the effects of the different formulations. At Samaru and Kano, establishment of untreated seed was satisfactory and the effects of the dressing were less marked.

94. Trials on the suppression of dhub grass (*Cynodon dactylon*) were continued on observation plots of 1/27 of an acre, followed by single and double disc ploughing. Sodium trichloracetate and two experimental formulations were tested at different rates. Trichloracetate and one of the experimental formulations were very effective, giving 80-90 per cent. kill.

95. In survival trials on cotton planted 10 months after only trichloracetate showed little after-effect, 85-97 per cent. of the seedlings surviving on the double-disc'd plots, and double discing on the whole reduced the lethal after-effects as compared with single discing, but the difference was not very marked.

96. *Tsetse Control.* A field trial of the elimination of riverine tsetse, using insecticides, was commenced in 1954 in Benne Province. Residual DDT was applied against a fly population predominantly *Glossina palpalis* with a few *G. tachinoides*. A zero count was obtained by the early rains, but the population shows signs of recovery during the later rains. The trial is being repeated, using a heavier dosage, and making greater use of the dry season, when the residual effect is of longer duration.

97. 2 : 4 : 5-T was tested against certain riverine plant species, which are a problem in anti-tsetse clearing. The results after one year are, however, disappointing. Spraying of water or diesel oil emulsions on the cut stems of *Raphia sudanica* generally effected stunting and retardation of growth, as did direct injection of oil emulsion into the stems, but the percentage kill was low. Spraying of the standing foliage with a water emulsion had no effect. *Mimosa asperata* defoliated quickly, but showed signs of recovery in a few months, as did *Ficus* sp. *Syzygium guineensis* appeared susceptible, when undiluted 2 : 4 : 5-T was painted on a slash.

Northern Rhodesia

98. *Tobacco.* Various fungicides for soil disinfection and protective spraying against anthracnose (*Colletotrichum tabacum* Boiny) in seed beds have been tested in laboratory, greenhouse and field trials. For soil disinfection, four proprietary thiocarbamate fungicides proved superior to copper, mercury and sulphur compounds. All showed some degree of phytotoxicity, which was severe with Thiram (tetra methyl thiuram disulphide) and Ziram (Zinc dimethyl dithiocarbamate), less severe with Ferbam (ferric dimethyl dithiocarbamate),

and mild with Zineb (zinc ethylene bisdithiocarbamate). This latter material applied broadcast with fertiliser at the rate of 5 oz. Zineb per 30 sq. yds. of seed bed, followed by spraying the seedlings at 3 weeks with a gallon of Zineb solution containing 3 oz. per 25 gals. water, gave complete control in farm trials.

99. *Maize*. For the second season in succession MCPA was used for pre-emergence weed control. At Mount Makulu, on heavy red clay-loam, MCPA at 1 lb. acid equivalent per acre gave control of grass weeds equal to cultivation. No advantage was observed from increasing the dosage up to 2 lb. acid equivalent per acre. A similar experiment at Mukalaikwa, on grey sand, was invalidated by waterlogging of the plots. 2 : 4 : 5-T at 2 per cent. concentration applied to the stem bases, gave good control of several shrubby species in an indigenous grass paddock. The principal species involved were *Acacia* and *Trichodesma* spp. Ammate (Ammonium sulphamate) at 7.5 per cent. proved ineffective. The cost of the 2 : 4 : 5-T application was about £40 per acre.

100. Good control of couch grass (*Cyodon dactylon*) was obtained by the use of Atlacide (sodium chlorate, calcium chloride mixture) applied at 2½ lb. per 2 gal. of water per 5 sq. yds. This treatment might have some application in gardens where small areas require treatment since it is somewhat expensive.

Singapore

101. *Parasitology*. Resistance to insecticides of local mosquitoes has been tested for WHO, using their standard equipment and chemicals supplied by them.

Tanganyika

102. *Coffee*. Control experiments on white stem borer, *Anthores leuconotus*, are now being completed, dieldrin being the insecticide in general use against this pest. Experiments using a dieldrin containing lacquer are proceeding.

103. *Cashew Nuts*. Approximately 60 per cent. control of *Helopeltis anacardii* M. and *H. bergrothi* Rent. has been obtained on young trees by eight applications throughout the growing season of an 0.5 per cent. gamma BHC dust at 15-20 lb. per acre. These experiments were of necessity carried out on small plots and the dusted trees were subject to intense cross-infestation from adjacent untreated plots.

104. *Maize*. Control of first-generation larvae of the Noctuid stalk-borer, *Busseola fusca* F., has been achieved by three applications of 2.5 per cent. DDT dust into the funnels of the plants at weekly intervals beginning about three weeks after emergence of the maize. Provided that the crop is well grown, trials on peasant holdings have shown that considerably increased yields and financial profit can be obtained by the use of insecticide. Large-scale trials and demonstrations have been organised to stimulate interest in insect control and to show the better African farmer the value of dusting against *Busseola*.

105. *Cereals and Beans*. A number of seed dressing trials, mostly with aldrin, have been carried out against a miscellanea of soil pests including chafer, cutworm and *Cydnus*. Good control has been obtained against *Euxoa segetum* with aldrin at the rate of 0.4 per cent. actual aldrin provided the seed is planted in the top inch of soil.

106. *Sugar*. Aldrin has proved to be more effective than BHC against the chafer *Cochliotes melolonthoides* for up to 2 years after application, and experiments are still in progress.

107. *Malaria Division.* The majority of the insecticide work of this Division of the Tanganyika Medical Department was related to actual mosquito control measures and not research. However, the Division is co-operating in an urban larviciding airspray trial at Dar-es-Salaam utilizing dieldrin granules. Preliminary tests have been made to determine dosage, swathe width and aircraft altitude. This research is being carried out in co-operation with the Colonial Insecticide Research Unit, East Africa.

Trinidad

108. *Mosquitoes.* The Medical Department have carried out investigations in an attempt to ascertain the nature of the resistance of *Aedes aegypti* L. to DDT, and whether this resistance was purely environmental or physiological and whether it was universal throughout the Colony. Studies were also carried out to determine the extent of the effectiveness of Gammexane and dieldrin against *A. aegypti*. The results of these studies will be reported during the year.

109. Work was also carried out concerning certain points regarding the bionomics of *Anopheles aquasalis*. Blood preference studies of this mosquito are being analysed, and work has been started on a critical examination of the effect of insecticides on adult densities of this mosquito with respect to malaria transmission and also the effect of residual DDT house spraying in the female/male ratios in nearby day-time resting places. Bionomic studies of *A. albitarsis*, *A. neomaculipalpus* and *A. eiseni* have been commenced, in order to determine what part these mosquitoes play in the transmission of malaria.

110. Further studies of the physiology of the bromeliads were begun, because of an important residual quantity of *A. bellator* still being found in copper sulphate-treated areas. Studies on the rate of regeneration of bromeliads and also on the rate of growth of seedling bromeliads were also carried out.

111. *Agriculture.* Weevil Borer (*Cosmopolites sordidus* Germ.) on Bananas. The experiments begun in 1954 were continued, miscible concentrates of aldrin and dieldrin being applied by dipping corms, and dusting of planting holes and corms immediately prior to planting, with aldrin dust, has also been tried. These experiments are being continued through 1956 and 1957, but recommendations based on the results so far obtained are that healthy or non-bored corms may be dipped or soaked in a 2 per cent. aldrin solution, the period of immersion varying from 5-6 hours for large suckers to 3-4 hours for small ones. This treatment is considered to last at least for 6 months, when preventive spraying around the stem and base of the plant with 2 per cent. dieldrin every 6 months is continued.

112. *Banana Leaf Spot* (*Mycosphaerella musicola*, Leach). Experiments, begun in 1954, have continued and Bordeaux mixture and commercial preparations of copper oxychloride and copper oxide have been tested, and final yield data will become available shortly. The efficacy of low-volume oil-based sprays is also being tested against high-volume water-based sprays. So far, a much greater efficiency of the low-volume oil-based sprays is indicated.

113. *Control of Bacterial Wilt* (*Pseudomonas solanacearum*). Experiments have been carried out using a commercial antibiotic preparation containing Streptomycin and oxytetracycline (Terramycin) but results are not yet available.

114. *Sweet Potatoes.* A further trial using miscible concentrates of aldrin and dieldrin against *Megasthes grandalis*, Gen. is now progressing on a much larger scale.

115. *Coconuts.* An experiment was begun in 1955 for the control of the coconut weevils, *Rhyncophorus palmarum* L., and *Rhina barbirostris* L., alleged vectors of red ring disease, *Aphelenchoides cocophilus*. Four insecticides, used separately include dieldrin and chlordane, in miscible form, DDT paste and BHC dispersible powder, but results are not yet available.

116. *Citrus*. Control of Melanose spotting (*Dioporthic citri*) in grapefruit is being investigated. Pruning of dead branches followed by spraying with a commercial preparation of copper oxide has been carried out, but results are not yet available.

Uganda

117. A small-scale control operation against *Simulium neavei* was carried out in an area of the West Nile district. Onchocerciasis infection rates in this area varied from 70-100 per cent. The vector, *Simulium neavei*, was breeding on crabs living in wooded stretches of several rivers. Flow rates of these rivers varied considerably, the maximum being 6 cubic metres per second, and the minimum 0.28 cubic metre per second. The insecticide used, Arkotine S.D. 18 containing the equivalent of 18 per cent. p,p'-DDT, was applied from calibrated constant flow tanks, having variable emission rates. Each river was treated weekly over an eight-week period. The minimum effective dosage rate was 0.5 parts DDT per million of water for rivers exceeding a flow rate of 1 cubic metre per second, and 1 part DDT per million of water for rivers having a lower flow rate. Experience indicated that these application rates should be doubled initially to allow for the very great biological absorption of DDT by other species of *Simulium*.

118. No larvae were found on crabs from the twelfth day onwards except in one case, where a 400 yards grass swamp prevented the passage of insecticide. This area was subsequently under control 22 days later. Although the area under control is not effectively isolated from another focus of *S. neavei*-borne Onchocerciasis 20 miles to the south, no larvae were present on crabs 3 months after the end of treatment, which contrasts with the fact that prior to treatment, over 50 per cent. of the crabs were infested, over half of them bearing several larvae and pupae. This operation was carried out in confirmation of the work done on this problem by the Division of Insect Borne Diseases, Kenya.

119. *Maize*. The transference to local maize varieties of resistance to polysora rust proceeded at Kawanda.

120. *Rice*. Fifteen varieties selected for resistance to blast disease at Kawanda have been forwarded to Mbale for testing in the area where most rice is grown.

121. *Bananas*. Panama disease was reported from two new areas: Toro in the west and Bugisu in the east.

122. *Cotton*. All seed for planting throughout Uganda was dressed with Percot or Armasan dust. The annual survey did not reveal any main stem infection higher than 15 per cent. whereas formerly figures of 50 per cent. or more were frequent.

123. Entomology.

- (a) Many types of sprayer and duster have been tested and definite recommendations for equipment suitable for use in tropical conditions can now be made.
- (b) *Lygus vesselei* can be controlled and cotton greatly improved by low-volume spraying with DDT. Pyrethrum dusting against *Antestia* on *Arabica* coffee is becoming normal practice in certain areas and is being extended to the Coffee Lace Bug, *Habrochila ghesquierei*.
- (c) *Chilo zonellus* has been proved to be the most serious of the cereal stem-boring caterpillars, but *Busseola fusca*, *Pesamia calamistis*, *S. poephaga* and *S. botanephaga* also do considerable harm. Sorghum and maize are often heavily damaged. Preliminary work has been done on the various species of Dipterous stem-borers and on the Sorghum midge, *Contarinia sorghicola* and other pests of cereal heads.

124. *Veterinary.*

- (a) Investigations into the incidence, life history and control methods of liver fluke in Uganda were undertaken throughout the year. Studies were commenced on the virus of fowl pest following outbreaks of the disease in Uganda.
- (b) Research continued into the bionomics of biting flies other than tsetse. A laboratory breeding unit of *Stomoxys calcitrans* was successfully established.

APPENDIX

Publications

Recommendations for the Chemical Control of Weeds in Mulched Coffee. Robinson, J. B. D., Coffee Board Bulletin, 20, 88, 1955.

Preliminary Tobacco Eelworm Investigations in Uganda. E. African Agric. J., 1955, 21, (1).

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Spray Application Problems : XXX. Mobile observation platforms for the examination of tree tops. Kearns, H. G. H., and Morgan, N. G. *Ibid.*

Spray Application Problems : XX. Light-weight small power sprayers (34 and 70 cc. I.C. engines). Kearns, H. G. H., and Morgan, N. G. *Ann. Rept. Long Ashton Res. Stat., 1954.*

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Studies on Aqueous Suspensions of Insecticides. Part V. The sorption of insecticides by soils. Barlow, F., and Hadaway, A. B. *Bull.ent.Res., 1955, 46, 547.*

Residual Insecticides and Mosquito Control. Hadaway, A. B. WHO/Mal/145 for Lagos Conference.

Studies of Spray Deposits. 1. Effect of spray supplements on the toxicity of copper oxide fungicide. Somers, E. *J. Sci. Food Agric., 1956, 7, (2), 160-172.*

The Biology of the Dermestid Beetles, *Trogoderma granarium* Everts, *Trogoderma versicolor* (Creutz.). Hadaway, A. B. *Bull.ent.Res., 1956, 46, pt. 4, 781-796.*

Choice of Nozzles for Spraying Buildings with Residual Insecticides. Burnett, G. F., and Woodcock, K. E. (1956) *E.A. Med. J. 33, 54-64.*

Variations in Mortality with Differences in Humidity among Mosquitoes exposed to B.H.C., Dieldrin and D.D.T. Burnett, G. F. *Nature (1956) 177, 663-664.*

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The Influence of Temperature and Humidity upon the Action of Insecticides. Part 1. During the post-treatment period. Hadaway, A. B., and Barlow, F. C.I.R.U./Porton/Report No. 117.

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Aerial Spraying Trials. Part 2. Methods of assessment. Jarman, R. T. C.I.R.U./Porton/Report No. 108.

Aerial Spraying Trials. Part 3. The performance of the Auster crop sprayer. Jarman, R. T. C.I.R.U./Porton/Report No. 113.

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Colonial Products Council Third Annual Report (1955-1956)

Courtauld Institute of Biochemistry,
The Middlesex Hospital,
Medical School,
London, W.1.
12th October, 1956.

SIR,

I have the honour to enclose herewith the Annual Report of the Colonial Products Council for the year 1955-56.

I am,

Sir,

Your obedient servant,

E. C. DODDS,
Chairman.

The Right Honourable Alan Lennox-Boyd, M.P.,
Secretary of State for the Colonies.

COLONIAL PRODUCTS COUNCIL

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DR. R. A. E. GALLEY, Ph.D., A.R.C.S., D.I.C., F.R.I.C., Director of Research and Director, Colonial Products Laboratory.

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DR. J. WALKER, D.Sc., Medical Research Council.

PROFESSOR SIR SOLLY ZUCKERMAN, C.B., M.A., M.D., D.Sc., F.R.S., Office of the Lord President of the Council.

MR. W. F. DAWSON, M.B.E. (*Secretary*).

DR. P. C. SPENSLEY, M.A., B.Sc., D.Phil., F.R.I.C. (*Scientific Secretary*).

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
THIRD ANNUAL REPORT, 1955-56

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COLONIAL PRODUCTS COUNCIL
AND
COLONIAL PRODUCTS LABORATORY
THIRD ANNUAL REPORT

PART I. GENERAL

1. *Meetings.* There was one meeting of the Colonial Products Council during the year.

2. *Membership.* Mr. Lauchlan Rose, M.C., joined the Council during the year. Apart from this, there were no changes in the membership.

3. *Overseas Visits.* In the course of a visit by Dr. R. A. E. Galley, Director of Research, to East, Central and West Africa in February and March, 1956, arrangements were made for continued collaboration with the Colonial Products Laboratory on problems related to cereals, beans and coffee, particularly with regard to (a) quality standards and (b) loss in quality, in transit to British ports, of materials susceptible to infestation.

Dr. P. C. Spensley, Scientific Secretary of the Council, attended the Conference on Solar Energy and the World Symposium on Applied Solar Energy, held in Tucson and Phoenix, Arizona, in November, 1955. On the way there visits were made to Trinidad and Jamaica and, whilst in the United States, the opportunity was taken of inquiring into matters of interest to the Council and Laboratory, particularly with their forthcoming move from the Imperial Institute to new premises in view.

Mr. A. E. Chittenden represented the Laboratory at the first meeting of the European Group of the American Technical Association of the Pulp and Paper Industry in Paris in May, 1955, and subsequently visited a number of pulp mills in France.

4. *Pyrethrum Research.* Proposals made some time ago for an expanded programme of research on pyrethrum have now been implemented by the responsible East Africa authorities (Departments of Agriculture and Pyrethrum Boards of Kenya and Tanganyika). Under the scheme, fundamental chemical investigations are to be carried out at the Colonial Products Laboratory, while concomitant biological studies will be undertaken at Rothamsted Experimental Station.

This work will be co-ordinated by the newly-formed Pyrethrum Research Committee (United Kingdom). A corresponding Committee in East Africa is being formed to guide the agricultural and short-term research work on pyrethrum in progress in those territories. Close liaison between the two Committees will be maintained.

5. *Committee Meetings.* The Pyrethrum Research Committee (United Kingdom) mentioned above held their first meeting in October, 1955, and agreed a preliminary research programme (*see Part II (b)* for a note on current investigations).

A meeting of the Laboratory's Consultative Committee on Vegetable Fibres was held in June, 1955, at which the problems discussed included the production of *Agave lecheguilla* fibre in Colonial territories, the market possibilities of Mauritius hemp and research into new uses for sisal.

A meeting of the Laboratory's Consultative Committee on Hides and Skins was held in December, 1955, when the principal item considered was the Report of the Tanners' Mission to Nigeria in 1954, together with comments on the Report made by the Government of the Northern Region and by the Federal Government.

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 810 inquiries during the year ; 40 inquiries are in hand. Examples of those dealt with are given below :—

Essential Oils

8. *Geranium Oil.* A company beginning the production of geranium oil in Tanganyika has been given information about the harvesting and distillation of the leaves, and a grower in Kenya, who was having heavy losses of young plants, has been advised about the problems involved in transplanting and rooting geranium cuttings.

9. *Cedarwood Oil.* Recommendations have been made to the East African Industrial Research Organisation and the Forest Utilization Office about the design of stills for producing cedarwood oil in Kenya, and a possible alternative method of packing the sawdust charge into the still has been suggested.

10. *Cinnamon Leaf Oil.* The position of Seychelles cinnamon leaf oil has again been considered, both from the point of view of its value relative to other eugenol-containing oils and also its possible displacement by other substances as a starting material for vanillin production.

11. *Miscellaneous.* The prospects for essential oils in Tanganyika have been reviewed for the Department of Agriculture. It was recommended that the production of geranium and patchouli oils should be maintained, paying special attention to quality ; the possibility of producing neroli and petitgrain oils from existing bitter orange trees should be examined ; both lemongrass and citronella (Java type) should be grown and trial plantings made with lavandin.

The Trade Commissioner for Nigeria in London was advised that essential oils considered to be suitable for production in the Eastern Region of Nigeria were lemongrass and citronella, and, provided the quality were good, the citrus oils, orange, lemon and lime. Other oils which might possibly be produced were star anise and palmarosa.

Spices

12. *Chillies.* Advice has been given to the Director of Agriculture, Kenya, concerning the production of chillies in the Colony. It was considered that, whilst limited quantities of well-prepared chillies would find a market, any substantial increase in their cultivation was inadvisable. Suggestions were also made as to how local exporters might keep in closer touch with market conditions.

13. *Nutmegs.* The extent to which nutmeg trees should be replanted in Grenada to replace those destroyed in the then recent hurricane has been considered. Improvements in the distillation plant for producing nutmeg oil from defective nutmegs have been suggested to the Trade Commissioner for the British West Indies, British Guiana and British Honduras in London ; any substantial increase in production of the oil was not recommended.

Rubber

14. *Latex Production and Use.* Information has been supplied to the Department of Local Government, British Guiana, about the preservation and concentration of rubber latex and the local production, on a small scale, of molded articles.

Oilseeds, Oils and Fats

15. *Copra.* At the request of the Director of Agriculture, Fiji, copra was assessed in terms of the quality and amounts of the products that it would yield when fully processed. Hundredweight-sized samples of various grades were submitted to laboratory and trade examination. It was estimated that the difference in value between the highest and lowest grades of Fijian copra was some 90 shillings per ton, and that if this differential could be offered to the primary producers, it would recompense them for the increased cost of producing the superior product.

16. *Marketing Standards and Futures.* Considerable interest has been shown in formulating specifications for controlling the sale of oil-seeds for export. Inquiries under this head concerned the assessment of market positions for the seed and oil of sesame, castor and cotton; also for copra, coconut oil and tea seed oil. Advice has been given also on standards for edible oils.

17. *Processing.* Several questions have been answered regarding the processing of oil seeds and oil refining, including the preparation of "vanaspati", a "ghee" substitute.

18. *Miscellaneous.* A firm in Jamaica has been supplied with information on the development of conophor as a crop. A firm in the United Kingdom has been given details concerning the occurrence of *Allanblackia floribunda* and *A. parvifolia* in Uganda in connection with the possibility of using the fats from the seeds as a substitute for cocoa-butter. Information has also been supplied about the production and utilisation of tobacco seed oil.

Grain Crops

19. *Maize.* Continued interest has been shown in the possibility of milling maize from locally-produced grain in the West Indies. The areas particularly concerned are Antigua and Barbados. In consultation with milling engineers in the United Kingdom several small quantities of Antiguan maize were milled experimentally. The products were flown to the Colony for small consumer-acceptance trials. Not unexpectedly, preference was shown for roller-milled products, and three experimental layouts were tried. The product from the final trial gave complete satisfaction and was pronounced fully equal to meal at present imported. A request has now been received for a similar experiment using the Barbados-grown maize.

20. *Rice.* Samples of paddy, both raw and parboiled, received from the Director of Agriculture, British Guiana, were hulled by a "Wemanco" machine. The hulled rice was then treated by the wet-brushing technique developed at the Cereals Research Station, St. Albans, for oats. Unfortunately, only small quantities of the product are as yet available. These have been stored and will be examined at intervals by a small testing panel.

21. *Sorghum.* An inquiry was received from the agricultural authorities in Tanganyika for information concerning the market for this grain, at present used in the United Kingdom chiefly as a feeding stuff. Its application for other purposes, such as starch manufacture and as a breakfast cereal, has been explored. The type of grain preferred by users will be further examined with reference to the varieties grown in East Africa.

Starches

22. *Cassava*. The market for cassava starch has been investigated for British Honduras, Nigeria and Kenya. The possibility of developing the root as a raw material for glucose manufacture has also been examined.

23. *Arrowroot*. The revision of the monograph in the British Pharmaceutical Codex is being considered in consultation with the authorities in St. Vincent. Samples of starch from Montserrat and Mauritius were submitted for valuation and the general opinion was that there would be a market for both. However, at the valuation given, production in Mauritius was unattractive.

Fruit

24. *Pineapples*. With the assistance of members of the Laboratory's Consultative Committee on Fruit Products, advice has been given to the Government of Kenya that the prospects seem favourable for the cautious expansion of the canned pineapple industry, although it was considered that difficulties may be encountered in disposing of increased quantities of pineapple juice and crush. Suggestions have been made concerning the improvement of the quality, and the probable long-term highly competitive nature of the canned pineapple market was emphasised to Kenya and to other Colonies. Observations have been made to the Department of Agriculture on the initial Kenya Quality Standards for canned pineapple which are at present operated on a voluntary basis. Advice has been given on the future development of the standards, and the importance of strict adherence to the specifications on the part of packers was stressed. Information has also been provided to the Department of Agriculture, Kenya, on the market for fresh pineapples in the United Kingdom and in certain other countries.

25. *Citrus Fruits*. The Departments of Agriculture in Jamaica and Trinidad have been informed of the expanding production of the pink and red-fleshed grapefruit varieties in the United States, which are at present popular with consumers in some countries. Observations have been made to a firm in Trinidad regarding the processing of limes; there is general satisfaction with the products obtained with the established method of treating the fruit and experiments to investigate a suggested modified method did not appear to be justified at present. Information has been supplied to a Co-operative Association in Trinidad regarding the reduction of the amount of oil incorporated in the juice as a result of washing citrus fruit with hot water prior to extraction and on the possibility of using sugar cane wax in wax formulations for coating grapefruit, which is unlikely to be advantageous economically.

26. *General*. Particulars have been supplied to the Trade Commissioner for Nigeria in London concerning the world trade in fresh bananas in recent years and the market for banana products. Similar information has also been given to the Departments of Agriculture, Kenya and Mauritius, and to a firm in Trinidad. A market report on canned youngberries has been provided for the Department of Agriculture, Kenya, who were advised that the fruit is unlikely to be saleable in more than limited quantities. Information on the processing of tomato products and on the equipment required, has been supplied to a firm in Kenya, and notes on guavas as a source of Vitamin C have been sent to the Department of Agriculture, British Somaliland. The Department of Agriculture, Northern Rhodesia, has been given details of the considerations involved in the establishment of a cannery.

Other Foods

27. *Vegetables.* Commercial inquiries suggested possibilities for a limited production in Kenya of canned vegetables, such as asparagus and green beans, for the United Kingdom market. Information has been supplied to the Department of Agriculture on the possibilities of small exports of fresh asparagus to the United Kingdom market which might be economically practicable during certain months.

28. *Edible Nuts.* Information has been supplied to the Government of the Gambia and the Department of Agriculture, Kenya, regarding the marketing of cashew kernels. The prospect of developing the export of Souari nuts (*Caryocar nuciferum*) from British Guiana has been investigated but is considered unpromising.

29. *Fish.* Information has been provided to a firm in Tanganyika regarding the transport of fresh fish, and concerning suitable packaging material. Processes for the manufacture of fishmeal were also described.

30. *Tea, Coffee and Cocoa.* Inquiries continue to be received about the marketing of these commodities. The possibility of alkalisng cacao in Jamaica in order to prepare "soluble" cocoa for local use has been examined for the Government Chemist there. Details of apparatus suitable for drying cacao have been furnished to the agricultural authorities, Trinidad. The possibility of preparing a solid tea extract has been discussed with a firm of tea planters in Ceylon. Samples of St. Helena coffee received from the Department of Agriculture were assessed as promising.

31. *Miscellaneous.* The possibilities of small white haricot beans as a crop have been under examination in consultation with the authorities in British Honduras, Jamaica, Trinidad and Nigeria. "Quinoa" and "canibua" (*Chenopodium* spp.) have been put forward as crops suitable for cultivation in tropical high altitude areas. The market for various derivatives and by-products of sucrose has been assessed for the guidance of the Sugar Technological Laboratory, Trinidad. Details of machinery for splitting peas and beans have been supplied to the Agricultural Department, British Guiana, and information provided to various Colonies on maize and rice driers. The possibilities of suppressing the sprouting of tropical root crops (e.g. yams and sweet potatoes) have also been reviewed for the guidance of the agricultural authorities in Barbados.

Animal Feedingstuffs

32. *Miscellaneous.* Inquiries continue to be received from Colonial areas concerning the compounding of feedingstuffs designed to minimise the need for imported materials. The dom palm nut (*Hyphaene thebaica*) proposed for use in the Sudan and Nigeria is an unusual material. Details concerning its nutritional value have been supplied. Inquiries have also been received concerning protein concentrates from tropical green leafy materials.

Tobacco

33. *Miscellaneous.* Advice on methods of tobacco analysis, and particulars of literature dealing with cultivation and manufacture have been supplied to several Colonial and overseas inquirers. An assessment of the market prospects for Mauritius tobacco has been made on behalf of the Tobacco Board of Mauritius: in present circumstances, the current grades and qualities of leaf would need to be offered at fairly low prices to be of interest to United Kingdom or Continental markets.

Vegetable Insecticides

34. *Pyrethrum*. Information relating to the drying, processing and analysis of pyrethrum flowers has been given to various official and commercial organisations. Details of suitable electric moisture meters have been collected on behalf of the Pyrethrum Board of Kenya. Observations on certain suggested changes in the mercury reduction method of pyrethrin determination have been furnished to the Association of Official Agricultural Chemists, Washington, D.C.

35. *Ryania*. Interest has continued in the insecticidal wood of *Ryania speciosa*, obtained from Trinidad and British Guiana. Arrangements for trials on some pests of East African crops have been put in hand.

Synthetic Insecticides

36. *Estimation*. Information on suitable methods and apparatus for the determination of D.D.T., B.H.C. and similar insecticides has been supplied to a number of laboratories.

Vegetable Drugs

37. *Miscellaneous*. Inquiries dealt with have concerned market prospects for East African cinchona, the santonin content of *Artemisia* species, the preparation of aloes, information on *Rauwolfia* species, and cultivation details of *Dioscorea* species used as sources of steroidal saponins.

Vegetable Fibres and Canes

38. *Coir*. In co-operation with a firm of engineers in the United Kingdom, further progress has been made in devising a suitable mechanized method of making rubberised coir mattresses. Small scale plant, incorporating an opener, hopper-feed machine and spraying equipment, has been ordered by a firm in Trinidad where it is hoped to commence production in the near future. Some promising samples of coir fibre suitable for brushmaking have been received from various Colonies, but the fibre would need to be dressed in the country of origin before it would find a market in this country.

39. *Mauritius Hemp*. At present most of the fibre produced in Mauritius is used locally for the manufacture of sugar bags. For various reasons, it is now desired to find other uses for the fibre and inquiries have been made regarding the possible market for it in this country and the quantities which could be absorbed. The Laboratory is now awaiting fairly large samples with which to test the market.

40. *Palmyra Fibre*. Information has been furnished to the Department of Commerce and Industries, Nigeria, on the harvesting and preparation of Palmyra fibre, which is used for brushmaking.

41. *Miscellaneous*. A large number of inquiries has been received from Government Departments regarding the botanical identity of various fibres. Other inquiries have dealt with the retting and processing of hemp and the machinery required for spinning the fibre; the preparation of rattans for basketry purposes; the composting of sisal and abaca wastes; the baling of abaca and other fibres; the preparation and uses of Algerian fibre and the suitability for and extraction of *Sansevieria* fibre for local rope-making in Montserrat.

Paper-making Materials

42. *Miscellaneous*. Numerous inquiries on the technical and economic questions relating to the establishment of pulp and paper industries in the Colonies have been dealt with during the year. Information regarding the

supplies of fibrous and non-fibrous raw materials, fuel, chemicals and water for the production of pulp and paper on a small scale has been given to the East African Industrial Research Organisation, Kenya, and to the Uganda Development Corporation.

Other inquiries dealt with included the production of "mineralised board" (building boards made from a mixture of cement and fibrous material) from raw materials such as cedarwood waste, bagasse and papyrus for the Director of African Housing, Uganda, and the Industrial Development Commission, Trinidad. For this type of board the key to the economics of the process as a whole is the cost of cement in the territory concerned. Many inquiries were answered on the possibility of producing paper pulp from materials occurring in the Colonies which, although quite suited physically for the manufacture of pulp, would be quite uneconomic from the commercial point of view owing to the intermittent nature of supplies, poor yield of pulp obtained and the high consumption of the chemicals required for pulping them.

Hides, Skins and other Animal Products

43. *Hides.* Details of hides prices on various world markets have been supplied to the Industrial Development Corporation, Jamaica, together with information on methods of curing hides.

Some concern was expressed by the East African High Commission during the year regarding the future of markets, particularly in the United Kingdom, for East African hides and the possible effect of supplies of hides from America. The Laboratory expressed the view that, providing the standard of preparation were satisfactory, the hides would probably continue to find a market in this country.

44. *Flaying.* Advice has been given to the Director of Agriculture, Malta, on the advantages and disadvantages of an electrical flaying apparatus as compared with pneumatic flaying equipment.

45. *Meat.* In connection with the setting up of cold storage plant for mutton in the Somaliland Protectorate, information has been supplied to the Director of Agriculture and Veterinary Services on conditions for freezing meat and concerning factors which might lead to meat spoilage.

46. *By-products.* The utilization of animal by-products was the subject of a note prepared for Government authorities in Jamaica, the Gambia and British Guiana.

Tanning Materials

47. *Wattle.* Information has been supplied to the Director of Agriculture, Tanganyika, concerning the future of markets for wattle bark. It was considered that, as far as was foreseeable, even in the face of competition from substitutes and synthetic tannins, the demand for wattle should be good for some years to come. Details of possible uses for wattle poles, after stripping, have also been provided; suggested uses included pit props, charcoal, chipboards and paper-pulp.

(b) INVESTIGATIONS CARRIED OUT IN THE COLONIAL PRODUCTS LABORATORY

48. During the year under review the Laboratory has completed 80 investigations; 40 investigations are in hand. Examples of these are given below:—

Essential Oils

49. *Slash Pine.* Sawdust and sawmill waste of slash pine (*Pinus caribaea*) from British Honduras have been examined for the Conservator of Forests as possible raw materials for a local turpentine industry, but the yields of oil of

turpentine obtained, 0·03–0·04 per cent., were too low to make exploitation worth while. It was suggested that attention should be concentrated on starting a gum turpentine industry for which suitable material was known to be available.

50. *Volatile Oil from Strobilanthopsis linifolia.* Oil distilled by a planter in Northern Rhodesia from the flowers, leaves and stem-tips of this plant, has been submitted to a detailed examination. The oil was shown to consist almost entirely of sesquiterpenes, or oxides and alcohols derived from them. The chief constituents were caryophyllene and caryophyllene oxide; copaene and ledol were also present, as well as an unidentified sesquiterpene and a sesquiterpene alcohol.

51. *Vetiver Oil.* An unusually high yield (4·8 per cent.) of oil has been distilled at the Laboratory from vetiver roots (*Vetiveria zizanioides*) supplied by the Director of Agriculture, British Guiana. Because of its different odour, the oil could not be considered as a suitable alternative to Java or Reunion vetiver oils, but its high alcohol content suggested that it might be a promising source of vetivenol for the perfumery industry.

52. *Cyprus Sage Oil.* The long term investigation of this material has been continued. A general tendency for yields to reach a maximum sooner when the time of flowering was earlier, has been shown and it was of interest also that the way in which the optical rotation of the oil varied with the locality maintained the same pattern in different seasons.

Regarding the best period for cutting the herb, it appears that leaves from various districts may have their maximum oil content in any month from July to November. The period fixed by law for cutting, viz., 1st August to 30th November, is therefore approximately correct, but it might possibly be extended to include July, especially in a year of early flowering.

53. *Ylang-ylang Oil.* A sample of ylang-ylang oil, which had been distilled in Zanzibar from flowers gathered from an experimental block of trees at the Kizimbani Experiment Station of the Department of Agriculture, had analytical constants corresponding closely to a "First" quality oil. The odour was, however, rather inferior to what was expected of this quality, due to lack of top note, but since this oil is usually fractionated to obtain the necessary grades, the unfractionated sample was considered very promising.

54. *Lime Oil.* Three samples of lime oil, distilled by the Zanzibar Clove Growers' Association from limes grown by the Department of Agriculture have been found to be comparable analytically with West Indian oils, except for the citral content which was higher than usual for distilled oils. Trade opinions on the samples varied but were on the whole favourable. Modifications in the distillation technique were suggested which might improve the quality of the oil.

55. *Cedarwood Oil.* Samples of cedarwood (*Juniperus procera*) sawdust and oil from various sawmills and oil distillers in Kenya have been examined, and in instances where both oil and sawdust from the same mills were submitted it has been found that the oil was generally dirtier and of a much lower alcohol content (calculated as cedrol) than it need have been with the material available. Recommendations have been made for improving the quality of the oil so that its properties might approximate more closely to those of the competitive American cedarwood oil from *Juniperus virginiana*.

Oilseeds, Oils and Fats

56. *Groundnuts.* The work described previously has been continued for the Department of Agriculture, Gambia. Examination of samples of the 1954-55 crop has shown that the proportion of mature nuts present in the market and ship samples was higher than in 1953-54; fewer defective pods were found than in the previous year's samples. Damage during shipment and by decortication appeared to have caused an increase in the acidity of the oil, but the number of samples on which this conclusion was based was small. A detailed assessment of insect infestation by the Pest Infestation Laboratory has shown that post-harvest damage was somewhat lower, whereas the pre-harvest damage was considerably greater, than in 1953-54.

57. *Tung Oil.* Work on Nyasaland *Aleurites montana* oil has been continued for the Agricultural Chemist. A comparison has been made of the quality of the oil extracted in the Laboratory with that of oil expressed in Nyasaland.

Samples of tung nuts, forwarded by the Director of Agriculture, Swaziland, have been examined but these were of the *fordii* species. The oil extracted from these nuts fully complied with the British Standard for this type of oil.

58. *Croton megalocarpus.* Seed submitted by the Director of Agriculture, Kenya, has been found to contain 33.9 per cent. of an oil having properties similar to those of candlenut oil. The oil is of potential interest to the paint trade in view of its low content of linolenic acid, in which respect it resembles tobacco seed oil. The residual meal, after extraction of the oil, should prove acceptable as a fertiliser and feedingstuff. Toxic materials could not be detected in either the oil or the meal. The plant is grown by the indigenous population of Kenya and the possibilities of developing the seed commercially are being considered in consultation with the East African Industrial Research Organisation and the agricultural authorities in Kenya.

59. *Shea Nut Butter.* The Laboratory has continued to advise the authorities in West Africa on the processing of this material which is frequently of high acidity. Samples have been examined of residual fat and distillates obtained from crude butter which had been de-acidified by vacuum steam distillation. The refining technique had increased the red component colour of the fat but reduced its content of unsaponifiable matter.

60. *Palm Oil.* The reasons for the discount applied to Nigerian edible palm oil on the grounds of difficulty of bleaching have been investigated for the Nigerian Produce Marketing Co. Ltd. Nigerian oil was found to contain more carotenoids than Belgian Congo or Malayan oil. The behaviour of the oils on heat and earth bleaching was examined.

61. *Miscellaneous.* Routine examinations have been carried out on samples of various products in connection with marketing inquiries. The pentosan content of Gambian groundnut shells was found to fall between 16.1 and 19.2 per cent. with a mean value of 17.3 per cent. Collaborative tests have been carried out for the British Standards Institution on the determination of the carbonyl value of oiticica oil. Samples of castor oil have been examined in connection with the revision of the British Pharmacopoeia.

Waxes

62. *Sugar Cane Wax.* Work on this material has continued. The latest product to be received from Barbados, has been found to be somewhat superior in its behaviour to previous samples examined. Earlier samples, although low in resin content, were disappointing when tried in polish formulations. The paste polishes made with all grades of Barbados sugar cane wax had the firm

consistency usually associated with those made from carnauba wax. Both Barbados and American sugar cane waxes contain less than 50 per cent. non-acidic material in the form of esters, alcohols and hydrocarbons compared with 82 per cent. found in a sample of prime yellow carnauba wax. The acids present in sugar cane wax also differ from those found in carnauba wax in that they are of a higher molecular weight, whilst the alcohols have a lower molecular weight. The composition of the wax is still under investigation at the Laboratory.

Grain and Root Crops

63. *Rice*. Laboratory work has been carried out in connection with proposals made by the agricultural authorities in British Guiana to utilise parboiled rice polishings as a supplementary food. The effects of storage on this product over a period of 12 months at tropical temperatures have been studied. The polishings showed rapid deterioration at the end of the period and the oil content had fallen from 19.2 to 4.7 per cent. The acid and peroxide values of oils extracted from the rice were high. There was also marked insect infestation in the the stored samples, due possibly to initial larval infection.

64. "*Gari*". This is a West African food produced from cassava root by a process of grating, squeezing, fermenting, drying and frying with or without the addition of small quantities of oil. It can be eaten without further cooking and, hence forms a valuable midday snack for the local population. Eleven samples received from the Nigerian authorities have been examined in comparison with other cassava products. It was shown that "*gari*" differed from most other cassava products in that a proportion of the starch granules present were gelatinised. It contained more fibre and furnished more ash than tapioca which also contains gelatinised starch. It was concluded that mechanisation of the existing industry did not present any insurmountable difficulty and that the nutritional value of the product could be improved by careful study and control of the process of gelatinisation.

Starches

65. *Arrowroot*. A proposal, by the Industrial Development Board, to erect a starch factory in a depressed area in Antigua has been examined. The yield there of this crop is stated to be satisfactory and since local consumption is about 30 tons per annum, a small local factory should not embarrass St. Vincent. Technical difficulties mainly relate to the shortage of suitable processing water. Experimental work carried out in the Laboratory showed that whilst the local well water could be used for preparing a starch which would find a local market, a final washing with pure water (rain water might be suitable) would result in a starch of much higher viscosity performance.

"Creole" and "banana" rhizomes have been examined for St. Vincent in connection with reports that a blue-coloured starch was occasionally obtained from factories there. It was found that the "creole" variety contained slightly more starch, more fibre and less protein than the "banana" variety. Ferrrous iron in the extraction water for processing both varieties causes discolouration of the starch.

Samples of arrowroot starch from the agricultural authorities of Montserrat and of the water used for their manufacture have been examined. The water was found to be relatively pure and the starch had a high viscosity but its colour, fibre content and the amount of ash furnished did not conform to the standard proposed for Grade 1 starch. With care during the processing, starch of Grade 1 standard should be obtainable.

66. *Cassava*. The examination of starch for the Government Chemist, Jamaica, has now been completed. Owing to its high ash and impurity content and its low viscosity, the starch would be classed as a second-grade material. It was unsuitable for dextrin manufacture but it could be used for the paste and adhesive trades. Suggestions were advanced with a view to improving the quality of the present production.

Fruit Products

67. *Concentrated Orange Juice*. The presence of suspended white particles had been observed in a sample of pasteurised concentrated orange juice from a firm in British Honduras. On examination at the Laboratory these appeared to be of a complex nature, consisting of cellular material associated with an unusually high proportion of hesperidin. Observations were made regarding the possible reasons for the presence of the particles in the juice.

Other Foods

68. *Insect Contamination*. Work on the effects of insect infestation on maize has been continued in collaboration with the Pest Infestation Laboratory.

Total and water-soluble acidities of maize from an underground storage pit in Tanganyika have been found to be higher than those of insect-infested and control samples of maize examined previously.

Ten samples of South African white flat dent maize were subjected to attack by a known number of *Tribolium castaneum* adults, for three months. Studies of the samples compared with those of control samples showed that the measurement of fat acidity was a better index of the deterioration in quality of the maize than the measurement of water-soluble acidity. The increase in water-soluble acidity which occurs on prolonged shaking with water was due, apparently, to further extraction of acidic material rather than to hydrolysis of complex phosphates by enzymes.

69. "*Charqui*" and "*Biltong*". Samples of these dried meat products were received from the Director of Veterinary Services, Kenya, for comparative examination. The "*biltong*" was found to be slightly superior nutritionally to the "*charqui*"; it contained more protein and more of the B group of vitamins.

Animal Feedingstuffs

70. *Rubberseed Meal*. In connection with a proposal by the Marketing Officer, Trinidad, to utilise rubberseed meal as a feedingstuff, it has been found that the fibre content was too high for the meal to be suitable for this purpose. On sieving, however, the product had a composition similar to that of linseed meal, but the oil present had a high acidity. It was considered that steps could be taken to reduce this acidity should the product be developed commercially.

Tobacco

71. *Cyprus*. Four further samples of Virginia-type tobacco were submitted by the Director of Agriculture but these showed no improvement upon those examined in the previous year. A number of "*Yellow Leaf*" Turkish-type samples has been analysed in connection with fertiliser experiments. Such leaf might find a use in blends but would be of little interest to the United Kingdom market.

72. *British Honduras*. Several samples of leaf grown for local use, submitted by the Director of Agriculture, have been examined. All contained high percentages of nicotine and had rather unacceptable flavours. Various recommendations were made for improvement, including measures to keep down the nicotine content.

Vegetable Insecticides

73. *Pyrethrum*. A proposed chromatographic method for the removal of "false pyrethrins" before analysis has been studied as part of a collaborative experiment organised by the Association of Official Agricultural Chemists, Washington. It was found that careful standardisation of the absorptive capacity of the alumina would be essential for the success of the method.

As part of the new research programme, mentioned in Part I, improved methods of separation of the "pyrethrins" by paper chromatography have been developed.

Synthetic Insecticides

74. *Analysis*. Various analyses of insecticides and residues (D.D.T., B.H.C.) in East African maize and beans, and Gambian groundnuts have been made in connection with storage experiments. Estimations of the percentage of gamma-isomer in B.H.C. formulations have been carried out for the Department of Agriculture, Kenya. The residual parathion contents of a large number of Cyprus olive oil samples have been determined as part of a large-scale experiment on the control of the olive fly, *Dacus oleas*. Samples of D.D.T., B.H.C., dieldrin and chlordane have been tested for the World Health Organisation in connection with tropical storage trials.

Vegetable Drugs

75. *Aloes*. A specimen of aloes prepared in the Somaliland Protectorate from the juice of *Aloe abyssinica* has been examined and found to conform to the requirements of the British Pharmacopoeia except for the amount of ash furnished. Attempts to prepare aloin from the sample by the usual process were unsuccessful: this would limit the market for the material. Further study of this type of aloes is being made.

76. *Papyrus Juice*. A sample submitted by the Uganda Development Corporation has been analysed for organic compounds of potential interest (alkaloids, steroids, etc.) but no substance of this kind was detected.

77. *Corallopsis opuntia*. Preliminary examination of a sample of this seaweed received from the Director of Agriculture, Seychelles, has indicated that the material may be of some commercial interest, and a further sample is being examined in more detail.

Vegetable Fibres

78. *Kenaf Fibre*. A sample of kenaf fibre (*Hibiscus cannabinus*) from the Director of Agriculture, Tanganyika, submitted for investigation as a jute substitute, has been found to be suitable for coarse yarns only. It was suggested that the best outlet would be for use at the East African Bag and Cordage Co. Ltd.

79. *Abacà*. Samples of abaca (*Musa textilis*) have been examined with a view to determining the effect of artificial drying on fibre properties. Differences found in moisture regain between sun-dried and artificially-dried fibres could have been due to experimental error and it would be necessary for a large number of determinations to be carried out before statistically significant results would be obtained.

80. *Fibre Identification*. Additions continue to be made to the collection of authentic fibres, and samples have been supplied from the collection to the Metropolitan Police Laboratory and the South Western Forensic Science Laboratory.

Investigations have been carried out into improving methods of fibre identification, including the determination of the acetyl content of jute and jute substitute fibres. Material has been submitted for incorporation in the 4th Edition of the Textile Institute's publication, "Identification of Textile Materials". Exhibits illustrating fibre identification were shown at the Royal Microscopical Society's Symposium on "Fibre Microscopy" and at the annual *Conversazione* of the Institute of Biology.

The study of the types of crystal associated with jute fibre and the commoner jute substitutes has been supplemented by microscopical investigations of the distribution of crystals in the whole stem, using polarized light.

Paper-making Materials

81. *Reeds and Grasses*. The investigation of six samples of grasses and reeds from Northern Rhodesia has been completed. Although it was found possible to pulp the most abundant species together by the sulphate process, the yield was very poor and the pulp very slow draining.

82. *Rice Straw*. The main investigational work on rice straw from British Guiana has been completed; only low yields of slow draining pulp could be produced by the sulphate process. However, on the whole, rice straw would appear to show some promise as a possible raw material for pulp and paper manufacture in British Guiana, and the practical and economic considerations relating to the local production of paper from rice straw alone and in mixture with jute tow pulp are being investigated.

Hides and Skins

83. *Study of Faults*. Work on the correlation of diseases in the living animal with faults in the finished leather has started. The veterinary departments in Kenya, Uganda and Northern Nigeria have agreed to co-operate in supplying samples; four half hides have already been received from Nigeria and these have been vegetable tanned. Results of the microscopical examination are not yet available.

Tanning Materials

84. *Mangrove Bark*. A sample of mangrove bark (*Rhizophora racemosa*), submitted by the Forestry Adviser, the Gambia, has been found to contain 15.1 per cent. of tannins and 9.1 per cent. of soluble non-tannins. The manufacture of a solid extract from such bark was considered unlikely to be an economic proposition, although the bark itself might be used locally for tanning.

Publications

85. (i) *Publications in the Laboratory's Journal "Colonial Plant and Animal Products"*.

"The Genus *Rauwolfia*: Some Aspects of its Botany, Chemistry and Medicinal Uses". Feuill, A. J., 1955, 5, 1.

"Tea from Mauritius". Johnson, Miss R. M., and Raymond, W. D., 1955, 5, 51.

"Sisal Wax from Kenya". Raymond, W. D., Thorpe, E. F. J., and Ward, J. B., 1955, 5, 58.

"Melon Seed (*Citrullus vulgaris*) Oil from Sudan". Fairchild, Miss P. L. K., Johnson, Miss R. M., and Raymond, W. D., 1955, 5, 62.

"The Extraction of Oil from Conophor Nuts (*Tetracarpidium conophorum*)". Fairchild, Miss P. L. K., Raymond, W. D., and Spickett, R. G. W., 1955, 5, 63.

"*Aframomum angustifolium* Seed from Zanzibar". Coomes, T. J., Islip, H. T., and Matthews, W. S. A., 1955, 5, 68.

"Tanning Materials of the British Commonwealth : Mangrove Bark". Pearman, R. W., 1955, 5, 96.

"Preserved Ginger : Production and Trade". Brown, E., 1955, 5, 119.

"Pyrethrum Trends and Prospects". Feuell, A. J., 1955, 5, 128.

"The Volatile Oil of *Strobilanthes linifolia* from Northern Rhodesia". Coveney, R. D., Matthews, W. S. A., and Pickering, G. B., 1955, 5, 150.

"*Ricinodendron viticoides* Nuts from Tanganyika". Fairchild, Miss P. L. K., Raymond, W. D., and Spickett, R. G. W., 1955, 5, 158.

"Olive Oil from Cyprus". Raymond, W. D., and Ward, J. B., 1955, 5, 162.

(ii) *Publications in Other Journals.*

"A Source of Hecogenin. Part III—Further Observations on its Extraction from Sisal Juice". Spensley, P. C., *Chem. and Ind.*, 1956, 229.

"The Production of Vegetable Oils in Colonial Territories". Raymond, W. D., *Crown Agents Rev.*, 1955, No. 17, 25.

"Paper Chromatography of Pyrethrins and their Derivatives". Quayle, J. R., *Nature* 1956, 178, 375.

(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

86. During the year under review Dr. W. G. C. Forsyth was appointed Director of the Institute in succession to Dr. A. C. Thaysen. Dr. W. F. Dudman was appointed to the post of Senior Microbiologist.

87. *Fermentation of the Cacao Bean.* Experiments on controlled curing of cacao beans in "micro-fermentaries" have continued. Two fermentaries of the de Witt pattern are in use. These micro-fermentaries have been constructed in such a manner that they are easily cleaned and it is possible to reduce chance contamination almost to zero with careful handling. Fermentation of samples on which the normal microflora are well established by previous exposure to sweatings gives a product barely distinguishable from that given in the normal sweat-box. The microbial sequence is the same but generally a smaller concentration of organisms is present in the micro-fermentary due, it is thought, to a higher concentration of acetic acid which cannot so readily evaporate off in the micro-fermentary as in the sweat-box. This in turn means that the pH of the sweatings in the micro-fermentary is somewhat lower than in the usual sweat-box, a phenomenon which would appear to be a minor drawback in the de Witt type of apparatus. Nevertheless, roasted samples of good quality are generally obtained. A method of reducing the volatile metabolic by-products or of facilitating their escape would be an improvement.

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Some experiments in which beans have been inoculated with pure cultures of single micro-organisms—in several cases with types not normally associated with cacao fermentation—are proving very interesting and may give a final answer to the importance or not of micro-organisms in influencing the quality of cocoa flavour.

Experiments on the aseptic fermentation of beans for quality assessment have continued. The results indicate that acetic acid is essential for the development of a strong chocolate flavour and that the presence also of alcohol gives some “mellowness”.

When fully-fermented cacao beans are extracted with methanol, all the flavouring substances are removed so that the residue, on roasting, is tasteless. Experiments were carried out in which the mixture recovered from the methanol extract by evaporation of the methanol was re-incorporated with the methanol-insoluble residue, the product being then moulded into balls which were wrapped in greaseproof paper and roasted. These “artificial beans” did develop a chocolate aroma and flavour, though not as strong as that in fermented cacao beans which had simply been crushed, moulded, wrapped and roasted. Attempts at isolating a flavour precursor by fractionation of the methanolic extract, and roasting the fractions with the residue were unsuccessful. The roasting of these artificial beans is far from satisfactory and a method of getting good roasting will be necessary before worthwhile results can be expected.

The anthocyanin pigment in the cacao bean which moves the faster on chromatography is now available as a pure crystalline hydrochloride giving analysis corresponding to cyanidin mono-arabinoside. The slower moving anthocyanin has been obtained crystalline but has not yet been entirely freed from contaminating glycosides. It is probably a cyanidin monogalactoside. Attempts are being made to prepare synthetic cyanidin glycosides to determine the point of glycosidic linkage.

The enzyme system concerned in the chemical change of the pigments during anaerobic fermentation acts on the pure cyanidin arabinoside when presented as sole substrate.

The methods used in fractionating the phenols of the cacao bean have been published and the problems still remaining summarised (*see* paragraph 93).

Some 50 replies to the questionnaire on methods of cacao curing have been received from the world's cacao growing areas and are being collated.

88. *Plant Polyphenols*. The work on peltogynol is being continued in collaboration with the Chemistry Department of the University College of the West Indies through the interest of Professor Hassall in the finer structural problems involved.

An investigation of considerable interest is being made on the action of polyphenol oxidase on catechol. Chromatographic and manometric techniques have been combined to give novel results. A reasonable hypothesis has been developed to explain the molar decrease in oxygen uptake as the concentration of substrate increases.

89. *The Effect of Ammoniated Molasses on Rumen Microflora*. This work is being carried out at the request of the Imperial College of Tropical Agriculture who are attempting to introduce ammoniated molasses as a foodstuff for ruminants. Fractions containing iminazole or its derivatives are found to be toxic to both the rumen protozoa and bacteria at a 1.5 per cent. but not at a 0.15 per cent. level.

90. *The Hankey Culture Collection*. Routine provision of cultures and bacteriological examinations for local industries have continued throughout the year. Thirty-four cultures were sent overseas on request.

91. *Microbial Synthesis.* Some thirty isolates of *Aspergillus terreus* have been screened for itaconic acid production from molasses and several high yielding strains found. However, while this work was in progress, the incentive was largely destroyed by a report that successful commercial production from molasses had been obtained elsewhere.

In a similar manner isolates of *Acetobacter acetigenum* and *Acetobacter xylinum* are being screened for cellulose production from molasses and an investigation of optimum conditions for large scale production has been started.

92. *Miscellaneous Investigations.* The matters in which the Institute has been called upon, in the year under review, to assist various industries and organisations have included the following :—

- (a) *The Co-operative Coconut Growers' Association of Trinidad and Tobago* : maintenance of cultures used in the manufacture of margarine.
- (b) *Walters Trinidad Brewing Co. Ltd.* : maintenance of cultures, testing, and general microbiological supervision of their factory.
- (c) *Trinidad Leaseholds Ltd.* : samples of oil field water have been analysed for the presence of sulphate-reducing bacteria and several bactericides have been tested for their effectiveness in controlling the numbers of these organisms.
- (d) *The Department of Agriculture of Trinidad and Tobago* : in collaboration with the Fisheries Officer, the possibility of preserving carite—a local food fish—by wet salting has been examined and the nature of any spoilage investigated.
- (e) *Paint Manufacturers & Agents* : blackening of paintwork is an all-too-common occurrence in Trinidad and numerous paint scrapings were again received during the year for identification of the fungus involved. This, in most cases, proved to be either a *Pullularia* sp. or a *Cladosporium* sp. A “graveyard” of panels has been set up to study the effect of preservatives with painted wood derived from both local and imported commercial timbers.
- (f) *The Sugar Manufacturers' Association (of Jamaica) Ltd.* : an investigation into the deterioration of sugar when stored in bulk for long periods was started, the particular interest being in those organisms capable of growing at high sugar concentrations. While 40 per cent. moisture is necessary for bacterial growth, yeasts were found growing at much lower moisture contents.
- (g) *The Industrial Development Board of Antigua* : they being interested in the possibility of producing a bottled “beer” from cane juice as a more nutritious alternative to rum drinking, it was found that with the addition of very little hops a fairly palatable brew could be produced using a strain of *Saccharomyces carlsbergensis*.
- (h) *The Forest Department of Trinidad & Tobago* : some work was done on a disease of local mahogany trees and also on maintaining sterile conditions for germination of “birdvine” seeds.

93. *Visits.* The Director, while on leave, attended the Third International Congress of Biochemistry in Brussels, the Annual Meeting of the British Association for the Advancement of Science at which he read a paper on Cocoa, and the Cocoa Conference in London.

The Curator and both Microbiologists attended the Conference of the British West Indies Sugar Association in Barbados.

94. *Publications*. "Cacao Polyphenolic Substances, 3. Separation and estimation on paper chromatograms". Forsyth, W. G. C., *Biochem. Journ.*, 1955, **60**, 108-111.

"Two major problems in the scientific understanding of cacao fermentation". Forsyth, W. G. C., *Zucker-und Susswarenwirtschaft.*, 1955, **10**, 512-3.

Sugar Technological Laboratory, Trinidad

95. *Experimental Sugar Factory*. The factory was operated for a shorter time than usual, six weeks, because it was necessary to economise on running costs. Mechanical improvements are still being made.

96. *Clarification Studies*. Investigations into the effect of drought on the properties of sugar cane juice were continued. The two varieties referred to in last year's report were again subjected to drought conditions in a greenhouse but ratoons, i.e. sproutings from the roots left from the first crop, were used instead of fresh plants. Analyses were made of the juice and, in a few cases, of the leaves. Although statistical evaluation of results was not possible, comparison of the results obtained in the two years showed certain trends. Unquestionably the effect of drought was to produce juices which were difficult to clarify. The concentration of most of the juice constituents, and especially of the nitrogen and phenol content, tended to rise as drought proceeded. The total nitrogen in the leaf did not rise in this way, and there were indications that, in fact, it fell. It was established that both plant and ratoon canes behave in the same way, in respect of juice analysis and settling characteristics, towards drought conditions.

Studies were also carried out on sugar cane grown in the open field with and without irrigation in collaboration with the Venezuelan Department of Agriculture, the plants being grown at the experimental station at Yaritagua, west of Caracas, where the rainfall is very slight and there was complete drought for three months. Samples of the cane were cut at monthly intervals and analysed. Not all the results are yet available, but from those that have been obtained it seems that the juice is difficult to clarify, and the total amino acid, amide nitrogen, organic acid and phenol content increased as the drought continued, in both the cane which was irrigated and that which was not. One possible explanation of these results is that the response to drought is stimulated not only by the water supply at the roots but also by the relative humidity of the atmosphere.

97. *Experiments on the Liming of Cane Juices*. Various experiments were carried out on the effect of adding milk of lime to cane juice and of various degrees of mechanical treatment of the flocs. There was found to be little difference between the result of adding all the lime required in one batch and adding it gradually. When another method of clarification was used it appeared that mechanical agitation affected the quality of the clarified juice adversely, but that when agitation was combined with the addition of phosphoric acid, juice of a higher clarity was obtained than when no mechanical treatment was used.

98. *Variety Trials*. Six varieties were weighed, milled and their juices processed in the Experimental Sugar Factory. The juices were analysed for phosphate, total nitrogen and amino nitrogen, and settling tests were carried out. High yields of cane and sugar per acre were not necessarily correlated with juices of highest purity. The juice of one cane clarified particularly well, and the mud was easily handled.

99. *Versene for Evaporator Cleaning.* Much information concerning the cleaning action of Versene has been derived from laboratory experiments in which Versene solutions were sprayed, under various conditions, into single, badly scaled evaporator tubes, removed from a commercial factory. It was suggested that the rate of scale removal depends on pH, and it was found that at pH 6 it was more than twice that at pH 11. A second factory trial was undertaken with the third body of the evaporator, and the scale was satisfactorily removed by boiling Versene solution at pH 6. The regeneration process required only half the quantity of chemicals needed to produce Versene at pH 11 and Versene losses were reduced from 8 per cent. to 2 per cent. per week. An electrolytic regeneration technique was tried but has now been abandoned since the original process is simpler and its slightly inferior efficiency is off-set by the reduced loss of Versene. The mechanism of the action of Versene has almost been elucidated and methods for determining the concentration of Versene are being developed.

100. *The Bach Polycell Clarifier.* Further tests have been carried out to determine the maximum throughput of the three elements of the clarifier.

101. *The Diffusion Process in Sugar Manufacture.* Theoretically, complete extraction of sugar from the cane should be possible with a diffusion process, and although previous attempts to exploit this have been unsuccessful, a detailed theoretical and practical investigation has been carried out into diffusion techniques. It was found that the type of diffuser used in the beet industry could not be used for treating bagasse. The quality of juices obtained by water extraction of milled cane is good and this suggests that ion-exchange processes might well be used with such juices. The various possibilities are now being examined experimentally.

102. *Solubility of Sucrose.* Further investigations are being carried out into the effect of salts on sucrose solubility, using the method of Dauncey and Still. So far, the reproducibility of results has been found to be better than by any previous method. The performances of different designs of saturoscope are being investigated with reference to their use for solubility determinations with molasses.

103. *Determination of the Nitrogen Balance in a Commercial Sugar Factory.* It was found that the quantities of nitrogen present in the cane juice are not negligible and that it is possible to draw up a balance sheet showing the fate of the nitrogen in its passage through the factory. Only about 40 per cent. of the nitrogen in the juice is removed by lime-heat clarification and the remainder undergoes little modification between the clarified juice and the final molasses.

104. *Sugar Curing.* It was found that the addition of large quantities of a proprietary, non-ionic detergent to massecuites—a mixture of crystal sugar with syrup—increased the amount of pure sugar obtained. This, however, would be an expensive process and the same results could be obtained by raising the temperature of the massecuite slightly before curing it. As the purity of the sugar increases, it becomes progressively more difficult to improve it further by raising the temperature of the massecuite. Several methods of increasing the purity of raw sugar were tried. They all gave some improvement, but the most successful was that of washing the sugar in a centrifugal basket with a large volume of water.

105. *Glucose and Fructose.* A pilot plant has been constructed to determine the technical and economic feasibility of producing glucose and fructose from raw sugar. The process is not yet fully developed but approximate costs of production have been calculated. There would be a considerable market for fructose if its use in the diet and treatment of diabetics were developed.

106. *Oxalic Acid from Bagasse*. Experiments have been carried out in the laboratory on the oxidation of bagasse with nitric acid to produce oxalic acid, and on the recovery of the nitric acid for re-use. An approximate material balance was made and a preliminary estimate of the cost of manufacture derived.

107. *Ammoniated Bagasse*. Bagasse pith can be ammoniated to give a product which has a pleasant appearance, taste and smell, and when mixed with molasses is readily eaten by cattle with no ill-effects and no tainting of milk. It might possibly be suitable for use as a protein supplement for ruminants. A large amount of pith would be available as a waste product of the manufacture of paper from bagasse and the large fibres rejected in the manufacture of bagasse board would also be suitable for ammoniation. Processes using both liquid and gaseous ammonia under various conditions of temperature and pressure have been tried, the most satisfactory so far involving the use of anhydrous ammonia.

108. *Ammoniated Molasses*. Investigation of the chemical character of ammoniated molasses has continued and several of the components have been identified. The iminazole and pyrazine derivatives of small molecular weight may be removed from the ammoniated molasses by solvent extraction, the extract amounting to about 5 per cent. of the total weight. The ammoniated molasses, although not palatable when given alone, is acceptable to cattle if fed with coarse fodders. Water buffalo can apparently eat it without ill effects but a violent toxic reaction occurred in a feeding trial with cattle. The iminazoles and pyrazines of small molecular weight extracted from ammoniated molasses are toxic to chicks, but the residue left after the extraction is not toxic. One of the components, 4-methyliminazole, is known to be toxic to rats and it is probably this which causes the reaction in cattle. Trials with sheep suggest that ammoniated molasses modified with acid is not harmful. From feeding trials it appears that the addition of ammoniated molasses increases the digestibility of the protein of the grass fed with it.

109. *Laevulinic Acid*. A pilot plant for the production of Laevulinic acid is being constructed and production should start shortly. This project is being carried out in collaboration with a United States firm of chemical manufacturers.

110. *Lactic Acid*. A pilot scale investigation into the commercial manufacture of lactic acid by a chemical process is being undertaken to correlate the various pieces of research now completed and to modify laboratory techniques to make them practicable on a large scale.

111. *Publications*. "Scale Prevention Trials on the Use of the Superstat Device". Schmidt, N. O., Wiggins, L. F. and Yearwood, R. D., *Proc. B.W.I. Sugar Tech. Meeting*, 1954, 149.

"Studies on the Analyses of Evaporator Scale from the I.C.T.A. Experimental Sugar Factory". Schmidt, N. O., *Proc. B.W.I. Sugar Tech. Meeting*, 1954, 141.

"The Use of Versene in Evaporator Cleaning". Massiah, B. V., Mayers, J. C., Holland, I. D., Schmidt, N. O., Wiggins, L. F. and Wise, W. S., *Proc. B.W.I. Sugar Tech. Meeting*, 1954, 155.

"The Effect of Chlorotic Streak Disease on Sugar Yields in Trinidad". Hutchinson, P. B. and Wise, W. S., *Proc. B.W.I. Sugar Tech. Meeting*, 1954, 122.

"Some Analytical Methods for Minor Constituents of Sugar-cane Juice". Williams, J. Howarth, *Proc. B.W.I. Sugar Tech. Meeting*, 1954, 167.

"Some Effects of Drought on Cane Juice". Schmidt, N. O., Wiggins, L. F., Williams, J. Howarth and Yearwood, R. D. E., *Proc. B.W.I. Sugar Tech. Meeting*, 1954, 171.

"Formaldehyde as an Expedient in the Settling of Mud during the Defecation of Cane Juice". Schmidt, N. O., *Proc. B.W.I. Sugar Tech. Meeting*, 1954, 183.

"Studies on Ammoniated Molasses. Part I. The Production of Ammoniated Molasses". Joblin, A. D. H., Thomson, A. F. and Wiggins, L. F., *Proc. B.W.I. Sugar Tech. Meeting*, 1954, 208.

"Studies on Ammoniated Molasses. Part II. Ammoniated Inverted Cane Molasses as Feed for Ruminants". Joblin, A. D. H., Howes, J. R. and Wiggins, L. F., *Proc. B.W.I. Sugar Tech. Meeting*, 1954, 212.

"A General Survey of the Possible Uses of Bagasse". Winstanley, J., *Proc. B.W.I. Sugar Tech. Meeting*, 1954, 198.

"The Fibre Structure of Cane Varieties B.37161 and B.4362". Hutchinson, F. B., Wiggins, L. F. and Wise, W. S., *Proc. B.W.I. Sugar Tech. Meeting*, 1954, 165.

"Some Observations on Sugar Curing". Yearwood, R. D. E. and Schmidt, N. O., *Proc. B.W.I. Sugar Tech. Meeting*, 1954, 189.

"Sugar Technological Research in the British West Indies". Wiggins, L. F., *Sugar J.*, 1954, 17, (7), 18.

"Amino Acid Content of West Indies Sugar-cane". Wiggins, L. F. and Williams, J. Howarth, *J. Agric. Food Chem.*, 1955, 3, 34.

"The Aconitic Acid Content of B.W.I. Molasses". Drake, J., Wiggins, L. F. and Wise, W. S., *Int. Sug. J.*, 1955, 57, (678), 160.

"Some Preliminary Observations on the Nature of Ammoniated Molasses". Wiggins, L. F. and Wise, W. S., *Chem. & Ind.*, 1955, (23), 656.

"The British West Indies Sugar Research Scheme". Wiggins, L. F., *Chem. & Ind.*, 1955, (32), 1001.

"The Amperometric Determination of Ethylenediaminetetraacetic Acid with Zinc Ions". Wise, W. S. and Schmidt, N. O., *Analyt. Chem.*, 1955, 27, (9), 1469.

"The Solubilities and Heats of Crystallisation of Sucrose and Methyl α -D-Glucoside in Aqueous Solution". Wise, W. S. and Nicholson, E. B., *J. Chem. Soc.*, 1955, 2714.

"The reaction of Magnesium Halides with α β - Anhydro-Sugars". Richards, G. N., Wiggins, L. F. and Wise, W. S., *J. Chem. Soc.*, 1956, 496.

The Forest Products Research Laboratory, Princes Risborough

112. *Fibreboard Production*. Work has continued on the production of fibreboard from secondary Colonial timbers, and hardboards of more than adequate strength have been made by the semi-chemical process from each of the timbers so far examined.

113. *Water Resistance*. With some of the dense hardwoods, such as morabukea from British Guiana, some difficulty was experienced in producing boards having a satisfactory degree of water resistance. Various methods of reducing water absorption of the boards have been investigated, using pulp from morabukea, to compare their effectiveness and their influence on other properties of the boards. It was found that satisfactory water resistance could be achieved without loss of strength, either by the application of drying oils to the boards

after pressing, followed by heat treatment, or by the addition of wax emulsion and synthetic resin to the pulp. Useful information was also obtained on the effect of control of pH of the pulp on the subsequent behaviour of the boards during heat treatment.

114. *Defibrator*. A laboratory model Defibrator has been installed, but owing to various mechanical defects, it has not yet been possible to put it into operation.

115. *Publications*. "The Production of Hardboard from Tropical Timbers. I. Kempas (*Koompassia malaccensis*)". Farmer, R. H., and Packman, D. F., *Colon. Pl. Anim. Prod.*, 1954, 4, 293.

"The Production of Hardboard from Tropical Timbers. II. Red Meranti (*Shorea leprosula*), Keruing (*Dipterocarpus crinitus*) and Balau (*Shorea laevis*)". Farmer, R. H., and Packman, D. F. *Colon. Pl. Anim. Prod.*, 1955, 5, 39.

University College of the West Indies

116. *Calotropis procera*. We regret to report that Dr. K. Reyle was killed in a mountaineering accident in Switzerland after working for the Council for only three months. Before his death he was continuing the investigation, started by him some time previously, on the active principles of *C. procera*, a plant which has been used in India for medicinal purposes since antiquity. A new steroid aglycone, calotropagenin, was obtained from the glycoside calactin and a structure proposed for it.

117. *Monamycin*. Under the supervision of Professor C. H. Hassall, Mr. K. R. Magnus has defined conditions for growing the organism producing the antibiotic, Monamycin, in deep culture. He has also developed an improved procedure for isolating the substance from both shallow and deep cultures. In the last stages of the isolation, purification of Monamycin by counter-current distribution has been employed. This has proved the most practical procedure to date for the preparation of pure Monamycin on a laboratory scale and it may very well be applied on a large scale.

The Queen's University of Belfast

118. *Caesalpinia crista* and *Baikiaea plurijuga*. Mr. N. A. Dobson, under the supervision of Professor R. A. Raphael, has continued his work on bonducin which he extracted from the nuts of *C. crista*. Various degradation products have been obtained of the only crystalline derivative, that given by alkaline hydrolysis, which has the properties of a polyhydroxy long-chain aliphatic compound. Mr. Dobson has also been examining the chemistry of baikiaian, a constituent of the heart-wood of *B. plurijuga*.

Birmingham University, Department of Chemistry

119. *Nitrogen-Containing Sugar Derivatives*. Under the direction of Professor M. Stacey and Dr. A. B. Foster, Mr. D. Horton has been taking part in the Department's investigation of the reaction of sugars and amino-sugars with compounds containing amino groups. It was found that, in the presence of mineral acids alone, N-acetyl-D-glucosamine undergoes a polymerisation reaction, and two of the oligosaccharides produced have been isolated in a pure state. The structure of one of these is being determined.

120. *Mucopolysaccharides and Mucoproteins*. Professor Stacey has continued his study of the production by micro-organisms of carbohydrate-protein complexes, cane sugar and ammonium salts being the substrates. The macromolecules obtained can be extruded through fine jets to form fibres, but these need treatment with formalin to render them insoluble in water.

Birmingham University, Department of Pharmacology

121. *Anti-acetylcholine Activity*. During the year, Mr. A. R. Timms, supervised by Professor A. C. Frazer, extended his studies on non-specific acetylcholine antagonism. Two main lines of approach to the problem were followed. The first dealt with the correlation between physico-chemical properties and pharmacological activity in the piperazine antihistamines. Attempts to measure the lowering of the surface tension of water by the halogenated and non-halogenated piperazine antihistamines proved unsuccessful. Differences in oil/water solubility were found which might explain the observed differences in mode of action between the two but not the differences in potency. The comparison between dissociation constant and activity was inconclusive. The second line of investigation showed that there were similar differences between the effect of halogenated and non-halogenated antihistamines on other spasmogens such as nicotine and barium as had been observed with acetylcholine. The mode of action of barium, nicotine, acetylcholine and histamine on guinea-pig ileum was re-examined and further experiments are being carried out on the correlation between the activity of barium and atropine.

Glasgow University

122. *Bitter Principle of Orange Seeds*. Mr. G. F. Phillips has continued his work on limonin, the main bitter principle of citrus fruit, under the supervision of Professor D. H. R. Barton. Improved methods for the preparation of various degradation products have been effected and the functional groups of the molecule have been characterised.

123. *Alkaloids*. Supervised by Dr. M. F. Grundon (now at the Queen's University, Belfast), Mr. J. R. Crowder has continued his investigation into methods for synthesising compounds concerned in the preparation of bisbenzylisoquinoline alkaloids, and has studied the reactions of various related substances.

Royal Technical College, Glasgow

124. *Triterpenoids*. Under the supervision of Professor F. S. Spring, Mr. G. Brownlie and Mr. J. L. Stewart have continued their investigations on triterpenoids. Mr. Brownlie's studies on the two ketones obtained from cork have led to the elucidation of their structure. Mr. Stewart has established the structure of a ketone isolated from alder bark and this and earlier work has contributed to an understanding of the formation of triterpenoids. The following papers have dealt with aspects of the work of Mr. Brownlie and Mr. Stewart :—

“The Constitution of Taraxerol (Skimmiol); A New Naturally Occurring Triterpenoid Type”. Beaton, J. M., Spring, F. S., Stevenson, R. and Stewart, J. L., *Chem. & Ind.*, 1954, (47), 1454.

“The Partial Synthesis of Taraxerol”. Beaton, J. M., Spring, F. S., Stevenson, R. and Stewart, J. L., *Chem. & Ind.*, 1955, (2), 35.

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Nottingham University

125. *Hardwood Extractives*. Work on the extraction and identification of constituents of resistant hardwoods of Colonial origin has continued under the supervision of Professor F. E. King. The work of Mr. D. W. Rustidge on the dihydro-compound derived from the timber Rengas suggests that the methylated flavonol obtained from it contains a nuclear methyl group. The dihydro compound resembles dihydroquercetin but the ether derivatives of the two, which were synthesised, were distinct. The following woods have been subjected to solvent extraction and the extracts examined:—Andiroba (*Carapa procera*), Canarium (*Canarium schweinfurthii*) and East African Camphorwood (*Ocotea usambarensis*). Mr. J. D. White has extracted a substance identified as arjunolic acid from Abura (*Mitragyna ciliata*). An investigation of the spatial relationships of the three hydroxyl groups of this compound was undertaken. The exudate of Tchitola (*Pterygopodium oxyphyllum*) has been shown to consist of a hydrocarbon, an alcohol and a new liquid diterpene acid. The structure of the acid has been investigated, its molecular formula having been determined, and the reactions of the methyl ester studied.

Work on Plant Material Supplied by the Council

126. *Vangueria tomentosa*. Studies into the nature of vangerigenin, the sapogenin of this species, have been initiated by Professor D. H. R. Barton of Glasgow University.

127. *Artocarpus integrifolia*. Dr. W. Cocker, at Trinity College, Dublin, is working on this species and has isolated a number of compounds, one of which appears to be an α : β -unsaturated ketone.

128. *Fagara xanthoxyloides*. Professor H. Erdtman of Kungl Tekniska Högskolan, Stockholm, has published the results of his work on *Fagara xanthoxyloides*. Extraction of the bark with light petroleum yielded an oil from which were obtained two compounds. One was identified as lupeol and the other was identical with d-sesamin. Fractions obtained from the mother liquors of the sesamin consisted of mixtures of d- and l-sesamin, the d-form preponderating. The properties of the substances isolated were compared with those of "fagarol" isolated by Paris and Moyses-Mignon from the same species. It was concluded that *F. xanthoxyloides* is able to synthesise d- and l-sesamin although the amounts may vary from specimen to specimen. An alternative explanation is that there may be various strains of *F. xanthoxyloides* or hybrids between closely related species.

129. *Anona senegalensis*. Investigations of the leaf wax from this species by Dr. A. Mackie of the Heriot-Watt College, Edinburgh, have continued. Palmitone has been isolated from both the hard and soft waxes. From the unsaponifiable fraction of the soft wax two sesquiterpene oils have been obtained which are promising Sclerostome larvicides.

130. *Citrullus colocynthis* and *Ecballium elaterium*. Dr. D. W. Mathieson, at the University of London School of Pharmacy, has been working with *C. colocynthis* which is reported to contain 1 per cent. of elaterin. So far, none has been isolated from the separated pericarp, seeds or pulp and this finding has been confirmed by other authors working independently. An alcoholic extract of the pulp has given large amounts of glycosidal resin which may be a glycoside of elaterin. The instability of elaterin itself towards acids or alkalis prevents normal hydrolytic procedures being used and enzymatic hydrolysis has not yet been achieved. Meanwhile, elaterin has been obtained from *Ecballium elaterium* and has served as a starting material.

131. *Dichapetalum toxicarum*. Sir Rudolph Peters, at the Agricultural Research Council's Institute of Animal Physiology, Cambridge, is continuing his investigation of the very interesting pharmacologically active principles of the seeds of this species.

132. *Dioscorea hispida*. The work on dioscorine, obtained from this species, has been continued by Dr. A. R. Pinder at University College, Cardiff. Further investigations on the Hofmann degradation have been carried out and on the basis of these, and other work, a formula has been proposed for dioscorine. The presence of a tropine framework and of a six- or seven-membered ring seem well established, but the mode of union of the two ring systems requires further proof, and investigations to this end are proceeding.

133. *Thylachium spp.*, *Entada gigans*. Dr. R. Schoental at the Medical Research Council's Toxicology Research Unit, Carshalton, has been investigating the toxic effects of *Thylachium thomasi* and *T. africanum* which are used as "famine foods" by the natives in East Africa. Minced fresh and dried roots, respectively, were fed to rats, and had a detrimental effect on their growth. In some cases anaemia occurred and on post-mortem examination gastrointestinal haemorrhage or slight fatty changes in the liver were sometimes present. It is thought that the toxic principles may be volatile isothiocyanates, and this would be in accordance both with the finding that very dry roots appear harmless to rats, and with the native practice of carefully soaking the roots in water and then cooking them to remove the toxic factor. Experiments with the seeds of *Entada gigans* are in progress, but so far they have produced no striking toxic effects.

Miscellaneous Projects

134. *Ammoniated Molasses.* In support of Professor Wiggins' work in Trinidad, the National Institute for Research in Dairying, Shinfield, has carried out feeding trials with ammoniated molasses. As mentioned in our last report, this material caused toxic reactions when fed to cattle but, following a suggestion from Professor Wiggins, a further trial was carried out in which the ammoniated molasses was treated with acetic acid before feeding. The use of certain quantities of acid seemed to provide a product with reduced toxicity, and it remains possible therefore that, although ammoniated molasses itself is a dangerous feedingstuff, the acid-modified material might still prove to be a useful feed supplement. However, it has still to be demonstrated conclusively that the nitrogen present is of nutritional value to the animals.

135. *Comirin.* The results of further commercial trials of Comirin by horticultural and pharmaceutical firms both in this country and in the United States are now available. They suggest that although the substance is a potent antifungal antibiotic, the advantages of Comirin over similar products already on the market are not so great as to justify its commercial production. Moreover it does possess certain disadvantages not found with other preparations.

Committee on Colonial Road Research First Annual Report (1955-1956)

Road Research Laboratory,
Harmondsworth,
West Drayton,
Middlesex.
12th July, 1956.

SIR,

I have the honour, on behalf of the Colonial Road Research Committee, to transmit to you the First Report of the Committee covering the period from 1st April, 1955, to 31st March, 1956.

I have the honour to be,

Sir,

Your obedient servant,

W. H. GLANVILLE,
Chairman.

The Right Honourable Alan Lennox-Boyd, M.P.

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.
- R. U. LAW, ESQ., M.I.C.E., Messrs. George Wimpey & Co. Ltd.
- 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 Advisor 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., Advisor 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 2nd meeting held on the 28th June, 1956.
- C. E. BELIZAIRE, ESQ., B.Sc., Public Works Department, British Honduras.
- C. A. BROWNE, ESQ., M.B.E., I.S.E., Assistant Director (Roads), Public Works Department, Uganda.
- B. H. BULLEN, ESQ., B.Eng., A.M.I.C.E., Director, Public Works Department, Nigeria (Western Region).
- J. H. DURR, ESQ., B.Sc., M.I.C.E.,* Commissioner of Roads and Road Traffic, Southern Rhodesia.
- K. P. HUMPIDGE, ESQ., B.Sc., M.I.C.E., Director, Public Works Department, Nigeria (Federal).
- R. C. MARC, ESQ., M.Sc., A.M.I.C.E., Director, Public Works Department, Nigeria (Northern Region).
- R. MASON, ESQ., B.Sc., A.M.I.C.E., Deputy Director, Public Works Department, Nyasaland.
- J. A. McLEOD, ESQ., Public Works Department, Singapore.
- D. McVEAN, ESQ., A.M.I.C.E., Director, Public Works Department, Cyprus.
- P. R. MORRIS, ESQ., B.Sc., A.M.I.C.E., Public Works Department, Kenya.

* Attended by special invitation.

- R. MILNE, ESQ., Deputy Director, Public Works Department, Sierra Leone.
- G. T. MYLES, ESQ., B.A., B.A.I., A.M.I.C.E., State Engineer, Public Works Department, Brunei.
- W. L. OSBORNE, ESQ., O.B.E., M.I.Mun.E., Director, Works and Hydraulics Department, Trinidad.
- G. RAWLINGS PAPE, ESQ., B.E., M.I.C.E., M.I.W.E., Commissioner of Works, Northern Rhodesia.
- J. B. WHITE, ESQ., M.I.C.E., A.M.I.W.E., Director, Public Works Department, Uganda.
- F. H. WOODROW, ESQ., O.B.E., B.Sc., M.I.C.E., Director, Public Works Department, Tanganyika.
- I. WYN PUGH, ESQ., M.I.C.E., M.I.W.E., Director, Public Works Department, Gold Coast.

COLONIAL ROAD RESEARCH COMMITTEE

FIRST ANNUAL REPORT

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COMMITTEE ON COLONIAL ROAD RESEARCH
FIRST ANNUAL REPORT

1. The period under review has seen the first meeting of the Committee and the inception of the Colonial Section of the Road Research Laboratory. The Committee held its first meeting in June, 1955, the meeting being attended by representatives of the following Colonial Governments : Cyprus, Gold Coast, Kenya (representing East Africa) and Nigeria. The programmes of research of the newly formed Colonial Section were discussed and agreed.

The main items in this research programme are :—

- (a) Economic justification for roads.
- (b) Pavement design.
- (c) Drainage, erosion and moisture movement.
- (d) Bituminous surfacings.
- (e) Machinery and labour problems.

The Committee is concerned that the conditions should exist in Colonial Territories to make it possible to apply the results of research to produce economies. These economies are obtained by the selection and exploitation of local materials, from the use of more economical methods of structural design and from the development of more efficient techniques of controlling construction and maintenance processes.

In some territories the facilities for applying the results of research exist in the Materials testing and control laboratories operated by the Public Works Departments, but there is often difficulty in obtaining qualified Materials Engineers to make these laboratories fully effective. In other territories the number of engineering staff in the Departments is so small that it has not been possible to set up any materials laboratory at all.

The Committee feel that there is a grave danger that the full benefits of research will not be obtained unless an adequate number of Materials Engineers can be made available. They suggest that one means worth careful consideration would be to form a supplementary group of Materials Engineers based at the Road Research Laboratory and available to serve for periods in the different territories according to need. As part of their functions they would be able to assist in training local staff.

Staff and Accommodation

2. The Head of the newly formed Colonial Section of the Road Research Laboratory, Dr. R. S. Millard, was appointed in November, 1955. The Colonial Liaison Officer, Mr. F. H. P. Williams, joined the Section. Between November, 1955, and January, 1956, two other Scientific Officers and three Experimental Officers were appointed to the Section from existing staff of the Road Research Laboratory. At the end of March, 1956, the Section was short of complement by three Scientific Officers, three Experimental and Assistant Experimental Officers and three Assistants (Scientific). Every effort is being made to find suitable people to fill these posts, particularly Scientific Officers who are especially necessary for a vigorous attack on the research problems.

3. Temporary laboratory accommodation has been provided pending the construction of new buildings in the Laboratory grounds at Harmondsworth, Middlesex.

Visits

4. Mr. F. H. P. Williams, as Colonial Liaison Officer, completed a three-month tour of East Africa, Northern Rhodesia, Nyasaland, Southern Rhodesia and the Union of South Africa in April, 1955. He made a two-month tour of the Gambia, Sierra Leone, Gold Coast and Senegal in the autumn of 1955 and a seven-week tour of Nigeria early in 1956. Reports of these visits are in preparation. In addition opportunity was taken to make contact with the Materials Laboratory in Southern Rhodesia, the Bituminous Binder Research Unit (now part of the Road Research Institute of the C.S.I.R. of South Africa) and the Section de Recherches, Travaux Publics, Dakar, and to acquaint them with information about the establishment of the Colonial Section at the Road Research Laboratory. The main research problems of roads in these colonial territories in West Africa and East and Central Africa have been described in Colonial Research Publications Nos. 8 and 17, arising from visits of the Colonial Liaison Officer between 1946 and 1950. Since then there has been a marked increase in traffic in all areas. The general policy in East and Central Africa and the Gold Coast has been to concentrate on developing the trunk road system to a reasonable standard; in other territories in West Africa the effort has been employed more generally over the road system of the territory. Shortage of trained engineering staff, foremen and inspectors, is probably the biggest problem in each territory. Training schools are in operation in the Gold Coast, Nigeria and Kenya for supervisory staff in the lower grades. The shortage of qualified engineers in Public Works Departments is being met in some cases by the employment of consulting engineers.

5. Dr. Millard toured Uganda, Kenya and Tanganyika in March, 1956. In the course of the visit he met representatives of the Colonial Governments concerned with roads and road transport, the Public Works Departments, the Engineers of Local Authorities, Consulting Engineers and Contractors. The particular problems of each territory were reviewed in collaboration with the responsible engineers in each Public Works Department, and plans were made to initiate investigations into what are judged to be the most important.

Research Activities

6. For the short time between their appointment and the end of the period under review, the staff were engaged in surveying the information already available on colonial soils, on their use in road construction and maintenance and also in the examination of samples of road materials referred to in paragraph 10.

7. Two investigations which have been in progress as part of the programme of the Road Research Board are of special interest in Colonial Territories. One concerns an examination of the moisture conditions in soils under airfields in tropical and sub-tropical climates, undertaken in co-operation with the Air Ministry. More knowledge is required of the moisture conditions, particularly under impervious surfacings, in order to provide a method of pavement design applicable in these climates.

8. Data has been collected over a period of years by the Air Ministry on the movement and distribution of moisture in soils under airfields in tropical and sub-tropical areas. This data is being analysed at the Road Research Laboratory; so far the data from one airfield, Tengah Airfield, Singapore, has been examined and a report has been issued⁽¹⁾. The analysis of the records from ten other airfields is to be continued by staff of the Colonial Section.

A method of forecasting the moisture conditions under pavements in the temperate climate of Great Britain has been developed by the Laboratory and this work is the beginning of an investigation to provide a method applicable in other climates such as those of Colonial Territories.

9. The possible use of rubber in roads is of particular interest to the Malayan Government. The Laboratory has been engaged for some years in a co-operative research with the Natural Rubber Development Board on this subject. Laboratory investigations have shown that the incorporation of rubber in bitumen can produce binders and road mixtures which at the required resistance to deformation at high temperatures are at the same time less brittle at low temperatures. The value of this modification in properties has been demonstrated in the special case of mastic asphalt mixtures used to repair cracks in asphalt over concrete, and a series of full-scale road experiments is in progress in the United Kingdom to determine the possible practical value of rubber in normal surface dressing and surfacing mixtures. An experimental surface-dressing laid in 1953 has not so far shown any advantage from the incorporation of rubber in the binder⁽²⁾. The value of rubber in bituminous road surfacings will be influenced by local climatic conditions and it is thus welcome to record that a full-scale road experiment is in progress in Malaya in which the performance of a range of compositions of bitumen macadam with and without rubber is being examined. The surfacings were laid by the Public Works Department on the Seremban-Port Dickson road in September, 1954, and the design of the experiment follows recommendations made by the Road Research Laboratory after the visit of the Colonial Liaison Officer in 1953.

Testing and Information Services

10. The Laboratory has welcomed many visitors during the year in consultation on particular Colonial road problems, in addition to answering by correspondence a growing number of technical enquiries. Amongst these enquiries were several involving the examination of samples of road-making materials; these included samples of three lateritic aggregates from Grenada which were examined to assess their suitability for use in concrete, and two series of samples of sand-bitumen surfacing mixture from a road construction contract in Northern Nigeria which were analysed to determine if their composition lay within appropriate specification limits. At the request of the Director of Federal Public Works of Nigeria, advice was given on the design and construction of a new road between Maiduguri and Bama. This involved an examination of samples of soil from existing wet and dry season routes. As a result of the examination it was recommended that the new road should follow the wet season route. The soil on this route is a medium-coarse sand and the laboratory tests indicated that a thickness of construction of 4-in. over the compacted soil would be adequate for the expected traffic. The soils on the route were found suitable for making sand-bitumen mixtures and recommendations were made for the composition of base course and wearing course mixtures to make up the 4-in of construction required⁽³⁾. These investigations, although of a routine nature, are valuable in building up knowledge of field conditions in the different colonial territories and it is hoped to continue such help without impairing the direct effort on research.

11. 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. During the year the following research notes were circulated :—

Soil Stabilisation—A review of plant	RN/2523
List of surface-active agents for use in surface dressing ..	RN/2551
Roads and road problems in the Caribbean area	RN/2553
Speeds and speed limits	RN/2626
List of laboratories undertaking the testing of road materials	RN/2679

12. At the courses on Soil Mechanics, Bituminous Materials and Concrete held at the Laboratory in the winter of 1955-56, 44 of the 218 places were filled by Colonial Engineers. Two engineers from Nigeria attended the Laboratory's course on Traffic and Road Safety in the spring of 1956. In one of the Soil Mechanics courses a series of lectures specifically concerned with Colonial conditions was given and it is hoped that this service will be extended as the body of knowledge in the Laboratory on colonial road problems increases.

References

- (¹) Research Note No. RN/2689. The movement and distribution of moisture in soils at overseas airfields—I. Tongah Airfield, Singapore. (Unpublished.)
- (²) Road Research Board. Report of the Road Research Board, with the report of the Director of Road Research, for the year 1955. Department of Scientific and Industrial Research. London, 1956. (H.M. Stationery Office.)
- (³) Research Note No. RN/2803. Recommendations for the construction of the Maiduguri-Bama Road in Nigeria, B.W. Africa. (Unpublished.)

Road Research Laboratory,
July, 1956.

Colonial Social Science Research Council Twelfth Annual Report (1955-1956)

London School of Economics and Political Science,
Houghton Street,
Aldwych,
London, W.C.2.
6th December, 1956.

SIR,

I have the honour, on behalf of the Colonial Social Science Research Council, to transmit to you the Twelfth Report of the Council covering the period from 1st April, 1955, to 31st March, 1956.

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

TWELFTH ANNUAL REPORT

Membership

- PROFESSOR SIR ARNOLD PLANT, B.Sc.(Econ.), B.Com., Sir Ernest Cassel Professor of Commerce, University of London.
- MR. L. FARRER-BROWN, J.P., Director, The Nuffield Foundation.
- PROFESSOR VINCENT HARLOW, C.M.G., M.A., D.Litt., Beit Professor of History of the British Empire, University of Oxford.
- MR. H. V. HODSON, M.A., Editor of "The Sunday Times", formerly Reforms Commissioner, Government of India.
- MR. W. B. L. MONSON, C.M.G., Assistant Under-Secretary of State, Colonial Office.
- 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.
- MR. R. W. STEEL, M.A., B.Sc., Senior Lecturer, Department of Geography, University of Oxford.
- 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.
- MRS. E. M. CHILVER (*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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- 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.
- V.—The Educational Research Institute for Fiji and Western Pacific Territories.
- VI.—The Social Research Unit, University of Malaya.

COLONIAL SOCIAL SCIENCE RESEARCH COUNCIL

ANNUAL REPORT

I. INTRODUCTION

1. The Council held four meetings during the year 1st April, 1955 to 31st March, 1956. Six meetings of Committees took place.

2. The Chairman resigned in the early part of the year owing to ill-health and was succeeded by Professor Sir Arnold Plant.

Professor Evans-Pritchard resigned from the Council in view of his prospective absence overseas on sabbatical leave, and Professor Schapera joined the Council and became Chairman of its Committee on Anthropology and Sociology.

Professor Margaret Read, C.B.E. resigned from the Council on assuming the duties of Director of the Institute of Education and Professor at University College, Ibadan.

Dr. Audrey Richards, C.B.E., accepted the Secretary of State's invitation to rejoin the Council on completing her five-year contract as Director of the East African Institute of Social Research, Makerere College.

Dr. Lucy Mair accepted the Secretary of State's invitation to join the Committee on History and Administration ; and Mr. John Beattie and Dr. Edmund Leach joined the Committee on Anthropology and Sociology.

3. Mr. R. W. Steel visited East and Central Africa in the course of the year and attended the Inter-African Conference on Social Sciences held at Bukavu in August-September, 1955, as a member of the British delegation. Professor Malcolm Guthrie, who attended the Conference at the Secretary of State's invitation, took a leading part in its linguistic sessions. Mr. G. I. Jones, Member of the Standing Committee on Anthropology and Sociology, undertook an inquiry on behalf of the Government of the Eastern Region of Nigeria on the position of Chiefs.

4. The Secretary of State nominated Dr. Audrey Richards, Professor Busia, of the University College of the Gold Coast, and the Secretary of the Council to be United Kingdom members of the C.C.T.A./C.S.A. Inter-African Committee on Social Sciences. At the end of the year Professor Daryll Forde was invited to become a member of the Scientific Council for Africa South of the Sahara (C.S.A.).

II. GENERAL

5. Issues against the allocation of £525,000 to 31st December, 1955, for social science research amounted to £108,591. The most important new grants made during the year were to Makerere College for the continuation of the East African Institute of Social Research (£82,329), to the Government of Northern Rhodesia for the central office and headquarters expenditure of the Rhodes-Livingstone Institute (£32,770), to University College, Ibadan, in support of the Department of History's Benin project (£20,000) and a further year's contribution to the maintenance of the West African Institute of Social and Economic Research (£7,483), to the Swaziland Government for a survey of land tenure and land use (£6,875), a contribution towards a study of family attitudes in Jamaica undertaken by the Conservation Foundation (£7,000), and towards its Colonial Social Science Research publications fund (£2,500).

6. Priorities were established by the Standing Committees, and the Council decided to set aside a higher proportion of its balance than formerly to encouragement of historical studies. Special attention was being given at the

end of the year to the development of comparative studies of election procedures. The British Dominions and Colonies Programme of the Carnegie Corporation of New York made a number of most generous contributions in the course of the year towards research in the Colonies : a contribution (£11,000) towards the Benin History project, further funds to Makerere College for the continuation of the E.A.I.S.R./Carnegie Leadership study, and a grant (reported on further in the C.E.R.C. Annual Report) to the Institute of Social and Economic Research, University College of the West Indies.

7. Several American scholars supported by grants from the Ford Foundation are now working in British African territories, some of them in close co-operation with regional research Institutes and University Colleges.

8. Leverhulme grants were awarded at the end of the year to Dr. Audrey Richards, for further work in Northern Rhodesia, and to Dr. Philip Dark, who completed his contract with W.A.I.S.E.R., University College Ibadan, in March, 1956.

9. UNESCO is supporting a study of feminine leadership among the Yoruba by Dr. Baker and Miss Bird of the University of Edinburgh who are working from University College Ibadan. Consideration was being given at the end of the year by W.H.O. to support of experimental demographic research in East Africa.

III. THE REGIONAL INSTITUTES OF SOCIAL AND ECONOMIC RESEARCH

10. A full account of the activities of the Institutes will be found at the end of our report.

11. The directorship of the E.A.I.S.R. was assumed early in 1956 by Dr. Lloyd Fallers, Ph.D. Chicago, who had previously returned from Princeton University to take charge of the E.A.I.S.R./Carnegie Leadership study. Dr. Fallers had previously worked at the Institute, completing a sociological study of the Basoga.

12. Dr. (now Professor) J. Clyde Mitchell relinquished the Directorship of the Rhodes-Livingstone Institute for the Chair of African Studies at the University College of Rhodesia and Nyasaland. Mr. C. M. N. White acted as Director until Mr. Henry Fosbrooke, lately Senior Sociologist Tanganyika Territory, took up his appointment.

13. Dr. H. D. Huggins visited the United States under a United States State Department programme.

14. The life of the West African Institute of Social and Economic Research was extended for one year to allow contracts to be completed, pending the appointment of a Professor of Economics and Social Studies who will direct a Nigerian Institute of Social Research and reorganize it as a University Institute along the same general lines as the East African Institute of Social Research at Makerere College. The Gold Coast Government has voted funds to continue the research previously undertaken by the Economic Research Unit and W.A.I.S.E.R. in the Gold Coast, which will continue under the auspices of the Department of Economics and Politics of the University College of the Gold Coast.

15. The Educational Research Institute at Nasinu is completing the projects it undertook and during 1957 will be integrated with the new Government Teachers Training College.

16. The Social Research Unit at the University of Malaya has completed its three field projects and will not be continued until plans for the new faculty organization at the University are further advanced.

IV. RESEARCH IN THE COLONIAL TERRITORIES FINANCED INDEPENDENTLY OF COLONIAL DEVELOPMENT AND WELFARE FUNDS

17. A comprehensive account of research projects undertaken by Universities and University Colleges in British territories in Africa South of the Sahara will be included in papers presented to the International African Conference on Social Sciences held in Bukavu under the auspices of C.C.T.A./C.S.A. which are to be published for the Commission by the Institut Royal Colonial Belge. They are not, therefore, published in this report. It is also proposed to issue under C.C.T.A./C.S.A. auspices annual registers of research in the social and economic sciences in Africa South of the Sahara.

18. In the *Federation of Malaya* the Department of Social Welfare carried out a pilot survey of beggars. 90 per cent. of the regular beggars and an estimated 50 per cent. of the occasional casuals were interviewed on their own pitches and in their own languages. Cross-checks showed that there was virtually no intentional lying. The resultant report demolished certain popular beliefs about the number of beggars, the reasons for their existence, and easy cures for this social problem. The report was a detailed but purely factual one, prepared with a view to providing the Federal and State/Settlement Governments with reliable information on which realistic and constructive policies could be framed.

19. In *Singapore* the Research Section of the Department of Social Welfare continued work on a survey of the tastes of listeners to Radio Malaya's Chinese programmes and the survey of family living conditions in Singapore. A report on the latter survey has been printed under the title "Urban Incomes and Housing". Assistance was given to the Social Research Unit of the University of Malaya, who conducted a survey of social conditions in an overcrowded section of the city. An analysis was made of the case files of approximately 14,000 people who received Public Assistance allowances in July, 1955, in order to give data required by the Social Security expert from the International Labour Office now at work in Singapore. The analysis shows the distribution of categories of recipients by ethnic groups, type of allowances and place of residence, besides other data as the average size of households by community. The information obtained will also enable the Department to assess the trend of disbursement of Public Assistance allowances between 1953 and 1955.

20. The activities of the *University of Hong Kong* in the field of the social sciences is described at length in the Colony's Annual Report. Outside the University, in the field of historical research the Instituto Portugues de Hongkong published during the year the fourth issue of its Bulletin (in English) to appear since the war. This included a study of Mr. J. M. Braga of the earliest Portuguese contacts with this part of the China coast, with particular reference to the voyage of Jorge Alvares in 1513.

21. The *Sarawak Museum*, besides undertaking extensive archaeological investigations, is continuing its investigations of the Kelabit and other upland people of the far interior, with special reference to social and economic changes under modern conditions. The collection of folklore and ancient song material from the many races who are rapidly losing this part of their culture is also proceeding.

22. In *Northern Rhodesia* the Rhodes-Livingstone Museum, apart from its continuing work in the prehistoric archaeology of Northern Rhodesia and the adjacent territories, has undertaken research in the material culture of the Northern Rhodesia tribal peoples and those of the neighbouring Bantu and Bushman groups. Anthropological activity is centred around the collection and classification of the material culture of the indigenous peoples of the

territory, both for purposes of museum display and the building up of study collections. The Museum is also undertaking research into the structure of rhythm and melody in African music.

23. The research work being undertaken by members of the *Cyprus Department of Education* is as follows :—

Mr. A. Kouros : Assistant Inspector of Elementary Schools.

Mr. Kouros has now completed his work on intelligence tests for Greek children leaving elementary school and is due to present his work as a thesis for the M.A. of London University in May, 1956. Mr. Kouros will be able to do further research using these tests. Such research might include the incidence of mental deficiency and ineducability, the selection of candidates for secondary schools, and the diagnosis of special defects.

Mr. F. S. Maratheftis : Master.

Mr. Maratheftis is continuing his work on the historical and geographical factors which have affected the development of Nicosia from earliest times.

Dr. D. Christodoulou : Master.

Dr. Christodoulou obtained a Ph.D. degree of London University with a thesis on "The Evolution of the Rural Land Use Pattern in Cyprus."

He is now working in Cyprus on a comprehensive inventory and scientific analysis and mapping of the physical and human resources of Cyprus.

24. The post created by the *Kenya Government* of Government Sociologist has been filled by Mr. Gordon McL. Wilson who had undertaken two ethnographic studies, one in Tanganyika and one in Kenya, under the auspices of this Council.

V. COLONIAL DEVELOPMENT AND WELFARE PROJECTS IN PROGRESS

Projects undertaken by the International African Institute

Handbook of African Languages

25. Two volumes of the four volume survey have already been published : *La Langue Berbère*, by Andre Basset, *Languages of West Africa*, by D. Westermann and M. A. Bryan. A third volume—*The Non-Bantu Languages of North-east Africa*, is now in the press and will be published during October ; the fourth volume—*Bantu Languages of Africa*—will shortly be ready for printing. In addition to a number of preliminary publications (Bantu : *Modern Grammatical, Phonetical and Lexicographical Studies*, by Clement Doke, *Distribution of the Nilotic and Nilo-Hamitic Languages of Africa*, by M. A. Bryan, *Notes on the Distribution of the Semitic and Cushitic Languages of Africa*, by M. A. Bryan, *Classification of Bantu Languages*, by M. Guthrie) the following special studies have also been published : *The Bantu Languages of Western Equatorial Africa*, by Malcolm Guthrie (1953), *The Southern Bantu Languages*, by Clement Doke (1954).

Linguistic Survey of the Northern Bantu Borderland

26. This project in which the Governments of Belgium and France, the Government of Nigeria and of the Anglo-Egyptian Sudan, O.R.S.T.O.M., I.F.A.N. and I.R.S.A.C. also collaborated, was carried out by four linguists who made an extensive field survey under the direction of Professors Malcolm Guthrie and A. N. Tucker. The field material collected in the course of this survey was abundant and of great interest, but in view of its quantity it was decided to publish it in four volumes. The first of these, including an account of the Survey, a classification of the languages studied, together with demographic material and maps, has now been published, the cost of publication being

defrayed from the Handbook grant. Volume II and Volume IV—which contain detailed linguistic analyses of the languages briefly described in Volume I—are now in the press, the cost of publication being borne by the International African Institute; Volume III, which is to be published at the expense of the Belgian Government, will go to press shortly.

Ethnographic Survey of Africa

27. Since the inception of this scheme, 28 volumes have been published, as well as three volumes published in France, two in Belgium, and two for the publication of which the I.A.I. has undertaken financial responsibility. Two volumes concerned with peoples of Nigeria and one on Ethiopia are now in the press; two others covering East African territories are in preparation. These volumes have been well received and seem to have met the need for brief, systematic accounts of the peoples of Africa based on the most recent information. An indication of their usefulness is the fact that approximately £5,250 had been received from sales up to June 30th, 1956, in respect of the volumes financed from the C.D. and W. grant; two volumes are now out of print.

Other African Projects

Preparation for publication of Lord Lugard's Diaries

28. The preparatory work supported by a grant from C.D. and W. funds has been undertaken by a research assistant working under Miss Perham's supervision and Miss Perham is now preparing the Diaries for publication.

Survey of Material on Labour Productivity in Africa

29. Miss McCulloch has completed her bibliographical survey of available material on labour productivity in British African territories. This has been rendered to C.C.T.A. and its findings incorporated by the Director of the Inter-African Labour Institute in a report, covering all African territories South of the Sahara, made to the member governments of C.C.T.A. Publication of this is under consideration. Miss McCulloch's bibliography can be consulted in the Colonial Office Library.

Land Tenure in British Africa

30. The first volume of Dr. Meek's survey relating to Nigeria and the Cameroons under British Trusteeship is now printing. A contribution towards the cost of publication has been made by the Federal and Regional Governments of Nigeria.

Study of Local Government Training in West Africa

31. Professor R. E. Wraith, now at Makerere College, has presented his report to the Secretary of State and to West African Governments.

Preparation of Ga-Adangme Dictionary

32. Dr. Berry is still working on the project.

Socio-Economic Study of Oshogbo, Nigeria

33. Dr. Schwab's report on the social organization of Oshogbo has been completed and is being read.

Field Study of the Nomadic Fulani, Northern Nigeria

34. Sections of Dr. Stenning's report to the Northern Nigeria Regional Government have been forwarded to it for information and comment.

Cameroons Development Corporation Labour Force

35. Mr. Malcolm Ruel's report on *Banyang Labour Migration* has been presented to the Council and forwarded to the Cameroons Development Corporation and the Commissioner of the Cameroons.

**Study of the Mbembe People*

36. A field grant was awarded to Miss Rosemary Harris, M.A., in association with the Edward Elmslie Horniman Trust Fund of the Royal Anthropological Institute, to enable her to make a two years' study of the social organization of the Mbembe, one of the Cross River peoples of Southern Nigeria, and write up the results at University College, London.

Study of the State of Gonja

37. Arrangements were being made at the end of the year for Dr. J. R. Goody's visit to the Gold Coast.

Sociological Research, Gambia

38. Mr. Gamble's survey of the Kombo Region is proceeding satisfactorily. In addition to his survey work Mr. Gamble has been preparing a series of files to be handed over to the Government on the completion of his work. Material has also been collected for the International African Institute's ethnographic survey volume on the Wolof and contacts and exchanges of information have been maintained with Dr. Ames of the University of Wisconsin, I.F.A.N. at Dakar and with Missions on linguistic and ethnographic topics.

Study of Indo-Mauritian Social Structure

39. Dr. Benedict's field studies are proceeding satisfactorily and a detailed progress report from him has been presented to the Council. After an intensive survey of villages in the Northern district of the island Dr. Benedict took up residence in one at the end of October, 1955, where he has since been working.

Study of the Somali

40. Mr. I. M. Lewis arrived in Somaliland in October and is studying the social organization of the Somali tribes.

Study of the Kikuyu Family, Kenya

41. Dr. Jeanne Fisher is finally revising her reports to the Kenya Government for duplication. They will be available in the Colonial Office Library for reference.

Study of the Teita, Kenya

42. Mrs. Harris' report, *The Ritual System of the Wataita*, was successfully presented as a Ph.D. thesis at Cambridge and publication is under consideration. A joint report on modern conditions in the Teita district has been presented to the Kenya Government and forms part of contributions from various sources to the Twentieth Century Fund's Survey of Tropical Africa directed by Dr. Kimble.

Anthropological Study of the Kiga, Uganda

43. Dr. Baxter was about to leave the field at the end of the year after spending a short period at the East African Institute of Social Research on a preliminary analysis of his material.

**Survey of Land Tenure and Land Usage in Swaziland*

44. As a result of recommendations made by Professor Mitchell to the Swaziland Government the Council has recommended that a 100 per cent. C.D. and W. grant should be made to enable the Swaziland Government to recruit a sociologist and ancillary staff. The Swaziland Government has not yet been successful in recruiting staff for this survey.

**History of Basutoland*

45. A grant was made at the end of the year to Mr. J. N. Mohapeloa of the Basutoland Education Department to visit archives in South Africa, in connection with the history of Basutoland which he is engaged in writing.

* Projects started in the year under review.

South-East Asia and Pacific*Anthropological Studies in Sarawak*

46. The Dr. J. D. Freeman study of *Iban Agriculture* was published near the close of the year as Colonial Research Study No. 18. This completes the publication of the investigations made as a result of Dr. Edmund Leach's recommendations to the C.S.S.R.C. *The Socio-Economic Survey of the Malay Community* directed by Mr. Tom Harrison, Curator of the Sarawak Museum, will be completed shortly and a report is expected in the coming year.

Social Research in Singapore

47. Mr. Maurice Freedman's study of Chinese family organization is just about to be issued in the Colonial Research Studies series.

Caribbean*Social Survey of Rural Areas of Jamaica*

48. Miss Edith Clarke's completed manuscript was being considered for publication at the end of the year.

Social Mobility in Jamaica

49. Dr. S. Collins presented a report on his field work to the Council and has completed papers for publication in learned journals on his research.

Amerindian Studies in British Guiana

50. Dr. Audrey Butt successfully presented a thesis based on her field work in British Guiana for a D.Phil. at Oxford University. She has now taken up an appointment at the Pitt Rivers Museum and will not be returning to British Guiana for the time being.

Crown Colony Government in Jamaica

51. Dr. Fitzroy Augier has now transferred from the Institute of Social and Economic Research to the Department of History at the University College of the West Indies where he will complete his manuscript.

**Study of the Working Class Movement in the British West Indies*

52. The Council awarded a field grant to Mr. Francis X. Mark to enable him to consult materials in Trinidad and Jamaica on the growth and organization of the Working Class Movement. At the end of the year he visited the Institute of Social and Economic Research for consultations, and arrangements were under way for a brief visit to British Guiana to enable him to make contact with local labour leaders who had played an important part in the growth of the Movement.

* Projects started in the year under review.

VI. THE STANDING COMMITTEES OF THE COUNCIL

53. 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.
- K. E. Robinson, Esq.,
University of Oxford.

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".
- Miss Lucy Mair,
University of London.
- F. J. Pedler, Esq.,
United Africa Company.
- Miss Margery Perham, C.B.E.,
University of Oxford.
- Professor C. H. Philips,
University of London.
- K. E. Robinson, Esq.,
University of Oxford.
- R. E. Robinson,
University of Cambridge.
- Sir Douglas Veale,
The Registrar,
University of Oxford.

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

- V. Harris, Esq.,
Research Department, Colonial Office.

VII. PUBLICATIONS BY WORKERS ASSISTED FROM COLONIAL DEVELOPMENT AND WELFARE FUNDS

54. 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 11th Annual Report) are :—

- Andrzejewski, B. W., *The Problem of Vowel Representation in the Isaaq Dialect of Somali*, Bulletin of S.O.A.S., Vol. XVII/3, 1955.
Accentual Patterns in Verbal Forms in the Isaaq Dialect of Somali, Bulletin of S.O.A.S., Vol. XVIII/1, 1956.
- Armstrong, R. G., *The Lineage Concept in African Sociology*, paper read at meeting of Central States Anthropological Society, May, 1955.
State Formation in Negro Africa, paper read at meeting of American Anthropological Society, Boston, Nov. 1955.
Peoples of the Niger-Benue Confluence (Sections : The Igala and The Idoma and Neighbouring Peoples), Ethnographic Survey of Africa, I.A.I. London, Feb, 1956.
- Bohannan, Paul, *A Tiv Religious and Political Idea*, "South-western Journal of Anthropology", Summer 1955.
Some Aspects of Investment among the Tiv, "American Anthropology", Jan, 1955.
- Brown, Paula, *Peoples of the Niger-Benue Confluence (Section : The Igbara)*, Ethnographic Survey of Africa, I.A.I. London, Feb, 1956.
- Butt, A. J., *Ritual Blowing among the Akawaio*, "Man", Vol. LVI, 48.
- Collins, S. F., *Social Mobility in Jamaica with reference Rural Communities and the Primary School Teacher*, Transactions of 3rd World Congress of Sociology, Vol. III, 1956.
- Cunnison, Ian, *Headmanship and the Ritual of Luapula Villages*, "Africa", Vol. XXVI, 1, Jan, 1956.
- Dike, K. O., *Trade and Politics in the Niger Delta 1830-1885*, O.U.P., 1955.
- Elliott, A. J. A., *Chinese Spirit-Medium Cults in Singapore*, Monograph No. 14 on Social Anthropology, L.S.E., Dec, 1955.
- Fallers, L. A., *The Politics of Land-holding in Busoga*, "Economic Development and Cultural Change", Vol. III, 3, 1955.
- Forde, Daryll, *Peoples of the Niger-Benue Confluence (Section : The Nupe)*, Ethnographic Survey of Africa, I.A.I. London, Feb, 1956.
- Freedman, Maurice, *The Plural Society of Malaya*, "The Times British Colonies Review", Summer 1955.
- Freeman, J. D., *Report on the Iban of Sarawak*, Sarawak Government Printing Office, 1955.
Iban Agriculture, Colonial Research Studies No. 18, H.M.S.O., London, 1955.
- Gann, L. H., *The Northern Rhodesian in the Copper Industry and the World of Copper 1923-1952*, "Human Problems in British Central Africa", Vol. 17, 1955.
- Gluckman, M., *The Judicial Process among the Barotse of Northern Rhodesia*, Manchester University Press, 1955.
Custom and Conflict in Central Africa, Blackwells, 1956.
Anthropology in Central Africa, Journal of the Royal Society of Arts, 1955.

- The Reasonable Man in Barotse Law*, Journal of African Administration 1955–1956.
- Bemba Succession and Civil Wars*, "Human Problems in British Central Africa", No. 20, 1956.
- Gutkind, P. C. W., *Town Life in Buganda*, "Uganda Journal", March, 1956.
- Mulago Village Survey*, "Uganda Argus", April, 1955.
- Gulliver, P. H., *The Age-Set Organisation of the Jie Tribe*, Journal of the R.A.I., 1956.
- Hughes, A. J. B., *Kin Caste and Nation among the Rhodesian Ndebele*, Rhodes-Livingstone Institute, paper No. 25, 1956.
- Uzimu: some preliminary notes on Vengeance among the Rhodesian Ndebele*, "Human Problems in British Central Africa", Vol. 19, 1955.
- Lloyd, P. C., *The Development of Political Parties in Western Nigeria*, "American Political Science Review", Vol. XLIX, No. 3, 1955.
- The Yoruba Lineage*, "Africa", Vol. XXV, 1955.
- Yoruba Myths: a Sociologist's Interpretation*, "Odu", No. 2, 1955.
- Middleton, J. F. M., *The Concept of "bewitching" in Lugbara*, "Africa", Vol. XXV, No. 3, July, 1955.
- Myth, history and mourning taboos in Lugbara*, "Uganda Journal" Kampala, Vol. 19, No. 2, September, 1955.
- The roles of chiefs and headmen in Lugbara*, Journal of African Administration, London, Vol. VIII, 1, Jan, 1956.
- Prins, A. H. J., *Ateita Bow and Arrows*, (ills.), "Man", Vol. LV, 42, 1955.
- The Geographical Distribution of the N.E. Bantu Population*, with 2 maps, Journal Royal Netherlands Geographical Society, LXXII, 1955.
- Shungwaya, die Urheimat der Nordost Bantu, Eine Stammes—Geschientliebe Untersuchung*, "Anthropos", Vol. 50, 1955.
- Ruel, M. J., *Banyang Secret Societies*, "Man", 4, Jan, 1956.
- Schwab, W. B., *Kinship and Lineage among the Yoruba*, "Africa", Vol. XXV, 4.
- Smith, M. G., *The Economy of Hausa Communities of Zaria Province*, Colonial Research Publications, No. 16, H.M.S.O. London, May, 1955.
- A framework for Caribbean Studies*, Extra-Mural Dept. U.C.W.I., Jamaica, June, 1955.
- On Segmentary Lineage Systems*, "Man", Vol. LV, Jan, 1956.
- Sofer, C. and R., *Jinja Transformed: a Social Survey of a Multi-racial Township*, East African Studies, No. 4, E.A.I.S.R., 1955
- Turner, V. W., *A Lunda Love Story and its Consequences*, Selected Texts from Traditions Collected by Henrique Dias de Carvalho at the Court of Mwatianvwa in 1887; tr. and annotated, "Human Problems in British Central Africa", Vol. 19, 1955.
- Wachsmann, K. P., *Harpsons from Uganda*, Journal International Folk Music Council, 1956.
- Folk Musicians in Uganda*, Uganda Museum Occasional Paper, No. 2, 1956.
- Winter, E. H., *Bwamba: a Structural—Functional Analysis of a Patrilineal Society*, Heffers, 1956.
- Bwamba Economy*, East African Studies, No. 5, E.A.I.S.R., 1956.

EAST AFRICAN INSTITUTE OF SOCIAL RESEARCH

DIRECTOR'S REPORT, 1955-1956

1. *Publications.*(a) *Published.*

Bwamba : A Structural-Functional Analysis of a Patrilineal Society, by E. H. Winter. Heffers, 1956.

The Trade of Lake Victoria, by V. C. R. Ford. East African Studies, No. 3.

Jinja Transformed, by C. and R. Sofer. East African Studies, No. 4.

Bwamba Economy : the Development of a Primitive Subsistence Economy in Uganda, by E. H. Winter. East African Studies, No. 5.

Labour Migration in a Rural Economy : a Study of the Ngoni and Menduli of Southern Tanganyika, by P. H. Gulliver. East African Studies, No. 6.

(b) *In the Press.*

Alur Society : a Study of Processes and Types of Domination, by A. W. Southall.

Bantu Bureaucracy : a Study of Conflict and Change in the Political Institutions of an East African People, by L. A. Fallers.

An African Labour Force—two case studies in East African Factory Employment, by W. Elkan. East African Studies, No. 7.

(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.

Kampala : an Account of an Urban Community, by P. C. W. Gutkind and A. W. Southall. East African Study.

African Co-operation : a Study of African Co-operative Activity in the Nyanza Province, by H. Fearn. East African Study.

2. *Staff.* Much to the regret of all members of the Institute, Dr. A. I. Richards, C.B.E., who has directed the Institute's work since 1950, retired at the end of 1955. Her services to the development of the social sciences in East Africa were recognized in the many tributes paid to her by colleagues at the Institute and Makerere College and by her many friends. Dr. Richards was succeeded as Director by Dr. L. A. Fallers.

During the year, many members of the staff finished their field studies and went on leave to write up their material, leaving only a small staff in residence pending the arrival of new recruits later in 1956. Drs. P. J. and Laura Bohannan (anthropologists), Drs. L. and M. Ainsworth (psychologists), Mr. Hugh Fearn (economist), and Mr. Martin Southwold (anthropologist), all of whom were engaged on the study of leadership in Buganda and in Nyanza Province of Kenya, completed their work and went on leave, as also did Mr. J. H. M. Beattie and Miss J. La Fontaine (anthropologists), Mr. P. C. W. Gutkind (sociologist, Kampala survey) and Mr. Walter Elkan (economist). Mrs. F. Erhlich resigned from the administrative staff.

The staff at the 1st April, 1956 was as follows :

Director	..	..	..	Dr. L. A. Fallers.
Anthropologists	..	..		Dr. A. W. Southall.
				Dr. L. Bohannan (on leave).
				Miss J. La Fontaine (on leave).
				Mr. Martin Southwold (on leave).

Sociologist .. ..	..	Mr. P. C. W. Gutkind (on leave).
Economists and	}	Mr. H. Fearn (on leave).
Economic Historians ..		Mr. Walter Elkan (on leave).
Linguist .. ..	..	Dr. W. H. Whiteley.
Administrative Staff ..	..	Miss G. B. Hunter.
		Miss B. Berrange (on leave).

3. *Associated Research Workers.* Mr. Walter Sangree, a Fulbright scholar, is carrying out a study of the Tiriki of North Nyanza District, Kenya, in close co-operation with the Leadership Project. Dr. P. T. W. Baxter, a C.S.S.R.C. Fellow, has finished his study of the Bakiga and had begun writing up. Miss Paula Hirsch, a Ford Foundation Fellow, is completing her study of the position of women among the Acholi. Dr. David Apter of Northwestern University, another Ford Foundation Fellow, is engaged in a study of relations between the Uganda and Buganda Governments. Professor L. Doob of Yale University completed the study of acculturation in Buganda and North Nyanza in which he was engaged under a Carnegie Corporation grant. Mr. Robert LeVine, also a Ford Foundation Fellow, arrived in November to begin a study of child-rearing among the Kisii of South Nyanza District, Kenya. Mr. and Mrs. Neville Dyson-Hudson arrived in December to begin a joint anthropological-ecological study of Karamoja District, Uganda, under the auspices of the Fulbright Program and the Wenner-Gren Foundation.

4. *Work in Progress. The Leadership Project.* Field research for the comparative study of leadership in Buganda and in Nyanza Province of Kenya has in the main been completed and the writing-up phase has begun. It is planned that the results of the project, which has been financed by the Carnegie Corporation of New York, will be published in two symposium volumes and in a number of more specialized collateral monographs. Following is a provisional outline for the two symposium volumes:—

Volume I. Buganda.

- I. Introduction : Aims and Scope of the Project.
- II. A Century of Ganda-European Relations.
- III. The Traditional Ganda Political System and its Recent Evolution.
- IV. Leadership in the Ganda Village.
- V. Kinship and Authority in Buganda.
- VI. The Ganda Trader.
- VII. The Ganda Farmer.
- VIII. Social Mobility in Buganda.
- IX. Authority in the Ganda Value System.
- X. Authority in the Ganda Personality.

Volume II. Nyanza.

- I. Introduction : Aims and Scope of the Project.
- II. Leadership and Authority Old and New : Wanga.
- III. Leadership and Authority Old and New : Tiriki.
- IV. Leadership and Authority Old and New : Luo.
- V. The Economy of Nyanza.
- VI. Local Government in Nyanza : the Inter-Tribal Political System.
- VII. Authority in Luo and Luhya Personality.

The comparative analysis and the more detailed monographs by individual members of the project staff will require separate volumes. The possibility of publishing popular summaries of the findings of the project, either in English or in the vernaculars or both, is under consideration. A Luganda summary of the results of an earlier joint project—the study of immigrant labour in Buganda—has been prepared and will soon be published. On the basis of this experience, it should prove possible to determine to what degree there is a market for such popular accounts of the results of Institute research.

The Kampala Survey. The social survey of the Kampala urban area has also reached the writing-up stage. Cyclostyled reports on Mulago and Kisenyi Mengo, the two communities studied intensively, have been circulated and a volume on the results of the survey as a whole is being prepared. The following provisional table of contents has been drawn up :

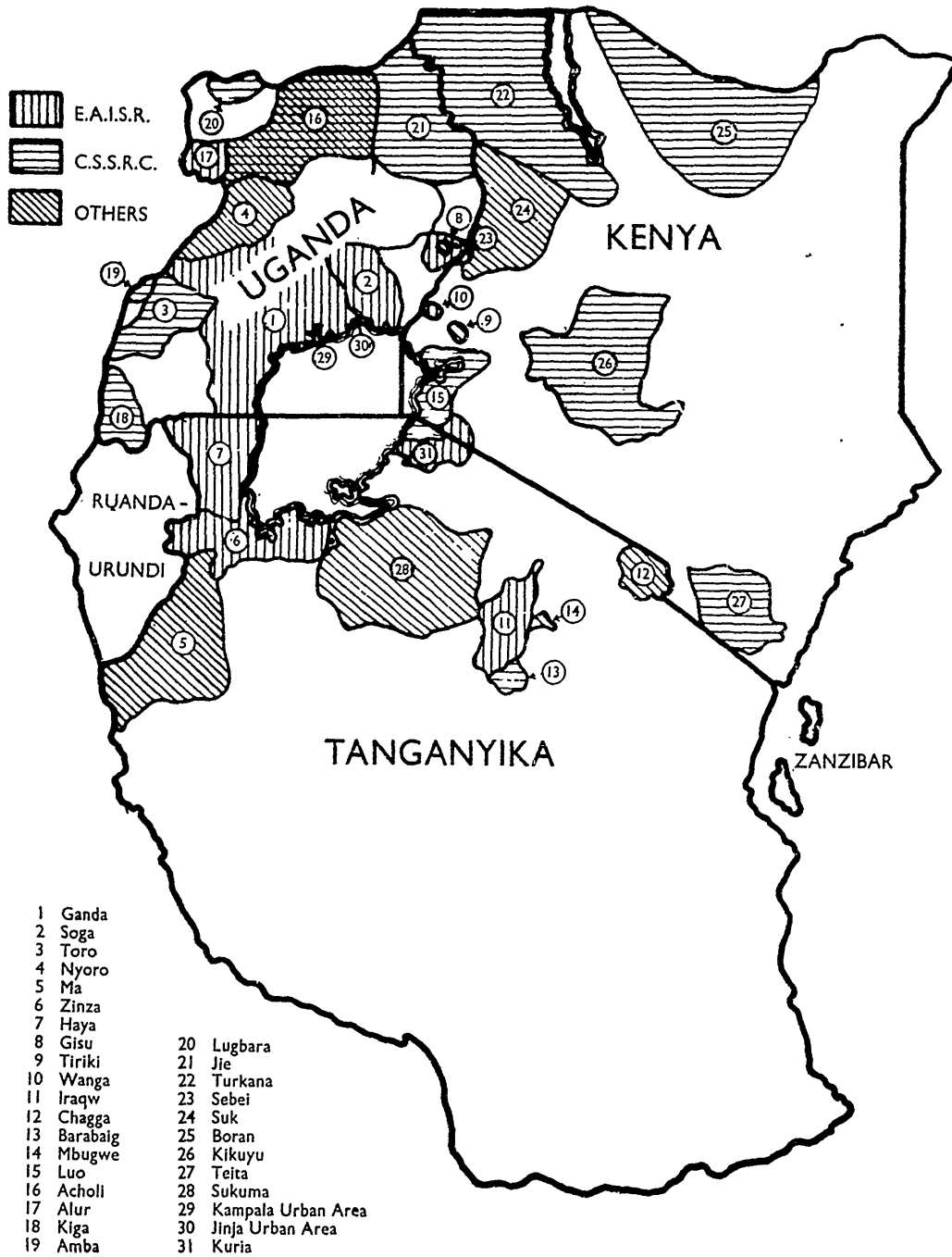
- I. The Nature of African Towns. Significance of the urban revolution—types of urban growth in Africa—towns in multi-racial communities—the contribution of tribal structure and culture.
- II. The Growth of Kampala. Early capitals of Buganda—headquarters of the early missions—the coming of Asians—trade, commerce and communications—labour immigration—a commercial capital—Township authority to Municipality.
- III. Land. Early grants—the 1900 settlement—types of land tenure—extension of the boundary—speculation, sale and rent—the urban fringe—landlord and customary tenant—land and development—planning and the land.
- IV. The People of Kampala. Ethnic groups—emergence of mixed-bloods—language, religion and area of origin as determinants of residence—economic determinants—occupation and ethnic origin—education and ethnic origin—differences in family patterns, length of residence and use of leisure.
- V. Economic Structure. Main types of enterprise—associations, pressure groups, unions and their relationship to ethnic groups—beginnings of African commerce—the state in commerce and industry—channels of supply and distribution.
- VI. Labour. The composition of the labour force—place of work and place of residence—career patterns—cheap labour and labour shortage—wage labour and economic development.
- VII. Municipal Government. Municipal Council membership, powers and activities—participation of economic, ethnic and status groups—planning functions and their effectiveness—difficulties of interwoven authorities.
- VIII. African Urban Government. The Buganda governmental system in an urban setting—political, economic and social roles of Ganda elite—non-Ganda African elite—non-Africans outside the Municipality.
- IX. The Urban Community. Greater Kampala as an arena for interplay of political forces during a crucial transition period.

Six Years' Work. Since the past year has in the main been devoted to the completion of projects fully described in previous reports and since the Institute is entering a new financial and research planning period, it seems appropriate to devote a portion of this report to a brief review of the past six years' work and to a forecast of future plans and needs¹. The accompanying map shows the geographical distribution of research carried out by fellows and associates of the Institute during the years 1950-55. The first and most obvious point to be made is that research has to a marked degree been concentrated in the Lake Victoria area. Although there has been work in all three of the mainland territories, Uganda has had the lion's share. In part this areal concentration has been deliberate. One of the Institute's consistent aims in the social anthropological field has been systematic comparative analysis and this can best be carried out initially, at any rate, in societies closely related to one another. Thus fellows and associates have concentrated upon producing broadly parallel studies of the Inter-Lacustrine Bantu peoples and upon filling the gaps in the comparative literature concerning the Nilotic and Nilo-Hamitic peoples. Areal concentration has also simplified collaboration and mutual stimulation between anthropologists and other social scientists, who often work on an areal basis, and who are aided by having anthropological data as background.

Concentration upon the Lake Victoria area has, however, left very serious gaps which must be filled in the near future if the Institute's claim to an "East African" outlook is to be vindicated. Perhaps most serious of all is the lack of research in the Coastal area. The Arab-African culture of the coast is of great interest both as a local variant

¹ A fuller report on the Institute's first six years is being prepared for publication.

Research by E.A.I.S.R. Associates and Fellows 1950-1955



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of Islamic culture and as a centre for the diffusion of external influences in the East African hinterland. It is hoped that fruitful co-operation may be established between the Institute and the proposed School of Archaeology and History at Bagamoyo so that the study of ancient and contemporary coastal cultures may go hand in hand. Other large areas, including much of central and southern Tanganyika, remain virtually untouched and must receive attention in the near future.

A second point illustrated by the map is the large number of non-Institute social scientists who have in one way or another been associated with the Institute. The provision of a centre to which such persons might attach themselves has, indeed, been a major Institute function and it has worked to the advantage of both sides. With the increase in numbers of social scientists working in East Africa, however, it has seemed desirable to formalize such arrangements. A procedure for formal affiliation, including a fee to help cover overhead costs on services provided by the Institute, has been put into operation.

A final lesson drawn from the past six years' work may be mentioned. Although not primarily an organization for "applied" research, the Institute has always had as one of its aims the provision of practically useful information. Combining "academic" and "practical" inquiry is not, in the Institute's experience, difficult; by far the greatest difficulty in this regard is that of publication. The ordinary means of publication are often painfully slow, with the consequence that research results do not become widely available soon enough to be of maximum use. An effort is therefore being made to produce and circulate cyclostyled reports on those aspects of the research which are of immediate practical interest. This both increases the practical utility of research and at the same time removes the pressure for immediate practical relevance from publications of a more academic nature.

5. *Conferences.* As in past years, conferences were held in May and in January. The May conference was a "working seminar" for fellows and associates only and was attended by Mr. Beattie (acting for Dr. Richards, who was on leave), Drs. P. J. and I. Bohannan, Mr. Elkan, Dr. Fallers, Mr. Gutkind, Miss Hirsch, Miss La Fontaine, Mr. and Mrs. Sangree, Dr. Southall, Mr. Southwold and Dr. Whiteley. The January conference was of a more formal and more public nature and a number of guest were invited. It was attended by Dr. Richards, Dr. L. Bohannan, Dr. Apter, Dr. Fallers, Dr. and Mrs. R. Gray, Miss Hirsch, Mr. and Mrs. Sangree, Dr. Southall and Dr. Whiteley, as well as by Messrs. Goldthorpe, Welbourn, Ehrlich and Kennedy of Makerere College and by Messrs. Gill, Coutts, Oram, Lawrance and Bell of the Uganda Government.

6. *Exhibition.* In December, an exhibition of Institute research and publications was held and was attended by H. E. The Governor of Uganda and by many members of the public. The exhibition itself and the publicity which it received in the local press resulted in a substantial increase in public understanding of the Institute's work.

7. *Director's Visits.* In August and September Dr. Richards attended the First Inter-African Conference on the Social Sciences at Bukavu and the meeting of the C.S.A. Council at Luanda. In March, Dr. Fallers visited Dar es Salaam, Zanzibar and Nairobi for discussions with members of the three governments concerning research to be undertaken by the Institute in future.

8. *Visitors.*

C. J. Hackett, W.H.O., Geneva.
 Hugh Tracey, African Music Society, Johannesburg.
 Dr. J. J. Maquet, I.R.S.A.C., Astrida.
 Robert de Wilde, I.R.S.A.C., Astrida.
 Mr. and Mrs. Carl Murchison, Provincetown, Mass., U.S.A.
 Mr. and Mrs. Winnington-Ingram, Blantyre, Nyasaland.
 Desmond Heap, City of London, London.
 The Very Revd. W. Koenraallt, Breda, Holland.
 Dr. G. Zeegers, The Hague, Holland.
 Dr. Holmberg, Bukoba Swedish Mission, T.T.
 Mr. and Mrs. R. West, Yale University.
 Dr. F. F. Richter, German Consulate, Nairobi.
 Dr. Geissenmaerer, Bonn, Germany.

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Mr. M. W. Tohle, M.P., Dusseldorf, Germany.
 Professor R. Tress, University of Bristol.
 Dr. Faje, Achimota, Gold Coast.
 Dr. Williams, Achimota, Gold Coast.
 Vernon McKay, State Department, U.S.A.
 Simon Beisheuvel, National Institute of Personnel Research, Johannesburg.
 Dr. Odendael, Pretoria.
 Dr. Idenburg, Leiden, Holland.
 Professor M. Herskovits, Northwestern University, Evanston, U.S.A.
 Mrs. Prudence Smith, B.B.C., London.
 Dr. R. W. Steel, Jesus College, Oxford.
 Charles L. Touset, Institut Francais d'Afrique Noire, Dakar.
 Professor Bengt Sundkler, Uppsala, Sweden.
 Mrs. R. Fane, Capricorn Society, Gilgil, Kenya.
 Professor S. L. Washburn, University of Chicago.
 Dr. S. W. Wallbank, University of Southern California.
 Professor D. C. Rife, Ohio State University.
 Miss Margaret Bates, Oxford University.
 Dr. H. Tegnaeus, Uppsala, Sweden.
 Messrs. Belshaw, Stula, Ajore, Leet, Elvin, U.N. Mission on Community Development.
 M. P. M. Henry, C.C.T.A.
 Dr. Suliyanti, U.N. Mission on Community Development, Indonesia.
 Mr. J. H. Mower, U.S. Consulate, Nairobi.
 Mr. F. Hammond, U.S.I.A. Washington.
 Miss Ann Larimore, University of Chicago.
 Mr. Fishman, Baptist Mission, India.
 Mr. and Mrs. Arthur Biggs, Geographic Attaché, American Embassy, Cairo.
 Professor Clyde Mitchell, University College of Rhodesia and Nyasaland, Salisbury.
 Mr. John Leslie, Secretariat, Dar es Salaam.
 Dr. P. H. Gulliver, Arusha, Tanganyika.
 Dr. de Schlippe, Agriculturist, Belgian Congo.
 Mr. P. Evans-Jones, Natural Resources Officer, Karamoja, Uganda.
 Mr. R. Sangster, Forestry Officer, Morogoro, Tanganyika.

9. *Finance.* A grant of £82,000 from the Colonial Development and Welfare Fund has been received for the four-year period beginning on April 1st, 1956. The Carnegie Corporation of New York, upon application by the Institute, have provided an additional 25,000 dollars for the completion of the Leadership Project. The East African Tobacco Company have donated 100 guineas to the general funds of the Institute.

APPENDIX II

WEST AFRICAN INSTITUTE OF SOCIAL AND ECONOMIC RESEARCH UNIVERSITY COLLEGE, IBADAN, NIGERIA

ANNUAL REPORT, 1955-6

This report is on the last full year of the Institute's active life. It is now being wound up, to be replaced in the Gold Coast by the recently formed Economic Research Unit headed by Professor J. W. Williams (Professor of Economics in the University College of the Gold Coast); and plans are being made for an organisation to conduct social and economic research in Nigeria.

Organisation and Staff

The Executive Committee, whose formation as the directing body of W.A.I.S.E.R. was reported in the Annual Report for the year 1954-5, was dissolved by the Principal of the University College, Ibadan, in October, 1955, and he himself resumed the Acting Directorship. The Administrative Secretary, Dr. Dark, left Nigeria on leave on 15th September, and his contract having expired he has not returned. Since his departure his duties have been divided among the Assistant Bursar, University College, Ibadan,

the Registrar's Department, U.C.I., and Mr. Morton-Williams, a Research Fellow of W.A.I.S.E.R. No new appointments to the Institute's senior staff have been made. Mr. Ardener's Research Fellowship in Anthropology, however, has been extended for a year to enable him to make a study of marriage in part of the Southern Cameroons.

During the year the Senior Establishment of the Institute was :—

Executive Committee (dissolved October, 1955)—

Professor O. A. Ajose (Preventive and Social Medicine, U.C.I.).

Professor B. J. Garnier (Geography, U.C.I.).

Dr. K. O. Dike (History, U.C.I.).

Acting Director (from October, 1955)—

Dr. J. T. Saunders, Principal, U.C.I.

Administrative Secretary (left Nigeria September, 1955, contract expired 11th March, 1956)—

Dr. P. J. C. Dark.

Research Fellows—

Mrs. A. I. Acquah (Sociology).

Mr. E. W. Ardener (Anthropology).

Mr. K. D. S. Baldwin (Economics—Resigned, 31st October, 1955).

Mr. E. K. Hawkins (Economics—Contract expired 30th September, 1955).

Mrs. M. E. Humphreys (Economics—Contract expired 31st July, 1955).

Mr. P. C. Lloyd (Anthropology).

Mr. P. Morton-Williams (Anthropology).

Mr. R. M. Prothero (Geography—Contract expired 30th September, 1955).

Mr. W. A. Warmington (Economics).

Recipients of Grants—

Dr. R. C. Abraham (Linguistics).

Mr. O. Arikpo (Anthropology—31st May, 1955.).

Research and Publications

(1) *Survey of the plantation labour force of the Cameroons Development Corporation.* Mr. and Mrs. Ardener completed their field study among some of the tribes in Bamenda Province of the social factors in the supply of labour to the Plantations. They returned to the United Kingdom, where Mr. Ardener and Mr. Warmington have been writing the report on the scheme. The report is nearly finished.

(2) *Social Survey of Accra.* Mrs. Acquah completes her research in Accra in July, 1956. She has already drafted the greater part of her Social Survey of Accra, which is to be published by the University of London Press Ltd.

(3) *Niger Agricultural Project Mokwa.* Mr. Baldwin completed and reported his study of economic and social aspects of the large-scale experiment in agricultural development and resettlement at Mokwa, Niger Province. The report has not yet been published.

(4) *Economics of the Motor Transport Industry.* Mr. Hawkins completed his field work, touring in the three Regions of Nigeria and amassing information on road transport, and then returned to the United Kingdom in Mid-1955. He has begun to publish his findings.

(5) *Economics of the Gold Coast Cocoa Farmer.* Mrs. Humphreys has now completed her study of Cocoa farmers and labourers in the Gold Coast, having, after her Fellowship of W.A.I.S.E.R. ended, joined the Economics Department of the University College of the Gold Coast and continued her research.

(6) *Ethnographic research in Warri.* Mr. Lloyd has been making a study of the social organisation and history of the Itsekiri people in Warri, concentrating on the political system.

(7) *Ethnographic Research in Oyo.* Mr. Morton-Williams has been working in Oyo, once the metropolis of the Yoruba empire, mainly on the traditional, political and religious systems.

(8) *Linguistic Research.* Dr. Abraham, having completed his study of the Yoruba language, is now working on Ibo. His analysis and dictionary of Yoruba will soon be published.

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(9) *Social Organisation of the Ejagham of South-Eastern Nigeria*. Mr. Arikpo's grant to enable him to write up his ethnographic study was extended to 31st May, 1955. It is hoped that his work will be published before long.

(10) *Demographic Survey of the Northern Region of Nigeria*. Mr. Prothero, who held a Research Fellowship in Geography for one year (October, 1954, to September, 1955) on secondment from the Geography Department, University College, Ibadan, completed his field work on population—land relationships in Sokoto Province. He now holds a lectureship in the University of Liverpool and is making good progress in preparing his work for publication.

(11) *The Oil-Palm Economy of the Ibibio Farmer*. Publication of Miss Anne Martin's Study of the Oil-Palm Economy of the Ibibio Farmer has been delayed by circumstances outside her and the Institute's control, but it is now being printed by the Press of the University College, Ibadan, and is due to be published in June, 1956.

(12) *Trade and Politics in the Niger Delta*. Dr. Dike's book, "Trade and Politics in the Niger Delta 1830-1885" prepared for publication while he held a Senior Research Fellowship in History at the Institute, has recently been published by the Oxford University Press.

(13) *Cinema-Audience Research in Rural Nigeria*. Mr. Morton-Williams's report on the research he made in 1951-2 on the impact of mass-education films on illiterate audiences among four Nigerian Peoples is being printed and will very soon be published by the Federal Information Service, Government of Nigeria, under the title "Cinema in Rural Nigeria".

(14) *A Cultural History of Benin*. This scheme, to be financed by the Federal Government and the Carnegie Corporation, has now been transferred to the History Department, University College, Ibadan, and will be directed by Dr. Dike.

Visitors

As in the past, the Institute has provided facilities for researchers from overseas Universities.

Dr. Tanya Baker and Miss Mary Bird, of the Department of Social Anthropology, University of Edinburgh, arrived in October, 1955, and are being housed and given Library and other facilities by the Institute, while they make a study of the social role of leading women in the changing society of Western Nigeria.

Dr. R. W. Wescott, a Ford Foundation Fellow from Boston University, has been given similar facilities since his arrival in November, 1955. Dr. Wescott, who is both linguist and anthropologist, is making a study of the Benin language.

Dr. and Mrs. Feilberg, from the University of Copenhagen, have been accommodated by the Institute since November, 1955, while carrying out research in association with the Geography Department, U.C.I.

Miss Rosemary Harris of University College, London, visited the Institute for about six weeks, in February and March, 1956, but was housed by the University College. She was on her way to make an ethnographic study of the Mbembe of the Cross River Area, South-Eastern Nigeria.

Other visitors, who made brief visits, were : Professor W. O. Brown, Department of African Studies Boston University ; Dr. Phyllis Deane, Department of Applied Economics Cambridge University ; M. A. de Cargouet, Liaison Franc-Britannique en Afrique ; Dr. Vernon McKay, School of Advanced International Studies, John Hopkins University ; Mr. J. P. Garlic, Department of Anthropology, University College, London ; Mr. B. E. B. Fagg, Nigerian Antiquities Service ; Mr. and Mrs. Robert E. Fleming, Socony-Vacuum Oil Company, Lagos, Dr. and Mrs. Roseberg, Department of Anthropology, Boston University ; Dr. R. D. Curtin, Department of History, Swathmore College, Northwestern University.

Conferences

The Fourth Annual Conference of the Institute was held at the University College of the Gold Coast from 28th March to 2nd April, 1955. Delegates attended from the United Kingdom, France, the United States, Gold Coast, Nigeria, Dakar, Ivory Coast, Dahomey and the Belgian Congo. Papers were read covering a wide range of the social sciences. A Linguistics Committee was set up to study the possibilities of making a linguistic survey of West Africa.

The Fifth Annual Conference was held in Ibadan from 15th to 20th March, 1956. Delegates attended from the United Kingdom, the United States, Gold Coast, Nigeria, Dakar, Dahomey, French Togo, and Dr. Audrey Richards, C.B.E., retiring Director of the East African Institute of Social Research, came from Uganda.

Contributors of papers were asked to relate them to the theme "Means of social and economic control", and it was found that this theme led to a valuable exchange of ideas and research experience. The Linguistics Committee submitted its report and is now disbanded. The Conference for the first time extended over a weekend, and expeditions were made: the first, on the Saturday, was to the Department of Agriculture research station at Moor Plantation; the second to the ancient city of Ile Ife, where the Museum and sites of archaeological interest were visited.

"Proceedings" of these two conferences, and of the third, held in March, 1954, are due to be issued in June, 1956.

These conferences have been found sufficiently useful for delegates to have asked for means of holding them in the future, in spite of the end of W.A.I.S.E.R., to be sought, and efforts are being made to accomplish this.

Library

The Institute's Library has continued to grow, as a collection of reference works and journals intended for the use of Research Fellows on tour. It has not been built up to be a full Library of West African Literature, as the University College Library has an outstanding collection of Africana to which Institute Fellows in residence in Ibadan can refer. The College Library has kindly continued to provide many services to the Institute.

(Sgd.) P. Morton-Williams

May, 1956

APPENDIX III

INSTITUTE OF SOCIAL AND ECONOMIC RESEARCH UNIVERSITY COLLEGE OF THE WEST INDIES

ANNUAL REPORT

April, 1955–March, 1956

STAFF

Director—H. D. Huggins

M. G. Smith.

D. T. Edwards.

L. E. Braithwaite.

R. T. Smith.

G. E. Cumper.

ECONOMIC STUDIES

Employment Survey, Barbados—G. E. Cumper. A sample survey of employment in Barbados was begun in February, 1955, and the field work completed in December, 1955. A report, giving estimates of current employment and unemployment based on preliminary tabulations, a survey of current labour problems and recommendations for action was submitted to the Government of Barbados in February, 1956.

Employment Practices in Barbados and Jamaica—G. E. Cumper. A detailed analysis of the material gathered by the Barbados employment survey has been begun, and this, with historical material on the Barbadian economy accumulated during 1955, will be incorporated in a larger work on labour practices in Jamaica and Barbados, with special reference to the sugar industry.

Small scale agricultural production in Jamaica—D. T. Edwards (with Dr. John R. Raeburn, Consultant). This study of the economics of agricultural production and resource use on small farms in Jamaica pays particular attention to the possibilities of change. The field work has been completed for the farms in the nine areas under study. (It has proved possible for almost all the farm people to be examined medically and arrangements have been made for records of their diets to be analysed nutritionally.) Analysis of the data is well advanced; draft reports on various aspects are anticipated in the latter part of 1956.

Economic Growth—*H. D. Huggins and E. R. Chang.* In the first part of the research project examination was made of the investment stream and of its hypothetical composition. Assumptions were made in regard to level of national income, rate of growth of income and the order of investment required. Contributions to the stream were assumed to come from domestic savings (including depreciation accumulations which made allowance for replacement) and the residual was taken to be derived from borrowings from abroad. Simple models were constructed to illustrate some of the interactions of these factors.

In the second phase an empirical study is being made of the investment practices of a number of firms and an attempt made to analyse the sources of capital accumulations in these enterprises. This involves a study of balance sheets, of a recent five year period, during which economic conditions have been reasonably stable and during which, aggregative estimates indicate, investment has been taking place actively. While, because of problems of double counting, the project cannot be regarded as a capital formation study but rather as an examination of capital appreciation within the firm, it is hoped that this second phase will throw light on some of the assumptions of the earlier investigation.

Agricultural credit by Small Farmers—*C. S. McMorris* (in association with D. T. Edwards.) The purpose of this work is to describe the use of credit by small farmers, their knowledge of, and attitudes to the available credit institutions in relation to use by small farmers. The field work, analysis and drafting of the report are in the final stages.

SOCIOLOGICAL STUDIES

Trinidad Studies—*L. E. Braithwaite.* The studies relating to Trinidad were circulated for comment.

Education of West Indians Abroad—*L. E. Braithwaite.* A monograph was prepared as a result of a study which sought to place the problem of the education of the West Indians in Great Britain as part of the general process of the education of the elite of undeveloped areas in metropolitan countries. The traditional origins of the system of higher education abroad were outlined before the problems of adjustment of the West Indian student in Britain were analysed. Among topics dealt with were the effect of racial discrimination, of the disruption of the individual's primary-group relationships; relationships with other colonials and their organization; the appeal of communism to the colonial student; the problem of colonial student hostels.

University and Religion: Higher Education in West Indian Society—*L. E. Braithwaite.* Arising out of research on the education of West Indians in Britain an essay has been prepared on the relevance of this research to the developing University College of the West Indies. The establishment of the University was viewed as an instance of the transfer of one social institution to a new and unfamiliar environment. Problems arising from this were examined and the potential contribution of the social sciences in a colonial society was outlined.

Rural Labour Supply—*M. G. Smith.* A field study of problems of rural labour supply in Jamaica was undertaken. A report of this investigation was submitted to the Jamaica Government in February, 1956. In December, 1955 Dr. Smith made a study of household composition and family structure in a selected sample of 500 homes in Kingston. The purpose of this is to provide comparative material on urban and rural household and family organisation in Jamaica. The urban sample of 500 homes is balanced by a rural sample of 1,000 studied during the labour survey.

Autobiography—*M. G. Smith.* Revision of the autobiography "Dark Puritan" has been completed and publication has now been arranged. This is a study of a cult leader's life and the background to cult organization generally.

Carriacou Kinship Monograph—*M. G. Smith.* A first draft of the Carriacou kinship monograph based on a field study has been completed.

Segmentary Lineage Systems—*M. G. Smith.* An essay was prepared on the inadequacies of segmentary theory which are most clearly revealed by current treatments of lineage form and formation.

Social Integration of East Indian Population—R. T. Smith. A field study in Jamaica was undertaken for the primary purpose of collecting data on the social integration of the East Indian population. The material will be used as a comparative control for further studies to be carried out in British Guiana. A preliminary report has been prepared.

Social Structure in British Guiana—R. T. Smith. A field study in British Guiana was started as an extension of previous studies of the social structure of coastal rural communities. In this study primary attention will be devoted to the East Indian population.

Correction of proofs was completed of the book on "The Negro Family in British Guiana", which is to be published in 1956 by Messrs. Routledge and Kegan Paul.

ASSOCIATE ACTIVITIES

Professor Andrew W. Lind of the University of Hawaii, with the Institute on a Fulbright Fellowship, made a study of the social adjustment of the Chinese in the British Caribbean.

Professor A. R. Lindesmith of the University of Indiana spent two weeks to advise on the sociological aspects of drug addiction in Jamaica.

Mr. C. A. Moser of the London School of Economics worked in association with the Institute while making preliminary investigations relating to the measurements of levels of living in Jamaica.

Dr. G. J. Kruijer, a rural sociologist, arrived in the island in February on a U.N. Fellowship to undertake a survey of the Christiana Area Land Authority.

Dr. F. R. Augier was awarded a field grant by the C.S.S.R.C. for the purpose of examining records in Jamaica to see whether local documents threw any additional light on his study of aspects of nineteenth century Jamaican history.

Mr. F. X. Mark was awarded another of the C.S.S.R.C. grants to enable him to visit Jamaica and Trinidad in connection with his research on the working-class movement in Jamaica and Trinidad.

Dr. Vera Rubin of Columbia University visited the area briefly in preparation for a programme or research by and training of students from Columbia and several other universities in the United States. The programme will be in the field of anthropology and will be centred around cultural change.

Dr. Clarence Senior and Mr. Douglas Manley undertook an investigation of the conditions under which migrants live and work in the United Kingdom. A primary purpose of the investigation, which was sponsored by the Government of Jamaica, was to provide information on measures that might be taken to establish a welfare service for these migrants.

Mr. G. W. Roberts began a study with a view to determining the nature of the migration and its possible effect upon the Jamaican economy with special reference to skilled and semi-skilled workers.

Publications Programme. The Journal, *Social and Economic Studies*, published by the Institute has appeared regularly and it is encouraging that it has now become one of the better known professional journals dealing with social and economic research in the "underdeveloped" territories. The Journal has a wide international circulation and goes to a representative range of libraries throughout the world. It is a welcome sign that scholars from different parts of the world are submitting manuscripts for publication.

An Editorial Advisory Board has been set up and the following scholars have agreed to serve :—

Prof. R. G. D. Allen,
 Prof. Kenneth Boulding.
 Prof. Raymond Firth.
 Prof. P. Sargant Florence
 Prof. M. Fortes.
 Prof. David Glass.
 Prof. M. Gluckman.
 Prof. Sir Keith Hancock.

Prof. W. A. Lewis.
 Prof. Robert Merton.
 Prof. E. F. Nash.
 Prof. Talcott Parsons.
 Prof. Margaret Read.
 Mr. K. E. Robinson.
 Mr. Dudley Seers.
 Prof. J. Tinbergen.

Relationships with Governments. A feature of the past year has been the increasing evidence of collaborative effort between the Institute and the several governments. The Jamaica, Windward Islands, Barbados and British Honduras governments have each approached the Institute with requests for cooperation in research on problems with which it was thought that the Institute could make a contribution. Experience with these relationships is making clearer the types of work for which the resources of the Institute or of the government are the better suited.

Awards. M. G. Smith was awarded the Curl Bequest Prize for 1955 for his essay on segmentary lineage systems. The Curl Bequest Prize is awarded annually by the Council of the Royal Anthropological Institute upon the results or analysis of anthropological work.

H. D. Huggins was granted an award by the U.S. State Department under the Leaders Programme to visit scholars and institutions in the United States in instances where the research undertakings in the U.S. institutions and in the West Indian Research Institute were considered of mutual interest. Visits included the following universities or colleges: George Washington, Columbia, Johns Hopkins, Yale, Harvard, M.I.T., Center for International Studies, Amherst, Oberlin, Michigan, Chicago, Northwestern, California, Stanford, Food Research Institute, Stanford Research Institute; and Economic Institute of the International Bank.

Visitors. Professor Ira Reid, Mr. Percy Arnold, Sir Alfred Savage, Mr. Britton Harris, Mr. C. A. Moser, Mr. G. W. Roberts, Mr. R. Snider, Dr. Clarence Senior, Mr. J. K. A. Quahhie, Mr. K. Bosomprah, Professor George Taylor, Mr. Michael Foster, Mr. O. N. Emeruwa, Mr. Peter Stern, Miss Janet McGrindle, Dr. George Wythe, Dr. Martin Dworkis, Mr. Richard Llewelyn Davies, Dr. Gordon K. Lewis, Mr. A. P. Thorne, Dr. Vera Rubin, Professor A. W. Lind, Mr. S. A. Hammond, Miss A. Liles, Mr. Louis Moss, Professor A. K. Galbraith, Dr. G. J. Kruijer, Professor A. R. Lindesmith, Miss J. F. Kraal, Professor M. Davie, Professor Frank Tannebaum, Mr. Dudley Seers, Sir Sydney Caine, Sir Frank McDavid, Representatives of the Commonwealth Parliamentary Association, Miss Mary Hiltz, Dr. Walter Adams, Dr. S. H. Stackpole, Mr. Alan Pifer, Mr. C. S. Roberts, Mr. D. J. Kirkness, Dr. J. W. Cook, Mr. T. Knox-Shaw.

A list of publications for the year is attached as an appendix.

APPENDIX

SOCIAL AND ECONOMIC STUDIES

Quarterly Journal

June, 1955-March, 1956

Vol. 4, No. 2 :

The Role of Merchandise Trade Statistics in Statistical Policy	Dudley Seers
Tax Exemption and New Industry in Puerto Rico ..	Milton C. Taylor
Political Cultism in West Kingston, Jamaica	George E. Simpson
The Experience of Jamaica with Modified Crown Colony Government	Ronald V. Sires
The Unification of British Guiana	Rawle Farley

Vol. 4, No. 3 :

The Malthusian Model as a General System	K. Boulding
Regional Differentials in Wages	H. D. Huggins
The Water Resources of the Clarendon Plains	S. A. G. Taylor
Formal Associations of a Negro Community	D. Manley
Emigration from Barbados	G. W. Roberts
Parent-teacher Relationship in a Jamaican Village ..	E. P. G. Seaga

Vol. 4, No. 4 :

Puerto Rican Emigration : A Threefold Comparison ..	Sidney Mintz
The Moslem Family in Britain	Sydney Collins

Supplement to Vol. 4, No. 4 :

Size, Structure and Growth of the Economy of Jamaica A. P. Thorne

Vol. 5, No. 1 :

A System of Labour Force Statistics	J. Harewood
Symposium of the Hicks Report :	
Taxation and Economic Development	Richard Goode
Report on Finance and Taxation	Arthur Hazlewood
Pioneer Industry Legislation	A. D. Knox
Some General Comments on the Hicks Report	A. P. Thorne
Financing Development	G. D. N. Worswick
Some Observations on the Chinese in British Guiana	Morton H. Fried
A Carib Village in Dominica	E. P. Banks
Naming Customs in St. Lucia	Daniel J. Crowley
A Note on the Relationship of Illegitimacy and the Birth Rate	D. Ibberson

APPENDIX IV

RHODES-LIVINGSTONE INSTITUTE

DIRECTOR'S REPORT, 1st April, 1955 to 31st March, 1956.

The Trustees

The present Board of Trustees is composed of :

President : Sir Arthur Benson, K.C.M.G.
 Secretary for Native Affairs : W. F. Stubbs, C.M.G., C.B.E.
 Financial Secretary : R. A. Nicholson, C.B.E.
 Provincial Commissioner, Central Province : F. M. Thomas.
 Col. Sir T. Ellis Robins, D.S.O., E.D.
 H. Franklin, O.B.E., M.L.C.
 L. Tucker, M.L.C.
 W. C. Little.

At a meeting of the Trustees in March, 1956, it was decided to extend the Board by co-opting representatives of the Federal Government, the Governments of Southern Rhodesia and Nyasaland, the University of Rhodesia and Nyasaland, and one other, for which last it was hoped that a suitable African might be found.

In view of the difficulties of assembling this extended Board at frequent intervals, it was decided to establish a Standing Committee to deal with day-to-day business, and an academic advisory body to keep the Institute's research programme under review. This latter will provide a second link with the University a Trustee being the first—whilst a third occurs with the establishment of a University Social Research Committee, on which the Director has been invited to serve.

Staff at 31.3.56.

Director	H. A. Fosbrooke, M.A. (Cantab.).
Administrative Secretary	Miss J. Longton, B.S.S. (Social Welfare) (Natal).
Librarian	Mrs. U. K. N. Stevenson, B.A. (Cantab.), F.L.A.
Assistant Librarian	R. S. Ng'ombe.

Anthropologists	..	..	..	W. Watson, D.F.C., Ph.D. (Manchester), M.Sc. (Cantab.). J. van Velsen, B.Sc. (Oxon). V. W. Turner, Ph.D. (Manchester), B.A. (London).
Senior Sociologist	..	..	..	A. L. Epstein, Ph.D. (Manchester), B.A. (Dublin).
Sociologist	..	..	..	Mrs. E. M. Collins (nee Richardson) B.Sc. (London).
Senior Research Assistants	..	..	..	S. C. Katilungu, Diploma in Social Welfare. E. Tikili, B.A. (S.A.).

In addition there are eight Junior Research Assistants and six African Central Office Staff.

Dr. A. L. Epstein assumed duties as Senior Sociologist on 20th March, 1955.

Mr. C. M. N. White, M.B.E., M.A. (Oxon) seconded from the Provincial Administration succeeded Dr. J. C. Mitchell on his retirement to take the Chair of African Studies at the University College of Rhodesia and Nyasaland.

Mr. White was Acting Director of the Institute from August, 1955, until the end of February, 1956.

Mr. H. A. Fosbrooke was appointed as substantive Director in November, 1955, and assumed duty at the Institute on March 3rd, 1956.

Research in Progress :

(1) *Urban Studies.* Work is proceeding on the punching and verification of research material collected in the line of rail towns. The social survey of Livingstone, supervised by Miss H. M. McCulloch has been completed and the manuscript is now in the hands of the printers.

In October one section of the African Research Team completed a social survey of Fort Jameson. The material collected is being punched onto Powers-Samas cards prior to tabulation. This team is at present assisting Dr. William Schwab, a Ford Foundation Fellow, in his study of Gwelo, Southern Rhodesia. Another section of the team is engaged in collecting data for the forthcoming Health and Nutrition Scheme in the Fort Rosebery area. Mr. A. A. Nyirenda has completed his survey of market vendors in Lusaka and his manuscript is ready for publication. Dr. Mitchell is at present working on the material collected previously under his direction on the general subject of urbanization.

Mrs. E. M. Collins (nee Richardson) has completed her study of family economics and nutrition on the Copperbelt of Northern Rhodesia. She left the field in April, 1955, and is at present writing up her material and preparing it for publication.

Dr. A. L. Epstein who was appointed Senior Sociologist in March, 1955 is engaged in a study of social relations in urban communities in Ndola, Northern Rhodesia.

(2) *Rural Studies.* Dr. V. W. Turner, whose contract with the Institute terminated in February, 1955, has completed his manuscript on the Lunda/Ndembu of the Mwinilunga district and his book is expected to be available early in 1956. Dr. Watson left the field in September, 1955 and is at present in the United Kingdom where he is engaged in writing up his field material on the Lungu people of Northern Rhodesia.

Mr. J. van Velsen left for the United Kingdom in September, 1955 and is now writing up his material on the Lakeside Tonga of Nyasaland. His contract has been extended for a further four months for this purpose.

The Sir Gilbert Rennie Library

In addition to the usual duties of classifying and cataloguing books and pamphlets dealing with correspondence arising from borrowers' queries and from exchange arrangements with other societies, the Institute's librarian is also responsible for the membership of the Institute and for distributing the Institute's publications. Institute members are classified as Official, Honorary, Ordinary and Exchange. The Official members are those organisations who make contributions to the Institute's funds: Honorary members are those to whom publications are sent for publicity reasons:

Exchange members are those who receive the Institute's publications in exchange for theirs. Ordinary members are private individuals who make a subscription of thirty shillings a year. In addition to receiving the periodical publications from the Institute, they are entitled to borrow books from the Library by post. During 1955 nineteen new ordinary members joined the Institute, and seven new exchange arrangements were entered into with other organisations. At the end of 1955 the membership total stood at 615. This is less than the total for 1954, which was 648, but the drop in membership is largely explained by the fact that at the beginning of 1955 the list of members was brought strictly up to date, and the names of all those ordinary members who had not paid their subscriptions for two or three years were struck off the membership roll.

During 1955 a total of a hundred and ninety-six books and pamphlets was added to the Library. This total comprises seventy-five more items than were added in 1954, and was made possible by the generous gift to the Library of one hundred pounds from the Rhodesian Selection Trust. The total of 196 includes books purchased, books presented to the Library and books received on an exchange basis, but does not include the reports received from the various government departments of Northern and Southern Rhodesia, Nyasaland, Tanganyika, Uganda and Kenya. Four new periodicals were taken in the Library, all on an exchange basis. Four hundred and fifty-three books were borrowed during the year; this is about eighty volumes less than were borrowed in 1954, but still represents an increase of one hundred and sixty-eight over those borrowed in 1953. As about two thirds of the borrowing is carried out by the Institute's own staff, and as several members of staff left the Federation during the year (and thereby automatically became disqualified from borrowing) the decrease in borrowing is probably explained by their absence. The Library is, however, also used by outside people engaged in individual research, by welfare officers and by government officials in general. A particular effort was made this year to fill in gaps in that section of the Library which deals with the early discovery and development of Rhodesia.

The special bibliography, which aims to include all works dealing with aspects of human relationships in the three territories, and which was restarted in 1953, continues to grow; it covers a wide range of subjects, varying from early marriage customs and ceremonies to the problems of urbanisation and detribalisation which are current to-day.

Conferences

The ninth conference of the Rhodes-Livingstone Institute Research Officers which was of a general nature was held in March, 1955.

Publications

The year 1955 has been a period of great activity in the writing up and preparation for press of material gathered in the field by the Institute's officers. It is expected that the year 1956 will see a spate of books and papers issuing from the publishers at very close intervals. Among publications which should appear in the near future are Miss Elliott's study of the labour system in Northern Rhodesia, which is being prepared for the press by Miss H. M. McCulloch; Dr. Colson's book on Tonga family structure and economic development; Dr. Turner's work on Lunda/Ndembu social structure; Mr. Gann's 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". Dr. A. L. Epstein has also completed a manuscript on his work on political organisation in an urban area, and this is already with the publishers.

Between April, 1955 and March, 1956 three issues of the Institute's Journal, *Human Problems in British Central Africa*, appeared and the Rhodes-Livingstone Paper No. 25, *Kin, Caste and Nation among the Rhodesian Ndebele*, by A. J. B. Hughes. It is expected that Dr. Mitchell's book, *The Yao Village*, will have been published by the time this Report is in print. Of the two books that were published between April, 1954 and March, 1955, Barnes' *Politics in a Changing Society* continues to sell quite well, while Gluckman's *The Judicial Process among the Barotse of Northern Rhodesia* has proved to be almost a "best-seller", having paid back all expenses by January, 1956. The sales from *Shona Customary Law* remain moderate, but *Seven Tribes of British Central Africa* is now completely out of print, and in response to demand a reprint has been sanctioned.

Visitors. The following were among those who visited the Institute during the year under review :—

- Sir William and Lady Murphy, of Bromley, Southern Rhodesia. Sir William is a Director of the Rhodesian Selection Trust Group.
- D. A. Clarke, Librarian of the University College of Rhodesia and Nyasaland, Salisbury, Southern Rhodesia.
- Carl G. Rosberg, on the staff of the African Research and Studies Program, Boston University, U.S.A.
- Dr. Ellen Hellmann, Vice-President, South African Institute of Race Relations, Johannesburg, South Africa.
- Professor H. P. Pollak, Professor of Sociology, Natal University, South Africa.
- J. Conway Morgan, Head of Central African Department, Colonial Office, London.
- H. J. Rousseau, Professor of Education, University College of Rhodesia and Nyasaland, Salisbury, Southern Rhodesia.
- David Jolly, Librarian, Northwestern University, U.S.A.
- Irene S. van Dongen, Lecturer in Geography, Columbia University, U.S.A.
- L. H. Samuels, Economist, Witwatersrand University, South Africa.
- J. L. Keith, Director of Colonial Students, Colonial Office, London.
- Paul-Ernest Joset, Charge de Mission, Uccle-Brussels, Belgium.
- B. A. Fletcher, Head of the Institute of Education, University College of Rhodesia and Nyasaland, Salisbury, Southern Rhodesia.
- In September 1955 Dr. Schwab, a Ford Foundation Fellow, commenced a general study of the Gwelo (S.R.) urban community and was assisted by the Institute who provided teams of Research Assistants to aid him in his work.
- On 3rd March, 1956, Arthur Tuden, of Princeton University, U.S.A. arrived to undertake a study of the Ila—of Smith and Dale fame—working under a Ford Foundation grant. Such facilities were placed at his disposal as might forward his study project which the Institute had on its own programme.

Other Activities

The Acting Director has continued to serve on the Geographical Place Names Committee. He had hoped to carry out preliminary investigations into the low birth rate of the Luvale and allied peoples, but transport difficulties made this impossible. During his period of secondment he completed the manuscript of a Lunda-English Dictionary which, it is expected, will be published by the Northern Rhodesia-Nyasaland Joint Publications Bureau. He also completed the first draft of a manuscript on the Luvale, incorporating topics included in his previously published papers and much unpublished material. If the opportunity for further fieldwork to fill in some gaps can be obtained, this study could form a book dealing with the main cultural and economic features of the Luvale, and would fill a gap in the ethnographic accounts of Northern Rhodesia tribes.

The Acting Director also made considerable progress in preparing a supplement to the existing Luvale dictionary by A. E. Horton ; assisted in oral language examinations for interpreters in the Judicial Department, and read manuscripts in North-western languages for the Joint Publications Bureau.

Future Prospects

Finances deriving from Scheme R370 ceased at the end of March, 1956, but a number of workers continued on strength completing the work commenced under the scheme. Dr. Epstein has before him several months of fieldwork, to be followed by a period of writing up, on which latter task Drs. Watson and Turner and Mr. van Velsen are still engaged. Financial support for the next programme of research for the period 1956-1960 has been coming forward in a satisfactory manner and subject to availability of suitable staff, a considerable programme should be accomplished during this period.

Trustees considered that priority should be given to social surveys, to an economic appraisal of peasant farming, to a study of the impact of the Kariba Scheme on the social and economic life of the Valley Tonga and to educational research. Concerning the last named, close liaison is being maintained with the newly founded Institute of Education attached to the University College at Salisbury.

APPENDIX V

ANNUAL REPORT OF THE EDUCATIONAL RESEARCH INSTITUTE
FOR 1955*Staff*

The work of the Research Institute was virtually at a standstill during January, February and March, while the Principal was acting as Education Officer for the Southern District. At the same time, the Fijian Research Assistant was serving as a Visiting Teacher, and the Indian Research Assistant as a clerical assistant at the Education Department headquarters.

Normal activity was again interrupted during July when the Principal of the Research Institute was seconded to the World Health Organization for a month to act as Educational Psychologist on the staff of the Seminar on Nursing Education held in Suva.

Text-Books

When work was resumed in April, the Director of Education in Fiji asked the staff of the Research Institute to continue the preparation of text-books for Primary Schools. By the end of 1955 six reading books in Fijian had been prepared and accepted for publication by overseas firms. Proofs of two of these were received, corrected and returned during December.

Negotiations were carried out with a publisher for the preparation and publication of a Fiji Atlas. The firm concerned was unable to quote a price which would sell the atlas in Fiji. Discussions were therefore opened with the Literature Bureau of the South Pacific Commission with a view to publishing an atlas to suit several territories.

Work was commenced on the preparation in English of a History of Fiji and a Geography of Fiji in simple language for use in Primary Schools. The manuscripts were near completion at the end of 1955.

Curricula and Teaching Methods

The staff of the Research Institute assisted in various ways in the development of improved curricula and teaching methods. The Fijian Research Assistant completed an important task in the preparation of the first comprehensive curriculum for Fijian language teaching. This is expected to be published early in 1956. The Indian Research Assistant was Secretary of the Hindi Curriculum Committee.

To assist teachers in composition of timetables for a number of classes taught by one teacher, the Research Institute staff prepared model timetables for various combinations of classes, together with advice about their operation and adaptation.

Throughout most of the year the Fijian Research Assistant broadcast from the local radio station lessons on the learning of Fijian. The Indian Assistant conducted weekly classes for teachers of Urdu. The Principal conducted weekly classes in Suva and Nausori on Teaching Method. The whole staff assisted in the setting and marking of examinations conducted by the Education Department and in the publication of Departmental Journals for teachers.

Future Plans

The Research Institute was established in January, 1952 for a period of five years, and thus concludes its work under its present organisation at the end of 1956. It is considered imperative that the eleven text-books in various stages of preparation should be published before that date so that the authors will be fully available for completion, correction and proof-reading of the books, and so that the multitude of publication arrangements and negotiations will not be left for others to complete. This will therefore be the main task of the Research Institute in 1956.

R. S. ADAM,

Principal, Educational Research Institute.

APPENDIX VI

REPORT ON THE WORK OF THE SOCIAL RESEARCH UNIT

University of Malaya, Singapore

During the year under review the work of the three Fellows, Mr. W. H. Newell, Dr. K. O. L. Burridge, and Dr. B. L. B. Kaye, has continued and has led to the presentation of three Reports to the Social Research Committee. Mr. W. H. Newell's Report, entitled "Chinese Farmers of the Village of Treacherous River" was the first to be completed and was considered at a meeting of the Committee in January. Publication of all or part of the Report is now being discussed with external assessors.

Dr. K. O. L. Burridge's Report on Field Work in Batu Pahat, Johore, was considered at a meeting in February. This report is now in the hands of external assessors.

At the time of preparation of this report on the work of the Unit, Dr. B. L. B. Kaye's Report entitled "Upper Nankin Street, Singapore" has just been completed and circulated to members of the Committee, but has not yet been considered.

It is not therefore possible to indicate what parts of the Reports will be published, or probable dates of publication, at present.

In April, 1955, before any of the reports on fieldwork were available, the Committee had to consider the future of the Unit, funds for which were due to lapse on 1st April, 1956. It was felt by the Committee that the appointment of a senior fellow to supervise and co-ordinate research was essential if the original purpose of the Unit, which was to organise group research, was to be achieved.

The Committee also had before it the report of a commission consisting of Sir Roland Braddell and Professor R. G. D. Allen on the organisation of Administrative and Legal Studies and the appointment of certain professors and lecturers in these fields.

The Committee felt it desirable to try to preserve some continuity in the Unit, in view of the probability that social research would be organised as part of a new Faculty. It did not, however, recommend the continuation of the Unit in its present form. Attempts are now being made to secure finance for a senior lecturer who would be able to organise research of the type originally envisaged in the Unit but neither the funds nor suitable candidates were available by 1st April, 1956. With the departure of the existing Fellows on the termination of their contracts there will inevitably be a break in the continuity of the Unit, but it is hoped that further appointments may be able to be made in the future.

Tsetse Fly and Trypanosomiasis Committee Report for 1955-1956

Colonial Office,
Sanctuary Buildings,
Great Smith Street,
London, S.W.1.
8th November, 1956.

SIR,

I have the honour to transmit herewith the Report of the Tsetse Fly and Trypanosomiasis Committee for the year ended 31st March, 1956.

I have the honour to be,

Sir,

Your most obedient servant,

W. B. L. MONSON,
Chairman.

The Right Honourable Alan Lennox-Boyd, M.P.

THE TSETSE FLY AND TRYPANOSOMIASIS COMMITTEE
REPORT FOR 1955-56

Membership

- MR. W. B. L. MONSON, C.M.G., Assistant Under-Secretary of State, Colonial Office (*Chairman*).
- *PROFESSOR P. A. BUXTON, C.M.G., F.R.S., Professor of Medical Entomology, University of London.
- CAPTAIN K. F. T. CALDWELL, formerly of the Kenya Game Department.
- DR. J. CARMICHAEL, C.M.G., M.R.C.V.S., 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.
- 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. E. M. LOURIE, M.B., D.P.H., Chief, Section of Biological Standardisation, World Health Organisation.
- DR. L. HARRISON MATTHEWS, M.A., F.L.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 Africa Tsetse and Trypanosomiasis Research and Reclamation Organisation.
- MR. W. F. DAWSON, M.B.E. (*Secretary*).

Ex-Officio Members

The Directors of the East African Tsetse and Trypanosomiasis Research and Reclamation Organisation and the West African 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 Insecticides, Fungicides and Herbicides Committee.

It is the practice to invite the Scientific Liaison Officer for the Rhodesias and Nyasaland to attend meetings.

Terms of Reference

The terms of reference of the Committee are :—

“To consider and advise on the co-ordination of action, including research and reclamation, directed against human and animal trypanosomiasis.”

* Died 11th August, 1956.

† Died 13th December, 1955.

THE TSETSE FLY AND TRYPANOSOMIASIS COMMITTEE

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THE TSETSE FLY AND TRYPANOSOMIASIS COMMITTEE

I. THE COMMITTEE

1. The Tsetse Fly and Trypanosomiasis Committee met three times during the period under review. The Chemotherapy Panel, set up by the Committee, was also active.

2. The Committee suffered a severe loss in the death of Professor P. A. Buxton, C.M.G., F.R.S., the Professor of Medical Entomology at London University. Professor Buxton, one of the original members of the Committee, made a notable contribution not only to research on the tsetse fly but also to the shaping of policy in regard to tsetse control and trypanosomiasis in the British African territories.

3. The membership of the Committee during the year was otherwise unchanged.

4. In the course of the year the Committee was called on to give advice on the usual variety of topics ranging from the disbursement of its allocation of C.D. and W. research money to research projects in the field (on which it advises the Secretary of State) to novel concepts such as the control of tsetse flies by the liberation of male flies sterilised at the puparial stage by the application of gamma rays. By far the most pressing subject considered by the Committee and its Chemotherapy Panel was the situation arising from the advent during the period of a number of new trypanocidal drugs. These drugs offer the prospect of advances in the control of trypanosomiasis in domestic animals, particularly by prophylaxis. The Committee's immediate problem was the procedural one of arranging and co-ordinating trials of these drugs in Africa. At the end of the period under review the Committee had reached the conclusion that an important new phase had been reached in the control of bovine trypanosomiasis and accordingly it recommended that a conference of high-level veterinarians from the African Administrations should be held to stimulate progress and concerted effort. Close liaison with the manufacturers of trypanocidal drugs has been maintained throughout.

II. THE EAST AFRICAN TRYPANOSOMIASIS RESEARCH ORGANISATION

General

5. The Organisation suffered a severe loss with the death, in July, of Dr. C. H. N. Jackson. His place in charge of Tsetse Research, has been taken by Dr. J. P. Glasgow. Good progress was made in filling research staff vacancies on the trypanosomiasis side at Tororo; a veterinarian, a protozoologist and another medical research officer have arrived and started work. A third medical officer was engaged to take charge of the Sleeping Sickness Laboratory at Tinde, and Dr. K. R. S. Morris, recently Director of Tsetse Control in the Gold Coast, also joined the staff.

6. The Headquarters of the Organisation moved from Nairobi to Tororo in March, 1956, and, at the same time, the title was changed to its new, simplified form. The revenue from the sale of property in Nairobi and Arusha has been used for building additional houses in Tororo. These are expected to be completed by early 1957.

Tsetse Research

7. Present policy is to give priority to research on behaviour and physiology of *Glossina*, with an emphasis on laboratory studies, hitherto much neglected. This programme made a good start with the acceptance for publication by the

Royal Society of a paper on "The polypneustic lobes of the tsetse larva", a study on larval respiration. The water content of the pupa and adult tsetse is being studied, and so is the mechanism of its control and the behaviour of the adult fly in relation to changes in air humidity.

8. Further data have been collected on colour changes in *G. pallidipes* associated with variations in the pupal environment. It is hoped so to calibrate these changes that the conditions encountered by the pupa may be deduced from the appearance of the adult.

9. Collaboration with the Lister Institute of Preventive Medicine on the food supply of *Glossina* has continued. Evidence has already been collected from numerous sources differing in either place or season that different species of *Glossina* tend to have preferred hosts and that certain common game animals are probably neglected as sources of food.

10. For some years now fly-round data in field work have been collected on an arbitrary sampling basis as opposed to the basis of vegetation differences formerly in use. Sufficient data have now been collected to begin analysis of results and the first paper by Jackson has been published. A recent improvement in technique has been the development of a means of finding and catching some species of tsetse while at rest. By this means it is now possible, for the first time, to catch both sexes of flies in approximately the naturally existing proportions, and to catch flies which have only recently fed.

11. Studies on *G. mortisans orientalis* have continued at Kingolwira, and quarterly observations have been begun at Butambara Field Station, in order to obtain information on whether the long-term cycle of *G. swynnertoni*, as observed at Shinyanga is repeated in *G. morsitans*. In the Lambwe Valley, where six years data are available, there has been a general increase in *pallidipes* density since 1950. At the latter station also a study of arboricides on thicket has been completed in collaboration with the Colonial Insecticides Research Unit.

12. Also at Lambwe two other investigations have been begun. One is the study of *G. pallidipes* by traps, which give sampling results strikingly different from those obtained by fly-boys; the other is an investigation of the emigration of *G. pallidipes* from its thicket habitat into surrounding reclaimed areas, in which catches by both fly-boys and traps are being used.

Trypanosomiasis Research

13. Another paper on the Tinde *rhodesiense* transmission experiment has been prepared. This strain has not lost its infectivity to man in 18½ years of fly transmission through a variety of hosts, but several changes in its behaviour are apparent which have now been statistically analysed.

14. The apparent change over from *gambiense* infections to *rhodesiense*, in Nyanza Province, Kenya, has been the cause of concern and the problem is under investigation at the request of the Medical Department especially with a view to determining whether *G. pallidipes* is the vector, as opposed to *G. palpalis* as formerly.

15. A serological investigation of *congolense* infections in mice was started, with the intention of extending it to compare strains of the same trypanosome from different areas in East Africa. Part of the object of this work is to devise a simple diagnostic test for infections of this trypanosome in cattle, since there is ample evidence that a high proportion of native cattle are infected in some areas although yielding negative blood slides and maintaining apparently good condition.

16. Some success has been obtained in the maintenance of trypanosomes *in vitro*, but difficulties have been encountered which are the subject of investigation, particularly into the questions of sugar and oxygen metabolism. Biochemical investigations of normal native cattle, particularly in respect of calcium, phosphorus, total protein and gammaglobulins were undertaken, as a necessary preliminary to the biochemical study of infected animals.

17. The experiment at Kiboko on acquired resistance under protection by antrycide pro-salt has been completed, and it unfortunately gave no significant result. A similar carefully controlled laboratory experiment has been in progress at Tororo for nearly a year. Exposure to infection has been artificially controlled and each animal has been submitted to as wide a range as possible of haematological, serological and biochemical tests.

18. The investigation of natural infections of *Glossina palpalis* and *pallidipes* in the Samia fly-belt south of Tororo has continued and has produced some valuable results which are now being prepared for publication.

19. Work on the early development of trypanosomes in the mammal, which was initiated by Professor R. M. Gordon, has continued and some important results have been obtained. It is expected that these will be ready for publication shortly.

20. A visitor to the Laboratory, Dr. Wijers of the Tropical Institute, Amsterdam, began a study of polymorphism in *T. rhodesiense* and *T. brucei* infections in laboratory animals. This also is being continued.

21. Dr. K. R. S. Morris has begun extensive investigations into the epidemiology of sleeping sickness in East Africa, and particularly in Uganda. These investigations are both historical and ecological: historical because he hopes to trace the introduction of the disease into Uganda in 1901 and the course of the endemics and epidemics in the years since, and ecological, because he will study the factors influencing the present low rate of endemic infection.

22. The research station at Tinde is now in full working order with a medical research officer posted there; and work is being done on the infectivity to man of strains of trypanosomes and the effects of cortisone on trypanosome infections in animals, in addition to the continuation of the long-term Tinde experiment on *T. rhodesiense*.

Reclamation Work

23. A proposal was made (and later accepted) to hand over savings on the Masai-Chepalungu Pilot Scheme to the Kenya Government, for continuation of work in that area. In Ankole, in spite of an extensive advance of *morsitans* in 1954, the clearing necessary to eliminate this tsetse from country infested since 1938 was almost completed, using both hand labour and bull-dozers. Certain areas treated in 1952 and 1953 now yield no fly to fly-boy patrols. An experimental group of cattle, both Zebu and Ankole breeds, has been introduced into one area, both with and without antrycide pro-salt treatment. In Mkata, in Tanganyika, a 1 : 30,000 vegetation and soils map of the ranching scheme area was finished and clearing work in the set season retreat area brought to completion. At Urambo, the advisory work of the Organisation has yielded admirable results reflected in marked reductions of the incidence of both human and animal trypanosomiasis.

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III. THE WEST AFRICAN INSTITUTE FOR TRYPANOSOMIASIS RESEARCH

General

24. Dr. T. A. M. Nash, C.B.E., was appointed Director with effect from October, 1954. Other staff changes were the appointment of Dr. A. M. Jordan as Research Entomologist and Mr. H. T. B. Hall as Veterinary Research Officer. Dr. D. Gall, Research Epidemiologist, resigned to take up an appointment in the United Kingdom. During 1955, the research programme was much affected by vacancies and by leave movements, but the position has since improved.

25. On 3rd February, 1956, the Institute at Kaduna was honoured by a visit from Her Majesty the Queen and the Duke of Edinburgh. The Royal Party was shown over the laboratories and in addition saw demonstrations of various aspects of the research work undertaken there. The Institute continued to cultivate public relations. The museum or information bureau has been kept up to date and improved. The number of visitors to the Institute increases year by year and it is now a common occurrence to show round large parties of Emirs and Chiefs, school children, students and police. Two talks on the work of the Institute were given on the Nigerian Broadcasting Service.

26. Dr. J. Williamson, Biochemist, attended the Third International Congress of Biochemistry held at Brussels in August, 1955.

HUMAN TRYPANOSOMIASIS

Epidemiology

27. A further field study was made in Bakundi District of Adamawa Province where two strains of *T. gambiense* were collected in 1954.

Strains of T. Gambiense

28. Of the strains being maintained by direct transmission, all have remained virulent and can now be passed from adult rat to adult rat by syringe inoculation without difficulty. The virulence is maintained at a higher level if the strain is passaged from the earliest phases of the developing infection rather than from the later regressive phases.

29. Two strains have been maintained in rats by cyclical transmission through *G. palpalis*. Both these lines have proved to be comparatively avirulent in contrast to the present virulent behaviour of the same strains on syringe passage.

Pathology

30. Additional experiments have been carried out to confirm that the high red cell sedimentation rates observed in sleeping sickness are due to factors in the plasma rather than to factors in the red cells themselves. When normal cells were suspended in sleeping sickness plasma the sedimentation rates approached the original sleeping sickness rates, while the patients' red cells in normal plasma gave only very slightly increased rates. Therefore an abnormal composition of the plasma is mainly responsible for the high sedimentation rate in sleeping sickness. This abnormality of the plasma is presumably the great increase in gamma globulins reported previously.

31. Besides the electrophoretic studies which have been continued, Kunkel's zinc sulphate turbidity test was adopted for routine estimations of gamma globulin levels. Many sera were examined and the correlation between this test and the electrophoretic results appeared to be close. The sleeping sickness patients showed mean gamma globulin levels which were twice as high as in the African "controls".

32. A high gamma globulin level and an abnormal gamma component appear to be common to human trypanosomiasis, kala azar and liver disease of various kinds. Although clinical disturbance of the liver is not an obvious feature of sleeping sickness, tests of liver function have now shown a definite degree of liver damage in both human and simian trypanosomiasis.

Diagnostic Methods

33. Laboratory trials of the sulphosalicylic acid method for the estimation of cerebrospinal fluid protein, read in the M.R.C. Photometer, were concluded with promising results. When compared, under laboratory conditions, with the Sicard and Cantaloube's method its accuracy proved to be about twice as good.

Chemotherapy

34. The field trials with Melarsen which have been in progress in collaboration with the Nigerian Sleeping Sickness Service have now been largely concluded. For field use the individual dose should not exceed 20 mgs. per kg. (max. 1.5 gm.). Injections are given at 5 day intervals up to a total of twelve. Only minor toxic effects were noted on this dosage scheme.

35. Among cases treated only with melarsen, and so far followed up for two years, the results have been good. There have been no relapses among early cases who before treatment showed no alteration in the cerebrospinal fluid. In those cases, who before treatment showed an increased cell count or total protein of the cerebrospinal fluid, the good results noted one year after melarsen therapy have been maintained during the second year; in approximately 60 per cent. of late cases the C.S.F. values were reduced to normal and remained at that level. The comparable figure for those who had received one of the standard dispensary courses of treatment was 35 per cent. In cases which had relapsed after one or more courses of treatment with the routine drugs, melarsen cured approximately 50 per cent., i.e., the C.S.F. values were normal at the end of both one and two years.

36. During the year studies have been made on the mechanism of acquired drug resistance using four syringe passaged strains of *T. rhodesiense*, three of which had been made resistant to melarsen, stilbamidine and butarsen respectively. Homogenates of normal and resistant trypanosomes are being studied by electrophoresis to see if any change in the relative proportion of acidic and basic groups can be detected, which might indicate a change in the cell structure.

37. A comparison was made between the sensitivity of a syringe-passaged strain and a fly transmitted strain of *T. rhodesiense* to certain trypanocides. Both strains could be cured equally well by suramin but the fly strain was more resistant to cure by tryparsamide or melarsen, and it was highly resistant to pentamidine. Despite these differences in the curative doses, both strains were equally sensitive to the minimal effective doses of the drugs so far used, i.e. to doses which produce a temporary clearing of the peripheral blood infection. Apparently the fly-transmitted parasite, unlike the syringe passaged ones, were able to lodge in tissue sites inaccessible to the drug, rather than the parasites themselves were inherently less drug-sensitive.

ANIMAL TRYPANOSOMIASIS

Studies on T. Vivax

38. The rat-adapted, Ilorin strain of *T. vivax* is still being maintained in these animals after four years. This strain however has now lost its infectivity to sheep and in addition it is no longer transmissible through *G. palpalis*.

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39. Experiments to ascertain the factors governing the infection of *G. palpalis* with fresh strains of *T. vivax* have been completed. There is a positive correlation between infection rate and pupal temperature, and a negative correlation between infection rate and the fly maintenance temperature. To obtain the highest infection and survival rates, it is recommended that pupae be incubated at 28° C. and flies maintained at 23° C. ; under these conditions the trypanosome developmental cycle should be 12-13 days or less. If a quick cycle is desired flies should be maintained at 28° C.

40. The course of development of *T. vivax* in sheep was studied from the time of the infected bite until trypanosomes first appeared in the blood. Subcutaneous tissue is only infective for 48 hours at which time the blood first becomes infective ; however, no definite trypanosomes can be found until they appear in the lymphatic glands at 96 hours and shortly afterwards in the blood.

41. Attempts were made to culture *T. vivax* using variations of the whole blood plus Ringer solution media. In some cases the trypanosome was maintained for up to 9 days, and in one case was subcultured at 4 days.

42. Comparative studies were undertaken of the metabolism of two strains of *T. vivax*, one established in the rat and no longer able to undergo cyclical transmission in the fly, and the other a " natural " fly transmitted strain in sheep. On the basis of the normal respiratory and glycolytic rates of *T. vivax* and the effect of certain chemical inhibitors, it would appear that *T. vivax* possesses a type of metabolism intermediate between the *brucei* and *congolense* groups.

Immunity Studies on the N'Dama and Zebu Breeds of Cattle

43. The immune response to trypanosomiasis was compared in the N'Dama and Zebu breeds of cattle. These differ considerably. In the resistant N'Dama breed there is a rapid rise in antibody titre detectable by the 4th day after challenge. By the 12th day, antibody is present in such excess that trypanosomes are immediately lysed. The antibody titre remains at this level for at least 45 days and then declines slowly. Even after two years antibody is still detectable and further challenge leads to an immediate rise again. In most cases this immune reaction leads to complete cure. In the susceptible Zebu breed antibody is not detectable until the 13th day after challenge. Titre continues to rise until parasitic crisis occurs, after which it decreases. Parasites then reappear and once again the titre rises, the cycle being repeated. At no time does the titre appear to rise to the degree seen in the N'Dama. The inability of the Zebu to produce a high titre of antibody for a prolonged period appears to be the reason for the fatal trypanosomal infections which occur so commonly in this breed.

Chemoprophylaxis and Chemotherapy

44. Experiments were started to investigate the possibility of forming suramin complexes with veterinary trypanocidal drugs. Lourie and Guimaraes (1951) had already shown that suramin could inhibit many of the pharmacological and toxic effects of pentamidine, primarily by the formation of an inactive salt complex. Tests here showed that suramin, which is acidic, also formed such complexes with ethidium and dimidium bromides, the bis-cinnolinium compound " 528 ", antrycide methyl sulphate, and Berenil, all of which are basic. A single subcutaneous maximum tolerated dose in rats and mice of the suramin complex of ethidium, dimidium, antrycide, " 528 ", and berenil was found to provide a maximum decrease in the toxicity of these drugs of approximately 10-, 5-, 14-, 8-, and 3- fold respectively. Using a strain of *T. congolense* in rats and mice, there appeared to be no diminution of therapeutic activity of the drugs when combined with suramin. In addition the complex formed with antrycide methyl sulphate protected for a considerably longer period than the single drug.

45. Following the preliminary tests in small animals, prophylactic and toxicity trials were carried out using susceptible Zebu cattle which were subjected to extremely heavy challenge, regularly repeated, by *T. vivax* in laboratory bred *G. palpalis*. Infection rates in these flies were in the region of 90–100 per cent.

G. Palpalis

46. The peak population occurs in the early rains, being followed by a drop in numbers as the rains proceed—the exact reverse of what happens in the north. This species prefers farmland and thin fringing forest. Since the flies live virtually as long in thick forest as in thin, the latter is possibly preferred by *G. palpalis* because the better visibility facilitates the finding of food hosts.

47. Experiments with marked flies in the region of a frequented watering site showed that in the dry month of January, 1955, only 2·4 per cent. of those marked were recaptured after 13 days. The comparable figure for the wet month of June, 1955, was only 0·8 per cent. There is therefore nothing comparable to the concentration of flies at the water hole which is such a feature of the epidemiology of sleeping sickness in the north. This lack of close, personal man-fly contact may well be a reason for the scarcity of sleeping sickness in Southern Nigeria.

G. Longipalpis

48. Seasonal fluctuations in fly density and seasonal preferences for various types of vegetation have been similar to those described for 1954. Dissections of wild male *G. longipalpis* have given an infection rate of 21 per cent. in 1,742 flies examined. Of those infected, 82 per cent. were infected with trypanosomes of the *vivax* group, and 18 per cent., with those of the *congolense* group.

49. The addition of an ox to the fly round has resulted in female percentages in the catches rising from about 1 per cent. to sometimes as high as 30 per cent.

50. Dry season searches for pupae have shown that breeding takes place under logs either inside or just outside the forest islands.

Fusca Group

51. Four species of this group are to be found in the vicinity of the Field Station—*G. tabaniformis*, *G. fusca*, *G. nigrofusca* and *G. medicorum*. The latter is only to be found in the forest islands and riverine forest within the savannah. These large forest tsetse are probably of considerable economic importance. *G. tabaniformis* was by far the most frequently captured species. On the other hand, the infection rate was highest in *G. nigrofusca* at 30 per cent. with only 5 per cent. in 372 specimens of *G. tabaniformis* examined.

52. Pupae of *G. medicorum* have been found under small logs in the forest islands or even in the grassland just outside, and in association with those of *G. longipalpis*.

53. Considering antrycide and its suramin complex, whereas the maximum tolerated dose of antrycide pro-salt in 5 mgs. per kg. and the protective period at this dosage only just over 2 months, at least 40 mgs. per kg. of the antrycide methyl sulphate-suramin complex can be safely given. At this dosage, the first breakthrough in five cattle tested was after 5½ months. A dosage of 10 mgs. per kg. alone will protect for 3 months.

54. Using ethidium bromide, the maximum tolerated dose of this drug alone is 5 mgs. per kg. and the first break through occurred at 2 months. In contrast, 7 months protection to date (March, 1956) has been achieved with ethidium bromide-suramin complex, two animals having received 5 mgs. per kg., and three 10 mgs. per kg. In addition to the regular challenge with *T. vivax*, these cattle were subjected to a provocative challenge with *T. congolense* at 5 months without break through.

55. The berenil-suramin complex seems to have little prophylactic activity in cattle. The Institute, through the good offices of the National Research Development Corporation, has filed provisional patents in respect of these new suramin complexes.

56. Pilot trials have also been carried out with three compounds manufactured by Messrs. Boots Ltd., namely R.D. 1660, R.D. 2787 and R.D. 2801. The last seems the most promising as a single injection of 2 mgs. per kg. protected for about 5 months, while no toxic effects were observed at this dosage. R.D. 1660, in its present form would not appear suitable for use because of its low trypanocidal value.

57. Trials of the therapeutic and prophylactic activity of a number of drugs singly or combined and in maximum tolerated doses, have been initiated in pigs with controlled infections induced by *T. simiae* infected *Glossina morsitans*. So far, the results indicate that in pigs neither ethidium bromide nor a suramin-bromide complex is curative; antrycide pro-salt can sterilize the infection for a period of at least 2 months, but the period of prophylaxis is less than this.

Insect Vector

Field Investigations

(a) The Ugbobigha Field Station in Southern Nigeria

58. Field studies on the various species of tsetse to be found in the vicinity of the Field Station have now been carried out for two years. As compared with the Kaduna area in the north, the climate at Ugbobigha is much more humid and although the extremes of temperature are not great, the mean monthly temperature tends to run at a considerably higher level throughout the year. The entomological results obtained will be given under the different species of tsetse studied.

(b) A Pilot Scheme to Assess the Value of Obstructive Clearing as a Practical Tsetse Control Measure

59. The field trial of the method of obstructive clearing, financed by C.D. & W. Scheme R.552, has been continued. Along the first two miles of stream cleared by this method in early 1954, the fly catches were reduced to zero by the following dry season. Some reinvasion took place during the height of the wet season in 1955 but this was due to immigrants from an uncleared stream during the rains. With the advent of the dry season these flies disappeared suggesting that even after two years conditions along the cleared streams are such that the fly cannot re-establish itself permanently even if it does get a foot-hold in the rains.

60. During January, 1955, a further 1½ miles of stream were cleared, unfavourable conditions of vegetation being deliberately accepted. The clearing was completed by the end of January and not a single fly has been seen on the experimental reach from April to December inclusive. Owing to much better isolation no wet season immigration took place.

61. The cost of the ruthless and partial clearings made to isolate the experimental sections was 678 man days per mile; the cost for the obstructive clearing of 3.75 miles of stream was only 390 man days per mile.

Laboratory Investigations

(a) Systematic Studies

62. The systematic study of the West African species of the *fusca* group of tsetse flies has been continued. A guide to the identification of these species by dissection of the genitalia is being prepared.

63. Over 400 flies of the *fuscus* group collected in various parts of the Cameroons have now been identified in the laboratory. *G. haningtoni* and *G. tabaniformis* made up 91 per cent. of the flies examined and would appear to be by far the commonest species. Both *G. fuscus* and *G. nigrofuscus* appeared rare and localised in their distribution. Seven specimens of the newly described *G. nashi* were collected from six widely separated localities.

(b) *Laboratory Rearing of G. Palpalis*

64. Basic research into the optimal conditions for rearing *G. palpalis* in the laboratory has been continued. The greater the average age of the female stock the lower is the reproductivity per female.

65. Experiments to assess the effectiveness of the breeding technique have been carried out on two isolated colonies of flies. One of these was given the opportunity of feeding every day, and after the initial expected decline, it increased 27 per cent. in seven months. The other was given the chance of feeding only every other day, and it was much slower in showing any increase, while, more important, the average weight of the pupae produced by this colony was consistently less than that for the colony which could feed every day. In the laboratory, at least, female flies remain sexually attractive to the male and are prepared to mate, irrespective of whether they have mated before, until they are about one week old. In older females, the desire for mating was shown to decrease rapidly with increasing age.

66. Older pupae are rather more resistant to submergence than younger ones are, but none can withstand inundation for four days.

67. During the year, the monthly production of pupae in the fly room averaged 4,900 as compared with 4,680 in 1954. Large numbers of pupae and flies were issued for experimental work to all sections of the Institute and to workers in other parts of the world; issues totalled 12,923 in 1955, as against 10,797 in 1954.

Scientific Communications

Publications

Reports and scientific papers published, or prepared for publication, during the year are listed below by Authors in alphabetical order.

DESOWITZ, R. S.—The Effect of Antibody on the Respiratory Rate of *Trypanosoma vivax*. *Nature* (in press).

Idem.—Observations on the Metabolism of *Trypanosoma vivax*.

DESOWITZ, R. S., and FAIRBAIRN, H.—The Influence of Temperature on the Length of the Developmental Cycle of *Trypanosoma vivax* in *Glossina palpalis*. *Ann. Trop. Med. and Parasitol.* Vol. 49, No. 2, pp. 161-163.

FAIRBAIRN, H.—The Animal Reservoirs of *Trypanosoma rhodesiense* and *Trypanosoma gambiense*. *Ann. Soc. Belge de Med. Trop.* Vol. 34, No. 5, pp. 663-669.

FAIRBAIRN, H., and WATSON, H. J. C.—The Transmission of *Trypanosoma vivax* by *Glossina palpalis*. *Ann. Trop. Med. and Parasitol.* Vol. 49, No. 3, pp. 250-259.

GALL, D., HUTCHINSON, M. P., and YATES, W.—Cerebrospinal-fluid Protein Estimation in Sleeping Sickness: Sicard and Cantaloube's Method and a Sulphosalicylic-acid Method. *Ann. Trop. Med. and Parasitol.* (in press).

NASH, T. A. M.—The West African Institute for Trypanosomiasis Research, Annual Report 1954. *Gaskiya Corporation, Zaria, Nigeria*.

Idem.—A Review of Professor P. A. Buxton's book entitled "The Natural History of Tsetse Flies". *Nature*, Vol. 176, No. 4486, pp. 755-756.

WILLETT, K. C., and FAIRBAIRN, H.—The Tinde Experiment: a Study of *Trypanosoma rhodesiense* during Eighteen years of Cyclical Transmission. *Ann. Trop. Med. and Parasitol* (in press).

NASH, T. A. M.—The Fertilisation of *Glossina Palpalis* in Captivity. *Bulletin of Ent. Res.* Vol. 46, Pt. 2. August, 1955.

NASH, T. A. M.—The West African Institute for *Trypanosomiasis* Research. Annual Report, 1955. *Gaskiya Corporation, Zaria, Nigeria.*

IV. ACTIVITIES OF TERRITORIAL DEPARTMENTS

68. Extensive and valuable work has been carried out during the year under review by the territorial departments of the African Administrations.

69. Local research in human trypanosomiasis is illustrated by the work of the Sleeping Sickness Unit of the Tanganyika Medical Department. Therapeutic trials with Mel B have been continued at Tabora Hospital. This drug is of real value in the treatment of advanced-stage cases and it is already possible to advise it as the standard treatment for the advanced-stage patient provided the patient can be treated in hospital under medical supervision. The Unit is to set up at Tabora a self-contained sleeping sickness ward for the treatment and clinical study of human cases.

70. In the veterinary field the growing importance of the treatment and control of trypanosomiasis by the use of drugs is reflected in many reports. Much experimental work has been carried out which paves the way for a better understanding of animal management under local conditions and for the introduction of more efficient trypanocidal drugs. Economically, this work is of great importance in present-day Africa. On the one hand, it offers promise of making available new pasture land in bush country hitherto dominated by the tsetse fly; on the other hand, it offers better hope of controlling the disease in grazing areas invaded by the fly, as, for instance, in Northern Rhodesia, where the problem of trypanosomiasis in cattle outside the known fly areas is reported to be assuming alarming proportions. The Annual Report for 1955 of the Northern Rhodesia Game and Tsetse Control Department remarks in this connection that it is no exaggeration to say that it is only the activities of the Veterinary Department and the efficiency of their trypanocidal drugs that is preventing enormous losses from occurring in many of their major cattle-producing areas.

71. The research work carried out in Northern Rhodesia included studies of cross resistance to drugs, in trypanosomes occurring in cases treated with Dimidium, Ethidium and Antrycide, and the control of tsetse flies by the use of insecticidal sprays. An isolated infested area of some 200 square miles at Chingola, was reduced by discriminative clearing from 1953 onwards to some 25 square miles. This was given five sprayings in the dry season of 1955 using 1 per cent. gamma-isomer B.H.C. in dieseline. An immediate reduction in fly of over 99 per cent. was observed and no increase in fly had been detected by the end of the year. Though some fly persists no build-up of fly was observed in 1955 in an area similarly sprayed at Mulungushi in 1954. Experiments continue with arboricides, but application by spraying has so far produced disappointing results.

72. Herbicides have shown similarly disappointing results in experiments in Northern Nigeria on riverine plants, which, because of their regenerative powers, form a problem in anti-tsetse clearing. A further experiment is to be made in Northern Nigeria in the use of residual D.D.T. applied against a fly

population predominantly *Glossina palpalis* with a few *Glossina tachinoides*. The first experiment of this sort begun in 1954 in Benue Province apparently destroyed the fly completely in the initial stages but fly returned during the ensuing rains. In the field of cattle trypanosomiasis the Veterinary Department of Northern Nigeria report that of the 9,777 slides examined during the year 888 (9.08 per cent.) showed *T. vivax*, 1,512 (15.4 per cent.) *T. congolense* and 109 (1.1 per cent.) mixed infection. The higher percentage of *T. congolense* in slides examined had been noted previously.

73. In the Gold Coast entomological research continued. The bionomics of the nine local species of tsetse are still under investigation, mainly by the method of age-grouping the trap catches in all the different climatic zones. The possibility of using improved types of traps as a control measure is being investigated in the course of this work. In the veterinary field, basic research continues on animals infected with trypanosomes especially as regards haematological and histo-pathological changes.

74. In Uganda, the Tsetse Control Department has embarked on experiments to control *Glossina palpalis* by spraying of insecticide. Preliminary trials with "Arkotine" have given promising results in the Toro district, using a method evolved recently in Kenya by the combined efforts of the Tsetse Control Unit of the Kenya Veterinary Department and the Colonial Insecticides Research Unit. Another new development of particular interest in Uganda is the beginning of a service for identifying the sources of food of wild tsetse flies. With the collaboration of Mr. B. Weitz of the Lister Institute of Preventive Medicine, animal hosts are identified from smears of the gut contents of engorged tsetses on filter paper. One result to date is to confirm that in Uganda the hippopotamus is a highly important source of food for *Glossina brevipalpis*.

75. The Department of Veterinary Services in Kenya continues to make a notable contribution to the control of animal trypanosomiasis by the use of drugs. Work on the temporary use of tsetse infested areas for relief grazing of cattle protected by various drugs was continued. Previous experiments suggested that the degree of prophylaxis afforded by antrycide pro-salt might depend upon the "challenge" which the drug had to withstand, i.e. the virulence of the trypanosomes and the frequency of infected bites.

76. As a result, a further series of experiments was conducted in order to ascertain when antrycide resistance would develop under different fly densities and if a more economical method of dosing could be evolved. 1,000 native-owned cattle were placed in the Simba district in a low fly density and treated with antrycide pro-salt at two-monthly intervals. A final dose of antrycide methyl sulphate was given before return to the reserve at the end of six months. At the beginning of the experiment .06 per cent. of the animals were infected before the first treatment. No trypanosomes were detected by blood and gland smear examination in any of them at the end of the second and fourth months but by the end of the six month period before the final treatment with the methyl sulphate, 0.24 per cent. had become infected.

77. At Makindu 900 native-owned cattle were admitted for six months to an area, the boundary of which was only one mile away from bush with a *G. pallidipes* density reaching 500 at certain times of the year. These animals were given antrycide pro-salt before entry and at two-monthly intervals. At the end of six months they were all treated with ethidium bromide and returned to the reserve. Before the first injection with antrycide pro-salt the infection rate in the herd was 0.12 per cent. At the end of two months the infection rate was 0.58 per cent., by the end of the fourth month it was 0.41 per cent., and it reached 2.0 per cent. by the end of the sixth month.

78. Further experiments are now being conducted in a light fly area using antrycide methyl sulphate at two-monthly intervals to investigate whether in light fly densities the cost of treatment cannot be reduced by using the methyl sulphate only.

79. Experiments on the use of dieldrin as a spray against tsetse flies have indicated that this insecticide may be more effective in the field than D.D.T. at a similar or even lower cost.

80. Studies on the ecology of *G. austeni* have shown that it can be controlled by merely cutting out the undergrowth until the light intensity and temperatures are so increased that it finds its habitat is no longer congenial and does not deposit pupae. Also, it has been demonstrated that in selected sites for larviposition *G. austeni* favours the densest types of forest and chooses areas where light in the undergrowth is less than 10 per cent. of that outside it.

81. Experiments with aboricides have been carried out in collaboration with the Colonial Insecticides Research Unit using 2, 4, 5-T. on various types of vegetation and on "sodom apple" (*Solanum*) in pasture lands but so far with no great success.

V. GENERAL

82. Since the inception of the International Scientific Committee for Trypanosomiasis Research in 1948, the Committee's secretariat has been provided by the Colonial Office as an arrangement of convenience. By agreement this responsibility was transferred in 1955 to the secretariat of the Commission for Technical Co-operation in Africa South of the Sahara. This has severed a link between the Tsetse Fly and Trypanosomiasis Committee and the International Committee, since both were served in the past by the same Colonial Office secretariat.

Report of the Director, Anti-Locust Research Centre, on Locust Research and Control, 1955-56

Anti-Locust Research Centre,
1, Princes Gate,
London, S.W.7.
11th June, 1956.

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 1955-56.

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 1955-56

ANTI-LOCUST RESEARCH CENTRE

Personnel

1. The Principal Scientific Officer vacancy has been filled by the appointment of Dr. P. T. Haskell as Senior Scientific Officer from 1st October.

2. In addition to Dr. R. C. Rainey, Senior Principal Scientific Officer of the Desert Locust Survey, who continued to be attached to the Centre, Dr. W. J. Stower and Messrs. J. F. Griffiths, G. Popov and H. J. Sayer were posted by the Survey to the Centre for long periods for working out their field results. This arrangement serves to mitigate the disadvantage of field workers being out of touch with current fundamental research and is of great value for the general co-ordination of field and laboratory investigations, which is further strengthened by the Centre's personnel frequently going out for field work and visits to regional organisations (*see* paragraph 6). Dr. J. P. Dempster, of the Cyprus Moroccan Locust Research Team, has also been attached to the Centre while preparing a report on his work with the Team.

Accommodation

3. The necessary modifications and equipment of the new premises for the Centre at 1, Princes Gate, Kensington, have been carried out, and the move was effected in January 1956, except the Locust Laboratory, the equipment of which is not yet completed, and the Taxonomic Section for which the Trustees of the National History Museum have provided a room in the Entomology Department.

Locust information service

4. The current Desert Locust plague continued on a large scale in 1955. During the year the Centre received 1,171 reports on the locust situation from 42 territories, and much of the time of the Geographical Section was taken up in the plotting of current information and the preparation of monthly summaries and forecasts. In addition, special memoranda and maps illustrating current plague developments were prepared for the meetings of the F.A.O. Desert Locust Control Committee at Rome in April and Damascus in August, and special maps and a memorandum on Desert Locust infestations in the Ethiopian-Somali area and on their importance to other countries, were prepared for the meeting on Desert Locust control in that area convened by F.A.O. at Addis Ababa in February, 1956.

5. Abstracts of current literature issued during the year numbered 262 and they have been distributed to nearly one hundred institutions and research workers.

Conferences, tours and lectures

6. Dr. Uvarov attended a Franco-Spanish meeting on Desert Locust control in Western Africa organised by F.A.O. in January in Madrid, where he also gave a lecture in the Instituto Español de Entomología. In February he paid a visit to the research unit investigating swarm behaviour in East Africa (paragraph 25). In April, he attended a meeting of the F.A.O. Technical Advisory Committee in Rome. In late April-May he was invited to take part in the Arid Zone Symposium arranged by the American Association for the Advancement of Science and UNESCO in New Mexico and visited the Range Grasshopper Research Branch, U.S. Agricultural Service, in Arizona, as well as the headquarters of the Agricultural Research Service at Beltsville and the University

of Illinois where two invitation lectures were given. In May–July he travelled in East Africa, Somalilands, Ethiopia and Arabia with the Desert Locust Control Commission appointed by the East Africa High Commission to review the operations of Desert Locust Control and to make recommendations for the future. In August Dr. Uvarov attended, as Consultant, a session of the F.A.O. Technical Advisory Committee on Desert Locust Control at Damascus. Between the end of September and early November, he attended the annual meeting of the Council of the International Red Locust Control Service at Pretoria, to which also he is consultant, and carried out an extensive tour of the areas infested by the Brown Locust, at the invitation of the Government of the Union of South Africa ; during the tour, lectures on current locust research were given at the Universities of Pretoria, Cape Town and Grahamstown. Dr. Taylor visited Cyprus in May to discuss the final stages of research on the ecology of the Moroccan locust. He also attended in June a meeting in Paris of the Executive Committee of the International Council for the African Migratory Locust and the full meeting of the Council itself. In November–December he carried out an extensive tour in Ethiopia, Somalilands and Saudi Arabia to visit research workers in the field, with the Director of the Desert Locust Survey. Miss Z. Waloff, carried out field reserach on swarm behaviour in East Africa in February–March.

7. Dr. Rainey read a paper on “Recent data on movements of Desert Locust swarms”, by himself, Miss Waloff and Mr. H. J. Sayer, to Section D of the British Association meeting at Bristol in September. Mr. A. T. Thompson gave a talk on the locust problem to the South London Natural History Society in December.

Locust research discussions

8. Taking advantage of the fact that several locust research workers from abroad were posted to the Centre, while a number of others were on home leave, the Centre organised in July a series of informal discussions on current research. The original intention was a modest one, but the plan developed on an unexpected scale, since locust workers from several overseas countries also wished to take part. As a result, the meetings were attended by acridologists from Canada, Cyprus, Denmark, East Africa, France, French Sudan, Israel, Yugoslavia, Northern Rhodesia, South Africa and Syria, as well as by research workers from several universities and other institutions in the United Kingdom. The meetings lasted a week and covered a wide range of current, mainly unpublished, investigations ; they were particularly valuable because the discussions were completely informal and served to stimulate individual workers as well as to direct attention to the problems which require particular attention at present.

Students and visitors

9. Owing to the lack of accommodation it was not possible to accede to several requests to accept foreign students for training, although this would be very desirable from the point of view of the general development and co-ordination of research. An exception was made for Mr. Z. Gradojevic, an F.A.O. scholar from Yugoslavia, who was attached first to the Moroccan Locust Research Team in Cyprus and then continued his research training at the Centre. Mr. N. Anderson, a Fulbright research student, was attached to the Centre for a short period before going abroad for field work on locust behaviour with the Desert Locust Survey and the International Red Locust Control Service. Mr. L. C. Putnam, entomologist in charge of grasshopper research in Canada, also spent several weeks at the Centre and visited two organisations in Africa.

Locust Laboratory

10. The main emphasis has been on breeding *Schistocerca* and about a third of a million hatchlings and 26,000 adults were produced during the year. Most of these were used within the Centre, and supplies were regularly sent to research workers of the Centre at Oxford and Porton, as well as to many other laboratories and research workers in this country and on the Continent. An albino strain of *Schistocerca* appeared in the laboratory and is being maintained by breeding; it is expected to be useful in research, particularly on pigments and phase variation. Stocks of *Locusta*, *Nomadacris*, *Anacridium* and *Eyprepocnemis* were also maintained and a stock of *Romalea* was established. The popularity of locusts for research and teaching purposes continued to increase, and to encourage this, a pamphlet of instructions for rearing and breeding locusts has been published for free distribution.

11. Experimental work in the Locust Laboratory was continued by Mr. P. Hunter-Jones (effects of locust parental density on the offspring), Dr. M. J. Richards (seasonal factors in maturation of locusts; density effects on feeding and maturation), Mr. G. Cavanagh (effects of food and flying on weight and maturation), and Mr. A. Antoniou (life-cycle of *Eyprepocnemis sp.*).

Extra-mural research

12. Dr. P. E. Ellis, apart from a period of field work (para. 23) continued at Oxford her comparative studies of marching, feeding and aggregation in several locust and grasshopper species.

13. Dr. R. H. Dadd, at the Imperial College of Science and Technology, commenced studies of locust nutrition and was able to formulate an artificial diet on which Desert Locust nymphs developed successfully. Such a diet, when perfected, would make it possible to carry out a number of experiments on the factors of locust metabolism and growth; at present, the results of such experiments tend to be affected by the uncertain composition and variation of natural food, such as grass.

14. Dr. S. A. Malek, of the University of Alexandria, working at Manchester University, commenced extensive researches on the structure, formation and hardening of the integument in different stages of locust development. When completed, the results should contribute greatly to a better understanding of locust physiology, as well as to the problem of insecticide action.

15. Mr. D. A. H. Hearfield, working at the University of Leeds, studied the biochemistry of the blood and fat body of locusts. Dr. G. Hoyle, at the University of Glasgow, studied the anatomy and physiology of the nervous system and the nervous control of muscular activity.

16. Dr. Eleanor Slifer, of the Iowa University, was awarded a Senior Fulbright scholarship for research on the fine structure and innervation of thermoreceptive areas in Acrididae which she carried out at the University of Birmingham. Other independent extra-mural research in this country and abroad continued to expand.

Taxonomic Research

17. The completion of the Catalogue of African Grasshoppers by Mr. H. B. Johnston has made it possible for Dr. V. M. Dirsh to commence the preparation of keys to African genera. Miss J. B. Mason has been carrying out a survey of the gross structure of the tympanal organ in Acrididae in relation to taxonomy and wing development.

Biogeographical research

18. Further progress has been made in the season-by-season analysis of the development of the current and preceding Desert Locust plagues, and in the re-examination, in the light of recent information on swarm movements and behaviour, of the historical data on the inter-plague periods. The results suggest the possibility that some swarming populations occurring within the Desert Locust distribution area during the inter-plague periods may sometimes play an important part in recrudescence of the plagues.

19. The preparation of the annual and seasonal frequency maps of swarm incidence and of gregarious breeding over the total distribution area of the Desert Locust has been completed for 1938–53; these years were selected as being the best documented and most representative of both the plague and the inter-plague periods. The maps have demonstrated the existence of several areas with particularly high frequencies of hopper and swarm infestations, and will be of value for the planning of long-term investigations and control of the Desert Locust.

Statistical investigations

20. In connection with Miss Z. Waloff's field work (para. 22), Mr. D. E. Davies has been concerned with covariance analysis of data provided from analyses of lipid dry tissue and moisture content of field samples of Desert Locusts and with estimation of heights and volume densities of flying swarms from photographs. Two parameter distributions of various types have been fitted to egg-field data obtained by Mr. G. Popov and data on egg-parasite distribution collected by Mr. D. J. Greathead. Statistical analysis of morphometric data of laboratory-bred locusts has been completed for Mr. P. Hunter-Jones and analyses of similar data on field samples of Moroccan Locusts are being continued.

Control investigations

21. The previous policy of close co-operation with regional organisations and industry has been continued. An extensive programme of research on insecticides by a small unit from the Centre, under Mr. R. D. MacCuaig at the Ministry of Supply Chemical Defence Experimental Establishment, Porton, included tests of sprays applied to flying locusts in a wind-tunnel, studies on the cumulative toxicity of dinitro-ortho-cresol, γ BHC and diazanone and tests of new insecticides.

Field research

22. Miss Z. Waloff took part in further observations, and photographic and cinematographic recording, of the behaviour of Desert Locusts in swarms, in conjunction with the Airspray Unit of the Desert Locust Control Organisation. Special attention was paid to the factors leading to the continued cohesion of flying swarms, in spite of the disruptive effects of convective turbulence and wind, and to the variation in weight and fat content of locusts in relation to their maturation, feeding and flight activity.

23. Dr. P. E. Ellis spent about three months in the field in Ethiopia supplementing her previous research on the behaviour of hopper bands of the Desert Locust.

24. Mr. D. J. Greathead continued his survey of parasites and predators of the Desert Locust in Kenya and Eritrea. Part of the year was spent in London in identifying the material, preparing descriptions of parasites and analysing numerical data on field infestations.

REGIONAL ORGANISATIONS

Desert Locust Survey

25. A vast accumulation of data resulting from field investigations on locust ecology, behaviour, etc., carried out very intensively during the last few years, suggested the need for taking stock of the available information before proceeding further with field work. Accordingly, some of the Survey's research workers were posted to the Centre for various periods in order that they might work out their accumulated results and prepare them for publication (paragraph 2). Such field investigations as have continued included observations on swarm behaviour by a group of scientists from the Survey, with Miss Z. Waloff from the Centre and Dr. P. T. Haskell from the Imperial College (now on the staff of the Centre). Dr. P. E. Ellis spent two periods with the Survey in field work on hopper behaviour. Mr. G. Popov of the Survey continued investigations on the ecology of oviposition until he was posted to the Centre for analysing the results; at the end of the year he was loaned to the International African Migratory Locust Organisation (paragraph 27). Intensive investigations on the assessment and improvement of control methods, particularly aircraft spraying, under Mr. D. J. McDonald of the Survey, continued throughout the year.

International Red Locust Control Service

26. Good progress has been maintained in the quantitative assessment of locust populations. Experiments in controlling grass fires from certain areas by fire-breaks demonstrated that the exclusion of fires has definitely influenced the distribution of locusts. Studies on locust behaviour in relation to vegetation indicated the relative importance of certain grass species as food, affecting movements of adults. Detailed assessments and critical evaluation of the costs of the various control methods, including aircraft spraying, produced valuable data for the planning of operations.

Provisional International Council for the Control of the African Migratory Locust

27. The Research Service of this organisation, now consisting of Mr. J. T. Davey and Dr. B. Nickerson, former research scholar of the Centre, continued to study movements of adult locusts; the seasonal pattern of such movements has been established and observations are in progress on the conditions in which they occur, especially at night. Towards the end of the year, the services of Mr. G. Popov, of the Desert Locust Survey, were loaned to the organisation in order to study the ecology of egg-laying by the Migratory Locust; this provides an interesting example of interchange of specialised personnel between regional organisations.

Cyprus Locust Research Team

28. The field work of the Team was completed in the spring and its members are now engaged in preparing comprehensive reports for publication.

LOCUST CONTROL

29. The Niger outbreak area of the African Migratory Locust and the Rukwa Valley and Mweru-Wantipa outbreak areas of the Red Locust continued to be supervised by the respective permanent international organisations and no escapes of swarms occurred.

30. The Desert Locust situation continued to be grave for most of the year, but by the end of the year the infestation, although heavy, was more or less localised in north-western Africa and the Arabian Peninsula. The International

campaign in the latter area, co-ordinated by the Food and Agriculture Organisation of the United Nations, was intensified, but the total effort continued to be inadequate. Moreover, in 1956 its international character was undermined by the request of the Saudi Arabian Government that the British Unit should be withdrawn. On the other hand, there were most hopeful beginnings of international co-operation in locust control in the Ethiopia-Somali area, with the Imperial Ethiopian Government taking a prominent part in the campaign.

CO-OPERATION WITH INTERNATIONAL ORGANISATIONS

31. Dr. Uvarov acted as Consultant to the FAO Technical Advisory Committee on Locust Control during its meetings and special memoranda, maps, etc. compiled by the Geographical Section of the Centre provided the background for planning international campaigns against the Desert Locust.

32. The World Meteorological Organisation has instituted a programme of research on synoptic meteorology in relation to locusts and appointed an expert, Dr. E. B. Kraus, who made a preliminary survey of the problem and submitted recommendations. Another expert, Mr. C. I. H. Aspliden, is continuing to develop the programme, in close co-operation with the Centre and the Desert Locust Survey.

33. At the invitation of UNESCO, Dr. Uvarov prepared for publication a survey of literature on the locust and grasshopper problem of arid lands and read a summary of it at a meeting in New Mexico (paragraph 6).

APPENDIX I

ADVISORY COMMITTEE ON ANTI-LOCUST RESEARCH

Membership

- SIR GEOFFREY EVANS, C.I.E., M.A. (*Chairman*).
- MR. G. A. BULL, B.Sc., Meteorological Office, Air Ministry.
- DR. W. E. CHINA, M.A., Keeper of Entomology, British Museum (Natural History).
- SIR GEOFFREY CLAY, K.C.M.G., O.B.E., M.C., Agricultural Adviser to the Secretary of State for the Colonies.
- MR. C. W. G. DAKING, B.Sc., Meteorological Office, Air Ministry.
- MR. J. R. DOWNIE, M.A., Colonial Office.
- DR. W. J. HALL, C.M.G., M.C., Director, Commonwealth Institute of Entomology.
- MR. G. E. PATRICK, B.Sc., Ministry of Supply, D.A. Arm.
- 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

ANTI-LOCUST BULLETINS

GUICHARD, K. M., 1955. Habitats of the Desert Locust (*Schistocerca gregaria* Forskål) in Western Libya and Tibesti. *Anti-Locust Bull.*, London, No. 21 : [4+] 33 pp., 4 maps, 10 pls.

VESEY-FITZGERALD, D. F., 1955. The vegetation of the outbreak areas of the Red Locust (*Nomadacris septemfasciata* Serv.) in Tanganyika and Northern Rhodesia. *Anti-Locust Bull.*, London, No. 20 : [2+] 31 pp., 8 pls.

JOURNAL PAPERS

ALBRECHT, F. O., 1955. La densité des populations et la croissance chez *Schistocerca gregaria* (Forsk.) et *Nomadacris septemfasciata* (Serv.); la mue d'ajustement. *J. Agric. trop. Bot. appl.*, Le Mans, 2 : 110-192, 24 figs.

BUCHTHAL, F. & WEIS-FOGH, T., 1956. Contribution of the sarcolemma to the force exerted by resting muscle of insects. *Acta Physiol. scand.*, Stockholm, 35 : 345-364, 12 figs.

CHAPMAN, R. F., 1955. Roosting behaviour in some African grasshoppers. *Ent. mon. Mag.*, London, 91 : 76-81, 4 figs.

CHAPMAN, R. F., 1955. Some temperature responses of nymphs of *Locusta migratoria migratorioides* (R. & F.) with special reference to aggregation. *J. exp. Biol.*, Cambridge, 32 : 126-139, 4 figs.

DAVEY, J. T., 1956. A method of marking isolated adult locusts in large numbers as an aid to the study of their seasonal migrations. *Bull. ent. Res.*, London, 46 : 797-802.

DEMPSTER, J. P., 1955. Factors influencing small-scale movements of some British grasshoppers. *Proc. R. ent. Soc. Lond.* (A) 30 : 145-150, 2 figs.

DIRSH, V. M., 1955. Contribution a l'étude de la faune entomologique du Ruanda-Urundi. *Ann. Mus. Congo belge*, 8vo., Tervuren, (Zool) 40 : 67-72.

DIRSH, V. M., 1955. Revision of the genera *Cardenius* I Bolivar, *Cardeniopsis* gen. n. and *Cardenioides* gen. n. (Acridoidea, Orthoptera). *Publ. cult. Cia Diamant, Angola*, Lisbon, no. 24 : 85-113, 101 figs.

DIRSH, V. M., 1955. Tanaoceridæ and Xyronotidae: two new families of Acridoidea (Orthoptera). *Ann. Mag. nat. Hist.*, London, (12) 8 : 285-288, 1 fig.

DIRSH, V. M., 1956. Preliminary revision of the genus *Catantops* Schaum and review of the group Catantopini (Orthoptera, Acrididae). *Publ. cult. Cia Diamant, Angola*, Lisbon, no. 28 : 151 pp., 518 figs.

HAMILTON, A. G., 1955. Parthenogenesis in the Desert Locust (*Schistocerca gregaria* Forsk.) and its possible effect on the maintenance of the species. *Proc. R. ent. Soc. Lond.* (A) 30 : 103-114, 1 pl.

HASKELL, P. T., 1955. Locust research discussions in London. *Nature, Lond.*, 176 : 590-591.

HASKELL, P. T., 1955. Further observations on the occurrence of *Sphex aegyptius* Lep. (Hym. Sphecidae) with swarms of the Desert Locust. *Ent. mon. Mag.*, London, 91 : 284-285.

HOYLE, G., 1955. Functioning of the insect ocellar nerve. *J. exp. Biol.*, Cambridge, 32 : 397-407, 11 figs.

JONES, B. M., 1956. Endocrine activity during insect embryogenesis. Function of the ventral head glands in locust embryos (*Locustana pardalina* and *Locusta migratoria* Orthoptera). *J. exp. Biol.*, Cambridge, **33** : 174-185, 1 pl., 3 figs.

KERMACK, W. O. & STEIN, J. M., 1955. Non-protein nitrogenous constituents of locust muscle. *Biochem. J.*, Cambridge, **61** : xvi.

KETTLEWELL, H. B. D., 1955. Labelling locusts with radioactive isotopes. *Nature, Lond.*, **175** : 821-822.

KILBY, B. A. & NEVILLE, E., 1956. Aminoacid metabolism in locust tissues. *Biochem. biophys. Acta.*, New York & Amsterdam, **19** : 389-390.

ROBERTSON, I. A. D., 1954. The numbers of eggs in pods of the Red Locust, *Nomadacris septemfasciata* (Serville) (Orth., Acrididae). *Ent. mon. Mag.*, London, **90** : 254-255.

SAYER, H. J., 1956. A photographic method for the study of insect migration. *Nature, Lond.*, **177** : 226, 1 fig.

STEIN, J. M., 1955. The occurrence of lanthionine in locust muscle. *Chem. & Ind.*, London, No. 27 ; 774.

TAYLOR, T. H. C., 1955. Locust reporting and anti-locust research. *Trop. Agriculture, Trin.*, **32** : 186-192.

VESEY-FITZGERALD, D. F., 1955. Vegetation of the Red Sea coast south of Jedda, Saudi Arabia. *J. Ecol.*, London, **43** : 477-489, 1 map, 7 pls.

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

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A. BUILDING AND HOUSING RESEARCH

1. Despite the small increase in staff, mentioned in the previous report, the Colonial Liaison Section, Building Research Station, Department of Scientific and Industrial Research, has continued to find it no easy task to meet present commitments. In part this is due to the fact that it was necessary to make a number of emergency and special, as well as routine, visits overseas. During the period, the Colonial Liaison Officer, as Housing Adviser to the Colonial Office, flew out at short notice to Barbados, Grenada and British Honduras to assist in plans for hurricane reconstruction, while other members of the Section made special visits to Gibraltar and Kenya; in addition, an architect was overseas for the whole period assisting first the British Guiana and later the Barbados Governments. And in part it is due to the growing calls for assistance of an advisory character—discussions have taken place during the year either in London or overseas with ministers or senior officers in 22 territories (Barbados, British Guiana, British Honduras, Fiji, Gambia, Gibraltar, Gold Coast, Hong Kong, Jamaica, Kenya, Leeward Islands, Federation of Malaya, Malta, North Borneo, Northern Rhodesia, St. Helena, Singapore, Tanganyika, Trinidad, Uganda, Windward Islands and Zanzibar)—and to the widening character of the Section's work—which now spans from problems of air-conditioning to town planning legislation. In relation to the quite substantial expenditure on building under the Colonial Development and Welfare Acts—let alone the very large direct expenditure by Colonial governments during the last ten years—the provision for this central building and housing advisory and research service has been slight, especially as similar services overseas at regional or territorial levels do not yet exist or have only recently been established.

Visits

2. Members of the Section made many visits overseas during the year; the aggregate time spent abroad by six officers exceeded forty weeks. Territories visited included: Fiji, Gambia, Gibraltar, Hong Kong, Kenya, Federation of Malaya, Malta, Sierra Leone, Singapore, the Rhodesias, Tanganyika, Uganda, the West Indies and Zanzibar. One officer also visited the U.S.A. to attend the Conference on Solar Energy at Phoenix, Arizona.

3. Two visits made by the Colonial Liaison Officer were of an emergency nature: the first was to discuss housing and building prior to financial discussions in London between Her Majesty's Government and the Government of Malta; the second to Barbados, Grenada and British Honduras—to advise on reconstruction after the hurricane of September, 1955.

Enquiries and Technical Investigations

4. *Climatological studies.* The close cooperation on climatology and building problems with the Meteorological Office has continued. Particular attention has been given to the possibility of meeting the specialised requirements of building research by punched card techniques using standard meteorological data on a suitably designed punched card format. On the initiative of the Building Research Station, representatives of other D.S.I.R. organisations working in the colonial field have been brought into the discussions, and a joint working party has been formed which meets at regular intervals. The object of these meetings is to try to provide the Colonial Meteorological Services with suitable information on probable trends in climatological requirements of the various specialised research organisations represented together with suggestions as to how they could be met in practice. The discussions, which have so far taken place, have shown that much common ground exists between different research

organisations, and it appears likely that standard meteorological data on punched cards will meet the majority of research requirements. However, more information on solar radiation and rainfall intensity is needed. Special working parties are to be established to discuss these two requirements in more detail.

5. An officer of the Section visited Trinidad to make a special climatological study of the site of a new hostel building to be erected at the Imperial College of Tropical Agriculture. A grant of £50,000 towards the cost of this building has been given by the Nuffield Foundation. The design is being carried out by the Foundation's Division for architectural studies, which sponsored the visit.

6. During this visit useful discussions on building climatology took place with the Director of the British Caribbean Meteorological Service. The opportunity to visit the U.S. Weather Bureau at Puerto Rico was also taken. The air hurricane location group operates from this centre and useful information about hurricane trends was obtained.

7. During the year much attention has been given to special studies of radiation; and techniques have been established for estimating both direct and diffuse radiation under a wide variety of conditions. The problem of the estimation of radiation on inclined surfaces has received special attention. The temporary services of a computer enabled more rapid progress to be made for a time. It has not so far been possible to write up the large volume of data acquired, but this is under way.

8. *Solar water heating and solar distillation.* An officer of the Section attended the World Symposium on Applied Solar Energy at Phoenix, Arizona, in November, 1955. This visit was sponsored by the Rockefeller Foundation. Interest in solar water heating in the colonial territories is increasing, but it has not so far been possible to prepare a report on the subject. The preliminary analysis of the questionnaire sent out two years ago, however, has been completed, and it appears that correctly designed solar water heaters will prove more economic than electrical immersion heaters in most colonial territories. A report on solar distillation for supply of drinking water has been prepared. These prospects appear very much less favourable.

9. *Air conditioning.* Interest in air conditioning overseas is developing rapidly, and there are a number of technical problems which require urgent investigation. The small scientific staff of the Section, however, makes it impossible to give more than a perfunctory attention to this increasingly important topic. A survey of present difficulties, however, has been made, and a short factual report based on the recent visit of the Colonial Liaison Officer to the Far East has been prepared. The present situation is, however, not satisfactory. The pace at which air conditioning is being introduced into a number of territories is quickening, and more accurate information on the basis of which air conditioned buildings can be designed and cooling loads assessed is required. In the absence of an alternative, designers tend to turn to American sources of information, which may not be directly applicable.

10. *Pumice concrete.* In the autumn of 1955 another officer visited Nairobi at the request of the Kenya Government. The main purpose of the visit was to assist in the solution of technical problems connected with the use of pumice concrete in the construction of some 5,000 houses and flats. Existing pumice concrete buildings, sponsored by the Department of Education, were inspected and tests were initiated in the Materials Laboratory of the Public Works Department. A general report on the use of pumice for building in Kenya with particular reference to its use in the Nairobi housing project was issued later.

11. *Grain storage pits.* While in Tanganyika underground grain storage pits were inspected and a short report prepared. The inspection of some pits was undertaken in conjunction with an officer from the Pest Infestation Laboratory (D.S.I.R.).

12. *Technical studies on building materials.* It was mentioned in last year's report that a study was being made of the use of bituminous felts in flat roof construction. This study was augmented by the results of a survey of the behaviour of bitumen felts in East Africa during the autumn of 1955. A report has now been issued as a Colonial Building Note (No. 38).

13. Following this visit to East Africa further reports were issued on the use and production of lime prepared from coral limestone and on the manufacture of burnt clay products.

14. *Liaison and enquiry work on materials.* A plan to make use of the deposits of pozzolana and limestone in St. Vincent for the manufacture of building materials has been finally prepared and submitted to the appropriate authorities. This was done in collaboration with the Mineral Resources Division, Colonial Geological Survey. Preliminary discussions have also taken place with the Pest Infestation Laboratory in connection with the storage of cocoa in West Africa.

15. *Architectural, housing and town planning matters.* Work in this field has again been very diversified. Co-operation and exchange of information with all three Service Departments on overseas building problems has continued. This applies also to consultation with the Crown Agents for Oversea Administrations and the Ministries of Works, and of Housing and Local Government. Advice has been given on problems such as the design of post offices and telephone exchanges in Nigeria and a legislation chamber in Trinidad. Assistance was also given to the Volta River Preparatory Commission. The study of overseas planning legislation has continued and several territories have been assisted in drafting their ordinances. Suggestions for a building code has been sent to St. Helena.

16. *Dissemination of technical information : publications.* The fifth course for architects and engineers in H.M. Oversea Civil Service was held in September, 1955. Special visits were arranged in connection with the subjects dealt with during the course ; these included the Cement and Concrete Association's Research Station, the Forest Products Research Laboratory, an asbestos-cement factory and various buildings under erection by the London County Council. Similar visits of an instruction character were also arranged for various overseas visitors, including a number of United Nations Fellows.

17. The Section again assisted with lectures at the London School of Hygiene and Tropical Medicine, the School of Tropical Architecture (Architectural Association) and the Ministry of Labour (courses for Oversea Labour Officers).

18. The demand for Colonial Building Notes continues to increase. About 900 copies of each issue are now circulated to governments and others overseas. During the year eight issues were published. They and other published work of the Section are listed below :—

Woodhouse, W. M.

“ Housing in the West Indies ”. “ Corona ”. July, 1956. (H.M.S.O.)

Colonial Building Notes

No. 31, Commonwealth countries with warm climates : research into warm climate building problems. Planning legislation in the colonies. Etc.

No. 32, Review of facilities for research and technical information for building and housing in less technically developed areas, including the Commonwealth. Etc.

No. 33, The use of gypsum and anhydrite in building ; with an appendix on the manufacture of gypsum plasters. Etc.

No. 34, Concrete building blocks : their manufacture and use. A note on the testing of concrete blocks.

No. 35, Housing in Hong Kong : 1954-1955. Housing Malaya : 1954. Town planning in the African city, Leopoldville, Belgian Congo. Etc.

No. 36, Miscellaneous information on housing and building.

No. 37, Sudan ; low-cost housing in Khartoum. Experimental houses built of hollow soil-cement blocks ; tests at Vereeniging by the National Building Research Institute, Pretoria. Uganda ; low-cost housing using post-and-panel construction. Etc.

No. 38, Bituminous roofing felts : their use in flat roof construction in tropical regions. Early experiences with bituminous roofs.

B. FALKLAND ISLANDS DEPENDENCIES SURVEY**1955-56 Season****Introduction**

19. Ten main bases are at present maintained on the mainland of Graham Land and its offlying islands ; two of these bases, on the Danco Coast and the Loubet Coast, were established this year.

20. The Falkland Islands Dependencies Survey Scientific Bureau in London has continued to publish the results of the field work in the series " F.I.D.S. Scientific Reports ".

21. During Dr. Fuchs absence with the Trans-Antarctic Expedition Sir Raymond Priestley has assumed duty as acting Director of the Bureau.

22. The annual relief of the Survey's bases has been carried out this year by the Royal Research Ships " John Biscoe " and " Shackleton ".

Field Work

23. (a) *Sledge journeys.* A main sledge journey of 900 miles was made from the Hope Bay area in addition to several supporting journeys. Short journeys have also been made from Horseshoe Island and Anvers Island.

(b) *Topographical Survey.* A start has been made on a systematic aerial survey by Huntings Aerosurveys Ltd., using Canso Aircraft and Helicopters operating from the " Oluf Sven ".

The third South Georgia Survey Expedition, leader Mr. Duncan Carse, completed the survey of the island incidentally identifying the route of Shackleton's 1911 crossing.

Local surveys have been continued at all bases.

(c) *Geological Survey.* At Anvers Island an intensive examination has been made of the Copper Peak area and further fossil collections have been made from Hope Bay. A geological survey of Doumer Island has been made.

(d) *Geomorphology.* The study of the geomorphology of Deception Island has been continued.

(e) *Biology.* An ornithological survey of Doumer Island has been carried out. Bird ringing has been continued at Port Lockroy and Signy Island and a number of recoveries made. A study of the life cycle of the Dove Prion (*Pachyptila desolata*) has been made at Signy Island. The mass death of thousands of Crabeater Seals on the sea ice south of Hope Bay has been observed and specimens collected for investigation of the cause of the holocaust.

(f) *Medical.* A full programme of physiological research, investigating cold acclimatisation from many aspects, has now been completed.

(g) *Ionospheric observation.* Has been continued at Port Lockroy.

(h) *Radio-sonde.* Ascents have been continued, a height of 73,500 feet having been reached on one occasion.

(i) *Other Work.* Routine meteorological and ice observations have been continued. Ice observations have been co-ordinated by a special investigator who will work up the results in the United Kingdom after his return. A systematic study of the physiology of sledge dogs has been carried out and the dog breeding and training programme at Hope Bay has been continued. Comparative studies have been made of various diets and the factors affecting the work of sledge dogs have been studied with the help of a specially devised Strain Gauge apparatus.

C. GEODETIC AND TOPOGRAPHIC SURVEYS

Staff

24. Recruitment of qualified surveyors and of cartographic draughtsmen remains difficult and the full complement of staff has not yet been reached. The total in post on 1st April, 1956, was 300, including a few Officers and senior Other Ranks seconded from the Royal Engineers (Survey).

Geodetic Surveys

25. Exceptionally adverse weather has slowed down progress almost everywhere.

26. In Tanganyika most of the eastern portion of the first order chain was observed between Morogoro and the Nachingwea base.

27. Observations connecting the Kenya chain to the Tanganyika network in the vicinity of the Usambara Mountains and to the east of Mt. Kilimanjaro were completed and observations of the main chain were carried northwards to approximately 37° 30' E. where work had to be suspended owing to the presence of Mau Mau gangs in the area.

28. In Swaziland the beaconing of the primary network is complete but a considerable amount of observing remains to be done.

29. Reconnaissance of the chain in Uganda to connect the 30th Meridian Arc in the vicinity of Mbarara to the Kenya chain north of Kisumu is complete and beaconing is in progress.

30. In Northern Rhodesia a network of primary triangulation connecting the Southern Rhodesia system to the south of Livingstone with the Northern Rhodesia triangulation around Lusaka and Namwala has been reconnoitred. Beaconing and observing are in progress.

31. Work commenced in North Borneo at the beginning of January to extend the primary triangulation framework of that Territory.

32. Precise traversing has been continued in the Gambia throughout the year. Preliminary computations indicate a satisfactory closure of the first loop.

Minor Triangulation and Photo Control

33. In Tanganyika, mapping control for 20,000 square miles of country between Dar es Salaam and Iringa and in the Kilombero Valley has been completed, together with 7,500 square miles in and around the Usambara mountains. The latter control is being extended eastwards to the sea and southwards to connect with previous work in the Dar es Salaam area.

34. On completion of St. Lucia, a party moved to St. Kitts and Nevis for triangulation and height control, and has now moved on to the British Virgin Islands.

35. Observation of the secondary net in the Kigezi-Ankole districts of Uganda is complete. In addition a very large number of existing triangulation points were identified on air photographs in the East Ankole-Masaka areas and in the Mengo district. Height control was established for part of the Mengo district.

36. In Swaziland, reconnaissance and beaconing were completed of a network of secondary triangulation covering the Territory, and several stations have been observed.

37. Beaconing and observing of the secondary triangulation in eastern Bechuanaland has been continued and reconnaissance has been extended northwards despite unusually heavy rains.

38. Reconnaissance, beaconing and observing of secondary triangulation and minor control covering some 4,000 square miles were completed in the Coast Province of Kenya. Height control was supplied for a part of this area.

39. In Somaliland two surveyors started work on planimetric and height control for large and medium scale mapping of several development areas.

Air Photography

Caribbean

40. Four thousand square miles of British Guiana has been photographed this year, and a further 9,000 square miles has been claimed in the current contract. It is also claimed that the Island of Dominica has at last been completely photographed after many unsuccessful attempts. The large scale cover of Jamaica has been completed.

41. A contract for air photography in British Honduras for forestry purposes has been placed.

East Africa

42. The contract in progress at the beginning of the year produced, in addition to the cover referred to last year, about 26,000 square miles of photography in Kenya and about 12,000 square miles in Tanganyika.

43. The contract in progress at the end of the year has produced about 16,000 square miles in Tanganyika, about 15,000 square miles in Uganda, and about 18,000 square miles in Kenya. Another contract for the coming year is now being negotiated.

West Africa

44. Contracts have been placed for areas in Northern Nigeria, the Southern Cameroons and in Sierra Leone.

Far East

45. The R.A.F. flew a number of sorties, of which details are not yet available.

Antarctica

46. A contract was placed for an area in the Falkland Islands Dependencies and the Falkland Islands themselves. This contract had to cover a much wider range of requirements than the actual photography, including charter of a ship, hire of helicopters, modification of the ship for helicopter take off and landing etc. The results of the expedition will not be known for some months.

Mapping

47. Fewer changes in priority have resulted in output being well maintained in spite of some depletion of staff.

48. Maps were published at 1 : 50,000 covering areas in Tanganyika, Kenya, Sarawak and the British Solomon Islands (Guadalcanal). In this last area the series is now complete. A very densely populated area in Nigeria was mapped at 1 : 100,000 while further sheets of the 1 : 125,000 series of Somaliland were published. Continued progress has been made with the 1 : 200,000 mapping of the Falkland Islands Dependencies.

49. Work has commenced on mapping Fiji (Viti Levu) at 1 : 50,000 and new blocks of mapping have been taken up at 1 : 100,000 of Nigeria ; and at 1 : 50,000 of S.W. Uganda, N. Borneo, British Honduras. A map of Gambia at 1 : 125,000 is in production.

50. The preparation of contoured editions is being continued for Basutoland, Swaziland, Tanganyika and the West Indies. The 1 : 25,000 series of Mauritius is being revised and contoured.

51. Mapping at larger scales continues of a number of Caribbean Islands. The 1 : 10,000 map of Barbados is nearing completion and plotting continues for Grenada, St. Vincent and St. Lucia.

52. A fully coloured contoured map of Mt. Kenya at 1 : 25,000 is nearing completion.

53. Work continued for the Directorate of Colonial Geological Surveys and for the Colonial Forest Air Survey Centre and a variety of miscellaneous maps and diagrams etc. were produced for special purposes.

D. GEOLOGICAL SURVEYS

54. A further allocation of £1,250,000 has been made available for Geological Surveys under the Colonial Development and Welfare Act, 1955, to cover the period to the 31st March, 1960. In addition to providing for the work of the Headquarters Directorate, this sum will give some help to those territories which are themselves unable to meet the cost of their Geological Survey Departments.

55. There were 205 geologists, geophysicists and chemists in the 21 territories where geological surveys were proceeding during 1955, and good progress was made in the exploration of mineral resources and in solving problems connected with engineering and water-supply, although there still remained a shortage of 20 geologists.

56. The Director of Colonial Geological Surveys and members of his staff visited East, West, Central and South Africa, Somaliland Protectorate, the Caribbean region, and the United States and Canada, to examine developments, attend conferences and give specialist help.

57. In a number of territories mineral occurrences discovered and prospected by the Geological Surveys have been taken up by mining companies, e.g. carbonatite structures in Kenya. Tanganyika and Northern Rhodesia were being so explored. An oil company drilling in Tanganyika is obtaining valuable geological information and has drilled a deep test-well in Mafia Island. There have been some small exports of columbite, beryl and mica from Somaliland Protectorate during the year.

58. Drilling in the Onitsha, Benue and Kabba Provinces of Nigeria has indicated 244 million tons of workable coal reserves of quality similar to that which is mined at Enugu. Investigations continued on the primary columbite in the Younger Granites of the Jos Plateau.

59. In Malaya, investigations to effect improvements in the recovery of cassiterite, monazite, ilmenite and columbite were continued. An experienced hydrologist appointed by the United Nations Technical Aid Administration advised concerning investigations that could increase water supplies in certain areas.

60. In Cyprus, a mining company has discovered a new cupreous pyrite orebody of approximately 3 million tons as the result of geophysical prospecting followed by drilling. Gold lodes have been discovered in Guadalcanal, British Solomon Islands, by the Geological Survey Department.

61. The universities of the United Kingdom and other members of the Commonwealth give valuable assistance to the overseas Geological Surveys. The Geochemical Prospecting Research Centre recently established at the Imperial College of Science and Technology in London with the assistance of a Colonial Development and Welfare grant, receives overseas geologists for training and also sends its staff to carry out investigations in the territories. The Professor of Geology from the University of Durham and a Colleague have visited Sierra Leone to investigate occurrences of chrome iron ore and to do geophysical work on the Colony Peninsula. Members of the Universities of Bristol, Edinburgh and Oxford have spent several months investigating problems in Kenya. A geologist with the Oxford University Exploration Club Expedition to Sarawak spent six months in the Upper Rajang and the Usunapau Plateau, followed by several months preparing his report at the Geological Survey Headquarters in Kuching. Two Lecturers from Sydney University helped the Geological Survey of the Solomon Islands Protectorate by mapping in Ysabel, in the Russell Islands and on the south coast of Guadalcanal.

VULCANOLOGICAL RESEARCH IN THE CARIBBEAN

62. Seven of the eight seismographs required were operating in Trinidad, Grenada, St. Vincent, Barbados, St. Lucia, Dominica and Antigua, and the records collected and examined by the seismologist at the base office in Trinidad. The object of the scheme is to do research on records over a continuous period, in the hope of finding a pattern to provide means of forecasting possibly disastrous volcanic or seismic crises in time to enable safety precautions to be taken.

E. INDUSTRIAL AND ENGINEERING RESEARCH

East African Industrial Research Board

63. The East African Industrial Research Board has been reorganised and its new terms of reference are :—

- (a) to advise the High Commission and the East African Governments concerning matters affecting industrial research in East Africa and the functions of the East African Industrial Research Organisation (hereinafter referred to as the Organisation) ;
- (b) to determine the research policy of the Organisation and to ensure that, within the finances available to the Board, the activities of the Organisation, and the relative priorities of items within its research programme, are such as best to implement that policy ;
- (c) to review the progress of researches undertaken by the Organisation ; to examine this progress in relation to the determined research policy ; and to amend priorities or to terminate such researches as may appear unprofitable.

Investigations into the artificial drying of coffee and other aspects of coffee processing, and the processing of pyrethrum are being continued. The extraction of hecogenin from sisal waste is now established. There is to be further investigation of the composition of waste from sisal, coffee and pineapple, to ascertain for what other purposes they can be used.

The Ceramic specialist has developed new techniques for the production of robust types of simple glazed pottery, using almost entirely locally occurring raw materials. He is also developing a new type of lightweight composite roofing tile.

64. The Industries Branch of the Federal Department of Commerce and Industries has published research memoranda and papers on the following subjects :—

- (a) The salinity of sea-water in and around Lagos Harbour.
- (b) The performance of coir fibre extraction machinery.
- (c) The dyeing and bleaching of Nigerian fibres other than cotton.
- (d) The yield of fibre from Sunn Hemp growing trials 1954-55.
- (e) Mould growth and its prevention.
- (f) Indigo dyeing, and research on ancient and modern methods in Nigeria.
- (g) Batching emulsions for Nigerian bast fibres.
- (h) Bleaching and dyeing of Nigerian handspun yarns and hand-woven cloth.

Applied research was undertaken into the following :—

- (a) The shelf life of groundnut flour.
- (b) The preservation of palm wine.
- (c) The design and operation of small passenger and load-carrying craft for use on inland waterways.
- (d) The processing, spinning and weaving of indigenous hard and soft fibres and the preparation of cloth, matting, ropes and cordage.

65. The level of demand from Colonial Governments for services of Consultants and Specialists has been maintained during the year.

66. This was dealt with by the Crown Agents' Advisory Service which has also furnished advice and assistance to Oversea Technical Officers while on leave arranging study courses and visits as required.

67. A close relationship has continued with the Colonial Liaison Officers for Road and Building Research, and contact has been maintained with the Water Pollution and Hydraulic Research Laboratories.

68. "The Crown Agents' Review" continued to include articles concerned with the practical results of technology and research, and to place on record descriptions of civil engineering work in the Colonies such as the Apapa Wharf Extension at Lagos. It also contained a brief survey of the development of telecommunications and broadcasting in Colonial Territories, and some account of the activities of the Falkland Islands Dependencies Survey and of preparations for the International Geophysical Year.

F. ANNUAL REPORT OF COLONIAL RESEARCH

1955-1956

METEOROLOGY

69. During the year 1955-56 Colonial territories again undertook such research work in the field of meteorology as limited resources and staffs permitted.

70. In East Africa, most attention has been given to the development from small scale experiments to attempts at practical application of the use of a film of cetyl alcohol, spread over the surface of lakes and reservoirs, as a means of reducing the very serious loss of water due to evaporation. These attempts at practical application have indicated that when large areas of water are to be treated an additional spreading agent is required so as to reduce the cost of applying the material and to ensure that the whole surface is covered. At the end of the year under review further experiments in the use of a spreading agent were about to start. These investigations into the use of cetyl alcohol have aroused almost world-wide interest, over fifty enquiries from four continents having been received.

71. Although a number of successful attempts at the artificial stimulation of rainfall in East Africa were recorded during the year, the major experiments foreshadowed in last year's report into the use of rockets as a means of dispersing finely-ground hygroscopic materials into the base of cumulus cloud had to be postponed owing to a number of technical difficulties and were not started until April, 1956.

72. Work has continued in West Africa on the study of evaporation from large areas of water, especially from the lake which would be formed by the Volta River Project in the Gold Coast, but also in connection with the Niger-Benue survey.

73. The Royal Observatory at Hong Kong operates a seismological station and is gradually assembling a climatology of tropical storm microseisms. In addition, in recent years the Observatory has classified the most important synoptic patterns of South-east Asia and has used them in explaining the constitution of climate in the region. Much work in this field, however, remains to be done. Future plans include wind surveys for the proposed new international airport and studies of the meteorological needs of certain local industries such as cotton spinning and weaving, food processing, the storage of perishable goods and building design.

74. A preliminary report on the research into the generation of electricity from wind-power in the Falkland Islands, referred to in the 1953-54 Report has been forwarded to the British Electrical and Allied Industries Research Organisation and the Colonial Research Council.

75. A new development of some importance was foreshadowed in the year under review when, following a resolution on the need for research in tropical meteorology passed by the 1955 Conference of Commonwealth Meteorologists, arrangements were made for a senior officer of the Meteorological Office, Dr. A. G. Forsdyke, to conduct a survey of the research requirements for tropical meteorology, with special reference to Colonial territories. Dr. Forsdyke is in correspondence with the various Colonial Meteorological Services as a preliminary to visits which he plans to make to a number of tropical territories starting in the latter part of 1956. This project is to be supported by C.D. & W. funds.

76. A number of papers, mainly on local meteorological matters, were published by members of the Meteorological Services of British West Africa, Hong Kong and Malaya, some appearing in the Quarterly Journal of the Royal Meteorological Society. Papers of this nature were also published by members of the British Caribbean Meteorological Service including two on the hurricanes HAZEL (1954) and JANET (1955) which caused severe damage in the area.

G. WATER POLLUTION RESEARCH

77. To provide information for use in East Africa where experiments have been made on the use of cetyl alcohol for reducing the rate of evaporation from reservoirs, the Water Pollution Research Laboratory investigated the effect of this substance on the rate at which water would absorb oxygen from the air. Under certain conditions a considerable reduction in the rate of oxygen uptake was observed. Not enough information is available about the normal rate of oxygen uptake in reservoirs for conclusions to be drawn about the effect on the condition of the water, but the possibility of causing anaerobic conditions in certain circumstances should be considered.

78. Liaison with correspondents in the Colonies was maintained during the year and answers to specific enquiries concerning disposal of sewage were provided. Visitors from Malaya, Nigeria and Uganda were shown the work in progress at the Laboratory.