

1959-60 Cmnd. 938 Colonial Office. Colonial research 1958-1959. 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

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COLONIAL OFFICE

# COLONIAL RESEARCH

## 1958-1959

REPORTS OF THE

Colonial Research Council

Committee for Colonial Agricultural,

Animal Health and Forestry Research

Colonial Economic Research Committee

Colonial Fisheries Advisory Committee

Colonial Medical Research Committee

Colonial Pesticides Research Committee

Colonial Products Council

Colonial Road Research Committee

Colonial Social Science Research Council

Tsetse Fly and Trypanosomiasis Committee

Director, Anti-Locust Research Centre

and

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

*Presented to Parliament by the Secretary of State for the Colonies  
by Command of Her Majesty  
December 1959*

LONDON

HER MAJESTY'S STATIONERY OFFICE

PRICE 18s. 0d. NET

Cmnd. 938

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Colonial Research Council  
Annual Report  
on Colonial Research  
(1958-1959)

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Colonial Office,  
The Church House,  
Great Smith Street,  
S.W.1.  
4th November, 1959.

SIR,

On behalf of the Colonial Research Council, I have the Honour to submit to you the Council's Annual Report on Colonial Research for the year 1958-59.

I have the honour to be,

Sir,

Your obedient servant,

PERTH,

*Chairman.*

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

## COLONIAL RESEARCH COUNCIL

### Membership

THE MINISTER OF STATE FOR COLONIAL AFFAIRS (*Chairman*).

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

SIR CHARLES DODDS, M.V.O., D.Sc., M.D., F.R.C.P., F.R.I.C., F.R.S.  
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DR. W. H. GLANVILLE, C.B., C.B.E., D.Sc., M.I.C.E., F.R.S. (Chairman, Com-  
mittee for Colonial Road Research).

DR. W. J. HALL, C.M.G., M.C., D.Sc. (Chairman, Colonial Pesticides Research  
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PROFESSOR SIR ARNOLD PLANT (Chairman, Colonial Economic Research Com-  
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SIR WILLIAM SLATER, K.B.E., D.Sc., F.R.I.C., F.R.S. (Chairman, Committee  
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PROFESSOR SIR ALEXANDER TODD, M.A., D.Sc., F.R.I.C., F.R.S. (Professor of  
Organic Chemistry, University of Cambridge).

MR. C. E. LAMBERT, C.M.G. (Secretary).

### Terms of Reference

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

COLONIAL RESEARCH COUNCIL  
ANNUAL REPORT OF COLONIAL RESEARCH FOR 1958-1959

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APPENDIX

Table I: List of schemes approved for Research grants under the Colonial Development and Welfare Acts during the period 1st April, 1958 to 31st March, 1959.

Table II: Allocations for Research under the Colonial Development and Welfare Acts, 1940, 1945, 1950 and 1955 to 31st March, 1959.

Table III: Actual issues in respect of Research Schemes, 1940-1959.

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

Agricultural, Animal Health and Forestry.

Economic.

Fisheries.

Medical.

Pesticides.

Colonial Products and Tropical Products Institute.

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 (1958-1959)

### INTRODUCTORY

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

2. During the year the Earl of Perth visited East Africa and Nyasaland, and as in previous years a number of visits were made to various territories by members of the Council and Committees. Members attended meetings in East Africa, West Africa and the West Indies of the respective Research Advisory bodies for the regions. These and other visits by scientists from the United Kingdom are referred to in more detail in the reports of the individual committees.

3. Expenditure during the year under review was £1,224,000 as compared with £1,330,641 during 1957-58.

### GENERAL

#### *Colonial Development and Welfare Research Schemes made in 1958-59 and their Cost*

4. 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. Seventy-one new schemes and 63 supplementary schemes were made, involving grants totalling £798,974. These compare with 85 new schemes and 54 supplementary schemes made during the previous year entailing grants totalling £1,123,850. It will be appreciated, however, that each year many of the schemes shown as new schemes are in fact in continuation of earlier schemes. As will be seen from Table II, these grants bring the total sum allotted to Colonial Development and Welfare Research schemes since 1940 to £19,493,932. The net commitment, after allowing for revision of schemes and unspent balances, was on the 31st March, 1959, about £17·25 m. of which some £17 m. is chargeable against the funds provided under the 1945, 1950 and 1955 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 nearly £14·7 m.

5. About 33 per cent. of the gross allocation of Colonial Development and Welfare Research funds has been for agricultural, animal health and forestry schemes, 17 per cent. for medical research, 9 per cent. for fisheries research, 10 per cent. for tsetse and trypanosomiasis research, 8 per cent. for social science and economic research, 9 per cent. for pesticides research, 5 per cent. for research sponsored by the Colonial Products Council, 3 per cent. for anti-locust research, and 6 per cent. for miscellaneous schemes including building and road research. Approximately 37 per cent. of the gross allocation

has been for schemes to benefit the East African territories, 17 per cent. for the West African group, 8 per cent. for South-East Asian territories and Hong Kong, 12 per cent. for the West Indian colonies, British Guiana and British Honduras, 5 per cent. for the Central African territories (Northern Rhodesia and Nyasaland) and 21 per cent. for other territories and for schemes of general interest.

6. New projects during the year include:—in the United Kingdom, research on tropical virology at the London School of Hygiene and Tropical Medicine, research on folic acid metabolism at Birmingham University and research on bilharzia by the Medical Research Council; research into farm production costs in Kenya; soil surveys in the Eastern Region of Nigeria, the British Solomon Islands, the Leeward Islands and the Windward Islands; an investigation into fusarium disease of coffee in Nyasaland; research on the toxæmia of pregnancy at the University of Hong Kong; a study of the factors influencing arterial blood pressure in a Jamaican population; and in Fiji the establishment of a cocoa research station.

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

7. Although 25 new appointments on Research Branch terms were made during the year, resignations and retirements accounted for 20 officers with the result that the total complement in March, 1959, was 207 officers compared with 202 in March, 1958. One Research Fellow studying nematode damage on East African crops completed his investigations during the year; a second continued his work on human trypanosomiasis at the West African Institute for Trypanosomiasis Research. Two further Research Fellowships were awarded for investigations at the University College of the West Indies into arterial hypertension in Jamaica and into the effect of diet on the levels of various cofactors and enzymes concerned with carbohydrate and fat metabolism. In addition three research studentships were awarded for the training of candidates for research appointments overseas; two in medicine and one in soil science.

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

8. The tenth meeting of the C.S.A. was held in Kampala and under the auspices of the Council, specialists meetings on Physical Hydrology, Roads, and Virus Diseases and Rickettsiosis were held at various centres in Africa. Meetings of the CCTA/CSA Committees on Geology, Soils and Social Sciences were also held during the year.

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

9. A high level of co-operation was maintained throughout the year, much valuable information and advice being provided by the various laboratories of the United Kingdom Research Councils. Notes on building and water pollution research are included in report No. XII. The Director of the Hydraulics Research Station visited Nigeria in January 1959.

*Colonial Research Publications*

10. The following report has been published by Her Majesty's Stationery Office:—

Colonial Fishery Publications Series.

No. 11 An Ecological Survey of the West African Marine Benthos, by Alan R. Longhurst (21s.).

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## APPENDIX

TABLE I

LIST OF SCHEMES APPROVED FOR RESEARCH GRANTS UNDER THE COLONIAL DEVELOPMENT AND WELFARE ACTS DURING THE PERIOD 1ST APRIL, 1958 TO 31ST MARCH, 1959

Scheme No. (Prefix "R")	Benefiting Territory	Description of Scheme	Amount
464A	General ... ..	Training of ecological students in the United Kingdom. (Supplementary provision.)	£ 3
628B	do. ... ..	Trypanosomiasis research at the London School of Hygiene and Tropical Medicine. (Supplementary provision.)	510
624B	do. ... ..	Cost of sending blood samples to the United Kingdom for sickle-cell investigations. (Supplementary provision.)	100
669A	do. ... ..	Research on leprosy. (Supplementary provision.)	1,250
709B	do. ... ..	Colonial Pesticides Research Unit, Porton, 1956-1960. (Supplementary provision.)	10,120
716B	do. ... ..	Secretariat of the Colonial Medical Research Committee, 1956-1960. (Supplementary provision.)	2,604
724B	do. ... ..	Headquarters staff of the Colonial Pesticides Research Committee, 1956-1960. (Supplementary provision.)	1,688
734A	do. ... ..	Colonial Products Council—Extra-mural activities, 1956-1960. (Supplementary provision.)	6,186
753A	do. ... ..	Preparation of precipitin sera at the Lister Institute, 1956-1960. (Supplementary provision.)	1,196
756C	do. ... ..	Employment of an Assistant on sickle-cell research at the Post-Graduate Medical School of London. (Supplementary provision.)	1,650
759A	do. ... ..	Purchase of separates of scientific articles written by officers employed under Colonial Development and Welfare schemes, 1956-1960. (Supplementary provision.)	250
791A 791B	do. ... ..	Leprosy research at the Strangeways Research Laboratory. (Supplementary provision.)	2,500 100
832A	do. ... ..	Contribution towards the cost of maintaining the Agricultural Research Council's Unit of Experimental Agronomy, Oxford (1957-58). (Supplementary provision.)	40
863A	do. ... ..	Employment of an Assistant on tuberculosis and leprosy research at Guy's Hospital Medical School. (Supplementary provision.)	672

## COLONIAL RESEARCH COUNCIL

Scheme No. (Prefix "R")	Benefiting Territory	Description of Scheme	Amount
874D 874E 874F 874G	General—cont. ...	Fish Culture Research Institute, Malacca. (Supplementary provision.)	£ 3,078 3,078 3,080 16,207
895A	do. ...	Visit to East Africa in connection with helminthic diseases. (Supplementary provision.)	65
922	do. ...	Trachoma Research, 1958-60 ...	31,405
923	do. ...	Maintenance of the Anti-Locust Research Centre, 1958-59.	65,657
926	do. ...	Visit to East and Central Africa in connection with the preparation of a reference book on electoral procedures.	700
928 928A	do. ...	Colonial Pesticides Information Service. (Supplementary provision.)	6,439 191
932	do. ...	Visit to Nigeria on leprosy research ...	520
934	do. ...	Tropical Section, Road Research Laboratory.	121,568
935	do. ...	Study of development of trade unionism in the Colonies.	1,000
939	do. ...	Research on Natural products of medical interest at the University College of The West Indies.	12,550
944	do. ...	Extension of accommodation for the Colonial Pesticides Research Unit at Porton.	2,800
945	do. ...	Visit of member of Medical Research Council to Tanganyika.	447
948	do. ...	Visit by members of Colonial Medical Research Committee and other specialists to International Conferences and Congresses.	1,500
951	do. ...	Research into the deposition of <i>trypanosome rhodesiense</i> in the human host.	5,030
954	do. ...	Basic research on tropical virology ...	1,750
962	do. ...	Morphological studies in the United Kingdom.	4,250
964	do. ...	Research studies in folic acid metabolism at Birmingham University.	2,100
965	do. ...	Contribution towards the cost of maintaining the Common Services Section of British Commonwealth Scientific Office (London) during 1959-60.	646

Scheme No. (Prefix "R")	Benefiting Territory	Description of Scheme	Amount
969	General—cont. ...	Equipment for use in a comparative investigation of the formation of the ocular and cerebro spinal fluid.	£ 875
970	do. ...	Immunological studies in trypanosomiasis at the Lister Institute.	13,400
976	do. ...	Group for research in Bilharzia ...	4,580
979	do. ...	Visit to Northern Nigeria for study of leprosy.	500
982	do. ...	Assistance for work on abnormal haemoglobins.	300
985	do. ...	Physiological studies on fish spawning ...	4,100
986	do. ...	Transportation of specimens to the United Kingdom for studies on haemolytic streptococci.	100
989	do. ...	Contribution towards cost of maintaining the Agricultural Research Council's Unit of Experimental Agronomy, Oxford (1959-60).	7,200
990	do. ...	Assistance for work on Colonial fisheries problems.	2,187
991	do. ...	Visit to Northern Nigeria for a physical investigation of the Fulani people.	410
	<b>Africa</b>		
931	General ...	Visit to Brussels of member of Lister Institute to attend 7th Meeting of the International Scientific Committee for Trypanosomiasis Research.	27
978	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.).	6,996
	<b>East Africa</b>		
666D	General ...	Investigation of snail vectors of schistosomiasis at Mwanza, Tanganyika. (Supplementary provision.)	2,969
745B	do. ...	Study of plant steroids at Makerere College. (Supplementary provision.)	840
768A	do. ...	Research on relapsing fever. (Supplementary provision.)	1,845
770A	do. ...	East African Inland Fisheries Research Organisation. (Supplementary provision.)	1,115



Scheme No. (Prefix "R")	Benefiting Territory	Description of Scheme	Amount
850A	East Africa—cont. General—cont. ...	Tuberculosis therapy investigation in East Africa. (Supplementary provision.)	£ 1,315
864A	do. ... ..	Colonial Pesticides Research Unit, Arusha (1957-58). (Supplementary provision.)	2,050
924	do. ... ..	Sorghum breeding research in East Africa	15,000
930	do. ... ..	Aerial spraying experiment by Colonial Pesticides Research Unit, Tanganyika.	2,000
936 936A	do. ... ..	Colonial Pesticides Research Unit, Arusha (1958-59).	71,188 960
938 938A	do. ... ..	Physiological and biochemical research at Mwanza, 1958-59.	10,222 3,582
942	do. ... ..	Desert Locust Survey (1958-59) ... ..	23,372
953	do. ... ..	Control of malaria at Taveta/Pare by therapeutic measures.	840
958	do. ... ..	Colonial Pesticides Research Unit, Arusha. Housing and laboratory accommodation.	9,100
959	do. ... ..	Visit to Tokyo of delegate to attend the International Congress on Leprosy.	100
974	do. ... ..	Visit to East Africa of expert on cardiovascular disease.	485
980	do. ... ..	Publication of "Agricultural Insects of East Africa, 1908-56".	500
992	do. ... ..	Visit of a fisheries expert to East Africa ...	112
983	Kenya ... ..	Research into farm production costs, Kenya	6,330
929 929A 929B	Somaliland Protectorate	History of the Horn of Africa ... ..	260 150 40
946	Uganda ... ..	Anthropological study of the Karamoja tribe.	150
952	do. ... ..	Study of the subsistence crop geography of Uganda.	1,130
955	do. ... ..	Sociological research in Uganda ... ..	5,075
858A	Zanzibar ... ..	Control of <i>Pseudothrips wayi</i> on coconuts. (Supplementary provision.)	511
817A	Central Africa General ... ..	Investigation into control of cotton pests in Nyasaland and Southern Rhodesia. (Supplementary provision.)	2,247
752A	Northern Rhodesia	Agricultural Research Services. (Supplementary provision.)	4,722

Scheme No. (Prefix "R")	Benefiting Territory	Description of Scheme	Amount
937	Northern Rhodesia —cont.	Linguistic study of the Tonga dialects in the Gwembe area.	£ 1,050
963	do. ... ..	Study of the influence of Christian Missions on the development of Northern Rhodesia.	310
609A	Nyasaland ... ..	Silvicultural research. (Supplementary provision.)	4,846
967	do. ... ..	Investigations into Fusarium disease of coffee.	7,220
	<b>West Africa</b>		
311F 311G 311H	General ... ..	West African Building Research Institute. (Supplementary provision.)	4,625 6,529 20,650
471E	do. ... ..	West African Maize Research Unit. (Supplementary provision.)	3,710
771B	do. ... ..	West African Timber Borer Research Unit. (Supplementary provision.)	1,681
304B	do. ... ..	West African Standing Advisory Committee for Agricultural Research. (Supplementary provision.)	112
933	do. ... ..	West African Timber Borer Research Unit (1958-59).	2,261
949	do. ... ..	Visit to Italy of Officer-in-Charge, West African Rice Research Station.	90
950 950A	do. ... ..	Study of the Ahmadiya Missionary Movement in West Africa.	650 180
973	do. ... ..	Visit of expert to Nigeria to attend Conference on Tuberculosis and Leprosy.	50
644C	Gambia ... ..	Appointment of an Entomologist to the Medical Research Council Laboratories, Fajara, Gambia. (Supplementary provision.)	2,700
961	Nigeria ... ..	Soil survey, Eastern Region, Nigeria ...	14,802
	<b>South Africa High Commission Territories</b>		
651A	Swaziland ... ..	Study of land holding and land usage among the Swazi. (Supplementary provision.)	93
873A	do. ... ..	Agricultural research. (Supplementary provision.)	22,728
846A	Atlantic St. Helena ... ..	Control of agricultural pests by biological methods. (Supplementary provision.)	370

Scheme No. (Prefix "R")	Benefiting Territory	Description of Scheme	Amount
957	<b>Mediterranean</b> Cyprus ... ..	Archaeological research ... ..	£ 1,600
988	Malta ... ..	Research into Brucella Melitensis ... ..	3,000
853A	<b>Middle East</b> Aden ... ..	Preparation of a history of Aden. (Supplementary provision.)	280
966	<b>Indian Ocean</b> Seychelles ... ..	Pest Control ... ..	1,850
975	do. ... ..	Appointment of an Agronomist for coconut research.	2,000
943	<b>Far East</b> Hong Kong ... ..	Research on toxæmia of pregnancy at the University of Hong Kong.	3,667
710A	<b>South East Asia</b> North Borneo ... ..	Investigation of diseases of manila hemp by a Plant Pathologist. (Supplementary provision.)	5,915
711A	do. ... ..	Appointment of a Soil Scientist. (Supplementary provision.)	664
987	<b>Singapore</b> ... ..	Regional Fisheries Research Institute, Singapore.	1,380
927	<b>Western Pacific</b> <b>British Solomon</b> Islands Protec- torate	Soil survey ... ..	6,290
947	do. ... ..	Research on crop agronomy ... ..	7,001
972	do. ... ..	Seismological station in the Solomon Islands.	2,800
941	<b>Fiji</b> ... ..	Socio-economic study of Fiji ... ..	1,924
956	do. ... ..	Investigation into control of banana scab moth and small coconut leaf moth.	6,670
984	do. ... ..	Establishment of a cocoa research station...	15,825
914A	<b>New Hebrides</b> ... ..	Economic survey of the New Hebrides. (Supplementary provision.)	81
960	do. ... ..	Sociological study of Aoba, New Hebrides	1,143
93c (d)	<b>The West Indies</b> General ... ..	Psychological research in the West Indies (Supplementary provision).	623
623c	do. ... ..	Junior Research Fellowship at the University College of The West Indies. (Supplementary provision.)	310
673A	do. ... ..	Histochemical nutritional research at the University College of The West Indies. (Supplementary provision.)	4,000

Scheme No. (Prefix "R")	Benefiting Territory	Description of Scheme	Amount
	<b>The West Indies—</b> cont.		£
742E	<b>General—cont.</b> ...	Colonial Microbiological Research Institute, Trinidad. (Supplementary provision.)	19,440
743B	do. ...	Participation in a hurricane research project of the United States Weather Bureau. (Supplementary provision.)	1,223
812A	do. ...	Secretariat of the Standing Advisory Committee for Medical Research in the British Caribbean. (Supplementary provision.)	730
891A 891B	do. ...	Seismic Research Unit, Imperial College of Tropical Agriculture, Trinidad. (Supplementary provision.)	17,312 2,914
925 925A 925B	do. ...	Tropical Metabolism Research Unit, Jamaica.	39,524 1,790 1,262
977	do. ...	Sugar Research Scheme, Imperial College of Tropical Agriculture, Trinidad.	8,332
981	<b>Jamaica</b> ...	Study of factors influencing arterial blood pressure in a Jamaican population.	4,874
940	<b>Leeward Islands and Windward Islands.</b>	Soil Survey, Leeward Islands and Windward Islands.	3,710
573D	<b>Trinidad</b> ...	Appointment of a Senior British Laboratory Technician at the Rockefeller Foundation Regional Virus Research Laboratory in Trinidad. (Supplementary provision.)	2,200
675A 675B	do. ...	Contribution towards the cost of maintaining the Rockefeller Foundation Regional Virus Research Laboratory, Trinidad. (Supplementary provision.)	8,253 2,832
	<b>Other Caribbean Territories</b>		
968	<b>British Honduras</b>	Preparation of a History of British Honduras	130
971	do. ...	Collection of samples of dioscorea species	942

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	606,776*	1,074,904*
31st March, 1947	1,099,382*	2,174,286*
31st March, 1948	2,073,340*	4,247,626*
31st March, 1949	1,666,229*	5,913,855*
31st March, 1950	1,814,124*	7,727,979*
31st March, 1951	2,514,536*	10,242,515*
31st March, 1952	879,902*	11,122,417*
31st March, 1953	1,096,904*	12,218,821*
31st March, 1954	738,065*	12,945,194*
31st March, 1955	533,548*	13,478,742*
31st March, 1956	1,889,486*	15,368,228*
31st March, 1957	2,202,880*	17,571,108*
31st March, 1958	1,123,850*	18,694,958*
31st March, 1959	798,974	19,493,932*

\* These figures include expenditure (totalling £137,376 up to the 31st March, 1957) incurred on Scheme R. 7 (work of the Colonial Products Research Council: see Appendix II to Progress Report of the Colonial Research Committee for 1942-43, Cmd. 6486).

TABLE III  
ACTUAL ISSUES IN RESPECT OF RESEARCH SCHEMES, 1940-1959

Financial Year	Issues
1940-41	£ Nil
1941-42	6,670
1942-43	13,793
1943-44	30,450
1944-45	58,345
1945-46	93,307
1946-47	169,388
1947-48	428,301
1948-49	764,211
1949-50	1,285,348
1950-51	1,411,352
1951-52	1,233,262
1952-53	1,268,562
1953-54	1,289,840
1954-55	1,176,317
1955-56	1,374,323
1956-57	1,534,746
1957-58	1,319,145
1958-59	1,224,000
	£ 14,681,360

709

Committee for Colonial Agricultural,  
Animal Health and Forestry Research  
1958-1959

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Agricultural Research Council,  
Cunard Building,  
15, Regent Street,  
London, S.W.1.  
31st August, 1959.

SIR,

I have the honour, on behalf of the Committee for Colonial Agricultural, Animal Health and Forestry Research, to transmit to you the Fourteenth Annual Report of the Committee covering the period 1st April, 1958 to 31st March, 1959.

I have the honour to be

Sir,

Your most obedient servant,

W. K. SLATER,

*Chairman.*

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

COMMITTEE FOR COLONIAL AGRICULTURAL, ANIMAL HEALTH  
AND FORESTRY RESEARCH

**Membership**

- SIR WILLIAM SLATER, K.B.E., D.Sc., F.R.I.C., F.R.S., Secretary, Agricultural Research Council (*Chairman*).
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- DR. R. A. E. GALLEY, Ph.D., A.R.C.S., D.I.C., F.R.I.C., Director, Tropical Products Institute and Officer-in-Charge, Colonial Pesticides Research.
- DR. W. J. HALL, C.M.G., M.C., D.Sc.
- MR. G. V. B. HERFORD, C.B.E., M.Sc., Director, Pest Infestation Laboratory, Department of Scientific and Industrial Research.
- DR. J. C. F. HOPKINS, D.Sc., A.I.C.T.A., Director, Commonwealth Mycological Institute.
- SIR JOSEPH HUTCHINSON, C.M.G., Sc.D., F.R.S., Professor of Agriculture, Cambridge University. (*From January, 1959*.)
- MR. M. V. LAURIE, O.B.E., M.A., Chief Research Officer, Forestry Commission.
- 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.
- PROFESSOR J. W. MUNRO, C.B.E., D.Sc., M.A., Professor Emeritus of Zoology and Applied Entomology, University of London.
- MR. G. W. NYE, C.M.G., O.B.E., Adviser to the Secretary of State on Agriculture.
- PROFESSOR J. E. NICHOLS, M.Sc., Ph.D., F.R.S.E., Professor of Agriculture, University College of Wales.
- MR. E. O. PEARSON, B.A., A.I.C.T.A., Director, Commonwealth Institute of Entomology.
- DR. A. B. STEWART, M.A., B.Sc., Ph.D., F.R.I.C., Macaulay Institute of Soil Research.
- MR. C. SWABEY, Adviser to the Secretary of State on Forestry.
- DR. G. TAYLOR, D.Sc., F.R.S.E., F.L.S., Director, Royal Botanic Gardens, Kew.
- MR. D. RHIND (*Secretary*).
- MR. R. MOWFORTH (*Assistant Secretary*).



## STORED PRODUCTS RESEARCH SUB-COMMITTEE

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

## CROP PROTECTION SUB-COMMITTEE

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

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

**1. GENERAL**

The Committee lost the able services of Dr. Norman Wright, its Vice-Chairman, who resigned on his appointment as Deputy Director of the United Nations Food and Agriculture Organisation in Rome. Sir Joseph Hutchinson and Mr. E. O. Pearson joined the Committee.

2. The Committee continued to foster collaboration between overseas and United Kingdom research by visits by its members. Sir Frank Engledow visited Nigeria to advise on research organisation. Mr. Nye visited the Caribbean area and Mr. Roddan (Deputy Agricultural Adviser) visited Sierra Leone, the Gambia and Malta. Mr. Herford paid a visit to Trinidad, British Guiana and Jamaica in connection with stored products research. Dr. Bell visited Nigeria for consultations on maize research and attended the 10th Meeting of the East African Agriculture and Fisheries Research Council. Professor Beveridge and Mr. Rhind attended meetings of the East African Agriculture and Fisheries Research Council. Mr. Pearson visited Rhodesia and Nyasaland, particularly for cotton pest research. Mr. Marshall visited Angola for meetings of the Interafrican Bureau of Epizootic Diseases and the International Scientific Committee for Trypanosomiasis Research. He also visited a number of islands in the Caribbean and British Guiana. Mr. Swabey attended a Forestry Conference in French Equatorial Africa and visited Nigeria, Cameroons, Sierra Leone and the Gambia. He also visited forestry establishments in Belgium and France. Mr. Rhind attended the F.A.O. Regional Conference in Tokyo, the Coconut Study Group in Manila and visited Hong Kong, Sarawak, Brunei and North Borneo on a Far Eastern tour and also visited Ghana to attend West African Research Committees. Mr. Rhind also served on several committees concerned with overseas research.

3. The Committee recommended grants to a value of £137,587 during the year. Since 1942 grants recommended for agricultural, veterinary and forestry research have amounted to about £M6.35 to which must be added local contributions amounting to a sum not much less. About 75 per cent. of this has been for research on agricultural subjects. The distribution of this assistance amongst colonial territories has been about 41 per cent. to East Africa, 19 per cent. to the West Indies, 11 per cent. to West Africa, 9 per cent. to Central African Federation, 6 per cent. in the South East Asia area, about 8 per cent. in the United Kingdom and the balance of about 5 per cent. in other places. On the basis of populations, the grants have been in the descending order of West Indies, Central Africa, East Africa, Southeast Asia and West Africa.

**II. SUMMARY OF PRINCIPAL RESEARCH DEVELOPMENTS**

4. While research on the subjects with which the Committee is concerned is very widespread, there are zones where the amount of work in progress is concentrated because of population and economic factors. Three such zones

have developed under the stimulus of the provision of money provided under the Colonial Development and Welfare Acts, in East Africa, West Africa and the West Indies. In each of these regions a reviewing and controlling organisation has been created which is intended to ensure that the lines of research pursued will ensure the greatest possible co-ordination with the needs of the region and so bring benefits to it.

5. In East Africa a series of committees has been set up under the East African Council for Agricultural and Fisheries Research. The Council, at Ministerial level, has extensive powers of review and of budgetary control over the research organisations assigned to its care. These include Agriculture, Veterinary, Marine and Inland Fisheries and Trypanosomiasis research. The Secretary of State sends two representatives to the Council, not for purposes of control, but to ensure a close link between the Council and the advisory committees in the Colonial Office which are concerned with the research under the Council and to make available through the members of these advisory committees the fullest scientific knowledge from the United Kingdom. (For convenience in East Africa the Research Council embraces subjects which are the concern of advisory committees other than the Committee for Colonial Agricultural, Animal Health and Forestry Research and the Secretary of State's representation is therefore not in this case confined to members of one advisory committee.) Under the Council a series of subordinate committees deal with research matters in greater detail down to Specialist Committees which may be concerned with particular problems.

6. In West Africa for various reasons it has not been possible to follow the East African pattern, mainly because of differing constitutional form and the absence of any unified centre of administration. It has, nevertheless, been possible to draw together those interested in the inter-territorial research units. Some of these are statutory bodies in a sense self-governing within their special constitutions, while others have no independent existence. To ensure that territories which contribute to these research units shall be able to guide the programmes of work to their benefit, committees have been established under the central administration of the West African Research Office, an inter-territorial body which co-ordinates the work and administers inter-territorial research organisations. The Secretary of State sends representatives to some of these committees to ensure that there are links with research elsewhere.

7. In the West Indies under the Federal Constitution a Council and Committees have been set up on a pattern similar to that in East Africa, but with the difference that the consideration of research programmes is assigned to a Research Committee reporting direct to a Council at Ministerial level, this Council being concerned with agricultural and other development as well as research. As in East Africa, detailed examination of research is the work of subsidiary committees. The Secretary of State sends representatives to the Research Committee.

8. In the three regions of East and West Africa and the West Indies, where major efforts in research are made, there is provision for full expression of local opinion and also for co-operation with research in the United Kingdom and elsewhere. For research in other areas reliance is

placed on direct contacts with the Secretary of State's advisory staff and on visits by members of the Committee or by other scientists.

9. Before leaving the subject of co-operation in the research field, it is appropriate to mention the association with international bodies on which members of the research staff overseas have places and whose meetings are attended by Colonial Office representatives. Amongst such international organisations are the Advisory Committees of U.N.E.S.C.O. on Arid and Humid Zone research, various study groups of F.A.O., C.S.A./C.C.T.A., the Interafrican Bureau of Epizootics as well as numerous committees and boards of United Kingdom institutions.

10. Scattered through the sections of this report will be found brief mention of progress with soil surveys. The record of the compilation of this basic information makes unspectacular reading, but its permanent value is very great. In the West Indies soil surveys have made good progress. Some such surveys have been in great detail for individual farm planning, while others have been for the broad indication of possible land development. In East and Central Africa surveys of both soil and vegetation zones have progressed well. In North Borneo surveys have revealed soils of exceptional fertility in some areas while in others, fortunately not extensive, soils with excessive chromium contents which are hopelessly infertile.

11. Nearly all Agricultural Departments and many research stations are carrying out trials with fertilisers all over the Colonial territories. This valuable work is leading to results which, economics permitting, could greatly enhance yields of crops. To attempt a summary would be tedious, but one result merits special attention. Following results from the interaction of shade and fertiliser on cocoa observed at the Regional Research Centre of the West Indies, the West African Cocoa Research Institute laid down trials which have given very large crop increases over two years when shade is reduced and fertiliser added. This is only possible when capsid damage is controlled with insecticides, but when this is done the second year yields rose from 958 lb./acre on shaded plots without fertiliser to 3,091 lb./acre on fertilised plots with shade trees removed. Subsidiary effects due to control of capsid damage and die back diseases on the reactions to virus diseases have changed the picture of cocoa growing in West Africa in a radical manner, the outcome of which cannot yet be clearly seen.

12. Another fertiliser result of note is the widespread response of seedling tropical pines to small doses of phosphates at planting time. These responses are remarkable in many places and the stimulus to growth assists establishment in re-forestation areas. Whereas fertilising forest trees in the same way as crops may be quite uneconomic, the quantities required for this initial boost are so small as to be negligible in establishment costs.

13. The integration of animal husbandry with crop production and mixed farming is another subject where a great deal is being done in many places and where steady progress can be recorded. The grass flora of many tropical lands appears to grow rampantly, but is notably unstable and frequently of low nutrient value or largely unpalatable to livestock. Its improvement has been a longstanding problem for both agricultural and veterinary departments. Much has been done to find species which give good nutrient yields and which animals will eat and to find out the degree of grazing such species can sustain. Such work continues, perhaps with rather a lot of

emphasis on herbage analysis here and there, but already a few outstandingly useful species of grass and legumes have been found. Despite this progress, much more work on tropical grasses and legumes for pastures is required.

14. Cattle in the tropics play a greater variety of roles than in temperate climates and are kept under widely differing conditions. Nearly everywhere attempts at improvement of stock are being made and the introduction of blood from European areas has been common. While this has succeeded under special conditions of husbandry or in cool areas, the responses of such hybrid animals to heat, humidity and a low plane of nutrition have not always been good. While breed mixing continues in many places attempts are now being made to find out more about the basic physiological differences between breeds from temperate regions and those of the tropics, particularly those from Asia (*Bos indicus*). Distinct differences in food intake and utilisation, water requirements and heat tolerance have been revealed.

15. Pigs and poultry have received much attention and, apart from direct disease control and improvement of husbandry methods, breeds suitable to local markets and of better performance have been evolved. The Samaru breed of poultry in Northern Nigeria has been widely accepted and triple cross pigs in Singapore come much earlier to market than the local breed.

16. Insect pests take a heavy toll of tropical crops and research on control methods is an important part of the work in Colonial departments. The powerful new insecticides are not an unmixed blessing because their effects on parasites and predators which, if undisturbed, would exert a degree of natural control, can be harmful. A warning of such an unpleasant side reaction is given on the use of chemicals for capsid control of cocoa which itself is most valuable. This complex problem is not lost sight of in the tropics where a multiplicity of chemical controls could easily remove all profit to the grower. This is not to say that chemical control of insect pests should everywhere be avoided. Trials in several places on control of termites attacking forest trees have given very encouraging results from some of the chlorinated hydrocarbon insecticides which have very long persistence in soils. This work may enable the planting of susceptible species such as pines and eucalypts to be successful where formerly termite damage was inhibitory.

17. Research on fungus and virus diseases of plants has continued to produce useful results. The serious coffee berry disease in Kenya shows promise of control by a captan spray which has also been found to be effective against coffee rust disease.

18. Agricultural machinery has mostly been designed for temperate conditions so that many models do not entirely suit in the tropics. A machinery testing unit has been organised in East Africa where tests are carried out and modifications suggested where necessary. Very valuable data have been collected, some of which will be of immediate economic value. For example, adjustment of diesel engines for altitude gives marked economy of fuel and study of dust extractors in relation to engine wear is important.

19. Research into methods of control of animal diseases has made great progress. Apart from trypanosomiasis, which is the subject of a



separate committee, other major diseases of animals are now largely controllable as a result of research on their causative agents or the vectors of them. With the help of a grant from the Wellcome Trustees, an institute has been set up in Kenya for research on Foot and Mouth disease. This institute will work in close collaboration with the Foot and Mouth Disease Research Institute, Pirbright. In Africa strains of the virus occur which are unknown in Europe, but which are a potential danger. Protective vaccine for one African strain has been made at Pirbright and a field trial with it made in East Africa. First results are encouraging.

20. Pleuropneumonia amongst cattle continues to give trouble. Entirely satisfactory vaccines against it have not yet been made in Africa. Either the protection is good, but the reaction too severe and unacceptable to cattle owners, or the reaction is mild but the protection is insufficient. Research is continuing and there are hopes that an Australian form of vaccine may prove efficient.

21. Rinderpest control in Africa has steadily extended, but the discovery of the disease in goats in part of Uganda raises a new problem. Reservoirs of the virus in game are receiving more attention and the agar gel double diffusion precipitation test is a discovery of much practical value for diagnosis.

22. Much forestry research is necessarily long-term, but progress is being made in silvicultural methods and in practices designed to promote regeneration in forests after exploitation. Poisoning of unwanted trees with the newer hormone arboricides is useful and further work on their use is in hand.

23. Control of damage by boring insects to felled logs and to lumber is being studied in East and West Africa. It has been possible to recommend insecticide formulations suitable for the protection of logs, both for overland and water transport in West Africa.

24. The problem of weeds in arable crops is serious in the tropics. The area of land sown is often limited by the ability of the farmer and his family to do the essential hand weeding and rising labour costs increase the problem of weed control in larger farms. Research on the newer herbicides has therefore become a prominent feature in the programme of several agricultural departments and at research centres. At the Regional Research Centre of the West Indies preliminary work has given useful information on crop tolerances and weed susceptibilities, and at several departmental experiment stations work is in hand. Particular attention has been given to weed control in rice fields where transplanting is not a feasible method of establishing the crop. Control of grass weeds is particularly troublesome and more research is needed.

25. Work on the control of damage to stored products, mainly by insects, was carried out in collaboration with the Pest Infestation Laboratory of the Department of Scientific and Industrial Research and by a Pool of Stored Products workers. Particular attention was given to rice storage problems in Sierra Leone, British Guiana and at the Regional Research Centre, Trinidad.

### III. LIAISON WITH RESEARCH INSTITUTIONS

26. Close and most valuable association was maintained with many research institutions and organisations in the United Kingdom. The Committee again expresses its appreciation of the large amount of assistance which it has received from many sources and many individuals who have willingly given their time and made available their knowledge and experience. This has been of very great help to research overseas. It is not possible to list all sources from which scientific help has been received, but to give a picture of the extensive and varied contacts which are maintained mention may be made of the Commonwealth Agricultural Institutes and Bureaux, laboratories of the Department of Scientific and Industrial Research, research units of the Agricultural Research Council, laboratories and institutions under the Ministry of Agriculture, Fisheries and Food, numerous state-aided research institutions, such as East Malling Research Station, the Foot and Mouth Disease Research Institute, Pirbright, the Grassland Research Institute, the Long Ashton Agricultural and Horticultural Research Station, the National Institute of Agricultural Engineering, Rothamsted Experimental Station, the Forest Products Research Laboratory, the Hannah Dairy Research Institute, the Macaulay Institute for Soil Research, many scientific departments in Universities, the Empire Cotton Growing Corporation and others.

27. Outside the United Kingdom there are a variety of scientific contacts with specialist organisations such as herbarium collections in France, Holland, Sweden and Germany, collaboration with the University of Lorraine on the taxonomy of timber boring insects, representation on U.N.E.S.C.O. committees dealing with research in the arid and humid tropics, with F.A.O. study groups on cocoa, coconuts, rice and other matters. These and other links with research both at home and in the international field make available through the Committee a breadth of knowledge which is very valuable and it also helps to overcome the inevitable disadvantage of isolation amongst research workers in colonial territories. Collaboration which the Committee has specially fostered and for which funds from one source or another are provided are separately described in this section of our report.

#### *Commonwealth Institute of Entomology*

28. Entomologists working in the Colonial territories continued to make good use of the facilities available to them at the Commonwealth Institute of Entomology. Material sent in by them amounted to about one-third of all that received by the Institute for identification, which in 1958-59 numbered over 54,000 specimens, and resulted in over 2,800 identifications being made. Many such entomologists make a point of visiting the Institute when they are on leave, and this, together with correspondence in connection with the identification service and with the very numerous requests for information that it receives, enables the Institute to keep in close personal touch with work in progress throughout the Colonial field.

29. A substantial part of the results of such work are eventually published by the Institute in the *Bulletin of Entomological Research*, of which Vol. 49 (1958) contained 28 papers that were directly or indirectly concerned with Colonial entomological problems.

*Commonwealth Institute of Biological Control*

30. A considerable part of the work of the Commonwealth Institute of Biological Control is concerned with problems of the colonial territories, and during 1958-59 work has been carried out for Barbados, Bermuda, Dominica (C.D. & W. funds), Jamaica, Mauritius, St. Kitts-Nevis and the Seychelles, and, in addition, enquiries have been received about biological control problems from a number of other territories. Visits have been paid by the Director to Barbados, Bermuda and Trinidad, and by Mr. F. D. Bennett to Dominica and Jamaica.

31. In Barbados a major co-operative effort is being made by the Department of Agriculture and the Institute to obtain establishment of larval parasites of the sugar cane borer *Diatraea saccharalis*. In Bermuda biological control work on the two scales *Pseudaulacaspis pentagona* and *Pulvinaria psidii*, the snail, *Otala lactea*, and the white fly, *Metaleurodicus cardini*, continues. In the Seychelles complete control of the citrus black fly, *Aleurocanthus woglumi*, has been obtained following the introduction of *Eretmocerus serius* from Jamaica. Parasites and predators of mealybugs have also been sent from California. Work has been carried out for Jamaica on the citrus weevil, *Prepodes* spp., and also on *Saccharosydne saccharivora*, the West Indian cane-fly, a pest of sugarcane, *Cactoblastis cactorum* has been successfully established in Nevis, and according to latest reports is spreading and causing considerable damage to cactus (*Opuntia* spp.) which it is hoped to control. Shipments of *Hyperaspis trilineata* have been made to St. Kitts in an attempt to control sugarcane mealybugs. In Fiji the Tephritid *Tetraeuaesta obscuriventris* has been successfully established from material sent from Trinidad for the biological control of the weed *Elephantopus mollis*. Work in Dominica has consisted of the introduction of predators of the banana weevil, *Cosmopolites sordidus*, and investigations into the possibilities of biological control of the coffee leaf miner, *Perileucoptera coffeella*. Investigations are being carried out in India for Mauritius on the parasites of sugarcane borers.

*Commonwealth Mycological Institute*

32. Much of the work of the Institute has again been concerned with crop diseases in the Colonial Dependencies. Nearly 900 identifications have been made during the year of material sent from Bermuda, British Cameroons, British Guiana, British Solomon Islands, Cyprus, Jamaica, Kenya, Mauritius, Nigeria, Northern Rhodesia, Nyasaland, St. Helena, Sarawak, Tanganyika and Uganda. Important records include mildew (*Oidium heveae*) and leaf spot (*Helminthosporium heveae*) on rubber in British Cameroons; tropical rust of maize (*Puccinia polysora*) in the British Solomon Islands; *Spilocaea eriobotryae* on loquat in Cyprus; a severe outbreak of blast (*Piricularia oryzae*) on rice in British Guiana; smut (*Ustilago scitaminea*) of sugarcane and powdery scab (*Spongospora subterranea*) on potato in Kenya; banana leaf spot (*Mycosphaerella musicola*), black spot (*Guignardia citricarpa*) of lemon, and Melanose (*Diaporthe citri*) of citron in Nigeria. The presence of potato and tomato blight (*Phytophthora infestans*) in Nyasaland and St. Helena was confirmed by Miss. Waterhouse.

33. Attention has been given to the revision of West African fungi by Mr. Deighton, who has prepared for publication special studies on the

Cercosporae, Meliolineae, and Sierra Leone fungi, and in collaboration with Dr. T. W. Tinsley, a list of plant virus diseases in Ghana and Sierra Leone.

34. The normal number of plant pathologists have made use of the Institute and three, from Nigeria, Tanganyika and Uganda, worked for some time in the herbarium. Facilities were provided for several months for two plant pathologists from East Africa to finalize and prepare for publication the results of their researches. The Culture Collection has continued to maintain and supply cultures for tropical research workers on a slightly increased scale.

#### *Adviser on Tropical Soils*

35. Except for a brief visit to Paris to discuss arrangements for the Third Inter-African Soils Conference to be held in November, 1959, Dr. H. Greene remained in the United Kingdom throughout the year. He is liaison officer for British delegates to this Conference.

36. In association with Mr. A. J. Vernon of the Statistics Department, Rothamsted, Dr. Greene has been concerned with a long term fertilizer experiment, now continued by Dr. P. A. Loizides, in Cyprus and with experimental programmes on groundnuts and rice in the Gambia, on tomatoes and potatoes in Malta, on coconuts in the Seychelles and in the British Solomon Islands Protectorate, with some preliminary pot tests comparing soils in Swaziland and with the maintenance of soil fertility in Nigeria. Mr. M. Greenwood, of the Research Station, Long Ashton, very kindly contributed valuable suggestions on this major problem of the maintenance of soil fertility in the more humid parts of Nigeria and he also very kindly contributed to the discussion of a series of experiments carried out by Mr. J. K. Obi in Northern Nigeria. These involved factorial application of N P K fertilisers and dung to representative crops at several sites.

37. During the year Dr. Greene has sent to his correspondents overseas three batches of technical news items and reprints having a bearing on tropical soil problems. Coverage is of course extremely imperfect but it is hoped that these occasional circulars enable the rather isolated specialist to feel that he is not entirely outside the stream of scientific progress.

38. Following on requests for soil analyses from overseas territories with limited facilities, a chemist has been appointed to Rothamsted Experimental Station for this work. Analyses have been carried out so far for Borneo and others are in hand for Swaziland and Basutoland. A study is being made of a series of soils from Nyasaland and their parent materials. This will include mineralogy and thin section examination with a view to following the alteration of the primary minerals. In conjunction with the Government Chemist, Tanganyika, a study is being made of the mineralogical changes in the soils of the Ukiriguru catena to supplement the extensive chemical data available.

#### *Department of Statistics, Rothamsted Experimental Station*

39. From 1st April, 1958, to 18th August, 1958, the member of the Department chiefly responsible for work done on behalf of the Colonial Office was M. H. Westmacott. On his leaving the Department on the latter date, his duties in this connection were taken over by A. J. Vernon, who continued to discharge them till the end of the year. Other members of the

Department gave assistance with special problems, in particular H. D. Patterson (rotation and other long term experiments), H. R. Simpson and J. C. Gower.

40. As in previous years requests for assistance received from the colonies were fairly evenly divided between problems of experimental design and analyses of results. Major items of work were as follows :—

*Designing new experiments*

41. Plans for an important series of manurial trials on cocoa in the Fiji Islands, a very large experiment with cocoa varieties, spacings and manures at Kumasi Technical College, Ghana, and a long-term rotation experiment at Ibadan, Nigeria, were given detailed consideration and recommendations made. The Ibadan experiment was studied in collaboration with Dr. H. Greene.

*W.A.I.F.O.R. (Benin, Nigeria) Uniformity Trial analysis*

42. This work, for L. C. Chapas, which was mentioned in last year's report was finished in the early months of this year. The electronic computer was an invaluable aid in this extremely lengthy analysis.

*W.A.M.R.U. (Ibadan, Nigeria) Variety Trial analysis*

43. C. L. M. van Eijnatten now submits all his routine variety trial results to the Department for analysis. While each analysis is in itself elementary, several are required for each of a large number of trials twice yearly, giving a bulk of work that again is an ideal task for the electronic computer.

*Nyasaland, Department of Agriculture, Rotation experiment analyses*

44. P. Brown of the Agricultural Research Station at Chidetze has submitted results that are accruing from a series of rotation experiments started some six years ago after consultation with the Department. The designs are extremely complex and there are in all over a thousand plots giving annual records so that a full analysis will be a major task. G. E. Hodnett, now of I.C.T.A., Trinidad, who helped to design the trials, is assisting in preliminary discussions of the form the analysis should take.

*Fiji, Department of Agriculture, Cocoa manurial trial analysis*

45. A rather complex analysis of growth data from a manurial trial in Fiji was done for A. G. Cassidy.

*Gambia, Department of Agriculture, Groundnut trial analyses*

46. J. A. Austin, Director of Agriculture, Gambia, submitted through Dr. H. Greene, the results of all his 1958 field trials on groundnuts for analysis. Again the analyses were individually simple, but the bulk of the work made it a task for the electronic computer.

47. A number of minor enquiries were also dealt with from several territories and some of the correspondents came to discuss their problems in person. Personal contact was also maintained with Dr. H. Greene, with whom many of the items, as well as other problems of his, were discussed at length. Several colonial officers spent varying times in the Department working on their problems or receiving instruction.

**IV. REGIONAL RESEARCH****(a) EAST AFRICA***East African Agriculture and Forestry Research Organisation*

48. Last year's Report began by stressing that a general Regional Research Station such as E.A.A.F.R.O. can only fulfil its proper functions satisfactorily if its programme of work is sufficiently well tied in with that of the Territorial Departments for there to be continuous and active co-operation between their research and administrative officers and those at E.A.A.F.R.O. It is a great pleasure to record once again that this co-operation has been readily forthcoming, and to emphasise that much of the work reported here as being done at E.A.A.F.R.O. has involved much active help from many Territorial officers.

49. The Physics Division is continuing to co-operate with the East African Territories in carrying out a series of long term experiments on the effects of changes of land-use in high catchment areas on the amount of water in the rivers flowing out of them, and on the evenness of the river flow throughout the year. The importance of this work in a country such as East Africa where water is scarce, and which has a climate having pronounced wet and dry seasons, needs no emphasising. The present well regulated rivers rise in catchment areas covered with natural forest—a land use giving a very small monetary return per acre—but if one replaces these natural forests by other methods of land use, which will give a higher financial return per acre, river flows are likely to be very badly upset.

50. One experiment is situated in the Mbeya Range of Tanganyika where steep hill sides are cultivated by African peasants for a few years before they are abandoned and allowed to revert to forest. The effect of clearing this forest and cultivating the land is being compared with recently abandoned land and with land which is being kept in protected forests. During the year difficulties were experienced in measuring the stream flow from the cultivated land on the steep hill sides due to the amount of soil being carried in the river, but the Tanganyika Water Development Department has installed silt traps which it is hoped will overcome this difficulty.

51. A second experiment is in progress in the tall rain forest at Kericho where a 1,700 acre catchment is being converted into a complete tea estate, and the neighbouring catchment is being left in undisturbed dense forest. Messrs. Brooke Bonds have already started opening up this area; the Hydraulic Engineer's Branch of the Ministry of Works has installed the autographic streamflow gauges, the Forest Department has cleared the perimeter traces and the Physics Division have completed the detailed topographical survey of the catchments. The third experiment is on the east side of the Aberdare Mountains in which the effect of converting catchments covered with bamboo forest into catchments in which all the less steep slopes are planted with softwoods is being measured. All the requisite data are being collected on three small catchments and during the year two further catchments, each of 2,000 acres, have been brought into the experiment. The preliminary results indicate that well tended young plantations of cypress and pine use rather less water and have had no adverse effect on stream flow compared with the natural bamboo forest.

52. The fourth experiment in the Karamoja of Uganda is designed to test the effect of controlling grazing on flash flooding in an area of shallow soils in the semi-arid region. A very great difficulty in this work is the problem of measuring the amount of water in a flash flood loaded with silt. This is a technical problem being studied intensively by the Uganda Water Development Department.

53. A subsidiary problem which has arisen in the catchment area experiments is the measurement of rainfall in high forested areas. Two methods are being tested : placing platforms at treetop level, which may be 100 ft. above the ground, and installing the rain gauge there, and cutting a clearing in the forest of a sufficient size so the rain gauge can be placed at ground level. This year's work has shown that it is not necessary to have the whole rain gauge on the treetop platform, only the collecting funnel need be there, and the measuring part of the gauge and the reservoir can be housed underground, at the base of the tree, and be connected to the funnel with  $\frac{1}{4}$  in. diameter PVC tubing.

54. Work has continued on finding an accurate and simple method for predicting the amount of water crops are using day by day at different stages of their growth, and in particular the effect of depth of rooting and of the dryness of the soil. On the theoretical side work is continuing on adapting Penman's formula to East African conditions, and the detailed studies made last year have shown that the wind speed and relative humidity of the air are usually of less importance in East Africa than in Great Britain, and correspondingly the radiation term is of more importance, and it should be measured directly rather than computed from sunshine hours. On the practical side considerable progress has been made in adapting a cheap and simple form of radiation integrator for this work ; and in addition an important finding has been that the amount of water a crop growing in an evapo-transpiration tank uses is dependent on the way the water is applied.

55. A new experiment, being undertaken jointly with the Tea Research Institute of East Africa, concerns the effect of shade trees on the yield of tea bushes under two contrasting systems of pruning, and on the micro-climate around the bushes. Shade trees are commonly used in East Africa but little is known about the benefits or disadvantages they confer on the tea.

56. *Decomposition of soil humus.* Much of the work of the Chemistry Division has continued to be concerned with the processes responsible for the rapid oxidation of a part of the soil humus every time a soil is dried and re-wetted. Dr. H. F. Birch has now shown that there are at least two processes at work. One was described in last year's report, and is due to some of the soil humus dispersing in the water which is added to the dry soil, and this dispersed humus decomposes much more quickly than that held on the soil particles. The second process is probably due to the soil drying killing much of the microbial cells in the soil, and these dead cells are decomposed much more readily by the micro-organisms which are introduced when the dried soil is re-inoculated with a little fresh soil. The killing need not be done by heat, it can be done equally effectively by the usual

partial sterilising chemicals such as formalin, a finding which links together the effects of soil drying with partial sterilisation.

57. This flush of oxidation of humus each time a soil is re-wetted results in a corresponding rapid production of nitrate, which can be as high as 200 lb. per acre of nitrate—nitrogen with soils well supplied with humus, and rarely falls below 40 lb. per acre in the lower fertility soils. The consequences of these flushes of production of nitrate on agricultural practice and on general soil fertility studies in East Africa in particular are now being studied.

58. *Plant Breeding.* The plant breeding work is being reorganised as a consequence of L. R. Doughty's retirement from the staff. Two lines of work are being closed down. The first is research into the efficiency of the Brieger method for obtaining synthetic varieties of maize well adapted to the locality but giving yields more comparable to hybrid maize than to the local varieties from which it was produced. Although this work has not quite been finished the preliminary findings suggest that the method is unlikely to produce maizes having yields appreciably higher than the best local varieties. The material is however being transferred to the maize breeding section of the Kenya Department of Agriculture, where it will receive its final checking. Unfortunately the early part of the growing season was climatically very unfavourable for maize, so the results of the field variety trials will be very erratic and will have little applicability to more normal conditions.

59. The second line which is being effectively closed down is the breeding of cassavas for resistance to mosaic and brown streak virus diseases through the transference of resistance from other species of the genus *Manihot*. This work was done primarily at Amani, and it is quite clear that the methods in use will not give cassavas which are immune from mosaic, nor ones with a really high resistance in areas where the disease is very severe. But a number of very useful lines have been produced, which are now either being multiplied up for distribution in African areas, or are actually being distributed. The work of bulking up seedling material which has been selected for resistance and for other desirable qualities will be concluded in 1960, and the material will be available for distribution to the Territorial plant breeders and experimental officers for comparative yield and palatability trials.

60. Work on the breeding of maize for resistance to the virus disease "streak" is well under way and before long the later generations from the first crosses between pure lines resistant to streak and susceptible varieties will be available for testing their resistance to streak, which will enable one to assess the prospects of transferring this resistance to the local varieties.

61. Work on the breeding of maize resistant to *Puccinia polysora* is in abeyance. A number of resistant lines of maize are being kept in being, so that should a new race of the rust appear in the field, it will be possible to resume a search for genes conferring resistance to this race. Meanwhile the resistant maizes that have been produced in East Africa are remaining free from rust in the field.

62. A new sorghum breeding research project has been started during the year, and the work will be done at the Serere Agricultural Experiment



Station, Uganda, through the very kind co-operation of the Director of Agriculture. Muguga is climatically unsuited to sorghum growing, and the device of doing this work at small specialist sub-stations, such as Eldoret, had many disadvantages, most of which should be overcome by stationing E.A.A.F.R.O. staff at a properly staffed research station.

63. The object of the work is to study how far the yields of East African sorghums can be increased by incorporating into them characters from a wide range of sorghums and related species from both within and outside East Africa which will confer resistance to a number of pests and diseases which are obviously reducing yields seriously. In particular it is hoped to assemble together in a number of sorghum varieties a range of characters likely to reduce the damage done by *Quelea*, as well as by *Striga* and a few fungal diseases and insect pests, whilst maintaining palatability and good storage properties. A second line of work is to study the potentialities of tetraploid sorghums in which as many desirable characters as possible are incorporated.

64. *Plant Pathology.* The Virologist has been concerned with a known virus disease—ratoon stunting of sugar cane—and with stem pitting in Arabica coffee, which might be due to a virus. The sugar cane work has been partly searching for reliable diagnostic symptoms for the presence of the disease. All the published methods based on an examination of the sugar cane plant have been examined and none has been found reliable. It has also been in part inoculating a wide range of plants with the virus, including plants which are susceptible to many plant virus diseases, in the hope of finding at least one plant which will develop recognisable symptoms fairly rapidly and reliably when infected with the virus, again so far without any success.

65. Stem-pitting is a disorganisation of the xylem cells at the base of the trunk of Arabica coffee, causing it to swell into a bottle-shape, and when the bark is peeled off the wood has vertical grooves and pits. It was first recognised at the Tanganyika Coffee Research Station, Lyamungu, in 1956, where some young coffee trees having this disorder were also chlorotic and died, and the plant pathologist there was unable to isolate any visible pathogen.

66. The present stage of the investigation is that this disorder has been recognised in Arabica coffee at a wide range of sites in Kenya and Tanganyika, mainly in trees up to seven years old; it has now been accurately described, and the chlorosis originally noticed is not a part of it. But the cause has not yet been found, though the tests needed to show if it is due to a virus are in progress.

67. During this year Mr. A. G. Whitehead, who was working here as a Colonial Research Fellow, joined the staff as a nematologist. He has completed a survey of the incidence of nematode diseases on the more important crops of East Africa. The work of identifying the various species of nematode attacking the crops, and their relative importance is in progress. A number of new species, genera and sub-families, have been found and described, and many crops are attacked by a number of closely related species simultaneously so the separation of the complex into its component species is a relatively slow process.

68. *Animal Husbandry.* The Animal Husbandry Division has been reorganised by Dr. W. J. A. Payne who joined the staff early in the year to take charge of it. The Division is primarily concerned with problems of the nutrition of farm animals, but its programme includes general problems of animal management, particularly as these affect the efficiency of food utilisation. The present work falls into two principal sections: the nutrition and management of pigs, whether for bacon or for pork, and the assessment of the quality of beef carcasses whether on the slaughtered or in the live animal.

69. The pig nutrition work was centred on the problems of feeding rations high in maize. It was found that such rations had little effect on the hardness of the fat, contrary to a commonly held belief, but it gave pigs with much slower growth rates, although the conversion ratio of food to liveweight was not much affected. It was found, however, that the growth rate could be brought back to a more normal figure if the ration was enriched with 1 gramme of nicotinic acid per 100 lb. of ration, an addition which has little effect on the cost of the ration.

70. Two problems of pig management are being looked into. The first is finding suitable farrowing houses to reduce the rather high pig mortality which is characteristic of many areas in the Kenya Highlands, due probably to the difficulty of keeping the piglets warm at night at these altitudes. It is likely that the round farrowing house, developed at Ruakura, New Zealand, fitted with an infra-red lamp for the piglets is likely to reduce mortalities very considerably at little additional cost. The second problem concerns the raising of piglets apart from their dams after they have received colostrum. These can be raised satisfactorily on a cheap milk substitute at Muguga, though the standard of management necessary may be too high for it to be of practical importance under farm conditions.

71. Analyses of carcasses of beef animals are now a regular feature of the work of this Division. One of the objects of this work is to study how the typical Boran-type Zebu cattle put on edible meat, fat and bone as they mature and as their standard of nutrition is altered, and to compare this with the behaviour of British breeds, both in Great Britain and in East Africa. One result which has already come out of the preliminary work is that as the Boran cattle mature, they lay down a considerably higher percentage of intermuscular fat and a lower percentage of subcutaneous fat than do British breeds in the British Isles. Some co-operative work is also in progress with the Animal Production Division of the East African Veterinary Research Organisation on the reliability of the antipyrene method for estimating the total fat in a live animal, but so far the results have been disappointing.

72. *Silviculture.* The silvicultural research programme can vary only very little year by year. Work on nursery techniques and the best techniques for planting exotic softwoods in the forest continues, as does work on the rate of healing of pruning wounds. More forest tree plots have been planted in the Arboretum, including six of *Pinus patula* grown from seed from carefully thinned stands of Kenya trees all of which had a growth rate appreciably faster than normal. In addition an international Eucalypt trial is now well

under way in much larger plots, in which the growth rates and habits of growth of 12 species or strains are being compared.

73. The work of the East African Herbarium has unfortunately had to be rather curtailed this year as it has been running short staffed with two instead of three botanists, as Dr. P. J. Greenway retired early this year and it has not yet been possible to recruit another taxonomist.

*East African Veterinary Research Organisation*

74. The rapid expansion of the scientific staff of E.A.V.R.O. which has been reported in recent years has not been maintained in 1958. This has been partly due to inability to find suitable candidates for remaining vacancies, but also to the restriction on recruitment caused by the present financial stringency. Three posts of Research Officer, two of Laboratory Technician and five of Laboratory Assistant have been placed in abeyance in the draft estimates for 1959-60. This reduction in the approved scientific establishment of the Organisation is a serious set-back.

75. In the Division of Virus Diseases Mr. Scott has extended his research on inactivated rinderpest vaccines, described last year. A poor but safe vaccine results when rinderpest virus is inactivated by treatment with formalin, and efficiency in such vaccines necessitates the addition of adjuvants. Recent preliminary experiments indicate that rinderpest virus inactivated by slow dessication is an excellent immunizing agent without the addition of adjuvants: this promising work is at an early stage and is being extended to larger numbers of cattle and an investigation of the duration of the immunity produced.

76. Mr. Scott continued his research on the strains of rinderpest which he first adapted to the hamster and the mouse. The hamster-adapted strain has reached the 346th passage. It is still non-lethal and characterised by complete absence of clinical signs in the hamster, but is now attenuated for cattle. The two mouse-adapted strains, one originally from hamsters and the other a bovine strain, are also clinically inapparent in mice and attenuated for cattle.

77. While at Edinburgh University, Mr. Scott completed his studies on the pathogenesis of Rift Valley fever virus in hamsters. He has shown that contact transmission of the virus occurs frequently between infected and healthy hamsters; natural transmission of the disease is by insect vectors. He has confirmed and extended the findings of Dr. M. P. Weinbren of the Virus Research Institute, Entebbe, on the propagation of Rift Valley fever virus in *Arvicanthis* rats. He found that viraemia persists for 14 days after inoculation and thereafter the rats were immune; the infections were clinically inapparent and the case mortality rate low. The search for possible reservoir hosts of the virus in nature will continue. Earlier findings that guinea pigs are refractory to Rift Valley fever were confirmed. Virus could only be recovered from guinea pigs immediately after inoculation, thereafter virus disappeared completely and permanently.

78. Dr. R. D. Brown began research on Nairobi sheep disease, which has increased in significance in recent years. He is studying the pathogenesis of the virus in sheep and goats and is beginning serological research on the disease.

79. The successful application of the gel diffusion reaction to rinderpest by Mr. G. White at the end of 1957, and his development by this means of a rapid specific diagnostic test for the disease, was mentioned last year. This test has been used on a number of occasions to establish a diagnosis at Muguga of rinderpest in material from field outbreaks, notably in game in Tanganyika where the disease was detected by this method in wildebeeste, buffalo, eland and wart hog. Mr. White is working on refinements in the test designed to make it more sensitive and thus to detect very small quantities of antigen, and is also attempting to elaborate the gel diffusion reaction as a quantitative means of measuring antibody as well as antigen. His work during the year has fully confirmed the importance of the gel diffusion reaction for rinderpest, which was tentatively forecast last year and has provided an additional laboratory technique which will be especially valuable in the differentiation of rinderpest from similar diseases.

80. In the Tissue Culture Section of the Division, Mr. Plowright, assisted by Mr. Ferris and Mr. Whitcomb, has made excellent progress in studies on the propagation in cell culture of several viruses of East African diseases, and in the application of tissue culture methods to the investigation of a number of outstanding disease problems, notably in rinderpest.

81. The research on the growth and cytopathogenicity of rinderpest virus in tissue culture and on the attenuation of the virus in culture was completed and published. A long-term experiment was started at the beginning of the year to determine the immunity produced, and to measure the antibody levels, following inoculation of cattle with 40th passage culture virus; the first group was challenged six months after vaccination and were found to be solidly immune. The quantitative tissue culture serum neutralisation test for rinderpest developed by Mr. Plowright and Mr. Ferris has been applied to the investigation of a number of problems. These included the immune response to inactivated spleen vaccine in cattle which had received lapinized rinderpest virus 15 months previously, the antibody response in Freisian dairy cattle inoculated with K.A.G. rinderpest virus vaccine, and the antibody response to Kabete "O" virus challenge. The test has been successfully used as a routine measure for determining the susceptibility to rinderpest of purchased experimental cattle and has materially reduced the need for the expensive retesting of batches of vaccine due to occasional immunes among the test animals. It will be most useful in serological surveys to determine the incidence and distribution of rinderpest in antelopes and other game animals, which is becoming increasingly significant as rinderpest is eliminated from cattle.

82. The studies on the growth and cytopathogenicity of sheep pox virus in cell culture have been completed and published. Research is in progress on the possibility of developing a method of immunization against sheep pox by attenuation of the virus in tissue culture. Two lines of virus passage are being investigated, one in sheep testis cells and one in calf testis cells, and very promising preliminary results have been obtained. A vaccine prepared from culture virus, to replace the traditional method of "ovination" would be a distinct advantage. The virus of Nairobi sheep disease has been successfully propagated in sheep testis and kidney cells and restricted but characteristic cytopathogenic changes have been demonstrated. The virus was still pathogenic for sheep and mice after 11 culture passages.

83. Mr. Plowright continued the research on the cultivation of the South African "Neethling" strain of lumpy-skin disease virus which he started in 1957 in collaboration with Dr. R. A. Alexander and Dr. D. A. Haig of Onderstepoort. This work was begun during his visit to South Africa under the aegis of the Inter-African Foundation for the Exchange of Scientists and Technicians which was described in the last report. Valuable additional information has been obtained on the growth and cytopathogenicity of the virus, and on optimal methods for producing maximum yields of virus in culture. The latter data would have a direct practical application in any investigations on the development of a vaccine for lumpy-skin disease.

84. Mr. Plowright and Mr. Ferris made an intensive study of bovine papular stomatitis during the year. This appears to be a relatively widespread disease, and is of importance in the differential diagnosis of diseases causing mouth lesions of cattle, including foot-and-mouth disease and rinderpest. It is thus of significance as one of the rinderpest-like diseases, which will become increasingly important in the final stages of the eradication of rinderpest in East Africa. A clinico-pathological study was made of the naturally occurring disease in adult cattle and calves. Four strains of a pox-like virus were isolated in tissue culture from these cases.

85. The Division produces all rinderpest vaccines used in East Africa, and in several other territories. As was stressed last year, the requirements for E.A.V.R.O. rinderpest vaccines have progressively diminished as the disease has been satisfactorily controlled by the use of these vaccines.

86. The work of the Division of Bacterial Diseases consists solely of research on contagious bovine pleuropneumonia and production of vaccine for this disease. The experiments mentioned last year to attempt to elucidate the reasons for severe reactions to avianized pleuropneumonia vaccine were completed by Dr. Piercy and Mr. G. J. Knight. Little additional information was obtained on the causes of these reactions, but the results of this work were satisfactory in that there was no evidence in support of the slight suspicion that this vaccine may very rarely produce cases of pleuropneumonia.

87. Adverse reactions to avianized vaccine were referred to in the last report. These were particularly severe in the Loliondo area of Tanganyika Masailand where 3 per cent. mortality followed the inoculation of about 40,000 cattle. As a result, it was necessary to discontinue the use of vaccine prepared from all but the mildest egg-passaged strain of the organism; indeed the Veterinary Department had difficulty in persuading the cattle owners to accept any vaccination. During 1958 a serious outbreak of pleuropneumonia occurred in Kenya Masailand, and the disease spread further in Tanganyika. Vaccine prepared from relatively virulent strains of organism could not be used due to the danger of severe reactions, and mild vaccine failed to control the acute, rapidly spreading type of disease which was encountered. The position towards the end of the year was that the Kenya and Tanganyika Veterinary Departments had lost faith in avianized pleuropneumonia vaccine.

88. Experience during the past two years or so indicates that the favourable opinions on the value of avianized vaccine which developed following its early use in Kenya were not wholly justified, and that the ideas then current on its efficacy in controlling and eradicating pleuropneumonia were perhaps over-optimistic. The ability to dry the vaccine, and therefore to

store it for long periods and to transport it easily in the field, are significant advances over the old culture vaccine. However, the avianised vaccine has the same essential disadvantage as culture vaccine, namely that vaccine strains of the organism which do not cause severe reactions—which are now quite unacceptable to stockowners—do not give adequate protection, especially against acute virulent outbreaks of the disease. The difficulty of satisfactorily combining safety and immunizing potency remains, and this is still the principal problem in research on the development of an effective vaccine.

89. Much more research is very evidently required on the development of a wholly effective vaccine. A large-scale experiment is in progress at Muguga to compare avianized vaccine produced by the normal E.A.V.R.O. method from a strain of moderate attenuation, with culture vaccine produced by the method which is reported as being successful in Australia. The two Australian-type vaccines have been prepared from the V.5 strain of organism which has been used for vaccine production in Australia for many years, and which was kindly supplied to us by the laboratories of the Commonwealth Scientific and Industrial Research Organisation in Melbourne.

90. Serious problems were experienced early in the year in the work of Mr. C. R. Newing on the techniques of preparation of antigen and other reagents for the complement fixation test for bovine pleuropneumonia. Some batches of the antigen produced by the method employed by Mr. Newing proved to be unstable and unreliable, and this defect caused considerable difficulties when the antigen was used at Kabete in May and June in the testing of bovine sera from the outbreak in Masailand. The results of these tests were unreliable and a serious situation developed, since the Kenya Veterinary Department were largely dependent on quarantine and sanitary measures and the complement fixation test in their endeavours to control the disease.

91. Following Mr. Newing's departure on leave in July, Mr. G. White, undertook the production of complement fixation antigen, and by the application of the method used by Campbell and Turner in Australia he was successful in producing several batches of satisfactory antigen although different batches varied somewhat in potency. He found that the previous failure of antigen to fix complement satisfactorily had apparently been due to premature harvesting of the organism. Mr. White has also worked on the rapid slide agglutination test, including the development of an antigen for the test which is suitable for use with whole blood as well as serum, and which appears to be more stable than the antigen hitherto used.

92. In the Division of Protozoal and Arthropod-borne Diseases Dr. S. F. Barnett and Mr. K. P. Bailey completed the survey of the incidence and nature of East Coast fever in enzootic areas in Kenya. Studies on the epizootiology of E.C.F. in "fringe" or epizootic areas in collaboration with the territorial Departments have been started in Tanganyika.

93. Dr. Barnett and Mr. Brocklesby have carried out much research on the theilerial disease of buffaloes resembling E.C.F. which is transmissible to cattle. The causal parasite of this disease has been shown to have characters which are very similar to those of *Theileria lawrencei* as described in South

Africa and Southern Rhodesia, and it is considered to be this species. A strain of the parasite obtained from a wild buffalo and maintained in tame buffaloes at Muguga has been transmitted to cattle, and the behaviour and morphology of the parasite in this host have been extensively studied. The clinical picture and pathology resemble closely those of E.C.F. *T. lawrencei* and *T. parva* are antigenically similar, since cattle recovered from one parasite are usually immune to infection with the other, but the two parasites are differentiated by morphological characters and absence of piroplasms in the blood of cattle. It has hitherto been considered that although *T. lawrencei* could comparatively easily be transmitted from buffalo to cattle, most cattle reacting to the parasite are not infective to ticks and the disease could not therefore be transmitted from cattle to cattle. In a recent experiment at Muguga ticks fed on a reacting ox were found to be infective for other cattle, and it is now more difficult to define the differences between the two diseases.

94. A herd of about 50 Zebu cows from an enzootic E.C.F. area and previously used in research on this disease at Muguga, and the progeny of this herd, have been grazed without dipping throughout the year in a forest area heavily infected with *T. lawrencei* and a study made of the disease occurring in these cattle. Calves became infected at an early age and the majority recovered; the rate of recovery was similar to that following exposure to natural E.C.F.

95. The study of the distribution of *T. lawrencei* in East Africa is incomplete, but it is known to occur in some of the highland forest areas of Kenya and very probably exists in similar areas elsewhere which are inhabited by buffaloes. *Rhipicephalus appendiculatus* is the principal, if not the only, natural vector of the parasite.

96. Future research will determine whether the natural disease in buffaloes is due to an aberrant type of *T. parva* adapted to game, or to a different species of *Theileria*, but for the present it is regarded as *T. lawrencei*. Whatever the decision may be, the important consideration is that there exists in East Africa a theilerial disease transmissible by ticks to cattle which closely resembles E.C.F., and that the eradication of E.C.F.—and of this disease—will be complicated in affected areas by the fact that it is carried by wild game.

97. Dr. Barnett and Mr. Brocklesby have continued the collection and study of Theilerias from the field, and several interesting strains have been obtained. One strain has all the characters of *T. parva* but is of low pathogenicity. In the first passage of this strain in 19 cattle, 85 per cent. recovered and all were subsequently immune to infection with fully virulent *T. parva*. The recovery rate was influenced by the number of ticks fed; when this was 10 ticks or less it was over 90 per cent. The mild character of this strain was retained after three passages in ticks. It therefore has promise as a means of immunizing cattle and this is being followed up. Two other strains have been studied which have the general characters of *T. mutans*. They are transmitted by *R. appendiculatus* and produce Koch's bodies and a disease in experimental cattle resembling very mild E.C.F.; all animals recover and are thereafter fully susceptible to *T. parva*. The chief interest and importance of strains such as these is the confusion

which they would cause in the field, where they are likely to be diagnosed as mild E.C.F. since there is no means of differentiation other than cross immunisation. The occurrence of such a strain on a farm and its diagnosis as E.C.F. has already been encountered.

98. The research on Theilerias has included immunogenic analysis to determine whether there is any difference between field strains. This is of importance in the development and application of the method of immunisation by the use of Auofac, which was described in the last report. Four recently isolated Kenya strains were found to be identical by cross immunity tests with the laboratory strain used in the Muguga immunisation process. This is being extended to Tanganyika and Uganda.

99. An investigation has been made to determine whether a by-product of the manufacture of the antibiotic Terramycin, which has some chemotherapeutic action against *T. parva*, could be used for immunisation against E.C.F. in the same way as Auofac. It was found to be ineffective at dose levels at which Aureomycin is effective. Further attempts are being made with a soluble form of Terramycin.

100. Miss J. B. Walker's long-term researches on East African ticks, particularly on the taxonomy, breeding and life-cycles of the vectors of disease have progressed steadily. She has given very valuable assistance and advice to officers in the Veterinary Departments in the identification of ticks, especially the differentiation of the rarer species from the common vectors of disease, and has thereby played an important part in the work on the distribution of ticks which is being undertaken by the territorial Departments.

101. In the Division of Helminth Diseases Dr. J. A. Dinnik and Mrs. N. N. Dinnik have continued their studies on the systematics and life-cycles of the Paramphistomes, or stomach flukes, of domestic ruminants of East Africa and their research on *Fasciola gigantica*, the African liver fluke.

102. A comparative study of the morphology of three species of *Paramphistomum*, *P. microbothrium*, *P. phillerouxi* and *P. daubenyi* is nearly finished and will be published shortly. Studies on the life-cycles of *P. phillerouxi* and *Caromyerius exoporus* have been completed. The snail host of the latter has been shown to be *Anisus natalensis*; this is the first time that investigations have been made on the larval development of a species belonging to the family Gastrothylacidae. This long-term work on the Paramphistomes of East Africa, which has included the determination of the snail hosts of nine of the twelve species of fluke hitherto identified, will be completed and discontinued in 1959 and it is anticipated that research will then begin on Bilharzia infections of domestic ruminants.

103. The research of Dr. and Mrs. Dinnik on liver flukes has established that *Lymraea mweruensis* can serve as a snail host of *F. gigantica*. They have continued the work on the effect of temperature on the development of the eggs and larval stages of the liver fluke. Their observations have included the significant finding that miracidia may remain dormant in the egg during the cold season for up to 90 days and then hatch normally and infect snails when the temperature rises.



104. An investigation was made on the morphology and life-cycle of *Fasciola nyanzi*, a liver fluke collected from hippopotamus in Western Uganda, which was first described by Leiper in 1910. *Lymnaea natalensis* was found by laboratory experiments to be a snail host of this fluke. Attempts are in progress to determine whether this parasite may also infect domestic ruminants.

105. Dr. G. M. Urquhart has done much research on bovine cysticercosis, particularly the factors determining susceptibility or resistance to infection in experimental calves, and their significance in the epizootiology of beef measles in East Africa. The factors investigated have included varying sources of tapeworm eggs, the age of the calves, the possible effects of colostrum in protection, and the influence of pre-natal and immediate post-natal natural infection on resistance to subsequent experimental infection. Much interesting information has been obtained indicating that considerable resistance appears to be acquired early in life. Older experimental cattle, aged 18 to 24 months, were found to possess a high degree of resistance. There is little doubt that the failure of earlier attempts at Muguga and elsewhere to produce consistently successful experimental infection was due to this resistance of Kenya cattle. The epizootiology of the disease in cattle is very evidently complex, and much work requires to be done in order to provide the basic knowledge essential to its proper understanding.

106. Information is also urgently needed on the period of survival of beef measles cysts in infected cattle, and a long-term experiment has been planned to investigate this problem, in collaboration with the University of Glasgow, in fully susceptible calves in Scotland.

107. Dr. Urquhart is making a laboratory study of fascioliasis including the experimental disease, pathology, pathogenesis and haematology by infecting a group of calves and slaughtering them at regular intervals from 10 to 120 days post-infection. Similar clinico-pathological investigations are being made on experimental *Paramphistomum microbothrium* infection of calves at Muguga.

108. The functions and programme of the Division of Deficiency and Metabolic Diseases were outlined in the last report. Dr. Horrocks has established and equipped a laboratory at Muguga and begun two main lines of research. His principal work will be on the development of techniques for chemical estimation of minerals and trace elements of importance in animal disease in East Africa, and these studies will concentrate on cobalt and manganese. He will also investigate the significance of sodium chloride in nutrition and disease of livestock, in collaboration with the Veterinary Departments of Tanganyika and Uganda.

109. In the Pathology Division Mr. W. Flowright, assisted by Mr. W. G. MacLeod, has continued the long-term research on the morbid anatomy, histopathology and pathogenesis of the major East African diseases of livestock. In their studies on the pathogenesis of virulent rinderpest in cattle, pathological data have been collected on 80 animals infected with two strains of bovine virus and standards for the pathological changes produced by these strains have been established. These will prove valuable as a basis for comparison in investigations of other strains of rinderpest virus. Mr. MacLeod has done much work on the haematology of cattle infected with bovine, caprine and lapinized rinderpest viruses.

110. An important aspect of Mr. Plowright's pathology research has been his studies on the correlation between the histological changes produced by viruses in infected animals and the cytopathogenic effects caused by the same viruses in cells growing in tissue culture. Similar cytological effects in the intact animal and in cell culture have been found in rinderpest, sheep pox and bovine papular stomatitis.

111. Studies have also been made on the pathology and haematology of natural cases of bovine petechial fever, which occurs relatively commonly at Muguga as an intercurrent disease in experimental or vaccine cattle, and the pathology of sheep pox and Nairobi sheep disease has been investigated.

112. The Animal Production Division consists of three Sections, namely Physiology, Metabolism and Genetics, the work of the first two being inter-related. Mr. G. D. Phillips and Mr. A. MacGregor have continued the programme of work of the Physiology Section on ruminant digestion. Their principal line of research is a study and comparison of the digestive physiology of indigenous Zebu and exotic types of cattle, with a view to determining their relative capacity to utilise the kind of herbage generally occurring in the drier and semi-arid areas of East Africa. Their main work has been a long-term experiment comparing the rate, time and amount of digestion, in 10 pairs of cattle. Each pair consists of a grade Hereford and a Zebu steer, and the pair is kept under observation in metabolism crates for five weeks, the experiment being planned to last a year. Observations and estimations have been completed on five pairs and valuable data already obtained.

113. An ancillary study is being made under precisely controlled experimental conditions on the water requirements of grade and Zebu steers. This includes variations within types of animal, the effects of different intervals between watering, and the relations between water intake and dry matter intake. This research is still in progress, but it has shown that grades require more water than Zebus. An experiment is being done to determine whether water intake is dependent on dry matter intake or vice versa. There is already some evidence from this work that water intake may be the independent and dry matter the dependent factor, and that limitation of water results in a reduction of food intake; an important practical point in areas where provision of water is a problem.

114. The main purposes of the long-term research of the Genetics Section on the growth and production of beef-type indigenous Zebu cattle are to ascertain the relative importance of breeding and management in the improvement of beef quality, and to determine the heritabilities of beef characteristics and carcase quality by the use of sire progeny groups, and thus to investigate the possibility of improving them genetically. The original aim was to produce steers weighing 1,000 lbs. and ready for slaughter at three years old. The first of the steers born at Muguga are now approaching this age and preliminary observations suggest that the target of 1,000 lbs. is not optimistic. Twelve steers have already exceeded it, their average weight being 1,043 lbs. and average age 148 weeks. However, it appears at this stage that Muguga-bred steers reared solely on grass will not be finished and ready for slaughter at 1,000 lbs. weight, and the original

objective has therefore been provisionally altered to 1,176 lbs. The first steer to reach this weight was slaughtered at the age of 153 weeks.

115. The following average weights of the last 10 steers and 10 heifers bred at Muguga to reach the weaning age of 36 weeks, and 72 and 108 weeks respectively, also show that the herd of Northern Frontier Province Borans continues to thrive satisfactorily at Muguga.

<i>Weeks</i>	<i>Steers</i>	<i>Heifers</i>
	lbs	lbs
36 ... ..	463	407
72 ... ..	634	555
108 ... ..	822	658

The figures for heifer weights are noteworthy. The objective first set was to produce heifers which have reached a minimum weight of 550 lbs., and which can then be served, at 90 weeks of age ; this weight is being exceeded at 72 weeks.

116. It is necessary to stress that the genetics herd of cattle is being maintained solely on grass. The rainfall at Muguga in 1957 and the first half of this year was exceptionally good and the grass plentiful. During the dry conditions of the second half of 1958 the general rate of weight increases in the herd was not entirely maintained, which served to emphasise the obvious fact that satisfactory progress is dependent on a reasonable level of rainfall and grazing.

*Visiting Scientists.*

117. The scheme for co-operative research on virus diseases at Muguga by E.A.V.R.O. and the United States Department of Agriculture, which was first described in the last report, has made excellent progress. When Mr. Scott returned from leave, the organisation of the scheme was adjusted so as to bring the research of the American team into closer contact and inter-relation with the Division of Virus Diseases ; this has proved to be a most satisfactory arrangement. In October, Dr. K. M. Cowan was posted to Muguga by the U.S. Department for the usual two year tour. He is a very experienced serologist whose knowledge will be most valuable, not only to the co-operative research at Muguga, but also to other laboratories doing serological research on animal disease in East Africa, which will benefit from his advice.

118. A notable advance was achieved by Dr. W. A. Malmquist in his research on the growth of the virus of African swine fever in tissue culture. The cells used were macrophages from the bone marrow and peripheral blood of domestic pigs. He has found that a focal haemagglutination, or clumping of red blood cells, occurs around macrophages infected with the virus, and that the macrophages undergo eventual destruction or cytolysis. This procedure provides for the first time a method for the identification of African swine fever virus without the inoculation of pigs, and opens up an entirely new field for *in vitro* studies. Following Dr. Malmquist's successful demonstration of focal haemagglutination in African swine fever, experiments were done at the Animal Disease Laboratory of the U.S. Department of Agriculture at Beltsville, Md. to determine whether this phenomenon occurs in cell cultures of the virus of American hog cholera, which is

clinically and pathologically very similar to African swine fever, but immunologically distinct. This work showed that hog cholera virus does not produce these effects in identical tissue culture systems. Consequently an *in vitro* test is now available for the differentiation of African swine fever virus and hog cholera virus, and important progress has thus been made towards one of the main objectives of the co-operative research project, namely the development of a rapid laboratory method of distinguishing the two diseases and of immediately recognising African swine fever should it ever gain access to North America. Arrangements are in progress to extend to three years Dr. Malmquist's present tour at Muguga.

119. Dr. D. E. DeTray continued his epizootiological studies on African swine fever in the indigenous wild swine of Kenya in collaboration with the Game Department. Plans are being made to extend this work to Tanganyika and Uganda, and future research will concentrate on determining the incidence in wart hog, bush pig and giant forest hogs and the mechanism of transmission.

120. Dr. A. W. Stableforth, Director of the Ministry of Agriculture's Veterinary Laboratory at Weybridge, spent a week at Muguga in June; his visit provided a valuable opportunity for discussions on problems of mutual interest to East Africa and the United Kingdom. Dr. R. F. Riek, who works on host reactions to parasitism in cattle at the Veterinary Parasitology Laboratory of the Commonwealth Scientific and Industrial Research Organisation in Queensland, spent a week with E.A.V.R.O. in November.

121. Dr. R. Sobrero, Director of the Veterinary Laboratory at Merca, Somaliland, studied E.A.V.R.O. methods of production of bovine pleuropneumonia and rinderpest vaccines for three weeks in November.

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*The University College of East Africa, Makerere College, Faculty of Agriculture*

122. Mr. W. H. Boshoff has continued his studies on the anaerobic fermentation of Elephant Grass (*Pennisetum purpureum*) for the production of methane gas. He has also carried out preliminary observations upon the relative merits of rotary tillage and tined cultivations in the eradication of African couch (*Digitaria scalarum*). An investigation into the suitability of small two-wheeled tractors for various operations on small farms in Uganda was commenced, but is held up pending the arrival of certain equipment.

123. Mr. A. Huxley has continued his studies into the germination and early seedling growth of *Coffea spp.*

124. Mr. J. L. Joy has continued his work upon a study of maize marketing in Kenya and progress and prospects in the application of mechanisation to African farming in Uganda.

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(b) *WEST AFRICA*

*West African Cocoa Research Institute*

125. In further field trials on the insecticidal control of capsids, gamma-BHC and endrin have again been found most effective. Where capsids are controlled new pests such as the pod-husk miner (*Marmara*) and *Earias* have emerged. Although these new pests are relatively unimportant economically, their emergence has indicated the need for a more fundamental ecological approach to cocoa pests, with the emphasis on the general insect populations on cocoa rather than on capsids and mealybugs.

126. Now that efficient methods are available for the control of capsids and other pests it has become possible to study the effects on mature cocoa of virus infection alone. Preliminary work in Nigeria suggests that much of the deterioration of virus infected trees may be due to associated pathogens and environmental conditions. Studies on the relations between the various classes of cocoa viruses have continued. From the available evidence it would appear that the viruses can be divided into the three distinct groups, viz. cocoa necrosis virus, cocoa mottle-leaf, and cocoa swollen-shoot virus. An outbreak of cocoa virus disease has been discovered in Sierra Leone. In experiments on ant destruction with dieldrin mealybugs have now been kept under control for well over a year from the original applications. More economical methods for dieldrin application are being sought.

127. A team of scientists has been seconded to the Ibadan Sub-Station from the Colonial Pesticides Research Unit in Tanganyika, to investigate the chemical control of fungus diseases, particularly black-pod. A series of field and laboratory experiments on various fungicide formulations has been

started. In continuing work on resistant varieties of cocoa at Tafo improved techniques for assessing susceptibility to black-pod are being developed. Cocoa diseases other than black-pod are receiving increasing attention.

128. Crosses between introduced Upper Amazon cocoas and local varieties have again yielded well. Favourable quality reports on many of these hybrids have been received from European and American manufacturers. Extensive trials throughout Ghana and Nigeria are continuing. Pollination studies have contributed information which has proved useful in the design of seed gardens.

129. In a shade and manurial trial at Tafo the second-year results have confirmed those of the previous year, with significant responses to shade removal and to the application of an NPKMg fertiliser mixture. The unshaded fertilised cocoa has yielded over 2,900 lb. dry cocoa per acre this season. Increased field experimentation on major and minor nutrients is being supplemented by culture solution studies on mineral deficiencies. A spectrographic laboratory has been set up.

130. Investigation of the conditions which are necessary for the successful fermentation of Amelonado cocoa has established that beans killed by deep freezing, immediately after removal from the pod, can be fermented in the usual way to give an acceptable product.

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### *West African Institute for Oil Palm Research*

#### *Agronomy Division*

131. Progress continues to be made in the work of raising seedlings in pre-nurseries and nurseries. Mulch and the application of fertilisers in the pre-nurseries has now become standard practice and with the wider spacing used much more robust seedlings can be put out into the nurseries in April. This treatment when combined with fungicidal sprays against Anthracnose reduces the loss on transplanting to the nurseries to a negligible number. In previous years up to 10 per cent. of the seedlings were lost from Anthracnose attack shortly after transplanting.

132. In the nurseries themselves an experiment has been started to determine the effect of different types of mulch when applied in the wet and dry seasons. Previously bunch refuse mulch has been used very successfully, but the early results of this experiment indicate that the use of a roofing felt mulch may be equally or more effective. Irrigation in the short dry season in August has also been introduced and mention of this treatment in connection with Blast disease is made under Plant Pathology.

133. Work on the establishment of dry-season nurseries has continued. Hitherto nurseries have only been planted at the Institute and Agricultural stations at the beginning of the wet season, the object being to provide robust seedlings for transplanting to the field in the following year. This



means that seed must be stored for up to a year with consequent loss of viability. The establishment of nurseries at the end of the wet season and their maintenance under irrigation will make it possible to issue seed twice a year and thus increase the number of seedlings obtained. Successful methods have been devised for forcing seedlings forward during the dry season and the beginning of the rains, and one area of 39 acres was planted out in June at the Main Station from seedlings which had only been planted in the nursery in the previous September and October.

134. In 1957 Blast disease was not a problem in the dry-season nurseries, but in 1958 it was found that seedlings planted early, i.e. in August or early September, were very susceptible to Blast in October. Susceptibility decreased very rapidly, however, and with plants put out in early November no cases of Blast were reported, while in the October plantings the number of cases was very few.

135. Transplanting experiments are largely completed and a general review of the work undertaken is being published in the Institute's Journal.

136. Field experiments on pruning, manuring, seedling selection, spacing, intercropping and the combining of planting palms with annual crop rotations are continuing. The effect of intercropping on the growth of the palms has again been most striking in all areas. A magnesium experiment has been planned for Sierra Leone where deficiency of this element appears to be widespread.

#### *Engineering Division*

137. A detailed study of the operation of all stages of milling in a Pioneer mill has been carried out and a very clear idea of labour requirements of Pioneer mills, both with and without bunch steriliser and stripper, has been obtained. From this work it has been concluded that these mills cannot be expected to show profits unless they are situated in areas where between 2,000 and 2,500 tons of fruit can be obtained annually and where the quality of the fruit is such that about 20 per cent. extraction of oil to fruit is obtained. It is known that operators of hand presses can compete quite easily with Pioneer mills and commonly pay more for fruit. Improvements of the Institute's Pioneer mill have been effected by steam-jacketing the digester and injecting steam during centrifugal extraction. Progress has also been made in the improving of laboratory techniques, Alkaline Blue 6B being introduced as the standard indicator for f.f.a. determinations while Dean Stark apparatus is now in use for determining oil and water in fibre.

#### *Plant Breeding Division*

138. A new breeding programme, based mainly on *tenera* selfing and crossing, has been introduced. It is intended that these *tenera* selfings and crosses, which give *dura* and *pisifera* as well as *tenera* progenies, will, after further selection, provide the parents for producing high quality seed for distribution. In the meantime the quality of the seed being produced is being improved by the selection of palms according to new standards from within good progenies only, and by the taking of *pisifera* pollen from palms which have been progeny tested or which belong to a very good progeny. The new breeding programme also contains provision for the production of improved *dura* parents from *dura* x *dura* crosses and selfings, and a special programme of selection of Deli parent palms.

*Plant Nutrition Division*

139. This division is now in full working order, both the plant nutrition unit and the leaf analysis laboratory and equipment having been completed. With regard to leaf analysis, work on techniques and sampling is now proceeding. In pot culture all macronutrient deficiency symptoms have been explored and described and, in particular, the first description of the symptoms of calcium deficiency has been published. In addition, symptoms of iron, boron, and manganese deficiency have been revealed, but it has not yet been possible to produce symptoms of copper, zinc and molybdenum deficiency.

*Plant Pathology Division*

140. In the course of work on the pathogens causing Blast disease of nursery seedlings it was shown that a *Pythium* species could be parasitised by *Rhizoctonia lamellifera*. A description of this work has now been prepared for publication in the Transactions of the British Mycological Society. The inverse correlation which is thought to exist between rainfall in August-September and the incidence of Blast during the following dry season has gained further support from experience during the 1958-1959 dry season, but it has not yet proved possible to establish this relationship by the application of irrigation water during those months. A further experiment will be carried out during 1959.

*Plant Physiology Division*

141. Further work on the germination of oil palms has led to a more accurate determination of the optimum moisture contents for germination of both *tenera* and *dura* nuts. Work on the flush effect of removing seed from the high temperature of a germinator to ambient temperature has indicated that once the high temperature reaction is complete, germination will proceed far faster at ambient temperature, and it is hoped to perfect a system in which the application of heat to oil palm seed would be continued for between two and three months after which the seed would be transferred to ambient temperature and full germination would then take place in a relatively short period of time.

142. Studies of stomatal movement have continued and a relationship was found between stomatal closure and air temperature. It is hoped to carry out full investigation of midday closure in relation to air and leaf temperatures and it is expected that this will shed some light on the inter-relationships of transpiration rate, stomatal closure, humidity, total radiation and soil moisture content in the oil palm.

*Soil Chemistry*

143. Further progress has been made in relating the magnesium and potassium content of the soil to fertiliser requirements and it is now believed that the controlling factor in magnesium deficiency is the exchangeable magnesium/potassium ratio. Where there is an ample supply of magnesium it is possible to say that deficiency symptoms will definitely not appear, but difficulties are found at low levels of magnesium where symptoms may or may not occur, and where very small variations in the Mg/K ratio can change symptoms from nil to severe, even on the same plot. For potassium,

the fraction exchangeable potassium<sup>2</sup>/total exchangeable bases is now found most useful in determining deficiency levels. Studies of soil nitrogen variations have started in Sierra Leone.

#### *Statistics Division*

144. A full study of the two uniformity trials at the Institute's Main Station has now been completed and will shortly be published. The Statistician has planned a calibration trial which will enable comparisons to be made of palms of different ages independently of climatic variations and will make possible the determination of the effect of climate independently of age. It is expected that a much greater understanding of the growth, flowering and fruiting behaviour of the oil palm will thus be obtained.

#### *Publications*

BROEKMANS, A. F. M.—Growth, Flowering and Yield of the Oil Palm in Nigeria. *J.W. Afr. Inst. Oil Palm Res.* **2** (1957) 187.

BULL, R. A.—Symptoms of Calcium and Phosphorus Deficiency in Oil Palm Seedlings. *Nature*, **182** (1958) 1749.

HARTLEY, C. W. S.—Advances in Oil Palm Research in Nigeria in the last twenty-five years. *Emp. J. Exp. Agric.* **26** (1958) 136.

HUSSEY, G.—An Analysis of Factors Controlling the Germination of the Seed of the Oil Palm, *Elaeis guineensis* (Jacq.) *Ann Bot. Lon.* **22** (1958) 259.

REES, A. R.—Field Observations of Midday Closure of Stomata in the Oil Palm, *Elaeis guineensis* Jacq. *Nature* **182** (1958) 735.

The following papers were in the Press for the 8th number of the Journal of W.A.I.F.O.R.

SPARNAALJ, L. D. and GUNN, J. S.—The Development of Transplanting Techniques for the Oil Palm in West Africa.

ROBERTSON, J. S.—Blast Disease of the Oil Palm: its Cause, Incidence and Control in Nigeria.

HUSSEY, G.—The Germination of Oil Palm Seed. Experiments with *Tenera* Nuts and Kernels.

BULL, R. A. and ROBERTSON, J. S.—The Problems of "Little Leaf" of Oil Palms—A Review.

KOWAL, J. M. L. and TINKER, P. B. H.—Soil Changes under a Plantation Established from High Secondary Forest.

#### *West African Rice Research Station*

145. The Station has now its complete complement of professional staff. The Officer-in-Charge paid short visits to F.A.O. in Rome and to the Italian Rice Research Station at Vercelli. One of the Botanists spent a month in the Western and Eastern Regions of Nigeria and the Soil Microbiologist visited the Gambia.

146. Improvement of rice varieties by introduction, selection and hybridization, has continued. Further new introductions have been made to the collection and yield trials of the most promising of those obtained in recent years have again been carried out in as diverse conditions as

possible. The first releases from these have now been made after three years trials. These are Faya ex Nyasaland and Radin China 4 ex Malaya which have both proved consistently high yielders under a range of West African conditions.

147. Hybridization is being extended. Techniques are being developed for cytological investigation into the problems of sterility in *sativa* x *glaberrima* crosses, and a large number of such crosses have been attempted. A diallel set of crosses involving four parental varieties has also been made to investigate the inheritance and importance of various yield components and to estimate the value of the parents for future breeding programmes.

148. The drier for small rice samples has now been satisfactorily developed and work on milling quality has continued on artificially dried grain, with greater uniformity of results. Investigations into cooking quality and palatability of a group of rice varieties have also been carried out by means of a tasting panel and correlations between the results of these and of standard physical and chemical tests have been examined. The main immediate result has been to show that the new releases Faya and Radin China 4 are acceptable to local tastes and in fact are significantly more acceptable than some widely grown and liked rices.

149. Investigations into the factors influencing duration, in particular day length and light intensity, continue with the aim of developing photoperiod insensitive varieties. A standard successional sowing experiment has this year been laid down at sites in all four contributing territories and it is hoped that the results from this will give useful preliminary information.

150. A practical method has been developed whereby dormancy of freshly harvested paddy can be broken completely in less than a week by treatment with heat and oxygen. This is expected to be of use in speeding up the breeding programmes and developing photoperiod insensitive varieties for out-of-season cultivation.

151. Work on viability has continued and an analysis of the factors involved, which is shown to apply to other major cereals, now makes the prediction of the length of viability period appear possible from a knowledge of the storage temperature and relative humidity.

152. Investigation of the drought resistance of rice seedlings and comparison of upland and swamp varieties in these respects has been carried out as the start of a general investigation into water relations of the rice plant.

153. Studies of tidal mangrove soils have continued, from both chemical and microbiological angles. The rate and mode of organic matter decomposition has been considered, from the mangrove vegetation itself to the humus in the muds and particular attention has been paid to the undecomposed fibrous matter which is associated with soil acidity problems. It has been found that the soil properties, both chemical and physical, undergo radical changes on passing from the topsoils to the horizons rich in fibrous material. For example, the organic carbon increases from 4 to 12 per cent. and the carbon: nitrogen ratio rises from the already high figure of 20 to 60. Phosphorus on the other hand drops from 0.1 per cent. to 0.02 per cent. and total sulphur increases from 0.2 per cent. to nearly 10.0 per cent.

154. The behaviour of the various sulphur fractions in tidal mangrove soils under oxidising conditions has been investigated. In the soil studied, the dominant fraction was elemental sulphur, which is oxidised by *Thiobacillus thio-oxidans* to form sulphuric acid, the cause of the high acidities which have been noted in empoldered mangrove soils in the past. Detailed investigation of the process of elemental sulphur oxidation in these soils has shown that it may under certain conditions be stimulated by the application of liming material. The results suggest that where large reserves of elemental sulphur are present, neutralisation of some acid soils by liming material might stimulate further acid production, thus increasing the amount of lime required. An explanation for this effect has been suggested.

155. The whole of the sulphur present in the soils investigated does not occur in elemental form. A small proportion is present as monosulphide and some may occur in organic form. The polysulphide fraction appears to be of major importance. Although polysulphide can be oxidised to form sulphuric acid the present work indicates that oxidation occurs only below pH 3.0, and that in mangrove soils, even below this pH value, polysulphide sulphur does not contribute to the formation of acid sulphate. It is suggested that the reclamation of permanently saline swamps might be achieved without the development of highly acid conditions if the formation of pyrites sulphur rather than of elemental or sulphide sulphur could be induced in the soil. Should it be possible to establish suitable conditions whereby the amount of lime required to neutralise the acid formed would be considerably reduced, or it might even be possible to eliminate the use of lime altogether, relying on the natural rise in soil pH value which occurs on reduction at the beginning of the rainy season.

156. A start has been made on the examination of the soil from one of the inland flood plains of Sierra Leone and this has revealed a surprising lack of manganese even in a thick ironstone layer. Furthermore the topsoils are deficient in iron and laboratory experiments have shown that rice grown in these soils is very susceptible to sulphide toxicity. Respirometric studies on the organic matter of these soils has also been carried out with results sufficiently interesting to warrant further investigation.

157. An observation was carried out on the use of 2, 4-D and MCPA for weed control on inland flood plains. No differences were observed between application at the time of sowing rice and one week after, or between the chemicals. Grass weeds, the major weeds in the area, appeared unaffected by any treatments, but germination of the rice was adversely affected by rates of 1 and 2 lbs. acid equivalent per acre.

#### *Publications*

JORDAN, H. D. "Rice Destruction by Crabs." *World Crops* 10 (1958) 83.

#### *West African Maize Research Unit*

158. Local and introduced maize varieties were tested for yielding capacity in a series of trials carried out within the main environments in the West African territories served by the Unit. A group of yellow flint varieties has proved very successful in rain forest areas and could serve as a source of breeding materials for high rainfall areas. Further trials were made during

the year to test the performance of a number of selected varieties in the different environmental areas of Nigeria and Ghana. A similar series of trials made during 1957 showed that the behaviour of the varieties used was consistent within rainforest areas but very variable in Guinea Savannah regions.

159. During the year plant breeding mainly consisted of the inbreeding of selected plants and the top-crossings of  $S_1$  stages to determine combining ability. The programme is designed to obtain good combining lines which eventually will be composed into synthetic varieties. A preliminary synthetic is in the last stages of combination and is being released shortly. The release of this white dent variety will give useful information on the organisation of extension services required for the distribution of future varieties.

160. An investigation on the mechanism of drying-out of the ear at maturity is in progress with an aim to determining factors influencing high moisture retention at harvest time. This undesirable character may exclude some otherwise highly desirable varieties from the breeding programme.

161. The evaluation of the rust resistance of inbred lines has continued in the juvenile and adult stages. A high degree of resistance to *P. polysora* has been found in derivations of the variety Mexico 5 (SLP 20-4A).

162. No sources of resistance have yet been found to the most troublesome of the leaf blights, *Cochliobolus heterostrophus*. Lines provided by Dr. Ullstrup, Beltsville, Maryland, have all shown high susceptibility in the field. A method has been devised for the evaluation of blight resistance in the seedling stage.

163. A new disease of maize, bacterial stalk rot, was first observed during 1958 and caused losses up to 20 per cent. in some introduced varieties. The causal organism is *Erwinia carotovorum* var. *aroideae*.

#### *Publications*

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#### *West African Timber Borer Research Unit*

164. The work of 1957-58 on the protection of logs against ambrosia beetles had shown that the high protection given by insecticidal formulations of g BHC to logs in the forest did not apply to water transported logs. Using g BHC at 0.75 per cent. and Aldrin at 1.5 per cent. as the active ingredients a comparison was made of the efficacy of grease, resin and oil formulations of the insecticides in protecting water transported, bark-removed, logs. g BHC in dieseline gave the best results, giving over 90 per cent. protection throughout 14 weeks exposure in water. Resin formulations (arclors and coumarone indenenes) of both g BHC and Aldrin proved more efficacious than greases, due largely to differences in ease of application, but neither formulation compared with the simple solutions of insecticide in dieseline.

165. The study of susceptibility of different timbers to ambrosia beetle attack has been extended to include timbers of Nigeria and the Cameroons, experiments being set up at Ibadan, Sapele and Buea. These results also gave additional information on the geographical and ecological distribution of the different species of beetles.

166. The biological studies on ambrosia beetles have concentrated on flight and periods of activity in the high forest. By means of extensive trapping it has been shown that flight at lower levels of the forest is certainly not haphazard, direction probably being determined by direction of incident light and local air currents. Trapping throughout the year has shown a clear seasonal variation in the number of beetles in flight. Catches were comparatively high from May–November after which they fell, remaining at a low level until the following May. This distribution of beetle abundance shows some correlation with the annual distribution of rainfall in Ghana and it would appear that beetles are undoubtedly more abundant in the wet than in the dry season. Studies of diurnal variation in activity in *Doliopygus conradti* Strohm. (*Platypodidae*) reveal that though this species is crepuscular, by far the greater proportion of active individuals fly in the evening and very few in the early morning. Work now in hand indicates that this may be true of most crepuscular species of ambrosia beetles.

167. The study of powder-post beetles, has been included in the 1958–59 programme (*Lycidae* and *Bostrychidae*). A survey of the distribution and relative importance of different species has been initiated in Ghana, Nigeria and the Cameroons. The *Bostrychidae* proved to be the more wide-spread and common pests. To date 12 species of *Bostrychidae* and only 2 of *Lycidae* have been found. Field studies on the seasonal variation of starch content in standing and felled trees of *Triplochiton scleroxylon* K. Schum. have started and the results will be related to the variation in susceptibility of Wawa to attack by powder-post beetles. At the same time laboratory stocks of the more important species are being established and tests on susceptibility carried out using different timbers and beetle species.

168. Work has commenced on the “borer of living Wawa”, (*Symmerus tuberculatus* Chap.), the Forestry Departments of Ghana and Nigeria, and the Timber Trade giving their fullest co-operation. So far work has been confined to surveys of the log yards in mills and a survey of certain Forest Reserves to locate beetle attack on the growing tree.

#### *University College of Nigeria, Faculty of Agriculture*

169. *Entomology and Grain Storage.* Regular collections of insects were made from 59 different crops grown on the Faculty Farm and 309 species new to the Faculty collection were found. The study of the beetle, *Callosobruchus maculatus* with special reference to the effect of food on its biology continues. The joint project on grain storage with W.A.S.P.R.U. now possesses storage bins constructed from aluminium, pre-cast concrete, concrete block, steel, and plywood. Comparison of these bins for the storage of maize continues. It has been established that maize can be stored for periods of six months or more with little deterioration. Maize losses in storage due to attack by *Calandra oryzae* are being studied in conjunction with the agricultural economist.

170. *Reference Collection.* This now contains over 2,000 species and a mimeographed list of these is being prepared. An insect identification service for agricultural officers is now a possibility.

171. *Soil Science.* With the advent of a new lecturer in this subject the emphasis has changed from mineralogy to soil fertility. Six projects have been initiated:

- (1) Root distribution of six tropical pasture species on Iwo soil.
- (2) Differences in soil fertility under a five year Giant Star grass (*Cynodon plectostachyum*) pasture and a mixed Giant Star grass—*Centrosema* pasture.
- (3) The influence of five different cover treatments on soil properties.
- (4) The influence on three different burning treatments on soil properties.
- (5) A study of non-symbiotic nitrogen fixation under different cultural treatments.
- (6) The influence of nitrogen and phosphorus fertilisation and of cutting regime on the yield, composition and botanical composition on Giant Star grass—*Centrosema* pasture.

172. *Nutritional Chemistry.* Investigations on the influence of time and frequency of cutting on the yield and chemical composition of *Pennisetum purpureum*, *Andropogon tectorum*, *Panicum maximum* and *Tripsacum laxum*, four of the most important fodder grasses grown in Nigeria, were completed. These studies have shown that optimum cutting intervals vary for the different grass species when yields of total nutrients are considered. While *Pennisetum purpureum* Schum. should be cut every twelve weeks, *Andropogon tectorum* Schum. should be sampled at every six to eight weeks to obtain maximum yields of carbohydrates and total nutrient content of each of the grasses.

173. The preliminary studies on the comparative effects of grass-legume mixtures and grass pastures, on live weight gain of Zebu cattle have been concluded. While good pasture grass can carry 1.5 beasts per acre during the rainy season, the pasture carrying capacity drops to one beast per acre during early periods of the dry season, and supplementary feeding becomes necessary on unirrigated pasture towards the end of the dry season. The carrying capacity of grass alone is lower than that of grass-legume mixtures.

174. Investigations on the nutritive value of cassava to the pig continue. Nutritional balances of nitrogen, calcium and phosphorus on adequately balanced pig rations with either cassava or guinea-corn as the main source of carbohydrates are being determined.

175. *Animal Husbandry.* Three-breed crossing experiments using closely in-bred lines of Tamworths, Large Blacks, and Large Whites continue. Results indicate that the tri-hybrids make significantly greater live-weight gains than the di-hybrids or the non-inbred parent pigs. A programme of rotational crossing, that is, continuous cross-breeding utilising the three breeds to produce alternate generations from the hybrid dams is now in progress.

176. Comparisons of the production of local poultry and a number of imported breeds continues, the performance being tested under different management conditions, viz., deep litter, battery, free-range and semi-intensive



systems. Experiments on broiler production financed by the Rockefeller Foundation are now about to commence. The broiler house provided by the Foundation has now been completed.

177. Observations on the dairy and beef herds of White Fulani Zebu cattle under conditions of moderate exposure to trypanosomes continue. Total infection rate (from stained blood smears) with trypanosomes in the untreated female herd dropped from 57 per cent. in 1957 to 16 per cent. in 1958. No losses from trypanosomiasis occurred and no treatments were given. All positive smears in 1958 were observed between the wet period from June to September. A similar trend in infection rate occurred in the period 1950-57. Although more *Glossina palpalis* were seen on the College farm during 1958 than in previous years total fly-counts were nevertheless low, which suggests that mechanical transmission, particularly by Tabanids, which are more numerous in the wet season, may have been the chief mode of infection. Antrycide pro-salt treated bulls and steers remained free from infection. Bulls and steers on Centrosema/Star grass stands from 1956-58 averaged 925 lb. live weight in three years, two months, average daily gains for the final two years continuous grazing on 1½ acres per head being 0.71 lb. No supplements were fed except salt. A summary of data on the College flock of Dwarf sheep for the period 1950-58 indicates that under local conditions three crops of lambs in two years may be expected. The twinning rate was 20.6 per cent. and triplets 3.0 per cent. The best age to breed ewe lambs was twelve months. Of 22 carcasses examined low carcass percentage increase with age was due to slow growth rate, poor conformation, except at maturity, and comparative lack of body fat. Sales of local sheep are nevertheless governed largely by religious festivals and social occasions, carcass quality not being closely related to purchase price. The most economic age for selling live sheep was placed between twelve to eighteen months.

178. *Agricultural Economics.* The study of the rural economy of Nigeria, land tenure changes and policy, commodity marketing, and the relationship of agricultural improvement to general economic development continued. A study of types of 4-course rotation has been designed and is run jointly with the Agronomist. The purpose is to evolve a system of crop rotation that will be economic and can be fitted into the existing structure of peasant farming in Nigeria. These projects now receive the support of the Rockefeller Foundation.

179. *Agricultural Engineering.* A preliminary investigation into the economics and effectiveness of mechanised weed control in maize intercropped with groundnut continues. Analysis of complete workshop records of the use and repair of vehicles, tractors and implements to determine operating costs will begin shortly. Preliminary work has begun on a project designed to investigate the use of the Heat Pump to provide conditioned air for grain drying. A small research and development machine-shop largely financed by the Rockefeller Foundation will soon be in operation.

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CASWELL, G. H. The Abnormal Form of *Callosobruchus maculatus*. *Bull. Ent. Res.* (in press).

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McILROY, R. J. Agriculture at University College, Ibadan. *Shell Public Health & Agricultural News* (SPAN) (in press).

MODEBE, A. N. A. The Effect of Dietary Antibiotic on the Digestibility of Food by Pigs. *J. Dept. of Agric. (Ireland)* (in the press).

OYENUGA, V. A. Problems of Livestock Nutrition in Nigeria. *Nut. Abs. and Revs.* (1958) 28, 985-1000.

OYENUGA, V. A. Effects of Frequency of Cutting on the Yield and Composition of some Fodder Grass in Nigeria: *Pennisetum purpureum* Schum. (in press).

PORTERFIELD, J. S., HILL, D. H. and MORRIS, A. D. Isolation of a Virus from the Brain of a Horse with "Staggers" in Nigeria. *Brit. Vet. J.* 114, 11, 425-433.

### (c) WEST INDIES

#### *The Imperial College of Tropical Agriculture, Trinidad Agriculture*

180. *Crop Husbandry: Yams (Dioscorea alata, var. Lisbon)*. Experiments aiming at extending the season of availability of yams have continued. The optimum concentrations of ethylene chlorhydrin for breaking dormancy have been confirmed. An eight per cent. solution is required for tubers treated in January and a four per cent. solution is required for those treated in March, lower concentrations being needed as the normal germination time, May, approaches. Cut tubers should be dipped in the solution and then placed in a closed box for twenty-four hours before planting in an outside, watered nursery when germination occurs in two or three weeks. All parts of the tuber can be used, but tops give the best results. The growth period of yams planted from January to June appears to be uniformly seven and a half to eight months and the use of 2,4-D to hasten the maturity of early planted yams now appears unnecessary. Good yields have been obtained from yams planted in January and the cost of irrigation is more than offset by the enhanced price received for early yams so that early planting and production is an economic proposition. The only aspect of this work now requiring further investigation is the use of MENA to inhibit germination during storage, as although this material is effective for this purpose it tends to cause wartiness which detracts from the value, although not the eating qualities of the tubers.

181. *Rice*. Work on rice has continued with the main objective of developing a technique of direct seeding of swamp rice which will eliminate the need for transplanting but gives as good results as the latter procedure in terms of yield or economically. This has necessitated investigations on the control of weeds and the control of snails which do great damage to germinating seedlings. As indicated in the next section, the major weeds can be controlled with herbicides. Snails can be controlled by applying fifty pounds per acre of five per cent. BHC, but efforts are being made to find a cheaper

method. Various other factors connected with different methods of direct seeding are also being investigated and in the coming year these methods will be compared with transplanting.

182. *Herbicides.* It has been shown that rice will tolerate a mixture of three-quarters of a pound per acre of dinoseb and one pound per acre of sodium MCPA and that this mixture will satisfactorily control the principal weeds found in rice in Trinidad, namely *Fimbristylis miliaceæ* and *Sphenoclea zeylanica*. Work with yams indicates that 2, 4-D compounds are very promising for use as pre-emergence herbicides for controlling weeds in this crop. Of a number of chemicals tested as post-emergence applications, CIPC at four pounds per acre was the one to which the crop was most tolerant, but it did not give satisfactory weed control in the field even when several applications were made at three weekly intervals. Groundnuts were found to tolerate applications of two pounds per acre of MCPB applied just before emergence and up to four pounds per acre when applied three weeks after emergence. The crop is most susceptible to pre-emergence sprays applied immediately after planting and susceptibility is increased by rain-fall immediately after pre-emergence spraying.

183. Experiments have indicated that MCPB is unlikely to be a useful pre-emergence herbicide for maize, because although this crop shows a high degree of tolerance to pre-emergence MCPB if rain does not occur soon after application, in the presence of rain even small doses of MCPB give rise to considerable distortion and reduced growth rate. On the other hand, post-emergence applications two weeks after planting gave good weed control and did not damage the crop appreciably.

*Animal Husbandry: Animal behaviour studies with cross bred Zebu-Holstein cattle.*

184. A comparative study was made of the behaviour patterns of cross bred Zebu-Holstein milking cows on pangola grass pastures at three different stations within a ten mile radius. The "norm" for the behaviour pattern was midway between the temperate "norm" for *Bos taurus* and the tropical "norm" for *Bos indicus* cattle, there being three peak grazing periods: early morning, mid to late afternoon and around midnight. The period of effective grazing ranged from 6.5 to 8.7 hours per day, that of ruminating from 6.0 to 6.7 hours. The proportion of grazing occurring by day varied with the herd and its management from 53 per cent. to 86 per cent.

185. The data suggested that such dairy stock in Trinidad could with advantage be night paddocked on the best available grazing, since at night temperature is not a limiting factor to grazing and there are no managerial interruptions for milking, etc., which may cut into peak daytime grazing periods.

*Water requirements of cross bred Zebu-Holstein cattle.*

186. This trial was carried out at the Central Experiment Station, Centeno, and involved the comparison of the water uptake both of adult cows, growing heifers and young heifer calves during the wet and during the dry season. Water uptake was measured in two parts:—(a) Water drunk,

(b) water consumed with herbage. The water consumed with herbage was estimated by chromic oxide inert marker techniques, after determination of the water content of the grass eaten in each day.

187. Increased water uptake during the dry season was greater in the case of water consumed with grass than in the case of water drunk. As the dry matter percentage of grass during the dry season is greater than that of grass in the wet season, it follows that the total herbage intake of the stock was greater during the dry season period. Further studies on the variation in herbage intake with season are planned.

#### *Entomology.*

188. There is a prevalent belief in Trinidad (as in Africa and Asia) that Bamboo is more susceptible to attack by borer beetles (*Dinoderus*) if felled during the first quarter of the moon; also that immature bamboo is more heavily attacked than that which is "ripe", i.e. nearing the end of its life. In conjunction with N. W. Simmonds, Professor T. W. Kirkpatrick made a series of experiments to test these suppositions. As was expected, it was found that the phases of the moon have no influence on liability to attack. Moreover, the local belief that "ripe" bamboo is less attacked is entirely unfounded; it is, in fact, much more susceptible.

#### *Regional Research Centre, Trinidad*

##### *Banana Research*

189. The situation in male parent breeding is now such that a brief review of the situation is possible. In past years (roughly from 1948 until the present time) one particular seeded hybrid clone has been an important source of male parent material; this hybrid, SH 13, was raised from a cross of *Musa acuminata* subsp. *banksii* from Samoa with a strain of *Musa acuminata* subsp. *burmannica* from Burma. It has been extensively used in male parent breeding by crossing it with edible diploids, having been chosen for this purpose because it combined to some extent the large fruits and good bunch formation of *banksii* with the vigour of the Burmese parent; its fruits are much inferior to those of *banksii* itself, which, however, was not available.

190. The African banana collecting expedition (1948) extended the scope of banana breeding by adding two important edible diploids and the male parents currently in use in Jamaica were derived from crosses of one of these with SH 13. The eastern banana collecting expedition (1954-5) has still further extended the scope of breeding by providing more edible diploids as well as new stocks of *banksii*. Of the *banksii* forms collected in Samoa, Queensland and New Guinea, the majority are, under Trinidad conditions, of poor vigour and are susceptible to disease. A minority—notably some of the Samoan introductions—have, however, grown reasonably well and have produced splendid bunches at the College; crossed by edible diploids they have produced, in the last six months, several seedlings of outstanding promise. Tests of disease reaction and performance are, of course, needed before they can be properly assessed, but in appearance, at least, they are outstandingly better than any male parent yet intensively used in banana breeding—a rough judgment of them is that they are as much better than

current male parents as the current male parents themselves are better than "Pisang lilin". Concurrently with this development, new edible diploids are coming in from the East by way of quarantine at Kew. This, then, is an important line of male parent improvement which is founded essentially on new collections.

191. Another major line of improvement was indicated in the last report, namely the intercrossing of certain edible diploids and parthenocarpic selections from earlier crosses. Of the combinations so far tried, the edible diploid "Tongat" by other edible diploids seems especially promising. The development of this series of crosses is inevitably slow because the plants, being parthenocarpic, are infertile.

192. To summarise, we may say that all the signs in male parent breeding are of marked improvement, improvement which is very largely a consequence of the acquisition of new breeding stocks; but to this statement must be added the qualification that the promise of these new seedlings is subject to tests of disease resistance and actual performance as male parents.

193. On the cytological side, K. Shepherd has continued his studies of interchanges in *Musa acuminata* and of the cytology of interspecific hybrids in the genus as a whole. An interesting result is that there appears to be but a low degree of cytological differentiation between members of the section *Australimusa* ( $n = 10$ ). He has also found out that two new species have chromosome numbers hitherto unrecorded in the genus *Musa*. In *Musa*, the basic chromosome number ( $x$ ) is 10 or 11 while in *Ensete* it is 9. A recent accession from Borneo is, in appearance, related to the 20-chromosome bananas of the section *Callimusa* but has itself only 18 chromosomes ( $x = 9$ , a basic number previously known only in *Ensete*). The other new chromosome number appears in a gigantic wild banana from the mountains of New Guinea which has  $x = 7$ , a number previously recorded only in one species of *Strelitzia* in the entire order Scitamineae; the affinities of this interesting plant are doubtful for it has some features reminiscent of *Ensete*. Both species pose most interesting botanical problems.

#### *Cocoa Research*

194. *Plant Breeding.* The testing for resistance to Witches' broom disease continues on a large scale, present work being confined to the testing of sib-crosses and to gamete testing among the Trinitario-Scavina hybrids. In addition P 12, a selection introduced from Peru by Pound in 1943, was subjected to test after reports of apparent resistance had been received from other countries. The degree of resistance shown by P 12 is less than that of SCA 12 but more than other clones. P 12 also demonstrates factors for early vigour. One of the by-products of the inoculation test is the demonstration of differences in early growth of seedlings derived from various parents. On the basis of these observations a study of the genetic factors influencing growth has been initiated.

195. The Trinitario-Scavina hybrids continue to be of interest, the yields of all six crosses for 1957-58 being above those of the preceding years. The best crosses, ICS 6  $\times$  SCA 6, gave about 2,600 pounds of dry cocoa per acre. Flavour reports on these six groups from Messrs. Rowntree and Co.

are encouraging in indicating that the flavours can be recognised as belonging to the Trinitario group. Crosses between Scavina and Grenada selections (GS 29 and GS 36) have been made for investigations to be conducted in Grenada. In the older experiments there was little change from the previous year, the yields being about the same. Yields were recorded from the 1953-1954 Progeny Trial for the first time and were very encouraging. The progeny of ICS I  $\times$  ICS 98 yielded over six hundred pounds per acre, the same as the cuttings of ICS 95 planted in the experimental area. Cuttings of ICS 39, ICS 40 and ICS 60 gave about one thousand pounds per acre.

196. The early results from the first experiment involving  $S_1$  crosses were encouraging and it was decided to continue to use the system of breeding. The first series of test-crosses of  $S_1$  trees was planted in 1958 and other test-crosses are being made when possible.

197. Studies of the inheritance of pigmentation and the "crinkled-dwarf" character are continuing. Studies of the other *Theobroma* species were continued and it was possible to make the following new crosses; *T. angustifolia*  $\times$  *T. mammosa*, *T. subincana*  $\times$  *T. mammosa*, *T. subincana*  $\times$  *T. nemorale* and *T. subincana*  $\times$  *T. angustifolia*, as well as several new backcrosses. Interspecific hybridisation in the *Herranias* has been encouraging, twenty-four combinations having been obtained so far and  $F_2$  plants from some of the older crosses.

198. *Growth Regulators.* A controlled temperature room has been installed and investigation of the auxins of cocoa and bananas is continuing under rigidly controlled conditions. This has permitted biological assay by the use of the oat coleoptile curvature technique, a method more suitable for assays of material low in auxins such as dormant buds and young cherelles.

199. *Stock Scion relations.* Although it has been found that with a vigorous root stock the yield of some scions is greater than on their own roots, the increase with the higher yielding clones is hardly such as to make production of grafted plants a practical proposition. This experiment is, however, showing the predominating character of the scion. With the four stocks under trial the cropping pattern of the tree is largely determined by the scion. It would appear that the above-ground portion of a cocoa tree is very sensitive to atmospheric factors of which the most important is humidity.

200. *Copper Sprays.* Evidence is accruing that the use of fungicidal copper sprays, more especially when mist blown, gives increases in yield quite distinct from disease control. An experiment is being laid down at River Estate to investigate the effect of mist blown copper and other trace elements on yield both with and without the application of fertiliser to the soil.

201. *Fermentation.* Following a re-investigation of the optimal conditions of micro-fermentation, in which many conflicting claims were examined, a procedure for small scale fermentation was developed based on our experimental findings. Material prepared by this method showed moderate to strong chocolate flavour, in which foreign flavours are completely absent and in which the latent Trinidad flavour character of a bean is fully developed. A full account of the experimental procedure is being prepared for publication.

202. An investigation into the chemical mechanism of chocolate precursor formation during fermentation has been initiated and methods are being developed for the fractionation of the aromatic constituents of the bean.

203. Biochemical changes in the cotyledon of the bean during sun- and artificial-drying have been studied by chromatography and evidence obtained which indicates that the harshness of beans dried at elevated temperatures is to be attributed not to a higher content of free monomeric polyphenol at the end of the drying period, as was formerly believed, but to the formation of certain polyphenol-protein complexes, possessing different organoleptic properties from those normally found.

204. A laboratory-scale wind-tunnel has been designed and constructed for the purpose of exploring the physical factors determining the rate of drying and palatability of artificially-dried cocoa. By means of this equipment it has been possible to standardise the drying of small experimental samples from the micro-fermentary prior to flavour assessment.

205. An investigation into factors causing a decline in quality of Trinidad cocoa has been initiated and attention has been given to a recent, although now widespread, estate practice of filling the fermentaries over an extended period of time. The experimental results have been assessed with the assistance of the Cocoa Planters Association and will be published shortly.

206. The investigation on the validity of a spectrophotometric method of assessing the degree of fermentation of commercial samples has been concluded. Although the method is of utility in recognising under-fermented bean material, little correlation was found between the purple content and organoleptic quality in the more adequately fermented samples.

#### *Plant Pathology*

207. *Witches' Broom Disease.* The conditions necessary for the formation of sporophores by *Marasmius perniciosus* are being investigated with a view to (1) providing a regular supply of inoculum for testing resistance in hybrid seedlings in the plant breeders' programme; (2) examining the possibility of pathogenic strains within the species *M. perniciosus* and (3) controlling the disease by inhibiting sporophore maturation. The fungus has been isolated from broom-like vegetative growths and also from diseased pods of certain *Herrania* species grown at River Estate. The morbid anatomy and histology of the witches' brooms of *Theobroma cacao* and of the related genus *Herrania* are being investigated. These studies should indicate possibilities for improvement in the sanitation method of controlling the disease by exision of brooms and reveal the histological and cellular reactions of the host to invasion, which might provide information on the mechanism of resistance to the disease.

208. *Wilt Disease.* A cocoa disease, which from all accounts appears to be new to Trinidad, manifested itself early in 1958 in several isolated places in the island. The incidence of the disease is very closely associated with infestation of the cocoa trees by certain Scolytid beetles, notably *Xyleborus* species, which bore small shot-holes into the bark and wood. Several fungi have been consistently isolated from such diseased trees. Notable among these isolations is *Ceratostomella fimbriata* which, in association with the same Scolytid beetles, is known to cause a similar disease in cocoa in some

countries in Central and South America. Greenhouse inoculations with pure cultures are being made on different cocoa types and detailed mycological investigations are in progress. The symptomatology and epidemiology of the disease are being studied at River Estate where trees in many of the fields have been affected.

#### *Food Crops*

209. *Sweet Potatoes.* Altogether ninety-one clones have been accessioned and described and of these nineteen have proved to be synonyms. Sixteen low-yielding clones have been discarded. Two yield trials have been conducted, the highest yield obtained was five tons per acre which is low compared with yields reported from other countries. Present observations on certain clones and seedlings indicate that this figure will soon be exceeded. The earliest maturing cultivars, harvested at four months, generally received little damage from the *Megasthes* larva, a major pest of sweet potatoes in Trinidad.

210. *Pigeon Peas.* Selection aims initially at obtaining dwarf, early maturing strains; this is to be followed by selection for yield. Seventy-five seed lots have been accessioned; these have come from India, S. Rhodesia and many parts of the Caribbean; they are being grown in observation plots. The most desirable line so far recorded forms pods in four months from sowing when the plants are about three feet six inches in height. Selfing of desirable lines and individual plant selection is being practised.

211. *Yams.* Of the forty-five *Dioscorea alata* clones collected, sixteen cultivars have been distinguished and described. These are being selected on the basis of "shallow going" tubers with an even shape suitable for mechanical harvesting. A storage trial has shown that the "Lisbon" cultivars keep best. Selections are being multiplied for a yield trial.

212. *Soils Research.* The importance attached to soil moisture studies in the section goes back some years; a group of four Thornthwaite type evapotranspirometers has by now provided a direct measurement for "potential evapo-transpiration" in Trinidad during the dry season. A set of maps has been compiled from this information showing the "irrigation need" in Trinidad during the dry season. It is planned to extend this to the other islands by adopting the theoretical approaches of Penman and Thornthwaite for estimating potential transpiration rates.

213. Reference was made in last year's report to the comprehensive logging programme in operation for studying the cocoa experiments at River Estate. The initial logging programme on sixty-four selected plots in experiment 1 (shade, spacing and fertilisers) was halted after fourteen months to enable a preliminary assessment of the accumulated data to be made. As a result of this the logging procedure was restarted in November 1957, using all the two hundred plots in this experiment. This brought into the scope of the work those plots receiving different rates and times of fertiliser application. It is intended to continue this additional logging programme for one year only.

214. The preliminary assessment of the data established some striking effects associating dendrometric measurements with cocoa yield. Thus, approximately sixty-four per cent., of the yield variation in the field experiment studied was essentially due to variations in early growth of the



trees, those trees which had made the greatest growth at three years of age providing the greatest yield of cocoa at six, seven and eight years of age. The highest yields were of the order of two thousand pounds of dry cocoa to the acre irrespective of fertiliser addition.

215. This work casts doubt on the previously held view that erratic yielding behaviour in cocoa was due to sensitivity to adverse conditions of soil aeration. There now appears to be some basis for considering that weed competition and moisture shortages during the dry season may be more detrimental to the early growth of cocoa than any other environmental factor. Experimental evidence so far available indicates that research emphasis, with the object of increasing yields of cocoa, should be placed as much, if not more, on early growth factors than on conditions favourable to the adult tree.

216. Spectrographic work and associated pot tests on the various soils collected during the field surveys have continued. The main soils of St. Vincent, Grenada and the Ebini Livestock Station and Mahdia Valley in British Guiana have been investigated in this way. In the St. Vincent soil samples, spectrochemical analyses of trace elements were not expected to display low values since the soils of the island are formed mainly from basic igneous material. Responses to various minor and trace elements (including B, Mg, Zn, Mn) were, however, obtained in pot tests. In general, St. Vincent soils showed medium contents of V, Co, and Ni, a high Cu content and low Zr and Rb. In Grenada soils, responses to minor and trace elements were not as great as in St. Vincent soils. This is probably due to the generally higher content of mineral colloid in the former than in the latter. Small responses were obtained with magnesium and molybdenum. Soils from Grenada were generally high in Co, Cu and Mn. Rubidium was higher in Grenada than in St. Vincent reflecting a greater hornblende content in the country rock, whereas strontium was more abundant in St. Vincent than in Grenada indicating the greater content of hypersthene in St. Vincent.

217. Appreciable minor and trace element responses were obtained with soils from the Ebini Livestock Station, British Guiana. This was expected in view of the arenaceous nature of the Ebini soils. Plant responses in pots were obtained for calcium, magnesium, molybdenum and manganese. Spectrochemical analysis showed that contents of Co, Ni, Cu, Mn and Mo were all low while Zr was present at a level greater than 2,000 p.p.m. Samples of herbage from Ebini which were analysed spectrochemically displayed borderline levels with respect to animal nutrition for Co and Cu. Soils gathered from the Mahdia Valley, British Guiana, gave responses in pot tests to zinc, magnesium, calcium, copper and molybdenum. Concentration of V, Mo and Pb in lateritic ironstone gravels was in accord with geochemical theory. Co was low in all soils.

#### *Soil and Land Use Survey*

218. Considerable progress has been made during the year in the preparation and publication of soil maps in two colours. The following are complete:—

Soil map of St. Catherine parish, Jamaica ; scale 1:50,000 (two sheets).

Soil map of St. Vincent ; scale 1:20,000 (three sheets).

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Soil map of St. Andrew parish, Jamaica ; scale 1:50,000 (one sheet).

Soil map of Mahdia area, Potaro District ; scale 1:25,000 (one sheet).

Soil map of Bartica Triangle, British Guiana ; scale 1:50,000 (one sheet).

Soil map of Ebini Savannahs, British Guiana ; scale 1:30,000 (one sheet).

Soil map of Rupununi Savannahs (Northern section) : scale 1:50,000 (two sheets).

The first two reports to accompany these maps have already been published. The report on St. Vincent will soon be released from the printer while the report on St. Andrew parish, Jamaica, is in the press.

219. Soil survey operations in British Guiana have been temporarily stopped in the absence of fit base material for map compilation. Before the field work ended the section accepted sole responsibility for all soil survey work in British Guiana including the area of coastal swamps previously the responsibility of the I.C.A. authorities of America. A report on all operations to date with accompanying maps is shortly to be published.

#### *Statistics*

220. Work on the Scheme for the improvement of agricultural statistics in British Caribbean Territories has been continued throughout the year. Enumerations of farmers and agricultural sample surveys have been completed in all the Windward Islands and in Montserrat and Nevis of the Leeward Islands. The analysis of the data collected is now in progress.

221. Considerable experience for planning future surveys and information of immediate value have been obtained. One achievement of fundamental importance has been the production of a frame of farms. The position has now been reached when sample surveys may be readily conducted both for the regular collection of agricultural statistics and for *ad hoc* purposes of a more technical nature ; for example, on farming practices or the incidence of disease.

222. A series of reports on these surveys will be published by the Federal Ministry of Natural Resources and Agriculture. The first report, dealing with the scope and methods of the surveys, has been completed together with the report on the survey in Montserrat.

223. In the course of this work, definitions have been examined and tested, so that future agricultural statistics in the region may be on a more uniform basis. A paper has been prepared on the definitions of a farm and of a farmer in which the problems involved are discussed.

224. Close co-operation has been maintained with various departments in the College and with Departments of Agriculture. Assistance has been given with the design and analysis of experiments and with the interpretation of results. This part of the work of the statistics unit has included the summarisation of accumulated results of experiments.

225. During the year a sample survey to determine the incidence of melanose (due to the fungus *Phomopsis citri*) on grapefruit grown for the export market was completed with some interesting results. Assistance was given with the analysis of this survey which was undertaken by post-graduate

students. A similar survey has since been initiated on bananas grown for export. Assistance was likewise provided at all stages of the experimental projects which were carried out by the students.

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#### *Central Sugar Cane Breeding Station*

226. Sugar cane varieties produced at the Station now cover all but an insignificant proportion of the cane acreage of the British Caribbean sugar-producing territories and foreign contributors. They are also grown to a very considerable and increasing extent in non-contributing countries such as Puerto Rico and Cuba.

227. In spite of the 1958 drought, good growth in the breeding plots was ensured by judicious irrigation and flowering was satisfactory, so that a full hybridisation programme was possible. An increased proportion of crosses was made by the solution technique, and a pilot battery of inexpensive and permanent breeding lanterns was erected for use with this convenient and economical method. Polycross seed was produced from a range of selected parents for Jamaica and British Guiana, and selfing was continued in the lines being developed in the inbreeding programme.

228. Several imported parent varieties were used in crossing for the first time. Additions to the breeding collection were received for quarantine in Trinidad, and requests were made for others, notably from the recent collecting expeditions in the Pacific. Hybrids were obtained from the 120-chromo-

some *spontaneum* form Tukuyu 2, and populations from Barbados noble varieties crossed with introduced *officinarum* types were raised. These latter will be explored for male-sterile varieties needed in the breeding programme.

229. As a result of experiments with soil sterilisation technique, potting composts and irrigation methods, chlorosis in the seedlings has been minimised and the survival rate of seedlings after potting has been improved materially. Experiments with the Hawaiian "bunch-planting" method indicated that with present Barbados techniques, bunches are unsatisfactory as a general alternative to single planting, but a useful accessory when germinations are heavy and if survival is high in the early stages. These experiments are being continued.

230. A pilot top-cross experiment for genetical observations was planted out, using unselected seedling families from six crosses with B.49119 as common male parent, together with selfs from B.49119 and plots of the parent varieties raised from single-eye cuttings. Records will be made separately for a range of measurable components of yield. The experiment has as its object the exploration of the utility and possibilities of larger biometrical experiments which might be planted in several contributing territories to measure genetic and gene-environment interaction parameters.

The inbreeding programme has three main aspects :—

- (i) Crosses between related parents.
- (ii) Top-crosses, using selfs as male parents with proven female varieties, and
- (iii) The development of selfed lines homozygous for certain characters.

231. Crosses between related parents have been established as a profitable breeding scheme, and have already resulted in the development of commercial varieties such as B.49119, now a standard variety in Barbados and Antigua.

232. Inbreds resulting from two or more generations of selfing have been used in top-crosses, and their progeny have been compared in the regular First Year Seedlings Trial with those from crosses in the general breeding programme. The results were sufficiently encouraging to suggest a cautious expansion of this line of breeding work. Seedlings from crosses between inbred lines, too, were tested with the object of allowing a preliminary evaluation of the combining ability between members of different lines, and several interesting selections were made for inclusion in further trials.

233. The results of continued selfing in several lines have refuted the arguments of some opponents of the method, notably in regard to the vigour of seedling progenies, the extent of flowering in the derivatives, and the occurrence of self-sterility and male sterility. Particular attention is being paid to the development of lines characterised by high sucrose-in-juice, for the indications are that this may be fixed more easily than high yield, which appears to depend upon heterosis, with an exact balance of particular gene loci, rather than upon a fortuitous array of genes showing only intermediate or full dominance.

234. Cytological studies were concerned mainly with individuals in the inbred lines, and the results helped to clarify the picture of chromosome behaviour on selfing that is emerging. Chromosome losses, often considerable in early stages of selfed lines from interspecific foundation varieties, are less in subsequent selfed generations, and there is an approach to meiotic regularity with progress towards homozygosity.

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(d) *FLORAS*

235. Information on the flora of regions is a basic requirement for all work on land utilisation. While some areas are well provided with reasonably up-to-date floras, others are not so fortunate. The Committee has for some years fostered the preparation of new floras and the revision of old ones. Though these concern different regions the present report on them brings them together for convenience of reference. Taxonomic work of this kind can only be done in collaboration with the great European herbaria and grateful acknowledgment is made of the assistance received from the Royal Herbarium, Kew, The British Museum (Natural History) and many other herbaria both in England and abroad.

*Flora Zambesiaca*

236. This flora covers the basin of the Zambesi River and the Central Africa region including the territories of Bechuanaland, Northern and Southern Rhodesia, Nyasaland and Mocambique. It is being prepared at Kew with collaboration from all the British territories and the Government of Portugal. The first part of Volume I up to and including Elatinaceae is in the press and work on Vol. II is well advanced.

*Flora of Swaziland*

237. This flora is being prepared with the help of botanists in the Union of South Africa and with a C. D. & W. grant.

*Flora of Tropical East Africa*

238. Again there is a year of steady progress to be recorded. Five parts (*Caricaceae*, *Cornaceae*, *Melanthaceae*, *Primulaceae* and *Resedaceae*) have been published making a total of twenty-three parts. Four further parts are with the printers, of which *Droseraceae* and *Mimosoideae* are in proof. Unforeseen delays have prevented this latter part from appearing during the year under review, but it and *Droseraceae* should be out early in the next year, with *Loganiaceae* and *Rosaceae* not far behind.

239. The Joint Editorship has been taken over by Mr. C. E. Hubbard, O.B.E., Keeper of The Herbarium and Library of the Royal Botanic Gardens, Kew, in place of Dr. W. B. Turrill, O.B.E., F.R.S., who retired from that post in 1957.

240. The staff situation has improved considerably. Five of the six special posts are now filled, but only two of the botanists concerned can be considered fully trained. The sudden death in December of Mr. R. A. H. Graham caused a serious set back to the work, offset to some extent by the appointment of Mr. G. P. de Wolf, an experienced taxonomist, in January.

241. Mr. J. P. M. Brenan (of the Kew Staff) and Mr. J. B. Gillett have made good progress in the *Caesalpinioideae* and *Papilionoideae* respectively, but Mr. E. Milne-Redhead has been able to do but little on *Crotalaria*, largely owing to his increasing editorial duties. Preparation of the accounts of *Alismataceae*, *Araliaceae*, *Capparidaceae* and *Molluginaceae* is being carried out by Miss S. Carter, Mr. J. R. Tennant, Mr. G. P. de Wolf and Mr. C. Jeffrey respectively. Botanists outside Kew continue to assist, and Dr. E. Launert of the British Museum (Natural History) is writing the accounts of *Malpighiaceae* and *Zygophyllaceae*. Dr. B. Verdcourt, Botanist in Charge of the East African Herbarium, Nairobi, has contributed the account of *Theaceae*. Thanks are again due to the heads of various Botanical Institutions for generously lending type and other specimens for examination at Kew by those working on the Flora.

#### *Flora of West Tropical Africa*

242. This is a revision of the flora first published in 1927. The second part of Volume I was published during the year. Work on Volume 2, part 1, was continued by F. N. Hepper at the Herbarium, Kew, after his recent West African collecting expedition. Several botanists in institutions apart from Kew are kindly preparing accounts of families and it is now hoped to make good progress with the revision. The supplement on Ferns and Fern Allies has reached the proof stage.

#### *Flora of Cyprus*

243. Drafts of the families *Capparidaceae* and *Resedaceae* were completed during the course of the year; work on *Violaceae* and *Cistaceae* is now approaching completion, and it is hoped that it may be possible to deal with the *Polypetalae* as far as the end of *Malvaceae* before the end of the present year. Most of the Cyprus material in the herbarium has now been extracted from the general Oriental collections and put into separate covers. The acquisition of Edward C. Casey's valuable Cyprus collections should be of great assistance in future work on the Flora.

#### *Flora Malesiana*

244. This flora is being compiled under Dutch auspices and will cover the whole Malayan region including the territories of Sarawak, British North Borneo and Brunei. Help is being given to the Dutch botanists by British herbaria and botanists in our territories and a small C.D. & W. grant is made towards the cost of work within our area.

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

### ADEN

#### *Abyan Research Scheme*

##### *Plant Breeding*

245. Routine cotton selection work continued and ensures a pure seed supply for the Protectorate. Abyan cotton now has an established reputation, and selection policy is designed to preserve accepted standards, whilst achieving a yield advance.

246. Selected fifth backcross hybrid material exhibited a high degree of resistance to Abyan Root Rot of Cotton. A characteristic marginal browning of cotton leaves is believed to be associated with infection of partially resistant plants. The causal organism remains unidentified.

##### *Agronomy*

247. Work is in progress to establish whether there is a relationship between soil moisture content and incidence of Abyan Root Rot of Cotton. The efficacy of a number of soil sterilizers is being studied, with a view to possible chemical control.

248. Large responses were again obtained with nitrogenous fertilisers and results again favoured application by placement at sowing. Interesting preliminary data suggest that the optimum time of cotton sowing, with and without nitrogen fertilizer placed at the same time, is prior to field flooding. In current field experiments results to date show no cotton growth or yield differences between silt and silt-free plots.

##### *Soil Science*

249. Further experimental work has been undertaken to define the factors affecting water uptake by the cotton plant, Farbrother resistance units being used to measure soil moisture status. Generally the experiments confirm previous results that 30 cm. of water are sufficient to mature an above average crop of cotton.

250. Piezometer tube investigations have disclosed the existence of further slightly permeable layers in Abyan. All are overlain by coarse sand thus confirming previous suggestions.

251. Under the stress of low supply, total watering efficiencies of better than 50 per cent. were achieved in some areas of Abyan, but the oldest canalised area remained at a low efficiency of between 30 and 40 per cent.

##### *Entomology*

252. Investigations have been continued into the economic status and biology of *Diparopsis watersii*, the only bollworm of any importance in the Abyan delta. Field observation, based on egg counts and inspection of first-formed fruiting points, light trap records and emergences from long cycle pupae set in pupation cages, indicate an early emergence of moths from long cycle pupae formed the previous season following the watering of the land, which causes a considerable drop in soil temperatures. Much



of this flight is clearly spent before buds are normally available, and in consequence larval populations normally appear to remain low until most of the crop has set. It cannot yet be stated whether or not the gradual increase in local population is due solely to the breeding of successive short cycle generations or whether this is reinforced by a later moth flight from long cycle pupae of the previous season.

253. Endrin 0.1 per cent. emulsion sprayed to run off under conditions of heavy infestation appears greatly to reduce shedding and increases the size of the crop set. Spraying trials at more practicable application rates are in hand, but results to date indicate that yield response to insecticide application is limited by the low larval populations normally found in the crop during the main period of boll formation.

## ANTIGUA

### *Cotton Research*

254. The Central Cotton Station for the West Indies is in Antigua. A breeding and selection programme was continued with trials for performance on a range of soil types, crop husbandry practices, fertilizer responses, weed control with herbicides and chemical control of Pink Bollworm.

## BASUTOLAND

### *Soil and Crop Research*

255. The large programme of experiments at the Main Station and the six districts sub-stations was continued. Co-operative fertilizer trials on farmers' holdings were repeated.

### *Fertilizer Trials*

256. The black clays of the mountains are extremely fertile and in general do not require fertilization. The improvement in this region will depend mainly on the use of suitable varieties and weed control. Nitrogenous fertilizers improved yields on all sites in the lowlands, irrespective of plant populations. In contrast to previous results there were no interactions between nitrogen and spacing on maize. This is probably attributable to the unusually wet season when there was probably leaching and/or the impediment of mineralization under conditions of excessive soil moisture. Rainfall exceeded the average in the spring and it seems reasonable to recommend additional side dressings on lowland soils whenever rainfall is excessive. There were the usual responses to added phosphate and consistent NP interactions in the lowlands. The best time to apply nitrogen to maize appears to be six weeks after planting. All winter nitrogen treatments increased yields. The effect of summer side dressings was low but significant. Good responses from nitrogenous applications to an *Eragrostis curvula* ley were obtained.

257. All crops showed response to phosphatic fertilizers on foothill and lowland soils. After the third successive season basic slag and raw Rock Phosphate (High Grade) are superior to superphosphate. No responses to potash were recorded.

258. Four years after application lime increased yield substantially on red ferruginous soils, but heavy applications on lightly buffered grey soils

caused an iron chlorosis and a reduction in yields. Manure and Manure Ash continued to give yield increases. A molybdenum deficiency in certain soils has been established. Results on a possible zinc deficiency were inconclusive. A deficiency of manganese on foothill soils has been confirmed. Further research is being undertaken to investigate a possible sulphur deficiency indicated by pot experiments.

259. Further progress has been made with the four agro-economic units to establish the economics and productivity of various farming systems under conditions closely approaching those of Basuto peasant farmers.

260. Variety trials on maize, wheat, beans, cowpeas, peas and sorghum were continued at Maseru Experiment Station and two sub-stations in ecologically different regions. Mountain wheat variety trials have reached the stage when the eight most promising varieties are now being propagated for distribution to farmers.

261. A joint feeding scheme has been undertaken between a W.H.O. Field team and the Experiment Station to establish the effect on pellegra of feeding specially fortified maize meal. Initial results are most encouraging.

### **BRITISH GUIANA**

#### *Ebini Livestock Station*

262. Santa Gertrudis and Sahiwal bulls continued to be used with success for grading up the herd which now totals 900 animals. The majority of these graze on the infertile, minerally deficient savannahs, but improved fertilised pastures using Pangola grass (*Digitaria decumbens*) and Bahia grass (*Paspalum notatum*) have been extended to about 700 acres. These grasses require regular fertilisation, which is being studied, but the growth rate of steers grazing them indicate that it may be possible to market steers at two years old or younger. The mean birthweight of calves was 60 lbs. and liveweight at 360 days, 416.3 lbs., which is a daily liveweight gain of 0.98 lbs. The liveweight gain of steers over one year old averages 0.5 lbs. per day. Records of calving interval indicate that 400-500 days is normal on the savannahs. A study was commenced to compare the performance of a herd of cows kept permanently on improved pastures as compared with the savannahs. It is hoped that the growth studies, mineral feeding and pasture research will prove the Intermediate Savannahs to be a profitable region for beef production.

#### *St. Ignatius Livestock Station*

263. The herd, which totals approximately 450 head, is being graded up with Brahman and Santa Gertrudis bulls in two separate lines. The programme of research is to study the growth rate of animals, the advantages of mineral feeding and to search for grasses suited for intensive management with fertilisation. Management practices on the unimproved ranchland, which is generally poor, continued. Pangola grass (*Digitaria decumbens*) and Bahia grass (*Paspalum notatum*) show some promise, but there is a long dry season of about six months to contend with.

#### *Hosororo Station*

264. The development of the Station with Colonial Development and Welfare Funds continued. Research work was concentrated on the ironstone

hills with the object of promoting a more permanent and stable system of agriculture as opposed to the shifting cultivation practised on the pegassy (peaty) soils. Orchard crops of oranges, avocado pears and cocoa were planted. The development of livestock is to be encouraged in the area and buildings for cattle and pigs were constructed. Locuntu grass (*Ischaemum timorense*) is promising on the pegasse soils and farm-yard manure is proving an excellent means of overcoming deficiencies on the orchard crops.

#### *Soil Surveys*

265. The soil survey report of the southern savannahs of the Rupununi confirms that the soils are of poor fertility and recommends measures for their management. Soil survey of the Bartica triangle indicated that the sandy soils are of poor fertility. In the Moruka area reconnaissance of the Kumaka-Quebena ridge showed that sandy soils are available which will be suitable for coconut cultivation. Surveys of the Cane Grove and Vergenoegen Land Settlements were completed and were able to demarcate the soils where aluminium toxicity occurs.

#### *Jute*

266. The experimental cultivation of jute was brought to a conclusion following poor yields resulting from aluminium and iron toxicity. Even if promising yields of three-quarters of a ton per acre were obtained it seems unlikely that a crop can be grown economically under mechanisation and with paid labour at local rates.

#### *Botanical Survey*

267. The secondment of Mr. S. G. Harrison, a Botanist from Kew, made it possible for extensive collections on the Intermediate savannahs to be made in an effort to locate poisonous plants suspected of causing cirrhosis of the liver in cattle reared in the area. A few sporadically occurring species of *Crotalaria* might be the cause but do not seem to occur in sufficient abundance. Collections of plants were also made in the Rupununi savannahs.

### **BRITISH HONDURAS**

268. The response of pasture species to nitrogen has been studied. Using 80 lb. N/acre/year, yields have been obtained of 22,000 lb. dry matter per acre per annum from pangola grass, 21,000 lb. D.M. from Guinea grass and 17,000 lb. D.M. from jaragua grass. The D.M. contents are highest in the dry season but the means for the year are 31 per cent., 36 per cent. and 30 per cent. respectively. The protein contents were 5.5 per cent., 7.5 per cent. and 5.8 per cent. in the D.M. respectively. Yield curves for the year indicate that jaragua grass alone has any appreciable production at the height of the dry season (0.75 beasts/acre).

269. Continued trials with improved sugar cane varieties have still failed to find any variety notably better than POJ 2878.

270. Citrus growth on the heavier alluvial soils has always been retarded and juice acidity very high (up to 3 per cent. titratable citric acid at maturity). Outstanding improvement in growth has been achieved in only a few months by simple cultivations to promote aeration.

**BRITISH SOLOMON ISLANDS PROTECTORATE***Premature Nutfall of Coconuts*

271. As in previous years investigations have been confined entirely to studies on the Coreid bug, *Amblypelta cocophaga*, its effect on premature nutfall, changes in the associated ant populations as well as in devising methods of bringing about desired changes in the ant populations. Previous observations have suggested that citrus trees encourage the spread of *Oecophylla smaragdina* F., and the cover crop *Calopogonium muconoides* the spread of *Anoplolepis longipes* Jerd. Trials to check these hypotheses have commenced.

272. Insecticidal investigations were limited to one field trial and a series of laboratory tests. It was found that 1.5 per cent. dieldrin sprayed near palm trunks was quite ineffective in controlling the spread of *Phiedole magacephala* F. due to strong ground nesting colonies remaining between the palms. The results of more recent trials utilising a bulldozer to clear vegetation to ground level prior to spraying await evaluation. DDT emulsions and crystalline paste preparations were found to have negligible residual action against *Amblypelta* due to surface absorption by leaf and young nut tissue. Chemical assistance has been given by Long Ashton Research Station, England.

**GAMBIA**

273. Fertiliser experiments on groundnuts have resulted in a definite mixture of NPK being provisionally recommended for use by farmers. The suggested dressing rate is between one and two cwt. per acre, experiments having shown that yields may be increased by 20-40 per cent. with 120 lbs./acre, and by 23-83 per cent. with 240 lbs./acre.

274. Some recent experiments have shown that the soil in some parts of Yundum Experimental Farm are no longer typical and responses to P are small. On more typical land nearby the P-K interaction was considerable:—

Increase given by:—

<i>Treatment</i>	<i>100 lbs. of each per cent</i>	<i>200 lbs. of each per cent</i>
1. Superphosphate	— 2	5
2. Muriate of potash	21	10
3. 1 and 2	36	47

275. An Homès fertiliser trial on this same site indicated the demand for the major elements to be in the order:

K Ca Mg ; P N S

“ 80 per cent. K ” at 200 lbs./acre increased yields by 61 per cent. “ 80 per cent. P ” by 50 per cent. A mixture calculated from this trial will be tried in 1959, in comparison with other mixtures.

276. Trace elements tried with various major element dressings and at different rates produced no significant effect on groundnuts. From pot trials it seems likely that groundnuts have lower trace element requirements than many other plants, but this is only one of several possible reasons why trace element responses in pot trials have not been reproduced in the field.

**MALTA**

*Brucellosis Research*

277. A trial of the "Elberg" living attenuated *Brucella Melitensis* Vaccine was completed in a laboratory herd of goats. It was established that an effective immunity was conferred in this herd by the vaccine, and the first field trials were commenced. Extensive work was carried out on the typing of *Brucella* strains recovered from milk and tissues of cows and goats. Research was carried out on the possible incidence of Brucellosis in pigs in Malta. Results indicated that the infection is uncommon in these animals in spite of the close goat-pig contact in Malta.

**NORTH BORNEO**

*Soil Survey*

278. Good progress has been made with the survey of the soils of the Semporna peninsula and 25 sheets on a scale of 1 : 25,000 have been completed. The survey is complete except for a small part in the extreme north-west of the area. A block model of the area on a scale of 1 : 25,000 horizontal and 1 : 12,000 vertical has been built and will be of great assistance in land use planning.

279. The survey has revealed some interesting and important soils. Shallow rendizina soils occur over a coral platform near the coast and where this soil is a foot deep or more it is rich and coconuts do well. Where it is shallow, local agricultural practices lead to rapid deterioration. There is a considerable extent of rubbly soils derived from early Pliocene volcanic rocks which are largely used for dry rice cultivation. A fire climax of lalang now dominates these soils. The Sipit Valley, lying at a height of 50 ft., and covered with soils developed on a peneplain composed of strongly folded Miocene shales, sandstones, limestones and tuffitic sandstone, is of moderate fertility compared to much of this area, but because of its easy topography and ease of access it is suitable for large-scale development. The area lying between Mt. Pock and Sidongal and the Kalumpang river is ridge country with highly fertile soils derived from late Pliocene andesitic ash and easy of access.

**NYASALAND**

*Cotton Pest Research Scheme*

280. Investigations into the bionomics and economic status of cotton stainers (*Dysdercus* spp.) have continued at Makanga Experiment Station. A new alternate breeding host plant, *Trichilia roka*, has been discovered. In cage experiments it has been established that stainers do not cause shedding of bolls. The past season was characterised by very low stainer populations and this made evaluation of control experiments difficult. Investigation into the importance of the predator *Phonoctonus nigrofasciatus*, showed that on the alternate host trees at least it effects a considerable diminution in the numbers of its prey. In insecticide experiments which gave good control of stainers, there was very little difference in the amount of stained cotton on treated and untreated plots. Observations showed the stainer population was low and that much of the staining of lint was due to Bollworm.

281. Research on the biology and control of the Red Bollworm (*Diparopsis castanea*) continues to be carried out at Gatooma Research Station, Southern Rhodesia. The adult moths have been found to emerge throughout the cotton growing season and it is thought that there are up to four generations in each season. During the past season populations of Red Bollworm were very low. Control experiments were mainly concerned with the insecticide Endrin; in the main the results of these trials were inconclusive and in a farm scale insecticide trial there was no significant increase in yield due to spraying.

282. There was a heavy attack on cotton by American Bollworm, *Heliothis armigera*, throughout the Federation. This insect is not controlled by Endrin at the rates found suitable for control of Red Bollworm.

283. Studies on the pupation characteristics of Red Bollworm have shown that the long-term resting pupae are found in small numbers as early as the end of February. By May nearly 100 per cent. of the pupae are of the overwintering type; a small number of these pupae can survive for longer than one season. A range of different cultivation treatments has been found to have no material effect on the survival of Red Bollworm pupae.

## SARAWAK

### *Soils Research*

284. The Soils Laboratory, the capital cost of which is partly met from C.D. & W. Funds and partly from Sarawak Government Funds, was completed and officially opened in October, 1959. Work must necessarily be curtailed, however, pending filling of the two established Soils Surveyor posts. The secondment of the services of a F.A.O. Soils Specialist is gratefully acknowledged.

### *Pepper Diseases*

285. Work on foot rot disease (*Phytophthora* sp.) continued. Incidence over the last two years appears to have been less severe than in earlier ones. Three gardens were noted to have been seriously attacked in the 1st Division. A fourth is reported from Angkilili (2nd Division). Isolations of the fungus can be made at any time of the year. Fifty-five have now been made from 36 different localities, nearly all from the 1st Division. Although natural leaf infection was again found on young cuttings, none has been found generally in field plantings. This *Phytophthora* sp. appears to be strictly a soil-borne organism.

286. Work has begun to determine the effect of various factors on the behaviour of the pathogen in the soil. In unsterilised soil, at a water holding capacity of 80 per cent., the fungus was recovered from glass fibre tape after ten days. No recovery was made after a similar period at 50 per cent. water content. Without competition the fungus seems able to colonise dead pepper roots.

287. Preliminary zoospore inoculations on roots of 4-week old single leaf cuttings of 4 Indian, 3 Indonesian, and 2 Sarawak peppers were completed. First indications are that three of the Indian types and two of the Indonesian types have some resistance. Further laboratory work to confirm and extend these results is necessary.

288. Besides the *Phytophthora* sp. 22 species of fungi have been isolated from pepper, *Fusarium solani* and *Rhizoctonia* sp. most commonly; they appear to be early colonisers after infection by the *Phytophthora*. A pathogenicity test on seedlings indicated that only *Pythium splendens* and a *Sclerotium* sp. were able to infect intact tissue. These two fungi seem able to be typical damping-off organisms on pepper seedlings.

289. The nemacide/mulch experiment laid down in 1956 will be cropped for the first time in 1959. Although DD and mulch treatments seem to have reduced *Meloidogyne* sp. infection of the roots, the results are not clear cut because the eelworm appears to be non-randomly distributed in the experimental area. No above-ground differences due to DD treatment have been found. Although the vines on the mulched plots flowered significantly more than those not mulched, as the wet season developed they seemed to be suffering from excessive moisture levels under the mulch cover. There has been one case of foot rot in a mulched plot.

290. The Tarat manurial experiment developed foot rot in May 1957. Spread has been very slow. At the end of 1957 5.3 per cent. of the vines were dead; a year later there had been an increase to 9.5 per cent. The manurial treatments have been ended and the area is being used for a simple foot rot control experiment. A copper fungicide drench and a bottom pruning treatment were begun in August.

291. In July a cultivation/manurial experiment was planted out. It is a randomised plot design plus a  $3 \times 3 \times 3$  factorial confounded for the 3 factor interaction. It is to test 3 soil improvement treatments compared with traditional and 3 levels of N, P and K fertilisers. The experiment is in 2 separate blocks, one of which will be used for foot rot work.

292. The almost complete absence of fundamental information regarding the pepper industry has been a considerable drawback in making plans to place it on a more efficient footing than at present. Accordingly, as a first step, an economic survey of the industry was begun in December, 1958.

#### ST. HELENA

293. Attempts are being made at biological control of the Eucalyptus Snout-Beetle, *Gonipterus scutellatus* Gyll. Through the courtesy of the South African Department of Agriculture, two consignments of *Gonipterus* egg-capsules parasitised by *Anaphoidea nitens* were received in St. Helena on 2nd March, 1958, and 30th April, 1958, respectively. From the first consignment approximately 1,600 to 1,700 adults of *A. nitens* were collected into glass tubes, taken to eucalyptus trees and released; from the second consignment approximately 3,300 adults of this species were similarly dealt with. As *Anaphoidea nitens* adults subsequently emerged from *Gonipterus* egg-capsules collected in the field on 29th July, 1958, and 4th February, 1959, respectively, it is clear that the parasite has survived under natural conditions in St. Helena.

294. The control of Mediterranean fruit fly is complicated by the fact that this pest breeds locally in fruits of the following:—(i) coffee, (ii) prickly pear, (iii) *Harpephyllum caffrum* and (iv) *Aberia caffra*; the last-named plant forms many of the hedges grown on the Island. Under the existing conditions of fruit-growing, the prospects of controlling fruit fly by insecticides

are not good, for the trees—particularly peach, apple and pear—are almost invariably grown as widely scattered single trees or in isolated groups each consisting of a few trees. On peach trees cover sprays of DDT (0·2 per cent.) proved useless and malathion-protein hydrolysate bait-sprays showed only limited promise. Peach trees cover-sprayed with dieldrin yielded a large proportion of maggot-free fruit, but most of these peaches were bored by the caterpillars of a moth not yet identified.

295. Veterinary Pests. Cattle are affected by *Stomoxys calcitrans* and by ticks and poultry are subject to heavy infestations of stickfast fleas.

296. On cabbages the aphid *Brevicoryne brassicae* was controlled by repeatedly spraying with (a) DDT emulsion, (b) nicotine sulphate with Agral LN or (c) "Katakilla", the active ingredient of which is rotenone. Outstandingly good results against this pest were obtained by dusting with lindane 1 per cent. powder.

297. "Red Spider" mites (*Tetranychus* sp., *telarius* group). As chemical control measures for this pest were apparently unknown to local cultivators, dusting demonstrations were carried out in several gardens with an acaricidal preparation which had been successfully used abroad since 1937. This material—sulphur and hydrated lime, finely ground and mixed in equal proportions by weight—gave a very satisfactory kill of these mites in local beds of French beans, egg-plant and various garden flowers. For the benefit of growers who lack equipment for dusting, tests with liquid acaricides (Phenkaptone and Tedion V-18) are now in progress.

298. The most prevalent pests of *Citrus* in St. Helena are Psyllids (*Trioza erytrae*), which gall the leaves, and the aphids which form dense colonies on the terminal growth. Against *T. erytrae* and aphids on young citrus trees good results were obtained with malathion emulsion and Agral LN applied from a knapsack pump.

299. Cutworms. An operation which may be termed "jetting" was used in various local experiments against cutworms in vegetable crops; a knapsack pump with a straight-jet nozzle fitted to the spray lance was used to drive a cylindrical jet of liquid into the soil; the nozzle, held at a convenient height above the ground, was aimed at the soil around each plant in turn. As one proceeded from plant to plant the stream of liquid was instantaneously started or stopped by means of a spring-loaded, trigger-operated valve on the spray lance. This procedure has proved an effective means of distributing insecticidal emulsions, solutions and dispersible powders through the soil immediately surrounding (a) freshly transplanted seedlings and (b) plants already growing in the field or seedbed. In an experiment at Scotland Station (October–November, 1958), each of the treatments (i) and (ii) below, gave satisfactory protection from cutworms:

- (i) A suspension of 50 per cent. DDT dispersible powder in water (at 0·25 per cent. DDT) was jetted into the soil around each plant and a BHC-bran bait was then scattered on the surface soil around each plant.
- (ii) 50 per cent. dieldrin dispersible powder in water (at 0·2 per cent. of active ingredient) was jetted into the soil around each plant, after which a mist spray of the same suspension was applied over the entire soil surface of the plot.



A simpler method of cutworm control is merely to spray the surface soil with dieldrin 50 per cent. dispersible powder applied from a swirl nozzle. In the present investigation experience of this method has been consistently favourable, but experimental proof must await the finding of a heavy cutworm infestation over a suitably large piece of ground.

*SWAZILAND*

*Agricultural Research*

300. During 1958 a grant of £81,122 from C.D. & W. Research funds for agricultural research was authorised. The main aspects of the amended research plans were for a Central Research Station at Malkerns with two Sub-Stations, one at Goedgegun and one at Big Bend. Research Staff authorised was four Research Officers and a Plant Pathologist. During 1958 a start was made with the erection of the necessary facilities for this research organisation. On the farm of the Central Station the first citrus block of Valencia orange, Navel orange, Eurica lemon and Marsh's seedless grapefruit on rough lemon stock was established. A seedling nursery was established initially with 14 varieties. This has the object of supplying in future years disease-free budwood for Swaziland's rapidly expanding citrus industry.

301. A beef/arable unit of 42 irrigable acres was established with 18 acres arable (6 to yellow maize, 6 to rice and 6 to cowpea) and 12 acres of winter pasture and 12 acres of summer pasture. Two groups of 12 Nguni oxen were brought from ranch at Mpsi and one group stall fed and the other pastured at the farm. A summary of the results is shown below:--

	<i>Average weight on</i> 29.8.58	<i>Average weight on</i> 16.1.59	<i>Gain in weight over</i> 4½ months
	lbs.	lbs.	lbs.
Control Oxen (at Mpsi)	295	737	142
Stall-fed Oxen	650	696	146
Pastured Oxen	568	678	110

302. The ages of the oxen at the end of the trial averaged two years eight months. At this stage the animals were all undersized when slaughtered.

303. The conclusions were that: (a) de-horning ; (b) control of parasites and (c) better flooring and drainage in the kraal were necessary if better results are to be obtained from the intensive systems.

304. The farm at Goedgegun was planned with the following objects:—

1. To pioneer a dairy/arable unit based on 65 acres arable plus access to unimproved veld. The cropping system is based on a herd of 20 Jersey cows supported on home-produced feeds grown in rotation with leys, Napier fodder and cash crops ;
2. To obtain by comprehensive recording the " vital statistics " relating to a dairy herd kept in the middle/highveld of Southern Swaziland under the management conditions of the Goedgegun Government farm ;
3. To study the economics of intensive arable/dairy farming based on the sale of cream and the utilisation of skim milk for the feeding of pigs and poultry ;

4. To investigate the economics and farm management aspects of uniform milk production throughout the year which will entail winter feeding and controlled calving ;
5. To make available to local farmers yearling Jersey bull calves genetically superior to the average of dairy bulls in the vicinity.

305. A cropping programme to support the herd and the ancillary pigs and poultry was initiated. It is based on a seven course rotation of (1) Maize undersown with ley ; (2) Legume hay (cowpea), Maize, Cash crop (Tobacco and Soya) and three years ley. Much interest was shown by local farmers in this project.

306. In the absence of a full-time research worker a limited programme of soil fertility experiments was carried out. With the assistance of the Soil Fertility Officer from Basutoland a series of trials were again planted in the districts, late in the season. The trials were designed to give a picture of gross soil deficiencies and of response in maize at different spacings and fertilising with nitrogen and phosphate fertilisers.

307. The conclusions were that at both Stegi and Bremersdorp yields were significantly increased by thicker planting in a season in which the rainfall was near average. On the fertile Stegi soil fertilisers had no effect while at Malkerns, the response and the linear NP interaction attained significance.

308. During 1958, as in the previous season, experiments were conducted at Malkerns and Goedgegun to test hybrid maize varieties bred by the Department of Agriculture, Natal Region. This work was done in close co-operation with the authorities concerned in the Union of South Africa to whom it is wished to record a note of appreciation. From the results obtained, it appeared that the top-cross Natal Potchefstroom Pearl and an inbred line N3-2-3-3 was a superior yielder to the local commonly used and high yielding variety Ford Selection.

309. As a result of these investigations the Department started its own programme of hybrid production in 1958-59. Six acres at Aird Farm were planted to N.P.P. and N3-2-2-3 (as male parent) for top-cross production.

310. Two cotton variety experiments were conducted in co-operation with the Barberton Cotton Research Station to whom acknowledgement is made for the assistance given. Largely due to an attack of bollworm the yield differences between varieties were not significant.

#### *Colonial Pool of Entomologists at the Commonwealth Institute of Entomology*

311. During 1958-59, Mr. E. S. Brown was on secondment to the Foreign Office for work, under the Economic Aid Agreement clause of the Baghdad Pact, on the sunn pest, *Eurygaster intergriceps*. An interesting feature of this work has been his studies, in relation to the overwintering habits of the insect, of the variation in fat content ; determinations of the latter are being carried out by the co-operation of the Tropical Products Institute.

312. Mr. C. R. Wallace has continued his survey of the insects of economic importance in the island of St. Helena ; it appears that several of these could be fairly readily controlled with insecticides, and striking results have been shown in the case of the Mediterranean fruit fly, *Ceratitis capitata*, and onion thrips, *Thrips tabaci*, but economic and other factors

make their use on any scale unpromising. The parasite, *Anaphoidea nitens*, imported from South Africa for the control of the eucalyptus weevil, *Gonipterus scutellatus*, appears to have been successfully established.

313. Dr. I. W. B. Nye spent seven months at the Institute working up the results of his two-year survey of the pests of tropical cereal crops of East Africa, and in writing his report, which is now complete. The situation disclosed seems to be less serious than had at one time been feared, but a clear picture now emerges of the status of the various pests, and many points that were previously in doubt have been resolved. Dr. Nye has now left for a short assignment to the Seychelle Islands, to assess the results of control measures taken against *Melittomma insulare* on the basis of Mr. E. S. Brown's earlier work on this insect pest of coconuts, and to advise on further measures.

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BROWN, E. S. (with GREEN, A. H.). The Control by insecticide of *Brontispa longissima* (Gestro) (Coleopt., Chrysomelidae-Hispinae) on young coconut palms in the British Solomon Islands. *Bull. ent. Res.* **49**, 239-272.

#### *Colonial Pool of Plant Pathologists*

314. Mr. Holliday returned to Sarawak to continue his investigation of pepper foot rot. As a result of his visit to the pepper growing areas of India and Indonesia, he is now testing some promising resistant varieties to replace the local types which, in comparison, are highly susceptible. Field control experiments have been commenced and an investigation has begun of a suspected undescribed virus disease.

In Zanzibar, Dr. Wheeler has obtained some measure of control of lime withertip disease by the use of eradicant mercury sprays, and has obtained a positive response to nitrogenous fertilisers. He is studying the etiology of the disease, but it is as yet too early to assess results so far obtained.

#### *Colonial Termite Research Unit*

315. The Officer-in-Charge (Mr. W. V. Harris) visited the West Indies, British Honduras, the Bahamas and Bermuda in October, and Nyasaland in February. Possible extensions of the Unit's activities into these areas were considered, and opportunity taken to discuss problems of termite control with Officers of Public Works and Forestry Departments and others interested.

316. Extensive damage to living trees in British Honduras has been found to be caused by *Coptotermes niger*, both mahogany and pitch pine being affected. This is a matter for some concern since supplies of mature trees are rapidly diminishing, and afforestation on a large scale will be required to maintain the colony's principal export. In many parts of the tropics afforestation with *Eucalyptus* species is hampered, ground-dwelling termites attacking the young trees during the first three years after planting

out. Mr. Sands continues to co-operate with the Forestry Department, Northern Nigeria in field scale trials in a variety of localities with soil insecticides for repelling termites, while employing termites for laboratory bio-assay tests to determine the effective life of these chemicals when exposed to the Nigerian climate.

317. The amount of damage to buildings caused by termites appears to be increasing, especially in low-cost housing schemes where measures against them tend to be omitted on grounds of expense, but also in projects of a more ambitious nature. Collections made by the Unit during the past eight years together with published data have made it possible to produce a list of the more common termites affecting buildings in various parts of the world, which has already proved of value in dealing with queries from architects and builders. In some cases it has been possible to suggest measures for preventing damage to buildings which have already proved their value elsewhere, either during "on the spot" discussions or in correspondence. The danger of spreading dry-wood termites by the introduction of old and infested furniture into new buildings has been stressed. Mr. Harris was again invited to lecture to students in the Department of Tropical Architecture at the Architectural Association School in London. Other inquiries of a technical nature have included the termite-proofing of products.

318. Taxonomic work has continued at the British Museum (Nat. Hist.). Registered accessions to the termite collection during 1958 numbered 7,700, of which 6,800 were collected and identified by the Unit. Identifications, mainly of injurious species, for the Commonwealth Institute of Entomology or received direct numbered 92 species, in 381 samples. Mr. Sands has revised the genus *Amitermes* in the Ethiopian Region. Mr. Wilkinson described six new species of *Kalotermitidae* from Tropical Africa. Mr. Williams continues his studies on the genus *Cubitermes*.

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*Colonial Pool of Soil Scientists*

319. From May to October, 1958, Dr. A. C. Ballantyne was attached to the Bureau of Reclamation of the United States Department of the Interior for six months in-service training which included hydrologic studies, classification of land with a view to irrigation and drainage of irrigated lands. He has since started a survey of the Guadalcanal plain in the British Solomon Islands Protectorate.

320. Mr. J. C. Grant has completed the field work and is nearing the completion of a memoir on the soils of Hong Kong. These include badly eroded soils on deeply weathered rock of steep hillsides and the agriculturally important, lowland paddy soils. These, in accordance with preliminary studies made under the direction of Dr. E. Glentworth, are discriminated by differences in drainage which are found to be closely related to yields of rice.

321. Mr. D. M. Lang completed a soil survey of Malta which was done in association with the Geography Department of the University of Durham. Soil samples collected in Malta were analysed and examined microscopically at the Macaulay Institute and a memoir was prepared.

322. The soil map of Malta and Gozo is being reproduced at the Directorate of Overseas Surveys.

323. Mr. Lang has since begun a soil survey of the island of Dominica in the West Indies, being seconded for this to the Regional Research Centre.

324. Mr. G. F. Murdoch and Mr. J. P. Andriesse have completed a reconnaissance soil survey and have made an assessment of irrigation prospects in a part of Swaziland lying south of the Great Usutu River below the 1,000 ft. contour. This work was done under the direction of Dr. H. Greene. Soil maps are being reproduced at the Directorate of Overseas Surveys and progress has been made in preparation of the memoir to accompany them.

325. Mr. J. Stark has been associated with soil surveyors of the Regional Research Centre in a number of relatively small surveys of British Guiana in areas deemed to be of prior importance.

326. Mr. A. R. Stobbs has been posted to Sierra Leone to continue the soil survey of the inland seasonal swamps called "boli lands".

327. Dr. P. D. Jungerius has been appointed to the pool of soil surveyors with a view to soil survey in the Anambra River area of Eastern Nigeria.

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

328. During the period under review the Colonial Liaison Section, Pest Infestation Laboratory was brought up to complement by the appointment to the Assistant Colonial Liaison Officer post of Mr. W. B. Woodward. A literature Officer, Miss J. K. Swinburne, was appointed to the staff, the intention being to collate the scientific data from overseas territories amassed since 1952 and to prepare a publication "Tropical Stored Products Information" which should have several issues annually.

329. The first appointment to the Colonial Pool of Stored Products workers was made in January, 1958. Mr. F. Ashman, after a short period in the Pool, carrying out experimental work on a pest of copra, took up an

appointment with the Department of Agriculture in Kenya. Mr. P. F. Prevett, who has carried out work on rice for three years in Sierra Leone, has been appointed to the Pool.

330. The Assistant Colonial Liaison Officer toured the West Indies during November and December, 1958, seeing the food storage problems of the Leeward and Windward Islands. Among the matters of special concern were the new cornmeal factory in Antigua for which advice had been given on drying, storage and milling, and the importation of infested rice, copra, etc., into the islands.

331. A special problem of storage of wheat in fossae (pit storage) in Malta (Colonial Research 1957-1958, p. 334) provided an opportunity for useful experimentation and Miss M. B. Hyde of the D.S.I.R., Pest Infestation Laboratory visited the island. One of the fosse was "waterproofed" by the Public Works Department in a way advised by the Colonial Liaison Section, Building Research Station and another fosse had the walls untreated. The physical and chemical measurements of the grain and its surrounding atmosphere necessary to assess the efficiency of this method of storage are being made.

#### *Enquiries and Technical Investigations*

332. There has been an increasing interest in methods for controlling insect pests by the use of contact insecticides either by admixture or treatment of the surface of the bagged produce with insecticides such as lindane and malathion, e.g. dusting maize on the cob or treating the surface of bagged maize, paddy and groundnuts. Help has been sought in analysing chemical residues in produce from experiments on such aspects and has been given through the facilities at the Tropical Products Institute. The results of experiments carried out in Kenya and Nigeria indicate the effectiveness of dusting maize on the cob with lindane against *Calandra oryzae*. Determinations have been made of the insecticidal contamination of groundnuts and cereals in bags sprayed with malathion against infestation of *Tribolium castaneum*, and of rice from paddy admixed with lindane dust against infestations of *Rhizopertha dominica* and *Calandra oryzae*. Difficulties in analysing malathion residues in groundnuts have been experienced in Nigeria and it has been agreed that this will be investigated by the Tropical Products Institute and the Ministry of Agriculture, Fisheries and Food.

333. The practical use of contact insecticides in overseas territories is outstripping relevant research work. Much requires to be done to find reliable methods of analyses for the different insecticides used and to determine the effect of local overseas conditions on their lasting toxicity and on the residues in different produce treated in a number of ways.

334. The quality of produce based on damage by insects and the degree of insect infestation is being more seriously considered by several overseas territories. In certain cases the exporting country has taken a more stringent outlook on phytosanitation in the stored product sense than the European importing country. It is not surprising therefore that there is an increasing demand for stored product specialists to work in overseas territories and during the course of their duties to train local officers in various aspects of good warehouse keeping and quality control. Greater interest in

the quality of produce results in standards becoming more stringent. This applies to insect infestations, and, in certain cases, levels of infestation which previously were tolerated are now responsible for the expenditure of considerable sums of money to effect disinfestation. The efficiency with which inspection of produce is carried out must therefore be considered and, if possible, a correlation obtained between the assessments of infestation in exporting and importing countries.

335. The increasing use of methyl bromide in East Africa has prompted the need for some form of legislation in overseas territories. The Stored Products Sub-Committee has made recommendations on the form which legislation might take to control the use of this fumigant and hydrogen cyanide and of fumigation chambers and to establish standards for the training of fumigators. A new methyl bromide analyser based on the principle of thermal conductivity has been developed and this field instrument will make it possible to study in more detail the various problems of gas distribution in silos or in stacks of produce in overseas territories. The necessity to fumigate sorbative produce such as oilcakes, nuts and meals has occurred in a number of territories and advice on these problems has been based on laboratory data (more of which is being amassed).

336. During the past three years a particular type of plywood silo has been tested in Tanganyika, Kenya, Nigeria, Trinidad and Sierra Leone. Reports have been received from the various specialists involved in the territories concerned and these have been discussed with representatives of the commercial organisations in the U.K. responsible for the design and production of this silo. As a result, unsatisfactory features in the original design are being improved and a further six silos have been made available by the firm for experimental purposes in the Colonies. Three of these have been allocated, one to Kenya and two to Nigeria of which one will be in the Western Region (Ibadan) and the other in the Northern Region.

337. Technical investigations on post harvest problems are known to have been actively pursued in Jamaica (on cornmeal, corn, pimento, copra and ginger), British Guiana (on rice and paddy), Trinidad (on paddy and sugar), Gambia (on groundnuts), Sierra Leone (on rice and paddy), Nigeria (on groundnuts, cocoa, palm oil, maize and pulses), Kenya (on maize), Tanganyika (on maize) and Northern Rhodesia (on maize).

#### *Dissemination of Technical Information*

338. The volume of correspondence on the problems of Colonial and other overseas territories was less than in previous years, letters received totalling 967 and letters sent out totalling 866. Discussions were held with 98 visitors.

339. Special courses of instruction in the U.K. up to 6 months duration were arranged with the collaboration of several Government Departments (Department of Agriculture for Scotland, Ministry of Agriculture, Fisheries and Food, and the Tropical Products Institute) for eight officers, representing Kenya (2), Nigeria (3), Ghana (2) and Sierra Leone. One-day courses were arranged for Nigerian Produce Inspectors and Colombo Plan Students. The Colonial Office Food Storage Course on insect and rodent problems, held at the Ministry of Agriculture, Fisheries and Food was attended by

seven officers from Jamaica, Kenya, Northern Rhodesia, Malta and Nigeria. The instruction on storage problems on courses held at the London School of Hygiene and Tropical Medicine (Environmental Control Course), at Fisons Pest Control, Chesterford Park Research Station (Agricultural Officers' Course) and at the Institute of Rural Life (Community Development and Rural Reconstruction Course) was given by the Colonial Liaison Officer, Dr. D. W. Hall. This officer gave a paper entitled "Tropical Storage Problems", at the symposium on Pests of Stored Products held by the Society of Chemical Industry in January, 1958.

#### *Research Studentships*

340. One new Research Studentship was awarded and five students were in the second year of courses. The subjects included agronomy, entomology and veterinary science.

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

### *ANTIGUA*

#### *Sugar Cane*

341. During 1958, trials were again laid down for the purpose of determining which of the varieties developed at the Central Cane Breeding Station in Barbados are best suited for Antigua conditions. The trials include time of planting, variety, soil type effects, heat-treated planting material, etc.

#### *Livestock*

342. Breeding work continued at the Central Experiment Station on the further development of the Nelthropp for beef production. Favourable results were obtained in the selection of animals for early maturity. Greencastle village livestock pasture area successfully carried three animals to two acres during 1958.

#### *Aloes*

343. No further laboratory work was carried out during this period. Preparations were in progress in the last months for the processing of the harvest of the first trial plots.

#### *Arrowroot*

344. Samples taken from the Department's experimental plots at Cades Bay were examined in the laboratory. No variation of starch content was observed for the different manurial treatments involved.

#### *Essential Oils*

345. Experiments were commenced to determine the oil yield from trial plots of lemongrass and citronella. A wild grass known locally as fever grass was also examined and samples sent to Tropical Products Institute for examination.



**BARBADOS***Agronomy and Agricultural Chemistry*

346. The progressive rise in labour costs is affecting the economic value of mulching sugarcane, a long-established practice in the island. Trials are in progress to find alternative methods of maintaining yields, including mechanisation.

347. Trials with urea indicate that there may be economy in its use in place of sulphate of ammonia. Problems of soil moisture control under irrigation are becoming urgent and trials have started on modification of field drainage.

348. Selected varieties of maize yielding about 40 per cent. more than local varieties have been developed and are now being issued to farmers.

*Entomology*

349. Sugarcane Moth Borer (*Diatraea saccharalis* F.) has been largely controlled by the parasite *Trichogramma*, liberations of which seem no longer necessary. The possibility of introducing larval parasites of Moth Borer is being investigated. *Lixophaga* from Antigua and Trinidad, and *Paratheresia* from Trinidad and Mexico were liberated. *Lixophaga* has given encouraging results. A rearing technique has been worked out and larger liberations are planned for 1959.

350. Insecticide trials for the control of Rust Borer (*Diaprepes abbreviatus* L.) showed that very good control was given by dieldrin, even when used as a preplanting application. Further trials on dosage and methods of application are in progress. The emergence of beetles is correlated with rainfall and in a prolonged wet season the beetles are not abundant at any period.

351. Routine control of termites attacking buildings was carried out and some trials of soil treatment under and around infested buildings with dieldrin.

352. Much damage is done by pests of stored products and trials have shown that in addition to warehouse hygiene the use of malathion sprays on walls and fumigation with methyl bromide can give good control of insect pests. On advice from the Pest Infestation Laboratory, a fumigation chamber is being built.

**BECHUANALAND PROTECTORATE***Fertiliser and Manurial Trials*

353. In the southern part of the Protectorate there is good evidence that the soils are deficient in phosphate. This deficiency can be remedied by an application of either superphosphate at 100 lb. per acre, or by rock phosphate at 200 lb. per acre. There is no additional benefit obtained by heavier application, and the effects of the fertilisers continue into the fourth year after application, the rock phosphate tending to confer the most lasting benefit.

354. Generally over the Protectorate the most effective fertiliser is kraal manure, applied at 2-3 tons per acre; the effect remains significant in most trials for at least two years. Some advantage is gained from only 1 ton of manure per acre, but is more temporary, and it would appear to be most

economical of labour and of manure to use dressings of 2 tons per acre every two or three years. Heavier dressings, up to 6 tons per acre, give no additional benefit up to the third year after application, and are therefore wasteful of the available supplies of the material.

#### *Agronomic Investigations*

355. Trials of simple crop rotations and of the effect of grass leys are being continued; hitherto the results have been rather disappointing on the relatively fertile soils of Mahalapye Experiment Station, in that comparatively little benefit has been reflected in the yields of the index crop, Kalahari maize.

356. A large number of sorghum varieties have been tested in trials over the past seven years, and have now been reduced to eight or nine dwarf types, plus a similar number of the taller "standard" varieties. These are now under detailed tests, to find those most suited to local production, taking into consideration characteristics such as drought resistance, early maturity, susceptibility to insects and diseases, resistance to bird attacks and palatability to the African consumer.

357. The homozygous lines of *Pennisetum typhoideum* are now being classified according to characters of agronomic importance, preparatory to variety trials for yield and suitability to African agriculture in the various districts of the Protectorate. They show a wide range of all characters, such as earliness, grain and forage types, awn length, etc. All short-awned types have been discarded each season as having no protection against bird damage to the heads. Six synthetic polycross varieties were grown to provide seed for variety trials in which straight selections will be tested against these polycross varieties.

358. Trials with cotton continue, and a search is being made for varieties more resistant to bacterial disease ("Black Arm") than the A7215 at present being grown. The latter suffers little on the Mogobane Irrigation Scheme, but trial plots grown by Africans outside this area under dryland conditions have suffered severely. Present indications are that a more resistant variety is essential if the crop is to stand much chance of success when grown on a large scale. Various insect attacks have been recorded, but it is still too early to attempt to forecast their future effect on large-scale cotton growing in the Protectorate.

359. A detailed account of all investigational work the Department of Agriculture has carried out since 1947-48 is being written up so as to make the results available generally to officers and farmers throughout the Protectorate.

#### *Pasture research*

360. In addition to the existing five long-term pasture management trials to determine the optimum carrying capacity of the natural pastures under different systems of grazing with cattle and two with cattle and goats, an additional replicated three herd four paddock system incorporating burning has been introduced.

361. Of the grazing systems under trial, the two paddock mid-summer to mid-winter system gave the highest percentage seasonal live-weight increase, being even significantly better than a system on a pasture cleared of bush

and shrub in which the cattle were fed supplementary natural hay during the dry season. Steers rising three years gained an average of 253 lb. in liveweight over the 12-month period ended November, 1958, their average weights then being 1,130 lb. A similar consignment of experimental steers off the natural pastures during the dry season were slaughtered, the average cold dressed carcass weight being 580 lb., 73 per cent of these carcasses being graded as Super B and Prime B.

362. For the season under reference, the Afrikaner-Hereford crossbred animals showed a slight weight advantage over the indigenous Tswana and the Afrikaner steers in these trials. It is still too soon to draw definite conclusions but the indications are that there is no great difference between these commonly used ranching breeds of cattle under a fairly high standard of husbandry.

363. Further ecological work was initiated, comprising frequency of burning trials and isolation transects where the effect on the natural sward of continuous grazing for periods from one to 15 years and similarly the rate of recovery after such grazing will be noted. Botanical analysis of the pastures in these grazing trials is continuing, use being made of the specific frequency ring method and fixed circular quadrats; belt transects are used to record changes in tree and shrub growth.

364. Observations were made on 60 introduced grasses, clovers and fodder plants grown under assisted irrigation. A few which show promise of being adapted to local soil and climatic conditions will be grown again for further investigational work. Under dryland conditions pastures of *Eragostis curvula* (Schröd.) Nees, Witbank Strain and *Panicum maximum* Jacq. were maintained for the production of seed.

365. The collection of botanical specimens for the department herbarium continued.

## BERMUDA

### *Mediterranean Fruit Fly, Ceratitis capitata* Wied.

366. During 1957 and 1958, a concentrated effort has been made to reduce the Mediterranean Fruit Fly population in Bermuda. This has been done by trapping and the application of foliar and ground sprays. In these two years a total of eighteen thousand males were caught and destroyed in traps. The traps are baited with angelica seed oil which contains DDVP as the toxic agent. Foliar sprays contained malathion and a protein bait. Dieldrin was used in ground spraying.

367. Trapping indicates that the fly population was greatly reduced in 1958 over 1957, the first year for a long period where consistent trapping was carried out. This is thought to have been brought about by the different control activities exercised in these two years. No damage to citrus by fruit fly was recorded in 1958.

368. Field observations and records have established some very interesting points in the habits and activities of the flies. Fly populations rise sharply in citrus orchards approximately two weeks after ripenings of the wild surinam cherry crop. June and July are the peak months of fly abundance in the orchards. In 1958, concentrations were noted in two parishes, namely,

Paget and Warwick. Two-thirds of the flies trapped were captured on one property, "Sleepy Hollow", Warwick. Small numbers were trapped in seven of the nine parishes in Bermuda. No flies were taken in Hamilton and St. George's parishes. Captures made in isolated areas could usually be traced to peach trees growing in the vicinity.

369. There is every reason to believe that a continuation of the present control programme will result in a steady diminution of the Mediterranean Fruit Fly problem.

#### *Gibberellic Acid to Induce Sprouting of Potato Tubers*

370. Further tests were conducted with the plant growth stimulant, gibberellic acid, in an effort to determine if this material could be safely used to encourage sprouting of seed potato pieces. In Bermuda, it is the practice to dip Canadian seed potatoes, planted in the autumn, in an ethylene chlorohydrin solution to induce early sprouting. This material is highly toxic and a safer method is urgently needed.

371. In October of the current year, plots were set up (in triplicate) using potato pieces dipped in a gibberellic acid solution of 1 ppm, 2.5 ppm and 5 ppm. Similar plots using ethylene chlorohydrin (12 ounces of the 40 per cent. material to 4 gallons of water) were included in the test, and three check plots. At all strengths, tubers treated with gibberellic acid produced many, spindly shoots, more particularly at the higher concentrations. In contrast, the shoots produced by tubers treated with ethylene chlorohydrin, and the untreated sets, were strong in appearance and vigorous in growth.

372. Despite the above, it is felt that gibberellic acid may yet have a place in Bermuda's potato production programme. More attention will have to be given to the proper dilution of the chemical. It is felt that the degree of "greenness" of the tuber treated has a very definite bearing on the result. This point will be further studied.

#### *Control of Land Crabs*

373. During the summer of 1958, a full-scale field test was made to appraise the effectiveness of a recent recommendation for the control of land crabs, *Gecarcinus lateralis*. This recommendation consisted in treating individual burrows with a bait composed of bran, dieldrin, salt and water. This work was carried out, chiefly, at the "Old Battery" in Tuckers Town, Hamilton Parish. Some interesting results were secured :

1. Approximately 60 per cent. of the crabs in a treated area are killed in one or two days. The majority of the 40 per cent. can be expected to die after two to three weeks inactivity in the burrows. Total kill approximates 85-95 per cent.
2. The results secured are practically as good where the bait is broadcasted, as where individual holes are treated.
3. Two baitings of any given area during the summer months are recommended.
4. The amount of dieldrin recommended ( $\frac{1}{2}$  lb. to 20 lbs. of bran) was found to be about optimum.

374. Some interesting, and valuable, observations were made on the biology and habits of *Gecarcinus lateralis*.

### *Biological Control Projects*

375. During 1958, introductions of six species of parasites and eight species of predators were made by the Commonwealth Institute of Biological Control under the supervision of Dr. F. J. Simmonds, Director. These were designed to assist in the control of the Oleander Scale *Pseudaulacaspis pentagona*, the Green Shield Scale *Pulvineria psidii*, the White Fly on Fiddlewood *Metaleurodicus cardini* and the Edible Snail *Otala lactea*.

376. As far as can be learned, none of these parasites, or predators, had any appreciable effect on host abundance. This may have been due, in part, to weather conditions as the winter of 1957-58 was an unusually severe one, being characterised by gale-force winds, abnormally heavy precipitation and unusually low temperatures.

377. In an effort to reduce the numbers of two species of lizards (*Anolis grahami* and *Anolis leachi*), which have been held responsible for the disappearance of many introduced parasites and predators, 200 Kiskadees, *Pitangus sulphuratus*, were brought into Bermuda from Trinidad in 1957. These birds have been kept under careful study by a trained ornithologist, Mr. David Wingate, during the last two years. Six nests were kept under observation in 1958, two of which are known to have produced young. There were probably others. It is estimated that at the end of the present year there were 70 kiskadees present in the Colony. This is, of course, merely an approximation. What the fate of these birds will be is quite uncertain but they will have to increase much more rapidly than they have in the past, if they are to have any appreciable effect on the lizard population.

### *Herbicides*

378. A three-year study to devise a method for controlling Oxalis (*Oxalis* sp.), one of Bermuda's most troublesome and persistent weeds, was completed early in 1958. It was learned that two sprays of the weed-killer Kuron, interspersed by a single cultivation, will kill 95-98 per cent of these plants. The first application was made in the autumn, where oxalis was in the first flush of growth, followed by a thorough cultivation a month later. When the second growth of oxalis appeared, this crop arising from the dormant bulbs present in the soil at the time of the first spraying, a second application of Kuron was made. Planting of any crop one month after the second treatment was found to be safe and practical.

### *Slugs and Snails*

379. Field trials were carried out with a new slug and snail remedy against different species common to Bermuda. This material contains metaldehyde as the toxic principle. It was found to be extremely effective against the giant slug, *Amalia gagates*, and young and half-grown specimens of *Otala lactea*. However, it failed to kill the spiral snail, *Achatina* sp.

380. Through the co-operation of the Commonwealth Institute of Biological Control, introductions of the predaceous snail *Euglandina rosea* were made in January and March.

381. Adults of this mollusc were brought into Bermuda from Trinidad and Hawaii and liberated at four points, where an abundance of snails of different species was known to occur. It is interesting to note that two partially-grown specimens of *Euglandina rosea* were recovered at one of the points

of liberation twelve months later. These must have been the progeny of adults previously liberated. A laboratory study, dealing with the life history and habits of *Euglandina*, was carried out during the winter months.

#### *Bulb Mite, Rhizoglyphus solani*

382. Bermuda lilies are very frequently infested with all stages of the bulb mite. They feed, chiefly, on the tips of the scales or shells, which turn black. Very often the feeding of this mite changes the colour of the bulbs from golden yellow to dark brown, reducing their saleability. Infested bulbs are weakened by the attack of these acarids.

383. An effort was made to work out a control for this pest. Many miticides, and one fumigant (methyl bromide), were tested over a series of years, including the year of report. Of these, a dip of corrosive sublimate (mercury bichloride) was found to be the most effective. This was used in a dilution of 1-3,200, with water, and the bulbs immersed for a period of half an hour at a temperature of 70° F. This kills all stages of the mites, including the eggs. The treatment seems to have no ill-effect on the bulb, sprouting and growth being quite normal. However, plants originating from treated bulbs have not, as yet, been followed through to the flowering stage.

#### *The Herbarium*

384. During 1958, a start was made towards building up a herbarium to include specimens of the native plants of Bermuda. Collections of many species were made throughout the summer, which were pressed, mounted and suitably labelled. This activity will be continued through the years ahead with a view to, eventually, including in the herbarium a complete collection of Bermuda plants.

### **BRITISH GUIANA**

#### *Sugar Cane*

385. Variety testing of seedlings bred in Barbados and in British Guiana continued to be the main line of work. The two present major canes B 41227 and B 37161 continued to give good yields. The variety B 47258 has been recommended for planting and acreage has increased, but it is susceptible to aphids and rats. Other varieties advocated are D 141/46, B 4362 and B 45137. Routine testing against Leaf Scald Disease continued in order to give a resistance rating to new varieties.

#### *Rice*

386. The rice breeding programme continued and eight promising varieties are being made available for farmers' trials. These varieties are non-lodging and non-shattering and have been bred for mechanical harvesting. About 2,500 selections were made from 6,000 hybrids planted in the F<sub>3</sub> to F<sub>13</sub> generations.

387. Fertiliser trials have in many instances shown responses to lime, phosphate and nitrogen, but responses tend to be variable and unpredictable, which complicates advice which may be given to farmers. Rice storage investigations continued.

*Grasses*

388. Pangola grass (*Digitaria decumbens*) appears to be able to withstand high stocking rates on the coastal clay soils at the Central Agricultural Station and is highly productive if fertilised and irrigated. Coastal Bermuda grass (*Cynodon dactylon*) is also showing promise.

*Cotton*

389. The possibilities of ratooning were again shown with the varieties BLR 14/25 and BAR XLI, but infestation of the leaf-eating caterpillar (*Alabama argillacea*) occurred for the first time and was severe. It precludes ratooning when it occurs and as the ratooning cultivation practice was envisaged as the main hope for cotton in a wet, unreliable climate, the future of the crop is still open to doubt.

*Coconuts*

390. A selection programme was commenced to find high yielding palms, the seed of which could be used for planting. Fertiliser trials were also laid down.

*Forestry*

391. The formation of experimental plantations of *Pinus caribaea* continued and a total area of 61 acres has now been established, with an age range of 0-5 years. With few exceptions growth has been most promising, even on the infertile white sands where trees planted out in 1956 now average 6 feet in height. In December, 1958, a small area of *Pinus elliottii* was planted: germination of this species had been poorer than that of *Pinus caribaea* but a smaller loss was experienced in the nursery transplant lines and growth in the field since December has been quite satisfactory.

392. Experimental work in connection with the natural regeneration of exploited Greenheart forest continued at Moraballi Reserve and at Barabara, Mazaruni River. A total area of 517 acres was treated silviculturally. The object of this work is to secure as much natural regeneration of marketable timber species as possible. Preference is given to Greenheart wherever this occurs, but in its absence other species are encouraged instead. Visual assessments of results are, in general, satisfactory and in certain places markedly good.

**BRITISH HONDURAS***Forestry*

393. The first assessment on a pine plot established in 1956 to determine whether smaller quantities of triple superphosphate than 2 oz. per plant would be effective, has shown that there is a great deal of difference between plants treated with  $\frac{1}{2}$  oz. of fertiliser and untreated plants. Plants treated with 1 oz. and 2 oz. of fertiliser show slightly better growth than those treated with  $\frac{1}{2}$  oz., but the difference was not nearly so marked as between  $\frac{1}{2}$  oz. and no treatment. A similar experiment designed to show the best time of application of fertiliser to the plants has not been conclusive. The difference in growth can be accounted for by the different lengths of time between the application of fertiliser (3 treatments 3 months apart) and the date of assessment.

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394. Direct sowing on a large scale has not been so successful as on a small scale and a technique is now under trial in pricking savannah land. These plants have so far shown excellent survival, but they still have to experience their first dry season. If the technique succeeds it will make possible much larger scale planting at lower costs.

395. Measurements in the periodicity of growth of *Pinus caribaea* were carried out during the year to see whether there was any definite resting period. There does not appear to be any common pattern of periodicity except that most of the trees had a resting period of not more than a week during December, but, with different plants, even this was not always the same week.

#### *Natural Regeneration of Mahogany*

396. It has been noted in the past that natural regeneration of mahogany is much better in forest that has been burnt, and a small area was burnt before the seed fall in 1958 situated close to some mahogany seed trees. Sufficient seed fell into the burnt area, but was nearly all attacked by insects. It seems likely that a very large fire is necessary to bring about the right conditions, as such a fire would destroy the insects over the whole area.

#### *Silviculture of Little Known Species*

397. Small quantities of some eleven different species were raised in nurseries and planted out at wide spacing in young farm regrowth. Records of the reaction of these species to nursery treatment and planting techniques are being noted in case any of these species should become economically important in the future. The trials will also provide us with more knowledge of their silvicultural characteristics, of which very little is known.

### *BRITISH SOLOMON ISLANDS PROTECTORATE*

#### *Agriculture*

398. Some further investigations into factors affecting copra quality have shown the effect of stage and development of the nuts on the colour of the resultant copra and its oil; only mature ungerminated uncracked nuts gave copra free from discoloration. Free fatty acid content was increased by prolonging the interval between splitting nuts and drying; by ramming green copra; and by excessive cutting into small pieces.

#### *Forestry*

399. The series of "sample plots" established in kauri forest in 1957 were remeasured during 1958 after a year's interval. The measurements revealed a marked difference in growth rate as between kauri trees in unexploited forest and those remaining in felled-over forest. Preliminary indications are that kauri trees between four and eight foot in girth remaining in exploited forest may be expected to add girth increment at the rate of approximately one foot in ten years.

400. Experimental work on the natural regeneration of kauri was continued and poisoning of weed trees to assist seedlings and saplings remaining in exploited forest applied over some 300 acres during 1958. It is not yet possible to judge whether the optimum degree of canopy opening is being achieved.



401. Small scale experimental work on *Pometia pinnata* and forest dominated by this tree has been initiated. *Pometia pinnata* is the commonest timber tree in the Solomon Islands and seems likely to be of considerable importance in the forest economy of the territory. A sample plot to determine growth rates and a plot to assess the possibilities of natural regeneration after heavy felling have been laid down.

402. The programme of small scale trials of mainly introduced valuable timber species has been continued and plots are being established in six main centres under varying conditions of rainfall and soil. Over 30 species have been planted in plots and some of these, mahogany (*Swietenia macrophylla*), "cedars" (*Cedrela* spp), balsa (*Ochroma lagopus*), and teak (*Tectonus grandis*) show considerable initial promise. Particular attention is being paid to seed source and the testing of different varieties.

## CYPRUS

### *Agronomy*

403. Research continued in the development of rust resistant varieties of wheat. Results to date are disappointing from the yield aspect. A new barley variety, which is a selection from a cross between the widely grown "Athenais" and "Cyprus Black" varieties and has given yields of 15-27 per cent. higher than these varieties, is to be released for general cultivation in 1959. In field trials a new variety of cotton "Coker 124", introduced from the U.S.A., has proved superior in yield and lint length to the variety "Coker 100" which is at present widely grown in Cyprus.

### *Pasture and forage*

404. Work has begun on the improvement of promising legume and grass species by selection and breeding and on the pollination and seed setting of barrel medic (*Medicago tribuloides*). An interesting development arising from the introduction of exotics has been the increased popularity of Elephant grass (*Pennisetum purpureum*) for wind breaks.

### *Crop-livestock investigations*

405. Studies on the productivity of established dry land pasture show that although the local fat tail breed of sheep responds to better feeding, much better results are likely to be obtained when exotic breeds of sheep and goats are employed. The cash return from irrigated pasture was six times greater than from dry land pasture which in turn was higher than that normally obtained from dry land cereals.

406. Studies on the effect of goat grazing on scrub forest had to be temporarily discontinued because of the disturbed conditions.

### *Plant Nutrition*

407. Numerous fertiliser experiments have been in progress in many parts of the island, but the emergency conditions interfered, in many cases, with the measurement of yield. Nitrogenous dressings continued to raise the yield of carobs. Because of the low rainfall and an attack of the carob midge, yields were down to an average of about 17 lbs. per tree in the controls and 30 lbs. with the trees each receiving 5.6 lbs. sulphate of ammonia.

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408. In an experiment with lucerne on calcareous soil basic slag was not so effective as superphosphate with the early season cuts but proved markedly superior in the later ones. Determinations of N, P and K are being carried out on leaf and plant material and results of value for the diagnosis of deficiency are gradually emerging. It appears that the critical limit of the phosphorus content in the lucerne plant at the preflowering stage lies above 0.20 per cent. and of the nitrogen content of carob leaves above 1.0 per cent. with the results expressed on dry matter basis. Determinations of total and available phosphorus in the soils also have begun with a view to determining the P status of the various soil series.

### *Horticulture*

409. Field trials in the growing of deciduous fruit crops of apples, pears, plums and peaches in the plains were continued. No effect from straw mulching was apparent after 3 years of application. Further plantings were made of varieties of pears and peaches appearing to have low winter-chilling requirements.

410. Trials are continuing on the production of apple and cherry rootstocks in the plains. Plantings of both local and introduced new rootstocks resistant to woolly aphis were made.

411. Cuttings of more than 100 new varieties of vines imported during the year from several European countries and South Australia were rooted successfully at the Ayia Irini Quarantine Station. Some 3,000 cuttings have been imported in an effort to improve the quality of local wines.

412. An area of 17 acres of Valencia orange trees was planted at the new experimental citrus grove at the Government Farm, Morphou. Experiments to study effects of different fertilisers and water requirements are planned. A collection of all citrus varieties from the Island, and of certain imported varieties has also been planted at this grove.

413. Work was continued on the establishment of varietal collections of vines, carobs, pistachio and almonds.

414. Variety trials were carried out, and are being continued with tomatoes, musk melons, watermelons, onions and asparagus.

415. Trials to show the effect of polythene strips on the production of early cucumbers were continued and encouraging results were obtained. Trials are to be continued with this and other vegetable crops.

### *Plant Pests and Diseases*

416. Identification of races of *Puccinia graminis tritici*, which is responsible for the stem rust of wheat, continued. Races 14 and 24 were again identified, the former being the most predominant.

417. Investigations are continuing on the biology of the cereal leaf miner (*Syringopais temperatella* Led) in relation to rotation practices.

418. Loquat scab (*Spilocaea eriobotryae* (Cav.) Hughes) spread in recent years in a severe form. Very good control was obtained with lime sulphur, copper oxychloride, Zineb 78 and orthocide.

419. Experiments showed that a combined zinc oxide and sulphur dust was successful in controlling both zinc deficiency and citrus bud mite

420. Spraying with copper oxychloride or Zineb 78 gave excellent control of Potato Late Blight (*Phytophthora infestans*. (Mont) de Bary).

421. Brown rot (*Sclerotinia fructigena* Schroet) has, in recent years, caused severe damage to local apricot trees. A thorough pruning for the removal of diseased twigs and spraying with copper oxychloride at bud swelling gave good results. Similar spraying of unpruned trees was less effective.

#### *Soils*

422. Detailed soil surveys were completed of 22,000 acres. In addition a reconnaissance survey of 320 square miles of vine growing areas was carried out.

423. Applications of iron pyrites to an alkali soil at Syrianochori (Morphou Bay area) have improved soil structure and plant growth.

#### *Animal Husbandry*

424. A survey of the local dairy cattle industry started in 1957 was completed during the year. It was ascertained that some 90 per cent. of the dairy cattle population (estimated number of milch cows 1,400) of the island was to be found on 296 units, some consisting of specialist dairies, often having but little crop land, and others of normal farm holdings. Twenty-seven units were found to consist of more than ten milk cows each (5 with 50-80 ; 5 with 30-49 and 17 with 10-29). With one exception these larger units were located near the main towns. The predominant breed was the Dairy Shorthorn. Friesian and Jersey cattle were also found kept pure and as crosses. Most dairy farms were found to be dependent very largely upon purchased fodders. The standard of housing was found to be reasonably good especially with the larger herds. Sampling of milk from representative dairies showed the quality in general to be considerably lower than that anticipated.

425. Trials were continued with the early weaning of piglets (at 10 days) and their rearing under a battery system. Encouraging results were again obtained from the point of view of liveweight gain but the use of imported weaning mixture proved expensive.

426. The development of local strains of pigs of the Large Black and Large White breeds continued. This has involved a limited policy of in-breeding. Satisfactory results have been obtained.

427. Cross breeding trials using rams of the East Friesian and Sarda breed on ewes of the local fat tail breed are giving very satisfactory results from the point of view of milk yield. Artificial insemination is being employed, because of the difficulty of natural service.

#### *Animal Diseases*

428. A trial was made on an egg-attenuated strain of Foot and Mouth virus type A isolated in Israel. On local sheep results were not sufficiently conclusive to justify its use in a general immunisation campaign. In a field test of the efficiency of tissue vaccine type "A" and "AO" imported from Italy no case of infection was observed amongst 911 vaccinated sheep. Amongst 850 susceptible sheep in the same village there were 61 per cent. of clinical cases involving 13 out of 15 flocks. Generally tissue

vaccine has conferred a reliable immunity on cattle, sheep and goats for approximately one year. Preliminary field results with pigs indicate that this class of animal may be satisfactorily protected also.

429. Outbreaks of Swine Fever occurred for the first time. A long incubation period of 8-9 days was observed under both artificial and natural conditions of infection. Crystal Violet vaccine gave good results provided that it was administered 15 days before contact with infection.

430. The Algerian strain of Sheep Pox vaccine was tried and appeared to afford good immunity. Systematic reactions in vaccinated animals were mild.

431. An outbreak of caprine verminous pneumonia in a herd of 200 improved goats caused considerable mortality associated with acute oedema of the lungs. A mild lung-worm infestation, mainly of *Dictyocaulus* spp. was present. The condition would appear to be analogous with "Fog Fever" reported amongst cattle in the U.K. The incidence was much reduced following changes in management and routine treatment with cyanacethydrazide.

### Forestry

432. The abnormal conditions and the series of forest fires seriously handicapped research activities during the year. A Research Plan was prepared, the main objects of which are to outline the main problems and to assign priorities to them; to ensure correct research procedure and to ensure continuity of experimentation. Assessments were made of the research reforestation project for burnt areas which was started in 1957. The planned replication of these experiments could not be established during the year owing to the political situation.

433. Small scale nursery experiments concerning the raising of different types of planting stock, both with and without containers, were continued. Experiments were started to investigate the effect of deep planting *Pinus brutia*, based on results obtained in East Africa. Species trials with *Eucalyptus* and *Populus* species were maintained and limited extensions were established. Preliminary plans were made to establish permanent research plots in mountain areas to investigate regeneration problems in natural forest.

434. The incidence of *Myelophilus* attack in summer-thinned *Pinus brutia* forest, the relation of fire injury of *Pinus brutia* to borer attack in burnt areas and the life cycle of *Thaumetopoea wilkinsoni* were the main items of entomological study.

## FIJI

### Forestry

435. Studies of natural regeneration in mature mixed rain forest were continued. Various felling treatments were combined with measures to reduce weed species by poisoning and creepers by cutting. Experimental work in the regeneration of *Geuttardia speciosa*, one of the Colony's most durable hardwoods, was initiated in two areas in Vanua Levu.

436. Germination and viability tests of *Swietenia macrophylla* are being carried out. Seed, sealed in containers, under different conditions of humidity and temperature have been stored and will be tested at intervals.

437. Establishment techniques have been under trial with potted and bare-rooted plants, and varying degrees of soil cultivation and the use of fertilisers. Indications are that *Pinus caribaea* and *Eucalypts* generally require to be planted as potted plants at all altitudes, but *Pinus elliottii* only at lower elevations. Reduction of grass competition in the drier areas by intensive cultivation appears extremely beneficial. On the poorest soils applications at a generous rate of a complete fertiliser in the planting hole have given spectacular results with five different species of *Eucalypts*. At 8-9 months average height of control ranged from 1ft. 2in. to 2ft. 8in., while treated plots ranged from 3ft. 1in. to 5ft.

### GAMBIA

#### Forestry

438. A 36 plot experimental section has been formed at Yundum Forest Nursery, wherein possible indigenous timber species and exotics are being established for study. In addition to the observation of trial species under simulated plantation conditions, a trial area of introduced bamboo cultivation in small plantations was started.

439. Disappointing results were obtained from past wide espacement enrichment plantings (33ft. × 33ft.) and it is not intended to pursue this system further. Future plantings will be considerably more concentrated. Considerable damage is being caused in the few existing close planted areas due to the presence of numerous standing dead trees (poisoned and girdled) which do considerable damage when they fall—being very heavy timbers usually. Such trees also appear to serve as focal points for troops of monkeys on occasions, and these break a considerable number of leading shoots on plantation trees adjacent. Future preparatory ground techniques will aim to avoid the retention of dead trees as far as possible.

### GRENADA

440. The clonal cocoa trials have made remarkable recovery and progress since the hurricane of September, 1955. The yields for the crop year 1957 and 1958 have surpassed, in most of the clones, the pre-hurricane yields. There are seven clones now producing over 2,000 lbs. of dry cocoa to the acre, and fifteen others producing between 1,200 and 2,000 lbs. dry cocoa to the acre.

441. The N P K trials on the cocoa stations again did not reveal any significant differences between treatments. There was, however, a slight indication that double N in the presence of K could give some increase in yield. The Pen Manure versus N P K trial did not show any significant response to treatments. In the forking and mulching cultural trials the overall effect of mulching was significant.

442. In case the shade in the cultural and manurial trials has been masking the effects of the treatments, all shade was removed from all the trials.

#### Nutmegs

443. Investigations on the vegetative propagation of nutmegs continued. Considerable improvements in the marcotting or aerial layering technique of nutmegs was achieved. The technique adopted for marcotting is similar

to that described by H. Evans in the 1945-1951 Report on Cacao Research of the Imperial College of Tropical Agriculture, but with minor modifications. It takes a period of four to six months for roots to develop on the marcotted twig and sometimes as long as nine months. A further six to eight weeks is required for hardening off the severed rooted marcot in a closed bin or under continuous spray in open concrete bins. An additional four to six weeks is needed to acclimatise the marcot for field planting under artificial shade. A few observational plots were laid out in the field in August, 1957, and some of these marcots have produced fruit. During the year 39,115 nutmeg twigs were marcotted, 3,473 rooted marcots severed, potted and hardened off.

444. Trials on the rooting of cuttings were carried out during the year, and although some cuttings rooted, the results were poor. The period for developing roots varies from three to five months. Investigation on this method of propagation continues.

445. A third method of vegetatively propagating nutmegs was tried and has given very promising and encouraging results. The method consists of an approach graft in which a nutmeg seedling of unknown sex is grafted on to a twig of a female nutmeg tree. The union is completed within a period of three to five months. The twig of the female tree is severed below the union, the seedling stock is severed above the union, and the grafted twig is placed in a closed bin for four weeks to be hardened off. A large scale trial of this method of propagation is now in progress.

## HONG KONG

### *Agriculture, Fisheries and Forestry Department*

#### *Animal Industries*

446. During the year an Artificial Insemination Centre has been established at Castle Peak for experimental field work on artificial insemination in swine. Semen assays have been carried out and artificial insemination commenced on an experimental scale.

447. A new pig breeding station has been established on the "Dry Farming" Station at Ta Ku Ling where it is intended to carry out feed trials with special reference to local products. The cross breeding work at Sai Kung is nearing completion.

448. Flocks of improved Cantonese and Wai Chow chickens are being established with the intention of carrying out further cross breeding work to produce a suitable bird for local conditions.

#### *Agriculture*

449. The research activities of the division have been concentrated on improving crop varieties, testing new strains of vegetable seed, examination of new cropping techniques in relation to land-use, and fertiliser trials.

450. The division carried out a series of fertiliser trials on farmers' fields with two or three sites in each homogenous soil unit to discover the fertiliser requirements of rice. These trials confirmed the results obtained in experiments in the agricultural stations, showing nitrogen to be necessary in all areas but phosphate and potash gave little response. Unfortunately

these fertiliser trials were laid out in the detail required for statistical analysis and had little value as demonstrations to the farmers and more simple trials are projected for 1959.

451. Four new varieties of paddy seed introduced from Taiwan have been tested and found to be highly resistant to rice stem borer and moderately resistant to leaf hopper.

452. Abandoned tea terraces at altitudes of 1,000–2,000 feet have been rehabilitated and utilised to grow vegetables beyond the normal growing period. The yield has been only moderate and the expense of cultivating these high terraces is hardly justified though the soils are often deep and relatively rich.

#### *Soil Survey*

453. The soil survey was virtually completed and a full report should be available in 1959.

#### *Forestry*

454. During the year a small forest research branch was formed with a qualified forester in charge. A research programme was drawn up with projects under Forest Botany and Ecology, Erosion Control, Silviculture, Forest Injuries, Increment Studies and Utilisation. Work was started on a number of projects under the first three heads.

### **JAMAICA**

#### *Agriculture*

455. *Bananas*. The programme of breeding and testing seedling bananas for resistance to Panama Disease and suitability for the export market was continued. Improved male parents have now been bred out from material collected in Africa and the Far East, and these give new hope to the achievement of an immune banana with better marketing qualities than the Lacatan variety in the near future.

456. Results from a fertiliser trial on the Lacatan variety have shown marked positive responses in yield and quality of fruit to applications of potash and nitrogen. An interesting side-issue from this trial is the fact that the condition loosely described as "premature yellowing" has been shown to be a nutritional disorder caused by potash starvation. A cultivation trial with the Lacatan variety on irrigated land which compared the effects of mulching with sugar-cane bagasse, undisturbed weed growth, cover-cropping with *Canavalia ensiformis*, and the normal estate practice of monthly inter-row harrowing, was brought to a close after the second crop of fruit. The results showed that under the circumstances of this trial the normal estate practice was the most advantageous.

457. Investigations were also initiated to determine whether it is possible, and practicable, to control the flowering of the Lacatan banana so as to bring the fruit to reaping stage during the spring and summer months when the demand is highest and prices are most advantageous on the United Kingdom market.

*Cocoa*

458. The establishment of scionlings in the field by budding at stake has been disappointing as a method of expanding commercial plantings of clonal cocoa on a large scale. Supervision of the large number of budders who had to be engaged for carrying out the work has proven to be a formidable undertaking. Emphasis on this technique has been considerably reduced.

459. The modified "La Réunion" method of producing rooted cuttings, in which the cuttings are rooted directly in the pots, has given better and more consistent results than all other techniques which have been tried so far. Production efficiency during the year using this method was 70 per cent. in terms of plants produced for distribution as a percentage of cuttings initially set. It is proposed to rely exclusively on this method for the rooting of cocoa cuttings in future.

460. First results from a cocoa variety trial comparing I.C.S. clones with local Jamaican selections (J.C.V.) showed I.C.S. No. 95 and No. 60 in the lead as far as yield is concerned, followed by I.C.S. No. 1 and J.C.V. No. 1.

461. A spraying trial was laid down to compare the effects of Bordeaux (5-5-50) and Dithane Z-78 on Black Pod disease. Plots were split so as to accommodate a potash vs. no potash comparison. First results from this trial did not reveal any differences arising from the treatments.

462. *Coffee*. The fertiliser trial with *C. arabica*, var. *Typica*, which has been in operation for a number of years has again failed to produce any significant response to the fertiliser treatments. The new fertiliser trial which was laid down early in 1958 and which includes comparison between the Bourbon and *Typica* varieties of *C. arabica* was maintained. Symptoms of minor element deficiencies have appeared at an early stage. Three observation plots have now been established for comparison of the Sun-Hedge and Brazilian systems of growing coffee with the local Jamaican practice.

463. *Citrus*. Investigations on the post-harvest physiological disorder of oranges known locally as "Brown Stem" were terminated. While the results have not been conclusive, indications are that the malady is associated with moisture relations in the tree and in the fruit at the time of harvest and that its incidence is aggravated by delay in passing the fruit from the field to the packing house, and by certain packing house treatments.

464. Investigations have been continued to determine the agent or agents responsible for the malady of oranges in which affected fruit develop one or more round, bruised areas on the outer rind, each with one or more minute punctures which go right through into the pulp. The damage eventually leads to internal breakdown and loss of the fruit. Originally believed to be caused by a fruit-fly, the damage is now regarded as almost certainly the work of fruit-piercing moths. Two species of moth have been found in the act of piercing fruit in the field but it has not been established whether they were responsible for making the punctures or whether they were merely probing punctures which had been made by some other agent. Caging of moths around branches bearing mature, unblemished oranges in



the hope of inducing them to attack the fruit has so far been unsuccessful, as the insects became alarmed at the confinement and destroyed themselves trying to escape. So far no effective control measures have been established.

465. Two citrus cultivation trials, one on Valencia oranges on a free-draining soil in a dry area, and the other on Parson Brown oranges located on a site with impeded drainage, have been continued on Government Agricultural stations. In the Valencia trial the use of mulch as a ground cover gave by far the best results. In the other trial cover-cropping with *Canavalia ensiformis* was the most advantageous treatment. A root-stock/scion trial, combining 7 root-stocks and 4 scion varieties, has been carried through its eighth year. All scion varieties have made more rapid growth when budded on Rangpur lime than on the other six root-stocks.

466. Fiddler beetles (*Prepodes* and *Pachnaeus* spp.), are still the most important insect pests of citrus in Jamaica. Some control has been achieved with the use of soil insecticides (mainly dieldrin and chlordox) applied in the hole before planting and as a surface application under the drip canopy of mature trees. Trials are being carried out to determine the lowest effective concentrations at which these materials may be applied and the duration of their effectiveness after application.

467. *Coconuts*. Observations were continued on the seven field trials which were laid down to test the susceptibility of three dwarf varieties and one tall variety to the Lethal Yellowing or "Unknown" disease. One of the trials was discontinued owing to local management difficulties on the estate. Some of the plants of the tall variety have succumbed to the disease at less than two years' old. All three dwarf varieties still appear to be quite healthy.

468. Search for a possible vector of the disease has so far been unsuccessful. An insect survey on coconut trees in the affected areas has turned up several interesting species but none of these is considered to be a potential vector. No parasitic nematode has been found associated with the diseased condition. Investigations along these lines are however being continued.

469. The trial which was laid down to examine possible effects of iron and phosphate materials on the incidence of Frond Drop disease has been continued. Yield records were taken at monthly intervals and analyses were made of leaf material collected in each case immediately before application of the chemicals. So far no significant results have been obtained.

470. *Miscellaneous Fruit Trees*. Trials were carried out on methods of vegetative propagation with various local fruit crops which have so far been propagated exclusively by seed. This work is considered to be of considerable value in view of the importance of ensuring that any planting material produced for distribution to farmers has some assurance of reproducing the desirable characteristics of the selected parent trees. Particular attention has been given to Pimento which almost invariably produces a proportion of sterile trees when propagated from seed. Some limited success has been achieved with propagation by budding but so far the percentage of "takes" has not been high enough for large-scale production of planting material. Consultations have been held with the Botany Department of the University College of the West Indies with a view to initiating cytological studies on this problem of sterility in pimento, and the possibility of inducing

fruit formation by treatment with plant growth hormones. Trials on the control of Pimento Rust (*Puccinia psidii*), using a number of new chemical formulations, have given encouraging results under nursery conditions, and tests on a field scale have been started.

471. Two trials were laid down to investigate the response of Black Pepper to fertiliser treatments and to various degrees of shading. Observation plots were established of two clones of the West Indian Cherry, *Malpighia glabra*, imported from Puerto Rico, both of which are reported to produce heavier yields of fruit with a higher content of Vitamin C than any of the locally occurring material.

472. *Field Crops.* Five plots of Virginia tobacco were laid down in various localities in continuation of the programme of investigating the possibilities of expanding the production of this crop. Nematode infestation was encountered at each site and it seems clear that fumigation of soil with nematocides must be regarded as standard practice if the production of Virginia tobacco is to be profitably undertaken in these areas.

473. Field trials with root crops were continued. A variety trial comprising 49 cultivars of cassava was reaped and the yield data are in process of analysis. A field trial on yams which was replicated at three localities, involving various levels of N, P and K fertilisers and two methods of planting, was reaped and the yield data analysed. Significant responses were obtained to the nitrogen applications. Results from the two methods of planting were conflicting and appear to be related to the conditions of weather and soil in the three localities over which the trial was repeated. At one location planting on continuous ridges produced significantly higher yields than planting on individual mounds, both by weight and number of tubers reaped. The reverse was the case at the second, drier locality. At the third site there was no appreciable difference between the yields from the two methods of planting. Local types of sweet potato have been assembled at two experiment stations for classification and future variety trials. Fifty-six varieties of Pigeon Pea imported from Trinidad and seven local selections have also been planted in isolation plots for observation with a view to future variety trials.

474. Preliminary crossing of several imported varieties of corn with the local J.S.Y. variety was carried out as an initial step in a long-term breeding programme aimed at producing hybrids which will give high yields under Jamaican conditions.

475. *Laboratory Investigations.* Suitable accommodation for the Spectrograph unit was completed during 1958, and the instrument has been set up, so that determinations of Magnesium, Manganese, Iron, Copper, Strontium, Barium, Boron and Sodium are now possible. The first project being undertaken with this unit is a survey of the minor element status of citrus orchards which have been treated with fertilisers. During 1958, there were 660 analyses carried out on 95 samples of citrus leaves.

476. *Farm Machinery.* A winch-operated plough was imported from Germany by the Farm Machinery Division for trials on steep hillsides where tractor-drawn implements cannot be operated. The plough was used for straight up-and-down-hill work, the winch being operated from the power take-off of a Ferguson tractor. The implement was not entirely satis-

factory, but sufficient information was gained from the trials to indicate that this type of equipment may have an important part to play in the cultivation of steep slopes.

477. Trials were carried out with a Ferguson reciprocal mower, rear-mounted to a T.E.D. 20 tractor, for topping old Pangola grass. This combination did not do the job satisfactorily, apparently because the forward speed of the tractor was too rapid in relation to the rate of cutting of the blades.

#### *Livestock*

478. Research work continues on the development of the Jamaica Hope breed, and on the production of bulls for the development of the breed on private farms.

479. For the purpose of these research projects, a herd of about 500 head is kept at the Bodles Agricultural Research Station, and detailed records are kept of breeding, growth, fertility, and production of each animal individually. The data is analysed at regular intervals to provide basic information for research.

480. *Nutrition.* A new laboratory has been completed, and research on animal nutrition begun. Analysis of various locally available feeds has been undertaken to obtain information on their quality, and in the case of a few, for comparison with similar imported products. Preliminary trials are in progress to determine means of reducing rearing costs of dairy heifers. The Nutrition Research section collaborates with the Pasture Research section on measurement of the chemical composition of various grasses and of the yield of guinea and pangola grasses.

481. *Pasture Research.* Projects underway include—

- (a) Animal production trials with different grasses with and without irrigation ;
- (b) Fertiliser trials with pangola and guinea grass ; and
- (c) Observation plots with grasses and legumes.

#### *Veterinary*

482. *Newcastle Disease.* Further trials in the efficiency of commercial and laboratory-prepared (V.I.O. Laboratory) vaccines (oral, intranasal and intraocular) were conducted. The intranasal vaccines (Strains F & B<sub>1</sub>) offered no protection.

483. *Parasitology*—Fascioliasis. The intermediate host of the liver fluke, *F. hepatica* has now been identified as *Lymnaea cubensis* Pfeiffer.

484. *Virus Pneumonia.* Virus pneumonia, not previously recognised here, was diagnosed in two shipments of Large White pigs from the United Kingdom. A programme for the eradication of V.P.P. and the breeding of Virus Pneumonia-free pigs has been put into operation.

485. *Vibriosis.* The survey in the Bodles herd was completed. The herd conception rate at the start of the survey based on non-return to first insemination was of the order of 15 per cent. As a result of a control programme instituted, the conception rate on this same basis has risen to 51 per cent. at present.

*Forestry*

486. Owing to shortage of staff, the research carried out by the Forest Department was limited. The following projects were, however, undertaken :—

- (a) *Damping off fungi.* Adequate control has been obtained of damping off fungi affecting Pine seedlings by the use of Ferrous sulphate, sulphuric acid, aluminium sulphate and formaldehyde ;
- (b) *Establishment of suitable mycorrhizal association for Pinus caribaea.* For the successful growth of Pine plants a mycorrhizal association is necessary. Success has been obtained in producing this by confining Pine nurseries to hilly forest areas when forest soil containing suitable fungi is readily available ;
- (c) *Establishment of plots of Pines mixed with Broad-leafed species.* In order to avoid an undesirable monoculture with Pine which tends to produce poor soil conditions, plots containing a mixture of various species of broad-leafed trees and pines are under observation ; and
- (d) *Use of Exotics generally.* Due to the indifferent response to plantings of Jamaican species other than Mahoe (*Hibiscus elatus*) in the optimum habitat the plots of exotic species, chiefly Pine and Eucalyptus, have been put out all over the Island for observation. The Eucalyptus species will be used for reafforestation of highly eroded sites.

*KENYA**Agriculture*

487. Some of the most important new developments in the Research Division of the Department in 1958 were in the field of soil science. Dr. Thorpe, a distinguished American authority on soil classification arrived during the year on an eighteen-month visit under I.C.A. auspices. He was joined later by two experienced American soil surveyors. An officer of this Department has been attached to the American team for training in their procedures. Dr. Melich, another American specialist working on an I.C.A. project, pressed on with the introduction of the rapid routine procedures for the assessment of soil fertility, which he had tested in 1957 and found suitable for Kenya conditions. The careful interpretation into practical recommendations of the results of analyses made possible on a large scale by these rapid procedures should confer considerable benefits on Kenya agriculture.

488. The new laboratories at the Plant Breeding Station, Njoro, were opened during the year and the expanded breeding programme is now under way.

489. A new station in Nyanza Province, to be known as the Kano Plains Irrigation Station, was developed to an advanced stage by the end of the year. Another development in irrigation research was the expansion of the programme of experiments at the Hola Irrigation Scheme.

490. Two American Fulbright scholars arrived in Kenya in 1958. Dr. Moormaw is engaged on an ecological survey of the coastal strip of Kenya and Professor Heady is undertaking an assessment and description

of the semi-arid pastoral areas of Kenya, and studying the effect of animals (both game and domestic) on the grasslands and their effect on bush encroachment, together with an examination of the effectiveness of various measures of control.

491. *Grasslands*. In addition to the main pasture research carried out by the Pasture Research Team and reported later, pasture experiments were as usual undertaken at many of the general research centres in 1958.

492. In a ley species trial at Sotik, Rhodes grass, setaria and star grass, each with Kenya white and Louisiana clover, were compared. Setaria yielded best of the grass species and both it and Rhodes grass significantly out-yielded star grass over the first year. The Kenya white clover out-yielded the Louisiana clover. This same experiment included a comparison of 150 lb. double superphosphate per acre versus nil and demonstrated that under Sotik conditions a phosphate dressing is essential. It gives more bulk, a better balanced sward and less weed in the sward. At Kakamega, Nzoia Rhodes grass still led seven other strains of Rhodes grass in the second year of production, both as regards bulk and palatability, but two other strains, Chepararia and Endebess, were also promising. A trial at Ol Joro Orok on suitable grass varieties for vlel soils showed that despite waterlogging for over two months ronpha and Kentucky blue grass splits and S. 24 ryegrass have grown well. In the Coast Province the Biloela strain of *Cenchrus ciliaris* and Endebess Rhodes grass looked the best species in small plots.

493. A top-dressing trial at Sotik on a setaria ley showed that the effect of sulphate of ammonia, even at high rates of application, is short-lived. The effect of 3 cwt. per acre was lost after only one grazing. The effect of a top-dressing of superphosphate, however, was lasting. At Kanja farm, in Embu district, a manuring trial on established Kikuyu grass showed highly significant responses to various treatments. The residual effect of double superphosphate and the effect of re-applied sulphate of ammonia were significant at  $P = 0.001$ , both fertilisers being applied at the 2 cwt. per acre level. The effect of 10 tons of farmyard manure re-applied at the beginning of the season, was also significant at the same level of probability. Agricultural lime had been applied in this experiment in 1956 at 6.6 tons per acre. Significant increases in yield were obtained as a result of this treatment in the May and July cuts of 1957 only; thereafter the effect faded away. Napier grass mulching also had a pronounced effect on the productivity of the Kikuyu grass in this same experiment. In a separate trial close night paddocking of cattle on Kikuyu grass resulted in spectacular improvement in production.

494. At Sotik an experiment on undersowing grass to maize showed the method to be successful when the maize population per acre is about 14,000 plants (3 ft.  $\times$  1 ft.) and when the grass is not sown before the maize is about 3 ft. high. There is little loss in the yield of maize and the subsequent ley is good. At Ol Joro Orok work on undersowing grasses to barley, oats, wheat and linseed has confirmed the 1957 result that linseed is the best cover crop, with oats taken for silage the next best. Wheat and barley are comparatively poor.

#### *Fertilisers and Manures*

495. Trials with fertiliser applications on potatoes on the Kinangop have shown that NPK applications can give over 16 tons per acre, compared

with about 9 tons from control. Further trials showed that the best potato fertiliser on rich land in this area, consists of  $1\frac{1}{2}$  cwt. sulphate of ammonia, 1 cwt. double superphosphate, and  $\frac{1}{2}$  cwt. sulphate of potash per acre. Sulphate of potash is preferable to muriate where eating quality is concerned.

496. At Kitale an experiment to determine the best stage to apply nitrogen to maize has shown, over four years, that the knee-height stage is the optimum time for application. In 1955, 1956 and 1957, the mean increase in yield from a 2 cwt. per acre application of sulphate of ammonia at this stage was 3.46 bags per acre. In 1958 the same treatment gave an increase of 3.41 bags. Later applications of nitrogen, e.g., at tasseling, produced no benefit at all. A similar trial in Southern Province confirmed this result with regard to the best time of application. A 1 cwt. per acre application of sulphate of ammonia is shown to be adequate in that area.

497. In Central Province, at Kanja farm, the benefit of farmyard manure and double superphosphate both in maize and potato crops was confirmed, whereas 3 and 6 tons per acre applications of lime appeared to be totally uneconomic. At Embu Farm the application of farmyard manure, phosphate, and nitrogen, after ploughing out a productive Rhodes grass ley, gave no responses in maize, potatoes or sweet potatoes, whereas such responses are normal in arable cultivation in this area. The advantages claimed for ley farming in the star grass and lower Kikuyu grass zone, which Embu Farm represents, would appear to be real, provided the ley is a good and productive one.

498. Fertiliser results from the Coast Province have shown that urea applications can increase yields of cotton in the main cotton areas. On the poor soils of the Shimba Hills, where large phosphate effects are usual, basic slag and double superphosphate applied in 1957 had substantial and equal residual effects in 1958. Trials on the time of application of nitrogen to cereals have shown that split dressings are best under coast conditions, half at planting and half as a top dressing at an active period of growth. Another interesting result is that light annual dressings of fertilisers and of manure have both kept up yields on light sandy soils at Matuga over six years of continuous cropping.

499. Apart from the results of fertiliser trials with potatoes reported above, the most interesting other effect with this crop was that produced by chitting. It was found in the Rift Valley Province that chitted seed gave twice the yield of unchitted.

500. Cotton trials at the coast confirmed previous results. UK 51 and UK 55 varieties did not differ in yield under coast conditions, although UK 55 has been shown to yield slightly higher than UK 51 elsewhere. A slight improvement in yield resulted from tie-ridging, but the increase was not sufficient to warrant the extra work involved. Spacings varying from 3 ft.  $\times$  2 ft. to 3 ft.  $\times$  9 in. had no influence on yield. Early planted cotton once again out-yielded that planted later, the increase being larger on sprayed than on unsprayed cotton. The necessity for adequate control of weeds was spectacularly demonstrated by the complete failure of the unweeded cotton in another trial.

501. There have been trials with a whole range of miscellaneous crops to try to assess the possibilities of finding alternative crops or new crops for certain areas. For example at Kitale, where an alternative crop to maize

is of current interest, plots of the following were established:—Castor, soya beans, simsim, linseed, lentils, green grams, Michigan peabeans, sweetcorn, groundnuts, niger oil and *Sesamum angolense*. The *Sesamum angolense* crop is being tried for the production of a synergist for pyrethrum formulations. In Nakuru district cotton has been tried as a new crop with considerable success. Elsewhere plots of alternative crops have been established at most stations.

502. Mention might be made, for the first time in these reports, of experimental work on tea. Experiments under the auspices of this Department have been started with this crop only recently, so that they are all still in a preliminary stage. Cycle-of-pruning and time-of-pruning trials are in progress and fertiliser and spacing trials have been established.

503. *Rotations*. In a rotational trial at Embu last year's result which showed that maize following sweet potatoes yielded better than maize following English potatoes, which in turn yielded better than maize following maize, was confirmed in a second trial.

#### *Animal Husbandry*

504. *Cattle*. Trials were carried out at the Eldoret and Kitale stations in Rift Valley Province on the early weaning of calves. At Eldoret the Red Poll calves, weaned off milk to a special meal at 3 weeks of age, appeared to save Shs. 18/90 per calf, compared with those reared by normal methods. This saving does not include economies in labour and management attributable to the early weaning system. Results at Kitale with Jersey calves were disappointing due to the calves' appetite for the meal. The trials continue with various modifications to limit intake of meal to an economic level.

505. *Pigs*. The third and final phase of the Eldoret indoor-outdoor pig trial has now been completed. Interim results show that downgrading was the first cause of low profits, followed by poor conversion ratios. Other findings show that pigs fed ad lib mature for bacon 1-2 weeks earlier, have poorer conversion ratios, and are less profitable. Pigs reared outdoors mature for bacon some 2-3 weeks earlier.

506. Another trial on pigs at Eldoret proved the value of skim milk as the protein part of the diet. In this same trial amino-acid deficiencies were induced when the pigs were fed on normal farm rations of meat meal and cereals. Efforts are being made, in association with the East African Agricultural and Forestry Research Organisation, to correct the amino-acid balance of the rations.

507. The pig trial at Kitale on the feeding of high levels of maize and skim milk created widespread interest and proved conclusively that maize is indeed a useful pig feed when used with skim milk. Trials continue in an effort to find alternative proteins to skim milk for feeding with high-maize rations.

508. *Sheep*. A trial at Eldoret with Hampshire cross native lambs showed that fat lamb production is not feasible, under Eldoret conditions, off ley or rape, without supplementary feeding. Although the clover-leys fed group made better liveweight gains the rape fed group was more acceptable to the butchers as the gains in this group were more in meat and less in frame. The conclusion from this trial is that unless grazing can be improved the sheep should be sold as Highland mutton instead of lamb.

*Grassland Research*

509. Of the 174 new items tested in the plant introduction work, the most promising were Sabi Guinea grass from Rhodesia, Rhodes grass varieties from South Africa, Kenya and Senegal, and also varieties of red clover (*Trifolium pratense*), velvet bean (*Stizolobium*), Berseem clover, and *Andropogon gayanus*, the latter a grass from the semi-arid grazing areas of West Africa.

510. The preliminary grazing trials are for the further evaluation of species which have shown up well in the earlier nursery trials, and are continued for four years. During recent years, 44 varieties of Rhodes grass and 20 of molasses grass were tested in the nursery and then put through the preliminary grazing trials, and in the latter, the following ones showed up the best: Kitale commercial and Chania varieties of molasses grass, and Nzoia, Endebess, Mbarara and Chepararia varieties of Rhodes grass. *Pennisetum dowsonii* and *Panicum coloratum* also performed well in these trials.

511. Uniformity tests have been carried out with several Rhodes grass varieties by observations on single-spaced plants. A considerable amount of variation has been found within strains and this offers much scope for improvement by means of selection.

512. Progeny testing indicates that *Cenchrus ciliaris* and molasses grass are self-pollinated or apomictic, while Rhodes grass is cross-pollinated.

513. In a comparison of the leaf yield from 7 grass species which were managed for general purpose leys, molasses grass, Rongai Rhodes, and Coloured Guinea grass (*Panicum coloratum*) out-yielded Slender Guinea, Beck grass (*Beckeropsis unisetata*), star grass and Nandi setaria in the first season.

514. During the dry months of 1957-58 the leaf yield of 7 grasses was compared under late (dry) season grazing management. In that period Sigor Guinea grass and molasses grass outyielded Slender Guinea, Gold Coast elephant grass, Nzoia Rhodes, Giant setaria (*Setaria splendida*) and Columbus grass.

515. Comparison of *Trifolium semipilosum*, *T. repens* (Louisiana white clover), lucerne and *Trifolium rueppellianum* (Rueppells clover) in grazing mixtures during the last three seasons has shown that the perennial legumes yield more than the annual Rueppells clover under the conditions of this experiment.

516. *Glycine javanica*, perennial *Dolichos sp. nr. D. lablab* and *Desmodium uncinatum* are the three legumes which appear to be most satisfactory at present for use in late (dry) season grazing mixtures.

517. Further evidence of the beneficial effect of legumes on both yield and quality of leys has been obtained. In one experiment yield increases of up to 15 cwt. an acre of dry matter have resulted from the mixture of Kenya white clover, Louisiana white clover and lucerne with Nzoia Rhodes grass.

518. Observations on the management of general purpose leys, concluded this season, have confirmed that the proportions of grass and Kenya white clover in a mixed sward can be controlled. The clover is encouraged



by close mowing and frequent grazing with cattle, and is retarded by the reverse treatment.

519. Investigations on gypsum to correct sulphur shortage in the soil have been continued. It seems that first year stands of clover and lucerne often do not give a response, but the effect of gypsum usually becomes apparent in the second year and thereafter. A mixture of grass and clover responds most readily to gypsum treatments, but grass alone hardly responds, while maize so far has not shown any response at all.

520. Among the minor elements a statistically significant but small response to zinc was obtained on Kenya white clover (*Trifolium semipilosum*) and a number of instances of zinc effect have also been seen on observation plots. Work done so far indicates that some plants are more sensitive than others to zinc shortage.

521. In ley agronomy work the beneficial effect of inoculation of legumes has been confirmed yet again, in this instance on Clare subterranean clover. The inoculated plots produced a bigger yield per acre of dry matter, better plants and more protein per acre than uninoculated plants.

522. Last year's indications regarding the difficulty of obtaining efficient nitrogen fixation in legumes on deficient soils have been further supported this year.

523. The animal agronomy work, which is for the evaluation of pastures by means of meat and milk production, continues. The effect of fertilisers on production is being investigated, and also the relative value of different grass species.

524. Grass and legume seeds of all the varieties in current use are being multiplied to produce sufficient material both for trials within the department and Stock seed for the Seed Certification Scheme.

525. The Seed Certification Scheme has now been in operation for a year. Of the farms that have been visited for field inspection, eight have been passed for certification, the crops being : Mbarara Rhodes, 34 acres ; Nzoia Rhodes, 35 acres ; Nandi setaria, 21 acres ; Kenya white clover, 5 acres ; Bamenda white clover, 2 acres.

526. In the Pasture Research Chemist's work, the 0.225N, N, 2N, 3N and 6N-H<sub>2</sub>SO<sub>4</sub> fibre contents of the feed and of the faeces of star grass, canna tops, meadow hay and the same meadow hay fed with cassava have been examined, together with the crude protein and the true protein associated with the respective acid-fibres.

527. The N-H<sub>2</sub>SO<sub>4</sub> fibre content of lucerne at different stages of its maturity in relation to its conventional crude fibre content has also been investigated.

528. The sulphur content of star grass in relation to its phosphorus and its nitrogen content has been studied.

529. The development of the Molo Grassland Research Station is now finished and increased numbers of stock can be carried. Work during the year has shown the need for high phosphate dressings for clover growth. Where this has been provided, beneficial effects of legumes on grass and cereals have been obtained. The effects of trace elements on a soil which shows no overt deficiencies is dependent on adequate phosphate being

supplied and on certain interactions between trace elements. The economics of the above effects, particularly in relation to phosphate applications, can be determined only in long-term experiments which the station is now equipped to tackle.

530. *Ranching Areas.* The preliminary work in the ranching areas is now almost completed. The survey of ranching in the European Highlands is finished and a final report on the management, production, animal numbers and pasture problems in these areas has now been written up. Bush invasion has emerged as the major problem of ranching areas.

531. Preliminary investigations on bush control commenced during the year, and work is going ahead. The preliminary trials have given valuable information on the effectiveness of the various methods and their cost. They have also demonstrated the tenacity and power of regeneration of the East African bush species and difficulties of control.

532. Pasture research at Katumani in the Southern Province expanded rapidly during the year. Rainfall was much higher than average and preliminary results from experiments should therefore be treated with caution.

533. A large number of grasses were on trial under grazing to find productive, palatable and persistent types. Rhodes and *Panicum* varieties in general established easily and quickly and were more productive and palatable than grasses such as *Cenchrus ciliaris* and *Eragrostis superba* during the first year. These grasses are slower to establish but they are, however, more persistent in dry areas. Inadequate seed production and difficulties in establishment prevent their widespread use at present although they have proved useful in restoring a cover on denuded grazing in certain parts of Ukambani. Attempts to find suitable pasture legumes have been disappointing.

534. In a comparison of a single cut of silage crops, maize, local sorghum and perennial Kavirondo sorghum gave similar dry matter yields, whereas bulrush millet and Sudan grass gave about 40 per cent. less. However, Sudan grass gives valuable aftermath grazing and the silage cut gave as much crude protein per acre as maize.

535. In a fertiliser trial on Rhodes grass, yields averaged four tons dry matter per acre. There was no response to fertiliser at the start, but towards the end of the year nitrogen was showing a visible response.

536. The work of the Kamasia Pasture Research Station at Marigat has progressed well during the year. The main problems receiving attention at present are: (a) the rehabilitation of habitually over-grazed areas, both by reseedling and by the introduction of remedial grazing control, including investigations in connection with grazing schemes; and (b) the control of bush encroachment, with particular reference to *Tarconanthus camphoratus* (Leleshwa) and *Acacia* spp.

537. Ecological survey work, which featured prominently last year, has been limited as a result of the expansion of the experimental programme in other directions. Nevertheless, some time has been devoted to more detailed surveys of land condition and potential, and one report of this nature (for the Seya-Barsalinga area of Samburu) has been released during the year.

*Coffee*

538. *Entomology.* The two main lines of investigation were the biology and control of the Tip Stem Borer, *Eucosma nereidopa* Meyr., and improved methods of chemical control of the Leaf Miners *Leucoptera meyricki* Ghes. and *Leucoptera coffeina* Wshbn.

539. Detailed studies of the distribution of the night-flying *Eucosma* moth in the plantation, when at rest during daylight hours were made. Most occurred on the trunks of the coffee and shade trees. Many persistent insecticides were screened to find one suitable for spraying on the tree trunks. Five showed promise. Systemic insecticides against the caterpillars in the sucker tips were disappointing when used at economic rates. Much general information on the life history of this pest was acquired.

540. Three of the newer insecticides were found to kill *Leucoptera* caterpillars in closed mines but further field trials are required before they can be recommended as alternatives to Diazinon or Parathion. Pyrethrum, sprayed as an emulsion, gave a good kill of *Leucoptera* eggs at what may prove to be economic concentrations. Further laboratory work in co-operation with the Pyrethrum Board of Kenya is in progress. Heavy overhead irrigation killed (by drowning) almost all the caterpillars feeding in open mines—about 25 per cent. of the total larval population. Work on the parasite complex continues.

\* 541. Opportunities were taken to test some of the newer insecticides against the Scale insects *Ceroplastes luteolus* De Lotto, *Saissetia coffeae*, and *Asterolecanium coffeae* Newst. Both Malathion and Parathion gave good control of the Lace Bug *Habrochila ghesquierei* Schout. and one or the other is now in general use against this pest. New pyrethrum formulations gave disappointing results in trials against the Antestia Bug (*Antestiopsis* spp.) but aerial spraying with Malathion was successful.

542. *Chemistry.* Little new work has been undertaken this year with the study of soil nitrogen changes in relation to nitrogenous fertilisers and mulches. A period of consolidation and an appreciation of results obtained to date and their practical application has followed nearly four years of experimentation.

543. Meanwhile, active work has shifted to a study of some of the cationic constituents in the coffee leaf following preliminary work which described and defined a widespread deficiency or imbalance of magnesium (*Emp. J. exptl. agric.* 1958, 26, 259). The important and indirect part played by grass mulches, particularly Napier grass (*Pennisetum purpureum*), in relation to the occurrence and the severity of magnesium imbalance has been further studied by means of leaf analysis of both mulch grass species and coffee and of coffee cherry and soil analysis. Estate observations, following the inclusion of Epsom salts with routine copper fungicide or other pesticide sprays, have in general confirmed that this practice is beneficial in coffee mulched consistently and/or in heavy bearing, and it remains now for the detailed field trials to supply yield data over a reliable period of time in support, or otherwise, of magnesium fertiliser applications to the soil.

544. Work has continued on various micro-nutrient investigations of coffee nutrition without so far providing conclusive results. Observations in these trials point to a considerable need for a parallel investigation of

the carbohydrate status of the tree with special reference to crop production, i.e., season, physiology and quantity.

545. An interesting fact has emerged from a short-term and arbitrary study of root cation exchange capacity conducted on varieties and species of coffee in the museum plots on the Coffee Research Station. The results fall naturally into four quite well-defined groups. This requires a follow-up in terms at least of the cation concentrations present in the leaf of variety/species in each group grown on similar soil and under similar climatic conditions.

546. *Pathology and Physiology.* The growth experiments in the Coffee Research Station and Scott Agricultural Laboratories were continued but the high rainfall for the second year in succession obviated the application of much irrigation. At the Coffee Research Station the single stem trees showed a higher peak of growth in March than the multiple stem while the reverse was the case at the Scott Agricultural Laboratories. As in the previous year the shaded trees in the Coffee Research Station outstripped the unshaded.

547. A small test of gibberellic acid was carried out on mature multiple stem coffee trees, but it appeared that this material had no effect in such circumstances.

548. Germination tests of *Hemileia vastatrix* showed that spores kept in subdued light retain their viability as well as those stored in darkness, and they can also germinate in the same subdued light. This could have important consequences where there is heavy shade.

549. In spite of repeated inoculations, it has still been impossible to isolate the Race VII of *Hemileia vastatrix* named by Dr. d'Oliveira. Three separate collections from the same source have been tested with no success.

550. The timing of sprays experiment showed that, of the four applications, that taking place in January could be omitted where the rust infection was at a low level and there was a dry period from January to March. The control effected by each spray lasted in the region of three to four months but much depended on the level of infection present when the fungicide was applied. The higher concentration, i.e., 10 lbs. of Perenox per 100 gallons of water proved to have proportionately greater control of infection and the effect lasted considerably longer.

551. *Coffee Berry Disease.* Trials in both the East and West Rift districts have fully confirmed the results of the previous seasons' field work. It is now quite certain that effective control of the disease is possible at an economic level in both East and West Rift districts. The response to treatment varies with the crop and it is now possible to assess the most probable financial return for any given flowering-rate.

552. In the East Rift it has been conclusively shown that the critical period for control is the 11 weeks centred on the flowering period. This period needs detailed study and field experiments on this have been designed and completed. Results are now coming in. In the West Rift, the necessity for two control periods has been confirmed. Extensive trials for the further study of these are complete; but results are not yet available.

553. During the year, the use of mercurial sprays has been abandoned, partly because of their poisonous nature and partly because of their phytotoxic effect. Captan formulations, which this year's comparative trials have shown to be effective, are now used.

554. A severe outbreak of leaf rust on one field trial has enabled observations on the effects of Captan to be made. These are most encouraging; it is clear that the fungicide has affected, not merely the rust fungus, but the syndrome.

555. Laboratory work has concentrated on the relationship between disease incidence and inoculum potential. It has been shown that the infection potential of a plantation is in the main the result of inoculum production on the maturing twigs and not from the fruit, and that control treatments, in all probability are efficacious in that they affect this source of infection. This discovery is in complete accord with all field evidence and epidemiological studies and will, it is hoped, form the theoretical basis on which spray schedules will, in future, be determined. Studies on the relationship between infection-potential, infection, and growth characteristics, as affected by fungicidal sprays, are in hand.

556. *Vegetative Propagation.* Electrical soil warming equipment was installed in three frames with the object of shortening the time required to produce coffee cuttings. Preliminary results indicate that the time taken for rooting may be reduced by about 2 weeks only and that internodal cuttings will produce roots more quickly than nodal cuttings in a constant temperature of 72° F.

557. *Field Trials.* The mulch trial at the Coffee Research Station, Ruiru, there was a valuable yield response to all mulch treatments applied. In this trial the use of magnesium as fertiliser has not affected the yield of coffee during the two years it has been applied. On other trials at Ruiru and Kitale mulches did not increase coffee yields in 1958.

558. Treatments with cattle manure and a phosphate fertiliser did not increase the yield of coffee and with one exception nitrogenous fertilisers were not effective in improving the crop. In a trial comparing the efficiency of urea applied to the ground at rates of up to 200 lbs. per acre or to the leaves in high or low volume sprays at rates of up to 100 lbs. per acre all treatments improved yields substantially and there was little difference in the efficiency of the various methods employed to apply the fertiliser.

559. The trials at Kitale and Nakuyu continue to indicate that May is the best month in which to apply a copper spray to reduce leaf-fall.

560. In another spray trial to reduce leaf-fall at the Coffee Research Station, Ruiru, the "Micron" very low volume (10 g.p.a.) sprayer was compared with a medium volume (60 g.p.a.) airblast machine. Yield results from the first two years have indicated that if the spray volume per acre is reduced from 60 to 10 g.p.a. the concentration of fungicide (50 per cent. copper oxide formulation) does not need to be increased to obtain the same yield response; however, yield responses have increased with the concentration of spray employed up to 34 lb. per 100 gallons when it is applied with the "Micron" sprayer.

561. The variety trials planted at Kitale and on Kentmere Estate, Upper Kiambu, in 1954, carried their first full crop in 1958 and it appears that

the selections S.L. 34 and S.L. 28 have out-yielded all the Blue Mountain selections at both sites.

562. Towards the end of the year 24 valuable coffee plants were obtained from the Rust Research Centre, Lisbon, Portugal. It is hoped that this material will eventually enable the Coffee Research Services to provide seed of selections resistant to all races of leaf rust in East Africa.

563. *Trials in African Areas.* Above 5,000 ft. in Meru and Embu the varieties S.L. 28 and S.L. 34 continued to produce excellent crops of good quality coffee. The variety Meru Kents is being superseded by S.L. 28 and S.L. 34 in both districts.

564. In Fort Hall the variety S.L. 6 continued to show resistance to leaf rust and will be planted commercially as an alternative variety to K. 7 in the leaf rust (*Hemileia vastatrix*) endemic zones of Central and Nyanza Provinces. The performance of K. 7 in Elgon Nyanza was outstanding when compared with the varieties S.L. 2, S.L. 14, S.L. 28, and S.L. 34, and Kapretwa series A. In the Nyanza Province below 5,400 ft. the chief limiting factor to production was leaf rust.

565. Preliminary results from the rust exposure trials planted in 1956 indicate that S. 288 and S. 795 are completely immune to Races I and II of *Hemileia vastatrix*. Information on their crop potential and liquoring quality should be obtained during 1959.

#### *Sisal*

566. The feasibility of growing successive crops of satisfactory nursery plants on the same site by applications of sisal waste and nitrogenous fertiliser has been demonstrated. The trial comparing old and young suckers and nursery plants has been completed. There was little difference between nursery plants and old suckers, but young suckers, being smaller, took longer to produce their fibre yield.

567. The annual rate of leaf production has been shown to be far from constant. After an initial six months of establishment the maximum number of leaves is produced in the following three years, about 30-40 leaves per annum. After that the number is reduced by about five per annum, until poling begins when the plant ceases to produce new leaves.

#### *Sugar Cane*

568. In sugar cane variety trials in Nyanza Province B. 41227 has been found the most satisfactory variety under irrigation. B. 41211 also did well. Under rainfed conditions B. 37193 proved a good variety and in another trial which has completed its first ratoon NCo 339 leads over 24 other varieties. Gypsum and soil ripping treatments have given good results on poor soils with impeded drainage. Three cwt. of sulphate of ammonia applied in the short rains under trash gave the best increases in yield in a fertiliser trial on ratoon cane. Deep planting of cane at Kakamega proved very beneficial under dry establishment conditions.

#### *Horticulture*

569. Investigations were started into the possibility of developing an export industry for citrus juice. The Kenya Citrus Growers Association is

finding a considerable demand for its fruit and new acreage is being planted. A serious problem in East Nyanza is poor colour in oranges ; investigations are being made to combat this.

#### *Pineapples*

570. Comparisons of planting material at Jacaranda showed that suckers gave a significant increase in yield and earlier fruiting of the plant crop over both crowns and slips. The drying out of crowns and slips for periods of up to two months before planting, or a pre-planting dip containing an organo-mercury fungicide, had no effect on the rate of establishment or fruit yield compared with freshly-planted material. These pre-planting treatments may be of value under poor drainage conditions where basal-rot is prevalent.

#### *Berry Fruits*

571. Export trials of strawberries to the London market in the Christmas period were successful. However, much of the fruit was produced too far up-country, and it would be more satisfactory if production were zoned in the Limuru-Uplands-Bamboo Forest area. Several new trials with strawberries were started at Molo. Mass selection of seedlings, with the object of producing varieties suited to local conditions, is continuing. Export trials with Cape Gooseberries from Molo were extremely successful, though this can only be a small trade.

#### *Tomatoes*

572. Tomatoes grown for canning in the Trans-Nzoia, Nakuru and Naivasha district gave reasonable yields. Good results were obtained from a trial at the Irrigation Research Station, Mwea/Tebere. Eight varieties yielded at between 10 and 14 tons per acre. Ariana and Stokes-cross varieties were outstanding. At Thika, the most promising varieties in a trial of 14 which were tested for the fresh market were Hundredfold Amateur, German Strain Nos. 7 and 8, and Homestead.

### PLANT PATHOLOGY

#### *Plant Diseases*

573. A record number of 526 plant pathological specimens were examined in the laboratories. The discovery of Sugar Cane Smut (*Ustilago scitaminea*) was the outstanding event of the year. Bacterial Wilt of Potatoes (*Pseudomonas solanacearum*) appears to be spreading in Kenya and threatens to be a difficult problem to the expanding potato industry. Barley leaf diseases caused by *Helminthosporium teres* (Net Blotch), *H. sativum* (Spot Blotch) and *Rhynchosporium secalis* (Scald) were serious and formed the subject of a special survey. It was concluded that recent weather conditions were primarily responsible for the severity of these normally unimportant diseases. *Pyrenophora tritici-repentis* and *Septoria* spp. were serious on some wheat crops. Again, these diseases are normally of little importance and their severity was attributed to wet weather. Head Smut (*Sphacelotheca reiliana*) of maize was abnormally damaging. Maize White Blight (*Helminthosporium turcicum*) threatens to become the most damaging of all the Kenya maize diseases.

*Entomology*

574. In an experiment against Bean Fly almost complete protection was given to beans in early growth by the use of seed dressings. Aldrin was better than dieldrin or gamma BHC.

575. In pyrethrum, red spider mite was controlled by Rogor, Kelthane and Tedion while control of thrips was given by DDT, Chlorthion, Mestastox and Rogor. A new sampling technique, involving the use of a benzene-water interface, has given good results and increased the efficiency and speed of examining samples.

576. The Cochineal insect, *Dactylopius tomentosus*, established itself on prickly pear, liberations being made in Nairobi, Mariakani, Naivasha and Muhuru. The lacebug, *Teleonemia scropulosa*, was liberated in Nyanza to attack lantana. The lantana seed fly, *Agromyza lantanae*, was established in Nairobi and in the Fort Hall area.

577. At the coast laboratory testing of insecticides against the Coconut Coreid bug, *Pseudotheraptus wayi*, continued and the most promising insecticides are being further tested in field trials. Experiments to find economic control measures of cotton pests are being undertaken, and a study of the pests of the castor bean crop was made. Spraying regularly over the flowering period increased castor yields substantially.

578. Work in Nyanza was concerned chiefly with cotton pests. In the lake shore area figures so far received show yields increased from 290 lbs. per acre seed cotton (50 per cent. stained) to 700 lbs. per acre (20 per cent. stained) due to dusting with 60 or 80 lbs. per acre of BHC/DDT dust.

579. Experiments with dry seed dressings to control Barley Fly showed that dieldrin and heptachlor were better than aldrin or endrin. Thiodan and Thiometon were ineffective. A dieldrin spray applied three days after emergence of the coleoptile gave better control than seed dressings. Ten ounces of 50 per cent. to 100 lbs. of seed was found superior to lower levels of dosage. Nandi setaria at Nakuru was found to be an alternative host of the fly.

580. The bulk of stored products work was related to stack fumigations with methyl bromide gas. Fumigation and long-term storage under polyethylene sheeting was the most promising development of the year. At the coast a stored products entomologist found that a rapid re-infestation of *Tribolium castaneum* occurs following fumigation of maize. Work on dusting large stacks of maize with 0.5 per cent. gamma BHC resulted in a more refined technique. Several trials were directed at the control of moths in large maize stores. A fumigation of a store rendered gastight by sealing all openings was most promising.

581. *Taxonomy of Mealybugs*. The study of the species of *Coccus*, hitherto not revised, from Africa South of the Sahara has been completed and sent to the press. A supplementary study of the Coffee Green Scale complex from the same area has been carried out and is nearly completed. From this study it is apparent that *Coccus africanus*, the Common Green Scale of Coffee, consists of a group of distinct species. The work on *Ceroplastes* has been carried out and is approaching completion. It will cover all species in the Ethiopian region mentioned above. Work is also in progress on a paper describing new species of mealybugs from Africa South of the Sahara.



*Soil and Agricultural Chemistry*

582. During the year the soil survey team, working in Kenya under I.C.A. auspices, completed the field work of a semi-detailed survey of 130,000 acres in the North Eastern Kano Plains and the surrounding rising country. The survey was undertaken in connection with a proposal to develop cane sugar locally. Between one and three phases each of forty-two different soil types were described and mapped, mapping being on a scale of 1/50,000 to match the Survey of Kenya physical maps. The various soil types described were also assessed for their suitability for sugar production and on this basis a further map was prepared delineating the areas of varying suitability for sugar cane growing.

583. Subsequently a start was made on a similar survey of equal magnitude in South Nyanza. This latter survey was greatly facilitated by having a new set of aerial photographs taken of the area specially for the survey. The use of special infra red-sensitive equipment gave an additional clarity to the pictures so far as soil recognition was concerned.

584. Dr. Thorp, the head of the I.C.A. team, travelled widely in the Colony, collecting information on local soils with a view to advising on a framework within which a classification scheme for Kenya soils can be developed.

585. Other pilot surveys were undertaken in collaboration with the Farm Planning Officer in Nakuru district. These involved the delineation of the land units making up each of four 700 acre farms, and subdividing these into sampling units from which random samples are drawn for analysis, which is now under way.

586. Dr. Mehlich pressed on with the introduction of the rapid routine procedures which during 1957 he had tested and found suitable for Kenya conditions. He built up an organisation capable of handling seventy samples a day and determining chemically, or physico-chemically, pH and acid extractable sodium, potassium, calcium, magnesium, manganese and phosphorus. About twenty-four topsoil samples per day were examined by the use of the *Cunninghamella* organism for available nitrogen, phosphorus, sulphur and trace elements while with samples in which indications were obtained of trace element deficiency further tests were undertaken to identify the deficient nutrient. The survey profile samples were also examined chemically with a view to the characterisation of the soil colloids present in the various horizons, following a procedure which Dr. Mehlich developed for the approximate determination of expanding lattice, kaolinitic and sesquioxidic materials. The clay characterisation data which he so obtained has given the field surveyors notably increased confidence in their classification of the soils on which they have been working.

587. Parallel to the Mehlich analyses investigation of the nutrient status of carefully selected soils using the Webb-Hewitt technique and *Aspergillus niger* cultures was continued, thirty-two soils being examined in the course of the year. The most widespread and serious deficiencies revealed were those of phosphorus and nitrogen. Sulphur deficiency was common, all samples from Trans-Nzoia and the East Kano survey area being deficient or extremely deficient. Copper deficiency was found in four samples from areas of the Rift Valley where low copper status is known from farming

experience. Examination of a number of soils from the East Rift plateaux suggested the incidence of sporadic deficiencies in molybdenum.

588. Comparison of pot tests with *Aspergillus* indications suggested that some correlation exists so far as copper is concerned but that the present pot test technique is insensitive to zinc deficiency. Comparisons between the pot test and *Cunninghamella* results established a good correlation for nitrogen, phosphorus and sulphur but not for copper; available data remain insufficient for similar testing so far as other trace elements are concerned.

589. The African fertiliser trials programme was maintained, a good proportion of the trials being run into residuals. The application of superphosphate and FYM to English potatoes had pronounced residual effects in the main rains maize crop in the succeeding year in responding areas. But the residual effect, in the reverse order of cropping was decidedly less. The relationship described in 1957 between N and P responses and certain soil characteristics have been confirmed and elaborated. In particular a highly significant correlation was established between the phosphate response of English potatoes on red soils of volcanic origin in Central Province and the Mehlich determined acid soluble phosphorus of the unfertilised soil.

590. The lime investigations continued with a switch in cropping from cereals to grass/legume leys and row crops. Sugar beet at Kaptagat failed but kale at South Kinangop did well and showed the normal responses. Newly established ley at Eldoret and Marindas got away satisfactorily and responded better to the lime treatments than the preceding crops of cereals. Associated laboratory work revealed a marked accumulation of extractable phosphorus as a result of the repeated phosphate application at South Kinangop but not elsewhere. Here much of the phosphate present or added to the soil is held as aluminium phosphate and relatively little as occluded ferric phosphate. Elsewhere this latter is the main form in which phosphate is held by the soil. A low sulphur status is apparent at South Kinangop on those plots which have received no sulphate of ammonia.

591. In the wheat quality investigations glutens were isolated from a diversity of wheats and stabilised by vacuum freeze drying. Exhaustive attempts were made and are being continued to apply electrophoresis to the fractionation of the constituent proteins and in particular to find a medium in which these are adequately mobile. In the field, the long term effects of environment and grain size, the effect of past cropping history and the immediate effect of harvest conditions remained under investigation. The soil fertility background of a number of instances of exceptionally strong and exceptionally weak commercial wheats have also been examined. Results continue to be inconclusive. Nitrogen fertilising of wheat has been so ineffective in improving quality that its investigation has been discontinued.

592. *Wheat.* The season was a poor one due to prolonged rains and lack of sunshine. In consequence, yields were about average except in the higher areas where conditions were more favourable. There has been less stem rust than usual, but on the other hand brown leaf rust was widespread and very damaging in its attacks. The premium wheats, principally Canadian varieties, were severely attacked and yields reduced markedly in consequence. The chief races of stem rust present during the season were K.18 and K.19, but K.12, 14 and 16 were also damaging and in fact K.12 has shown a remarkable revival. A new race (K.20) is suspected.

593. Practically the entire multiplication programme is still devoted to introductions to bridge the gap until new resistant Kenya-bred material can be made available. In breeding work the new intensive back-cross programme was begun, based on 183 rust resistant introductions and 5 established Kenya varieties.

594. The following seven new varieties were released during the year:—RL 2150/A, 362.B.1.A.2, 367.AR, 367.BR, 339, H.462 and a new Sabanero selection. Three promising new varieties had to be withdrawn due to stem rust attack—Spica, Rio Negro and Frontana-Kenya 58—Newthatch (II-50-25). The only remaining variety in farm scale multiplication, Mentana<sup>2</sup> × Kenya C9906 is doubtful.

595. *Barley*. Crosses made in 1953 reached the final selection stage and were screened for leaf disease resistance. Material from the World Barley collections has been introduced to find field resistance to leaf diseases which have been particularly damaging in the past two years. The new variety Mid-Season Research was released.

596. *Maize*. At Njoro, the main activity was the formation of Synthetic II, and work continues to produce further improved varieties. At Kitale, the combined Hybrid and Synthetic programme consisted of the final screening of material derived from the old work, and more importantly, much new material dating from the start of the new programme two seasons ago. Ecological trials to assess the need for separate programmes in different areas and to identify the best stocks for breeding purposes have been laid down. Such trials have offered the opportunity for a general comparison of the synthetics developed at Njoro and Kitale and also those developed by E.A.A.F.R.O. at Eldoret. Kitale Synthetic I was released during the year and had moderate success.

597. On the coast, the first field bulking of the stock resistant to tropical maize rust was carried out on the Irrigation Scheme at Hola in the Tana River delta. This maize showed 99 per cent. resistance to the disease in the field.

#### *Irrigation*

598. *Hola*. On the red desert soils at Hola fertilisers have proved more effective than leaching or gypsum applications in improving crop growth and, of the fertilisers, nitrogen has proved the most effective. In observation plots finger millet, bulrush millet, several fodder grasses, most legumes, jute, sunflowers, cotton and cassava grew and yielded well. Several economic tree crops have been established successfully. The position regarding cotton varieties suitable to Hola is not yet clear but UK. 51 has yielded well, giving an average of 2,264 lbs. seed cotton per acre in one trial.

599. The growing and incorporation of a green manure crop on the grey desert soils produces striking results and where this has been done satisfactory growth and yields of cotton and even maize have been recorded. Where green manure is supplemented by cambered beds cotton yields appear to increase the longer the land is intensively cropped. Swamp rice yields well on the grey soils.

600. *Irrigation Research Station, Mwea*. The rice collection was enlarged by the addition of new varieties from Persia, Nyasaland and Surinam and by the end of the year numbered 84 varieties. Fertiliser experiments

on the variety Sindano showed fairly general responses to 1 cwt. per acre of both double superphosphate and sulphate of ammonia applied just before transplanting. Applying the latter fertiliser as a top dressing 3 weeks or 9 weeks after transplanting or splitting the dressing between all three times showed no advantage. Work on spacing showed that 6 ins. by 6 ins. usually gave a higher yield than wider spacings.

601. Observation plots were continued of a number of alternative crops on the black soil, both irrigated and unirrigated. A new aspect of this work was an investigation into fish, *Tilapia nigra*, as an alternative "crop".

602. On the red soils work was done on irrigation methods suitable for land with a very thin top soil and unusually high permeability, on possible irrigated cash crops for the red soil, and on crop growth and manuring on unirrigated land. So far the most promising irrigated cash crops are hibiscus fibre, tomatoes, asparagus, lucerne, sugar cane, melons and cucumbers.

#### *Agricultural Machinery Testing*

603. The East African Tractor and Implement Testing Unit, based at Nakuru, continued a programme of testing of production and special models of tractors and implements. Tractor trials covered extended trials on farms, altitude performance tests, comparative tests of performance by different makes of tractor, engine cooling problems, fuel filter tests, and investigation of a tractor specially modified for East African conditions.

604. Implement testing covered particularly performance of bush clearing machines of different types (knife and chain rotary types, crushers and flail models), bracken breakers and various cultivation implements.

#### *Veterinary Research*

605. The agar gel double diffusion precipitin test was used throughout the year to detect contagious bovine pleuro pneumonia antigen in specimens submitted for diagnosis. Positive confirmation was obtained in 41 cases by this means and antigen detected in lung, heart muscle, spleen, liver, kidney and blood.

606. Satisfactory pleuro-pneumonia antigen for complement fixation tests was prepared at Kabete for the first time. Strain differences appeared to be important in production. Antigen from two locally isolated strains failed to react with antibody in weak positive sera; that made from another strain showed no complement fixing power but agglutinated with positive sera. Development of complement fixing antigen was studied during the incubation of cultures and subsequent maturation at +4°C.

607. Trials were set up comparing dead vaccines received from the Director of Veterinary Services, Angola, with the stock avianised product. The dead vaccines conferred virtually no immunity whereas nine out of ten steers given avianised vaccine resisted challenge.

608. Survey of incidence of Johne's disease by complement fixation testing of blood samples continued. An analysis of results for 29 farms showed that 4.2 per cent. of 8,867 samples were positive, 8.7 per cent. were doubtful and 87.1 per cent. negative. Individual farms averaged between nil and 20 per cent. positive. Regular testing and slaughter of positive reactors over

four years on one farm resulted in a reduction of positive cattle from 6 to 0.5 per cent.; doubtful reactions were found in 5 per cent. at the last test. Correlation between test and autopsy findings were generally good but on two farms positive complement fixation test results could not be corroborated by clinical or bacteriological examinations.

609. Leptospirosis agglutination tests were carried out as a routine on bloods of animals moving from the Northern Frontier Province. A moderate incidence of infection was found but no outbreaks were diagnosed in settled areas. Research was carried out on the improvement of diagnostic tests and culture of organisms.

610. Bacteriological work continued on the pneumonias of calves, sheep, goats and camels and on bovine pyaemia. *C. pyogenes* was frequently isolated from cases of caprine pneumonia and was the organism most often involved in bovine pyaemia. Three cases of cameline pulmonary tuberculosis were confirmed.

611. The chemical section, in addition to their voluminous routine work on dip and butter fat testing, further extended the range of qualitative and quantitative procedures employed in toxicological analysis. A modification was made to the existing methods of determination of arsenic in animal tissues; a satisfactory scheme for detection of toxaphene was evolved. Methods of estimating the constituents of mixed acaricidal fluids were investigated. The laboratory dealing with mineral survey completed analysis of 510 pasture samples and 2,152 bloods. Trials planned for investigation of milk taint at Naivasha were suspended because only slight taint occurred.

612. Routine helminthological diagnosis disclosed the rare existence of *Thysaniezia* infestation of sheep at Kitale, of *Gaigeria* in sheep at Nakuyu and a relatively high incidence of *Dictyocaulus viviparis* infestation at Kabete. Trials were carried out on the efficacy and safety of an anthelmintic preparation containing hygromycin B.

613. Intensive study of beef measles was commenced by a team of workers. A survey of 1,000 slaughter carcasses showed that there was no interaction between parasitisations by *C. bovis* and *E. granulosus*. Serological tests were investigated using antigens made from *C. bovis*, *C. cellulosae*, *C. tenuicollis* and *F. gigantica*. Parallel work was started on intradermal tests. Calves were successfully infected by oral administration of *T. saginata* eggs but preinfection prevented superinfection in some cases. Concomitant studies were made of the hatching response of *Taenia* ova used. Observations were carried out on the dissemination of ova by filth flies and the visibility of ova excreted was determined.

614. Hides and skins research included detailed study of the lesions of lumpy skin disease on hides and of the pox diseases on sheep and goat skins. A striking similarity was apparent. Other investigations included a comparison of the incidence of mechanical damage and that caused by disease in different districts. The frequency of occurrence of different diseases was also investigated on a district basis.

615. In the pathology section lesions of naturally occurring and experimental lumpy skin disease were studied and compared with those caused by other diseases. Confirmation of 32 lumpy skin disease outbreaks was effected by this means. Changes seen conformed with that of a "Neethling"

type infection and bore a marked similarity to those of sheep pox. Infectious canine hepatitis was diagnosed for the first time in Kenya by histopathological examination of liver material from fatal cases.

616. In poultry diagnosis the confirmation of avian tuberculosis in one flock at Nanyuki was noteworthy as the disease had not been found in Kenya since 1949.

617. Weight loss in birds undergoing treatment for coccidiosis with sulphonamides was reduced by the addition of chlorotetracycline or oxytetracycline to the drinking water; inclusion of sucrose in the water increased the intake of drugs.

618. Outbreaks of Newcastle disease continued in small backyard poultry flocks in the Nairobi, Nakuru and Mombasa districts. Inactivated vaccine administered during an outbreak in a flock near Mombasa failed to check the disease and 1,200 birds died.

619. Streptothricosis was found in sheep flocks in the Rift Valley Province. The fungus *Dematophilus dermatonomus* was isolated and transmission experiments carried out. Crystal violet and methyl violet inhibited growth of the organism *in vitro*.

620. Survey of infectious infertility diseases was continued and the number of samples handled was almost double that in the previous year. Combined infections were found on 27 farms with *V. fetus* and *T. fetus* together on 23 of these. Examination of aborted bovine foetuses was disappointing and a specific breeding disease was diagnosed in only 19 of 101 cases submitted.

621. Contagious pustular dermatitis of sheep was confirmed on farms in the Rift Valley and virus isolated. Preliminary work was directed towards the production of vaccine.

622. Epizootiological studies on foot-and-mouth disease continued with the World Reference Laboratory reporting out of 272 samples 140 (51.5 per cent.) type "O", and 44 (16.2 per cent.) type "A". Only 83 (30.5 per cent.) failed to give a result compared with 42.6 per cent. in the previous year.

623. Intensive work on lumpy skin disease by the virology section resulted in the publication of six scientific papers. From 27 specimens of skin and other tissues obtained from field cases 11 virus isolations were made in cell cultures. Seven were of the "Neethling" type and four were orphan viruses. Their behaviour in culture was studied and compared with that of Onderstepoort "Neethling" and "Allerton" viruses.

624. Experimental lesions in cattle associated with lumpy skin disease viruses were studied. One strain of "Neethling" virus, isolated locally, was maintained for 21 direct cattle passages using the intradermal route. Sheep and goats were found to have limited susceptibility to "Allerton" and "Neethling" viruses. Experiments showed that no cross immunity occurred between "Allerton", "Neethling" and orphan viruses. A virus occurring naturally in sheep and causing a disease resembling sheep pox caused localised skin lesions when inoculated into cattle intradermally. Such animals were subsequently immune to intradermal challenge by "Neethling" type virus.

625. Eleven outbreaks of rinderpest-like disease were investigated. Rinderpest virus was recovered from five and one strain was particularly virulent and contagious. Two strains were passaged in cell cultures.

626. Several strains of sheep pox were isolated in cell culture. Transmission and immunisation experiments showed that cases of disease previously diagnosed as "nodular dermatitis" are a form of sheep pox.

627. Further work on Newcastle disease vaccine produced by inactivation of allanto-amniotic fluids of high virus titre confirmed the efficacy of this product. A total of 35,200 doses was made and 14,350 of these were issued for field use in East Africa. In 15 potency tests all vaccinates survived challenge in 13 and at least 80 per cent. in the other two. Complete protection was afforded for three months after vaccination and 70 per cent. were found immune after five months. Keeping qualities of the vaccine were investigated. In the field good protection was apparent in birds at risk.

828. The "F" strain of Newcastle disease virus was imported and 60,000 intranasal vaccine doses were prepared and stored in lyophilised form. A detailed study was made of growth in ovoculture. Keeping qualities at various temperatures of storage were determined. In a large laboratory trial 94 per cent. of chicks vaccinated at ten days of age were protected against challenge. A later trial with eight-week-old birds gave disappointing results and studies continue.

629. Serial passages of bovine infectious petechial fever continued. The period of immunity to rechallenge after recovery from the experimentally induced disease was extended to 16½ months. All treatments tried were ineffective. Repeated attempts to preserve the infective agent by lyophilisation or to isolate it in embryonated eggs or cell cultures were unsuccessful. The disease continued as an important cause of mortality in most parts of the Kenya Highlands.

630. Material from cases of enzootic haematuria were regularly inoculated into cattle by various routes. No transmission was effected. Early results of treatment using vitamin K injections were promising.

#### *Animal Husbandry*

631. Groups of pigs were fed three different levels of total protein. Those receiving the lowest proportion of protein (12 per cent.) to porker weight had the best carcass grading, worst conversion efficiency, but made the most gross profit. Further groups originally fed alongside and on the same rations were continued to baconer weight on rations lower in protein. Again those receiving the least protein (8 per cent.) were best in all respects except conversion efficiency.

632. A pig feeding trial was completed comparing the feeding of pollards with that of straight run wheat offal. Pigs fed straight-run offals were slightly superior in every important respect and no digestive disturbances occurred in either group.

633. Four trials with a total of 66 steers were carried out on the implantation of stilboestrol and hexoestrol or hexoestrol alone during the last 6-9 months of the fattening period. In all trials liveweight gains were greater in treated animals and grading results were slightly better.

634. The programme of producing improved stock of known economic value for issue to African areas has continued. While grading-up to pure Sahiwal forms the major portion of this work, selective breeding within the East African Zebu has received constant attention. A total of 2,377 breeding females are being used in the breeding herds and 507 of this number are engaged in purely indigenous breeding. A gradual rise in milk production is being recorded for the Sahiwal with higher grading, and resistance to disease is proving comparable to that exhibited by the indigenous strains of Zebu. The demand for these improved animals is now far exceeding the supply from Veterinary Department farms and A.I. is being used more extensively in African areas.

635. Very satisfactory birth and growth weights have been recorded in Hereford × Ayrshire cross-breeding work. This cross was initiated to investigate economic means of disposing of male progeny from commercial dairy herds. Liveweights exceeding 1,300 lb. have been recorded at 2½ years of age from animals receiving no supplementary feeding.

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### Forestry

636. Research into *Armillaria* Root Rot with special regard to pine plantations has been continued. Investigations included the establishment of experiments to compare the pathogenicity of isolates obtained locally, the

effects of variation in inoculum size and the effects of arboricides and other tree killing methods on the subsequent colonisation of roots by *Armillaria melea*. Collaboration in this field has been established with the Tea Research Institute of East Africa. A second survey of the incidence of the disease in Kenya pine plantations has been started.

637. Experimental work has continued on damping off of conifers after the seed bed stage and the factors leading to serious loss from this disease.

638. *Silviculture*. The silvicultural research staff was mainly employed in estimating the growth rates in softwoods plantations with a view of advantageous siting of the principal species. More than half of the plantations of softwoods had been sampled by the end of the year to determine the mean height and diameter of the best 100 trees per acre and the density of each plantation. Thinning experiments yielded useful information on density schedules suitable for production of timber and pulp and for timber alone.

639. Progeny testing of *Pinus patula* was continued and expanded. The first progeny plantation laid down in 1957 has already revealed one very superior mother tree.

640. The adoption of price differentiation by log size and knottiness during the year gave added interest to the experiments to determine the relative volume losses caused by various degrees of pruning. Nothing short of half height pruning appears to be economically advisable.

641. The method of determining favourable seasons for planting, devised by the E.A.A.F.R.O. Soil Physics Division again gave excellent results and has put planting forward by many months in most areas. It appeared, however, that success in planting depends more on the care taken in planting than on the soil moisture.

642. *Entomology*. Continued research on the biology of the important Cerambycid pest *Oemida gahani* Dist. gave the following results:—

The incidence of attack in young cypress plantations of less than ten years old was found to be generally slight, though three and four year old trees were found to be immune from attack.

Preference for oviposition on large wounds such as those produced by game was shown by the much higher rate of attack of game-damaged trees compared with undamaged, though pruned trees. Wounds produced by girdling were also much preferred to pruning scars.

643. Temperature measurements in cypress logs exposed to the sun through the day showed that temperatures lethal to larvae are unlikely to be reached in logs in the highland plantation areas. It is possible however, that the death of some larvae is caused by disease.

644. Evidence was obtained from laboratory experiments that the climatic conditions found in tropical coastal areas were unsuitable for the normal completion of the life cycle. Cage experiments at Mombasa tended to confirm this conclusion.

## MAURITIUS

### *Agriculture*

645. *Tobacco*. Methyl bromide was found to be more effective than ethylene dibromide in fumigating seed-beds. In addition, the weedicidal effect of methyl bromide was beneficial, there being no weedioidal effect from

ethylene dibromide. "Vapam" controlled all weeds of seed-beds except *Cyperus* spp. but the effect wore off in under 14 days from treatment.

646. Zineb was found to be as effective as Cheshunt compound for the control of damping-off diseases of seedlings. Aldrin and Chlordane were found to be equally effective in controlling red ants and cutworms on seed beds. Both insecticides were more effective when applied in powder form and mixed with the top soil than when applied as a soil drench. Ethylene dibromide reduced eelworm infection by one-third compared with controls in field trials.

647. *Citrus*. Propagation techniques are under investigation in regard to suitable budding and grafting seasons and the prevention of "bent-root" in seedlings to be used for stocks.

648. *Maize*. Maize rust, *Puccinia polysora*, was not of economic importance during the year. The production of maize silage was investigated and yields of up to 15 tons of green material per acre were obtained.

649. *Beans*. The mechanisation of Dwarf bean, *Phaseolus vulgaris*, production was improved. The use of Aldrin sprays in the control of *Melanoagromyza phaseoli* Coq. has been found to reduce the depredations of hares, aldrin presumably acting as a repellent.

650. *Fodder*. Elephant grass, *Pennisetum purpureum*, continues to be the most promising fodder for the lower elevations while *Setaria sphacelata* continues to thrive in the uplands areas. Lucerne, *Medicago sativa*, has grown well on all stations and promises to be a useful fodder for the poultry industry. Acacia, *Leucaena glauca*, has continued to yield well and leaf drying is being perfected using sun-driers with a view to the production of a leaf meal. Compounding of the leaf meal with molasses and minerals and cubing the mixture has been successfully carried out.

651. *Tea*. The number of clones selected for trial increased to 127. The establishment of field trials using rooted material from the 1957 selections became impossible with the destruction of the nurseries by cyclones in 1958. The introduction, multiplication and trial of shade and cover crops has continued. *Flemengia congesta* has showed promise as an inter-row green crop. Small scale fertiliser and weedicide trials were continued together with pruning and plucking trials. Tea seed can be kept in cold storage for 12 to 13 months without loss of viability and seedlings produced therefrom grow quite normally.

652. *Animal Husbandry and Health*. The policy in regard to the dairy industry of selecting within the "Creole" cattle in the country was continued and early results show considerable promise. In regard to the production of beef from the existing predominantly draught type cattle of Indian origin on the lowlands, it is intended to achieve an improvement by the introduction of beef type Zebus for crossing and breeding up.

653. The Veterinary Laboratory continued to produce Newcastle Disease vaccine and commenced production of Fowl Pox vaccine. The production of Swine Fever vaccine is in the experimental stage. An outbreak of Swine Fever was successfully controlled by crystal violet vaccination, restriction of movement of pigs within the country and slaughter. Aspergillosis in poultry and leptospirosis, *Leptospira canicola*, in dogs were confirmed as occurring in the country.

654. The use of spot tests ("Brom-thymol-blue indicator") to determine pH was used with success to detect mastitis in its early stages. Subsequent laboratory investigations confirmed the value of these spot tests in detecting sub-clinical mastitis.

655. *Pests.* The introduction of parasites to control the Pigeon Pea pod borers *Maruca testutalis* Geyer and *Etiella zinckenella* Tr. continued. Another parasite, *Phanerotoma* sp., was received from Trinidad and liberated. The *Heterospilus* project could not be proceeded with as the Commonwealth Institute of Biological Control was unable to obtain this parasite from Florida because of a lack of host material.

656. Seven more consignments of *Lamprophorus tenebrosus* Wlk, a predator of the Giant snail, *Achatina fulica* Bowditch, were received from the Department of Agriculture, Ceylon. There was no recovery of individuals liberated in the previous year.

657. To further the control of the fruit fly, *Ceratitis rosa* Karsch, the introduction of parasites from Hawaii was continued on a large scale. Over 56,000 adults of various species were liberated. Another parasite imported last year, *Opius oophilus* Silv. was recovered on *Ceratitis rosa*. Malathion and sodium silicofluoride were found useful in controlling *Ceratitis rosa*.

658. A new fruitfly, *Pardalaspis cyanescens* Bezzi, was recorded on tomato and is considered to be a serious threat to this crop. This fly is reported to be indigenous to Madagascar. The introduction of parasites from the latter country is under study as well as methods to control this fruit fly with insecticides.

659. A survey of the coconut beetle *Oryctes rhinoceros* L. was carried out in Diego Garcia. The scolid wasp, *Scolia ruficornis* G. introduced in 1951, was found active but in insufficient numbers to check the pest. The Commonwealth Institute of Biological Control has been approached regarding the possible introduction of other parasites and predators of this beetle. Attempts to collect *Scolia cryptophaga* Coq. for despatch to India were unsuccessful owing to the scarcity of the parasite. One consignment of *Tiphia paralella* Sauss. was successfully sent by air to Hawaii.

660. *Plant Diseases.* A survey of tobacco diseases was carried out and indicated that Brown Spot, *Alternaria lonpipes* (Ell. and Ev.) is not likely to be a limiting factor in the production of tobacco locally. Frog-eye, *Cerospora nicotianae* Ell. and Ev. was shown to be the most important disease of tobacco in Mauritius, both from the point of view of field spots in severely infected plantations and of the ensuing barn spots, even when field spotting was not considerable. Barn spot was successfully controlled by steam curing.

661. Preliminary investigation of tomato diseases showed that the aerial pathogens were amenable to control by Zineb and Maneb, but that soil pathogens, especially *Pseudomonas solanacearum* (E. F. Smith), did not respond to soil treatment with Vapam.

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*NIGERIA—Federal Research  
Agriculture*

662. *Cassava*. Comparison of the growth habits of different varieties of cassava has been continued. A low branched variety gave its maximum yield/plot at the widest spacing investigated (3' × 6'), whereas the medium and high branched varieties gave maximum yields/plot at the closest spacing (3' × 2'). The mean yield per stand, and the mean number of tubers per stand was greatest, in all cases, at the maximum spacing. Two varieties formed a closed canopy at all spacings and weed growth was effectively inhibited in these cases. Hybrid clone 37065.12 has continued to give high yields and only slight symptoms of mosaic disease have developed so far.

663. *Cassava Collection*. Acquisitions of *M. melanobasis* from Surinam and *M. glaziovii* from Puerto Rico proved highly susceptible to mosaic at Ibadan. Acquisitions have also been received from India and Kew. The yields of some of the acquisitions from Ghana in 1955, and also some local Nigerian varieties, are quite promising and there are now sufficient quantities of these for field trials.

*Cassava Hybridisation Trials*

664. The detailed assessment of the genetic potential of the interspecies hybrids continues. Two characteristics, in particular, are being examined: yield and resistance to cassava mosaic virus. The inheritance of starch content of tubers is also being investigated. Of the 190 hybrid clones which have been planted, four have shown no symptoms of infection with cassava mosaic virus; they had previously been recorded as mosaic resistant after 18 months' exposure to field infection in the seedling stage. These four hybrids are of *M. glaziovii* × *M. utilisima* origin.

665. *Yams*. Field trials of the three main economic species have shown that *D. alata* gives the highest yields, followed by *D. cayenensis* and *D. rotundata* in that order. No significant varietal differences were observed in the case of *D. alata*. A positive correlation has been noted between rainfall, mean fresh weight of vine, and mean fresh weight of tuber, for all three species. Staking and flower induction trials are being continued. A collection of 64 varieties of *D. rotundata*, 21 varieties of *D. alata*, 22 varieties of *D. cayenensis*, and 10 of *D. dumetorum* has now been assembled.

666. *Soil Chemistry*. A preliminary study of the organic matter in a typical Nigerian forest soil has been completed. There is a rapid decrease in the C/N ratio on passing from the 0–2" layer to the 2–7" layer (13.6 and 8.1 respectively). Below 7" the C/N ratio decreases slowly with depth. A bulked sample of soil from 0–4", passing a 1 mm. sieve, has been fractionated by dry and wet sieving, and sedimentation, into plant residues, sand, coarse silt, silt, and clay. The C/N ratio of the plant residues is 16, and it decreases steadily for coarse silt, silt and clay in that order. The organic matter in the

fractions shows large differences in susceptibility to oxidation by 6 per cent. hydrogen peroxide. The five fractions were extracted with 0.5M sodium hydroxide and 0.1M sodium pyrophosphate. The relationship between the C/N ratios of the fractions and their respective extracts are not constant, in some cases the ratio is greater in the original fraction than in the extracts, in other cases it is smaller. Alkali extracts more nitrogen in relation to carbon than neutral sodium pyrophosphate from all fractions except the plant residues. The total amount of organic carbon and nitrogen extracted by the alkali is greater than that for the pyrophosphate for all fractions except clay. The sodium hydroxide extracts 31-41 per cent. of the total organic matter originally present in the fractions; the pyrophosphate extracts 4.4 per cent. from the plant residue and increases to 73 per cent. for the clay.

667. The amount and distribution of phosphorus in the forest soil, and a cropped soil, has also been investigated. Both total and organic phosphorus have been measured. The top (0-4" layer) soil in the forest is rich in both total and organic nitrogen, 450 and 294 p.p.m. respectively; the top layer of a soil which had been cropped for 30 years continuously at Moor Plantation contained 148 p.p.m. total phosphorus and 62 p.p.m. organic phosphorus. The distribution of total and organic phosphorus down the soil profile in the forest has been determined. The organic phosphorus in the fine earth decreases from 400 p.p.m. in 0-2" layer to 100 p.p.m. in the 2-7" layer, it drops slowly to 42 p.p.m. at 25" and then rises slowly to 100 p.p.m. at 60". Below 4" the total phosphorus is largely determined by the total inorganic phosphorus present. The iron oxide concretions present in this forest soil are rich in phosphorus, the phosphorus content of the concretions decreases with depth (720 p.p.m. at 2", 360 p.p.m. at 60"). At all depths the coarse silt fraction contributes most to the total phosphorus in the fine earth (<1 m.m.). The clay fraction has the highest content of both total and organic phosphorus. The percentage of phosphorus present in organic form is highest in the silt fractions at all depths.

668. The equilibrium established in both the forest and cropped soil when shaken for 72 hours with potassium dihydrogen phosphate solution has been studied. The forest soil approaches equilibrium more quickly than the cropped soil. The absorbed phosphorus may be both adsorbed or chemically bound, and the response of both treated soils to ammonium fluoride extraction indicates that most of the phosphorus is present in an adsorbed form. However, after 14 days the cropped soil gave results which indicated that some of the initially adsorbed phosphorus had become chemically combined. The significance of this result for phosphate fertiliser application remains to be determined.

669. *Yam Beetle Studies.* A Tachinid fly, *Microphthalma flavipes* Mesn. was found to be a predator on the larvae of the yam beetle, *Heteroligus meles* Billb., in 1957, but in 1958 only a very small percentage of the larvae were parasitised.

670. The conditions for optimum growth of the larvae are being investigated in the laboratory, and also for the maximum survival in the moult (last larvae stage to pupae). It has been observed that the head capsules of the larvae often do not split sufficiently to allow the full emergence of the pupae and the latter consequently die.

671. Field observations indicate that, in the period April–June, the number of beetles in flight reaches a maximum between 7.30 and 8.15 p.m. The number of beetles in flight is correlated with the rainfall during the two preceding days; temperature also appears to have some effect. It has also been shown that the greater the length of the vine the greater the probability of the tuber being attacked by the beetle. The percentage of tubers attacked increases slowly as the vine length increases to 12 ft., after which it remains fairly constant at about 55 per cent. Four species of beetles have been observed, to date, attacking yam tubers, *meteroligus meles* Bilb., *H. appius* Burm., *Prionoryctes canaliculus* Arrow, and *P. rufopicens* Arrow.

672. Insecticidal control experiments have been continued. A 2.5 per cent. Aldrin seed dressing, and Gammalin A seed dressing, are the most effective both with respect to the reduction of beetle attack and increase of yield. Agrocide 7 reduces beetle attack, but there is also a reduction of yield. Spraying of the planting holes is not as effective as dressing the yam setts before planting.

#### *White Fly Studies*

673. Bionomic studies in the insectary indicate that the egg phase lasts 8 days, the larval phase 7 days, and the pupal phase 6 days. The life spans of the females and males in the insectary are 20–30 days and 2–3 days respectively. Unmated females in the insectary produce progeny—this appears to be the first observation of parthenogenesis in the genus *Bemisia*. Seasonal variations in the male/female ratio have been observed in the field populations, the maximum occur in June, July and August, the minimum in November–December. A hymenopterous parasite, *Prospatella* spp. has been found.

674. The control of *Bemisia* by insecticides, both of the chlorinated hydrocarbon and organo-phosphorus type, is being studied. Dieldrin and Rogor appear to be the most efficient of the insecticides tested, Rogor giving the more promising results in the majority of trials.

#### *Sorghum Midge*

675. The survey of the losses caused by the midge *Contarinia sorghicola* is being continued. A Trifolia Midge has been reared from eggs on “gamba” grass (*Andropogon gayanus*). Preliminary attempts to breed this midge on sorghum have been unsuccessful. Four parasites of *C. sorghicola* have been recorded at Samaru.

#### *Cereal Stem Borers*

676. The most effective of the insecticides tested for the control of maize stalk borer at Ibadan is Endrin; but its toxicity is a disadvantage.

677. Granular insecticide formulations are also being investigated. The biology of *Coniesta ignifusalis* has been studied: the development from egg to adult takes about 57 days. Eggs are laid under the leaf sheaths of young Millet plants and hatch 9–11 days later. The young larvae eat directly into the stem and are not normally exposed on the plant.

#### *Cassava Mosaic Virus*

678. The factors controlling the spread of cassava mosaic virus in the field are being studied. Attempts to isolate strains of cassava mosaic virus by single white fly transmission have so far proved unsuccessful.

### *Cowpea Mosaic Virus*

679. Two distinct viruses affecting Cowpea (*Vigna unguiculata* L.) have been isolated. The two viruses were found in a single plant in the field and were differentiated by the symptoms shown on certain leguminous plants. One is a strain of tobacco mosaic virus which causes systemic symptoms on *Mucuna aterrima* and French Bean; the other causes local and systemic lesions on *M. aterrima* but only local lesions on French bean. The latter, which causes the more severe symptoms in cowpea, has been called cowpea yellow mosaic virus. The cowpea yellow mosaic virus was isolated from single local lesions on the French bean leaves; the tobacco mosaic virus was isolated by heating the sap from infected leaves at 90° C. for ten minutes before inoculation. The physical properties of the two viruses have been determined. An antiserum has been prepared for the cowpea yellow mosaic virus. The host range of the tobacco mosaic virus has been found to include sword bean (*Canavalia ensiformis* DC), Sunn hemp (*Crotalaria juncea* L.), *Centrosema* sp., and *Stizolobium* sp.

680. Both strains of virus are transmitted by the Calerucid beetle, *Ootheca mutabilis* Sahlb. Laboratory studies indicate that the pathogen is probably carried on the mouth parts of the beetle. Dusting of the seed of cowpeas with "Thimet" before planting has not reduced the beetle population. Close spacing of plants (6" on 2' ridges) results in a significantly smaller percentage of infected plants than wide spacing (2' on 4' ridges).

681. The symptoms of a virus disease of yams show considerable variation. The leaves show either veinal clearing and interveinal chlorosis, or sever chlorosis and green islands, or a faint mottling of light and dark green. They tend to be lanceolate and are often distorted or curled. Symptom expression is more severe in *D. rotundata* and *D. cayenensis* than in *D. alata*. *Chrysolagria cuprina* Thoms. and *Lema tibialis* Lec. (Fam. chrysomelidae) have been found in large numbers on the yam vines and transmission tests will be made with these insects.

### *Rice Research*

682. The building programme at the Rice Research Station, Badeggi, is now almost completed. However, as a result of the lack of laboratory facilities during 1958 the work has been largely limited to field trials. Some progress has been made in the selection of varieties suitable for the agrobotanical zones A, B, C and D, defined in the 1957-58 report (para. 443). Attempts to hybridise selected varieties of *O. glaberrima* and *O. sativa* have not yet been very successful, the seed set varied between 2 per cent. and 68 per cent. for various crosses. Intra-specific hybridisation of *O. sativa* is also being attempted, but the programme has been curtailed by complete panicle sterility in many cases. The nutritional merits of *O. glaberrima* and *O. sativa* are being compared on the basis of chemical composition; so far no significant differences in nutritional value have been found. A rice preference survey of producers, millers, buyers and consumers has shown that the consumer preference is the most important factor, and that the consumers generally favour the longer grain types or those similar to GEB 24. Field trials comparing agronomic practices, herbicide treatments, and fertiliser treatments, are in hand. Significant increases in yield have been



obtained in some trials with sulphate of ammonia at 2 and 4 cwt./acre. Superphosphate has shown no significant effects at 2 and 4 cwt./acre, and no N × P interaction has been detected.

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#### *Stored Products Research*

683. The West African Stored Products Research Unit now operates only in Nigeria and its cost is borne in equal proportions by the three Regional Marketing Boards and the Federal Government.

684. The Unit has laboratories at Lagos, Ibadan, Kano and Port Harcourt, and in all regions practical results have been achieved on export crops and increasing attention is being given to local foodstuffs.

#### *Groundnuts*

685. At Kano, work has continued on insecticides for spraying bagged groundnuts and a new routine spraying treatment has been started using Malathion, which has been found to be more effective than BHC against *Tribolium castaneum*, the major pest. Methods of population sampling are being investigated in order to obtain a clearer picture of changes in population of this insect.

686. Promising results are being obtained in trials using diazinon against *T. castaneum*. It is hoped that diazinon will have greater stability on alkaline surfaces than malathion.

687. Temperature measurements have been made inside pyramidal stacks of groundnuts. Heating appears to begin at a central point near the base and to spread outwards. This tends to cancel out variations caused by atmospheric changes except in the outer layers of the pyramid.

688. Work has been carried out on a new shape of groundnut stack which uses less tarpaulins and less dunnage per ton than the normal pyramidal shaped stack at present in use. Storage experiments were continued in the experimental Ctesiphon buildings at Kano, and work has been carried out on the use of various types of hessian bags for the storage of groundnuts. An experiment has been carried out on the protection of seed groundnuts in rumbus with BHC.

*Cocoa*

689. Fumigation of cocoa with methyl bromide is the basis of routine insect control measures on cocoa in the Western Region and work continues on a study of this subject, particularly in connection with various types of gas proof sheets, and methods of protecting cocoa from reinfestation after it has been fumigated.

690. Investigations on cocoa in the Eastern Region have led to the formation of a small Pest Control Unit under the aegis of the Eastern Regional Produce Inspection Service. This Unit at present deals with the disinfection of the fabric of cocoa warehouses.

691. The results of tests on admixture of synergised pyrethrin dusts with cocoa beans suggested that the treatment could control the beetles commonly occurring but might not control the moth *Ephestia cautella*.

692. Experiments on various types of hessian bag for cocoa storage have been completed, but no change from the bags at present in use has been recommended.

*Palm Produce*

693. Research has principally been directed towards a study of the factors affecting the rate of increase of the free fatty acid content of palm oil, and several experiments have been carried out into the part played by micro-organisms in this lipolysis. Work is proceeding on this subject.

694. A visit has been paid to the Belgian Congo for liaison purposes regarding palm oil research and also to the Institut de recherches pour les huiles et oleagineux at Paris. Dr. Raymond of the Tropical Products Institute visited Nigeria over the question of bleachability of palm oil and as a result W.A.S.P.R.U. are investigating some of the factors thought to be involved.

*Grain, Cowpeas and Yams*

695. At Kano work has been carried out on underground pit storage of guinea corn, and also on insecticidal treatment of guinea corn in bags and in rumbus. Experiments on hermetic storage are being carried out on guinea corn at Mokwa and on cowpeas at Ibadan. Also at Ibadan various dosages of BHC. dust have been applied to maize on the cob stored in experimental cribs.

696. The joint experimental silo project with the Faculty of Agriculture, University College, Ibadan, is designed to test five types of silo:—concrete block, steel, aluminium, plywood and pre-cast concrete. Preliminary studies have been made in the aluminium silo of changes in temperature and moisture content.

697. Work has recently started on a survey of Yam storage in the Eastern Region.

*Storage at Port*

698. Attempts are being made to control the dusk flight of insects in the transit sheds at port. Misting and fogging operations using BHC. and malathion are being carried out experimentally.

*Forestry Research*

431

699. A newly appointed plant physiologist has started experimental research into the physiological requirements of forest seeds and seedlings.

700. A soils specialist has been appointed. His task is to apply existing pedological knowledge to certain silvicultural problems and, in particular, to study the soil changes which take place when forest cover is re-established in Derived Savanna.

701. Five years of pre-exploitation treatment in the Tropical Shelterwood system investigations in Lowland Rain Forest has now been completed. The results are encouraging.

702. Dr. E. W. Jones of the Imperial Forestry Institute, Oxford, visited Northern Nigeria for ecological research into the forest outliers in collaboration with this department. This work has an important bearing on the general problem of re-establishing forest conditions in savanna.

*Veterinary Research*

703. *Rinderpest*. Difficulties are now being encountered in obtaining completely susceptible animals for vaccine production, and it is likely that this problem will grow in the future. Work on Avianised Rinderpest vaccine continues, particularly on the BA strain from Tokyo. The virus was found to be more restricted in its distribution in the embryo than was recorded in Tokyo, and while titres from the liver and spleen were high, only in occasional batches was the titre high in the whole embryo. No further work is being carried out on the Damascus strain of Avianised Rinderpest Virus.

704. *Newcastle Disease*. Reports of the behaviour under West African field conditions of the Komarov strain of Newcastle Disease Virus have been received. A small degree of paralysis was recorded in two flocks; the percentage of herds affected being 0.1 per cent. and 0.4 per cent. respectively. When used in laying hens, the vaccine causes a complete cessation of laying for periods up to six weeks.

705. *Contagious Pleuro-Pneumonia*. The desiccated vaccine was found to protect cattle against subcutaneous challenge with virulent tissue fluid. The immunity is shown, to date, to last nine months.

706. *Fowl Pox*. Difficulties were met in that the vaccine of certain batches did not produce an immunity against the disease, although it appeared to cause typical lesions at the site of vaccination. It was found that the seed virus used for inoculating eggs for vaccine produced more diffuse lesions on the chorioallantoic membrane than usual. Reversion to earlier passages of the same strain of seed virus overcame this difficulty.

707. *Paritology*. A survey of helminths found in ruminants in the Eastern Region and Southern Cameroons was carried out by a Fulbright Fellow. Perhaps the most valuable assistance was the initiating of regional surveys and preparing simple keys for use in the local laboratories.

708. *Genetics*. Preliminary work on genetical resistance and serological response to strongyle infections in cattle was commenced. Antigens were prepared and a complement fixation test on serum from strongyle infected cattle was successfully carried out.

709. *Biochemistry.* Observations carried out at Shika, an Agricultural station in the Northern Region, showed that a normocytic normochromic anaemia existed but that mineral supplements relieved the macrocytic and hyperchromic nature of the anaemia. When animals were on the clinical borderline of phosphorus intake it was shown that the serum inorganic phosphorus was maintained at as high a concentration as possible at the expense of the lipid phosphorus fraction.

710. *Poultry.* Increasing trouble was encountered with the pure bred Leghorns, chiefly being poor feathering following moulting. Various additions to the diet gave little improvement. In comparison, the Light Sussex flock appears to be more hardy and no feathering troubles have been seen.

### NIGERIA—Northern Region

#### *Agriculture*

711. *Plant Breeding.* The *Cereals* subsection has conducted surveys on sorghum and millets grown in the Northern Region to obtain basic information on the material available in this large territory. A large collection of indigenous sorghums and millets has been made and information is being compiled on the different types, distribution, uses and potential of this material.

712. *Sorghum* research also includes a breeding programme consisting of (1) hybridization of local x American sorghums, (2) selections on irradiated material and (3) selections on promising local material. Variety trials are conducted throughout the Region in support of the breeding programme.

713. The *millet* programme is based on methods of selection within indigenous varieties and on hybridization of the better types. Selection work is also being done on bird-resistant lines and on varieties imported from abroad.

714. Studies on *maize* are done in co-operation with the West African Maize Research Unit, and consist primarily of testing varieties under the conditions of this Region. To date, the varieties Mexico 5 and Sicaragua have been found to be well adapted to Northern Nigeria and these are being recommended to farmers in the Riverain area. At Samaru a yield of over 4,000 lb. per acre of dry grain was obtained from Mexico 5 in a variety trial.

715. Promising results from Groundnut research have been obtained from imported French West African varieties and the breeding programme over the years, has produced varieties suited to different parts of the Region. In Kano the variety, Kano 50, is being distributed while in Bauchi Province Samaru 57 is now being multiplied for issue. In the Riverain Area Samaru 38 and Mwitunde have proved better than local types. In Benue Province the introduced Spanish 205 is being distributed to farmers after a series of trials which showed it to be the best suited variety.

716. Among other investigations being conducted are (1) studies on Rosette disease, (2) the causes of seed deterioration in some parts of the Region and (3) the causes of "blind nuts". Results to date have shown

that applications of calcium can remedy the latter problems and work is now in progress, in conjunction with the Chemistry Section, on methods of application and types of calcium best suited to our conditions.

717. *Soyabean* work has resulted in the recommendation of the variety Malayan for distribution in the Riverain Area. Selection work is being done on the Malayan variety while newly introduced varieties from abroad are being multiplied and tested. Agronomic trials on time of planting and spacing have been conducted and are continuing. Results to date indicate that close spacing is essential.

718. A *cowpea* breeding programme has been under way for three years. The work is being conducted on these lines :

- (1) Collection and selection of indigenous varieties.
- (2) Introduction and testing of foreign varieties.
- (3) Hybridization to combine high yield and palatability and studies to determine linkage of characters affecting palatability.
- (4) Studies on day-length response to find varieties which will yield well irrespective of time of planting.
- (5) A screening of all varieties for nematode tolerance.

719. The *Sesame* programme has produced the variety Yandev 55 which is being distributed in Benue Province. This is a selection from local material. Hybridization of local x Venezuelan and American varieties is producing very promising results. The aim has been to produce a heavy yielding, multi-locular, white-seeded, single-stemmed type. Hybridization to produce a non-shattering type is continuing.

720. Variety trials on *Tomatoes* are being conducted to find (a) high yielding varieties suitable for canning at Kano, and (b) varieties resistant to *Septoria* and nematodes.

721. The collection of the cultivated and wild varieties of *Yams* to assist the Federal workers has continued.

722. Work on *Cassava*, assisting the Federal Research programme, has continued with selection and mosaic testing at Samaru.

723. A large and variable population of *Sweet Potatoes* was obtained this year from true seed. Selection work is starting on this.

724. The Plant Pathologists are in charge of widespread studies on seed dressing. The application of Fernasan D to cereals is recommended and this seed dressing is now available to farmers throughout the Region. Indications are that another seed dressing, Fernasan 75 W, is better suited for groundnuts. Trials are continuing.

725. A comprehensive study of leaf diseases of sorghum continues as does the routine identification of diseases of all crops and recommendations for their control.

726. *Agronomy*. Analysis of the past years' work has shown that economic returns can be obtained from applications of superphosphate to groundnuts and soyabeans and sulphate of ammonia to yams. Rice responds economically to either or both of these fertilisers depending on the area.

727. The limiting factors to economic returns from fertilisers application to cereals include low standard of cultivation, low market value of grain produced and the inherent genetic make-up of indigenous varieties which have been selected over generations to produce a crop under conditions of low fertility. It has been shown, for instance, that economic returns can be obtained by applying fertiliser to introduced maize while the local varieties do not respond economically to the same fertiliser application.

728. Experiments on the control of *Cynodon dactylon* have shown that successful control can be obtained with Dalapon.

*Cotton Breeding.* Single plant selection on the cotton now being grown has resulted in a great improvement in the quality and quantity of the cotton crop grown in Northern Nigeria. Further work along these lines is continuing.

729. Yields of over 2,200 lb. seed cotton per acre have been obtained at Samaru by concentrating on crop husbandry and effecting control of insect pests. This shows the tremendous potential of the variety Samaru 26 J. The average farmers' yield in the North is around 250 lb. per acre.

730. Studies are also being conducted on the water requirements and plant nutrition of cotton. Meteorological, percolation, evapotranspiration and soil water storage studies are also being conducted.

#### *Entomology*

731. The organisation of a reference collection of the more important insect pests of the Region has continued and advice on control measures issued as required.

732. A survey of farmers' grain storage problems has begun, and experiments laid down to investigate possible methods of control, including admixture of insecticide with the grain.

733. Trials on the economic use of insecticide on cotton, particularly the control of the cotton stainer in the Riverain areas, have given very promising results. Provisional recommendations for the control of the stainer are being issued, but further investigations are required on infestations of red spider mite which have been found in several areas of sprayed cotton.

734. One hundred acres of experimental cotton at Mokwa, and nearly half of the cotton on the Seed Multiplication Farm at Daudawa were given several applications of spray during the season, using tractor mounted equipment. Yields at Mokwa were disappointing owing to the adverse effect on cotton growth of an abnormally prolonged drought, but spraying increased yields at Daudawa by about 80 per cent. compared with unsprayed cotton.

735. Observations on the aphid vector of rosette disease of groundnuts continued at Mokwa and Samaru, but the problem of the origin of the initial infection in the crop is still unsolved.

736. The results of Yam Beetle control trials have shown that it is still not possible to control this pest on early planted yams.

737. Investigations on cereal pests, under the direction of the Federal Entomologist, have continued, and a survey of damage due to sorghum midge has been completed.

738. Observations have been made on the biology and chemical control of citrus pests at Samaru and Mokwa.

739. Taxonomic and biological studies of termites in the Region have been carried out by an officer of the Colonial Termite Research unit, temporarily stationed at Samaru.

#### *Chemistry*

740. Studies on the nutrition of Zebu cattle for milk and beef have been continued. Preliminary results, determined directly from digestibility data, show that the energy and protein requirements of cattle at Shika for maintenance and milk production are of the same order as those found in cattle in temperate regions.

741. The Chemistry section, in collaboration with the Botany Section, has been conducting field experiments on the effect of calcium and minor elements on shelling percentage on "blind nuts". Results to date have shown no responses to minor elements, but the effect of calcium is highly significant. Further work is planned on types and methods of application of calcium.

742. Weekly fluctuations in nitrate and ammonia in soils under bare and bush fallow have been studied for two consecutive years. Bush fallow soil maintain a level of 0.5 ppm  $\text{NO}_3\text{-N}$  throughout the year. In bare fallow soils fluctuation of 2-70 ppm of  $\text{NO}_3\text{-N}$  are found during the rains and the build-up occurs during the dry season. Ammonia patterns are similar in both types of fallow.

#### *Soil Survey*

743. This section is now up to full strength in Senior Staff and a programme of training subordinate staff is under way. Some difficulty has been experienced in finding suitable candidates for these training courses. The Soil Survey teams have now covered 6,000 sq. miles in reconnaissance surveys. Two full teams are employed on this work and a third is engaged on development surveys.

#### *Forestry*

744. A large part of the work during the year was concentrated at Afaka, in experiments on the improvement of the Northern Guinea Savannah areas by methods of fire-protection and cultivation. These treatments are compared with planting of *Cassia siamea* and, in a separate investigation, the establishment of *Eucalyptus citriodora* by the "chitimene" technique of burning of the overwood and direct sowing. The main investigation was successfully established during the year, despite setbacks due to breakdown of the mechanical cultivation equipment, but one set of plots received their cultivation a year later than intended. An accessory investigation was the establishment of a plantation of mainly indigenous species by planting and direct sowing. Promising results have been achieved with planting of *Khaya senegalensis*, and direct-sowing of various species, the most successful being *Albizia lebbek*. Use of the "chitimene" method for establishing *Eucalyptus* has shown that marked improvement in germination and growth follows burning and direct-sowing in the residual ash.

745. Establishment of plantations of pole and timber producing species, in the Derived Savannah area immediately south of the Bauchi Plateau, continued successfully, and most encouraging results were achieved by direct-sowing of the pre-germinated seed of *Gmelina arborea*. The plantations established in the previous two years continued to show excellent growth of *Gmelina* and Teak on the better sites. Experiments were carried out into treatment with sawdust and wood-ash at the time of planting or direct-sowing.

746. On the Plateau, preparations continued for larger-scale trials of pot-raised *Eucalyptus*, ten different species being used, and four different types of container. Complementary trials were carried out into the use of insecticides to protect the seedlings and young trees from termite attack.

747. Remeasurement of the 1/10 regeneration plots in the areas of riverain high forest (Kureme) south of the Bauchi Plateau, gave indications that the silvicultural operations of cleaning and poisoning were achieving their intended purpose of inducing and assisting regeneration of the economic species. Fire protection of the savannah immediately adjoining the kurmi seems likely to effect an extension of the kurmi vegetation, which is already apparent on the southern side of the investigation.

#### *NIGERIA—Western Region*

748. *Livestock*. Investigations on the indigenous breeds of cattle, N'dama, Muturu and Keteku, were continued. The Samaru breed of chickens has been accepted as the local breed of choice and is now being used in cross-breeding trials with imported poultry.

#### *NIGERIA—Eastern Region*

##### *Agriculture*

749. Two major events have occurred during the year in the sphere of Agricultural Research. The first of these is the inclusion in the Regional Estimates of 13 Specialist Officer posts which will form the basis of a balanced Agricultural Research service for the Region. A Principal Research Officer post was created in 1957-58. The second is the approval of a Colonial Development and Welfare Scheme for a Soil and Land use survey in a selected part of the Region. Such surveys are vital to the future development of the Region.

750. Work on the development of agricultural potential in the Niger Delta has developed well during the year. The New Departmental Farm at Abobiri is now well advanced and rice cultivation by the farmers has developed satisfactorily. Work on the Main Research Station at Umudike and the new Departmental farm at Nekede are now practically a year ahead of schedule.

##### *Rice Variety Trials*

751. The Burmese variety HM-A9 gave the highest yield at both centres; GEB24 and Mas2401 were runners-up at Abakaliki and had highest tiller counts in spite of reduced spacing (3 to 4 plants per stand at 9 inches spacing as against 1 plant per stand at 12 inches spacing in 1957). Although GEB24 had poorer yield at Calabar yet its tiller count remained above all



varieties excepting HM-A9. Under the conditions of these trials, it would appear that the expression of the yield and tillering potential depend more on water supply than on spacing.

752. *Maize Variety Trials.* W.A.M.R.U. Co-operative trials (which were scattered throughout West Africa) were, as in 1957, sited at Abak, Umudike and Nkwelle. Once again the variety, Trinidad Bulk, was outstanding in its performance—being the highest yielder at Umudike and Nkwelle, and the third highest at Abak.

753. *Yam Variety Trial.* Generally yields were lower than in 1957. Again Chinese yam out-yielded all but one variety—Iguma, a white yam variety included in the trial for the first time. This variety shows great promise.

754. *Variety Collections and Surveys.* A survey of the Region's yam and cassava varieties has progressed to the study of all the collected varieties under one environment, at Umuahia.

755. The Bambara Groundnut seeds sorted out in 1957 have all grown true to testa colours, which suggests it may be self-pollinated.

756. *Cocoa—Black-Pod Control Trial.* There were four treatments:—

- (1) Picking infected pods during harvest (control).
- (2) Plantation Sanitation—Picking all infected pods at weekly intervals.
- (3) Spraying at the rate of 20 gallons of Perepod/acre at weekly intervals, but picking infected pods only at harvest.
- (4) Spraying at the rate of 20 gallons of Perepod/acre at 3 weekly intervals and picking all infected pods just before each spraying.

757. Treatment 4 gave the highest yield and was the only one to show a statistically significant difference from the control, though all treatments, especially treatment 4, gave a worthwhile financial return.

758. *Rice Herbicide Trials.* These were limited last year by shortage of herbicides. So far, 2,4-D (at 45 ml./1½ gal. water p.a.) has proved most economic, followed by 2,4,5-T (at ml. 23/1½ gal. water p.a.): this was so at all sites, covering a range of aquatic herbs and sedges. Applications at 8 weeks after transplanting seemed more effective than at 4 weeks.

#### *Veterinary*

759. *Goat Pneumonia.* This disease was previously recognised as a pleuro-pneumonia, but results of investigations have now led to the conclusion that it is a broncho-pneumonia most likely of viral origin.

760. *Cattle Fattening.* Relationship between gain of weight and action of stilboestrol implants in Zebu cattle was studied. The results obtained were inconclusive.

#### *Forestry*

761. Two sets of experiments are being carried out designed to produce information on establishment of natural regeneration and subsequent rate of growth of *Borassus aethiopum*.

Experiments on methods of natural regeneration of *Mitragyna ciliata* and artificial planting are in progress, but are subordinated to a far wider investigation being conducted by the Department of Federal Forest Research.

762. Enrichment plots laid down in 1957 were maintained. These consist of straightforward line planting with poisoning of overhead non-economics and the planting up of stump sites and extraction routes. Results are so far promising.

#### *NIGERIA—Southern Cameroons*

763. The arrival of a Cocoa Agronomist and a Pasture Research Officer during the last quarter of the year has greatly improved the staff situation. The main lines of research work in the Southern Cameroons during 1958 were trials on the major cash crops, particularly coffee and cocoa.

764. Nine trials on cocoa were in progress at the Barombi Kang experimental station throughout the year, the chief subjects of research being establishment in the field, disease and pest control, fertiliser requirements, and rehabilitation.

765. The overwhelming advantage of whalehide pots for field planting were clearly demonstrated in a trial using both the local Hybrid Trinitario cocoa and the new Upper Amazon types; an artificial shade trial showed that the Upper Amazon types are far less susceptible to lack of shade than the Hybrid Trinitarios under Cameroon conditions.

766. Routine monthly spraying treatments against psyllids and jassids have had to be modified since it was found that, particularly with insecticides based on BHC, a rapid build up of pod miner (*Marmora* sp.) ensued, which in turn, by roughening the surface of the pod, encouraged the incidence of black pod disease which rose to unprecedented levels.

767. Trials on methods of rehabilitating old cocoa showed that better results are to be obtained by coppicing in the dry season than in the wet season.

#### *NORTH BORNEO*

##### *Agriculture*

768. *Rice*. Two variety trials were laid down, one involving 16 long term varieties with a maturation period of 170 days or more and the second using eight short term varieties with a maturation period of 160 days or less. Each trial was repeated in each of four Agricultural Stations in different districts giving a total of eight trials in all.

769. A fertiliser trial involving the application of nitrogen (as sulphate of ammonia) 150 lb. per acre, Phosphate (as superphosphate) 200 lb. per acre in a 3 × 2 factorial design was repeated at three Agricultural Stations in different districts. Fertiliser trials using control, nitrogen and phosphate, on a simple four plot layout were laid down on farmers' lands in five districts. Fertilisers applied to nurseries have shown no responses over a period of three years and have been discontinued.

770. Selection work continued on the local varieties Bongolon, Gantang, Lillingi and Simpangan Kuning. Progenies of each of the four varieties were reduced to 19 upon which preliminary yield trials commenced. Selections will be ready for trial in farmers' fields in the 1959-60 season.

771. Mass selection of *indica x japonica* hybrids has been discontinued and selections in the F<sub>5</sub> and F<sub>6</sub> generations have been bulked for preliminary yield trials in the 1959-60 season. The variety Fe-bi-fun, a Taiwan variety with a maturation period of 4 months, was introduced in 1958. Double cropping trials have commenced.

772. *Tobacco*. Trials were carried out with five varieties of tobacco imported from the Philippines. In common with previous importations from Queensland and Indonesia, none of these showed any promise.

773. Trials carried out at Long Ashton Research Station on behalf of the Department, have shown that spraying methods at present in use with tobacco are useless. A fogging machine has been designed and is being made at Long Ashton. It is hoped that field trials can be made in 1960.

774. *Rubber*. An investigation has shown that rubber seedlings can be successfully budded when aged between 5 and 10 weeks. The commercial implications are being investigated.

775. *Coffee*. Parent trees have been selected with a view to obtaining increased yield, marked seasonal yield and resistance to Berry Borer, *Stephanoderes (Cryphalus) hampei*. Leaf cuttings have been successfully rooted in polythene bags.

776. *Citrus*. In an effort to obtain a satisfactory root stock for Mandarin and Sweet orange, a trial has been laid down at the Central Agricultural Station, Tuaran, using Pomalo, Sweet orange, Sour orange, Rough Lemon, Lime, Mandarin and Calomandin. At Keningau Agricultural Station, the rooting of leaf cuttings of citrus is under investigation, as is the rooting of the scion of citrus budded when very young (approximately 2 months).

777. At Keningau, work on grazing management continued and a total of sixty head of cattle were run during the year on 65 acres, sub-divided into 13 paddocks of 5 acres each, the animals being grazed for 24 hours on each paddock in rotation. Lalang (*Imperata cylindrica*) has now been almost entirely replaced by love grass (*Chrysopogon aciculatus*). Love grass is thickening, but there is still little evidence of better species coming in. At Tawau work on the management of cattle under coconuts continues with good results and there is clear evidence that cattle thrive where rotational grazing is practised under coconuts and that the yield of coconuts is markedly enhanced.

#### *Forest Research*

778. No Forest Botanist was available during the year, but collections were made by staff of the Department. Full advantage could not be taken of the flowering and fruiting of Dipterocarps which took place during March to October, but 253 new collections were made, 53 of these being Dipterocarps. Many of the new collections were made during complete enumerations of two virgin jungle plots, one at Sepilok near Sandakan, and the other at Mengalong, on the West Coast. The Ecologist accompanied Dr. M. Jacobs of Bogor on a collecting trip to Ranau and Gunong Kinabalu; the Sandakan Herbarium is to receive duplicates of the very numerous collections made. During the year 1,400 specimens were mounted in Sandakan Herbarium. A large collection of 984 specimens, 694 of these being Dipterocarps, was received from Brunei. In addition 209 specimens, including 148

Dipterocarps, were received from Sarawak. The following determinations were received during the year :—

Kepong	...	...	...	...	...	52
Leiden	...	...	...	...	...	222
Singapore	...	...	...	...	...	192
Others	...	...	...	...	...	148
Total						614

All the additional notes collected by the late Mr. G. H. S. Wood were duplicated and sent out to recipients of duplicate herbarium specimens. These notes included all determinations received so far.

### *Silviculture*

779. The arboricide trials using butyl ester were continued and concluded in the Kimanis Forest Reserve. All treatment was by frill girdle with 2 per cent. ester in diesolene. One block was treated with 2,4-D and the other with a mixture of 2,4-D and 2,4,5-T; the mixture appears to have given a quicker kill, but is approximately 34 cents per acre more expensive than 2,4-D alone. Further evaluation of this experiment is required after sufficient time has elapsed for all trees which are likely to do so to have died.

780. The series of plots to determine the best time after felling to carry out silvicultural treatment was completed and further observations made. It was noted that on an average eight undamaged trees of useful species between one foot and six feet girth remain after logging and should these trees be capable of growing satisfactorily after release, it would appear that they are sufficient to regenerate the stand. The ability of these trees to put on satisfactory increment is, however, doubtful, due to their dominated position in the old stand and the small size of their crowns; a sample plot has been laid down to provide the answer to this question.

781. Complete enumerations of all trees over one foot in girth were carried out in four sample plots, at Sepilok (two), Pangi, and Mengalong. All these plots show a basal area of approximately 170 square feet per acre, compared with 231 square feet at Apas. It is of interest to note that a previous enumeration made in 1956 in one of the Sepilok plots shows that during a two-year period the basal area remained almost constant, increasing by only 0.3 square feet.

782. An experiment was laid down at Sibuga Forest Reserve to indicate the optimum light conditions for the establishment and growth of seedling regeneration of various species of Dipterocarps. Shade houses giving light values of 100 per cent. (open), 80 per cent., 75 per cent. and 50 per cent. are being used and Dipterocarp seedlings planted within them. Very great differences in establishment, health and vigour are evident under the different shade conditions and it appears probable that shade is very beneficial for successful establishment and that a light value of 50-75 per cent. gives the best development subsequently.

783. Twelve plots, each of 1/1,000 acres, were laid down under fruiting trees of urat mata (*Parashorea malaanonan*) at Kennedy Bay, to study

recruitment of seedlings. All Dipterocarp seedlings were pulled out in these plots in order that the progress of this year's seedlings may be followed for a number of years.

784. Increment measurements were made at fortnightly intervals by very precise methods on five trees of seraya timba (*Shorea smithiana*). A close relationship with crown diameter and also with rainfall and leaf fall was shown.

785. A new series of girth increment plots has been commenced to rectify the serious defects in design which were found in existing plots. All new plots will be area plots established in young regenerated forests. Provision has been made for thinning treatments to be superimposed on the plots.

786. *Timber Research.* The graveyard test was examined at two years after establishment. Red seraya has proved to be more durable than keruing under these conditions; preservatives gave very good control over both termites and fungi in most cases. Most of the degrade in all billets occurred near soil level.

787. In collaboration with the British Borneo Timber Co. Ltd., a large scale trial of a proprietary B.M.C. water-based spray was made for control of pin- and shot-hole borers in newly felled logs. The results showed that seraya tembaga (*Shorea leprosula*) is very resistant to attack in a debarked condition, possibly due to the presence of horizontal resin canals. Bark itself appears on other species to give effective control up to three weeks, and the B.M.C. water-based spray up to six weeks. One gallon of concentrate was found to be sufficient for 2,000 square feet of log surface.

788. An effort was made to correlate incidence of punky heart, lobang pusing and brown stain in white seraya with site factors or other easily assessed factors. In no case was any obvious correlation found.

789. Consignments of seraya kelabu (*Shorea waltoni*) and obah suluk (*Shorea pauciflora*) logs for full scale timber tests were received at Princes Risborough. Reports on the results of such tests on urat mata beludu (*Parashorea malaanonan*), yellow seraya (*Shorea gibbosa*), majau (*Shorea leptoclados*) and keruing puteh (*Dipterocarpus caudifer*) were received during the year. A report on tests of kapur paya (*Dryobalanops rappa*) was received from the Forest Research Institute at Kepong; the timber of this species seems to be similar to kapur paji (*Dryobalanops lanceolata*) and can be used for similar purposes without distinction.

#### *Publications*

NICHOLSON, D. I.—An analysis of logging damage in tropical rain forest, North Borneo. *Malayan For.* 21 (1958) 235.

NICHOLSON, D. I.—One year's growth of *Shorea smithiana* in North Borneo. *Malayan For.* 21 (1958) 193.

NICHOLSON, D. I.—Natural regeneration of logged tropical rain forest, North Borneo. *Malayan For.* 21 (1958) 65.

WOOD, G. H. S. and AGAMA, J.—Check List of the Forest Flora of North Borneo. *N. Borneo Forest Record.* No. 6, 1958.

NICHOLSON, D. I.—Arboricide trials in North Borneo. *Malayan For.* 21 (1958) 17.

*NORTHERN RHODESIA**Agriculture*

790. *Soil Science.* The hypothesis that a great deal of routine field work could be avoided by the use of aerial photographs was tested in the field of Mumbwa district, and it was found that soil boundaries picked up on ground traverses coincided exactly with those determined from air photographs; in future, field work will be preceded by photographic analysis and may in the light of further experience be partly superseded by it. The trend is to greater use of aerial photography in land-use classification also, leading to a time-saving preliminary discarding from the aerial maps of at least the obviously unsuitable (e.g. rocky hills, steep slopes) before the ground team is put in to concentrate on the apparently suitable agricultural land: as the staff acquires greater skill and confidence the ground-air checks are showing ever better agreement.

791. The soils of the territory are being steadily sampled, analysed and mapped; the necessary follow-up to translate the data into useful agricultural information, ideally through the medium of full scale husbandry experiments is being attempted on a preliminary level through the use of fertiliser microplots.

792. A soil type known as *Mopani* from its associated vegetation is common in the Zambezi and Luangwa valleys, and occurs to a limited extent elsewhere. In brief, this soil—a solonetz?—has a good nutrient status but is particularly intractable and is therefore rarely used. Indications from observation plots that it may grow mellower under cultivation are now being followed up by more elaborate experiments. Recent work at the Sabi Valley Experiment Station in Southern Rhodesia has shown that soils apparently similar to the Northern Rhodesian *Mopani* are very productive under irrigation.

793. *Pasture Research and Ecology.* Experimental results from Hyparrhenia-dominated natural grassland on Mount Makulu show that repeated defoliation at the grazing stage maintains the values for percentage crude protein at a high level, that cutting to stimulate aftermath for early dry season grazing is a practice of value, and that burning to stimulate early growth late in the dry season is not justified by yield but is a practice which may be necessary at intervals for bush control. A large scale management trial based on such information awaits the build up of the herd of beef cattle of the indigenous Ngoni breed. Fertiliser trials on such grassland have shown, over several seasons, a consistent positive response to nitrogen in the form of ammonium sulphate; the mean effect of added nitrogen shows as an increase in bulk rather than in quality, and response to ammonium sulphate at rates up to 800 p.p.a. appears to be entirely linear. In one experiment conducted over the past three years, annual production on natural grassland was raised from an average of 2,700 lb. dry matter per acre to 4,300 lb. by the addition of 400 lb. ammonium sulphate per acre annually. Similar trials are now established or about to be established in various Provinces. These natural grasslands can be so manipulated as to produce yields of crude protein of the order, when nitrogenous manuring is used, of 240 lb. per acre over the season, yields comparable with the average although not of the best from the cultivated grasses under similar

conditions. This type of natural grassland apparently well repays some intensive management.

794. Work on the *Setaria*-dominated grassland in wet areas or "dambos" indicates that these are as likely to need management of a careful semi-intensive kind to produce good grazing in the dry season as are the upland communities. The "natural" growth cycle follows the same pattern.

795. *Plant Breeding*. Mani Pintar, the variety of groundnut which yielded well at Mount Makulu in 1956-57, again outyielded other bunch varieties in a season when the absolute yield level was about half—at 1,000 lb. p.a. shelled nuts—that of the former season. In the provinces also Mani Pintar was the yield leader at many centres.

796. Groundnuts have many troubles which culminate in yields which are low relative to other crops, in many districts. Diseases and soil deficiencies are among the causes limiting yield and now under investigation by plant breeders, pathologists and chemists. *Cercospora* leafspot can halve yields of susceptible varieties in a bad year. A leafspot experiment in 1956-57, a year of light attack, gave no difference in yield between various spraying and dusting treatments and the no spraying control, but in 1957-58, a leafspot year, the susceptible Manyema variety with no spraying gave only 636 lb. p.a. as against 1,436 lb. p.a. with Bordeaux spray, and rather less with some other sprays, all differences between treatments and control being highly significant. This type of experiment is being repeated in the districts as well as on Mount Makulu. The chemists using Chenery's technique in pot experiments have shown that the phenomenon of empty groundnut pods or "pops" is associated with the lack of boron and perhaps of calcium, and these findings are now being tested in the field in some of the areas where "pops" occur. These areas may be fairly widespread.

797. The yield of rainfed or summer wheat remains low, with *Helminthosporium sativum* and weed-growth as the first barriers to improvement. Selections were made for resistance to *H. sativum* but so far none shows resistance. Irrigated dry-season wheat on the other hand continues to give encouraging results, with yields on a plot scale reaching as much as a ton and a half of grain to the acre.

798. F<sub>1</sub> plants of cassava crosses are now under test for resistance to mosaic, which is a widespread and serious check on yield in the northern parts of the country.

799. *Agronomy*. In line with the Department's policy of weaning the African cultivator away from a subsistence and often shifting agriculture to a more intensive farming adapted to modern circumstances, long-term "fertility" comparisons based on agricultural yield have been started at Mount Makulu and in the districts.

800. Fertiliser trials in the districts again showed that maize responds to added nitrogen in virtually all localities, and more attention is now being given to fertiliser trials with crops other than maize. Indications are that nitrogen at least is a widespread lack throughout Northern Rhodesia, and that almost all crops are likely to respond; much thought is being given to the possibility of building a factory in the Federation for the production of cheap nitrogenous fertiliser and should this happen it could revolutionise yield standards among the African farmers.

801. The history of cotton growing in Northern Rhodesia has been largely one of failure due to insect pests. With the newer insecticides and the greater entomological knowledge now available the chances of success warrant a re-assessment of cotton growing, and test plots have been laid down throughout the country. Gatooma bred varieties protected against insects—chiefly several species of Stainers and three species of Bollworm—yielded up to 1,000 lb. p.a. of clean seed cotton on Mount Makulu in spite of a late start in the 1957-58 season. Close touch is being kept with the officers of the Cotton Pest Research Scheme who operate from Gatooma in Southern Rhodesia and from Makanga in Nyasaland; the cotton growing conditions and problems of the other two Territories of the Federation largely cover the range met in Northern Rhodesia and the Scheme's fundamental work promises to have application to the whole region.

802. Turkish tobacco is another crop now receiving attention as a promising cash crop for the African cultivator in the sandveld areas which constitute such a large part of the Northern Rhodesia plateau. The attainable yields are satisfactory, ranging to over 1,000 lb. per acre of cured leaf, and the indications so far are that response to fertiliser treatment is orthodox.

803. *Plant Pathology.* Throughout the year the Plant Pathologist participated in the eelworm survey of the Federation instigated by G. C. Martin. Officers of the Department were asked to help, and substantial progress was made although large gaps remain in the distribution map, e.g. virtually the whole of Barotseland and the Western Province. Four species of *Meloidogyne* have been recorded.

804. The Federal authorities, keeping close touch with Northern Rhodesia, gave much thought during the year to the improvement of phytosanitary regulations, and have produced a new Plant Pests and Diseases Act (1958).

805. *Miscellaneous.* Dr. Ballantyne, who returned to the Colonial Office pool in March, 1958, produced a report entitled "A Preliminary Agricultural-Soils Map of Northern Rhodesia", a report still in cyclostyled form as some of the mapping is incomplete.

806. Detailed reports were produced by the Pasture Research Section during the year, one on "Growth and Seasonal Composition of Hyparrhenia dominant grassland", and the other on "Growth, Yield and Chemical Composition of some Cultivated Grasses and Legumes".

807. Dr. Robson of Kew toured part of the country in company with the Plant Pathologist on Flora Zambesiaca matters and spent several periods at Mount Makulu during 1958-59.

### *Forestry*

808. A Division of Forest Utilisation was established during the year, which, together with the Division of Forest Ecology and the Division of Silviculture, forms the Research Branch of the Department.

809. Work by the Division of Forest Ecology continued on the collection of information on indigenous trees and on herbarium material, some 2,350 specimens being added to the herbarium. The Northern Rhodesia check list, under preparation at the Imperial Forestry Institute, Oxford, was completed and passed to the printers. The draft of the first volume of "Flora Zambesiaca" was checked. Vegetation studies were carried out in several districts



to assist the territorial survey of forest resources. Botanical collecting tours were made to the Mafingi Mountains and the Nyika Plateau in the company of Dr. N. K. B. Robson of the "Flora Zambesiaca" staff.

810. Additional staff was posted to the Division of Silviculture to assist with pressing problems, mainly of afforestation with exotic species. Projects and investigations actively pursued included the study of exotics, species trials, pilot plantings of likely species, establishment and weeding methods in plantations, enrichment of the indigenous woodland by direct sowing in ash patches, firebreak species, and preliminary anti-termite trials. Of the many pine species under trial the *P. insularis*/*P. khasya* group is proving the most adaptable to the sites and climatic zones in which pine planting has been tried. Trials in the Lake Basin Area have shown that clean weeding of pines gives a high rate of survival (92 per cent. or more), but that in such plots height growth and vigour are greatly enhanced by the application of 4 ozs. of Compound C fertiliser (6N : 18P : 12K) per tree on planting. Work proceeded on the establishment of seed orchards. On the southern plateau clean weeding of Eucalypts mechanically and the application of a compound fertiliser at time of planting has produced vigorous crops of excellent height growth while treatment of nursery stock with chlordane or dieldrin before planting has ensured a survival rate of over 90 per cent. for a full year after planting ; the survival of untreated plants was 25 per cent. to 73 per cent. In collaboration with Dr. Coaton of the Division of Entomology, South African Department of Agriculture, assessments were made of termite populations and degrees of attack by using Eucalypt sapwood trap-stakes in randomised plots at experimental stations ; preliminary results show a direct relationship between the percentage of stakes attacked and the degree of damage to planted Eucalypts in each area. Strenuous efforts continued to be made to obtain adequate supplies of seed of suitable tropical pines, but the position still remains unsatisfactory.

811. A Forest Utilisation Officer was appointed in February, 1958. His first duty was a survey of past work and present problems. On the findings of this survey a comprehensive, long-term programme was drawn up for utilisation research. By the end of the year detailed plans for eight projects had been drawn up and approved ; these concern various aspects of the use of timber in the copper mines including species, durability, preservation treatments, etc. Experimental work under these projects was in hand by the end of the year.

#### *Veterinary*

812. *Pasture Research.* From 1952 to 1958 the Pasture Research Programme has been mainly defining the problems and measuring the existing pattern of herbage and animal relationship. Many of these observations were carried out on the experimental plot-sized scale and have now reached completion or near-completion, while others have been in the nature of preliminary observational trials.

813. As the policy on this Station is the application of Pasture Research Work to livestock usage of the pastures most of the previous small-scale work has been extended to large-scale grazing trials using, as a basis for experimental design, information gathered from the previous trials.

814. The main results of veld fertiliser trials were a large increase (300 per cent.) in grass yield due to nitrogen fertiliser. Superphosphate alone produced little effect, but the combination of superphosphate and nitrogen fertilisers gave the greatest increase in grass-yields (400 per cent.).

815. A Napier grass spacing trial showed that the closest plant-spacings gave the highest yield of herbage, but from the practical point of view it is recommended that such spacing be great enough to allow for tractor cultivation.

816. In a rotational grazing and saved hay trial using four paddocks grazed on a simple rotation together with the harvesting of one paddock annually for hay which was fed back to the animals during the dry season, the feeding of hay allowed an increase in stock-numbers, but individual animals' weights, as opposed to beef yield per acre, were not increased. Veld hay is not palatable and there always remained a large surplus uneaten.

817. Observations of comparative stocking-rates and grazing management systems on the local *Hyperrhaenia* spp. veld showed that for large-scale extensive ranching the simple management of free-range stocking is best. However, on the long-term basis it is recommended that a quarter of the total area be spelled and burnt annually on a rotational basis to control bush encroachment, to discourage uneven grazing and allow seed-setting of the palatable grass species. The most important factor in beef-production per acre was the stocking rate, i.e. :—

the over-stocked Group I (3-4 acres/head) produced 194 per cent. more beef/acre than

the medium-stocked Group II (12.3 acres/head) and 350 per cent. more beef/acre than

the under-stocked Group III (20 acres/head) in spite of the fact that the Group I cattle suffered a mean dry-season weight-loss of 110 lbs./head as compared with the cattle in Group II and in Group III.

818. It was concluded that if total beef-production per acre is required, and not seasonal beef-production at a time of scarcity (dry-season), then it is preferable to graze a large number of poorer animals than fewer animals of heavier weight and better quality. This results from the advantages of maximum utilisation of veld-grass during the rains and the ability of cattle to recover during the rains from the growth retardation during the dry-season. There is, however, the proviso that maximum stocking-rates may irreversibly harm and change the vegetation-cover with resulting bush-encroachment and sheet-erosion. The optimum long term carrying-capacity will be lower than the short-term maximum stocking rate. Management for intensive beef-production should ensure maximum sustained utilisation of summer-veld growth with the supplementary provision of cheap home-produced fodder for the dry-season. This may require a high stocking-rate with resulting sub-maximal individual weight gains.

819. The optimum stocking-rates on this veld are :—

as high as 2.5 acres/head during the rains season and an optimum of 12.5 acres/head during the dry season. Stocking at 20 acres/head gave no better results than 12.5 acres/head.

820. First results from a kraaling trial intended to measure the seasonal effects on cattle-growth of restricted growth by the adoption of kraaling managements have been recorded. Cattle were in three groups :

- Group I.* Control group, not kraaled on constant free-range grazing.
- Group II.* Kraaled daily from 6 p.m.-7 a.m., an approved kraaling practice.
- Group III.* Kraaled daily from 4 p.m.-9 a.m., the undesirable average village practice.

821. These observations have so far run through only one dry-season, July-December, and the results show :—

*Mean Grazing times.*

Group I.	...	...	10.95 hours/day (100 per cent)
Group II.	...	...	9.2 „ / „ (84 per cent)
Group III.	...	...	6.13 „ / „ (56 per cent)

*Mean weight changes.*

Group I.	...	...	+ 33.95 lbs./head (100 per cent)
Group II.	...	...	+ 38.35 „ / „ (112 per cent)
Group III.	...	...	+ 16.15 „ / „ (47 per cent)

822. These results were unexpected and surprising, e.g. the 44 per cent. reduction of grazing time of Group III being reflected in an average weight gain difference of only 17.8 lbs./head compared with the Control Group I. This is probably explained by a difference in grazing intensities, i.e. the kraaled groups harvest a greater quantity of forage per hour than the control-group which graze at low intensity and spend unnecessary time foraging.

823. *Parasitology.* Investigations were continued into tick biology in relation to microclimate. Exposure of the eggs of *R. evertsi* to a natural ground-cover temperature of 52°C. for half an hour completely prevented eclosion.

824. Studies were made on the effects of inundation on ticks under conditions existing on the Northern Rhodesian flood-plains used extensively for winter-grazing by cattle and showed :—

Engorged female *R. evertsi* and *H. truncatum* spp. submerged under 3 cm. of water all survived a 72-hour submersion, but subsequently 75 per cent. died without ovipositing and the remaining 25 per cent. oviposited approximately 25 per cent. the number of eggs with a final 90 per cent. estimated eclosion.

825. Preliminary investigations were carried out to test the comparative therapeutic efficiency of modern anthelmintics against the common worms infesting local sheep.

826. Carbon tetrachloride and Tetrachloroethylene at 0.25 ml./kg. show a high efficiency in controlling hookworm (*G. pachycelis*) and these drugs are fairly well tolerated at therapeutic levels.

827. Proprietary preparations of carbon tetrachloride containing 25 per cent. carbon tetrachloride in an oil-base injected subcutaneously have little, if any, apparent effect on intestinal nematodes when administered at dosage levels of 0.05 cc./kg. and 0.2 cc./kg.

828. Hexachloroethane, although possessing a good all-round anthelmintic efficacy, proved to be toxic in a large number of cases when administered at the recommended dosage-levels of 0.3 gms./kg. Investigations confirmed the recommendation made by Dr. P. Le Roux (F.A.O. expert) in 1957 that when this drug is administered to sheep here at  $\frac{2}{3}$  the normal recommended dosage-level the sheep appear to tolerate that dosage-level, i.e. at 0.2 gm./kg. at which level clinical manifestations of toxicity are rare.

829. *Moniezia expansa* infestation in lambs was successfully treated by the administration of a proprietary N.C.A. solution mixture, the solution containing 6.4 per cent.  $\text{CuSO}_4$ , 3.0 per cent. Nicotine and 0.12 per cent.  $\text{As}_2\text{O}_3$  administered at a dosage-rate of 1 cc./1 lb. or 2.2 cc./kg. It was found necessary, however, to repeat the dose twice at a ten-day interval to complete elimination of the tape-worms.

830. Investigation into the viability of *N. vitulorum* eggs ingested by vultures feeding on mature worms and removed from the bird's guts indicated that 100 per cent. of these eggs developed and maintained viable larvae for three months on the ground surface. A number of mature *N. vitulorum* worms were found in the intestines of a calf, one week old, at Mbesuma Ranch indicating antenatal infestation.

#### *Animal Husbandry*

831. *Nucleus Breeding Experiment.* This long-term experiment was continued involving the indigenous Angoni, Barotse and Boran breeds, and the Indian Bhagnari breed. Selection is based on the response of the young stock to a high plane of nutrition. During the year the selected  $F_1$  generation was brought into breeding.

### NYASALAND PROTECTORATE

#### *Agriculture*

832. *Maize.* Maize breeding work at Chitedze aims at providing one or more improved varieties for use particularly by African cultivators in Nyasaland. Selection criteria include high yield, white flinty grain and long tightly-binding husks that cover the grain, thus affording a degree of resistance to insect damage when stored unfumigated. The method employed is to inbreed selected local stocks to produce inbred lines with the necessary quality and good combining ability. Locally-produced inbred lines are also combined with inbred lines introduced from other countries in order to produce hybrids and synthetic varieties.

833. Agronomic work on the fertiliser requirements of maize in district trials has expanded. Tentative response curves have been drawn up for various soil types and districts. Nitrogen is the major limiting nutrient, with phosphate becoming deficient in certain well-defined areas of the country. Progress has been made during the year in the search for a high-analysis N.P. fertiliser for issue to African cultivators in such areas. Studies on the time of application of nitrogen, on the use of Kholo manure, and on plant population have continued. Cultivation studies on early planting and weeding have again demonstrated the importance of carrying out these operations at the correct time.

834. *Groundnuts*. The main work is on comparison of varieties. Three new varieties have come to the fore, all of which are as good as, or better than, the standard varieties previously advocated. They are medium or long-term runner varieties and show wide adaptability even to areas where good results have previously been confined to early bunch types. Fertiliser trials with N, P and S have been conducted. In this crop also the advantages of early planting and weeding have again been shown.

835. *Tobacco*. Nursery management techniques, the use of mulches, fertilisers and various fumigants are being examined. The trade demand for a longer, wider dark-fired leaf has governed most trials, which have shown how these characters are affected by time of planting, variety, and cultural procedures. Fertiliser has given increased yield and leaf quality, though there is only a small response to phosphate dressings. The factors favouring the production of the highly-desirable thin "coloury" Burley leaf are being examined and recommendations made to estate owners as to fertiliser requirements of their soils, based on experimental results. Leaf analysis has helped in these projects.

836. *Tung*. Experimental work has been curtailed due to the severe recession in the world price of tung oil. Trials of new selections of *Aleurites fordii* from the United States, Swaziland and local sources have shown them to be very considerably inferior to improved clones of *A. montana*. There is conclusive evidence that *A. montana* is the only species worth growing in Nyasaland. Newer selections of this species show an improvement in potential yield, and vigorous B-types, being precocious, are the most popular. A selection of F<sub>1</sub> seedlings of *A. montana* × *A. fordii* hybrids has been planted out. Nitrogen remains the only fertiliser which has consistently maintained an increase in yield. In an attempt to find a means of supplementing growers' incomes, some tung has been underplanted with *Paspalum notatum* for grazing purposes; a reduced population of tung is being interplanted with coffee. A study has been made of girth measurements and recorded yields for trees of varying ages. A strong correlation has been found, which can be of considerable use in predicting future yields of young trees not yet in bearing.

837. *Tea*. The protracted and abnormally severe drought of the 1957 winter had a severe effect on young tea up to 10 years old; the new experiments at Mimosa suffered deaths of about 25 per cent. The standard errors of the experiments have increased considerably, and the usefulness of the experiments combining effects of different spacings with a variety of other management methods is giving great concern. A delay of at least ten years would have to elapse before replacements could reach an equivalent stage. Further valuable information has been obtained from soil moisture measurements taken throughout the season under various field and nursery trials. A considerable body of useful information has now been amassed on this important aspect of tea culture in Nyasaland. Fertiliser experiments have continued to show the benefits of sulphate of ammonia for tea, and are beginning to show interesting inter-relations with other management methods.

838. The Nyasaland Tea Association has financed a scheme whereby tea fermentation will be studied under the direction of the Biochemical Department of Cambridge University.

839. *Coffee*. Experimental work with *Arabica* coffee in Nyasaland is only in its fifth year. At this stage it is possible to infer certain basic requirements under the country's climatic conditions. Mulch is essential; Napier grass is the conventional material, but tung hulls are longer-lasting. Shade is beneficial, but the plants chosen must not compete with the coffee for moisture. *Sesbania* and banana are found to do more harm than good in this respect. Shelter is essential and observations on estates have shown the beneficial effect of dividing a plantation into small blocks protected at the boundary with *Grevillea* and/or Banana. A strict regime for pruning multiple-stem coffee must be introduced to prevent overbearing. A spraying programme is essential.

840. A series of microplot variety trials is being planted in two dozen different localities in the territory in order to assess the potential coffee-growing areas of Nyasaland.

841. *Robusta* coffee is growing satisfactorily in a high-rainfall area of the Northern Province.

842. *Cotton*. The new cotton variety A637 has again outyielded the standard Nyasaland variety CLB in trials at Makanga and elsewhere. Selections from A637 and related varieties made in 1957 have been tested for resistance to Bacterial Blight and Jassid attack, with the object of improving these characters. The first generation of a series of crosses between these and varieties from East, Central and South Africa have been grown.

843. A trial in which cotton was planted under irrigation before the start of the rains has shown that early planting does not necessarily result in early setting of the crop, and emphasises the importance of further investigation into the problem of excessive vegetative growth. (For work on cotton pests see para. 280-3.)

844. *Fruit*. Work has been concluded on Strawberry varieties, of which two of the Cambridge (U.K.) varieties and one from Australia have been outstanding both in yield and resistance to Leaf Spot (*Mycosphaerella fragariae*). A manurial and irrigation experiment has been run for two years. Response to phosphate although resulting in bigger plants was not as great as in the United Kingdom, probably because Bvumbwe soils contain adequate amounts. Irrigation is essential, non-irrigated plants only having a survival rate of between 16 and 33 per cent. according to variety. The experiment has shown that maximum yields are obtained from a dense population (nearly 26,000 plants per acre) of newly-produced runners planted in fresh beds each year.

845. Observations of other fruits have continued. Propagation of Avocados has received special attention. Grafting is preferred to budding, both saddle and veneer grafts being found effective.

846. *Other Crops*. At the Central Experiment Station the use of nitrogenous fertiliser on Sorghums and Finger Millet has been investigated. Experiments on Rice cultivation continue in the Karonga District of the Northern Province. No worthwhile yield has been obtained at any station this year from Castor, due to damage by an inflorescence blight, the cause of which is unknown. Sesame has shown promise at lower altitudes along the lake shore. Although small plot yields of Soya beans have been good, results from the crop planted on a field scale on ridges three feet apart under

African cultivation methods have been disappointing. Despite a search for varieties of cow peas resistant to *Asochyta* leaf disease none have been found so far. Tests of imported Amani Cassava hybrids have continued.

847. *Rotation Experiments.* Long term rotation experiments contrasting different combinations and lengths of legume/cereal rotations, together with different kinds of resting cover continue. Green manuring is also considered in these experiments. The trials have not yet continued long enough for general conclusions to be reached. Short term indications are tending to show a difference between the economic application of green manuring on naturally poor soils, where large yield responses are obtained, particularly where small nitrogen dressings are applied, and on inherently richer soils. The same trend in the short term is observed with applications of Khola manure. Studies on the fertility effects of grass leys are chiefly aimed at finding the best way to return the leys to arable cultivation.

848. *Pastures.* Investigations have been directed towards the most effective method of establishing Rhodes grass pastures from seed sown either on bare ground or under a nurse crop of maize. A practical method of collecting grass seed mechanically has been investigated. Work has continued on the comparison of ley grasses and legumes. Progress has been made, but a satisfactory legume of proved value has yet to be found. Other work was done on the carrying capacities of Rhodes grass leys, with and without the application of nitrogenous fertiliser.

849. *Soil and Chemical Investigations.* Field and laboratory tests have continued with the object of improving correlations between soil analysis and responses to major and minor nutrients, particularly with regard to maize and tobacco. Seasonal nitrate fluctuations and scatter throughout soil profiles under various crop and fallow treatments are being studied.

850. The moisture use and irrigation requirements of a variety of crops, in particular maize, tobacco, groundnuts, tea and cotton, are being studied at stations throughout the territory. Soil physical work is also being continued on the effects of different rotations and manurial treatments on the physical properties of the soil.

851. With a view to increasing the percentage of "coloury" leaf in Burley tobacco, and of heavy-bodied leaf in dark-fired tobacco, further studies on leaf composition have been carried out. The chemical causes of "pops" in groundnuts are being investigated.

852. At the Bvumbwe Station micro-nutrient studies have included zinc deficiency of coffee as related to shelter and shade; dieback of wattle, pine and *Grevillea*, and reduced response of maize to nitrogen. The arrival of the Mervyn-Harwell Polarograph has increased the scope of the work. Tea fermentation studies have been reduced since this project was taken over by the Department of Biochemistry of Cambridge University.

853. Determination of mineralisable nitrogen in soils has been undertaken with reference to fertiliser needs of flue-cured tobacco and low responses of maize to nitrogen application on montmorillonitic soils.

854. The value of nitrogenous fertilisers has been further demonstrated by elimination of dieback and copper and zinc deficiency symptoms on citrus together with improvements in fruit quality following nitrogen applications, and also by the 10 to 15 fold increase in protein yield per acre from pastures.

## Forestry

855. The Silvicultural Research Station in Chongoni Forest, near Dedza, was completed early in the year and was opened by H.E. the Acting Governor in May. These buildings, together with the Nyasaland Forest School, have been financed by a C.D. & W. grant.

856. The trial in Chambe Plateau Forest with P.57 *Widdringtonia whytei* underplanted in P.50 *Pinus patula* looks healthy but is not showing much height growth. The overwood was thinned earlier in the year and there may now be a response from the *Widdringtonia whytei*. The P.58 *Widdringtonia whytei* in P.50 *Pinus patula* has been seriously damaged by weevils.

857. The trial at Chikangawa Forest on the Vipya Plateau with P.52 *Widdringtonia whytei* underplanted in P.50 *Pinus patula* still looks most promising. The *Widdringtonia whytei* has been given full overhead light and seems to benefit greatly from the side shelter. At Chikangawa a trial plot of *Eucalyptus fraxinoides* is very promising.

858. In Lwafwa Forest on the Vipya the trials of *Cupressus torulosa* and *Pinus caribaea* are promising and have a better appearance than some of the other conifer plots.

859. At Luwawa Forest, also on the Vipya, the softwood trials around the dam continue to do well and indicate that the soil moisture conditions in that area are particularly good. Since the land is gently undulating, at least in the Eastern part, it would seem reasonable to suppose that the better soils are fairly general in this forest. Species showing excellent growth are *Pinus patula*, *Pinus elliottii*, *Pinus caribaea* and *Pinus montezumae* while a plot of *Cunninghamia lanceolata* is very successful and shows interesting growth.

860. The older trials of eucalypts in Mtangatanga Forest indicate that *Eucalyptus saligna* will produce good poles on this site. *Eucalyptus microcorys* and *Eucalyptus maculata* are both doing well, the latter being naturally slower in growth. New trials of *Eucalyptus maideni*, *Eucalyptus fraxinoides*, *Eucalyptus fastigata* and those of the conifers are doing well.

861. The trial plots in Champila Forest at the extreme south end of the Vipya indicate that good growth of all the main species can be obtained in this fertile grassland site even though the rainfall is rather low.

862. Trials of *Pinus michoacana* in Ndirande and Kanjedza Forests, the former on an exacting site and the latter planted very late, have survived the dry season remarkably well.

863. At Cholomwani and Massenjere Forests a further 3.8 acres of trial plots were formed, the species planted being *Pinus caribaea*, *Eucalyptus deglupta* and *Tectona grandis*. The *Eucalyptus deglupta* is from seed collected from the original plot on Zomba Mountain which was planted in 1940 from seed sent from New Guinea by Mr. Lane Poole, then Director General of the Commonwealth Forestry Bureau, at Canberra.

864. A total of 7.2 acres of trial plots were planted in Kalwe Forest and Mkwazi Hill Forest on the Nkata Bay lakeshore. Species planted included *Entandrophragma utile*, *Entandrophragma angolense*, *Khaya grandifoliola*, *Tectona grandis*, *Rauvolfia caffra* and *Dalbergia sissoo*. All these plantings



were made with striplings except in the case of *Khaya grandifoliola* and *Tectona grandis*, where both striplings and stump plants were used.

865. At Mua-Livulezi Forest at the foot of Dedza escarpment the trial plots were extended by a total of five acres comprising four acres of *Pterocarpus angolensis* planted as batons and one acre of *Pinus caribaea*. Half of the latter plot was planted in the open and half under natural canopy. To date the former has shown marked progress with a high percentage of establishment whilst the latter has shown much poorer growth and considerable mortality. The growth of *Tectona grandis* at this forest and also at Massenjere Forest in Port Herald District is most encouraging.

866. On the Nyika Plateau, although no extension of the total area of plantations taken over from the Colonial Development Corporation was made a large programme of beating up of the 1956-57 plantings was undertaken and a total of 980 acres was replanted. Ground was prepared for a series of establishment trials designed by the Silvicultural Research Branch. Also on the Nyika, permanent sample plots, R.70-100, were laid out in the P.54 plantations of *Pinus* spp. and enumerations were carried out in the original scattered plots Nos. 1-11, which were established by the Department in 1952.

867. Nchisi Forest. The plots of naturally regenerated *Newtonia buchananii* continued to receive treatment and further opening of canopy above was carried out. A small plot of underplanted *Chrysophyllum fulvum* was established in the rain forest. A series of trials to test various methods of planting were laid out on an exposed site. These included the EAAFRO deep planting and contour planting between open trenches.

868. In addition further underplanting of *Pinus* spp. under *Brachystegia* canopy of varying density was carried out. A 5 per cent. enumeration in December gave 66 per cent. survival on moderate slopes with considerable canopy and 31 per cent. on steep slopes with much less shade.

869. A plot of half an acre of *Cupressus torulosa* at an espacement of 4½ feet × 4½ feet was also planted in open grassland and in December showed an 85 per cent. establishment and good vigour. The NPK trials on *Pinus patula* have given inconclusive results.

870. Lusangazi Forest. Four trials of underplantings of *Eucalyptus saligna*, *Eucalyptus microcorys* and *Eucalyptus maculata* (R.42-45), were planted at Lusangazi to assess the effect of canopy. In this case, the well-developed *Brachystegia* woodland on relatively fertile soil has been cleared of undergrowth and the soil cultivated. Establishment has been most satisfactory and growth correspondingly rapid and even. In particular *Eucalyptus microcorys*, which seems to tolerate a fair amount of shade in its early stages, has been very successful so far. Exceptionally rapid growth has been made by *Eucalyptus saligna* and *Eucalyptus maideni*.

#### Veterinary Research

871. Investigations are in hand to determine the degree of incidence of *Brucella* abortion in the African areas as judged by the agglutination test, to determine the causes of mortality among poultry held in rural areas, to determine the level and type of bacterial contamination in milk supplied to the major townships, and to investigate the species and incidence of helminth parasites.

872. Work continues on the development of the Livestock Improvement Centres situated one in each Province of the Protectorate. Concurrent with this work investigations are being made into the comparative productivity of cattle of the Fresian and Jersey breeds under identical systems of management, and into the productivity of the two local breeds of Zebu cattle. Studies are also being made into the management techniques suitable to the maintenance of sheep and goats under local conditions, and into the adaptability of a number of breeds of poultry to the local environment and to the varying systems of management under which they will be kept in rural areas.

### *ST. VINCENT*

873. Studies in chemical weed control were continued in a variety of crops. Promising results were obtained from the use of "neburon" for both pre- and post-emergence spraying of bananas, and in pre-emergence control of weeds in arrowroot and yams. Trials with "monuron" in sugarcane and pineapples were incomplete, but it was established that "monuron" scorched arrowroot when used in pre-emergence application as low as one lb. per acre. "Dowpon" was used successfully in selective control of grasses in banana fields and in cotton at an application rate of 6 lbs./acre applied as a split application at two weeks intervals.

874. Studies in spacing of bananas have been started with a view to comparing wide inter-row spacings and closer row spacings versus square patterns of planting. It is expected that the former method will enhance leaf spot control and conservation of soil under banana cultivation.

875. Selection for yield and starch content was continued in "Banana" and "Creole" varieties of arrowroot and a programme of work has been drawn up for breeding work on the arrowroot plant to commence during 1959.

876. In a trial to study the effect of time of planting and time of harvesting of the "banana" and "creole" varieties of the arrowroot, it was established that both varieties contained their highest starch content at 9½-10 months after planting regardless of the month during which planting was done. After this period the starch content of "banana" arrowroot deteriorated more rapidly than that of the "creole" variety. There were indications that arrowroot planted during the dry months of March and April gave a higher yield of starch than arrowroot planted in the wetter month of June. This result however requires further study.

877. An area of 16 acres of Pangola grass has been established at the Camden Park Experimental Station. Studies and observations on the performance and management of Pangola pastures under conditions in St. Vincent were started.

### *ST. KITTS, NEVIS, ANGUILLA*

#### *Sugar Cane*

878. Variety B.41211 still appears as the best general purpose cane. B.49119 shows great promise in the wetter lands and has given a better yield than the standard B.41211 in a number of cases.

879. Fertiliser trials were mainly directed towards the evaluation of applications of superphosphate and general response was obtained from a dressing of 1 cwt. per acre, with no further increase from a 2 cwt. dressing. Additional nitrogen applied late to ratoons gave no significant response.

880. Treatment of setts by soaking with Dieldrex Teepol followed by an application of BHC/limestone mixture immediately after planting followed by a second application later gave the best control of mealy bug.

#### *Cotton*

881. Two variety and two fertiliser trials were undertaken. The results of the variety trials have not yet been obtained. In one fertiliser trial, large responses were obtained from N and K and in the other, small significant responses were obtained from P.

#### *Grasses and Pastures*

882. A number of observation plots of grasses were maintained. Good progress in the growth of pangola grass and giant star grass was obtained. It is unlikely that under reasonably fertile conditions any other grasses will be found to better them for general purposes under simple management.

### **SARAWAK**

#### *Agriculture*

##### *Rice*

883. In a trial on dry padi laid down on smallholders' land in the First Division, using a seed dressing of 3½ lbs. of a fertiliser mixture of sulphate of ammonia and double superphosphate (6.4 per cent. N., 12.2 per cent. P.) per gantang of padi seed (approximately 5½ lbs.) a marked economic return was recorded. Further trials have been laid down. An application of 200 lbs. per acre of the same mixture, applied as a top dressing on newly sown rice, also gave considerable increases in yield, but these were not economical.

884. In nursery manurial trials of wet rice on smallholders' land in the First Division no increase in yield was obtained when the nursery was manured with a fertiliser mixture (6.38 per cent. N., 12.0 per cent. P.) at the rate of 1 lb. per 12 square yards. A field fertiliser trial using the variety Sarendah indicated that a response in yield might result from the application of ammonium phosphate (16.5 per cent. N., 8.7 per cent. P.) as a basal dressing applied at a rate of 3 cwts. per acre.

##### *Livestock*

885. The pig feeding trial, modelled on the Lehmann system, initiated towards the end of 1957 was continued during 1958, but so far, on the basis of growth rates, there is little difference between the controls and the others. Sources of cheap animal protein are far from plentiful in Sarawak, consequently seldom, if ever, are Dayak pigs fed on anything besides banana stems, rasped sago, tapioca and occasionally rice bran. Since it is part of the Department's policy to introduce imported breeds such as the Middle-White into and near the larger towns, it is only to be expected that requests would be received for boars to cross with the local Dayak breed. In order, therefore, to assess the potentialities of the Middle-White X Dayak on a low protein diet, the Department has initiated feeding trials at Semongok Agricultural Station.

*Forestry Research*

886. The five-year programme of forest research has been finalised and will come into effect in 1959. The programme emphasises research into the ecology and silviculture of peat swamp forests and the collection of volume and yield data of the main timber trees of the peat swamp forests.

887. Work in 1958 was concentrated on the organisation of the joint herbarium of the Forest Department and the Sarawak Museum and on the collection of botanical specimens, particularly of the family of Dipterocarpaceae, which fruited in Western Sarawak early in the year and which flowered throughout the country from August to September.

888. The field work of the ecological survey of the peat swamp forests was completed and a final report will be prepared in 1959. A list of the flora of the peat swamps is in draft, including epiphytes and ground flora.

*SIERRA LEONE**Agriculture*

889. The chemist has been engaged in carrying out surveys for the proposed rubber and oil palm plantation, and it has proved most difficult to find areas of 16 sq. miles with few swamps and gentle slopes. Of several potential rubber sites, much land was under coffee and cocoa plantations.

890. Laboratory investigations were limited to the analysis of local feeding stuffs, and the list of feeding values was extended. At the same time analysis of grasses from the Northern districts of the territory—cattle areas—continued. Routine analysis of certain swamp soils was carried out in order to discover the nutrient status and nitrogen relations. The speed of loss of ammonia from sulphate of ammonia applied to these soils is also being investigated.

891. An outbreak of "Swollen Shoot" disease of cocoa, the first to be recorded in this country, was discovered in April, 1958, at Gandorhun (Jaluhun) by a member of the staff of West African Cacao Research Institute at Tafo, Ghana. Thirty-seven trees showed leaf symptoms characterised by a clearing of the smallest veins. No typical swellings were observed. The disease was not severe since the trees supported a heavy crop of pods, all of which were harvested in good condition.

892. The origin of this disease is still a problem as the disease could not be found in any of the neighbouring farms. A *Ceiba pentandra* tree at the edge of the farm is suspected as an alternate host, but as yet none of the mealybug vectors associated with this disease in Ghana and Nigeria was observed.

893. A second virus disease was observed in a farm in Lower Bambara; it is not yet certain whether this outbreak is caused by a Swollen Shoot virus.

894. Experimental spraying against Black Pod of cocoa was continued for the third successive season in 1958 at Kpuabu. The result obtained in the private farm at Kpuabu showed that spraying, in general, was effective in suppressing the disease though 1.0 per cent. Carbide Bordeaux gave better control than either 0.4 per cent. "Perepod" or 0.4 per cent. "Kopapod". There was very little difference between the incidence of the disease in the control (unsprayed) plots and in plots which were underbrushed and diseased pods cut out periodically.

895. Black Pod disease was not serious on two sites within a 12-mile area round Kpuabu (not more than 1.0 per cent. of total pods infected) and as a result spraying was discontinued at these sites in August, two months earlier than at Kpuabu where the loss due to Black Pod was 26 per cent. of total pods.

896. Several cocoa farms in the South-Eastern and South-Western Circles were visited during the 1958 season and it is now almost certain that Black Pod is serious only in isolated farms. It has been decided to map all cocoa farms in which this disease is likely to be severe so that spraying to control the disease can be organised.

#### Forestry

897. Experimental planting of *Pinus caribaea* continues and this species is doing well on poor sandy soils; it may be of value in the future for afforestation of savanna woodlands. At Newton growth of 2 feet in 9 months has been observed.

898. At Aberdeen the experimental planting of *Melaleuca leucodendron* in a sandy saline mud (part of a swamp bunded for anti-malarial purposes) has proved a success, so much so that there is now profuse natural regeneration from some of straight-grown older crops (1949).

899. *Tabebuia pentaphylla* has recently been introduced from Trinidad and is thriving in the Freetown area.

900. Two trial plots were established in widely spread plantations of 14 years of age, in which it is proposed to study the growth of coffee or cocoa when they are planted as an understorey to timber trees.

901. A new species, provisionally identified as a *Didelotia*, is to be sawn by the mill at Kenema. The species occurs fairly frequently in the salvage areas near the Gola Forests from which timber will shortly be extracted.

#### Veterinary

902. To assess the degree of protection against trypanosomiasis in pigs conferred by Antrycide Suramin Complex prepared by the West African Institute for Trypanosomiasis Research, a trial was carried out in a locality where, in the past, the incidence of the disease had been extremely high. Over a period of twelve months two injections of Antrycide Suramin Complex were given, the period between injections being six months. Of ten treated pigs, all of which survived, two developed chronic trypanosomiasis, 10 and 19 weeks respectively after the first injection, these infections being completely cured by the second injection. Of several controls, two died from trypanosomiasis, one developed an acute infection and one a chronic infection. The results indicate that a promising degree of protection was afforded to the treated animals.

### SINGAPORE

#### Veterinary

903. Seven standard rations have been established and tested for all phases of poultry and pig production. Feeding trials are examining usefulness of cheaper components by comparing cheaper results of feeding against the standard rations.

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### *Poultry Breeding*

904. From the 1,000 birds of the Canton type purchased in 1958 families have been selected which lay about equally with Brown Leghorns. First crosses between Canton and Brown Leghorn birds have laid better than either parent with far less broodiness than amongst the Canton birds. Genetic controls of broodiness are being investigated because it is the greatest limiting factor to high egg production. For the broiler trade families have been selected which have gained 42 and 34 ounces in weight respectively for males and females at 12 weeks from hatching, which are acceptable weights.

### *Pig Breeding*

905. From reciprocal matings of Chinese and British breeds of pigs 133 head of  $F_1$  pigs have been bred and 39 individuals (11 males and 28 females) have been selected for *inter se* matings to give 122  $F_2$  generation pigs (57 males, 65 females). Both  $F_1$  and  $F_2$  take an average of 23 weeks on standard rations to reach market weight whereas Chinese pigs under the same conditions take 32 weeks. However, three families of pigs with 62 per cent. European 37 per cent. Chinese totalling 29 individuals, have been evolved. They reach market weight at 19 to 20 weeks. In these circumstances the breeding programme is being changed from establishment of a fixed first-cross, with 50 per cent. European, to one which expands the 62 per cent. European families. Both lots are equally prolific and have similar viability.

### *Botanic Gardens*

906. Close co-operation has been maintained with the Forest Departments of Sarawak, North Borneo and the Federation of Malaya and botanical institutions overseas from whom much valuable herbarium material has been received.

907. The closest collaboration has been maintained with the Flora Malesiana Foundation, the University of Malaya and the Phyto-chemical survey of the Malayan flora.

908. The Keeper of the Herbarium has continued his revision of the Malaysian Myristicaceae for the Flora Malesiana. Dr. Furtado continued his studies of palms and the Director of Malayan marine algae both in Singapore, the British Museum, London, and at the Kew Herbarium.

909. Exchanges of plants continued with overseas organisations, and 1,264 introductions of plants and seeds and 707 consignments out in exchange were made. Orchid hybridisation continued and hybrid blooms were displayed at several exhibitions locally and overseas.

### *Publications*

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SINCLAIR, J. Myristicaceae in Malaysia. *Gard. Bull. Sing.* 17 (1), 1958.

SINCLAIR, J. The Flora of Cox's Bazaar, East Pakistan. *Bull. Bot. Soc. Bengal*, 9 (2), 1958.

ADDISON, G. H. Descriptions of New Malayan Hybrids. *Mal. Orchid Review*, 5 (2), 5 (3), 1958.

FURTADO, C. X. When was *Gymnacranthera* Warb. validly published? *Taxon*, 7 (5), 1958.

## SOMALILAND PROTECTORATE

### *Agriculture*

910. Trials were made to find the optimum frequency of irrigation for the establishment of date off-shoots on a sand, a silt and a clay soil. The trials are not yet completed, but indicate that under all conditions daily irrigation is required until new growth starts.

911. Under bunded conditions variations in time of planting sorghum between mid-April and mid-June made no significant difference to the weight of the fodder or grain harvested. This points to the possibility of growing two crops, which will be tried next season.

912. Wheat and Barley varieties imported from Aden Protectorate produced crops of half a ton per acre on bunded observation plots.

913. A six-fold increase in bulk of shallots was gained and the crop matured in 100 days on a bunded observation plot. The yield was 3,120 lb./acre.

### *Forestry*

914. Establishment of areas where deferred grazing systems can be employed has been continued. The measurement of growth increment of sample plots has been maintained in the *Juniperus procera* forest. Of *Pinus* spp. introduced, *Pinus radiata* has passed through a two year check and is showing promise. Further species trials have been started using *Pinus* spp., *Cupressus* spp., *Eucalyptus* spp., and *Acacia* spp.

915. An experiment in seasoning technique to investigate and possibly eliminate the cracking which makes the local *Buxus hildebrandii* Baill. unsuitable for engraving has been started.

916. Experiments have been laid out concerning underground erosion, termite damage to local and imported timbers and the establishment of living zariba.

**TANGANYIKA***Crop Research*

917. *Cashew*. It had been shown that seeds having a high specific gravity had a higher germination percentage and germinated more uniformly than a random sample. This observation has been followed up and it has been found that seedlings from such seeds grow much more quickly than seedlings from low specific gravity seeds. Protecting seedlings from damage by *Helopeltis* spp. by dusting also leads to a greater rate of growth.

918. *Castor*. Control of Hemipterous pests of castor by dusting has not been successful. The young capsule is easily damaged by sucking bugs and when damaged falls off. This has resulted in slow progress in the breeding programme.

919. *Cotton (Empire Cotton Growing Corporation)*. A series of observation plots distributed throughout the Eastern and Tanga Provinces showed clearly the value of early planting, close spacing (4,840 plants per acre) and insect control by spraying as against no control or dusting. Malathion may be a useful addition to DDT for control of bollworms as well as aphids. Pyrethrum appeared to be of value in controlling jassid but not bollworm. In the Lake Province, Fusarium Wilt has been found in several new localities, but it still seems to be associated with one particular soil type occurring round the Lake fringe.

920. *Coffee, arabica*. At the Mbozi station work will now be concentrated on finding a method by which coffee roots can be induced to grow downwards from the planting hole to tap a larger volume of soil for plant nutrients and water. In addition, drought resistant varieties will be tested and attempts made by windbreaks and shade to mitigate the harsh effects of the environment.

921. *Coffee, robusta*. Work on improving methods of production by mulching, pruning, shading and the application of fertilisers and manures is continuing in Bukoba. A programme of selection of high yielding varieties has been started. Endrin has proved valuable for the control of Coffee-berry Borer and is now being tested in large scale field trials.

922. *Grass*. Pasture research is now the responsibility of the Department of Agriculture and research officers are stationed at the Central, Northern and Western Regional Research Centres. Besides standard investigations such as strain comparisons, methods of management etc., work has started on the integration of grassland, both planted pasture and natural grazing with arable cultivation at various levels of organisation.

923. *Pyrethrum*. Previous work has shown that in one area phosphate and organic manures give appreciable improvements in yield. This work will now be extended to see if it is possible to build up a cropping system that will maintain production at a higher level than at present. Work on control of thrips is of importance.

924. *Rice*. High yielding varieties acceptable to the African palate are available, but these are not acceptable to Asians. Several varieties acceptable to Asians are under test for yield and growth characteristics.



925. *Wheat.* A comprehensive selection programme for a short-term variety resistant to stem rust has been in progress for two years in collaboration with the Department of Agriculture, Kenya. Six varieties from Northern Rhodesia did not show any infection in 1958; every other variety tested did so to some degree. Small quantities of the Northern Rhodesia varieties have been procured for more extended testing.

926. *Inter-cropping.* In a year of unfavourable rainfall it was found that intercropping groundnuts with maize or sorghum generally gave appreciably higher production than pure stands. Approximately one and a half acres of pure stands were required to produce the yields obtained from one acre of intercropping. The importance of this to a peasantry largely dependent on the hoe is obvious.

927. *Date of Planting.* Late sown crops generally give low yields even though water and disease are not limiting factors. Fertiliser applications may increase yields, but do not nullify the effect. The effect is usually most noticeable on the production of seed rather than on leaf and stem production. For maize, groundnuts, soya and sesame grown on an irrigation farm, the loss in yield was considerable once the optimum time of planting (December) was past. Cotton and Castor proved to be exceptions. This problem merits considerable attention.

928. *Applied Pedology.* Soil reconnaissances and analytical investigations have covered a number of development projects. The soils of the Ruvu valley, Eastern Province, were found to be youthful and without salinity, but of variable texture. The soils of the Pangani basin, which have been further investigated, are very variable and often saline. They present considerable technical difficulties, but if they could be reclaimed, particularly in the headwaters region, very rich soils would be won. Other investigations in various parts of the country suggest that the south eastern third of the country is generally salt-free, whereas most of the rest of the country has some salinity.

929. Bukoba soils have been investigated to see whether there are reserves of fertility at depth which could be brought to the surface by deep rooting crops or leys. The soils are extremely impoverished below 1 ft. There is a fairly clear inverse relation between fertility and topsoil organic matter content and this suggests that organic matter, which contains a considerable amount of nitrogen, does not decompose normally, probably because of the lack of nutrients essential to microbiological activity.

930. Soil investigations in connection with plant nutrition work in the Southern Highland Province have brought to light marked shortages of exch. Ca and Mg. The correction of shortages of major nutrient cations has been advocated on the basis of Dr. A. Mehlich's findings that there are cation saturation levels varying with the type of colloid, which are generally optimum for plant growth. The idea has been called cation saturation adjustment of C.S.A to distinguish it from casual liming. It is expected to lead to basic and lasting soil improvement and may not be too costly where suitable limestones are locally available. The soil publication mentioned below outlines in some detail the case for C.S.A.

931. *Plant Nutrition.* This work has made considerable progress and the nutrient difficulties of coffee in different parts of the country are now

fairly clear. At Arusha on young alkaline soils there are Mn and B deficiencies and excess uptake of K with some minor interrelated difficulties. At Lyamungu, on generally good mature soils, there are Ca and B shortages at certain periods of active growth and soil shortages or unavailability of these nutrients may be largely responsible for biennial bearing. At Lushoto on old, but not very well known soils, there are Cu, K and B shortages. At Mbozi, on old soils, there are B, Zn, Ca and Mg shortages and the first three of these have been confirmed in field trials. At Bukoba on very impoverished soils there are shortages of Fe and B. Bananas, at Bukoba, are also short of Fe, B and, in addition, show K deficiency. Dieback of pines at Mbeya has been confirmed as B deficiency in field trials.

932. Pyrethrum at Uwemba has given some indication in field trials that K may help flowering and among the micro-nutrients Zn may be important. Attention has now been directed to Ca Mg nutrition in this crop and foliar fertilisation may be practicable.

#### *Publications*

CALTON, W. E.—Growing vegetables hydroponically—*Tanganyika Notes and Records*. (In press.)

CALTON, W. E.—Generalizations on some Tanganyika Soil Data. *J. Soil Sci.* (In press.)

#### *Veterinary*

933. *Rinderpest and Rinderpest-like Diseases*. The isolation of rinderpest virus from an eland and characterisation of the virus again focussed attention on the importance of game in maintaining infection in the Territory.

934. *East Coast Fever*. Immunization of young bulls for issue to the field using the Aurolac feeding technique was instituted, but was found difficult to apply on a large scale. Studies were made on the immune reaction of cattle in this disease.

935. *Mineral Deficiencies*. The mapping of deficient areas was continued systematically. Two mineral feeding trials to confirm the indications of analyses and to act as demonstrations in the areas concerned were in train.

936. *Ticks*. Trials of newly offered formulations of cattle dips were carried out. Not all commercial preparations suitable for use elsewhere met the exacting requirements of storage and use in East Africa.

937. *Livestock Research*. This division of Research was re-organised. The long-term breeding project with cross-bred Indo-African Zebus was continued, more attention being paid to selection for beef. The selective breeding of Boran and of Europe Zebu cross-bred animals for coastal dairies also continued. The cross-breeding programme with South African Boer type goats to improve the meat qualities of native goats was put on a sound genetical footing and the Kamorai milch goat and cross breeding work was also re-organised. Breeding of Black Headed Persian sheep continued.

#### *Publications*

HUTCHISON, H.—Variations in liveweight of cattle on farm and ranch in Tanganyika. *E. Afr. Agric. J.* (In press.)

HUTCHISON, H. G., MCFARLANE, J. S.—Gestation periods of Zebu cattle under ranch conditions. *E. Afr. Agric. J.* 24. 2.

ROBSON, J., ARNOLD, R. M., PLOWRIGHT, W. and SCOTT, G. R.—Isolation from an eland of a strain of rinderpest virus attenuated for cattle. *Bull. Epizoot. Dis. Africa.* (In press.)

938. *Forestry.* A five-year plan for silvicultural research was approved. The main projects include problems of softwood afforestation schemes, and the regeneration of mvule (*Chlorophora excelsa*), Camphorwood (*Ocotea usambarensis*) and lolyondo (*Olea welwitschii*). In addition, the Division dealt with the planning and statistical analysis of forest enumerations, and other mensuration studies including increment plots and volume tables.

939. Difficulties affecting the raising of *Pinus patula* and lolyondo seedlings in forest nurseries were largely overcome, and a successful technique was demonstrated for establishing *Eucalyptus* in land infected with termites.

940. Research on mvule concentrated on improving the present field-scale technique for stimulating regeneration by means of root suckers and the promising afforestation technique of using "nests" of mvule planted in a matrix of fast-growing utility species.

941. Work on camphorwood was largely concerned with increment and thinning in dense stands of root sucker regeneration.

942. The main work of the Utilisation Division included the investigation of the physical properties of *Pinus patula* and *Pinus radiata* from a number of different sites in Kenya, in anticipation of the utilisation of these species from Tanganyika plantations in years to come. Conversion, wood working, seasoning and preservation tests were done on indigenous species.

943. An investigation into the weights and shrinkage of twenty-three species was concluded. Additions were made to the natural durability and preservative trials and to the collection of authentic timber samples.

944. *Beekeeping.* The Beekeeping Division's field trials with simple bee houses for use by peasant beekeepers were not entirely satisfactory. The type of house tried was too complicated and required a degree of accuracy in construction of both house and hives which is beyond the ability of the normal African beekeeper. Work on a more simple type of house is proceeding.

945. The use of properly constructed bee houses for frame hive beekeepers in Africa has proved most successful. They have made it easy to carry out full hive management, which was not possible formerly owing to the viciousness of many strains of African bees.

946. A start was made on breeding from selected strains of African bees to improve the stock. African bees sent to Brazil for testing were found to be the most prolific, vigorous and productive bees ever encountered by the importer.

947. The bacteria *Streptococcus pluton* and *Bacterium eurydice* (European Foul Brood) were identified in African bees. This was the first record of this disease in the tropics, and the first record of any disease of bees in Tropical Africa.

**TRINIDAD AND TOBAGO**

948. *Cocoa*. Shade, spacing and fertiliser trials with clones continue to give valuable data. The plant breeding programme to produce improved clones continued. Results will be available shortly from trials with some of the early selections of clones from this programme.

949. Trials have been conducted for the control of Black Pod (*Phytophthora palmivora*) and Witches Broom (*Marasmius perniciosus*), using low volume water-based and oil-based sprays. No significant control was obtained.

950. *Ceratostomella* disease was recorded in Trinidad in March, 1958, and a survey of the Island has been undertaken to determine the intensity and distribution of the disease. Screening of clones to determine degrees of resistance has commenced. The principal shot-hole borers associated with this disease have been identified as *Xyleborus confusus* (Eichh.) and *Platypus rigulosis* (Chap.).

951. *Citrus*. In two rootstock trials, with Valencia orange and Marsh grapefruit scions, girth measurements have indicated that Dominica wild grapefruit, Sampson tangelo and Rough lemon have made significantly better growth than Sour orange, Cleopatra mandarin and Sweet orange. Rough lemon, Dominica wild grapefruit, Sweet orange and Sour orange gave significantly higher yields than Sampson tangelo. Rough lemon and Dominica wild grapefruit gave significantly higher yields than Cleopatra mandarin.

952. Transplanting trials have shown no significant difference between the bareroot and "en pilon" methods of transplanting.

953. In the tree management trials involving height of heading, height of budding and heading with training, no significant difference has yet become apparent between the different treatments.

954. No significant difference has been found in girth measurement or yield in trials involving differing practices of field management.

955. Fertiliser trials with N and N P K and lime have been laid down in the major citrus producing areas of the Island.

956. Investigations continued into the "unknown disease" of grapefruit. Results to date indicate the presence of a virus.

957. Low volume sprays are being tested for the control of Septoria spot of grapefruit, Scab, Melanose and thread-blight.

958. *Banana*. Further trials confirm that Banana Borer weevil can be controlled satisfactorily by spraying with dieldrin.

959. *Grass and Fodder*. Irrigation of Elephant grass continues to give good results—yield increases of up to 100 per cent. over controls have been obtained on irrigated plots. Investigations are in progress with the use of flail type grass harvesters.

960. *Drainage*. Preliminary investigations were carried out into the use of mole drains on fine textured soils. Further cultivation trials, aimed at finding the best method of imparting the necessary conditions for freer movement of soil water and greater aeration, were undertaken.

**Forestry**

961. The long term experiment, designed to give quantitative results of soil erosion under teak during the first 15 years of the life of plantations, continued.

962. Experiments on *Pinus caribaea* were started to determine the advantage of replacing transplant beds with transplant boxes, each box holding fifty-four plants. Since transplants must be given shade for three weeks after transplanting, a permanent shading shed was built containing ramps designed to permit the gradual and progressive introduction of the transplants to full light conditions. The boxes used for the transplants were made of pressure treated *Sterculia caribaea* and these boxes are expected to last for about six years. Indications at the end of the year were that this method would reduce the costs of plants considerably and that the final cost of each plant would be not more than three cents including cost of depreciation of shed, boxes, etc. (Cost equals 120 plants per man day.)

## UGANDA

### *Soil and Vegetation Surveys*

963. Progress in these two projects was maintained according to the original programme. Only one quarter of the Protectorate remains to be mapped as far as soils are concerned and one half for vegetation. The soil mapping is now complete for Eastern and Northern Provinces and the first draft reports are ready; Bunyoro, half of Ankole district, West Mengo and most of East Mengo have been surveyed on the 1:½ million scale and one county of Karamoja is left to be soil surveyed on the 1:50,000 scale.

964. The vegetation map of Eastern Province and its accompanying memoir were completed and the Buganda map commenced. Derived maps of Eastern Province were drawn on the scale of 1:1,000,000 to show Land-Use, Cultivation Intensity, Physiological Potential and Natural Climaxes.

### *Soil and Plant Chemistry*

965. In continuation of previous work, experiments were carried out at Kawanda to determine by what mechanisms nitrate accumulates in the top soil. Ammonia and nitrite oxidizing organisms have been found in soils from all districts in the Protectorate (except one extremely acid drained swamp soil from Kigezi, and one sodium clay from the Semliki Valley). Small field trials showed that nitrate accumulation in the top soil was reduced by spraying with sodium trichloroacetate, a microbiological inhibitor, and stopped by drying below 6.5 per cent. moisture content. All this supports the view that the main mechanism involved is microbiological nitrification.

966. The effects of soil conditions and of grass and legume fallows on the nitrogen status of the soil were also investigated. Two years fallow under *Chloris gayana* and inoculated *Stylosanthes gracilis* followed by a test crop of maize after digging in the fallow, resulted in an increase of nitrogen in the 0-6 inch soil layer of respectively 96 and 106 lbs. per acre, while if the nitrogen removed in the maize crop is added to these figures the net gain was 202 and 253 lbs. per acre; these gains were significantly greater than those under continuous cropping or a rotation of green manure followed by cotton.

967. Over 3,000 soil samples were analysed during the year, most of them submitted by the soil surveyors. Adaptations were made to the spectrograph for the porous-cup technique which enables many more elements to be accurately determined. By this method what is believed to have been

the first occurrence in Africa of magnesium deficiency symptoms in tea was confirmed in leaves collected in the Kivu district of the Belgian Congo. Selected soils were tested in pots for trace element deficiencies.

*Soil Amendments—Fertilisers*

968. Yields of seed cotton on the two fertiliser experiments at Kawanda were very low but responses to treatment were considerable. As the second residual test crop, after a complete fertiliser mixture, an increase of 83 per cent. on a 187 lbs. per acre crop of seed cotton was obtained, lime produced a further 29 per cent. increase while elephant grass ash gave 125 per cent. increase. In the same plots the following soya bean crop of 368 lbs. per acre showed an increase of 10 per cent. from the fertiliser plus lime treatment. In the "time of application of nitrogen" experiment a dressing of 2 cwts. per acre of sulphate of ammonia at squaring produced a 54 per cent. increase on a 310 lbs. per acre crop of seed cotton.

969. Further trials at Serere on a field scale with food crops have followed on the results of small plot experiments. An early planted millet crop was increased in yield by nearly 900 lbs. grain per acre by applying 40 lbs. each of nitrogen and phosphate. On this 2½ acre field the extra profit would be about Shs 300.

970. A large plot trial with groundnuts, yielding well at 1,000 lbs. shelled nuts per acre, gave a yield increment, due to fertiliser, of only 100 lbs. Field trials with dwarf, short-term sorghums have given disappointingly low yields, largely due to excessive bird damage. Attempts to increase the grain yield of this crop in the second rains by the use of fertiliser were unsuccessful, even though increased vegetative growth was obtained. It is likely that low rainfall limited the fertiliser response.

971. Trials with inorganic fertilisers were carried out on more than 400 farmers' plots of millet, throughout Teso and Bukedi. An average yield increase of 400 lbs. per acre of grain was obtained but the range was great and only about 50 per cent. of the farmers could be expected to make additional profits by using the fertiliser.

972. Responses at Labora with millet were small but a tobacco crop showed remarkable benefit from applied phosphate. Cotton, too, at this site seems likely to benefit from added phosphate and nitrogen, but yields are as yet incomplete. In Bukedi economic increases averaging 40 per cent. have been obtained with a nitrogen-phosphate mixture. Urea does not give as good results as sulphate of ammonia, and phosphate is of importance only if the nitrogen dressing exceeds 20 lbs. per acre. Splitting the nitrogen dressing had little effect but the benefit derived in the trials from row planting was quite obvious in comparison with the adjacent broadcast crop. In Bugisu 85 pairs of coffee plots are being used to study the effect of a light dressing of sulphate of ammonia on the peasant crop.

*Soil Amendments—Organic Manure*

973. At Kawanda 10 tons per acre of compost gave no benefit to an 1,800 lbs. per acre sorghum crop, neither did tie ridging to conserve moisture, help in any way.

974. The large long-term fertility experiment at Serere continued to demonstrate the value of farmyard manure. Crop yields for the last twenty years have now been statistically analysed. Earlier findings that farmyard

manure in only small quantities and infrequently applied (up to 5 tons per acre every 5 years) is the most important treatment, are confirmed. Yield differences due either to varying lengths of rest during the five year rotation, or to differing types of resting cover, are relatively small in comparison. A surprising feature is that, even under the most heavily cropped rotations without manure, the drop in productivity over the 20 year period has been relatively small. It is believed that this result has only been achieved by the strict soil conservation measures which are resultant from the lay-out of this experiment. The manurial effect is cumulative and may be best represented by the statement that each time 5 tons per acre of manure is applied an extra 70 lbs. per acre of cotton results in the immediately following crop, i.e. after the fourth application the best estimate of the yield difference between unmanured and manured plots is 280 lbs. per acre. Cotton grown two years and four years respectively after the last application of manure increases cumulatively by 55 and 35 lbs. cotton per acre per application of manure. The similar effect on sorghum is 60 lb. heads per acre, and with finger millet (grown 5 years after manure was last applied) 40 lb. heads. The groundnut effect is large and more variable, but is best estimated as a cumulative gain of 110 lbs. unshelled nuts per acre, per manuring.

975. The value to cotton of dung dropped by cattle grazing land at night during the year prior to ploughing, has also been studied. Light grazing has led to an increase in the following cotton crop of about 100 lbs. per acre compared with ungrazed fields, while very heavy grazing, resulting in a much greater concentration of dung, doubles this response. On this particular trial the assistance of the Soil Physics Section of E.A.A.F.R.O. is gratefully acknowledged. They showed that although the trampling, resultant from the heavy stocking rates, slightly reduced the acceptance of rainfall by the pasture, these differences between grazed and ungrazed plots disappeared after ploughing. However, only four months after these fields were ploughed the rainfall acceptance had dropped by nearly 60 per cent. in spite of an increase of more than 100 per cent. in the volume of large pore spaces.

### *Maize*

#### *Improvement of Local Varieties*

976. Trials over a number of years have shown that there are two varieties, Muratha and K8, which have highly desirable characters. Muratha yields very well, but it matures too late for this variety to be grown in the first rains, prior to cotton. K8, on the other hand, is an early-maturing variety, but its yielding capacity is only fair.

977. Attempts have been made to improve both varieties; in Muratha, to shorten its maturation period, and in K8 to increase its yield. This improvement was sought in two ways: by recurrent selection within each variety and by reciprocal crosses between the two varieties.

978. Using the first method, the second combination of selected lines from within each variety is now being compared with the parent material.

979. The parental material was itself derived from mass-selected strains from the original variety. In trials at 8 centres, the mass-selected bulk outyielded the parent variety by 10 to 20 per cent., but the maturation period

was not often shorter. Further improvement in yield by selection may therefore be difficult, but it is possible that a quicker-maturing Muratha can be obtained in this way.

980. Reciprocal crossing of K8 and Muratha, followed by back-crossing to the respective parent and selfing, has now resulted in the acquisition of a number of promising lines. The best selections will be bulked within each family and compared with both parents and their derivatives, in country-wide trials.

*Breeding for Resistance to Tropical American Maize Rust (Puccinia polysora Underw.)*

981. Two main sources of resistance have been supplied by E.A.A.F.R.O., namely :

AFRO 24: SLP 20 4a. A Mexican variety obtained from West Africa ;  
and

AFRO 29: Colombia 2. A white flint variety from Colombia.

982. These varieties have been widely used in the breeding programme to introduce resistant genes to the local varieties K8 and Muratha. Triple crosses of AFRO 29 x Katumbili x K8 or Muratha have also been used. Katumbili matures slightly later than Muratha and its yielding capacity is also somewhat less at Kawanda, but it was considered that greater variability would give a wider scope for selection purposes.

983. The first rust-resistant Muratha, obtained by an initial cross of AFRO 24 and Muratha, followed by backcrossing to Muratha, was compared with strains of K8 and Muratha at 12 sites in the maize-growing areas during 1958. On average, the yield of the rust-resistant strain was better than K8 and Muratha bulks, but not as good as the improved strains of these two varieties. It matured substantially earlier than the other Muratha strains, but later than the K8 strains.

984. Homozygosity for rust resistance has been established in other lines of K8 and Muratha, and these are now being multiplied for field trials in the coming season.

*Studies on Leaf Blight (Helminthosporium turcicum Pass.)*

985. With the greater use of early-maturing varieties, such as K8 and the rust-resistant strains, Leaf Blight has increased in importance, because these are more susceptible to the disease than the older varieties of the Muratha type.

986. It was found during 1957 that a twice-weekly application of Zineb increased yield, often by more than 50 per cent., although the chemical did not greatly decrease the incidence of Blight. No other disease was markedly affecting the unsprayed plots, but there may be a nutritional effect of spraying by the application of zinc and sulphur. In order to elucidate this effect, other chemicals have been compared with Zineb in field trials. Preliminary examination of the results indicates that increase of yields of similar magnitude can be obtained by spraying other dithiocarbamate salts, Thiram and Captan. The effect could not therefore be due to the zinc component, as these other chemicals do not contain zinc, but sulphur is present in all chemicals tested. Further work is required to separate the fungicidal and possible nutritional effects of sulphur.



987. The epidemiology of Leaf Blight in Uganda is very imperfectly known, and studies were commenced on this aspect 18 months ago. Trials conducted in both 1957 and 1958 have shown that mid-year plantings suffer most from Blight, as the greatest infection occurs during periods of dry weather between plant emergence and flowering.

#### *Bananas*

*Studies on Panama Disease (Fusarium oxysporum f. cubense (E.F.S.) Snyder and Hansen)*

988. In the variety trial at Kawanda, the modification of the soil conditions by the application of fertilisers and the change in inoculation methods have failed to induce infection by this pathogen. All work on varietal reaction to Panama Disease will, in future, be centred in Ankole. At one naturally-infected site at Nsika, Ankole, nine of the twenty varieties from Buganda were infected after one year's growth. Now that it is possible to obtain infection readily in these naturally-infected gardens, other varieties will be sent from Bukalasa to ascertain their reaction to Panama Disease.

#### *Sugar Cane*

*Ratoon Stunting Disease*

989. In the heat-treatment trial at Bukalasa, data from the plant and two ratoon crops show that the yield from the heat-treated setts is approximately 28 per cent. greater than that from infected cane. This is an average gain in five varieties. Some varieties such as POJ 2725 and POJ 2878 are more affected by Ratoon Stunting Disease, whereas yields of Uba and POJ 2961 are not markedly affected until the second ratoon crop.

990. Eight varieties have been released from open quarantine at Kawanda to the sugar estates, for comparison with the standard varieties. In the past, the most promising of the newly introduced varieties were selected at Kawanda for inclusion in replicated trials at the estates. It has now been found that the relative performance of the varieties can be entirely different at Kawanda. In future, all new varieties will be grown at the estates in observation plots in the first instance.

#### *Sorghum*

991. An intensive study of the Sorghum crop has been made at Serere over the past six years. It was found that the large number of varieties collected at Serere could be placed into a few definite categories and by certain ethnological groups to fit into specific farming systems. At present in the north and east, the sorghum crop is harvested at the wettest time of the year. It was concluded that longer-term sorghums are needed to be planted immediately following earlier planted first rains crops, and to come to harvest at the beginning of the dry season.

992. The deleterious factors affecting the sorghum crop are firstly grain insects, and secondly, birds. The prospect of obtaining resistance to both pests is not good; weevil resistant grains are very bird-susceptible. Grains with a fair degree of insect resistance with glumes entirely enclosing the seed have been produced, but when these ripen in July–August they are all eaten by birds in the immature stage. When these ripen in November they partly escape damage as there are then fewer birds feeding on the crop. But the problem of removing the glumes from such grains, remains to be solved.

993. Since the inception of sorghum breeding at Serere, the following progress has been made.

994. The production of various 90-day dwarf sorghum lines of similar grain type to the local varieties. But the local varieties are tall and they take more than 110 days to reach maturity. These improved lines are now being grown at Serere and a bulk of six lines is being grown at all variety trial centres in the Eastern Province, selections being made locally for both food and beer types.

995. The selection of the three sweet-grained (mealy endosperm) types which can be grown free from bird damage in the second rains, in various parts of Acholi. These have been issued to growers during 1958, and have proved very popular.

996. The establishment of various panmixia of lines, each panmixium being a bulk of varieties having certain characters in common, e.g. early or late maturity, bitter taste, corneous endosperm.

997. The work on sorghum breeding has now been handed over to a Senior Plant Breeder of E.A.A.F.R.O., who will carry out a breeding programme for the whole of East Africa at Serere.

#### *Finger Millet*

998. Agronomic trials at Serere have shown that the main problem of the finger millet crop is establishment, and that the best stand can be achieved by early sowing in rows, on new land prepared late in the previous year.

999. Blast disease, caused by *Piricularia oryzae*, destroys 10 per cent. or more of the heads in the north and east. A variety from Mozambique, No. 359, was found to be immune although infection was heavy on other varieties grown on adjacent plots. This immune variety is a large glumed form with a low threshing percentage and low yield, but it may be a useful source of resistance for crossing with the local varieties.

1000. Studies have also been made on the morphological characters of the varietal collection. The main distinguishing feature is the sequence of grain colour during ripening, and the length of the "fingers".

1001. The varieties have also been classified on their maturity periods. At Serere the earliest mature in 90-110 "drought-free" days. Most of the varieties take 100-120 days and the latest require about 115-135 days. When conditions for growth are good throughout the growing season the crop may mature up to 20 days earlier than when it is only fair. When severe drought periods intervene, the time to maturity is increased by the number of drought days.

#### *Groundnuts*

1002. Agronomic trials at Serere have shown that, under the particular climatic conditions in Teso, the best nett yields can be obtained by sowing in rows at 10 seeds per foot. The rows can either be single at a distance of two feet, or in twin rows six inches apart and  $2\frac{1}{2}$  feet between each pair. There is little difference between ridge and flat cultivation, except that it is difficult to sow twin rows on a ridge, and a single row on a ridge does not yield as well as twin rows on the flat.

*Mycology*

1003. *Beniowskia sphaeroidea* was common on elephant grass, *Pennisetum purpureum*; heavy infection occurred at Kawanda and it was also frequent at Kumi and Serere in Teso district. At Kawanda there appeared to be more infection on cut or grazed plots, and cattle tended to leave the worst affected clones. There was also a terminal leaf scorch associated with heavy infection at Kawanda.

1004. In order to assess the value of new fungicides placed on the market, spraying trials are made comparing their relative efficacy to control tomato diseases. At Kawanda, tomato crops are attacked by four major diseases: Septoria leaf spot, caused by *Septoria lycopersici*; Early Blight, caused by *Alternaria solani*; Late Blight, caused by *Phytophthora infestans* and leaf mould, caused by *Cladosporium fulvum*. One or more of these diseases attack every season, and this makes the tomato crop an ideal test host plant. Septoria leaf spot is the most common of the diseases and Maneb, Captan and Thiram were found highly efficacious in controlling it and consequently maintaining a high yield level.

*Entomology*

1005. *Cotton*. Extensive surveys have been carried out in Northern, Eastern and Western provinces. Spiny Bollworm (*Earias* spp.) was found to occur in many of the larger wild Malvaceae in all areas, including Buganda. In several isolated cotton plots in Karamoja *Earias* was present, whereas *Lygus vosseleri* could not be found, even on cereals. An extremely complex pest situation exists in Western Province, Mirids being common, *Earias* common, and several species of stainers (*Dysdercus* spp.) invading the crop, the stainer complex being very much a function of time of maturation of the crop.

1006. Laboratory experiments have shown that *Earias* larvae cause severe damage to the cotton plant, boring into growing points, removing many small fruiting points and "tattering" leaves. Extensive damage can occur at very low population levels, since, in young plants, no single boll or growing point is enough to sustain a larva through to maturity, and the larvae consequently wander extensively over one or more plants. Attempts are being made to establish a sampling technique for *Earias* that will include all its manifestations of damage. Counts in connection with this work have revealed figures of interest in relation to the shed-picture of cotton at Kawanda during the year. Over half of all sheds recorded were from monopodia, the great majority of these being basal monopodial bolls: 211 sheds were recorded from one plant over a 15-week period.

1007. Two major spraying experiments have been conducted at Serere. In both the insecticide was DDT at 1 lb. per acre. A repeat of the 1957 time of commencement trial largely confirmed the previous results. There were no significant differences between the yields from a 35, 55 or 75-days from germination spray start, but all were highly significantly better than the unsprayed control: in terms of yield per acre the difference was about 600 lbs. seed cotton. An analysis of clean and dirty cotton showed that the control and 35-day treatments had more dirty cotton than the 55- and 75-day treatments, which would indicate that the two latter treatments are best. However, in 1957, the 75-day treatment yielded no more than the control,

probably due to a dry September : in general, therefore, the experiment confirms the present recommended practice of commencing spraying at 8 weeks from germination.

1008. The second experiment was designed to test the effectiveness of reduced spray coverage ; applications were 4 at ten day intervals ; 3 at fifteen days ; 2 at twenty days and an unsprayed control, all treatments commencing at 8 weeks from germination. Final yields of seed cotton showed significant differences :—

<i>Treat</i>	<i>Yield (lb./acre)</i>	<i>L.D.S. @ 5 per cent.</i>
	Mean	
4x	801	164
3x	691	
2x	401	
0	208	

Differences significant at  $P = 0.001$

1009. The yield differences show a strong relationship to Leaf Damage counts, which revealed significant treatment differences, and to shed counts, which did not reveal significant differences.

1010. A heavy attack by tea mite (*Hemitarsonemus latus*) on Serere cotton, afforded an opportunity to check visual observations that DDT controlled this mite. Counts made on the frequency of application experiment showed, however, that varying numbers of applications of DDT had no significant effect upon mite populations, either way, neither could major differences be found in fruiting point counts on attacked and unattacked plants. It thus appears that, on the evidence so far, tea mite has little effect on the cotton plant, and DDT, within the range of applications tried, neither increases nor decreases the population.

#### *Cereal Pests*

1011. An experiment on stalk borer control was laid down at Serere on second rains sorghum. Previous work had indicated that cereal stem borers were not a serious problem in Uganda, but an experiment at Serere in 1956 showed that, in spite of apparently poor borer control, 1 per cent. DDT dust had given considerably higher yields than other treatments, including control. The 1958 trial compared a few treatments with several replicates, the treatments being 1 per cent. DDT dust at  $5 \times 1$  week intervals ; 2 per cent. dust at 5 and 3 times fortnightly intervals and an untreated control. All treatments gave a good degree of control of stalk borer, which persisted long after treatments ceased, but there were no differences in yield. This confirms the survey result that sorghum stalk borers are of little economic significance, and apart from minor work of more academic interest, that will be pursued as opportunity offers, the subject will be dropped from the section programme.

#### *Miscellaneous*

1012. The Kawanda collection of insects increased considerably during the year. A census of type material revealed almost 200 species of which paratypes are in the Kawanda collection ; current taxonomic work on Miridae, some Lepidoptera and Diptera will increase this total considerably, apart from occasional additions from material sent from overseas.

1013. The light trap has run successfully for a complete year. Comparative data on seasonal incidence can now be accumulated; already it has been shown that many major pests, e.g. *Earias* spp., *Heliothis* spp. *Cylas* spp., come in sufficient numbers to allow analyses being made. Such work enormously increases our knowledge of the annual cycles of insect pests, enabling in many instances a more rational, and therefore satisfactory, explanation of the causes underlying the incidence and activity of these insects.

#### *Stored Products Research*

1014. Two aluminium silos and one plywood silo, each of 20 tons capacity, have been erected, and a trial run, with about 15 tons of maize is under way, in one.

1015. Work on the control of Bruchids in grain legumes is nearing successful completion, as also investigations into control of maize pests in cribs of simple design. In both cases control is based upon Lindane dusting.

1016. Laboratory work into the biology of several of Uganda's major storage pests continues, and an investigation has commenced into the apparent insecticide resistance of a strain of *Oryzaephilus surinamensis*, originating from Namulonge.

1017. An extremely successful fumigation of maize at the Jinja plant was done with Phostoxin, an aluminium phosphide fumigant. A high degree of control was achieved, and it would appear that this product has a considerable future for bulk fumigation, under suitable conditions.

#### *Machinery*

1018. The main interest has centred upon machines to use in team-spraying techniques for *Antestiopsis* control. Both "ordinary" knapsacks of the hydraulic type, and motorised knapsacks have been investigated, and recommendations made. The work with the motorised knapsacks has revealed several faults of design; in some cases necessary modifications can be done here; for others it is a manufacturer's job; the necessary steps for incorporation of our suggestions are being taken.

1019. A new and promising air-blast sprayer has been tried on approximately 100 acres of (S.D. ploughed) cotton at Kasese, Toro. Again, some improvements have been suggested, but this preliminary run-up has shown that there may be considerable use for this type of machine for spraying in areas in which Special Development section is working, or e.g. in Madi where the traditional cultivation method is to open large blocks of land.

#### *Chemical Control of Couch Grass (Digitaria scalarum)*

1020. Following the success of the small scale trials on the control of couch with Dalapon reported previously, large scale trials were laid down to test the method for practical use and to obtain costings. These results confirmed that satisfactory control of the weed could be obtained in coffee with two applications, each of 5 lbs. of the chemical per acre. The quantity of water used is, of course, variable but for convenience in measuring in the field 88 gallons were used. The cost on a large scale worked out at about

86s. per acre per application. Subsequent control measures to avoid re-infestation, consist of spot treatment of any patches of the weed which are seen.

#### *Arabica Coffee Breeding*

1021. The first generation of hybrids incorporating rust resistance genes from the Sudan and Abyssinian types was planted out at Kawanda. Observation plots of a number of Mysore and Tanganyika selections shown as likely to be resistant to our rust strains were planted at a number of departmental farms.

1022. Further information obtained from the Bugisu variety trials has shown the very marked relationship between rust attack, die-back and altitude. The relationship of cropping to rust attack was clearly demonstrated: varieties showing a considerable measure of resistance throughout the season, succumbed when the crop was nearing maturity. The number of leaves carried bore an inverse relationship to the number of leaves attacked by rust. There was an interaction between varieties and centres for the amount of canopy carried. The variety K7 behaved well at all centres.

#### *Robusta Coffee Breeding*

1023. Two more clonal variety trials were planted, at Kukurairo and Nakabango. The trials at Kawanda have shown precocious and heavy bearing, typical of clonal material in comparison with seedlings.

1024. Following the discovery that receptacles would persist for up to 100 days even though unfertilised, all further compatibility testing was carried out in the laboratory.

1025. With self-pollinated flowers, in no case has the pollen tube been found to penetrate farther than the papillary layer of the stigma. There was no evidence of cross-incompatibility.

#### *Coffee Pathology*

1026. As had been suspected, the brown lesions frequently found on Robusta leaves, were caused by a *Colletotrichum*, most probably *coffeanum*, and a similar type has been isolated from lesions on berries. Sudden die-back of leaders has been associated with a *Fusarium*, producing symptoms similar to those of tracheomycosis.

#### *Coffee Pests*

##### *Antestiopsis* or *Antestia*

1027. Fundamental to any study of the biology and control of an insect, is an adequate population sampling procedure but for most coffee pests such information is lacking. Considerable effort, has been devoted to providing such an estimate for *Antestiopsis* and Berry Borer, with some success for the former and, as yet, none for the latter. Analysis of many previous *Antestiopsis* test-spray results revealed that they would fit no known distribution. This, combined with the great gaps in our knowledge of *Antestiopsis* population structure in general, rendered it very probable that the test-spray system elaborated in neighbouring territories was inaccurate. Investigations have shown that a systematic sample, of either a fixed number of trees, or a fixed percentage of trees, taken across a diagonal produced a population-frequency distribution curve that is negatively skewed, the amount of

skew depending on the general level of populations involved: a skew-normal distribution is good evidence that the sampling technique adopted is at least a considerable improvement upon previous techniques. Concurrently, investigations have been done into the efficiency of various test-spray insecticides and into other various minor matters of general technique. A standard sampling procedure, based upon ten trees taken across a diagonal, can now be recommended, of which the errors of sampling and recovery are known.

1028. Extremely good control of *Antestiopsis* by Malathion has been obtained in work in Ankole and Toro: for these areas 2 pints of a 50 per cent. concentrate per acre seems adequate. There is, however, little doubt that if pruning was timed immediately to precede spraying, one pint per acre would suffice.

1029. A pilot scheme using spray teams was carried out in the Ibanda area of Ankole in which 180 acres of coffee was sprayed at a cost which varied according to the type of sprayer used, of between 30s. and 40s. per acre. Excellent control was obtained which has continued to date. Although yield figures could not be obtained, the outturn from dried cherry from the area increased by at least 6-9 per cent. An estimate of the number of beans damaged by *Antestia* showed a drop from 39-17 per cent. Probably the greatest effect was on the morale of the cultivators, who for the first time in years took a keen interest in the cultivation and marketing of their coffee.

1030. On Elgon, *Antestiopsis* has been controlled by a DDT/Malathion mixture, but in view of the dangers involved in use of DDT on coffee, work is in progress on the evaluation of Malathion alone.

#### *Berry Borer*

1031. There is evidence from previous trials that Berry Borer can be controlled by Lindane and Dieldrin. However, it has become apparent that the successful conduct of spray trials against this pest depends in no small measure upon a satisfactory sampling technique. Spray trials have therefore been suspended while this is investigated. At present a very large mass of data accumulated from a series of trees stripped completely, and the position and condition of practically every cherry recorded, is being marshalled for analysis. Nevertheless, it is as well to point out that a considerable reduction in Berry Borer incidence can be achieved by more attention to correct harvesting practices.

1032. No control was demonstrated on the spray trial at Namalere, when the final crop yields were analysed. The population declined throughout the season because of causes other than control measures—from estate experience most probably regular and clean picking. It was found that there was a negative correlation between the size of the crop and the incidence of borer damage—another possible reason for the very low incidence of damage on well managed estates. It was also found that within a given area, the population throughout the season was correlated with the initial population.

#### *Coffee Physiology*

1033. Investigations on the cropping behaviour of Robusta coffee were continued. Examinations of more populations confirmed the strong correlation

existing between the total yield for the first four years of bearing and that for the fifteen or more years usually regarded as essential for variety testing. Examination of the cyclic bearing behaviour showed that there was a strong negative correlation between the yields in successive "on" and "off" bearing periods—in other words, the bigger the crop in an "on" period the smaller the yield in the succeeding "off". The biennial bearing habit becomes more marked with time, but the year to year differences are less as the result of a fall-off in yield with time.

#### *Coffee Agronomy*

1034. An economic response to the application of N was obtained with the small fertiliser trial at Kawanda, in spite of the very heavy application used. Foliar application of magnesium gave a negative response.

1035. The ground treatment trials at Namalere and Kituza began to show a favourable response to clean weeding whether by hand or mechanically, but further yield years will be required before it is known whether the increase is economic, and is justified by the extra soil conservation effort required.

1036. It was found that at Kituza, any form of clean weeding required the strictest attention to soil conservation; no form of all-over clean weeding is practised therefore, except where it is an experimental treatment. Terracing to a very marked degree is evident on a ten acre planting made at Kituza in April, 1958, where clean cultivation has only been carried out in the tree rows: thus it is evident that even on a three degree slope such as this, stop-washes were required at ten foot centres on the contour.

1037. A beginning was made with cocoa distribution to farmers and 4,000 seedlings were distributed to the Buganda Agricultural Services in April, 1958. Work on selection amongst the local types is continuing.

#### *Citrus*

1038. It is now accepted that virus infection is general in citrus grown in Uganda. The most disturbing feature during 1958 was the widespread decline of reputedly sweet orange seedling trees in Mengo district of Buganda. It is now suspected that these trees are actually hybrids with a susceptible species, possibly *Citrus aurantium*, and that the lack of attention paid to these trees has reduced their tolerance to the virus. New importations of sweet orange seeds have been sown at Serere, and it is hoped that the trees from those will form nucleus stocks for the replacement of the older "varieties".

#### *Pasture Agronomy at Kawanda*

1039. A range of indigenous and exotic legumes are under trial to ascertain their suitability for incorporation in ley mixtures. It has been found that the outstanding species for incorporation in leys with *Chloris gayana* or *Panicum maximum* are: *Medicago sativa*, *Calopogonium mucunoides*, *Glycine javanica* and *Trifolium semipilosum*. Species showing the most promise for association with *Pennisetum purpureum* are: *Centrosema pubescens*, *Pueraria phaseoloides*, *Glycine javanica* and *Desmodium asperum*. It has also been shown that Kawanda soils contain *Rhizobium* strains capable of fixing atmospheric nitrogen in association with a number



of tropical legumes. Species of *Trifolium*, *Medicago* and *Melilotus* do not nodulate in Kawanda soils unless previously inoculated with the effective *Rhizobium* strains, but no further inoculation is required on the same land.

1040. The most consistently productive legume has been the variety Provence of *Medicago sativa*. The regrowth after grazing is rapid and its bushy growth habit has led to an easy association with both *Chloris gayana* and *Panicum maximum*.

1041. Grazing records were started in June and already they show the value of swamp and elephant grass compared with the low stock carrying capacity of the improved permanent pastures and short grass leys. Elephant grass will be used to replace *Chloris gayana* for the following reasons:—

- (a) When planted in rows it can be kept clear of couch (*Digitaria scalarum*).
- (b) It provides high yields of nutritious herbage which is particularly valuable in the dry season.
- (c) It is deep rooting and one of the most beneficial of all ley grasses for regenerating soil fertility.

1042. Establishment of elephant grass is best achieved by mechanically ridging and planting overlapping stems along the furrow, three feet apart, covering being done by hand. Gap filling, in order to get a good stand, is essential in order to keep out weeds. Three feet rows fit in well with ox cultivation and form a quicker cover than wider rows. Varieties No. 6, No. 8 and No. 11 were observed to be slightly less palatable than the others. A white fungus *Beniowskia sphaeroidea* has infested much of the new elephant grass plantings causing the foliage to be somewhat less palatable. *Panicum maximum* promises to be another valuable grass. Lucerne grows well in association with it but cattle would not eat the lucerne under light grazing management. Out of 20 grasses planted for a quick cover on the steep area *Cynodon plectostachyum* and *Brachiaria decumbens* grew extremely well.

#### *Pasture Agronomy at Serere*

1043. *Hyparrhenia rufa* and *Panicum maximum* have outyielded other grasses in cutting trials and further trials are now concentrated on these species, together with *Chloris*. *Stylosanthes* is now considered the most promising legume. All three plants are palatable to stock and *Hyparrhenia* is able to withstand heavy grazing particularly well. A trial, both cut and grazed, demonstrates the continued spread of legumes as the ley grows older, and it has shown that “giant” *Chloris*, although yielding well initially, later falls to the production level of “local” *Chloris*. The gain in total fodder yield when a legume is included in a grass ley has been demonstrated.

1044. Elephant grass has yielded 38 tons per acre green material in its first year from five cuts. Nearly 2,000 beast-grazing days were obtained. The Kawanda varieties of this grass differ little among themselves, but the smooth type is the most palatable. The newly introduced “Cameroons” strain has greater promise.

1045. *Livestock.* At Kawanda drastic culling of unprofitable beasts reduced the herd from 175 to 131. The aim is to produce a good milking dual purpose animal and to supply heifers for a long-term Jersey-Nganda crossing programme. Largely due to elephant grass grazing and changing to the semi-range system of management, total milk produced increased by 68 per cent. over the average for the last six years despite fewer cows. Liveweight gains by young stock show similar increases.

1046. At Serere three bulls have completed their progeny tests, and six more are at present under test. Milk yields from the herd are higher than ever before (258 gallons per lactation, including 45 per cent. used by the calf) and liveweight gains, except for calves, are equal to, or better than, the previous averages. The total liveweight produced from the entire station is well up on previous figures and is a result of increased stock numbers and consequently better utilisation of available grazing.

#### *Forest Research*

1047. *Silviculture of Natural Forests.* The principle of monocyclic management having been accepted for all Uganda's high forest areas (see 1957-58 report), research techniques were consolidated accordingly. Detailed studies of natural regeneration in closed forest were continued and the results of past underplanting assessed for comparison. Valuable numerical evidence on factors affecting increment was obtained by electronic computation of increment data on four high-forest species. Crown size proved to be easily the most important single factor correlated with girth increment.

1048. *Silviculture of plantations.* The scale of plantation research was stepped up considerably in order to provide the necessary background to probable expansion of artificial afforestation in the not very distant future. The emphasis is on exotic softwoods, though the indigenous *Maesopsis* may also play an important part. Species trials were extended over a wide range of site conditions, including the hitherto relatively untried but extensive areas of forest reserve below 4,000 ft. In established softwood areas, experiments on minimum weeding requirements and thinning were laid down.

1049. *Protection.* Intensive tests were carried out on various types of electric fencing equipment as a possible means of preventing game damage to softwood crops and high-forest natural regeneration. Buffalo and antelope can be successfully controlled in this way but an effective barrier against elephant has yet to be devised.

1050. *Forest Entomology.* Ambrosia beetle attack on freshly felled high-forest logs has been effectively controlled by both BHC and Dieldrin compounds; being cheaper, the former will probably be preferred in practice. Work was continued on termites in plantations and on mvule gall.

1051. *Utilisation.* Projects completed during the year included general tests of *Pterygota mildbraedii* and peeling trials on *Lovoa brownii*, *Fagara macrophylla* and *Albizzia glaberrima*. Special strength tests were also completed on *Brachystegia microcarpa*, *B. spiciformis* and *Diospyros abyssinica* timber and on *Eucalyptus saligna* transmission poles. General tests of six further timbers and five other special projects were in progress at the end of the year.

*Publications*

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TACK, C. H.—The Strength Properties of some Uganda Timbers. *Uganda Forest Dept. Bull.* No. 5 (1958).

*Veterinary Research**Animal Diseases*

1052. Research into the causes of calf mortality and surveys on poultry disease were continued during the year. Work continued on the mouse adapted vaccine against Nairobi Sheep Disease, in collaboration with the Virus Research Institute, Entebbe. Preparatory work on the immunisation of susceptible cattle against East Coast Fever by the Aurolac technique was undertaken. Rinderpest in goats in Karamoja District was confirmed by the agar gel diffusion test towards the end of the year. During the course of laboratory work *Listerellosis* was diagnosed in lambs and a haemolytic *Pasteurella* was isolated from kids. A further strain of *B. melitensis* was isolated from an aborted bovine foetus. Studies were continued on the cattle Liver Fluke (*F. gigantica*), particular attention being paid to diagnosis, survival of infection and methods of preventing cattle from becoming infected.

*Nutritional Chemistry*

1053. Studies were continued on the digestibility of various East African hays in indigenous Zebu cattle. Special studies of the chemical composition of grasses from the pastoral areas of north-eastern Uganda were continued.

*Pasture Agronomy*

1054. Investigation was focussed on the effects of different systems of management of elephant grass, including the use of fertilisers, and cultivation under irrigation. Studies on the effects of cutting and burning of indigenous *Themeda* pasture were undertaken. Investigations were carried out by means of herbage transects into the effects on pasture of a reduction of hippopotami in the Queen Elizabeth National Park.

*Physiology*

1055. In connection with the application of Artificial Insemination in indigenous cattle, a comparison of quality, fertility and metabolism of semen obtained by electro-ejaculation and by collection with the artificial vagina was undertaken. Electrophoretic studies continued upon the absorption of globulins by newborn calves.

*Livestock Breeding*

1056. A herd of dual purpose Nganda cattle was maintained at the Livestock Experiment Station, Entebbe; fifty lactations during 1958 averaged 250 gallons, the maximum yield being 598 gallons in 305 days. Seven Kenana heifers from the Sudan completed heifer lactations in 1958 and averaged 379 gallons, with the best heifer yielding 519 gallons in 305 days. Comparative productivity studies on pure-bred Ankole Longhorn cattle and East African Shorthorn Zebu cattle were continued at the Mbarara Stock Farm. The Ankole herd maintained its superiority in milk production. The best recorded lactation in this herd was 440 gallons; nine animals produced

more than 300 gallons each, including a heifer which produced 360 gallons. Boran bulls have been imported from two well known herds in Kenya for experimental cross breeding with Ankole Longhorn cattle.

1057. Studies on the productivity of indigenous Somali type sheep and Mubende type goats were continued at the Mbarara Stock Farm. Two Dorset-horn rams have been imported from Britain for experimental cross-breeding with the Somali type sheep.

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WEINBREN, M. P., GOURLAY, R. N., LUMSDEN, W. H. R. and WEINBREN, Barbara M.—An Epizootic of Nairobi Sheep Disease in Uganda. *J. comp. Path.* **68**, 174.

#### *WEST INDIES*

1058. The Federal Government has appointed technical advisory staff, including an Agricultural Adviser, Agricultural Economist, Marketing Officer and Forestry Adviser. It has also set up a Regional Research Council "with a view to achieving a greater measure of co-ordination of research within the area than at present obtains".

#### *ZANZIBAR*

##### *Agriculture*

##### *Cloves*

1059. In preliminary observations on the effects of alpha-naphthalene acetic acid on the formation of clove flower buds, applications at a strength of 3 cc. per gallon of water gave crop increases of 150 per cent. when applied to the foliage about 5 to 6 months before the emergence of bud initials (11 to 12 months before harvest). Later applications had no effect.

##### *Cocoa*

1060. To investigate the suitability of other strains of *Forastero* cocoa for commercial production in Zanzibar, eleven strains of Upper Amazon cocoa and one strain of Amelonado were obtained from the West African Cocoa Research Institute. At the same time manurial and spacing trials with local strains of *Forastero* cocoa were continued.

##### *Rice*

1061. In trials over the past two years with rice varieties obtained from Trinidad, the three varieties Sughandi, Red American and D.52/37 did well in comparison with one of the best local varieties, giving significantly higher yields of good quality grain. Sughandi was shown to be particularly valuable in the wetter areas but disappointing in upland cultivation. D.52/37 was the most successful under dry conditions while Red American was successful in both situations. The highest yield was 3,040 lb. paddy per acre.

##### *Maize*

1062. In a trial in which maize was grown on ridges in soil known to be deficient in phosphate, the method of application of superphosphate was investigated. Applied at the rate of 2 cwt. per acre, the fertiliser was

either scattered broadcast over the land before ridging, or lined at the base of the ridges or placed in the planting sites. All three methods gave highly significant increases (900 per cent.) in yield over the control which received no superphosphate, but differences between the three superphosphate treatments were negligible. This confirms earlier work, and indicates the desirability of employing the broadcast method which is the cheapest to apply.

1063. Investigating the relation between plant spacing and fertility on the same phosphate deficient soil, a manurial dressing of 10 tons per acre farmyard manure with 2 cwt. per acre superphosphate and 1 cwt. per acre sulphate of ammonia gave yield increases averaging 2,052 lb. dry grain per acre. In both manured and unmanured plots yields continued to increase as planting distance increased and it is probable that the widest spacing (3' × 18") was too close. At these spacings there was no interaction between spacing or plant population and level of fertility.

#### *Cassava*

1064. Bulking and comparison of virus-resistant varieties received from Amani in 1957, together with earlier issues, continued at two centres. The majority of these varieties are back crosses of *M. glaziovii* × *M. utilissima* to cassava. A few involve *M. dichotoma* or tree cassava. Certain varieties consistently give significantly higher yields than the commonest local variety. Susceptibility to mosaic disease is variable but is generally considerably less in the Amani varieties than in the local strains.

#### *Wild Yams*

1065. Following enquiries by a United Kingdom drug manufacturing firm regarding wild yams as a source of diosgenin for the manufacture of cortisone, a living collection of local varieties of wild yams was built up, and yield records obtained. Samples of tubers were sent for analysis.

#### *Lantana*

1066. For the control of *Lantana camara*, which is becoming the dominant weed in parts of Zanzibar, a few specimens of *Teleonemia scrupulosa* were obtained from Kenya and released in August, 1958. They established themselves satisfactorily and have spread some 500 yards from the points of release in six months. The first most noticeable effect of the insects is a failure of the affected plants to carry flowers. Thereafter there is progressive leaf fall until the plants are stripped, all new growth being at once attacked. It remains to be seen whether the *Lantana* will recover to any degree after the main rains in April but this seems unlikely.

#### *Livestock*

##### *Artificial Insemination*

1067. Artificial insemination using the electrical stimulation method of semen collection was employed on the Kizimbani milk herd. During the first 4 months of the work cows which failed to hold to A.I. were put back to the bull after the second failure. During the remaining 7 months they were served naturally if A.I. failed at the first attempt. In the 11 months of the work 144 inseminations were made, of which 38 were repeats. Conception rate, including assumed pregnancies where cows did not return, was 41.5 per cent.

##### *Breeding for Beef*

1068. Boran bulls bred in Nanyuki, Kenya, have been introduced to ranches founded on local Zanzibar stock, in order to increase size

and rate of development. The first year's records of calves sired by these bulls show the increase in birth weight attained, 145 bull calves weighing 37.7 lb. and 161 heifer calves weighing 37.4 lb., compared with 35.5 lb. and 35.3 lb. for non-Boran calves born in 1957. Monthly records of weight are maintained up to calving or slaughter as fat bullocks. Growth rates for local bullocks are available and will be compared with those of the Boran-cross bullocks as they mature.

#### *Forestry*

1069. The forestry programme in Zanzibar includes the exploitation of two areas of natural high forest and their regeneration with worthwhile timber trees, the afforestation of a major catchment area, and the planting of low-grade land with fuel and semi-timber species. Apart from local and naturalised species including *Chlorophora excelsa*, *Calophyllum inophyllum* and *Casuarina equisetifolia*, exotics have been used, particularly *Eucalyptus camaldulensis*. Other exotic species have been under test from time to time. Of some 14 other *Eucalyptus* species tested (some for one or two years only) none appear likely to compare with *E. camaldulensis* for growth. *Casuarina torulosa* introduced from Queensland in 1957 is growing well but not so fast as *C. equisetifolia*. *Ceratonia siliqua* from Cyprus (1952) failed. Since 1951 there has been failure to establish *Pinus pinea* and *P. elliottii* both from South Africa. On the supposition that the cause might be lack of mycorrhiza, pine soil from Tanganyika and Kenya has been used, but growth was equally poor. The climate is assumed to be unsuitable. *Pinus patula* and *P. radiata* were imported for the first time in 1957. The growth of the later is slow but *P. patula* appears promising. *Araucaria cookii* imported in 1955 has grown 2 to 3 feet per year on good soil, and *A. cunninghamii* less well.

### VII. STANDING SUB-COMMITTEES

1070. In reviewing the work of the Sub-Committees for cocoa research and soils it was decided that the former was no longer necessary and that the latter would be of greater use as a consultative panel to discuss limited fields of work, particularly with soils scientists on leave from overseas. The Cocoa Research Sub-Committee has therefore been disbanded and its work will be done as necessary by the main Committee. The Soils Sub-Committee has been replaced by a Panel of consultants under the Chairmanship of Dr. H. Greene, Advisor on Tropical Soils.

1071. The Committee is grateful to the gentlemen who have served in the past on these two sub-committees, which have only been discontinued as a result of the changed pattern of research overseas.

#### *Stored Products Sub-Committee*

1072. The Sub-Committee met twice. Dr. Jepson attended the Reviewing Committee meeting of the West African Stored Products Research Unit and toured Nigeria. Dr. D. W. Hall, Liaison Officer at the Pest Infestation Laboratory of the Department of Scientific and Industrial Research, visited the West Indies and Miss Hyde visited Malta in connection with pit storage of cereals.

1073. A large number of enquiries from overseas have been dealt with and the Committee is grateful for the help it has received from the Infestation Control Division of the Ministry of Agriculture, Fisheries and Food.

Colonial  
Economic Research Committee  
Twelfth Annual Report  
(1958-1959)

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London School of Economics  
and Political Science,  
Houghton Street,  
Aldwych,  
London, W.C.2.

26th November, 1959.

SIR,

I have the honour, on behalf of the Colonial Economic Research Committee, to transmit to you the Twelfth Report of the Committee covering the period from 1st April, 1958 to 31st March, 1959.

I have the honour to be,

Sir,

Your obedient Servant,

ARNOLD PLANT,  
*Chairman.*

The Right Honourable Iain Macleod, M.P.,  
Secretary of State for the Colonies.



## COLONIAL ECONOMIC RESEARCH COMMITTEE

### Membership

PROFESSOR SIR ARNOLD PLANT, Professor of Commerce, University of London (*Chairman*).

PROFESSOR S. H. FRANKEL, D.Sc. (Econ.), Professor of Colonial Economic Affairs, University of Oxford.

PROFESSOR A. T. PEACOCK, D.Sc., Professor of Economic Science, University of Edinburgh.

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.

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

MR. A. J. PECKHAM (*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

### 12th Annual Report and Bibliography

#### I. INTRODUCTION

Two meetings of the Committee were held during the year.

2. Professor Sayers left the Committee at the beginning of the year on the expiration of his term of membership.

#### II. GENERAL

3. Issues from the Economic Research allocation in the four years up to the 31st March, 1959, amounted to £41,476.

4. New projects considered during the year are described below in Section V. Universities and research institutions were also asked for details of research in progress, or under consideration, having a bearing on the economic problems of Colonial subjects in order to assist the Committee in preparing its future programme of work.

5. The annual reports of the regional Institutes of Social and Economic Research, which appear as the appendices to the Annual Report of the Colonial Social Science Research Council, contain an account of economic research undertaken by them. An enquiry was started at the Nigerian Institute of Social and Economic Research into the economics of road communications in Nigeria. The East African Institute of Social Research is also engaged on a study of capital formation in East Africa. In Central Africa, the Rhodes-Livingstone Institute has been collecting rural family budgets with a view to ascertaining to what extent the local economy is dependent on subsistence agriculture as against remittances from the Copper belt. Work also continued during the year at the West Indies Institute of Social and Economic Research on the preparation and analysis of national accounts in the West Indies.

#### III. RESEARCH FINDINGS PUBLISHED

6. Professor Gilbert Walker's book "Transport in Nigeria" is expected to be published shortly.

#### IV. RESEARCH IN PROGRESS

7. Dr. Raeburn and Dr. Johnson completed the field work involved in their study of the economics of farming systems in Africa and the material is being written up.

8. Reports have been received from the members of the University of Durham team who have been investigating various aspects of Maltese agriculture in collaboration with the Royal University of Malta, and a final report is being prepared.

9. Mr. E. K. Hawkins completed his investigation during the year of the economics of road development in Uganda and is preparing his report.

10. Mr. Rowe has completed his report on The Economy of the Seychelles and its Future Development, which is being considered by the Government of the Seychelles.

11. Mr. J. S. G. Wilson made a first visit to the New Hebrides during the year with a view to preparing an Economic Survey of the territory and arrangements have been made for a return visit.

12. Further consideration of the general background to the question of the development of road and other communications in North Borneo suggested that the problem should be tackled in two halves: an economic study of the development prospects and an investigation of future transport needs. It was agreed in principle that a Colonial Development and Welfare scheme should be made to cover the first of these and arrangements are being made for Mr. J. R. Sargent, of Worcester College, Oxford, to undertake the second.

### V. NEW PROJECTS

13. A grant was made during the year to assist Mr. D. N. McMaster of the University College of East Africa in compiling a subsistence crop geography of Uganda.

14. Proposals have also been under consideration for research into trade in Mauritius since 1764 with a view to producing a selection of statistical material to serve as a basis for further investigation.

15. Applications were also received from the Governments of Nigeria and Uganda for assistance towards the cost of research into factors affecting industrial productivity in the two territories, as part of a joint C.C.T.A. project into absenteeism and labour turnover in various parts of Africa.

### VI. PUBLICATIONS BY WORKERS ASSISTED FROM COLONIAL DEVELOPMENT AND WELFARE FUNDS

16. 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 Eleventh Annual Report) are:—

Dosser, D. G. M.—“The Formulation of Development Plans in the British Colonies,” *Economic Journal*, 1959.

Elkan, W.—“Employment of Women:” *Inter-African Labour Bulletin*, Vol. III, No. 4.

“East African Trade in Woodcarvings:” *Africa*, October, 1958.

“The Marketing of Cotton in Uganda:” *Indian Journal of Economics*, March, 1958.

“Criteria for the Development of Industry in Uganda:” *East African Economics Review*, January, 1959.

“Central and Local Taxes on Africans in Uganda:” *Public Finance*, 1958.

“The Persistence of Labour Migration:” *Inter-African Labour Bulletin*, 1958.

“Regional Disparities in the Incidence of Taxation:” *Review of Economic Studies*.

“Labour in the Sudan:” A review article. *Inter-African Labour Bulletin*.

“Labour Migration in Africa:” *American Economic Review*.

Hawkins, E. K.—“Road Transport in Nigeria.” O.U.P., London, 1958.

Hogg, V. W.—“Review of Road Transport in Nigeria,” *J. Transport, Hist.* Vol. III, No. 4, November, 1958.

Raeburn, J. R.—“Some Economic Aspects of African Agriculture.” *The East African Economics Review*. Vol. V, No. 2, January, 1959.

Warmington, W. A.—“The Cameroons and the Fiscal Commission,” *West Africa* No. 2143. May, 1958.

“Saving and Indebtedness among Cameroons Plantation Workers.” *Africa* Vol. XXVIII, No. 4. October, 1958.

“Spare Time Activities in the Cameroons Plantations.” *West Africa* Nos. 2177 and 2178. January, 1959.

Wrigley, C. C.—“Buganda: An Outline Economic History.” *Economic History Review*. 1957.

“The Development of a Middle Class in British East Africa.” I.N.C.I.D.I. Record of 29th Session. 1955.

*To be published.*

“The Changing Economic Structure (of Buganda)” for inclusion in a volume to be edited by Dr. L. A. Fallers.

“Crops and Wealth in Uganda” to be published in the East African Series.

Colonial Fisheries Advisory  
Committee Annual Report on  
Fisheries Research  
(1958-1959)

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The Church House,  
Great Smith Street,  
Westminster,  
S.W.1.  
2nd November, 1959.

SIR,

I have the honour to transmit herewith the report of the Colonial Fisheries Advisory Committee for the year ended 31st March, 1959.

I have the honour to be,

Sir,

Your obedient Servant,

PERTH,

*Chairman.*

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

## COLONIAL FISHERIES ADVISORY COMMITTEE

**Membership**

THE MINISTER OF STATE FOR COLONIAL AFFAIRS (*Chairman*).  
MR. W. B. L. MONSON, C.M.G. (*Vice-Chairman*).  
\*DR. H. A. COLE, D.Sc.  
DR. G. E. R. DEACON, C.B.E., D.Sc., F.R.S.  
DR. C. F. HICKLING, C.M.G., Sc.D. (Fisheries Adviser to the Secretary of State).  
MR. T. S. LEACH, C.M.G., M.C.  
DR. C. F. A. PANTIN, Sc.D., F.R.S.  
DR. G. A. REAY, C.B.E., Ph.D., F.R.I.C.  
MR. F. S. RUSSELL, C.B.E., D.S.C., D.F.C., F.R.S.  
DR. E. TREWAVAS, D.Sc.  
MR R. S. WIMPENNY, O.B.E., M.Sc.  
PROFESSOR C. M. YONGE, C.B.E., D.Sc., Ph.D., F.R.S.  
MR. W. F. DAWSON, M.B.E. (*Secretary*).

**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.

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\* Joined with effect from 27th May, 1959.

COLONIAL FISHERIES ADVISORY COMMITTEE  
REPORT FOR 1958-1959

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## COLONIAL FISHERIES ADVISORY COMMITTEE

### ANNUAL REPORT ON FISHERIES RESEARCH, 1958-59

#### I. GENERAL

1. Three meetings of the Committee were held during the year. There were no changes in the composition of the Committee during that time, but Dr. Cole, successor to Mr. R. S. Wimpenny as Director of the Lowestoft Fisheries Laboratory, joined the Committee in May, 1959.

2. Professor C. M. Yonge, a member of the Committee, made two further visits to East Africa during the year to attend, as one of the Secretary of State's representatives, the 10th and 11th meetings of the East African Agricultural and Fisheries Research Council. He again visited the regional fisheries organisations at Jinja and Zanzibar, and Fisheries Departments in the territories. A further visit to East Africa was also made at local invitation by Mr. R. J. H. Beverton, of the Lowestoft Laboratory of the Ministry of Agriculture, Fisheries and Food, by kind permission of the Director. Besides advising on a variety of coastal fishing problems, in terms of development and conservation, he discussed with the East Africa Fisheries Departments his report on the state of the Lake Victoria Fisheries. While in Zanzibar, he attended a meeting of the East African Marine Fisheries Research Council.

3. The rapid progress being made in the development of the fishing industries in the dependant territories underlines the urgency of research into the problems of these fisheries, and the fish stocks which are their raw material. Yet the existing research establishments can deal only with a very limited number of continuing problems within their own region. However, as some of the problems arising can be dealt with by the secondment of specialists for limited periods of time, the Committee advised the Secretary of State that probably the best way of meeting the difficulty would be to make available, at need, the services of specialists from the United Kingdom; who, by visits of appropriate length, could bring to bear their experience and, where needed, their specialist techniques. For many years, the Colonial Office has enjoyed the co-operation of the Lowestoft Fisheries Laboratory of the Ministry of Agriculture, Fisheries and Food and as a result of the Committee's recommendation, a Colonial Development and Welfare Scheme was made during the course of the year to provide for an additional post on the establishment of the Fisheries Laboratory, at the cost of Colonial Development and Welfare research funds. This will enable the Director to release for overseas assignments an expert from his staff as required, without depleting his normal establishment.

4. Another scheme in accordance with this policy was made to enable Dr. H. D. Slack of the Department of Zoology, Glasgow University, who is in charge of the University's freshwater biological research station on Loch Lomond, to spend a year at the Tropical Fish Culture Research Station at Malacca. He had already been working at Glasgow on the factors controlling breeding in fish, with financial assistance from Colonial Development and Welfare funds and from the Nuffield Foundation. In March, 1959, by permission of the University, he started work



at Malacca on the factors which induce spawning in fishes, with special reference to the Chinese Grass Carp. This very valuable fish, which is cultivated for human consumption in fishponds on a vast scale in the Far East, has never been known to spawn in captivity. The fry have to be imported from China, where they spawn naturally in the West River. There is an important ancillary trade from Canton and Hong Kong in the export of the young of these and other valuable carp; but the cost is high and the supply has been uncertain. Success in inducing spawning in ponds would cheapen the cost of fry, and also enable this fish to be cultivated in other parts of the tropics at present far beyond the economical radius of distribution of naturally-spawned Grass Carp fry.

5. The Fisheries' Adviser, Dr. Hickling, continued to act as Director of the Malacca Institute while it was being established and while negotiations were continued with the Federal Government whereby it may enjoy independent status in Malaya under the control of a statutory Board of Management.

## II. FINANCE

6. Expenditure up to the 31st March, 1959, against the allocation of £840,000 from Colonial Development and Welfare money for fisheries research over the five-year period ending 31st March, 1960, was estimated at £519,840.

## III. REPORTS ON INDIVIDUAL COLONIAL FISHERIES RESEARCH STATIONS

### *Sierra Leone Fisheries Development and Research Unit*

7. The programme of the station continues, with emphasis on fish tagging experiments to work out the migrations of the fish, and if possible obtain some data on growth rates and mortality rates; and work on the selective effect of the meshes of trawls, with a view to advice on conservation of the fish stocks.

8. The marking of fishes caught by the trawl in the Sierra Leone estuary has now reached the point where some 5,000 fish have been marked. There have been 89 recoveries. The recovery rate was highest with the Bolster type of tag; 4.1 per cent. of Drepane marked were recovered. Over 50 per cent. of the marked fish were recovered by the Unit's own trawlers.

9. There were no fish returned from outside the estuary; and this suggests that there is little exchange of estuarine fish stocks with those on the open shelf.

10. As to the markings of bonga, a herring—or Shad-like surface-living type of fish; some 2,000 have been tagged and released, and some 1 per cent. recovered. The localities of recovery indicate very considerable movement into and out of the estuary during the dry season, which is also the main fishing season.

11. Data on mesh-selection by using trawls with different sized meshes have enabled the Unit to relate the length-girth rate of fish with the mesh-selection curve.

12. Collections of scales and otoliths of fish have been made, to see whether they bear any annual rings, or markings resembling annual rings, with the help of which an estimate of the age and rate of growth of the most important fish could be arrived at. The investigations continue, but are expected to produce only negative answers in view of previous experience.

13. The analysis of fish meals, especially for their protein content, is nearly complete.

#### *East African Fisheries Research Organisation*

14. The research policy of the Jinja research station on Lake Victoria is shifting from emphasis on original research towards a closer investigation of the effect of fishing on the stocks of fish in the lake, and the carrying out of development projects to increase these stocks of fish.

15. Ten years of original research at Jinja which are briefly reviewed, show that impressive advances have been made in all aspects of the biology and chemistry of Lake Victoria; so the shift of emphasis towards the effects of commercial fishing is based on a good knowledge of the physical and biological background.

16. It has already been shown that the bottom deposits of Lake Victoria are largely derived from plankton that has been precipitated, and contain very considerable quantities of plant nutrients that are not readily released by the normal processes of decomposition. This makes the lake less fertile than it otherwise might be.

17. The food value of this deposit has already been shown as an ingredient of the food of pigs; now it is shown that, used as a fertiliser, an application of about 10 tons of lake mud per acre to crops of finger millet gave a valuable increase in yield. The mud supplied significant amounts of nitrogen, phosphorus and sulphur.

18. Studies on the growth rate of fish in aquaria have been continued, and especially on the effects of temperature and of light. Temperature has, as might be expected, a marked effect on growth rate. After 120 days, *Tilapia zillii* kept at a temperature of 30° weighed 11 grms. as against only about half a gramme for fish kept at 19°C. These experiments can be expected to give further information on the interrelationship between age and size as factors affecting the onset of maturity.

19. In connection with these experiments, methods of cultivating the smaller crustaceans have been developed and are an essential factor in the successful rearing of fish raised from eggs artificially fertilised in the laboratory.

20. *Tilapia variabilis* was made the subject of a special investigation, in view of the fact that this fish is now assuming a greater importance in the commercial catches with the lifting of the ban on gillnets of less than 5" mesh. A tagging programme has already suggested that this fish has an even slower growth-rate than the more valuable *T. esculenta*, and that they may not be able to withstand heavy exploitation.

21. Special investigations have also been made on three other fishes of commercial importance, namely, *Clarias mossambicus*, *Mormyrus kannume* and *Labeo victorianus*, the last-named in collaboration with the Fish Division (Research) of the Kenya Ministry of Forest Development, Game and Fisheries.

*East African Marine Fisheries Research Organisation*

22. In accordance with a system of priorities laid down by the Research Council, priority has been given to deep sea tuna longlining and a survey of the North Kenya continental shelf. The third priority, to deal with the estuarine potential of the Tanganyika coast awaited a scientific officer to carry it out.

23. After a training cruise, the research vessel "Manihine" made three voyages using the floating longlines. The bait used was chiefly a small *Lethrinus* taken in large quantities at Lathom Island, but salted mackerel and sardines were also used.

24. Two of the three cruises caught fish to the extent of 14 and 56, fish for the setting of 1,575, and 1,500, hooks respectively, a catch of less than one and about three fish per 100 hooks respectively. On the third occasion some 26 fish, together with various sharks, were taken; but about half the gear was lost.

25. Much of the catch consisted of the valuable Yellowfin Tuna, but the catches also included 14 Marlins and a Sailfin.

26. From these preliminary trials, it seems that fishing just below or at the thermocline is more productive than above it. In these instances, the thermocline lay about 57 to 65 fathoms below the surface. Much more exploratory fishing is needed before the conditions and localities of good catches can be worked out.

27. The same is true of the North Kenya continental shelf. It has been found that, apart from some large features such as a submarine valley and two low submarine hills, the sea bottom may be very irregular, with hills and pits side by side.

28. In these irregularities, catches vary tremendously, and appear at present to be unpredictable; only continuous work over several years can lead to an understanding of the problem.

29. But the many line-fishing and echo-sounding trials have now reached the point where trawling could be tried on certain areas of the bank.

30. Trammel-nets were used during the year, and it was found that an average weight of 17 lb. of fish per net set was got over coral bottoms as compared with only 3½ lb. on soft bottoms. Sharks and rays formed the most important part of the catch; although they were only 39 per cent. of the fish by numbers, their large average weight made them 66 per cent. by weight.

*Northern Rhodesia-Nyasaland Joint Fisheries Research Organisation*

31. The work of this station was still hampered by a shortage of scientific staff; but research work was continued on the Bangweulu Swamps. Two visits were also made to the Zambesi, to study the changes taking place as the valley becomes flooded behind the Kariba Dam. Visits were also made at Lake Mweru and to the Kafue River; fish samples were collected and water analysed.

32. Heavy fish mortalities in the Kafue, and sometimes in Bangweulu, are due to oxygen-depleted water being drained out of swamp areas; if the fish cannot escape into better oxygenated waters, they may die.

33. In the Bangweulu Swamps, chemical analyses of water were made along various lines of stations on the main water route and in various lagoons in the main swamp. Oxygen concentration, one of the most important factors, was very low in the swamp, particularly in the papyrus zone. The oxygen concentrations in the river channels and lagoons are lowered by water from the swamp vegetation mixing with the river water flowing through the swamp, though this is offset to some degree by the photo-synthetic activity of submerged water plants.

34. Data on net fishing have been collected throughout the year from the swamp area. The distribution and relative abundance of various species of fish of commercial importance have been worked out, and correlated with the hydrological work. This again has been linked with some experimental work on the response of some species of fish to oxygen deficiency.

35. In view of the use of copper sulphate as a molluscicide in bilharzia control, experiments on the tolerance of fish to copper sulphate were carried out. One fish, the important *Tilapia macrochir*, was incapable of living in concentrations higher than 2 mg. per litre of copper sulphate, when of a length of 4 to 6 cm.

36. The systematics of the fishes of the region were overhauled, consequent upon this fish survey; and it was decided to draw up a check list of the fishes of Northern Rhodesia.

37. On Lake Nyasa, the single Research Officer of the organisation was mainly concerned with the biology of the "Usipa", *Engraulicypris sardella*. Important information has been gained on the feeding habits of this little fish, and some information on breeding cycles. A possible method of age-determination was evolved and is being tested.

38. In the field of hydrology, the transverse tilt of the thermocline was clearly demonstrated. No seasonal trend in the density of the Zooplankton was revealed.

#### *Fish Culture Research Station, Malacca*

39. The remaining swamp vegetation has been eliminated from the ponds, most of which are now in use. Protection of exposed ground against erosion has also been completed.

40. In November, 1958, there were 20 inches of rain, and utmost vigilance was needed to prevent the flooding of the ponds. An indirect effect of heavy rainfall is the leaching out of very acid material from the "gelam" swamp through which the inlet canal runs; and the water in the canal, from which the ponds are filled, may at times then have a pH as low as 3.

41. A full scale experiment was concluded on the effect of varying doses of limestone on fish production. The best dosage was about 20 cwt. of limestone per acre; this gave a fish crop of about 80 lbs. per acre per half-year. This experiment was followed by a second six-month experiment in which 20 lb. of  $P_2O_5$  at each of three limestone levels (0, 20, 40 cwts. per acre) was compared with a group of control ponds with 20 cwt. of limestone alone, and with groups of ponds containing 20 cwt. of limestone and 15 lb.  $K_2O$ , 20 lb.  $P_2O_5$  and both  $K_2O$  and  $P_2O_5$ . The results were due in May, 1959.

42. Routine observations on the chemistry and algology of the ponds continue. From time to time, algae are found in the ponds which have only previously been reported from localities thousands of miles from Malacca; suggesting that these lowly plants have a more or less universal distribution, at least in warm climates.

43. The importance of epiphytic algae and diatoms as food for fish has led to attempts to grow water plants, such as *Chara* and *Enhydris*, free from epiphytes, and to the preparation of pure cultures of algae and diatoms. It proved unexpectedly difficult but the work is continuing.

44. Two cultures of the Chinese Grass Carp have shown very fast growth. Bought respectively at the end of March and in July, 1958, as fingerlings weighing 2 grms., individuals in the two cultures had grown to about 4 kg. by March, 1959. In March, Dr. Slack, seconded from the Department of Zoology of the University of Glasgow, arrived at Malacca to investigate the possibility of breeding these fish in the ponds.

45. The *Tilapia* hybrids, crosses between the locally acclimatised *Tilapia mossambica* and a *Tilapia* not named, but of the *mossambica* group imported from Zanzibar, have given important and useful results. Briefly, when the sire in the cross is an African fish, the offspring are usually 100 per cent. males; while when the sire is a Malayan fish, the offspring have approximately the Mendelian ratio of three males to one female.

46. The effect of this is that it is now possible to stock ponds with *Tilapia*s almost wholly of one sex; and the result is very much faster growth because of the absence of breeding and consequent over-population of the ponds.

47. Four papers by members of the staff were read at the important Congress at Singapore in December, 1958, to celebrate the Darwin-Wallace centenary and the bicentenary of Linnaeus. Two papers were on algology, one on hydrology and one on the *Tilapia* hybrids. These will be published; and several other papers are published or in the press.

#### *Fisheries Research Unit, University of Hong Kong*

48. Biological investigations have continued on four important commercial fishes, namely, the Golden Thread, Wave Sea Bream, the Anchovy (*Stolephorus*), and the Yellow Croaker.

49. Research has continued on the Oyster industry of Hong Kong. Monthly samples of oysters have been taken from the Unit's experimental raft for weighing and measurement.

50. The routine oceanographic survey along four radiating lines of stations, the most westerly of which comes close to Hainan Island, was carried out in July, September and November. Data on salinity, oxygen content and pH were continued, and in addition, on phosphate and nitrate distribution, thanks to the acquisition of a Spekker double cell absorptiometer.

51. Experiments continue with non-indigenous fishing gear, and a large number of trawling stations was made covering a large area of the continental shelf. Hauls at night in shallow inshore waters have been made at regular intervals in connection with research on commercial prawns.

52. Research on inland fisheries continues with the investigation of the grey mullet, a valuable pond fish the fry of which are caught in brackish waters. In addition, research is directed towards the experimental rearing of five species of edible carp.

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53. The research vessel "Cape St. Mary" completed her trawling survey of the continental shelf off the coast of British Guiana, and the results are being worked up. Generally speaking, the best results were got in the shallow water, and the deeper water proved unprofitable for trawling.

Colonial  
Medical Research Committee  
Fourteenth Annual Report  
1958-1959

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Medical Research Council,  
38, Old Queen Street,  
London, S.W.1.  
1st October, 1959.

SIR,

On behalf of the Colonial Medical Research Committee, I have the honour to transmit to you the Fourteenth Annual Report of the Committee, covering the period 1st April, 1958, to 31st March, 1959.

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

### Membership

- SIR HAROLD HIMSWORTH, K.C.B., M.D., F.R.C.P., F.R.S., Secretary, Medical Research Council (*Chairman*).
- BRIGADIER SIR JOHN BOYD, O.B.E., M.D., D.P.H., D.T.M. & H., F.R.C.P., F.R.S. (late R.A.M.C.), formerly Director, Wellcome Laboratories of Tropical Medicine.
- MAJOR-GENERAL SIR GORDON COVELL, C.I.E., M.D., D.P.H., D.T.M. & H., Director, Ministry of Health Malaria Laboratory, Horton Hospital.
- SIR NEIL HAMILTON FAIRLEY, K.B.E., M.D., D.Sc., F.R.C.P., F.R.S., Consulting Physician, Hospital for Tropical Diseases, University College Hospital.
- PROFESSOR A. C. FRAZER, M.D., D.Sc., Ph.D., F.R.C.P., Professor of Medical Biochemistry and Pharmacology, University of Birmingham.
- PROFESSOR P. C. C. GARNHAM, M.D., D.Sc., D.P.H., Professor of Medical Protozoology, University of London.
- PROFESSOR R. M. GORDON, O.B.E., M.D., Sc.D., F.R.C.P., D.P.H., D.T.M. (late Professor of Entomology and Parasitology, Liverpool School of Tropical Medicine, University of Liverpool).
- DR. F. HAWKING, D.M., M.R.C.P., D.T.M., National Institute for Medical Research.
- PROFESSOR W. E. KERSHAW, V.R.D., M.D., D.Sc., D.T.M. & H., Professor of Entomology and Parasitology, Liverpool School of Tropical Medicine, University of Liverpool.
- PROFESSOR G. MACDONALD, C.M.G. M.D., F.R.C.P., D.P.H., D.T.M., Professor of Tropical Hygiene, University of London, and Director, Ross Institute of Tropical Hygiene.
- PROFESSOR B. G. MAEGRAITH, M.B., B.Sc., D.Phil, F.R.C.P., Professor of Tropical Medicine, University of Liverpool.
- PROFESSOR B. S. PLATT, C.M.G., M.Sc., Ph.D., M.B., Professor of Human Nutrition, University of London.
- DR. A. M. WILSON RAE, C.M.G., M.D., Ch.B., Chief Medical Officer to the Secretary of State for the Colonies.
- SIR LANDSBOROUGH THOMSON, C.B., O.B.E., D.Sc., Medical Research Council.
- PROFESSOR A. W. WOODRUFF, M.D., Ph.D., F.R.C.P., D.T.M. & H., Professor of Clinical Tropical Medicine, The Hospital for Tropical Diseases.
- DR. R. LEWTHWAITE, C.M.G., O.B.E., D.M., F.R.C.P., Colonial Office (*Secretary*).

### Terms of Reference

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



of medical research in and for the benefit of the Colonies, and, in particular, regarding:—

- (a) medical research in the Colonies financed from Colonial Development and Welfare funds ;
- (b) the promotion of such basic and long-term work as is required to be based on the United Kingdom and the supervision of workers engaged for this purpose ;
- (c) the promotion of work in, and for, the Colonies by workers in home universities and research organisations.

In addition the Committee will serve as a focus and clearing house of information.

#### SUB-COMMITTEES

##### MALARIA

BRIGADIER SIR JOHN BOYD, O.B.E., M.D., F.R.C.P., F.R.S. (*Chairman*).  
 MAJOR-GENERAL SIR GORDON COVELL, C.I.E., M.D., D.P.H., D.T.M. & H.  
 SIR NEIL HAMILTON FAIRLEY, K.B.E., M.D., D.Sc., F.R.C.P., F.R.S.  
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 PROFESSOR G. MACDONALD, C.M.G., M.D., F.R.C.P., D.P.H., D.T.M.  
 PROFESSOR B. G. MAEGRAITH, M.B., B.Sc., D.Phil., F.R.C.P.  
 DR. A. M. WILSON RAE, C.M.G., M.D., Ch.B.  
 DR. F. HAWKING, D.M., M.R.C.P., D.T.M. (*Secretary*).

##### HELMINTHIASIS

PROFESSOR W. E. KERSHAW, V.R.D., M.D., D.Sc., D.T.M. & H. (*Chairman*).  
 BRIGADIER SIR JOHN BOYD, O.B.E., M.D., F.R.C.P., F.R.S.  
 PROFESSOR J. J. C. BUCKLEY, D.Sc., Professor of Helminthology, University of London.  
 SIR NEIL HAMILTON FAIRLEY, K.B.E., M.D., D.Sc., F.R.C.P., F.R.S.  
 DR. F. HAWKING, D.M., M.R.C.P., D.T.M.  
 DR. R. LEWTHWAITE, C.M.G., O.B.E., D.M., F.R.C.P.  
 DR. J. NEWSOME, M.D., D.T.M. & H., Director, Medical Research Council Group for Research on Bilharzia Disease, St. Albans.  
 DR. A. M. WILSON RAE, C.M.G., M.D., Ch.B.  
 DR. J. WALKER, D.Sc., Ph.D., D.Phil., National Institute for Medical Research.  
 DR. T. WILSON, C.B.E., M.D., D.P.H., D.T.M. & H., Senior Lecturer in Tropical Hygiene, University of Liverpool (*Secretary*).

##### LEPROSY

BRIGADIER SIR JOHN BOYD, O.B.E., M.D., F.R.C.P., F.R.S. (*Chairman*).  
 DR. A. R. D. ADAMS, M.D., F.R.C.P., Senior Lecturer in Tropical Medicine, Liverpool School of Tropical Medicine, University of Liverpool.

- DR. E. M. BRIEGER, M.D., Honorary Pathologist, Papworth Hospital, Cambridge, Member of the Strangeways Research Laboratory, Cambridge.
- DR. S. R. M. BUSHBY, Ph.D., Wellcome Research Laboratories.
- PROFESSOR G. A. H. BUTTLE, O.B.E., M.R.C.S., L.R.C.P., Wellcome Professor of Pharmacology, School of Pharmacy, University of London.
- DR. R. G. COCHRANE, M.D., F.R.C.P., Technical Medical Adviser, American Medical Missions.
- DR. P. M. D'ARCY HART, C.B.E., M.D., F.R.C.P., National Institute for Medical Research.
- PROFESSOR S. D. ELEK, M.D., D.C.P., Ph.D., Professor of Bacteriology, St. George's Hospital Medical School, University of London.
- SIR NEIL HAMILTON FAIRLEY, K.B.E., M.D., D.Sc., F.R.C.P., F.R.S.
- DR. F. HAWKING, D.M., M.R.C.P., D.T.M.
- DR. G. R. F. HILSON, M.D., Reader in Bacteriology, St. George's Hospital Medical School, University of London.
- DR. D. G. JAMISON, B.M., B.Ch., Lecturer in Physiology, Corpus Christi College, Oxford.
- DR. E. MUIR, C.M.G., C.I.E., M.D., F.R.C.S.E., LL.D., Hon. Medical Adviser, British Leprosy Relief Association.
- DR. R. J. W. REES, B.Sc., M.B., National Institute for Medical Research.
- DR. D. S. RIDLEY, B.Sc., M.B., Pathologist, Hospital for Tropical Diseases, University College Hospital.
- PROFESSOR J. M. ROBSON, M.D., D.Sc., F.R.S.E., Professor of Bacteriology and Immunology, University of London.
- DR. J. ROSS INNES, M.D., D.T.M., Medical Secretary, British Leprosy Relief Association.
- PROFESSOR E. T. C. SPOONER, M.D., Professor of Bacteriology and Immunology, University of London.
- DR. A. G. MCD. WEDDELL, M.D., D.Sc., Reader in Human Anatomy, University of Oxford.
- DR. R. LEWTHWAITE, C.M.G., O.B.E., D.M., F.R.C.P. (*Secretary*).

#### MOLLUSC-BORNE DISEASES

- PROFESSOR G. MACDONALD, C.M.G., M.D., F.R.C.P., D.P.H. (*Chairman*).
- PROFESSOR J. J. C. BUCKLEY, D.Sc.
- PROFESSOR R. M. GORDON, O.B.E., M.D., Sc.D., F.R.C.P., D.P.H., D.T.M.
- PROFESSOR A. GRAHAM, B.Sc., D.Sc., Professor of Zoology, University of Reading.
- PROFESSOR P. L. LEROUX, D.Sc., M.R.C.V.S., Reader in Medical Parasitology, University of London.
- PROFESSOR W. E. KERSHAW, V.R.D., M.D., D.T.M. & H.
- PROFESSOR B. G. MAEGRAITH, M.B., B.Sc., D.Phil., F.R.C.P.
- DR. O. D. STANDEN, D.Sc., Wellcome Laboratories of Tropical Medicine, London.

- DR. E. L. TAYLOR, C.B.E., D.V.Sc., D.V.H., N.D.A., N.D.D., Central Veterinary Laboratory, Weybridge.
- DR. C. A. WRIGHT, B.Sc., A.R.C.S., Ph.D., D.I.C., British Museum (Natural History), London.
- DR. J. NEWSOME, M.D., D.T.M. & H., Director, Medical Research Council's Group for Research on Bilharzia Disease, St. Albans (*Secretary*).

## PERSONNEL

- PROFESSOR G. MACDONALD, C.M.G., M.D., F.R.C.P., D.P.H., D.T.M. (*Chairman*).
- MR. J. G. DUNCAN, M.A., LL.B., Assistant Secretary (Personnel), Medical Research Council.
- DR. A. M. WILSON RAE, C.M.G., M.D., Ch.B.
- DR. R. LEWTHWAITE, C.M.G., O.B.E., D.M., F.R.C.P. (*Secretary*).

## ADVISORY WORKING-PARTY ON THE SICKLE-CELL TRAIT AND SICKLE-CELL ANAEMIA

- PROFESSOR A. W. WOODRUFF, M.D., Ph.D., F.R.C.P., D.T.M. & H. (*Chairman*).
- DR. A. C. ALLISON, D.Phil., B.M., National Institute for Medical Research, London.
- PROFESSOR P. C. C. GARNHAM, M.D., D.P.H.
- DR. H. LEHMANN, M.D., Sc.D., Ph.D., M.R.C.P., F.R.I.C., St. Bartholomew's Hospital, London.
- DR. R. LEWTHWAITE, C.M.G., O.B.E., D.M., F.R.C.P.
- PROFESSOR B. G. MAEGRAITH, B.Sc., D.Phil., M.B., F.R.C.P.
- DR. A. E. MOURANT, D.M., D.Phil., M.R.C.P., Blood Group Reference Laboratory, Lister Institute of Preventive Medicine, London.
- DR. A. B. RAPER, B.Sc., M.D., M.R.C.P., D.T.M. & H., Department of Pathology, Bristol Royal Infirmary, Bristol.
- DR. J. A. FRASER ROBERTS, M.D., D.Sc., F.R.C.P., Clinical Genetics Research Unit, Institute of Child Health, Hospital for Sick Children, Great Ormond Street, London.
- DR. J. C. WHITE, M.B., Department of Pathology (Haematology), Postgraduate Medical School, London.
- DR. P. O. WILLIAMS, M.B., M.R.C.P., Medical Research Council.
- DR. G. H. BEAVEN, M.Sc., Ph.D., Medical Research Council Laboratories, Hampstead, London (*Secretary*).

COLONIAL MEDICAL RESEARCH COMMITTEE  
FOURTEENTH ANNUAL REPORT

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## COLONIAL MEDICAL RESEARCH COMMITTEE

### WORK OF THE COMMITTEE

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

Professor R. M. Gordon relinquished the Chairmanship of the Helminthiasis Sub-Committee, which he had held with distinction for many years, on his retirement from the Chair of Entomology and Parasitology at the Liverpool School of Tropical Medicine. Professor W. E. Kershaw, his successor to the Professorial Chair at Liverpool, accepted the invitation to become the Chairman of the Sub-Committee and a member of the main Committee.

#### *Development of Research Schemes*

2. Fifty-one research projects are in varying degree under the scientific aegis of the Committee. They range from large units, independent and self-contained or attached to existing research organisations and Colonial universities, to projects providing fully or in part for single investigators in the field or in the laboratory. In addition, many grants were made for home-based scientists to visit one or more overseas units, for the rapid transport of research material, and for the purchase of sundry pieces of apparatus. 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 the mutual scientific profit of home-based and overseas research workers.

The Committee has given increasing attention to the fostering of research in *schistosomiasis*. The Mollusc-Borne Diseases Sub-Committee has surveyed current work and considered priorities for study. It is in close contact with the Bilharzia Co-ordinating Committee in the East African territories. It is hoped to strengthen the research group investigating schistosomiasis at the East African Institute for Medical Research at Mwanza, Tanganyika, and the East African Institute of Malaria and Vector-Borne Diseases at Amani, Tanganyika. Another biologist will be posted to Mwanza by the Medical Department of the Tanganyika Government. Funds have been provided to secure the collaboration and co-ordinating rôle of Professor L. C. Beadle of Makerere College, whose investigations on swamp ecology are very pertinent to some aspects of schistosomiasis; and a young malacologist, who has completed three years of special training in Britain and nearby countries, is being assigned to him. A second trainee in malacology has recently been appointed.

New projects initiated include studies on hypertension in Jamaica, the toxæmias of pregnancy in Hong Kong, nutrition at the University College of the West Indies, Jamaica, and the arthropod-borne viruses at the London School of Hygiene and Tropical Medicine.

#### *Personnel*

3. The Personnel Sub-Committee has continued to advise on all medical appointments to the Research Branch of Her Majesty's Overseas Civil Service, and to scrutinise annually the emoluments of all members of that Service. During the year seven new overseas postings were made, one of them

a former Colonial Research Student, and two or them Colonial Research Fellows. Four Students are under training in Britain prior to posting overseas. Two officers resigned, one on completion of his short-term project.

#### *Finance*

4. The appropriate apportionment of funds allocated to medical research under the Colonial Development and Welfare Act of 1955 necessitated 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 varying financial participation of the Governments of Colonial territories. The valued collaboration of the Government of Ghana, in finance, personnel and other research facilities, has continued in the existing and projected medical research activities sponsored by the West African Council for Medical Research.

#### *Oversea Visits*

5. Seven members of the Committee and five members of the Sub-Committees visited various research units in the field, four of the latter to undertake short-term research projects.

### **REGIONAL ORGANISATIONS FOR MEDICAL RESEARCH IN THE COLONIAL TERRITORIES**

#### *East African Council for Medical Research*

6. This Council held its fifth meeting in Nairobi in February, 1959, which was preceded by a meeting in Kampala of its Scientific Advisory Committee and by a three-day Scientific Conference on "Cardiovascular Disease in East Africa." The Conference was opened by His Excellency the Governor of Uganda, and its President was Professor J. McMichael of the Post-Graduate Medical School of London. Some 60 scientists attended each day.

Sir Gordon Covell and Professor A. W. Woodruff, as delegates of the Colonial Medical Research Committee, participated in all meetings and visited each medical research unit in the region.

#### *West African Council for Medical Research*

7. The fourth meeting of this Council was held in Jos, Northern Nigeria, in February, 1959. It was preceded by a meeting of its Standing Scientific Committee and by the first Scientific Conference to be held under the auspices of the Council. The subject of the Conference was "Tuberculosis and Leprosy." It was opened by the Premier of Northern Nigeria, Alhaji Sir Ahmadu Bello; the President was Dr. R. Lewthwaite; Professor F. R. G. Heaf, Professor A. W. Williams, Dr. R. J. W. Rees and Dr. J. Pepys participated, their visits being assisted by funds provided from Colonial Development and Welfare research funds at the recommendation of the Committee. The two delegates of the Committee, Professor B. G. Maegraith and Professor P. C. C. Garnham attended all meetings, and visited the medical research units in the West African region. Some 100 scientists were present on each day of the Conference.

#### *Standing Advisory Committee for Medical Research in the British Caribbean*

8. This Committee held its fourth meeting in April, 1959, in Georgetown, British Guiana. The Committee has been fortunate to secure as its Chairman

Mr. B. H. Easter, C.M.G., a former Director of Education in Jamaica with long experience of affairs in the Caribbean region. The meeting was preceded by a Scientific Conference on "The Problems of Clinical Medicine and Surgery in the Caribbean", with Sir George Pickering, Regius Professor of Medicine at Oxford, as President. The Conference was formally opened by His Excellency the Governor of British Guiana, and was attended by some 70 medical scientists from the various island territories and from British Guiana and British Honduras. Sir George Pickering and Professor A. C. Frazer, as the delegates of the Colonial Medical Research Committee, visited the various medical research units throughout the region.

### REVIEW OF THE WORK IN PROGRESS

9. In addition to the reports from the research units under the scientific aegis of the Committee, summaries are included of medical investigations made by research units wholly or in part supported by the Governments of British Colonial Territories or Trust Territories or by research organisations based in Britain. For continuity of context most of these are placed immediately after kindred reports from the units under the aegis of the Committee.

#### *Helminthiasis*

##### (a) *Loiasis in the Cameroons and Nigeria*

10. *Entomological aspects.* At Kumba in the British Cameroons the Helminthiasis Research Unit under Dr. B. O. L. Duke, in a two-year study of the population densities and infection-rates of *Chrysops silacea* and *C. dimidiata* in Kumba forest, has demonstrated the difference in the seasonal biting densities of the two species, and it is now possible to compute a comparative index of the monthly risk of infection from the bites of *Chrysops* at Kumba. Around Kumba *C. longicornis* has recently been taken in small numbers on the wing, and its ability to act as a vector of *Loa* is being investigated more thoroughly.

11. *Work on Chrysops larval diagnostics* continues, but the problem becomes more complex the further it is pursued. The original tentative key for the identification of species has had to be abandoned and no simple means of identification is yet forthcoming. Field studies on *Chrysops* oviposition have revealed that most egg masses are laid in the afternoon. Plants are preferred to stakes as oviposition sites and egg masses are deposited only over wet mud surfaces.

12. In the laboratory, tests of the effects of D.D.T., gamma B.H.C., Dieldrin and Aldrin on *Chrysops* and *Tabanus* larvae are now almost complete. Dieldrin is the most potent insecticide for use against *Chrysops* larvae in the laboratory. In the field, breeding sites were sprayed with the four insecticides at a rate of 4 pints of 2.5 per cent. emulsion per 100 square feet. One series of experiments was carried out during the dry season and another during the wet season. Samples of mud from the treated sites are taken for chemical analysis at intervals of three, six, nine and twelve months after application; after three months mud sprayed with Dieldrin, Aldrin and D.D.T. was still lethal to *Chrysops* larvae, but samples taken after six and nine months showed that only Dieldrin-treated mud retained a lethal action on the larvae. Attention is therefore being concentrated on Dieldrin; a trial control scheme using this insecticide will begin at Kumba early in 1960.

13. *Parasitological and pathological aspects.* The long-term study of the hybrid strains of *Loa* mentioned in previous reports continues.

A study is being made of the skin reaction of man to the bites of uninfected *Chrysops* and to the bites of flies carrying infective forms of human and monkey *Loa*. The migrations of the parasite in the vertebrate host immediately after deposition by the fly are being studied. Movement away from the site of bite is fairly rapid, but there is no evidence yet that the worms migrate elsewhere than in the subcutaneous tissue and the inter-fascial planes.

14. Several compounds have been tested on monkeys as possible prophylactics for infection with *Loa*; MSbW, TWAs and TWSb (Friedheim) showed no prophylactic action; tests continue with diethylcarbamazine, pentamidine, and a new compound M & B 2948A.

A control scheme using Banocide in an attempt to eliminate the micro-filarial reservoir and thus control transmission of loiasis is now in progress on the rubber estate of Pamol Limited at Sapele. Pre-treatment fly dissections were done throughout 1958, and the blood survey of the population and Banocide dosage was begun early in 1959.

#### (b) *Onchocerciasis*

15. In the British Cameroons two comparative trials of suramin have begun, using a low total dosage of 2.7 g. spread over a period of 5 days and 5 weeks respectively, designed, in conjunction with previous trials, to find the optimum regimen of the drug against onchocerciasis. Trials of TWAs (Friedheim) and repeated courses of Banocide have also begun. Four cases were treated with Macrocydon, in up to five weekly doses of 20 cc.; the drug had no lethal action on microfilariae nor did it modify the subsequent reaction to Banocide.

16. Dr. D. J. Lewis, of the external scientific staff of the Medical Research Council, made studies in Kenya, Uganda and Tanganyika of the *Simuliidae*, some species of which are vectors of onchocerciasis. These and other entomological studies by him are recorded later at paragraphs 151-155.

#### *Publications*

DUKE, B. O. L.—(1958) "The intake of the microfilariae of *Acanthocheilone-ma streptocerca* by *Culicoides milnei*, with some observations on the potentialities of the fly as a vector." *Ann. trop. Med. Parasit.*, **52**, 123.

*Idem* and BEESLEY, W. N.—(1958) "The vertical distribution of *Simulium damnosum* bites on the human body." *Ibid.*, **52**, 274.

*Idem* and WIJERS, D. J. B.—(1958) "Studies on loiasis in moneys. I—The relationship between human and simian *Loa* in the rain-forest zone of the British Cameroons." *Ibid.*, **52**, 158.

#### (c) *Filariasis in East Africa*

17. Dr. P. Jordan, of the East African Institute for Medical Research at Mwanza, Tanganyika (Director: Dr. E. G. Holmes), reports that the treatment regimes in the pilot scheme for controlling bancroftian filariasis on Ukara Island in Lake Victoria, described in detail last year, were completed in July. Of those persons originally positive, a few still showed microfilariae



in their blood (3–7 per cent. in different villages). The microfilariae in these were generally scanty. There was some evidence that a few cases were partially resistant to the drug. Follow-up examinations continue.

18. *Culex fatigans* larvae were reared in media containing Na<sup>22</sup>. The emerging mosquitoes were radioactive to such an extent that their normal habits were affected, and they refused to take a blood-meal. Trials with Co<sup>60</sup> have begun, and highly radioactive mosquitoes, apparently unaffected by their radioactivity, have been obtained, and will be further studied.

As a preliminary to using sodium fluoride in the treatment of bancroftian elephantiasis, serum calcium levels were investigated. Contrary to reports from India, where the drug is claimed to act by reducing high serum calcium values, the serum calcium was within normal limits.

#### Publications

JORDAN, P.—(1958) "An attempt to eradicate bancroftian filariasis on Ukara Island." *E.A. med. J.*, **35**, 457.—(1958) "Action of diethylcarbamazine *in vitro* on infective larvae of *Wuchereria bancrofti*." *Brit. J. Pharmacol.*, **13**, 318.—(1959) "A pilot scheme to eradicate bancroftian filariasis with diethylcarbamazine. Results of the first year's treatment." *Trans. R. Soc. trop. Med. Hyg.*, **53**, 54.—(1959) "A note on the effect of a blood meal on infective larvae of *W. bancrofti* in *Culex fatigans*." *Ibid.*, **53**, 148.—(1959) "The possible role of low density microfilaraemia in the spread of *W. bancrofti* in East Africa." *Ann. trop. Med. Parasit.*, **53**, 42.

#### (d) Guinea-worm

19. Dr. S. D. Onabamiro, in studies on the possibility of utilising frogs infected with the larvae of the nematode parasite, *Camallanus lacustris*, in village ponds to reduce the incidence of guinea-worm infection in rural areas in Nigeria, obtained indications that the method might succeed if applied to small ponds in the rain forest areas. The frog *Xenopus sp.*, highly susceptible to infection by *C. lacustris*, was commonly found in ponds in such areas, and, when introduced into new ponds, readily adapted itself to the new environment. The introduction of a frog infected with *C. lacustris* rendered the others infected within a few months. The results obtained on other aspects of the investigation, viz., the rate at which the frogs discharge the larvae of *C. lacustris* into water, the span of life of free living *Camallanus* larvae in pond water, and the degree of selection of *Cyclops* of both the larvae of *C. lacustris* and *Dracunculus medinensis* when these are available in approximately equal numbers, are so far inconclusive.

20. People in several villages in the Western Region have now been persuaded to use the brass sieve devised for straining out *Cyclops* from pond water before drinking. A hundred families using this method of guinea-worm prevention were selected for observation from four villages in the Ijebu Province of the Western Region. They number 860, excluding infants less than one year old; of them 238, 192 and 304 suffered from guinea-worm infection 3 years, 2 years and 1 year respectively before the introduction of this method. By July, 1959, the method will have been in operation for one year, and assessment of the incidence of infection during the following year should indicate the degree of efficacy of this method.

Small scale experiments have begun on the use of DDT for destroying *Cyclops* in village ponds, based on similar work previously done in Ghana.

#### Publication

ONABAMIRO, S. D.—(1958) "*Dracontiasis*," in "Diseases of Children in the Subtropics and Tropics" (pages 815-821). By H. C. Trowell and D. B. Jelliffe. LONDON (Edward Arnold).

#### Malaria

##### East Africa

21. At the East African Institute of Malaria and Vector Borne Diseases at Amani, Tanganyika, activities during the year have continued to be divided between fundamental research, the application of knowledge to East African problems, and the dissemination of knowledge among those concerned in the application of anti-malaria measures in East Africa, or even elsewhere. Losses of valuable staff members have been balanced by accessions, and the team at Amani, although still incomplete, is now as strong as it has been in the past. While therefore certain lines of study have come to a pause, other long postponed projects are now being initiated, and in particular these include the question of population movements of *Anopheles gambiae*, and a more detailed ecological study of bilharzia snail vectors and their incrimination as vectors, coupled, in another direction, with a more solid contribution to the "building out" of insect vectors of malaria from urban areas and development projects.

22. Training was provided in one course for European Health Inspectors from Kenya and Uganda, and later in the year for Assistant Health Inspectors and other Medical Department staff from the three Territories. Instruction has also been made available to individual visitors.

Among the numerous scientific visitors, Dr. D. J. Lewis, in the course of a month's stay, examined the *Simulium* fauna of the Amani streams, and made introductory studies of the bionomics of the adult flies. (See also paragraph 153.)

23. Although the Director was on overseas leave during the year, he was able to make two extended tours of Uganda and Kenya. In the course of these he found time for a reconnaissance in certain localities in Uganda, and in the Machakos district of Kenya, which are of special interest from the malaria standpoint. Close collaboration with the W.H.O.-assisted Malaria Control Project in Zanzibar and Pemba has continued. The entomologist has given personal attention to the entomological assessment of the project in the island of Pemba. A particularly dry season interfered with plans for an anopheline dispersion experiment in that island.

Publications during the year covered a range not only of research results, but also of reviews of present knowledge. Dr. Gillies' translation and review of recent Russian work on age-grading of *Anopheles* calls for mention, although the application of that work to East African *Anopheles* has proved unexpectedly difficult. The changes on which interpretation of age is based are not equally visible in all groups of mosquitoes.

24. By means of the release of some 50,000 marked mosquitoes, the study of dispersal and survival of *Anopheles gambiae* has been actively continued. From an analysis of the 1 per cent. recaptured, it has been concluded

that they have a daily mortality of around 17 per cent. This is rather higher than the calculated natural mortality, and the figures indicate that it is probably independent of the age of the mosquito. Few appear to stray beyond  $1\frac{1}{2}$  miles from their point of release in the foothill area around Muheza.

25. The anopheline assessment in the Taveta-Pare Scheme has not shown any new trends in mosquito behaviour, nor in the susceptibility of *Anopheles gambiae* and *funestus* to Dieldrin. But it does seem that, from the greater proportion of survival in "untreated" houses recorded this year, the indigenous local routine of hut repair and reconstruction can be of relevance to the timing of spraying. A more detailed study of the atypical *funestus* species and varieties occurring in the area is being made. Bed bugs and domestic culicines are now highly resistant to Dieldrin.

The sixth and final cycle of spraying was completed in March, 1959. The cost of spraying the 17,500 houses treated on this round was further reduced to Shs. 3/75 per house.

26. The opportunity has been taken to study the circumstances, and the amount, of the exposure of the spraymen to Dieldrin. The mean daily sum of skin exposure was about 1.8 mg. per kilo of body weight. This level of exposure has resulted in a single instance of mild Dieldrin intoxication, which became manifest during the last spray round. The individual concerned was known to be careless in the carrying out of protective drills and it is likely that his exposure was at a somewhat higher level than the average figure quoted. The practicability of measuring the urinary excretion of Dieldrin by these spraymen has been explored; a technique has had to be elaborated and has proved to be time-consuming. Thus some backlog of material remains for examination before conclusions can be drawn.

27. On the human aspects of the Taveta-Pare experimental project, the vital statistics collected indicate an increased fertility and a declining infant mortality since the inception of spraying. There has also been maintained the rise in haemoglobin levels and the downward shift from the common African patterns of high gamma globulin values in the blood sera of the younger age groups. These findings are to be related to the great drop in the frequency and density of parasite infestation in children up to adolescence and the level has continued to fall during the year.

But there still remain parasite rates that lie around 10 per cent. in older children, and an intensified effort has been made to elucidate the basis of these rates. Although very few infections are still found among infants, a proportion of these seem to be acquired within the area of control, the remainder from outside visits. With increasing age such visits become more frequent. The further drop in the parasite rates suggests the continued waning of a residual parasitaemia. Little or no effect on general health has been observed in the records from dispensaries and schools. Analysis of anthropometric measurements is now in train.

A continuation of observations when this main scheme ends in June, 1959, is projected.

28. Work on the sorption of Dieldrin was interrupted by the departure of the W.H.O. chemist in May. His work confirmed that, in the East African muds examined, the sorption of Dieldrin was, broadly, related inversely to average soil particle size. A further investigation in the insecticide field has been a review of the value of spreading agents added to oil larvicides containing DDT. Experience under a variety of conditions indicates that no additional kill can be observed as compared with oil solutions containing no spreading agent.

29. In the engineering field the staff was strengthened by the appointment of a W.H.O. engineer in April. The two engineers have collaborated in carrying out surveys, and in the preparation of plans, for drainage schemes covering part, or the whole, of seven East African towns. Development of some items of desirable equipment has taken place at Amani, and trials of cheaper methods of drain lining instituted.

It is a pleasure to recognise the more active co-operation from those directly concerned in development work. Preliminary steps were taken to undertake joint technical studies on the feasibility of reducing the risks to health which appear to have arisen in certain areas of Uganda following the construction of dams.

#### *Publications*

CHRISTIE, M. G.—(1958) "Predation on larvae of *Anopheles gambiae*." *J. trop. Med. Hyg.*, **61**, 168.—(1958) "Improved collection of anopheline eggs and analysis of oviposition behaviour in *A. gambiae*." *Ibid.*, **61**, 282.—(1959) "A critical review of the rôle of the immature stages of anopheline mosquitoes in the regulation of adult numbers with particular reference to *Anopheles gambiae*." *Trop. Dis. Bull.*, **56**, 385.

GILLIES, M. T.—(1958) "Review of some recent Russian publications on the technique of age-determination of Anopheles." *Trop. Dis. Bull.*, **55**, 713.—(1958) "A simple autoradiographic method for distinguishing insects labelled with phosphorus-32 and sulphur-35." *Nature*, **182**, 1683.—(1958) "Notes on the biology of a new subspecies of *Anopheles wellcomei* from East Africa, and on the distribution of related forms." *Proc. R. ent. Soc. Lond.*, (A), **33**, Parts 1-3.

FLETCHER, T. E., PRESS, J. M., and WILSON, D. B.—(1959) "Exposure of spray-men to Dieldrin in residual spraying." *Bull. Wld. Hlth. Org.*, **20**, 15.

PRESS, J. M.—(1959) "Measurement of adsorption of residual insecticides using flowing chromatography." *Ibid.*, **20**, 153.

SMITH, A.—(1958) "Dieldrin-resistance in *Cimex hemopterus* in the Pare Area of North-East Tanganyika." *Ibid.*, **19**, 1124.—(1958) "Outdoor cattle feeding and resting of *A. gambiae* and *A. pharoensis* in the Pare-Taveta area of East Africa." *East African med. J.*, **35**, 559.—(1959) "Effect of residual house spraying in the plains on anopheline densities in huts on the Pare Mountains." *Nature*, **183**, 198.

*Idem* and DRAPER, C. C.—(1959) "Malaria in the Taveta Area of Kenya and Tanganyika. Part I. Epidemiology." *East African med J.*, **36**, 99.

YEO, D., and WILSON, D. B.—(1958) "Aircraft applications for anopheline control: Prevention of a seasonal increase with a granulated formulation of Dieldrin." *Ann. trop. Med. Parasit.*, **52**, 402.

#### *Trinidad*

30. The Government Malariologist, Trinidad, Dr. F. R. S. Kellett, reports much progress in curbing the incidence of malaria due to *Anopheles bellator* which poses special problems in that this vector bites out of doors, and breeds in species of Bromeliad epiphytes growing predominantly on the "Immortelle" shade trees in cocoa plantations. Many of the recommendations made by Professor Pittendrigh in his report, referred to last year, have been adopted. Improvements in spraying equipment and tactics have brought hitherto inaccessible shade trees within range of the copper sulphate spray. The use of anti-malarial drugs for prophylaxis and therapy has been intensified. A marked decline in incidence in the purely *bellator* areas during the year resulted.

#### *Nigeria*

31. Mr. R. Elliott, the Entomologist in charge of the Federal Malaria Service, reports the development of a new technique for the investigation of susceptibility to insecticides in *Anopheles* larvae. Studies of the spread of the BHC/Dieldrin resistance factor in populations of *A. gambiae* indicated that both BHC and Dieldrin, used as residual house treatments, lead to the spread of the resistance factor in the population and that BHC is a more powerful agent of selection than Dieldrin, leading to virtually 100 per cent. replacement of the susceptible by the homozygous resistant gene.

32. Regarding the persistence of insecticides, studies on the rate of de-activation of various formulations of DDT, BHC and Dieldrin on different types of mud indicate that sorption of insecticides is related to the particle size distribution of the mud, the proportion of fine material being important though not absolutely limiting. Changes in relative humidity have been shown to influence biological activity, all three insecticides showing enhanced activity under humid conditions. Studies of vapour-toxicity of deposits sprayed on mud indicate that DDT and Dieldrin, as well as BHC, can produce lethal concentrations in the vapour phase. Thatch surfaces were shown to be unfavourable substrate for persistence of BHC, but more favourable to DDT.

#### *Publications*

ELLIOTT, R.—(1958) "A method for the investigation of susceptibility to insecticides in *Anopheles* larvae." *Trans. R. Soc. trop. Med. Hyg.*, **52**, 527.

RAMAKRISHNA, V., and ELLIOTT, R.—(1959) "Insecticide resistance in *Anopheles gambiae* in Sokoto Province." *Ibid.*, **53**, 102.

#### *Gambia*

33. At the Medical Research Council's Laboratories in the Gambia, the permanent staff report that after twelve months of pyrimethamine prophylaxis the health state of 684 inhabitants of a rural Gambian village (Keneba) was contrasted with that of a neighbouring and untreated village (Jali). A preliminary analysis of the results indicated that (a) pyrimethamine (dosage 12.5 mg. for individuals under five years of age; 25mg. others)

administered fortnightly reduced parasitaemia profoundly. In the twelfth month of administration the parasite index in the treated village was 0.87 per cent.; in the control village a comparable index was 44.3 per cent. (b) mean haemoglobin values, as determined by the M.R.C. grey wedge photometer, were higher in the treated village, with the exception of the female age-groups 11-17 years and 31-40 years. (c) rates of hepatic and splenic enlargement were much lower in the treated village. (d) mean heights and weights for the various age groups by sex showed little difference in the two villages. (e) fewer children in the second year of life died in the treated village over the twelve months. The results are now being submitted to statistical analysis.

The potentiation of pyrimethamine by sulphadiazine in human malaria was studied, and results indicate that less than 1/10th of the minimum effective dose of pyrimethamine when given with  $\frac{1}{4}$  M.E.D. of sulphadiazine proves as effective as the M.E.D. of either drug given alone.

34. Entomological studies continued at Keneba on the behaviour from adult emergence to oviposition of mosquitoes of the *A. gambiae* complex. The movements of *A. gambiae melas* were studied with the aid of baited traps and resting shelters placed at varying distances from breeding places. Results showed, as wet season gives place to dry, the progressive restrictions of this mosquito to the saline swamps by unfavourable climatic conditions, and again confirmed the explosive and dramatic rise in urban populations with the return of favourable conditions in the pre-rains period. It is hoped that these investigations will ultimately shed some light on what constitutes "favourable conditions". Concomitantly, using a combination of the Polovadova and Gillies dissection techniques, the changes in the physiological age structure of *A. gambiae melas* populations were studied in relation to the characteristic periodicity found in this mosquito in and beyond its breeding places. Original observations on the anatomy of the mosquito ovariole were also made.

35. Professor B. G. Maegraith and Mr. M. V. Riley, B.A., have contributed the following summary of their studies at the Liverpool School of Tropical Medicine on tissue enzymes in malarial infection.

The work outlined in the previous report on the differences between the mitochondrial enzyme systems of livers from normal animals and from those infected with *P. berghei* malaria has been continued. Results obtained have shown that there is a biochemical lesion in the livers of mice infected with *P. berghei* in the terminal stages of the infection. The results were shown at the Royal Society of Tropical Medicine demonstration meeting at Liverpool in November, 1958.

36. Oxidation rates of succinate, glutamate and beta-hydroxybutyrate are depressed and addition of coenzyme to the DPN-linked oxidations effects only partial reactivation; P:O ratios are lowered with each substrate oxidation. Both latent and Mg<sup>++</sup>-stimulated adenosine triphosphatase activities are increased, whereas dinitrophenol-stimulated activity is decreased. The effect upon liver mitochondria of prolonged severe anaemia, similar to that experienced in the malarial infection, has been investigated. These results show

that although the liver damage is not so severe as in malaria, the anaemia of infection must contribute considerably to the described effects of the disease.

Work has since been concentrated on improving the techniques involved, and also on increasing the number of the assay procedures in order to detect biochemical disturbance earlier in the infection. Several dehydrogenase activities can now be used as diagnostic symptoms of the lesion and the test systems are more sensitive. Using these methods an attempt is now being made to relate the appearance and development of the damage to the duration and intensity of the infection. This is at present delayed by considerable variation in the rate of infection of mice by *P. berghei*. More definite results on this aspect of the problem should be provided by work on *P. knowlesi* infection of monkeys.

### *Virus Diseases*

#### *(a) The West African Council for Medical Research Laboratories, Lagos, Nigeria*

37. *Yellow fever.* The very low incidence of clinical yellow fever in many parts of Nigeria, where serological surveys using the specific or very nearly specific intracerebral neutralisation test show a high incidence of infection, may be due to partial resistance to the virus induced in the population by immunity to related group B arbor viruses. In the laboratory, rhesus monkeys have been hyperimmunised against dengue viruses by several injections of the Trinidad strain, and subsequently challenged with viscerotropic yellow fever virus. Several monkeys have been immunised with two related viruses, Zika and dengue. After challenge with viscerotropic yellow fever virus the monkeys immunised against related viruses survived longer than the controls, and the level of circulating yellow fever virus has been lower.

After immunisation with dengue, monkeys, whose sera were previously negative on a neutralisation test employing viscerotropic yellow fever virus intraperitoneally in suckling mice, became positive with a low titre. Such sera are negative in the neutralisation test using neurotropic virus given intracerebrally to adult mice.

Humans whose sera are positive to the test using viscerotropic virus by virtue of infection with related viruses but are negative to the test using neurotropic virus may be more tolerant of infection with yellow fever than persons whose sera are negative to both tests. Preliminary surveys on human sera have shown that, of those negative to the neurotropic neutralisation test, 33 per cent. were positive to the viscerotropic test in Abeokuta and 33 per cent. in Maiduguri. The sera tested are as yet too few to establish an epidemiological pattern of persons having non-specific serological positivity.

### *Yellow fever in Lagos*

38. In 1944 a survey was made on 114 sera of school children under the age of 16 years on Lagos island. Only 4 per cent. were positive, and there

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was doubt whether the children with positive sera had always been resident in Lagos. In June, 1958, of 60 sera from school children aged 8-9 years in Lagos, only 2 were positive on the neurotropic neutralisation test. These results indicate that there has been very little transmission of yellow fever and possibly also of related viruses in Lagos for some years.

Lagos has a piped water supply and there is continuous pot inspection for mosquito larvae. Nevertheless breeding of *Aedes aegypti* has been observed in trees holes. In order to evaluate the density of *Aedes* in Lagos clay water-pots were placed in various compounds, were examined weekly, and the number containing larvae noted. The results indicate that Lagos has a relatively large population of *A. aegypti*, which, if given the opportunity, will breed freely in domestic containers. The overall breeding in pots was 3 per cent. higher than that found during a similar density estimation made in the rural village of Ilobi in 1956 and 1957.

Many factors may be a cause of a low transmission. One possibility is that of a low susceptibility to virus infection in the local mosquitoes, and this is being investigated.

39. *Standard Yellow Fever Immune Serum*: Nearly 1,000 ampoules containing the desiccate of 1 ml. aliquots of yellow fever immune serum have been prepared as standard reference preparations for the World Health Organization. Three *Cercopithecus aethiops tantalus* monkeys which had been shown by haemagglutination-inhibition tests and neutralisation tests to be free from antibodies to yellow fever, or to viruses which could cross-react with yellow fever, were inoculated subcutaneously with viscerotropic yellow fever virus. After six months samples of serum were taken at intervals from the monkeys and pooled. This pool of serum was taken as the standard yellow fever immune serum, and desiccated by freeze-drying in 1 ml. aliquots in ampoules which were sealed under vacuum.

40. *Cytochemical studies*. Detailed studies continued on the histological and cytochemical changes in the livers of monkeys infected with yellow fever. Fluorescent microscopy has yielded new information of the distribution of nucleic acids during the course of the disease. The earliest changes are an increase in the ribonucleic acid (RNA) content of the nucleoli of the liver cells followed by a rise in the RNA content of the cytoplasm. In cells of rhesus monkeys, as degeneration ensues, the deoxynucleic acids become first distributed evenly throughout the nuclear sap and subsequently aggregated around the nuclear membrane. The proteins of the nuclear sap are precipitated as inclusion bodies. In the African species, *Cercopithecus aethiops tantalus*, a rise in ribonucleoprotein occurs in the cytoplasm, mainly at the periphery of the cell, and possibly also to a lesser extent in the nucleoli. The mitochondria became prominent and aggregated in those regions showing an increase in ribonucleoprotein. There is a loss of glycogen from cells showing these changes. The distribution of the increased ribonucleoprotein appears to be both focal and mid-zonal. It has been noted that in uninfected monkeys of both species there is more ribonucleoprotein in the cells of the peripheral region of the lobule than of the central region.



41. *Entomology.* Laboratory studies on *A. aegypti* have been directed towards establishing basic facts on the mosquitoes as a vector of disease and, under controlled conditions, factors involved in its ecology. When *A. aegypti* take a blood-meal it is observed that during and after feeding a relative large volume of fluid is excreted. By feeding blood containing radio-isotopes of cerium and sulphur it has been shown that the fluid excreted has not passed directly through the alimentary tract but has been absorbed first through the gut wall. It has also been shown that mosquitoes may take up to 30 per cent. more blood than would be expected from previous estimates based on the method of weighing the insects before and after feeding.

Laboratory studies on the factors underlying the population dynamics of this species have revealed that the sharp decline in numbers observed during previous field studies is not directly related to any external environmental factor or complex of factors, but to population pressure. Thus, under otherwise controlled and uniform conditions, as the number of larvae in a container are increased so is the developmental period extended and the mortality-rate increased. Apparently, as the population in the field is built up, a maximum density is reached in the breeding pots beyond which any further increase in numbers results in a high larval mortality due primarily to the larval population exhausting available food supplies.

#### *Publications*

BEARCROFT, W. G. C.—(1958) "An outbreak of subcutaneous tumours in rhesus monkeys." *Nature*, **182**, 195.

BOORMAN, J. P. T.—(1958) "The transmission of Uganda S. virus by *Aedes (Stegomyia) aegypti* Linn." *Trans R. Soc. trop. Med. Hyg.*, **52**, 383.

BOULGER, L. R., and PORTERFIELD, J. S.—(1958) "Isolation of a virus from Nigerian fruit bats." *Ibid.*, **52**, 421.

PORTERFIELD, J. S., HILL, D. H., and MORRIS, A. D.—(1958) "Isolation of a virus from the brain of a horse with 'Staggers' in Nigeria." *Brit. Vet. J.*, **114**, 425.

SURTEES, G.—(1958) "Notes on the breeding habits of some Culicine mosquitoes (Diptera: Culicidae) in Southern Ghana." *Proc. R. ent. Soc. Lond.*, Ser. A., **33**, 88.—(1958) "A description of the larvae of *Toxorhynchites* with a note on the larvae of *Filcalbia lacustris* from Southern Nigeria." *Ibid.*, Ser. B., **27**, 63.—(1959) "Studies on the breeding behaviour of *Aedes (stegomyia) aegypti* L. in Southern Nigeria." M.Sc. Thesis, Durham Univ.

#### (b) *The East African Virus Research Laboratory, Entebbe, Uganda*

42. The mechanism of transmission and maintenance in nature of the "arbor" (arthropod-borne) viruses in their many aspects continued to be the main interest of the Institute. Last year *Nairobi sheep disease virus* (NSD) was isolated from sheep and from ticks; this year it has been isolated from captive duikers. Antibody surveys show that human infections with this virus are very common around Entebbe; this is the first indication that NSD virus infects man. An attempt has been made to produce a vaccine this year, and the present indications are that this has been successful.

*Chikungunya* (CHIK) virus, first isolated in Tanganyika, has again been isolated from man and mosquitoes, this time in Uganda (and by other workers in the Union of South Africa). It is a highly important pathogen, and is a member of a group which is probably pan-tropical.

43. An extensive antibody survey on local residents has begun, and to date 186 sera have been tested against Rift Valley fever (RVF), yellow fever (YF), NSD and CHIK viruses. It is planned to test sera to a total of 250 against these and 16 other viruses. The results so far show a low incidence of immunity to RVF and YF and a high incidence of immunity to CHIK (11 per cent.) and NSD (23 per cent.). Other YF neutralization tests were made on a few human sera from the Sudan and on sera of galagos from Zanzibar. The latter showed an incidence of 18 per cent. immune.

During an experimental clearance of hippopotamus from two areas in the Queen Elizabeth National Park an Institute team obtained over 200 large sterile samples of serum, which are being tested against several important viruses.

44. Laboratory studies on YF have shown that the Brazza monkey, *Cercopithecus neglectus*, responds in much the same way as other African monkeys and that it can probably take part in cycles of transmission in nature. Other work on monkeys was a continuation of the studies on the normal temperature of rhesus monkeys. An exceedingly marked fall of temperature occurred by night, occurring even if the monkey was sleeping with others in the same cage.

Laboratory work on viruses included a study of *Semliki Forest* virus infection in the mouse with reference to the initial site of virus multiplication. It appears that initial multiplication may occur near the site of inoculation, and in the lymph glands draining the area. Studies with the same virus have shown that chicks of the red jungle fowl may be susceptible (those of the domestic fowl are not), and that circulation of virus may occur after inoculation in an African mousebird (*Colius*).

So far no viruses of the immunological group known as "C" have been isolated in Africa, but there is reason to suppose that they may be present. Strains of virus of this group have been obtained from America and, after some difficulty, have been adapted to the laboratory mice. This will permit antibody surveys to be made.

In the field of general zoology investigations have been confined to studies on two birds, a common Musophagid (*Crinifer*) which may be involved in local cycles of virus transmission, and a common migrant (*Motacilla flava*) at a time of stress, viz., the migration.

45. *Entomology*. Field work on *Aedes aegypti* has shown that host preferences vary greatly from spot to spot. So far, however, man and other primates have made up only about half of the positive tests. On the Kenya Coast reptiles form an important part of the diet, while in one area near Entebbe rodents seem to be the main food. Investigations on the biting-cycle on the Kenya Coast and near Entebbe have revealed a simple diurnal cycle with a small peak of activity in the morning and a major one in the late

afternoon. This differs from results recorded by other workers, but is considered a convincing finding as it corresponds to a flight cycle observed near Entebbe and to the oviposition cycle as described last year.

Oviposition in open air is commoner at ground level than at higher levels in this species and *A. simpsoni*, the reverse being the case in *A. metallicus*. No significant preference for a black sub-stratum for the eggs (as opposed to a white) was found in the field. (See also paragraphs 48–51).

46. Laboratory work on *A. aegypti* has confirmed, by experiments involving an advanced technique, that ovulation is controlled by the release of a hormone from the head at a certain time after a blood-meal. It has not yet been decided whether this hormone acts directly or whether perhaps it activates a neurosecretory centre in the thorax which in turn releases a second hormone. Further studies on cyclical behaviour in this species have shown that pupation and emergence show no nycthemeral rhythm. This is important in relation to observations on the cyclical nature of oviposition. Cyclical oviposition behaviour can be initiated by as little as 5 minutes' light per 24 hours. The rhythm is endogenous and persists for several days under constant conditions. It is possible to establish a non-24-hour rhythm by appropriate regimens of light and darkness; but, given an opportunity to change to a "normal" 24-hour rhythm, *A. aegypti* invariably does so. In the case of specimens reared and kept in constant darkness (in which circumstances oviposition is aperiodic) regular cyclical behaviour may be initiated by a single exposure to light. The converse is not equally true. A simple change from constant dark to constant light or *vice versa* is not an adequate stimulus for the initiation of regular cyclical behaviour.

An external character has been found which permits the distinction of *Mansonia pseudoconopas* from *M. maculipennis*, even when most of the external scaling has been worn off.

47. Studies on the all-important subject of age-grading in mosquitoes continued. In one species, *M. pseudoconopas*, it was found that colour changes permit age-grading to be carried out. Another approach was through the study of parasitic mites, and yet another through study of the ovaries, following methods used in Russia. Most of this work was done on mosquitoes of the genus *Mansonia*. Other studies on this group showed that in the sub-genus *Coquillettidia* birds are the preferred hosts, except in the case of *M. fuscopennatus*, which is a rather indiscriminate feeder.

In other groups (the subgenera *Aedimorphus*, *Banksinella* and *Dunnius* of the genus *Aedes*) analyses of biting-cycles, based on past field work, have been made. Known virus vectors (one very important) occur in two of these subgenera. Some interesting new findings concerning group behaviour and the influence of habitat have emerged.

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CORBET, P. S.—(1958) "Identification of adult *Mansonia (Coquillettidia) pseudoconopas* Theobald and *M. (C) maculipennis* Theobald (Diptera: Culicidae)". *Proc. R. Ent. Soc. Lond. (B)*, **27**, 127.

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*Idem*, HADDOW, A. J., and CORBET, P. S.—(1959) "Observations on the oviposition-cycle of *Aedes (Stegomyia) aegypti* (Linnaeus), II." *Ann trop. Med. Parasit.*, **53**, 35.

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WILLIAMS, M. C., WEITZ, B., and McCLELLAND, G. A. H.—(1958). "Natural hosts of some species of *Taeniorhynchus* Lynch Arribalzaga (Diptera: Culicidae) collected in Uganda, determined by the precipitin test." *Ann trop. Med. Parasit.*, **52**, 186.

48. Mr. G. A. H. McClelland, B.A., has completed the short-term study on *Aedes aegypti* in Entebbe and on the Kenya Coast, designed to determine if the population of this species is made up of "races" differing biologically, for which he was based on the Virus Research Institute, Entebbe. He reports as follows.

49. Twenty 24-hour baited-catches at Ganda, on the Kenya Coast, revealed sharply defined cyclical biting-activity in *Aedes aegypti*, with a maximum in the hour before sunset and little difference between a house interior and an adjacent compound. The general picture is thus similar to that out-of-doors at Entebbe and to the laboratory-observed oviposition-cycle. The figures revealed no differences between incidences of the type form and var. *queenslandensis*, which occurred together. The presence of eggs of *A. aegypti* in bamboo pots, placed in the plantations at Ganda and examined every four hours on three days, showed that the oviposition-cycle in the field resembles that observed in greater detail in the laboratory. The greatest number of eggs occurred in the period before sunset.

50. More than 100 *A. aegypti* stomach smears were collected at Ganda, and Mr. Bernard Weitz, of the Lister Institute, London, very kindly did precipitin tests on them. The results showed that man made up half the total results at both Ganda and Entebbe. After man, rodents were favoured at Entebbe, and reptiles at Ganda, yet no reptile feeds occurred at Entebbe and very few rodent feeds at Ganda. *Aedes simpsoni*, however, fed about equally on rodents as on reptiles at Ganda. One *A. aegypti* in 282 had fed on a bird. Significantly more fresh feeds were positive for man, which suggests that some mosquitoes fed on the catching personnel. Man only accounted for 25 per cent. of the partly digested feeds, probably a less biased picture, indicating that outdoor populations of *A. aegypti*, although living near man, are largely zoophilic.

Further precipitin test studies confirmed that *Mansonia fuscopennatus* is catholic in its choice of host compared with *M. metallicus* which feeds almost exclusively on birds.

51. Genetic studies on *A. aegypti* indicated complex gene control over the degree of paleness from pale var. *queenslandensis* to ssp. *formosus* which occurred together at Ganda. The presence of a recessive gene causing absence of the usual lateral silver spots was demonstrated, and there was apparent failure to separate the type form from ssp. *formosus*. It seems that the current definitions of the three forms must be open to question.

A significant difference in developmental time and an apparent difference in feeding preference between man and guinea-pig were demonstrated in the laboratory between a true-breeding line of *A. aegypti* var. *queenslandensis* without silver lateral spots, and a mixture of the type form and ssp. *formosus*.

(c) *The Trinidad Regional Virus Laboratory, Port of Spain*

52. From this laboratory, established in 1953 by the Division of Medicine and Public Health of the Rockefeller Foundation with the co-operation of the Government of Trinidad for the study of viruses in man, animals and arthropods in the Caribbean region, the Director, Dr. Wilbur G. Downs, reports that 29 virus isolations were made during 1958, 3 from humans, 16 from mosquitoes, 1 from ticks, 6 from wild birds and 3 from chickens. This makes a total of 159 arthropod-borne viruses isolated from 1953-1958.

53. The epidemiological highlight of the year was the isolation of St. Louis virus (SLE) from a nestling Silver Beak Tanager on July 29, in the Vega de Oropouche Region near Sangre Grande. This isolation was responsible for the initiation of an intensive programme of investigation in the region, resulting in two additional isolations of virus from mist-netted adult native passerine birds during August, three isolations from three different species of *Culex* mosquitoes during August-September, and an isolation from a human case with fever but no encephalitis in September.

54. While working on the SLE outbreak, an unexpected reward came. *Ilheus virus*, long sought in birds, was recovered from two mist-netted adult resident passerine birds, and in addition was recovered once from mosquitoes. This mosquito isolation was from *Culex caudelli*, and is the first instance of this virus being naturally associated with the genus *Culex*. These isolations were contemporaneous and from the same region as the SLE isolations. Also, earlier in the year, *Ilheus* was recovered five times from mosquitoes captured in the nearby Rio Grande Forest. Almost retrospectively, a virus isolation from a nestling cuculiform bird, *Crotophaga ani*, in March, was also found to be a strain of *Ilheus virus*; identification had been delayed due to technical difficulties associated with validation of the isolation.

55. Special attention was directed toward investigating the possible role of *Philornis* flies in the epidemiology of *Ilheus* and St. Louis viruses. These flies, as larvae, parasitise nestling birds. Virus inoculated into larvae survives and multiplies over long periods of time. Larvae may possibly be able to pick up virus from infected birds.

Studies continued on the susceptibility of mosquitoes to local viruses. Tr 9760 and Tr 3587 were shown to be capable of surviving in mosquitoes for at least two weeks. A strain of presumed Coxsackie virus (Tr 7553-37) failed to survive in mosquitoes. Several other virus types were isolated from mosquitoes, and *Newcastle Disease Virus* was isolated from the spleens of three chickens from an outbreak in Dutch Guiana.

A virus isolated from a human in 1956 has been shown by Dr. A. D. Macrae of the Colindale Laboratory, England, to be a strain of *Coxsackie Group B*, Type 4. Complement-fixation studies in Trinidad suggest widespread immunity to this virus or a closely related virus in the West Indies.

56. In the laboratory, the large group of 48 mosquito isolations (largely from the 1955 and 1956 seasons) were broken down, using a complement-fixation technique based on crude saline antigen preparations and mouse hyperimmune sera, into twelve apparently unrelated types. One member of each type has been designated as a prototype virus. These findings confirmed earlier neutralisation test (NT) findings for several groups, and considerably extended the classification to include all mosquito unknowns. One prototype, Tr 8349, appears to be closely related to, if not identical with, a previously known agent, *Wyeomyia* virus. Another prototype, Tr 9375, has affinities with California virus.

Tissue culture techniques using chick embryo and hamster kidney cells were explored and routine culture techniques established. Applicability of these tissue cultures to the study of "Arbor" viruses were partially explored. Further work with these and other cell lines is indicated.

57. A serum survey of the island of St. Lucia was undertaken; haemagglutination-inhibition (HI) studies reveal the presence of a Group B agent, and neutralisation test studies show widespread immunity to dengue; studies have not been completed on the other Group B agents. Specimens were also received from aboriginal Indians from Dutch Guiana. Group A and Group B immunity has been revealed on HI testing but studies have not yet progressed further. Work is also progressing (slowly) on analyses of sera from West Indian islands and territories visited earlier. Within two days after receipt of specimens from a region, an HI test can permit one to formulate a guess as to probable disease agents active (in Groups A and B). To validate this guess, much NT work using baby and adult mice is needed. This work gets low priority, and the validation of early impressions progresses slowly. Interesting leads or leads of possible public health importance are, however, explored early.

No evidence of recent yellow fever activity has been observed in 1958 in Trinidad or in the other island surveys.

In the Personnel section, the transfer of Dr. C. R. Anderson to the Virus Research Centre, Poona, India, has been keenly felt. He was to a major degree responsible for the establishment and maintenance of animal colonies, the training of technicians, the elaboration of basic laboratory techniques and the operation of the virological section of the laboratory (as contrasted with epidemiological and entomological section). His contributions of knowledge and experience were great.

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(d) *Research on trachoma*

58. During the year the Medical Research Council Trachoma Group greatly expanded its activities in the Gambia and at the Lister Institute, London, as its Director, Dr. L. H. Collier, reports briefly below.

59. *Isolation of trachoma virus in the Gambia.* Mr. J. Sowa considerably improved the original method of isolating virus described by T'ang *et al*, and succeeded in growing the virus from a high proportion of trachoma patients. Virus was isolated from 17 or 18 patients in whom conjunctival inclusion bodies were found. It was also isolated from 7 out of 12 inclusion-negative trachoma patients; a control group of 25 non-trachomatous subjects all failed to yield virus by chick-embryo inoculation.

60. *Identification of trachoma virus.* Dr. L. H. Collier, Sir Stewart Duke-Elder and Mr. Barrie Jones successfully inoculated two human volunteers with strains of virus isolated in Africa. The characteristic lesions of trachoma were induced, typical inclusion bodies were repeatedly demonstrated in the conjunctiva, and virus was again isolated from these subjects by chick-embryo inoculation. These results prove conclusively that the viruses isolated are aetiologically related to trachoma.

61. *Current research in the Gambia.* The isolation and identification of the causal virus opened the way for a more complete field investigation of trachoma than has hitherto been possible. Although there is a fairly well-defined trachoma syndrome, there are some patients in whom inclusion bodies cannot be demonstrated. Before investigating new methods of prophylaxis and treatment, it is essential to find whether the trachoma syndrome is always due to the same aetiological agent. Our knowledge of the mode of transmission, usual age of onset and influence of secondary bacterial infections is also incomplete. To solve these problems an enlarged section of the Medical Research Council Trachoma Group was sent to the Council's laboratories at Fajara, in the Gambia, where a new laboratory has been erected and equipped for their work by the generosity of the Wellcome Trustees. This team is investigating the entire population of two villages. The eyes of every inhabitant are being examined clinically, and the results correlated with the presence of inclusions, cultivable virus, and bacterial pathogens. This survey will be repeated 3 times during a period of 18 months, to gain information on the influence of varied climatic conditions. Newborn infants are being observed and investigated frequently, to determine when the infection is first acquired.

62. *Research at the Lister Institute.* Strains of virus isolated in the Gambia are being studied at the Lister Institute, where particular attention is being given to their antigenic constitution and relationship with other members of the psittacosis-lymphogranuloma group of viruses.

#### *Publications*

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#### *Relapsing Fever*

63. The field work done in East Africa for many years by Dr. G. A. Walton ended in mid-1958, and he is now making laboratory studies in London on the material brought by him from Africa, and reports as below.

64. Progress has been made in the elucidation of the status and inter-relationships of the seven biological forms of *Ornithodoros moubata* recorded by him. Analysis of data relating to the number of nymph stages required by many strains to reach maturity when fed on the rabbit produced striking differences which, when correlated with shape recognition tests made during adult feeds and with external taxonomic characters noted during preliminary examination of long series of individuals from selected strains, have allowed the various *Forms* to be placed in three main groups.

65. The first group, or *East African Domestic Group*, contains *Forms A, B and D*, all from African dwellings, in which morphological differences may be imperceptible. The second group, or *Wild Group*, contains *Forms C and F* from warthog and porcupine burrows. The third group, or *South African Domestic Group*, contains eight strains from African dwellings with a wide distribution in South Africa and Angola. The proportion of ticks requiring five or more nymph stages to reach maturity was 0.4 per cent. among 2,306 ticks of seven strains of the *South African Domestic Group*, 18.5 in 3,393 ticks of five pure strains of the *East African Domestic Group*, and 91 per cent. in 1,488 ticks of seven strains of the *Wild Group*.

Since the *Wild Group* character of "high number of nymph stages" is inherited by the hybrid offspring of crosses between strains of the *Wild* and *E. African Domestic Groups*, it is possible to identify hybrid strains and mixed strains containing individuals of both groups.

66. While two *South African Domestic* strains lost water in dry air at 0.16 mg. per day, five *East African Domestic* strains, two *Wild* strains and one cross between them, lost water at a mean rate of 0.32 mg. per day. A high degree of incompatibility was noted when a Transvaal strain of the *South African Domestic Group* was crossed both to a Kenya (Meru) strain of the *E. African Domestic Group* and a Kenya (Naivasha) strain of the *Wild Group*. When *South African Domestic* males were mated to *Wild* or *E. African Domestic* females, egg production was normal. No eggs laid by the *Wild* females hatched, only 7 per cent. of the *E. African Domestic* eggs were viable, and 48 per cent. of the 1st stage nymphs were abnormal. *South*



*African Domestic* females mated to *Wild* or *E. African Domestic* males produced 55 per cent. less eggs than normal, of which 69 per cent. failed to hatch and 41 per cent. of the 1st stage nymphs were abnormal.

67. Excluding *O. moubata* associated with tortoises (*Form G*), it would seem that the *E. African Domestic* and *Wild Groups* are fairly closely related, whereas the *S. African Domestic* strains form a separate physiological, biological and taxonomic group. The significance of taxonomic differences noted within the *Wild Group* is as yet far from clear.

#### Publications

WALTON, G. A.—(1958) "*Argas persicus* (Oken 1818), (Argasidae, Ixodoidea) in Tanganyika Territory." *E.A. med. J.*, **35**, 543.—(1958) "Notes on *Argas brumpti* Neuman 1907 (Argasidae, Ixodoidea) in Kenya and Tanganyika." *Ibid.*, **35**, 569.—(1959) "A biological variant of *Ornithodoros moubata* Murray (Ixodoidea: Argasidae) from South Africa." *Proc. R. ent. Soc. Lond.*, **34**, Pts. 4-6, 63.

#### Identification of blood meals

68. Mr. B. Weitz and Miss Lee-Jones of the Lister Institute of Preventive Medicine continued their work on the identification of blood-meals, mostly on the gut contents of tsetse flies, although some work on other arthropods was also undertaken.

69. *Feeding habits of tsetse flies.* The studies on the feeding habits of *Glossina longipennis* have revealed the adaptability of this fly. The monthly collection of this species made by Dr. P. E. Glover and his staff of the Department of Veterinary Services, Kabete, Kenya, showed a constant feeding on rhinoceros over a period of nearly two years. When elephant or buffalo herds entered the area, *G. longipennis* partly deserted its usual host in favour of these other large mammals. The availability of all animals was determined by spoor incidence and a marked discrimination for these hosts was evident. *G. brevipalpis* showed very similar habits in the same area, but *G. pallidipes* appeared less discriminating in the choice of its hosts. Dr. Glover collected large numbers of *G. swynnertoni* from another area and the identification tests showed that this fly behaved as previously observed in other areas, feeding mainly on warthog. In a third area, *G. brevipalpis*, *G. pallidipes* and *G. austeni* fed mostly on bushpig, warthog being absent from the area.

70. From Uganda, Mr. A. G. Robertson, Director of Tsetse Control, sent blood-fed specimens of *G. morsitans submorsitans* from Karamoja, where no tsetse control measures are in progress. In comparison with *G. morsitans morsitans* from other areas, the *G. morsitans submorsitans* proved to be a more catholic feeder and not nearly so dependent on suids. It was feeding regularly, although infrequently, on hartebeest, a species on which *G. morsitans morsitans* was never known to feed. *G. pallidipes* captured from Sigulu Island were feeding almost entirely on sitatunga. In Ankole, where cattle are present under the protection of drugs, *G. morsitans* feeds on ox considerably, and the importance of this domestic animal in maintaining the fly population is being closely observed there.

In co-operation with Dr. J. P. Glasgow and Dr. F. Isherwood of E.A.T.R.O. a study of the animal hosts of *G. pallidipes* in relation to vegetation phases confirmed the importance of bushbuck as the main host in the

Lambwe Valley, Kenya. There seemed to be a more restricted diet in the heavier vegetation where the greatest variety of mammals would be expected.

71. In West Africa the collections sent from the West African Institute for Trypanosomiasis Research have confirmed previous observations there. The adaptation of tsetse fly to its environment is well illustrated in the West African forest by the preference of most resident species (*G. tabaniformis*, *fusca* and *medicorum*) for Red River hog, the only suid present. Porcupine appears as a constant host of *G. tabaniformis*, while aardvark is an important subsidiary host of *G. fusca* and *G. medicorum*; *G. longipalpis*, of similar habits to the East African *G. pallidipes*, feeds similarly on bushbuck.

72. *Mosquitoes*. With Mr. G. A. H. McClelland of the East African Virus Research Institute, the studies of the feeding habits of various culicines of East Africa have been extended, and the study of the auxiliary hosts of *Anopheles gambiae* and *A. funestus* has been continued with Dr. A. Smith of Tanganyika.

73. A systematic investigation of the antigens of *Trypanosoma brucei* has been continued by Mr. Weitz. The liberation of trypanosome antigens in the serum of infected laboratory animals was observed. The biological characters of these antigens are being investigated, and studies of the specificity of the antigens are under way.

#### *Physiological and nutritional research*

##### *(a) Tanganyika and Uganda*

74. *Nutritional and biochemical*. A series of studies by Dr. E. G. Holmes and Dr. Sylvia Darke on the *absorption of foodstuffs* has now been completed at the East African Institute for Medical Research at Mwanza. Salient results are summarised briefly below. Findings based on direct determinations of the calorie and nitrogen content of the food and stools showed that the highest percentage absorption of dietary calories was achieved by a mixed group of healthy Europeans and Africans on a European type diet, and amounted to 95 per cent. of the intake. The absorption of others, all Africans, on African type diets, ranged from 86 per cent. to 94 per cent. The highest percentage absorption of nitrogen (again by the European and African group on the European type diet) was 90 per cent., while the other groups gave values of from 62 per cent. to 89 per cent. Heavy hookworm infestations reduced the absorption of nitrogen significantly.

75. While no doubt the nature and fibre content of the food is an important factor in absorption, evidence of other workers suggests that the previous dietary history of the subject may play a part. Where food intake is determined by appetite, absorption defects of this order may be of small practical importance; doubtless additional food will be eaten. But where intake is limited by economic considerations, or by the existence of a ration scale, matters may be different; diets which appear adequate when their value, especially protein, is computed from the current dietary tables may in fact be deficient.

76. Studies of the *cutaneous excretion of nitrogen* were made by Dr. Sylvia Darke, primarily to ensure that nutritional studies which included nitrogen balances were not invalidated by considerable cutaneous losses of nitrogen. Many previous studies have dealt with the composition of sweat, usually

collected under artificial conditions over short periods; very few have included loss from all elements, including epithelial debris, or have dealt with daily output.

To reproduce the conditions of previous studies, 14 male Africans were kept under observation in the metabolic ward, not confined to bed, but undertaking minimal activities. Their mean total cutaneous output of nitrogen was 0.254 g. per 24 hours (range 0.48–0.178). Of this 0.053 g. was water-insoluble, probably contained chiefly in desquamated epithelium, hairs, etc. The remainder, which was water-soluble, contained 0.045 g. of urea nitrogen + 0.037 g. of ammonia nitrogen; probably most of the ammonia was derived from urea by the action of skin bacteria. The nature of the remaining water-soluble nitrogen is as yet undetermined. Creatinine in small quantities and amino-acids were also present. Thus in minimal sweating (none perspired visibly) less than 0.5 g. of nitrogen per 24 hours is lost by the skin, a fact important to very accurate nitrogen balances. The allowance of 2 g. per 24 hours made in previous work is an over-estimate; so that the true nitrogen retention was even higher than was then stated. It is probable that in severe sweating cutaneous nitrogen loss may be quite considerable.

77. Miss F. J. Ritchie has studied the *energy cost of activity* in the manual work done by African women, such as carrying water or pounding food-stuffs. The values found for these women, whether sitting at rest, or walking, were very similar to those for European and American women, as also was the energy expended in walking. When walking with 3 gallons of water on their heads (a common daily task), the energy output was little greater than when walking unladen, probably being reduced by adopting a slower pace.

78. *Studies of body composition* by Dr. Holmes, Dr Darke, Miss Ritchie and Mr. W. W. Read have continued. Determinations of total body water were made by the tritium method in individual subjects and groups of subjects, on the rationale that if the total body water is measured, the difference between body weight and body water must give a measure of body solids. It seems certain that body solids must bear a relationship to the state of nutrition, though this relationship cannot be exactly interpreted until it is possible to define the body solids in terms of fat, protein and minerals.

These studies have raised issues of considerable scientific interest, requiring much further work for their elucidation.

79. *Serum protein studies.* Following indications obtained by Dr. A. R. Moore that the white blood cells in Africans had a lower proportion of neutrophils in relation to lymphocytes than did those of Europeans, and that the neutrophils increased during pregnancy, Dr. P. G. Lutz has studied the serum protein pattern during pregnancy by filter paper electrophoresis. The values for total protein, albumin, alpha-globulin, beta-globulin and the A/G ratio were not significantly different before and after delivery; differences found in the gamma globulin were just below the level of significance.

80. Dr. D. S. McLaren, in studies on *nutritional ophthalmology*, has pursued at the Institute several lines of approach to the connexion between

malnutrition and eye disease. Experimental work, commenced at the Human Nutrition Research Unit of the Medical Research Council, London, has continued, and human aspects of the subject have been explored, especially in relation to the problems of blindness in Tanganyika.

81. In various related studies, analysis of *birth weights* of African children indicated that maternal malnutrition is not a serious problem in the area. Again, data from child welfare clinics in Mwanza town and nearby villages indicate that the *rate of growth* after the age of 6 months begins to lag behind that of European children, not necessarily because of weaning practices or malnutrition; intercurrent infections play a part; urban children fare better than rural children. In an investigation of local sources of *vitamin A and carotene*, nine species of lake fish showed a high content of vitamin A in the liver. The green leaves of numerous plants in common use locally as vegetables are good sources of carotene; there is considerable loss, however, due to the methods of cooking used.

82. Studies of *malnutritional eye diseases in man* have centred mainly on three clinical conditions. Investigating *xerophthalmia* and *keratomalacia*, a visit to the Central Province of Tanganyika revealed that vitamin A deficiency is a major cause of blindness in the area. Plasma vitamin A and carotenoid determinations revealed that these are low in about 50 per cent. of pregnant women in Mwanza. Examination of the urine before and after dosing with vitamin A lends no support to the suggestion that loss in the urine may occur during pregnancy. Two short visits were made by Dr. McLaren to Ethiopia, at the invitation of the United States Interdepartmental Committee on Nutrition for National Defence, to assist in ophthalmological aspects of a nutrition survey.

83. The idiopathic eye condition, "*spontaneous iris prolapse*," possibly related to malnutrition, has been reported from East Africa for the first time, and the initial lesion shown to be in the corneal endothelium.

Regarding *cataract*, a high incidence of peripheral cataractous changes in the lenses of young children has been found in a survey near Mwanza; further examinations are in train to investigate their precise nature.

84. Investigations involving *experimental animal work* have included studies in rats and mice on the effects of protein deficiency on the sulphhydryl content and amino-acid composition of the lens, and on absorption and liver storage of vitamin A. In particular, the effect over many generations of post-weaning deprivation is being assessed in mice, which have been found to be more susceptible than rats to protein deficiency.

In rabbits fed from weaning on diets consisting of either banana or cassava corneal opacities have been produced.

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85. At the Mulago Hospital, Kampala, Uganda, the Medical Research Council's Infantile Malnutrition Research Unit under the direction of Dr. R. F. A. Dean continues its comprehensive study of the effects of malnutrition on the growth and development of African children. Particular subjects at present under investigation include biochemical abnormalities possibly due to malnutrition, the utilisation of locally produced foods for the prevention and treatment of nutritional disorders, and the psycho-motor and somatic development of the African child.

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JONES, P. R. M., and DEAN, R. F. A.—(1959) "The effects of kwashiorkor on the development of the bones of the knee." *J. Pediat.*, **54**, 176.

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#### (b) *Jamaica*

86. *Tropical Metabolism Research Unit*. Dr. J. C. Waterlow, the Director of this unit of the Medical Research Council, reports that his *studies on the liver* have been mainly concerned with oxidative phosphorylation in the malnourished liver. He has found that although the initial rate of phosphorylation, measured immediately after biopsy, is normal, the rate falls off much more rapidly in the malnourished than in the normal liver. Since oxidative phosphorylation depends on the integrity of the mitochondrial structure, this finding suggests an abnormal fragility or lability of the mitochondria in the malnourished liver. If this exists *in vivo*, it may be of importance in relation to some of the other features of the syndrome, e.g. potassium loss and sodium accumulation. The possibility of mitochondrial fragility resulting from protein deficiency is also being investigated by Miss Stephen in experiments on rats, using the assay of enzymes, such as malic dehydrogenase, as a test. It is now clear that the measurements of this kind made last year on human liver were premature, because the assay conditions were not sufficiently standardised.

Oxidative phosphorylation in the liver has also been measured in a series of diabetics before and after treatment, to see whether the reduction found experimentally in pancreatectomised and alloxan-diabetic animals also occurs in man. The results so far are suggestive but not conclusive.

Work has begun on the measurement of fatty acid synthesis from  $C_{14}$ -labelled acetate by liver tissue *in vitro*, an experiment which clearly needs to be done in these fatty livers.

87. *Changes in water and electrolyte distribution.* Dr. R. Smith has continued his estimation of total body water by tritium dilution. The results in about 20 more patients confirm the original findings, and emphasise the gross abnormality of composition and the severe protein depletion in these malnourished infants. Concurrently with these experiments, Dr. R. D. Montgomery has been measuring the oxygen uptake in these infants by a closed-circuit method. It is hoped by this means to estimate the basal metabolic rate in relation to active tissue mass. The 40 experiments he has done so far have not shown clear evidence of depressed metabolism per unit active tissue mass, but have revealed a remarkable degree of hyperactivity during the recovery phase.

The earlier observations of this Unit and other workers that a potassium deficiency exists in infantile malnutrition have been confirmed. The total exchangeable potassium is reduced in most of the cases on admission to about half the normal value on a body-weight basis. The potassium content of muscle biopsy specimens is low on admission and rises during recovery. Magnesium is also being measured spectrophotometrically on muscle biopsy specimens.

It was suggested by Dr. Oliver Wrong, who visited the Unit in June, 1958, that there might be a defect in the concentration of hydrogen ion by the renal tubule as a result of the potassium deficiency. This has now been demonstrated. There is a close correlation between both the muscle potassium content, the exchangeable potassium per kg. body-weight and the ability to acidify the urine after a standard dose of ammonium chloride. Some of the recovered cases, when fed on a diet low in potassium, are able to reduce urinary potassium loss to about 1 meq. per day in the face of body potassium depletion, whereas some cases on admission seem unable to do this at a comparable level of depletion. This finding, however, needs further confirmation.

In conjunction with Dr. Wrong and Dr. Gowenlock experiments to demonstrate changes in aldosterone secretion in infantile malnutrition have begun.

88. *Muscle proteins.* Previous work showed that in the weanling rat on a "Jamaican" diet, there is a severe reduction in muscle protein. Mr. C. B. Mendes has now found that the loss arises from a decrease in all the protein fractions except collagen. Measurements have been made of the rate of uptake of labelled methionine into muscle protein in normal and depleted rats, in order to test the hypothesis that, in protein depletion, synthesis in non-essential tissues such as muscle is reduced.

89. *Separation of phosphatides.* Dr. L. Rathbone has been working on the separation, identification and estimation of phosphatides in tissues with a view to subsequent metabolic studies. He has separated the phosphatides

of mouse liver into four groups by paper chromatography. He intends to use this procedure when the rates of some of the reactions thought to take part in the synthesis of major phosphatides are measured under approximately physiological conditions.

90. *Balance work.* The large volume of data on nitrogen and phosphorus balances accumulated over the last two years has been analysed. Two interesting points have emerged: (i) Even in the very severely ill malnourished baby, nitrogen absorption and utilisation appear to continue at normal rates, an indication that a general failure of protein synthesis is not the immediate cause of death; (ii) In cases of malnutrition there is usually a deficit of phosphorus that is even greater than that of nitrogen. A comparison made of the efficiency of nitrogen absorption and retention from cow's milk and human milk shows a small but significant advantage to human milk.

91. *Clinical studies.* A clinical trial has begun of the lipotropic efficiency of choline in these fatty livers. This is a resumption of work begun here in 1945.

In collaboration with Professor E. K. Cruickshank, Dr. Montgomery is making clinical, epidemiological and pathological studies on a complex neuropathic syndrome occurring in Jamaica, the main features of which are lesions of the long spinal tracts, optic atrophy, nerve deafness and selective muscle wasting. Adult women with this condition are investigated as in-patients in the Unit.

Dr. Montgomery is continuing work on the cause of death and the histology of the brain in tetanus. A clinical trial has begun in collaboration with University College Hospital, London, and University College, Ibadan, on the value of A.T.S. therapy in established tetanus.

92. *Causes of death.* The mortality of malnourished infants in the Unit's ward is still very high, viz. 29 deaths out of 130 admissions. In an analysis of the causes of death, it was noted that the type of case with the worst prognosis was the infant below the age of one year on admission with generalised oedema, hyponatremia and hypokalemia. In 9 cases with an initial serum sodium of 121 meq. per litre or less, only 2 survived. It is hoped that further study of the recent findings may suggest a more rational form of treatment for this type of case.

#### *Publications*

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WATERLOW, J. C. and STEPHEN, J. M. L.—(1958) "Further observations on enzymes in the human liver in malnutrition. Oxidative phosphorylation and phosphatide synthesis." *Proc. 6th World Congr. Gastroenterology, Washington*.

SMITH, R.—(1959) "Urinary acidification defect in chronic infantile malnutrition." *Lancet*, 1, 764.

STANDARD, K. L.—(1958) "A pilot nutrition survey in five low-income areas in Jamaica." *W. Ind. med. J.*, 7, 215.

93. *The activity of hypoglycin.* Dr. J. Patrick, of the Faculty of Physiology at the University College of the West Indies, Jamaica, reports that although much information has been obtained and published during previous work by him and his collaborators on the physiological and biochemical effects of hypoglycin—a hypoglycaemic substance isolated from the ackee fruit, the exact mechanism of its action is not as yet completely understood. In collaboration with Dr. P. C. Feng he has therefore approached the problem from a somewhat different angle, and is studying the metabolism of the substance within the mammalian body to obtain clues as to how hypoglycin acts and information on how it may be detoxified. Results so far indicate that high doses of hypoglycin are rapidly removed from the blood and very little or none appears in the urine in either bound or free form. Liver homogenates are capable of deaminating hypoglycin. A biological synthesis of radioactive hypoglycin is being attempted.

94. *Effect of diet on the interconversion of fat, protein and carbohydrate in the liver.* The study by Dr. Patrick, with Mr. A. Chung and Dr. E. Keen, of the effects of the diets of rats on the metabolic activity and constituents of the liver has continued. It had been shown that the rate of fat synthesis by the liver was mainly a function of the carbohydrate intake. To explain this, experiments have been carried out on the effect of dietary carbohydrate on various hormones, enzymes and cofactors concerned with lipogenesis. Among the significant effects found have been the following. A high carbohydrate intake appears to decrease the amount of insulin activity in the blood but not to affect insulin binding by the liver. The amounts of reduced coenzymes DPNH and TPNH are decreased by the high carbohydrate diet.

95. A study of the effect of diet on the conversion of radioglucose into amino-acids has been initiated. Methods for the isolation and identification of amino-acids by ion-exchange chromatography have been developed.

96. *Constituents of the liver in various diseases.* Work has been continued, in collaboration with Dr. J. A. Tulloch and Dr. J. C. Waterlow, on the changes in enzyme activities which take place in the livers of patients with diabetes. It has been found that a characteristic decrease in the concentration of hepatic glutamic aspartic transaminase takes place when the diabetes is stabilised. This is probably related to the decrease in gluconeogenesis in the liver which takes place. Work has been started on another enzyme, glutamic dehydrogenase, which is also concerned with gluconeogenesis.

(c) *Nigeria*

97. Dr. O. A. R. Bassir, Lecturer in the Department of Physiology at University College, Ibadan, reports that the encouraging results obtained with lactating mothers whose normal diets were supplemented with soya flour last year led to a series of feeding experiments in which mixtures of gari (*Cassava farina*) fortified with soya flour in varying proportions were fed to litter mates of albino rat weanlings. Control groups on commercial stock diet, gari alone and flour alone, respectively, were set up simultaneously. The animals were allowed to feed and drink to repletion. All received an additional ration of green leaves (*Talinum triangulare*) every other day. All were grouped so that the sexes were equally distributed in each group, to enable the reproductive performance of the animals on the different dietary



regimes to be studied. The soya and gari mixtures were supplemented with salt. Each rat was weighed at the same time daily for at least six months.

98. The best growth performance was obtained in the animals kept on the stock diet, and they produced the largest number of litters. Animals on a 1:1 gari-soya mixture gave a growth curve about half as steep as the stock animals. Those fed on gari alone hardly grew at all, were sterile and most died within three months. On the soya flour alone the growth of male rats was irregular, but the females grew faster than those on a 3:1 soya/gari mixture. The performance of rats on a 1:3 soya/gari mixture was not much better than that of the gari-fed animals, and some died during the experiment. The amount of food consumed daily by each group was determined periodically to find out whether appetite was a factor in the discrepancy in the growth rates. Only the rats fed on gari alone or on the 3:1 gari/soya mixture consumed significantly less.

Next, each group of rat weanlings of litter mates was put on a different soya/gari dietary mixture for a month at a time. The results, so far, indicate (a) that once the weaning stage has been passed on a good diet, it is difficult to retard the growth-rate by feeding the animal on the poorest of the dietary mixtures used; (b) the discrepancy in growth performance which is induced by weaning the rats on to a 3:1 gari/soya mixture cannot be corrected by transferring the animals after a month to the diets containing a higher ration of soya flour; (c) those animals which were weaned to the latter diets and afterwards transferred to the stock diet showed the best growth performance.

Other work includes a study in collaboration with Dr. Jelica Cvetkovic, Lecturer in Biochemistry, on the secretion of steroid hormones into breast milk and their urinary clearance during the week following parturition, a detailed analytical study of the food intake of about a thousand University students, and a study on the intake of fluids and the daily output of urinary electrolytes in a group of 100 volunteers.

#### *Publications*

BASSIR, O. A. R.—(1959) "Nutritional studies on breast milk of Nigerian women: supplementing the maternal diet with a protein-rich plant product." *Trans. R. Soc. trop. Med. Hyg.*, **53**, 256.

#### (d) *United Kingdom*

99. Professor B. S. Platt, Director of the Human Nutrition Research Unit of the Medical Research Council, London, has provided the following summary of the investigations on problems of nutrition of Colonial territories, which are the main theme of research in his Unit, and with which the work of the Department of Human Nutrition and the Applied Nutrition Unit at the London School of Hygiene and Tropical Medicine is closely associated.

100. The commonest form of malnutrition in Colonial territories is the result of insufficient quality and quantity of protein in the diets of children and their mothers. Experimentally two main types of protein malnutrition can be produced, notably in the pig; one is the marasmic form in animals fed on a diet containing low concentrations of protein of low nutritive value; the other, corresponding to kwashiorkor, can be produced with the same ration fed together with an approximately equal weight of carbohydrate. Some recent observations on these two syndromes in animals include

disturbances in osteogenesis, including "arrest lines" in bones, and the pronounced effects of the extra carbohydrate on the development of anaemia, hypoproteinemia, oedema and the derangement of the regulation of carbohydrate metabolism in blood and tissues. Evidence has been obtained that the animals on the diet containing a relatively large proportion of carbohydrate only survive a few weeks as compared with the marasmic animals which may survive from about six to eighteen months. In the short-lived animals there are changes in the central nervous system resembling, but not identical with, the changes found in hypoglycemia and hypoxia. These lesions together with the deranged sugar metabolism would appear to account for the "C.N.S." death encountered, and recall a similar fatal termination seen in young children with protein malnutrition in the Gambia, sometimes, probably erroneously, attributed to cerebral malaria. It is noteworthy that even in skilled hands there is still a high mortality rate of about 20 to 25 per cent. amongst the florid acute cases of protein malnutrition in young children. Experiments on appropriate methods of treatment in the terminal phase in animals on low protein/high carbohydrate diets are in progress. Some features of this condition resemble those seen in infantile beriberi, and Mr. C. C. Liang of the Department of Physiology in the University of Hong Kong in collaboration with Professor B. S. Platt has been re-examining the metabolic changes in vitamin B<sub>1</sub> deficiency. Glyoxylic acid, hitherto unrecognised as a metabolite in mammals, has been found to accumulate in vitamin B<sub>1</sub> deficiency, and symptoms are accentuated on administration of it to deficient animals.

101. Attention has been given in the last three years to the determination of the "protein value" of human foods, particularly those of tropical countries. Protein value is now expressed in terms of Net Dietary-protein Value (N.D.-p.V.); a single figure gives a measure of both quantity and quality of protein. Requirements and the protein value of foods can be given in terms of N.D.-p.V. This work, undertaken mainly with help from the Rockefeller Foundation, has yielded numerous data on the protein value of tropical dishes, meals and diets which will be of value in making plans for the prevention of protein malnutrition. Miss Helen C. Fox, a Colonial Medical Research Student, has been working on protein values of Jamaican foods and appropriate supplements. Mr. I. S. Dema, formerly on the staff of the Department of Agriculture, Nigeria, has also participated, with special reference to West African foods; he will be leaving the Unit to work in a team concerned with improvement of nutrition of West Nigerian villagers under the direction of Dr. W. R. F. Collis. Information obtained in the course of this work on N.D.-p.V.'s was incorporated in a working paper prepared in the Department of Human Nutrition for a joint agricultural-nutrition conference held in Bukavu, Belgian Congo, under the auspices of FAO and CCTA in November, 1958, on "grain legumes" (pulses) at which Professor Platt was Chairman of the section on nutrition. He also visited Ghana as WHO Consultant on a joint WHO/FAO mission to advise the Government on problems relating to nutrition. This visit has led to increased co-operation with the staff of the Ghana Government who are concerned with research in nutrition and closely allied subjects. A report of this joint mission by Professor Platt and Dr. J. Mayer is available from either of the two international organisations concerned.

*Investigations of sickle-cell trait and sickle-cell anaemia*

102. Dr. J. C. White has continued to work on the abnormal haemoglobins at the Postgraduate Medical School of London, assisted by Miss M. Ellis, B.Sc., and in collaboration with Dr. G. H. Beaven (M.R.C. Laboratories, London). The application of a sensitive combined method of alkaline denaturation and ultra-violet spectrographic analysis has enabled foetal haemoglobin (Hb-F) to be studied in the blood of young children. This continues to be formed in small amounts for several years after birth, traces persisting normally up to about 5 years of age, but it is not detected in older children and adults. In the hereditary haemoglobinopathies and thalassaemia, however, the persistence of variable and often appreciable amounts of Hb-F is a valuable diagnostic aid, when combined with electrophoretic studies and investigation of serum and bone-marrow iron, red cell fragility and other criteria. Studies on the minor haemoglobin and other protein components of red cell extracts are being integrated with the studies on Hb-F, using electrophoretic, spectrographic and other physico-chemical techniques. Blood from Cypriot patients with thalassaemia has been particularly studied, through the co-operation of Dr. Gillespie in Nicosia.

103. The boundary electrophoretic study of abnormal haemoglobins has been continued with Dr. E. A. Shooter at University College, London, with particular reference to minor haemoglobin components, haemoglobin A<sub>2</sub> and E<sub>1</sub> and the effects of storage. Detailed analyses of mixtures of haemoglobins A and S have been made, as well as of the behaviour of several "fast" haemoglobins.

104. Dr. G. H. Beaven and Mr. W. B. Gratzler at the M.R.C. Laboratories have made a critical study of the various techniques used for the separation of haemoglobin variants, with particular reference to the complete separation of the adult and foetal forms. Electrophoresis in agar gel has been confirmed to be particularly valuable for this purpose, and the method has been extended to include direct spectrographic observations on the separated haemoglobin zones.

105. The use of low-temperature spectra to increase the precision of the spectrographic differentiation of proteins, including haemoglobins, is also being studied. The extensive literature on haemoglobin variants has been reviewed in some detail in order to ascertain to what extent the general criteria used for the characterisation of proteins have been applied to the haemoglobin variants, and to consider various factors influencing the behaviour of haemoglobin which may be relevant to such work.

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*Idem* and BEAVEN, G. H.—(1959) "Foetal haemoglobin." *Brit. Med. Bull.*, **15**, 33.

BEAVEN, G. H., and GRATZER, W. B.—(1959) "A critical review of human haemoglobin variants: Part I: Methods for separation and characterization. Part II: Individual haemoglobins." *J. Clin. Path.*, **12**, 1 and 101.

106. Dr. H. Lehmann, of St. Bartholomew's Hospital, London, continued the study of the abnormal foetal haemoglobin tentatively called haemoglobin "Bart's". It was found in 14 more specimens of neonatal blood sent from Thailand, Singapore and America. All but one came from Mongoloid babies, the exception being a Negro child from Texas. In a Greek boy, aged 9, it was present after the age of infancy. The patient had thalassaemia, and it seemed that the abnormal haemoglobin had persisted in the same way as foetal haemoglobin usually persists in such a condition.

107. In collaboration with Dr. J. A. M. Ager and Dr. F. Vella a new haemoglobin was found in a family from Norfolk. This was the first instance of an abnormal haemoglobin being found in a purely British family; it was called, preliminarily, haemoglobin "Norfolk". Together with the same authors, another variant of foetal haemoglobin was discovered which differed both from haemoglobin F and haemoglobin "Bart's." It was discovered at the same time by Dr. Ph. Fessas and his collaborators from the Alexandra Hospital, Athens, and has been named haemoglobin "Alexandra."

108. In collaboration with Dr. V. M. Ingram and Dr. S. Benzer, several specimens of haemoglobin D from different parts of the world, examined after tryptic hydrolysis, revealed differences in the peptides, and that the haemoglobins, though behaving identically on electrophoresis, derived identical electrophoretic properties from different molecular charges. It is likely that haemoglobins thought to be identical on the basis of electrophoretic and chromatographic methods may prove to be different when examined by the new methods of hydrolysis developed by Dr. Ingram and his colleagues. This would apply particularly to the rare haemoglobins found sporadically in various parts of the world. One at present under investigation is a sample of haemoglobin G in a Chinese; this haemoglobin has only hitherto been discovered in West Africans and American Negroes.

109. Early in 1959, Dr. Lehmann visited Nigeria at the invitation of the Federal Government and of the Government of the Eastern Region. In Lagos, together with Dr. W. dos Santos, the effect of acetazolamide (Diamox) in sickle-cell anaemia patients was studied, following the report of Hilkevitz in 1957 that acetazolamide inhibits the occurrence of sickling of red cells *in vitro* and *in vivo*. This compound is known to cause acidosis. Ten patients with sickle-cell anaemia and one with sickle-cell haemoglobin C disease were treated with it, and were given at the same time sodium bicarbonate and potassium chloride supplements. No effect on the anaemia could be observed over two weeks; the supplements did not prevent acidosis and hypokalaemia caused by the carbonic anhydrase inhibitor.

In Eastern Nigeria, in collaboration with Dr. C. Nwokolo, a survey of haemoglobin types was made, and revealed that in the Ibo race the haemoglobin C incidence is below 1 per cent. This is in striking contrast with its 7 per cent. incidence west of the River Niger in the Yoruba race. It would seem that the River Niger forms a barrier to the spread of this haemoglobin eastwards, not unlike the barrier which the River Zambesi forms to the spread southwards of the sickle-cell haemoglobin.

Studies on the possibilities of preventing sickle-cell crises by anti-coagulant treatment have shown that thrombin-generation can be lowered substantially by the oral application of magnesium, and investigations are in progress

on the most suitable way of administering it on a long term basis. To prevent magnesium from acting as a purgative and to achieve the absorption of the ion, magnesium salts have to be given with amino-acids or with a protein liberating amino-acid on ingestion.

#### *Publications*

AGER, J. A. M. and LEHMANN, H.—(1958) "Observations on some 'fast' haemoglobins: K.J.N. and 'Barts'." *Brit. med. J.*, **2**, 929.—(1958) "Haemoglobin 'Norfolk': a new haemoglobin found in an English family. With observations on the naming of new haemoglobin variants." *Ibid.*, **2**, 539.

AKSOY, M., IKIN, E. W., MOURANT, A. E., and LEHMANN, H.—(1958) "Blood groups, haemoglobins and thalassaemia in Turks and Southern Turkey and Eti-Turks." *Ibid.*, **2**, 937.

SANGHVI, L. D., SUKERMARAN, P. K., and LEHMANN, H.—(1958) "Haemoglobin J trait in two Indian women, associated with thalassaemia in one." *Ibid.*, **2**, 828.

VELLA, F., AGER, J. A. M., and LEHMANN, H.—(1958) "An abnormal haemoglobin in a Chinese: haemoglobin G." *Nature*, **182**, 460.—(1959) "New variant of the foetal haemoglobin." *Ibid.*, **183**, 30.

BENZER, S., INGRAM, V. M., and LEHMANN, H.—(1958) "Three variants of human haemoglobin D." *Ibid.*, **182**, 460.

LEHMANN, H.—(1959) "Variations in human haemoglobin synthesis and factors governing their inheritance." *Brit. Med. Bull.*, **15**, 40.

#### *Leprosy*

##### *Nigeria*

110. 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.

111. *Trials of new anti-leprosy drugs.* *Diethyl-dithiol-isophthalate* (ETIP or "Etisul"), a derivation of ethyl mercaptan, was submitted to clinical trial in leprosy following favourable reports of its chemotherapeutic action in tuberculous animals. Its trial in leprosy, begun in 1957, has developed in 6 stages.

*Group 1.* This was a pilot trial in 18 previously untreated patients, 9 of them lepromatous, 9 suffering from other types of the disease. The preparation used was a 75 per cent. cream administered by inunction in a dose of 3 ml. twice weekly. Although all the lepromatous cases showed speedy improvement in bacteriological findings, the trial had to be abandoned after 3 months as patients became intolerant of the odour of the drug. Their subsequent unusually good progress on standard treatments strongly supported the bacteriological evidence of chemotherapeutic activity on the part of ETIP.

*Group 2.* A perfumed preparation was then administered in a dose of 6 ml. twice weekly to 22 previously untreated patients for periods up to 5 months, inunction being light and applied to a small area of the body. Progress was noteworthy in only 5 patients, and signs suggestive of drug resistance began to appear from the fourth month onwards.

*Group 3.* The same preparation was administered with thorough and extensive inunction to 15 previously untreated patients for periods of 10-15 weeks. In most, progress was very good for about 8 weeks, and then became erratic.

*Group 4.* When given to 22 patients late in the course of DDS treatment, combined treatment was tolerated excellently, but no acceleration in the absorption of granular bacilli was observed.

*Group 5.* Given in conjunction with DDS from the start in 34 previously untreated patients, the combination proved highly effective in the majority of cases, on bacteriological, clinical and histological assessment, while in 6 months no evidence of drug resistance has as yet appeared.

*Group 6.* Finally a group of 18 patients have received combined treatment with ETIP, DDS and DPT. After 4 months the progress of this group is the most outstanding of all.

It is already clear that ETIP is a drug of considerable potential importance. Free from toxicity, and apparently bacteriocidal in action, its use in combination with DDS promises considerably to accelerate the resolution of lepromatous cases.

112. A study of *Diphenyl thiourea compound CIBA 1906 (DPT)* is now in its late stages. During the past four years 200 patients have taken part in pilot and extended trials, which have demonstrated that this drug has a useful place in the chemotherapy of leprosy. Although its prolonged use may tend to drug resistance, in shorter courses it is an effective drug, suitable for those conditions in which DDS is not well tolerated, for initiating treatment, and for use in combination with DDS. Its lack of toxicity is a valuable property. The drug has recently been placed on the market.

113. *Diamino-diphenyl-sulphoxide (DDSO)* has also been studied in pilot and extended trials comprising 102 patients, and have continued for 3½ years. It has proved to be chemotherapeutically as effective as DDS, and is particularly useful when administered twice weekly. Toxic effects are as important as those of DDS. The metabolism of this drug is of interest in relation to DDS, and invites further study.

114. *Controls and records.* The build up of graphs showing the average progress of large numbers of patients receiving standard DDS treatment has continued, and provides a satisfactory basis for the control of progress in drug trials. The detailed recording of the condition of bacilli in all routine smears has become a standard procedure.

115. *Immunology.* Work in this field has been limited to the examination of skin reactions elicited by suspensions of normal skin particles, and lipids derived from nerve tissue and from tubercle bacilli.

#### *Publications*

DAVEY, T. F.—(1957) "Leprosy and yaws: points of contact." *Bull. Wld. Hlth. Org.*, **17**, 484.—(1957) "Decline in leprosy in a group of Nigerian villages between 1941 and 1956." *Internat. J. Leprosy*, **25**, 329.—(1959) "Diethyl dithiolisophthalate (ETIP or 'Etisul') in the treatment of leprosy. A second progress report." *Lep. Review*, **30**, 141.

*Idem* and HOGERZEIL, L. M.—(1959) "Diethyl dithiolisophthalate in the treatment of leprosy. (ETIP or 'Etisul'). A progress report." *Ibid.*, **30**, 61.

*Idem* and DREWETT, S. E.—(1958) "Lepromin-like activity of normal skin tissue." *Ibid.*, 29, 197.

### Uganda

116. From Makerere College, Uganda, Dr. R. F. Naylor, Lecturer in Chemistry, continuing his experiments designed to measure dehydrogenase activity in *Mycobacteria*, has used a bacterial suspension obtained from biopsies from lepromatous cases by maceration in isotonic phosphate buffer and rough separation from tissue elements. After incubation for suitable periods with tetrazolium salts under anaerobic conditions, the coloured formazan is extracted from the bacteria with organic solvents and estimated photometrically. While accurate comparisons are not possible, marked differences are obtained between results from untreated patients and those who have been on sulphone therapy for periods of a few months to several years. It is doubtful, however, whether the method can give sufficiently accurate results to be of value as a diagnostic tool.

117. A more sensitive method of detecting biochemical change is therefore being sought by the use of radioactive tracers in conjunction with the East African Leprosy Research Centre, Alupe, initially on *M. phlei*; first results indicate that, with saprophytes at least, the changes are sufficiently large to be detected by this method.

118. Dr. E. M. Brieger, at the Strangeways Research Laboratory, Cambridge, has re-examined seven cases of lepromatous leprosy after one year's treatment with DDS. Biopsy material for organ cultures was obtained on a visit to Oicha (Belgian Congo) in 1956 when the cases were still active, and on another visit in 1957, when the clinical condition had greatly improved after treatment. In biopsies of the treated cases maintained in culture as described last year, no significant increase of bacilli was seen after 5 weeks' culturing, nor any marked change in the fine structure of the bacilli. Lepra cells persisted. There was also no increase in bacillary numbers in one of three untreated cases, a lepromatous case of the diffuse infiltrated type.

119. To follow up these findings on more cases of various clinical types, Dr. Brieger and Miss J. M. Allen, a Research Assistant with the Medical Research Council, made a five-months visit to Uganda and the Belgian Congo, making the Pathology Department, Makerere College Medical School, their headquarters laboratory, by the kindness of Professor J. N. P. Davies. Leprosaria at Oicha, Buluba and Kumi (Uganda) and the East African Leprosy Research Centre at Alupe served as field laboratories, with Dr. C. K. Becker, Dr. W. M. Blenska, Dr. J. M. Lea and Dr. J. Garrod respectively co-operating in getting the biopsies required and providing laboratory facilities. The biopsies were from lepromatous cases of the nodular and diffuse infiltrated types (treated and untreated) and a few borderline and tuberculoid cases.

120. To discover whether the mass of bacilli at the end of the culture period in untreated lepromatous cases of the nodular type is due to true multiplication, the effect of growth inhibiting factors was studied by adding the sulphone drugs DDS and DPT (CIBA 1906) to the medium, by killing the cells by autoclaving, and by keeping the explants in the refrigerator or incubating them on plain agar. To compare the viability of bacilli at the beginning and end of the culture period, samples taken at intervals were

minced and incubated in a 0.05 per cent. solution of potassium tellurite in glycerol broth. After 24-48 hours' incubation electron microscope grids were inoculated, fixed in formalin and sent to Cambridge for examination. At sites of respiratory activity potassium tellurite is reduced to metallic tellurium which is visible as needles and granules in the electron microscope. Preliminary results with human type tubercle bacilli were promising. Results with the leprosy material are awaited.

121. The light and electron microscope studies on *in vitro* inoculation of explants were continued. Explants of monkey and guinea-pig spleen were inoculated with leprosy bacilli from untreated cases and maintained in culture for five weeks. A parallel series was set up using human tubercle bacilli as inoculum. For continued studies on the fine structure of leprosy bacilli, and especially on whether a nuclear apparatus is demonstrable in thin section in the electron microscope, samples of tissue juices rich in bacilli were embedded in drops of agar, fixed and sent to Cambridge, where they are being examined.

#### *Publication*

BRIEGER, E. M.—(1959) "The sub-microscopical structure of *Mycobacterium leprae*." In "Leprosy in Theory and Practice," by R. G. Cochrane. John Wright and Sons, Bristol.

#### *Kenya*

122. From the East African Leprosy Research Centre, Alupe, Kenya, Dr. John Garrod reports on therapeutic trials of DPT. The results to date suggest that DPT is better than DDS in some respects, especially in the first 12 months, but that from then onwards the advantage lessens. With DPT reactions are fewer and milder than with DDS, so that an effective dosage can be given continuously, whereas with DDS frequent breaks in treatment may be needed because of reactions. A therapeutic trial of Etisul, the I.C.I. ointment, is in train. Better effects are obtained than with any other drug. Combinations with DDS, DPT and TB1 seem to be more effective still.

From biopsies of patients data are being collected for a study of Ridley's "Biological Index." In October Mr. G. A. Ellard, M.Sc., a biochemist provided and financed by Messrs. Ciba, began work at the Centre. He has confirmed the general correctness of previous work done here on DPT and its metabolites. He has isolated limited impure quantities of one metabolite and found indications of another. The importance of this may be that, since this drug is excreted in large quantities in the stool, its action may be due to a metabolite found only in small quantities. He is collaborating with Dr. Naylor in the use of tetrazolium dyes, and is initiating studies on the possible take up of isotopes by bacilli.

#### *United Kingdom*

123. From the National Institute for Medical Research, London, Dr. R. J. W. Rees reports on his laboratory studies as follows.

124. *Studies on leprosy bacilli in the electron microscope* (in collaboration with Dr. R. C. Valentine). The evidence that infective and non-infective *Myco. lepraemurium* can be distinguished by differences in the internal structure of the bacilli seen in the electron microscope has been greatly strengthened by comparative studies with a readily cultivated bacillus,



*Escherichia coli*. When *E. coli* was incubated at 37°C in phosphate buffer an increasing proportion of bacilli showed cytoplasmic changes similar to those seen in the non-infective (degenerate) forms of *Myco. lepraemurium*. Viable counts, by plating out the suspensions and examination at the same time in the electron microscope, showed that this morphological change was correlated with loss of viability.

The change from the normal to the "degenerate" form of *Myco. lepraemurium* which had hitherto only been observed *in vitro* has now been demonstrated *in vivo* by treating infected animals with the therapeutically active drug—isoniazid. This finding suggests that electron microscopy might be used for following more precisely the fate of *Myco. leprae* during treatment in man. Electron microscopy has been used extensively and is of great value for following the survival of *Myco. lepraemurium* in tissue cultures and determining the "viability" of samples of human leprosy bacilli used for transmission experiments (see below).

125. *Multiplication of Myco. lepraemurium in tissue culture* has been studied in collaboration with Miss Y. M. Barr and Miss E. W. Garbutt. It had previously been reported that growth of *Myco. lepraemurium* could be initiated in an established line of rat fibroblast cells, strain 14 pf, but multiplication was limited to one or two generations. One possible limiting factor was the deterioration which inevitably occurred in the tissue cells between the third and fourth weeks, through not subculturing. New techniques were therefore developed for subculturing, approximately every three weeks, infected lines of tissue cells and for determining the number of bacilli present in samples removed from each subculture. By this method the bacillary population and the "viability" of the bacilli (seen in the electron microscope) has been followed in infected sublimes for periods up to 150 days. Recently more continuous, though somewhat irregular, multiplication has occurred in the first 100 days, followed by continuous and more rapid multiplication in the subsequent 50 days. Estimated increases of approximately 12 to 20-fold were recorded in the latter 50 days. It is of particular interest that the proportion of the "degenerate" forms of bacilli decreased during the latter half of the experiment.

126. *Supply of fresh leprosy tissue to laboratories in Britain*. This service has continued and material has been received from East and West Africa and Malaya. During a visit to West Africa early in 1959 Dr. R. J. W. Rees made direct arrangements with other leprologists to extend this service.

#### *Publications*

REES, R. J. W.—(1958) "The study of rat leprosy in tissue culture as an approach to propagating human leprosy bacilli *in vitro*." *Proc. 7th Internat. Cong. Leprol., Tokyo*.

*Idem*, VALENTINE, R. C. and WONG, P. C.—(1958) "The biological significance of different appearances of rat and human leprosy bacilli as shown by electron microscopy." *Ibid*.

GARBUTT, E. W., REES, R. J. W. and BARR, Y. M.—(1958) "Multiplication of rat-leprosy bacilli in cultures of rat fibroblasts." *Lancet*, 2, 127.

127. Dr. D. G. Jamison, of the Department of Human Anatomy, Oxford, has continued his investigations at Oxford and in Northern Nigeria, which are summarised below. Histological examinations of skin and peripheral

nerve biopsies, taken from treated and untreated leprosy patients during two visits to Northern Nigeria, have been made at Oxford in conjunction with Dr. A. G. M. Weddell. The results so far suggest that leprosy bacilli can be found in nerve bundles when they are absent from the skin. Another investigation, on the significance of fuchsinophil cells in the skin (cells staining positively with carbol fuchsin), has thrown doubt on the view, held by some, that they are indicative of an early leprosy lesion or of contact with a leprosy patient. Cells indistinguishable from them have been found in normal skin biopsies in African, Asian and European subjects; they are mostly mast cells.

128. In studies on the concentration technique, by which it has been claimed by others that leprosy bacilli can be recovered from the skin of those in contact with the disease, material from fixed biopsies taken with rigid precautions against contamination from eight subjects in close contact with untreated lepromatous cases failed to reveal any leprosy bacilli. The examination continues on a second series of biopsies.

129. A number of Nigerian school children were found to have enlargement of the ulnar nerve, yet no signs of cutaneous leprosy. The relationship of this sign to the onset of leprosy is being pursued.

130. Cutaneous sensibility has been investigated in all cases from which biopsies were taken, in a large range of leprosy patients under treatment and in a number of normal Africans in various parts of Northern Nigeria. The variations in cutaneous sensibility are being correlated with the alteration in the peripheral nerves of the skin in the various forms of the disease. One of the most interesting findings has been that in selected subjects with lepromatous leprosy the threshold for touch is lower than in uninfected subjects. While this may be due to variation in sensitivity it is interesting that the number of regenerating nerves surmounted by growth cones is greater in these cases than in uninfected subjects.

131. The efficacy of Etisul is being studied in four advanced lepromatous cases by smears and biopsies taken before treatment and by weekly smears and monthly biopsies taken after treatment.

Cultivation studies on material from untreated lepromatous cases are being undertaken at Oxford by Dr. R. L. Vollum.

### *Tuberculosis*

#### *East Africa*

132. *Therapeutic trials in pulmonary tuberculosis.* The basis of these trials, conducted by members of the staffs of a number of hospitals and laboratories in East Africa in collaboration with the Tuberculosis Research Unit of the Medical Research Council (M.R.C.), has been recorded in previous reports. A report (1959) of the *sulphone plus isoniazid trial* described briefly in the 1956-57 report has been published.

133. *Isoniazid trial (1957).* The twelve-month period of in-patient investigation has been completed, and eighteen and twenty-four-month follow-up examinations are proceeding. A preliminary report on the twelve-month period of observation in hospital was presented by Dr. J. Pepys (M.R.C.) to the Conference convened by the West African Council for Medical Research at Jos, Nigeria, in February, 1959. The patients receiving isoniazid alone in low or high dosage fared slightly worse clinically and radiographically, and

markedly worse bacteriologically, than the patients receiving isoniazid 200 mg./day plus PAS 10 g./day. The patients on low dosage isoniazid (200 mg./day) fared worse than those on high dosage isoniazid (20 mg./kg. isoniazid/day, plus pyridoxine 5 mg./kg./day). The information on catalase activity and virulence of the resistant strains is being analysed.

134. *Trial of isoniazid in combination with thiosemicarbazone (TB1), substituted diphenyl-thiourea, SU.1906, (DPT) or PAS (TB1/DPT trial).* The reasons for planning a controlled trial of TB1 with isoniazid were given in the 1957-58 report. The opportunity of an expanded new trial was taken to study DPT, which is active against *M. tuberculosis in vitro* and is virtually non-toxic. From the start of the investigation in September, 1958, up to February, 1959, 188 patients were admitted. The hospitals participating are in Nairobi and Port Reitz in Kenya ; Kibongoto, Dar-es-Salaam and Kongwa in Tanganyika ; Mulago in Uganda. The laboratories concerned are in Nairobi and Dar-es-Salaam in East Africa, and the laboratory of the M.R.C. Group for Research on Drug Sensitivity in Tuberculosis in London.

The treatment regimens are isoniazid 200 mg./day, plus TB1 150 mg./day, or DPT 2 g./day or PAS 10 g./day. The allocated treatment is to be given for twelve months, the first six months in hospital. Particular attention is being paid to possible toxicity of the TB1 to see whether it can be given safely for long periods, if it is effective in preventing the emergence of isoniazid resistance.

135. *General observations on the chemotherapy trials.* Firstly, the efficacy of the combination of PAS 10 g./day plus isoniazid 200 mg./day for routine therapy in East Africa is being questioned in view of a proportion of bacteriological failures ; a study of the effects of variations of the dosages of these two drugs in combination is therefore needed. Secondly, the increasing incidence of bacterial resistance to isoniazid in the sputum culture of patients submitted for possible inclusion in these investigations is alarming, and the sources of this resistance and its significance demand urgent investigation.

Dr. J. Pepys, (M.R.C.) reported on the East African trials at the International Congress of Tropical Medicine in Lisbon in 1958. Professor A. W. Williams and Dr. Pepys participated in the Conference on tuberculosis and leprosy at Jos. Reports were given on the East African Sulphone/Isoniazid Trial, the Isoniazid Trial, and the problem of the increasing prevalence of isoniazid-resistant strains in the initial sputum specimens of patients submitted to the trials.

#### *Publication*

East African/British M.R.C. Sulphone Investigation (1959). *Tubercle*, 40, 1.

#### *West Africa*

136. *Chemotherapy trials.* Dr. W. J. Bell, the Director of the West African Tuberculosis Research Unit, which has its headquarters at Kumasi, reports further on these trials in pulmonary tuberculosis.

137. *In-Patients.* Of two separate investigations in 300 in-patients to determine how best to use a limited period of hospitalisation (three months), the first was designed to determine whether a twin drug regime (streptomycin

plus isoniazid) offered any advantage over a triple drug regime (streptomycin plus P.A.S. plus isoniazid). All patients were previously untreated and exhibited full bacterial sensitivity to the drugs. Interim results reveal little difference between the efficacy of the two regimes. The second investigation was designed to determine whether the addition of prednisolone to a standard regime of chemotherapy would give a more rapid bacterial clearance of sputum in the far advanced case. There is no evidence so far that it does so.

138. *Out-Patients.* These are divided into urban and rural groups, urban out-patients being randomised between two chemotherapy regimes, viz. streptomycin daily plus isoniazid daily for three months and thereafter P.A.S. plus isoniazid daily for a further nine months, and P.A.S. daily combined with isoniazid daily for 12 months. Rural out-patients were allocated to one of two regimes—either P.A.S. (12 g. daily) plus isoniazid (300 mg. daily) for 12 months, or P.A.S. (6 g. daily) plus isoniazid (300 mg. daily) for 12 months. Analysis to date indicates that there are serious limitations to the definitive chemotherapy of pulmonary tuberculosis in Ashanti. Regular urinary P.A.S. testing has revealed that over 30 per cent. of cases in the isoniazid-P.A.S. groups have not taken P.A.S. regularly; around 50 per cent. of all out-patients have absconded from treatment by the sixth month of therapy; there has been evidence of a high emergence of isoniazid resistance and of a high bacteriological and clinical relapse rate during treatment. The evidence thus indicates that the drugs are not being taken in optimum dosage, constantly or over a prolonged period of time.

139. *A comparison of in-patient and out-patient chemotherapy.* A total of 99 patients have been randomised to two treatment groups, the one offering in-patient treatment for three months, and the other out-patient treatment for three months, in each group the drug used being streptoisonicotinal acid hydrazid (Streptohydrazid) administered daily. The time chosen is related to the maximum period of hospitalisation that can be offered to any patient in Ashanti. Streptohydrazid was the combination chosen for the reason that since streptomycin and isoniazid are given parentally with this combination, combined therapy could be assured. At the three months point there is no evidence, on the criteria of improvement in the general condition, clearing of the radiograph, and bacterial clearance of sputum, that in-patient treatment has anything to offer over out-patient treatment provided that constant therapy in each group can be assured.

140. *Bacteriological investigations.* Investigations into the general scatter of bacterial resistance in untreated cases and in cases under treatment are commencing. Preliminary observations in Ashanti suggest that there is an overall 20 per cent. resistance to one or other of the major drugs in patients reporting at the tuberculosis clinics and not admitting to previous drug treatment, and that it is 40 per cent. in patients under treatment. The investigations include assessment of the extent of resistance developing to streptomycin, P.A.S. and isoniazid at various treatment centres throughout Ghana.

#### *Research at the Medical Research Council Laboratories, The Gambia*

141. The Director, Dr. I. A. McGregor, has provided a summary of the activities of the Laboratories during the year. Excerpts from it pertaining to research on malaria and trachoma have been given in their appropriate

context earlier in this Report at paragraphs 33–34 and 58–62 respectively. Other activities are noted below.

142. *Bancroftian filariasis*. Long term studies on the value of small doses of Hetrazan continue.

*Serology*. An investigation in collaboration with Dr. M. Barr, of the Wellcome Research Laboratories, Beckenham, was begun, designed to assess the capacity of Gambian children for antibody production to specific therapeutic vaccines.

In collaboration with Dr. A. C. Allison, National Institute for Medical Research, sera from adult Gambians were examined and haptoglobin and beta-globulin contents determined. A high proportion of sera were found to contain no haptoglobin, while a few were found to possess rare and unusual types of beta-globulin.

143. *Entomology*. Studies on the *Anopheles gambiae* complex have been reported earlier at paragraph 34. In another study, frequent sampling of the *Culicoides* populations of the Keneba area has been made, using a variety of sampling techniques. Six distinct and one indeterminate species of *Culicoides* have been observed to occur in populations of considerable size, and the periodicity of these has been studied. A number of other species has been recorded in general collecting, but not systematically studied. Work on the *Phlebotomini* group of insects has been confined to general collecting. Larvae have been collected by soil sampling using Tullgren funnel equipment, while adults have been investigated by sticky trapping in a variety of outside habitats supported by light trap and hand collections.

144. *Visiting scientists*. The work of the visiting Trachoma Research Group has been reported at paragraphs 58–62. Other projects studied have comprised an investigation of the anaemias of the Gambia by Dr. S. Bell; the *in vitro* cultivation of *Plasmodium falciparum*, the determination of catalase levels in the blood of Gambians and the determination of glutathione content of the erythrocytes of Gambians, by Dr. A. B. Raper; the study of prevalent nutritional conditions in the Gambia and their effect on physique and health, and also a study of maternity and lactation in the Gambia, by Dr. A. M. Thomson; and a study of the schistosome vector snails and their habitats by Dr. B. Hubendick and Mr. A. D. Berrie.

#### *Publications*

BERTRAM, D. S., MCGREGOR, I. A., and MCFADZEAN, J. A.—(1958) “Mosquitoes of the Colony and Protectorate of the Gambia.” *Trans. R. Soc. trop. Med. Hyg.*, **52**, 135.

MCFADZEAN, J. A., and SMITHERS, S. R.—(1958) “Action of Piperazine on *Necator*, *Trichuris* and *Strongyloides*.” *Ibid.*, **52**, 235.

RAPER, A. B.—(1959) “Further observations on sickling and malaria.” *Ibid.*, **53**, 110.

GILLES, H. M. and CARRINGTON, S. B.—(1958) “Serum cholesterol in Gambian Africans.” *Ibid.*, **52**, 476.

GILLES, H. M. and WILLIAMS, K.—(1958) “Effect of Heparin *in vivo* on the release of microfilaria of *W. bancrofti* into the peripheral blood.” *Ann. trop. Med. Parasit.*, **52**, 516.

SMITHERS, S. R.—(1958) “Attempted control of *Bulinus senegalensis* Muller, a vector of *S. haematobium* in the Gambia.” *Ibid.*, 52, 315.

FOORD, R. D. and GILLES, H. M.—(1959) “A small outbreak of Bornholm disease in the Gambia.” *Brit. med. J.*, 1, 834.

*East African Institute for Medical Research, Mwanza, Tanganyika*

145. Dr. E. G. Holmes, the Director, reports on the four main research projects in progress there, viz. *nutrition and biochemistry, nutritional ophthalmology, filariasis and schistosomiasis*. Summaries of the progress made in the first three have been included earlier in this Report in their appropriate context, *vide* paragraphs 74-79, 80-84 and 17-18 respectively.

146. Work on *schistosomiasis* has been largely in abeyance owing to the officer in charge being on long leave. It was limited to the completion of surveys in the Lake Province of Tanganyika. With the provision of funds for liaison with Professor L. C. Beadle of Makerere College, and the impending posting to Mwanza of Mr. G. Webbe, M.Sc., by the Tanganyika Government for collaborative research on schistosomiasis, it is hoped greatly to intensify activity in this field.

147. Exploratory investigations to determine whether toxoplasmosis might be present in the Mwanza area have so far met with no success; brains from wild and domestic animals have proved negative for the infection.

During the year the research on *relapsing fever* by Dr. G. A. Walton terminated at the Institute, and has been transferred to London, as noted at paragraph 63.

*Research on the biology of sandflies in East Africa*

148. Mr. D. M. Minter, based on the laboratory of Dr. R. B. Heisch in Nairobi, continued his studies of the highly complex problem of the identification of the vector of *kala-azar* in the Kitui area of Kenya. This work was considerably interrupted by an infection incidental to his field work, which necessitated convalescence in Britain, during which period he prepared some 1,000 slide preparations of African *Phlebotomus* species which were presented to the Department of Entomology at the London School of Hygiene and Tropical Medicine, the Department of Entomology of the British Museum (Natural History), and the Department of Zoology, University of Edinburgh.

149. In the Kitui *kala-azar* area, in collaboration with colleagues of the Division of Insect Borne Diseases, he initiated an intensive mapping and data collecting operation, with the object of mapping every group of huts in an area of over 100 square miles along either side of the stretch of the Tana River. In conjunction with questionnaires to be answered by the head of each “family unit”, giving particulars of the number of persons of each sex in the unit, approximate ages, history of *kala-azar* in the unit, movement of persons, and the like, it is hoped that this survey will aid ultimate elucidation of the epidemiology of *kala-azar* in that area. Gland smears were made from dogs and examined for *Leishmania*; all were negative.

A “trial run” was made in the laboratory of a new technique, in which cultures of human-type *Leishmania* were injected directly into the exposed

spleens of anaesthetised hamsters; four weeks later the animals were partially splenectomised, and all found to have positive spleens. This was later tried in the field in the Kerio Valley (Baringo District), when large numbers of wild-caught sandflies from various types of habitat were injected into the spleens of tattooed hamsters in the same manner, after having been gently macerated in sterile saline and the cuticular debris filtered off. The hamsters were partially splenectomised some six weeks later, but were all found to be negative. Despite this, the method is being pursued, as it offers great promise of detecting the presence of small numbers of infected sandflies in an area; for the intra-splenic route is said to produce an infection in the spleen in about three weeks, as opposed to the 4-8 months when inoculation is intra-peritoneal.

A small number of gland smears from dogs in the Kerio Valley at this time were also negative for *Leishmania*.

150. During another visit to the Kitui kala-azar area, at a time when sandfly activity was minimal, it was possible to dissect all sandflies individually for *Leishmania* leptomonads. No positives were found. The ovarioles of some thirty females of three species, at different gonotrophic stages, were dissected out and stained, in the hope that it might prove feasible to distinguish parous and nulliparous females, or perhaps even ascertain the total number of gonotrophic cycles completed, this on analogy with the morphological changes known to occur in mosquitoes. Results were, however, discouraging, for no obvious differences were noted.

*Entomological research on various insect-vectors*

151. Dr. D. J. Lewis, of the external staff of the Medical Research Council, has furnished the following report on oversea visits made by him, aided by grants awarded on the recommendation of the Committee, and on the examination at the British Museum (Natural History) of material brought back by him.

152. *Phlebotominae*. Specimens collected by Professor P. C. C. Garnham and Dr. Lewis during the visit to British Honduras recorded in last year's Report were found to comprise 14 species, 8 of which were taken on man, including *Phlebotomus cruciatus* which is suspected of being one of the vectors of cutaneous leishmaniasis. Collections from Jamaica, Nigeria, Sierra Leone and the Sudan Republic were also studied, the African ones being of interest in relation to the patchy distribution of kala-azar.

153. *Simuliidae*. Dr. Lewis visited Kenya and Uganda to see the breeding conditions of the *Simulium neavei* complex, and went on to study this group at Amani in Tanganyika. Two species were found there but are being left without scientific names until the whole complex can be classified. The larvae of the man-biting species, the "Amani banded form", are found on the common crab, and appear to benefit from the association by being carried to suitable currents of water. It was found that parous flies—which include those infective with *Onchocerca*—tend to bite mainly during the middle hours of the day. Onchocerciasis is apparently mild, possibly owing to the scarcity of biting simuliids, which attacked at the average rate of only five per man hour even in selected catching sites. Nematodes dissected from flies and sent to Dr. G. S. Nelson in Nairobi proved to belong to more than one species.

The simuliids collected by him and Professor Garnham in British Honduras were found to number 13 species and to include *Simulium metallicum*, a vector of onchocerciasis in Guatemala, and *S. quadrivittatum*. Both these species bite man in large numbers, and the possibility of the disease spreading from Guatemala cannot be ruled out until more is known of its epidemiology.

154. *Age changes in Chrysops*. Parous females of *C. bicolor*, a common biting fly at Amani, were recognizable by the appearance of their accessory glands and several other organs. It was found, however, that the glands of nulliparous flies sometimes looked rather like those of parous ones as a result of mechanical stimulation during dissection, which caused them to secrete visible globules.

*Culicoides in Jamaica*. Midges are controlled locally to prevent annoyance to man. Specimens collected by Dr. Lewis proved to be mainly *C. furens* with a small proportion of *C. barbosai*. The finding of the latter in Jamaica shows that it should receive attention during any future study of *C. furens*.

155. *The ovarioles of Diptera*. In a continued study on age changes in simuliids and *Anopheles gambiae*, the ovaries of various Diptera were examined. The dilatations of the tunica are difficult to find in some species, and attention was paid to the follicular relics of which two general types were distinguished. One is large, particularly if a fly is caught soon after laying eggs. The other is small, probably because much of the follicular epithelium decays during oocyte development or passes out of the ovariole during ovulation. The relics give useful information about the condition of a population of flies in relation to disease transmission, and about the biting cycle of infective flies.

#### *Publications*

GARNHAM, P. C. C., and LEWIS, D. J.—(1959) "Parasites of British Honduras with special reference to leishmaniasis." *Trans. R. Soc. trop. Med. Hyg.*, **53**, 12.

LEWIS, D. J.—(1958) "Some Diptera of medical interest in the Sudan Republic." *Trans. R. ent. Soc. Lond.*, **110**, 81.—(1958) "Observations on *Simulium damnosum* Theobald at Lokoja in Northern Nigeria." *Ann. trop. Med. Parasit.*, **52**, 216.—(1958) "The recognition of nulliparous and parous *Anopheles gambiae* by examining the ovarioles." *Trans. R. Soc. trop. Med. Hyg.*, **53**, 456.—(1958) "*Simulium damnosum* in the Tonkolili Valley, Sierra Leone." *Proc. 10th Internat. Congr. Ent.*, **3**, 541.—(1958) "Some observations on Ceratopogonidae and Simuliidae in Jamaica." *Ann. Mag. nat. Hist.*, (13), **1**, 721.—(1959) "The species of *Phlebotomus* (Diptera: Psychodidae) in British Honduras." *Proc. R. ent. Soc. Lond. (B)*, **28**, Pts. 5-6, 79.

#### *Miscellaneous projects aided by small research grants*

156. During the year, additional to the considerable funds allocated to the larger research projects summarized earlier in this Report, many smaller grants were given, or renewed, for a miscellaneous range of problems to make possible the study of some facet that might otherwise be neglected. The problems included aspects of cancer and liver disease in East Africa, the sickle-cell trait and sickle-cell anaemia, leprosy, schistosomiasis, virology, nutrition, and physiology. The recipients were various workers engaged on



research with a tropical application at hospital medical schools in London, Birmingham and Liverpool, at University Colleges in Colonial territories, or in research units in those territories. Progress reports on all such work are reviewed from time to time by the Committee.

#### RESEARCH WORK UNDERTAKEN AND FINANCED BY THE MEDICAL DEPARTMENTS OF COLONIAL TERRITORIES

157. Summaries of the objectives of such current medical research in Colonial Territories, including Colonial Universities and Colleges, have been provided by various Governments. It is not possible to include them in full in a necessarily restricted report of this nature. Much of this research is being undertaken in collaboration with the staff of research projects financially sponsored, at least in part, by the Committee, and has been recorded in the foregoing pages. Thus in Nigeria interesting research on the chemotherapy of tuberculosis is being undertaken by Dr. Henshaw at Port Harcourt and Dr. Hetreed in Lagos in collaboration with Dr. Bell's Unit in Kumasi. In Kenya, Uganda and Tanganyika investigations by the territorial specialist tuberculosis officers are the basis of similar chemotherapeutic trials being undertaken in conjunction with the faculty of Medicine at Makerere College and the Medical Research Council. In Tanganyika studies are being made on drug resistance in malaria by Dr. Clyde and of the snail vectors of schistosomiasis by Mr. Webbe, both of the Tanganyika Malaria Field Unit at present sited at Amani alongside the E.A. Institute for Malaria and Vector-Borne Diseases. In British Guiana, the preliminary results of drug-treatment of bancroftian filariasis by Dr. Winston Adams, of the Government Medical Service, are being followed closely by the Standing Advisory Committee for Medical Research in the British Caribbean. In Fiji, the Government Medical Services are collaborating by complementary medical studies with the entomological studies of Mr. G. F. Burnett, seconded from the Pesticides Research Unit at Arusha, Tanganyika, for research on filariasis in Fiji. In Jamaica the serious midge nuisance near Montego Bay is being investigated by an expert from Edinburgh, Dr. D. S. Kettle. From Singapore has come the notable large-scale use of attenuated polio virus vaccine in the face of a poliomyelitis epidemic by Professor J. H. Hale of the Department of Bacteriology, University of Malaya, aided by funds generously granted by the Rockefeller Foundation, and by vaccine made available by Dr. A. B. Sabin of the Children's Hospital Research Foundation, Cincinnati.

158. From the Division of Insect-borne Diseases of the Kenya Medical Department, Nairobi, Dr. R. B. Heisch and his co-workers report the isolation of *Trypanosoma rhodesiense* from a bushbuck near Kisumu.

Two more strains of *Leishmania* believed to be *L. donovani* were isolated from gerbils (*Tatera* sp.) in a part of the Rift Valley where kala-azar is known to be endemic. Although it seems possible that kala-azar is a zoonosis in Kenya, gerbils acting as reservoirs, this has not yet been proved. The infections in gerbils were inapparent and it is not yet known whether sandflies can be infected from this source.

A *Rhipicephalus simus* was observed in the act of infecting a European woman in Nairobi with tick typhus. There seems little doubt this tick is an important vector in Kenya. Sera from wild rodents around Nairobi contained complement fixing antibodies to *Rickettsia conori*, while around

Nakuru there is serological evidence that wild rodents are reservoirs of *R. mooseri*.

159. The filariasis survey was continued in the coastal area. On the Tana River cats were found infected with *Wuchereria pateri*. *Taeniorhynchus* sp. was found to be the vector on the Tana and not *Ae. pempaensis* as on Pate Island. Numerous mosquitoes were dissected and the infective larvae of *W. bancrofti* were found in *Culex fatigans* (1.6 per cent.), *A. gambiae* (0.5 per cent.) and *A. funestus* (0.9 per cent.).

The isolation of schistosomes in hamsters was continued. *Schistosoma mansoni* was isolated from *Biomphalaria* snails in the Nairobi River. An American team working at Kibwezi on atherosclerosis in baboons discovered that some of these animals were naturally infected with *S. mansoni*. This interesting observation is being investigated, and baboons have also been shown to be infected from Lake Albert in Uganda.

A tapeworm survey was made on a cattle ranch near Athi River. A number of domestic animals were carefully examined, but no alternate definitive host of *T. saginata* was found. Other tapeworm species were found in *Arvicanthis*, dogs, a leopard, jackals, a hyaena, a bat-eared fox, an impala, gerbils and a Kaffir cat; these worms are being examined. Cattle and dogs at Ngong near Nairobi were found to be heavily infected with *Echinococcus granulosus*. Cystic stages of a tapeworm were found in game (zebra, wildebeeste and kongoni); they were hooked, which excludes *T. saginata*. It is also interesting to record that some of the cysts in measly meat are hooked, showing that "measles" is not invariably due to *T. saginata*.

Colonial  
Pesticides Research Committee  
Twelfth Annual Report  
(1958-1959)

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Commonwealth Institute of Entomology,  
c/o British Museum (Natural History),  
Cromwell Road,  
London, S.W.7.

14th October, 1959.

SIR,

I have the honour to enclose herewith the Twelfth Annual Report of the Colonial Pesticides Research Committee for the year 1958-1959.

I am,

Sir,

Your obedient Servant,

W. J. HALL,

*Chairman.*

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

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DR. A. B. P. PAGE, Ph.D., Imperial College of Science and Technology.

MR. E. O. PEARSON, M.A., Commonwealth Institute of Entomology.

DR. C. POTTER, D.Sc., D.I.C., Head of Insecticides Department, Rothamsted Experimental Station.

MR. D. RHIND, O.B.E., F.L.S., Secretary, Committee for Colonial Agricultural, Animal Health and Forestry Research.

PROFESSOR R. L. WAIN, D.Sc., Ph.D., F.R.I.C., Wye College, Ashford, Kent.

PROFESSOR V. B. WIGGLESWORTH, C.B.E., M.A., M.D., B.Ch., F.R.S., Department of Zoology, University of Cambridge.

### Ex-Officio Members

The Secretary of State's Medical, Agricultural, Animal Health and Forestry Advisers.

MR. G. W. THOM, O.B.E. (*Secretary*).

MR. K. WILSON-JONES, M.Sc. (*Scientific Secretary*).

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. HAWKINS, D.M., D.T.M., National Institute for Medical Research, Mill Hill.

DR. R. LEWTHWAITE, C.M.G., O.B.E., D.M., F.R.C.P., Secretary, Colonial Medical Research Committee.

PROFESSOR G. MACDONALD, C.M.G., M.D., D.P.H., D.T.M., Director, Ross Institute of Tropical Hygiene.

DR. A. M. WILSON RAE, C.M.G., M.D., Ch.B., Chief Medical Officer, Colonial Office.

MR. R. MOWFORTH (*Secretary*).

#### SUB-COMMITTEE ON METHODS OF APPLICATION

PROFESSOR H. G. H. KEARNS, 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 Pesticides Research Unit, Porton.

MR. A. E. H. HIGGINS, A.R.C.S., D.I.C., Imperial College of Science and Technology Field Station, Silwood Park.

MR. R. F. HILL, A.F.R.Ae.S., Colonial Pesticides Research Unit, Porton.

MR. A. C. PEACOCK, B.A., A.R.I.C., Chemical Defence Experimental Establishment, Ministry of Supply.

MR. G. W. THOM, O.B.E., Secretary, Colonial Pesticides Research Committee.

MR. K. WILSON-JONES, M.Sc., Scientific Secretary, Colonial Pesticides Research Committee.

MR. R. MOWFORTH (*Secretary*).

#### CROP PROTECTION SUB-COMMITTEE

DR. W. J. HALL, C.M.G., M.C., D.Sc., Director, Commonwealth Institute of Entomology (*Chairman*).

DR. R. A. E. GALLEY, Ph.D., D.I.C., F.R.I.C., Officer-in-Charge, Colonial Pesticides Research.

MR. G. V. B. HERFORD, C.B.E., M.Sc., Pest Infestation Laboratory, Department of Scientific and Industrial Research.

DR. J. C. F. HOPKINS, D.Sc., A.I.C.T.A., Director, Commonwealth Mycological Institute.

MR. G. W. NYE, C.M.G., O.B.E., Agricultural Adviser, Colonial Office.

MR. D. RHIND, O.B.E., B.Sc., F.L.S., Secretary, Committee for Colonial Agricultural, Animal Health and Forestry Research.

MR. G. W. THOM, O.B.E. (*Secretary*).

COLONIAL PESTICIDES RESEARCH COMMITTEE  
TWELFTH ANNUAL REPORT

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## COLONIAL PESTICIDES RESEARCH COMMITTEE

## TWELFTH ANNUAL REPORT

## PART I.—GENERAL

1. During the year the Committee held two Meetings and there was one Meeting each of the Sub-Committee of Insect Vectors of Disease, the Crop Protection Sub-Committee and the Colonial Spraying Equipment Committee. The Sub-Committee on Methods of Application did not meet.

2. There were several changes in Membership of the main Committee. Dr. J. Carmichael and Professor J. W. Munro ceased to be Members after the 31st August, and Dr. A. B. P. Page, Mr. E. O. Pearson, Professor R. L. Wain and Professor V. B. Wigglesworth were appointed from 1st September.

3. *General.* The year under review has been one of steady progress, with no outstanding events.

4. *Staff.*

*Headquarters:* Dr. R. A. E. Galley visited Yugoslavia, in June, 1958, in the capacity of pesticides consultant under the auspices of the World Health Organisation, and attended the Sixth International Congresses on Tropical Medicine and Malaria at Lisbon, presenting a paper on "Problems of Physics and Chemistry of Residual Insecticides". He also paid two visits to the World Health Organisation in Geneva; the first in connexion with preparatory work for the Ninth Session of the Expert Committee on Insecticides (held in the Tropical Products Institute during November, 1958), and the second in attending a meeting of the Scientific Group on bilharziasis. Mr. K. Wilson-Jones attended the African Weed Control Conference at Victoria Falls in July, 1958, reading a paper on the ecology of weeds in the Sudan Gezira. He also officiated, in the capacity of Technical Secretary, at the British Weed Control Conference at Brighton in November, 1958, and paid a short visit to the Fungicides Research Team at Ibadan, Nigeria, in January, 1959.

*Home:* Dr. A. B. Hadaway was seconded for six months to the Turkish Government under the auspices of F.A.O. in order to set up an insecticides standards laboratory and to give general advice and assistance. Mr. R. F. Hill spent a few days in January at the Centre of Agricultural Science at Wageningen and the National Aeronautical Research Institute in Amsterdam. The staffing position at Porton has remained difficult owing to the relative isolation of the station and lack of the right type of applicants. In particular, the post of physicist remained unfilled throughout the year.

*Overseas:* Mr. K. S. Hocking, Officer in Charge of the Colonial Pesticides Research Unit at Arusha, attended the Sixth International Congresses on Tropical Medicine and Malaria at Lisbon and presented a paper on "The Control of Tsetse Flies with Insecticides". At the request of the Director of the Department of Trypanosomiasis Control and Reclamation, Federation of Rhodesia and Nyasaland, Mr. Hocking visited Southern Rhodesia in November to advise on the use of insecticides against tsetse flies. He attended meetings of the Scientific Advisory Committees on Trypanosomiasis Research

at Sukulu in November, of the Trypanosomiasis Research Co-ordinating Committee at Maguga in December, and the East African Medical Research Advisory Committee at Kampala in January. Messrs. K. S. Hocking and K. S. McKinlay attended the annual meeting of the East African Specialist Entomological and Insecticide Committee which was held in Uganda in April, and together with Mr. D. Yeo also attended a meeting of the Inter-Territorial Co-ordinating Committee for Coconut Pest Research in Zanzibar in May. Dr. G. W. Ivens attended the African Weed Control Conference at Victoria Falls in July, and also visited many research stations in the Central African Federation. In September Mr. Yeo made a short visit to Abercorn, Northern Rhodesia, the headquarters of the International Red Locust Control Service. Mr. Yeo spent three months during the winter of the year under review in the French Sudan with the International Migratory Locust Control Organisation, investigating the possibility of using aircraft methods to prevent outbreaks of the African migratory locust. Mr. McKinlay also visited the Cotton Research Station at Gatooma in Southern Rhodesia in February. Messrs. P. O. Park and E. C. Hislop visited the Southern Cameroons in July, 1958.

## PART II. REVIEW OF RESEARCH WORK

### Colonial Pesticides Research Unit, Porton

(Dr. A. B. Hadaway in charge)

5. *Residual Properties of Organo-phosphorus Insecticides.* The residual contact toxicity of deposits of organo-phosphorus insecticides has been further investigated. On plywood panels chlordion is still toxic to *Aedes aegypti* after two months; diazinon loses its effect after 2-4 weeks through evaporation; malathion is persistent but is less effective than chlordion. Other tests are planned using mosquitoes resistant to chlorinated hydrocarbons. Further observations on the decomposition of the organo-phosphorus compounds on dried mud surfaces indicate that the reactions are complicated, depending upon the nature of the soil surface and the presence of metal ions with catalytic properties as well as on temperature, humidity and concentration.

6. *Pick-up of deposits by caterpillars.* The relative amounts of a particulate deposit picked up by late instar larvae of *Pieris brassicae* have been determined by counts of fluorescent areas on photographs of the underside of a larva taken under ultra-violet light after walking over a deposit of a fluorescent dye, salicyl aldazine. The amounts adhering to the segments bearing appendages seem to be related to the degree of contact and probably also to the pressure exerted by the appendage.

7. *Contamination of materials by insecticide vapours.* The factors are being investigated which influence deposition of insecticides on to various building and furnishing materials introduced into enclosures whose walls are sprayed with insecticide. Such a situation arises in houses and in aircraft. Dieldrin is the only compound to be used so far and is certainly capable of killing mosquitoes by this indirect route but the work is not sufficiently far advanced to report any details.

8. *Sampling insecticide deposits on mud surfaces.* The method which uses sodium carboxymethyl-cellulose as a film-forming agent has been compared with the adhesive-tape and siliconed-paper procedures. The two earlier methods are mainly unsatisfactory because they will only function efficiently on a restricted range of wall types. The surfaces need to be relatively smooth and hard. This new technique will operate on a wider variety of surfaces but is still not suitable for the softer and/or more irregular ones. Consequently it would appear to be the method of choice at the moment but is still by no means ideal.

9. *Seed Dressings.* Following work in East Africa on control of the bean fly, *Melanoagromyza phaseoli*, with seed dressings (see C.P.R.U./Porton/Report No. 158), attempts are being made to follow the distribution of seed dressings on beans. Using a fluorescent dye as a tracer, very little material appears to contaminate the soil surface or to remain on the stem.

10. *Application of pesticides from aircraft.* A number of functioning trials have been carried out to ascertain the aircraft speed and height at which the spray produced by the S.A.6 apparatus might be effective for penetrating foliage. Deposits on both faces of vertical and horizontal sampling cards were recorded when the helicopter was operated at various speeds and heights. The details and information obtained from these trials have been described in C.P.R.U./Porton/Report No. 159. A digest of the literature relating to the use of rotary wing aircraft for the dispersion of pesticides has been prepared.

**Agricultural Research Council, Unit of Experimental Agronomy,  
Oxford**

11. *Field Studies.* Promising results have been obtained with dalapon (2, 2-dichloropropionic acid) for the destruction of grasses prior to sward renovation. This chemical (and others) is also being tested for suitability in controlling bracken. Other investigations include: control of weeds in strawberries, blackcurrants and kale; control of aquatic weeds; and tests of the tolerance of cereal varieties to selective herbicides.

12. *Laboratory and Greenhouse Studies.* Work on the control of *Striga* spp. has been hampered by poor germination and this investigation has been suspended pending the arrival of fresh seed. Other work in progress includes studies on the persistence of dalapon, amino-triazole and simazin in soils, the effect of a number of compounds in inducing sterility in grasses, the effectiveness of mixtures of 2, 3, 6-trichlorobenzoic acid and MCPA, the selectivity of ethylenedipyridylum dibromide, and the effect of new formulations of amino-triazole on *Agropyron repens*. A preliminary experiment has been undertaken on the movement of dalapon in *Agropyron repens* using <sup>14</sup>C labelled material and autoradiographic techniques. One of the main projects during the year has been the investigation of a number of new materials having some potentiality for the control of *Avena fatua*. Investigation has continued of the factors affecting phytotoxicity and the selective action of herbicides, and of the influence of defoliant on the process of leaf abscission.

**Imperial College Field Station, Silwood Park**

13. *Mode of Action of Insecticides.* Further observations on the pick-up by blowflies (*Phormia* sp.) of mineral oil (containing a radioactive tracer for

the purpose of detection) have shown that the oil, advancing over the cuticle at first as a monolayer, is being simultaneously absorbed. The rate of diffusion over the cuticle, however, exceeds the rate of diffusion into the cuticle, and is such that a film of oil is established over the wings in 5-15 minutes. Measurements on individual flies indicate that the degree of activity during the exposure time substantially affects not only the quantity accumulated by the tarsi but also the rates of diffusion of the oil on the cuticle. Other experiments have shown that the tracer ceases to be useful after absorption because the radioactive substance becomes dissociated from the hydrocarbon. Comparative biochemical studies into the effect of chlorinated hydrocarbon insecticides on the esterases, cholinesterases and lipases of insect nerve tissue are progressing favourably.

14. *Olfaction in Insects.* Results of experiments indicate that fatty acids containing 12-18 carbon atoms per molecule are likely to be of field use to attract *Stomoxys calcitrans* because (1) they have a low vapour pressure and should persist well after application to a surface, (2) they are attractive at the saturated vapour pressure as well as at lower concentrations and thus serve to keep an attracted fly at the source for some time.

#### **Colonial Spraying Machinery Centre**

15. New accommodation has been approved for this pool of machinery. The Centre, made possible by contributions from the College, the machinery manufacturers, and the Colonial Office, serves for (a) instruction of undergraduate and postgraduate students and (b) the provision of special courses for agricultural officers and research workers from the Colonies. Negotiations are proceeding for collaborative work with the World Health Organisation on the assessment of spraying equipment for use in public health programmes.

#### **Long Ashton Research Station, Bristol**

16. An evaluation of methods for sampling and analysing spray residues on plant tissues has been carried out. In the light of results obtained in North Borneo on the control of frog eye of tobacco some modification is envisaged in the design of the spray equipment being used.

17. Methods of atomisation are being studied and new equipment developed for this purpose. A flying spot particle resolver has recently been installed for studies on droplets sizes and emulsions.

#### **Rothamsted Experimental Station**

18. Papers on the method of toxicity assessment using *Tribolium castaneum* and *Musca domestica* are to be published shortly. The method of assessment using *Musca domestica* has been described in a paper which is now ready for publication. Results obtained with this method will be described in a report which is being prepared for the Committee.

19. Small supplies of radioactive aldrin and dieldrin have become available, and these will be used for measurements of rate of evaporation under controlled conditions. A preliminary experiment using aldrin suggests that the loss of insecticides is linear with time, the rate of loss being constant.

**Colonial Pesticides Research Unit, East Africa**

(K. S. Hocking in charge)

20. *Experiments on Tsetse.* Observations have been maintained at Loljoro on two blocks of woodland treated with insecticide. One of these was treated by spraying with 5 per cent. gamma BHC in kerosene and four months later with 5 per cent. dieldrin. Both treatments reduced *Glossina swynnertoni* to a very low level for about two months, whilst the first resulted in a more rapid kill. A *G. morsitans* population, artificially introduced within the second block was substantially reduced by ground spraying with gamma BHC. These experiments have formed the basis of pilot scale trials at Chungai using gamma BHC. In the Kabiganda valley experiment, treatment with dieldrin was not entirely successful in eradicating fly. Work on laboratory colonies of *G. morsitans* has been completed.

21. *Experiments on Mosquitoes.* At Taveta Pare the sixth and last spraying cycle was completed in March. *Anopheles gambiae* is still without any evidence of resistance to dieldrin although it has been detected in varying degrees among other pests in the area. House collections of *Anopheles* on the village site of Mto wa Mbu, which has not been sprayed since September, 1957, have risen almost to the pre-1957 level. Some experiments have been carried out in the Maguga neighbourhood to compare formulations with and without resin and work on hut design has been started at Muheza in co-operation with the E. African Malaria Institute.

22. *Pseudothertaps.* Studies are in progress at Tanga to correlate *P. wayi* damage with coconut yield and to determine the effect of DDT treatment. Already it is evident that clean cultivation beneath the palms will improve the yield. Aerial spraying at Zanzibar is to be repeated with higher dosage rates. A laboratory colony of *P. wayi* has been established and is being maintained there.

23. *Other Agricultural Work.* Experiments have been carried out to determine spray deposits on coffee plants produced from air blast equipment and the persistence of diazinon on this crop. Studies have commenced on the coffee berry moth, *Thliptoceras octoguttalis*. Table tennis balls attached to cotton plants have been found useful for the assessment of dosage rates in the field.

24. *Biting Fly Research Team, Uganda.* Routine hand catching continues at Bukomero. Morris fly traps have been constructed and are in use in each of five cattle bomas. Fly traps are considered to provide a more accurate and consistent account of fly densities. Adult *Stomoxys* were reduced by 99 per cent. over 50 square miles by the insecticidal treatment of the periphery of one cattle boma—the only recognised breeding site in the locality.

25. *Locust Control.* During the visit of the physicist to the French Sudan, aerial spraying experiments were conducted against parent solitaries of the African migratory locust in the Central Niger Delta. Further work is on the control of settled locusts of *Schistocerca gregaria* on trees.

26. *Fungicides.* The persistence of copper oxychloride on coffee leaves has been studied, and the performance of a proprietary electrostatic duster has been assessed.

27. *Herbicides.* Work has been conducted on the control of herbaceous weeds in coffee, maize, beans, lucerne, pyrethrum and other crops, and of the water weed, *Salvinia*. Small scale trials have been started against the woody species *Grevillea robusta* and *Opuntia*.

28. *Molluscicides.* Work on molluscicides and snail ecology was started in November, 1958. Following a preliminary survey of the Nairobi area, three rivers, flowing within the city boundaries, were selected for field work in co-operation with the Division of Insect Borne Diseases, Kenya Medical Dept. Promising results have been obtained with a new molluscicide (Bayer 73) based on 2-hydroxy-5, 2'-dichloro-4 nitro-benzanilide.

29. *Miscellaneous.* Experiments have been carried out to determine the drift downwind of chemicals released from an Auster J-5G aircraft flying at about 10 ft. above the ground. Some estimates have been made of the deposits produced by a motor driven "Knapsack" sprayer. A nozzle testing table has been constructed, also an automatic dispensing device to facilitate the topical application of insecticides. A procedure for the residue determination of organo-phosphorus insecticides on plant material has been described.

30. *West African Fungicides Team.* A laboratory method for assessing fungicides for the control of black pod (*Phytophthora palmivora*) of cacao has been evolved and a method of measuring copper fungicide residues on pod surfaces worked out. Insecticide residue analyses have also been carried out for the Sleeping Sickness Service and Veterinary Division of the Northern Region.

#### **Filariasis Research Unit, Fiji**

(G. F. Burnett)

31. Laboratory work has included experiments to determine the susceptibility of Fijian mosquito larvae and a resistant *Aedes pseudoscutellaris* strain. In the field, house sprayings have been conducted with dieldrin against adult *A. fijiensis* and *Culex fatigans* supported by larvicidal measures. A mass drug administration has been described.

#### **I.C.T.A. Herbicide Unit, Trinidad**

32. *Herbicide studies.* Progress is reported in experiments to measure the effect of MCPB on groundnuts and of 2, 4-D and CIPC on yams. Tests are being organised with new herbicides provided by Wye College. Some set-backs have been experienced in certain other of the investigations through adverse weather conditions.

#### **Coconut Pest Research, Zanzibar**

33. A final report on the 100 acre experiment was submitted by the entomologist, prior to his retirement last May.

### **PART III. PESTICIDES RESEARCH NOT UNDER THE AEGIS OF THE COMMITTEE**

#### *Antigua*

34. *Agriculture. Insecticides.* Experiments have been continued to determine the effectiveness of various insecticide treatments for the control of pink bollworm, *Platyedra (Pectinophora) gossypiella* on cotton.

*Weed control.* Work has continued on the evaluation of herbicides for the control of weeds in cotton.

*Veterinary.* Five dipping tanks were maintained and used for the control of ectoparasites on livestock. No outbreaks of communicable diseases occurred.

#### *Bermuda*

35. *Agriculture. Insecticides.* Progress is reported in the eradication campaign being conducted against the Mediterranean fruit fly, *Ceratitis capitata*. Control measures include the application of foliar sprays (consisting of malathion and a protein bait), ground sprays (based on dieldrin) and the use of traps containing angelica seed oil with DDVP as the toxic agent.

*Molluscs.* Some experiments have been conducted against slugs and snails with a preparation containing metaldehyde. It proved extremely effective against the giant slug, *Amalia gagates* and half-grown specimens of *Otala lactea*, but failed to kill the spiral snail, *Achatina* sp.

#### *British Solomon Islands*

36. *Agriculture. Insecticides.* Investigations have continued on methods for the control of the coreid bug, *Amblypelta cocophaga*. Results are awaited of trials combining insecticide spraying with prior mechanical clearance of vegetation.

#### *Cyprus*

37. *Agriculture. Fungicides.* Very good control of loquat scab (*Spilocaea eriobotryae*), is reported with lime sulphur, copper oxychloride, Zineb 78 and Captan 50. A combined zinc oxide and sulphur dust was successful in controlling both zinc deficiency and citrus bud mite. Excellent control of potato late blight, (*Phytophthora infestans*), was obtained with copper oxychloride or Zineb 78.

Good results against brown rot (*Sclerotinia fructigena*), which has been the cause of severe damage to local apricot trees, have been obtained by removal of the diseased portions, followed by spraying with copper oxychloride spray at bud swelling.

*Forestry Research.* Main items of study included: the incidence of *Mycophilus* attack in summer-thinned *Pinus brutia* forest; the relation between borer attack on *Pinus brutia* in areas damaged by fire; and the life cycle of *Thaumetopoea wilkinsoni*.

#### *Fiji*

38. *Medical, Filariasis.* Investigations continue into the insect vectors of filariasis and the use of drug therapy.

*Agriculture. Insecticides.* The main control measure employed in the campaign against the rhinoceros beetle (*Oryctes*) has been to treat the crowns of palms with a sawdust preparation containing BHC. As a supplementary measure the parasite *Scolia ruficornis*, has been introduced from Palau. The species appears to have established itself successfully in Fiji but it is as yet too early to assess its effectiveness for this purpose.

*Herbicides.* The use of herbicides to destroy trees in conjunction with the planting of an accepted grass (e.g. *Ischaemum aristatum*) is proving useful in areas required for grazing.

#### Kenya

39. *Agriculture. Insecticides.* Observations are being made of the habits of *Eucosma* and an indication has been obtained of its susceptibility to chemical control. Further tests have also been carried out on the effectiveness of insecticidal treatments for the control of *Leucoptera* sp. Against *Antestiopsis* spp. aerial spraying with malathion proved successful. Beans were almost fully protected against bean fly by the use of seed dressings containing aldrin. Red spider mite and pyrethrum thrips were controlled by chemical means.

*Fungicides.* Captan formulations have been found effective against coffee berry disease. Mercurial sprays have been abandoned because of their poisonous nature and phytotoxicity. Sugar cane smut, *Ustilago scitaminea*, was reported for the first time. Bacterial wilt of potatoes (*Pseudomonas solanacearum*), appears to be spreading and several barley leaf diseases proved more serious than usual.

*Herbicides.* An economic control is being sought of annual grasses in sisal.

*Forestry.* Research into *Armillaria* root rot with particular regard to pine plantations has been continued.

#### Nigeria (Federation)

40. *Agriculture, Stored Products Research.* Trials on underground pit storage and insecticidal treatments in bags and in rumbus have been carried out on guinea corn. Malathion, which has been found more effective than BHC against *Tribolium castaneum* is being used to treat bagged groundnuts. The factors involved in the fumigation of cocoa with methyl bromide, and on the lipolysis of palm oil by micro-organisms, have been further investigated.

*Agriculture. Insecticides.* Studies are reported on the parasitism of larvae of the yam beetle (*Heteroligus meles*) by a tachinid fly, *Microphthalma flavipes*. Insecticidal control experiments have continued and it is found that seed dressings containing aldrin (2.5 per cent.) or gamma BHC (Gammalin A) are most effective in reducing beetle attack with concomitant increase in yield. Other studies include: the insecticidal control of *Bemisia*; a survey of the losses caused by the sorghum midge (*Contarinia sorghicola*); the use of a granular endrin formulation against maize stalk borer; the factors controlling the spread of cassava mosaic virus; and the bionomics of white fly.

*Fungicides.* Studies are in progress on the chemistry of extractives of West African timber trees, especially *Meliaceae*, and a series of compounds of interesting and related structures have been isolated from the genus *Entandrophragma*. This data may not only reveal important taxonomic relationships but also provide a guide to the type of compound likely to exhibit systemic fungicidal activity.



*Nigeria (Eastern Region)*

41. *Agriculture. Fungicides.* A statistically significant improvement in control of black pod of cocoa was obtained by spraying "Perepod" at the rate of 20 gal. per acre, at 3-weekly intervals each time removing any infected pods beforehand.

*Herbicides.* Treatments found most economic for weed control in rice include 2, 4-D (at 45 ml. per 1½ gal. water per acre) and 2, 4, 5-T (at 23 ml. per 1½ gal. water per acre).

*Nigeria (Northern Region)*

42. *Veterinary.* Prevention of the spread of spirochaetosis has been mainly by the destruction of the tick vector with acaricide. Promising results have also been obtained with simple modified perches which possess a trap to prevent the tick reaching birds roosting at night.

Control of the dense swarms of *Lyperosia* species, which suck the blood of cattle, and of the ticks *Amblyomma variegatum*, which attach themselves in large numbers during the rains, has been accomplished with BHC, applied in sprays and dips. Preliminary experiments with cutaneous streptothricosis in cattle have confirmed the effectiveness of this chemical method of control.

*Public Health. Tsetse control.* An experimental spraying in the Southern Guinea Savannah Zone with 4 per cent. dieldrin resulted in the elimination of *Glossina palpalis*. The technique has now been extended to treat 55 miles of river (including some patches of high forest). Obstruction clearing as a field method for the control of this species has been abandoned.

Following satisfactory results with a single spray application of a DDT 5 per cent. suspension to control *Glossina tachinoides* in the Northern Guinea and Sudan Savannah Zones, a scheme to treat over 350 miles of river was commenced late in the year. Progress is being closely observed from a temporary field station set up in the Sudan Zone.

*Northern Rhodesia*

43. *Public Health. Tsetse Control.* Tests carried out with a non-residual thermally applied aerosol containing 1 per cent. gamma BHC, in the upper Kazinzi Valley, indicated the need for absolute isolation of the treated area to prevent reinfestation from adjacent fly foci.

Further trials with 2 per cent. 2, 4, 5-T in dieseline at 15 gal. per acre confirm that this technique is unlikely to be widely used for arboriciding.

*Sarawak*

44. *Medical.* About 300,000 people in the rural areas have been directly protected against malaria during 1958 in the campaign run jointly by the Sarawak Government and W.H.O. A total of 28,894 kg. DDT and 310 kg. dieldrin have been used during spraying operations in 62,059 houses over an area of 121,907 sq. km.

*Sierra Leone*

45. *Forestry.* The possibility of employing sodium arsenite as an arboricide in preference to a more costly hormone spray at present in use is to be investigated.

*Singapore*

46. *Medical. Parasitology.* Studies were made of the biology and systematics of local culicine mosquitoes. In collaboration with W.H.O. the parasite *Coelomomyces stegomyiae* was investigated as a means of controlling *Aedes pelynesiensis* in the Pacific Islands.

*St. Helena*

47. *Agriculture. Insecticides.* Difficulty has been experienced in the control of Mediterranean fruit fly due to its habit of breeding in various plant fruits (e.g. prickly pear and *Aberia caffra*). Also many fruit trees are grown singly or in widely scattered groups. The aphid *Brevicoryne brassicae* on cabbages was controlled by repeated treatments with various insecticides. Special techniques have been developed for the control of red spider mites and cutworms in vegetable crops. Sprays containing malathion and Agral LN gave good control of psyllid and aphid on citrus.

*Veterinary.* It is reported that cattle are affected by *Stomoxys calcitrans* and by ticks, and that poultry are subject to heavy infestations of stickfast fleas.

*Tanganyika*

48. *Forestry.* A successful technique has been devised for establishing *Eucalyptus* in termite infested land.

The bacteria *Streptococcus pluton* and *Bacterium eurydice* were identified in African bees. This is the first record of any disease of bees in tropical Africa.

**PART IV. APPENDIX****Reports and Publications***C.P.R.U. Porton*

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Spray application problems. The determination of rotenone in *Lonchocarpus*. D. V. Richmond. *Ibid.* (In press.)

Spray application problems. The determination of residues of gamma-BHC. J. A. Pickard. *Ibid.* (In press.)

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Colonial Products Council  
Sixth Annual Report  
(1958-1959)

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Courtauld Institute of Biochemistry,  
The Middlesex Hospital,  
Medical School,  
London, W.1.

SIR,

I have the honour to enclose herewith the Annual Report of the Colonial Products Council for the year 1958-1959.

I am,

Sir,

Your obedient servant,

E. C. DODDS,

*Chairman.*

The Right Honourable Iain Macleod, M.P.,  
Secretary of State for the Colonies.

## COLONIAL PRODUCTS COUNCIL

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- SIR CHARLES DODDS, M.V.O., D.Sc., M.D., F.R.C.P., F.R.I.C., F.R.S.,  
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of Courtauld Institute of Biochemistry (*Chairman*).
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Scientific and Industrial Research.
- DR. H. J. CHANNON, C.M.G., D.Sc., F.R.I.C.
- DR. R. A. E. GALLEY, Ph.D., A.R.C.S., D.I.C., F.R.I.C., Director of Research  
and Director, Tropical Products Institute.
- PROFESSOR E. L. HIRST, M.A., D.Sc., LL.D., F.R.S., Professor of Organic  
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- DR. R. HOLROYD, M.Sc., Ph.D., Imperial Chemical Industries Limited.
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Chemistry, Dyson Perrins Laboratory, Oxford.
- DR. L. A. JORDAN, C.B.E., D.Sc., A.R.C.S., F.R.I.C., M.I.Chem.E., Director,  
The Paint Research Station, Teddington, Middlesex.
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- MR. D. RHIND, O.B.E., Secretary for Colonial Agricultural Research.
- MR. L. ROSE, M.C.
- DR. H. G. THORNTON, F.R.S., formerly of Rothamsted Experimental Station,  
Harpenden.
- PROFESSOR SIR ALEXANDER TODD, M.A., D.Sc., F.R.I.C., F.R.S., Professor  
of Organic Chemistry, University of Cambridge.
- 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. S. S. BAMPTON, B.Sc., Ph.D. (*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  
SIXTH ANNUAL REPORT, 1958-59

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# COLONIAL PRODUCTS COUNCIL AND TROPICAL PRODUCTS INSTITUTE SIXTH ANNUAL REPORT

## PART I. GENERAL

1. *Opening of the Tropical Products Institute.* On 6th May, 1958, the Institute's new building in Gray's Inn Road, London was officially opened by H.R.H. the Duke of Edinburgh. In the presence of a gathering of distinguished guests he unveiled a commemorative plaque in the Conference room. Afterwards His Royal Highness made a comprehensive tour of the building, meeting the staff and inspecting a number of current projects.

2. *Further change.* As from 1st April, 1959, the Colonial Products Council has been disbanded to leave the way clear for the Council for Scientific and Industrial Research to set up its own Committee with special responsibility for the Institute—this Committee will be known as the Tropical Products Institute Committee.

The primary reason for this transfer of the Institute to the Department of Scientific and Industrial Research is the steady progress towards independent status which has been and is being made by many British Colonial territories. As a matter of official policy it was decided that the Institute's services should remain available to the independent territories but it was not appropriate that this should continue as a responsibility of the Colonial Secretary. Support will however, continue to be provided for the Institute from the Colonial Office—from Colonial Development and Welfare Funds—for work of interest to the Colonies.

3. *Council Meetings.* There was one meeting of the Colonial Products Council during the year.

4. *Membership.* The membership of the Council has remained unchanged except that Dr. Bampton succeeded Dr. Spensley as Scientific Secretary.

5. *Visits.* Dr. P. C. Spensley, Assistant Director (Administration and Development) toured the West Indies in November/December, with Dr. W. G. Forsyth, Director of the Colonial Microbiological Research Institute, to discuss with Government and Industrial interests the possibilities for the future of that establishment.

During March, Dr. Spensley visited Malta to consider the potentialities of solar energy utilisation in the island.

Dr. S. S. Bampton, Scientific Secretary, visited British Honduras in January/March, to collect and assess the availability of species of wild yams (*Dioscorea*), with the object of finding a new supply of raw material for the production of cortisone and other steroid drugs.

6. *Lectures.* Dr. R. A. E. Galley gave the Jubilee Memorial Lecture entitled "Colonial Research—Natural Products and Pesticides" on 29th January, 1959, to branches of the Society of Chemical Industry at Bristol and afterwards at Glasgow and London.

At Cambridge in December, he spoke on "The Work of the Tropical Products Institute" to members of the Department of Agriculture and the Low Temperature Research Station.

7. *International Meetings.* Mr. H. T. Islip, Assistant Director (Advisory), led the United Kingdom delegation at a meeting of the International Standards Organisation's Committee on Essential oils held in Paris in September.

Dr. R. H. Kirby, Assistant Director (Economics) visited Cuba during October to attend the International Kenaf (*Hibiscus cannabinus*) Conference arranged by the Cuban Ministry of Agriculture and the United States Operations Mission to Cuba. While there, his field visits to experimental stations included one to the North Atlantic Kenaf Corporation at Belle Glade, Florida.

Dr. W. D. Raymond, Head of the Oilseeds and Foodstuffs Section, attended the meeting of the Oils and Fats Division of the International Union of Pure and Applied Chemistry, held in Brussels in August.

Dr. G. B. Pickering, Head of the Essential Oils Section, attended the 31st International Congress of Industrial Chemistry at Liege in September, where he presented a paper, prepared in conjunction with Mr. W. S. A. Matthews, entitled "Investigations on the Composition of two East African Essential Oils".

Dr. G. E. Howard, of the Essential Oils Section, attended the Second International Symposium on Gas Chromatography which was held in Amsterdam in May under the auspices of the Institute of Petroleum and the Royal Netherlands Chemical Society.

8. *Committee Meetings.* The Pyrethrum Research Committee (United Kingdom) held its third meeting in September. The problems discussed included the separation of the active constituents of pyrethrum, the biological evaluation and activity of these constituents, and the physiology of the plant in relation to the biogenesis of pyrethrins.

A meeting of the Consultative Committee on Vegetable Fibres was held in October to examine and report on samples of abaca fibre received from Malaya and British Guiana.

A meeting of the Oil Palm Sub-Committee of the Consultative Committee on Oils and Oilseeds was held in November under the Chairmanship of Professor T. P. Hilditch. The purpose of the meeting was to discuss the Institute's work to date on the causes of the difficulty of bleaching Nigerian palm oil, as indicated under Part II (b) of this report; future lines of study were considered.

## PART II. INQUIRIES, INVESTIGATIONS AND RESEARCH

9. This part of the Report is divided into three sections covering (a) inquiries dealt with at the Tropical Products Institute, (b) investigations carried out at the Institute 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 TROPICAL PRODUCTS INSTITUTE**

10. The Institute dealt with 778 inquiries during the year; 57 inquiries were in hand at the end of the period. Examples of those dealt with are given below :—

**Essential Oils**

11. *Recommendations of suitable Essential Oils for production in various territories.* The essential oils most suitable for production in Tanganyika were considered on behalf of the Director of Agriculture and increased production of geranium and bitter orange oils was recommended. An attempt to distil the scarce and valuable neroli oil from the flowers of bitter orange was also thought to be desirable.

In advice given to the Department of Agriculture, Kenya, the importance of going ahead with the production of geranium oil of the Bourbon type, from the plants reared in Kenya from cuttings of Reunion origin, was emphasised, samples of the oil received in the United Kingdom having been favourably commented on by the perfumery trade. Trial distillations with limes were agreed to be worthwhile and it was considered that lemon oil from prospective new plantations would find an outlet if the quality were satisfactory.

The Development Commissioner in Northern Rhodesia was recommended not to increase the production of nindi oil from *Aeolanthus gamwelliae*. The market for this oil, which yields a high quality natural geraniol, has suffered set-backs recently, partly owing to an increased use of synthetics.

**Spices**

12. *Pepper.* Details of the method of distilling pepper oil were supplied to the Department of Agriculture, Sarawak, where it was hoped to utilise profitably the waste material obtained in the dressing of black pepper (*Piper nigrum*) for export.

13. *Ginger.* The Department of Agriculture in Fiji and British Guiana and the Government of Sarawak were advised on the preparation of dried ginger, the different types of ginger available commercially and the general market situation for this spice.

14. *Culinary Herbs.* An inquiry was received from the Department of Agriculture, Kenya, about the market prospects for culinary herbs. It was felt doubtful whether herbs of suitable quality could be produced in Kenya and it was therefore suggested that before commercial cultivation was undertaken small trial cultivation under field conditions should be made. Commercial evaluation of the herbs produced in this way could be arranged by the Institute.

**Oils and Oilseeds**

15. *Coconut Products.* As the result of an inquiry from the Cocoa, Chocolate and Confectionery Alliance as to areas other than the Philippines and Ceylon where a desiccated coconut industry might be set up, East Africa was suggested as the most likely area and particularly the islands of Mafia and Zanzibar. After consultation with the Tanganyika Department of Agriculture, representatives of coconut growers in Tanganyika, the Alliance

and the Institute, tentative suggestions were made regarding the equipment required for the erection of a small factory on Mafia Island. However, many problems (especially that of marketing) would have to be solved before manufacture could commence.

The British Solomon Islands Protectorate exports some 20,000 tons of copra per annum. Information on the drying of copra was supplied to the Department of Agriculture, and modifications for improving the scope and efficiency of apparatus used in connection with the drying process were suggested.

Considerable interest has been shown in Tanganyika at the possibility of supplying broken coconut shell to firms in the United Kingdom. This material is used in limited amounts as a filler in the plastics industry and until recently the bulk of supplies have been obtained from Ceylon. Good-quality samples were received from firms in Tanganyika and these were forwarded to prospective buyers in the United Kingdom.

Advice was given to an inquirer interested in the manufacture in Mauritius of "vegetable ghee" from deodorised coconut oil.

16. *Tung oil.* At the request of the Department of Agriculture in Nyasaland, a research project directed at increasing the market for Nyasaland tung oil was drawn up. Advice on other steps which might be taken to help the Nyasaland industry, including the possibility of local utilisation, was also given.

17. *Ghee.* In Kenya, clarified butter fat or ghee is produced by the natives under primitive conditions. Advice was supplied to the Nyanza Province Marketing Board on suitable equipment and methods for refining, control and storage in order to produce a product of good quality.

### **Fruit, Nuts and Vegetables**

18. *Maltese Horticultural Products.* Work has continued in collaboration with the Malta Department of Agriculture, in connection with the development of horticultural products. Advice was provided following the inspection of a test commercial consignment of two varieties of early potatoes, and of experimental packs of tomatoes, sent to London markets. Notes were prepared for the information of the Government of Malta on the United Kingdom markets for cut flowers and imported strawberries. Information was supplied to the Advisory Committee on Agricultural Industries regarding the preparation of orange juice, tomato juice and grenadine (pomegranate syrup), with details concerning suitable equipment for their production.

19. *Grapefruit.* Information on the United Kingdom market and commercial requirements for fresh grapefruit was prepared for the Departments of Agriculture of the Eastern Region Nigeria, Trinidad and Zanzibar. It was pointed out that while supplies of this fruit still tend to be short during certain months, the United Kingdom consumer demand for grapefruit is somewhat inelastic and excessive imports at any one time usually result in reduced prices. While small shipments may be profitably sold from time to time by other countries, it was advised that the established sources of supply appear to be capable of meeting present major United Kingdom needs and that there is little room for new producers.

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20. *Fresh Pineapples*. A note on "The United Kingdom Market for Fresh Pineapples" was supplied to the Department of Agriculture, Sierra Leone, and comments were made on experimental consignments of the fruit sent to London from that country. Advice was also supplied to the Department of Agriculture, Kenya, in connection with consignments exported to the United Kingdom by air.

21. *Tomatoes*. A note on the United Kingdom market for imported tomatoes was supplied for publication in Cyprus.

22. *Lime Juice*. Information was provided for the Departments of Agriculture of the Gambia, Sierra Leone and Zanzibar, concerning the prospects for the development of a lime juice industry, this was accompanied by a review of the market position of the commodity over recent years. In Commonwealth countries the juice is prepared by the traditional method and is used for the lime juice cordial type of soft drink. Hence it meets a specialised demand which existing producers can largely supply.

23. *Soft Drinks Industries*. In connection with local soft drinks industries, advice was given to Antigua regarding the small-scale production of carbon dioxide, and observations were made concerning explosions in mineral water bottles which had occurred in the Solomon Islands Protectorate.

24. *Banana Products*. As is well known, the banana industry lacks the advantage of important processed products. Thus the utilization of surplus bananas, unsuitable for export in the fresh fruit trade, is an old and recurring problem in producing countries. Information concerning the outlets for banana products and their preparation was provided for the Southern Cameroons, Fiji, Kenya and Jamaica.

25. *Edible Groundnuts*. The United Kingdom provides a useful outlet for edible groundnuts which are imported for direct consumption or for use in the confectionery industry. Particulars were supplied to the Department of Agriculture, Nyasaland, concerning the present trade in these nuts and the United Kingdom commercial requirements. With this product, proper grading with respect to size is essential and consignments must be practically free from foreign matter.

26. *Cashew Nuts*. The cultivation of cashew nuts is of wide interest and a note on "Cashew Nut kernels: Their Production and Market" was prepared for circulation to Colonial countries in Africa.

27. *Asparagus*. Interest has arisen in Kenya in the possibilities of developing the production of asparagus for export, both as a fresh vegetable and as the canned product. Information was provided on the United Kingdom market for both these commodities. Attention was drawn to the high standard of quality that is required if out-of-season asparagus is to command high prices on the London market, to the limited demand for this luxury product, and to the fact that the supply position of canned asparagus is already very competitive.

#### Other Foods

28. *Molasses*. There has been a renewed interest in some tropical areas in processing and marketing molasses. The authorities in Tanganyika were advised that although there is a large world trade in molasses it was thought that in Tanganyika the freight costs might be unfavourable for marketing the product overseas. The use of molasses as an animal feedingstuff and as



a fertiliser was described, and an outline given of the use of molasses as a starting point in the manufacture of various chemical compounds. Details of methods for drying molasses on a commercial scale were supplied to the Industrial Development Board in Barbados.

29. *Coffee*. General information was given to the Directors of Agriculture in Jamaica and Kenya on the production of instant coffee, and the names and addresses of firms experienced in the manufacture of suitable machinery were supplied. Inquiries were also answered from official sources in the United Kingdom, Sierra Leone and Guatemala on the processing of coffee and its industrial utilisation other than for beverage purposes.

30. *Carob Beans*. The Colonial Office was advised that the replacement of cacao nibs by carob pods in the manufacture of chocolate was considered most unlikely. The production in California, of a chocolate-flavoured candy made from carobs (*Ceratonia siliqua*) has been reported, and interest was centred on the effect this development would have on the United States markets of British cocoa-producing territories and also whether there would be a greater demand for Cyprus carobs. Analytical figures for the composition of carob pods, cacao nibs and plain chocolate were quoted. The rôle of physiologically active alkaloids in establishing the popularity of cocoa, tea, coffee and similar products was discussed, and attention was drawn to the fact that carobs contained none of these alkaloids.

31. *Cassava*. The market for dried cassava roots from Tanganyika was investigated for the Department of Agriculture. Trade reports showed that the roots were not up to the standard required in this country for starch manufacture, but that they would be acceptable as an animal feeding material at the current price for such a commodity. Methods for improving their quality were suggested. Details of machinery suitable for washing, peeling and slicing cassava roots, were supplied to the agricultural authorities in Ghana and Uganda. Inquiries were answered from the Federal Institute of Industrial Research, Nigeria, the Department of Agriculture, Uganda and official sources in the United Kingdom concerning the mechanisation of *gari* manufacture. *Gari* is produced from cassava roots by a process of grating, squeezing, fermenting, drying and frying, with or without the addition of small quantities of oil. The possibility of adding protein concentrate, such as leaf protein, to *gari* was also considered.

32. *Miscellaneous Feedingstuffs*. As in former years, inquiries on the use of unusual products such as pineapple bran, sago pith meal, tapioca refuse and cacao shell for animal feeding were received, and appropriate information supplied to inquirers in the United Kingdom, Antigua and Ghana.

33. *Drying of crops*. In collaboration with the National Institute of Agricultural Engineering, detailed information on the drying of rice, groundnuts, soya beans, maize and benniseed was supplied to the Ministry of Agriculture in Nigeria.

34. *Food Storage*. The details of a scheme for the establishment of a new cold store in Antigua were carefully studied and comments thereon were forwarded to the Crown Agents for Oversea Governments and Administrations.

35. *Yams*. A list of *Dioscorea* yams which grow in Colonial areas together with references to articles giving information about the saponins

obtainable from the various species, were supplied to a firm in the United Kingdom. Although there are many species of *Dioscorea* yams, only a limited number give steroidal sapogenins and most of these have been found outside Commonwealth territory. The trade in yams is believed to be entirely local in tropical areas and is, in the main, concerned with the varieties cultivated for food.

### **Tobacco**

36. *Tobacco Offal*. An inquiry was received from the Kenya Government Chemist regarding the utilisation and disposal of offal from tobacco factories. It was considered that some of this waste might be employed for making snuff, but that the remainder would have to be denatured by alkali to avoid loss of revenue through possible illicit sale.

37. *Miscellaneous*. Information concerning tobacco drying and fermentation processes, and details of publications on various aspects of tobacco manufacture were provided for several official and trade bodies.

### **Vegetable Insecticides**

38. *Pyrethrum*. A summary of available methods for the estimation of micro-quantities of pyrethrum was prepared for the Colonial Liaison Section of the Pest Infestation Laboratory. Other particulars concerning publications and commercial methods of analysis were supplied to several firms.

### **Synthetic Insecticides**

39. *Methods of Analysis*. Inquiries on methods and apparatus for the analysis and determination of synthetic insecticides, either as formulations or as residues on stored products, continued to be received, and appropriate information was given to laboratories in West Africa and to visiting scientists from Nigeria, Uganda, Rhodesia and Nyasaland.

### **Vegetable Drugs**

40. *Kola Nuts*. Detailed surveys of the production and utilisation of these nuts (*Cola nitida*, *C. acuminata* and other species) were supplied to the Nigerian Ministry of Commerce and Industry and several United Kingdom firms. In West Africa the nuts enter extensively into native trade and life, being chewed as a stimulant by virtue of their caffeine content. Considerable quantities of the nuts are also exported to the U.S.A. and the United Kingdom, where they are chiefly employed in the manufacture of Kola-type soft drinks. It was considered that increased usage of the nuts in West Africa for local production of such drinks would be possible.

41. *Miscellaneous*. Information on the production and chemical assay of the proteolytic enzyme, papain (from *Carica papaya*), was furnished to a potential producer. Other inquiries were concerned with the market prospects for various drug plants and the production of hecogenin from sisal.

### **Vegetable Fibres**

42. *Kapok*. The Seychelles Department of Agriculture was given full information on the cultivation of kapok, its preparation for market, the yield cost and profit to be expected. It was advised, however, that large-scale production should not be encouraged because of the diminishing demand for kapok in the United Kingdom.

43. *Coir Fibre*. Information was supplied to the Department of Agriculture, British Guiana and the Director of Prisons, Sierra Leone, on the preparation of coir fibre for the commercial market, together with information on the machines used for the various stages of preparation of the fibre.

44. *Sunn Hemp*. Inquirers in North Borneo, Uganda and Southern Rhodesia were advised on the production and uses of *Crotalaria juncea* fibre. Sources of supply of seeds for experimental trials were suggested.

45. *Kenaf Fibre*. A firm in Kenya inquired about the market prospects for this fibre which is obtained from *Hibiscus cannabinus*. World production of kenaf is still small and the fibre is not as yet of much interest to textile manufacturers, who cannot consider using a new raw material until they are certain that sizeable supplies of consistent quality will be available. Small quantities of Kenaf are however used for sack manufacture in some of the countries where it is produced. The inquirer was therefore advised to explore the possibilities of developing a market for the fibre in Kenya. Advice on the methods of processing the fibre was also given.

46. *Pineapple Fibre*. The Director of Agriculture, Zanzibar, was furnished with information regarding the suitability and use of pineapple fibre for textile purposes. Samples of the fibre and of fabric made from it were supplied, and some observations were made regarding the cost of production of the fibre.

47. "*Wild Banana*". An inquirer in South Africa was informed that a "wild banana" species propagated only from seed might be *Musa ensete* or *M. ulugurensis* and advised that specimens of leaves, stems, and flowers should be sent to Kew for identification. Some observations were made concerning machines which might be suitable for the extraction of the fibre from banana leaf-sheath, and on the economics of production of such fibre.

#### Paper-making Materials

48. *Waste Materials for Building Boards*. Inquiries concerning this subject continued to be received from Kenya, Trinidad, India, Burma, Malaya and others. Many of these inquiries concerned rice husks, but other materials such as bagasse and wood waste were mentioned.

Information was required in most cases on both resin bonded and cement/fibre board, and the possibility of carrying out laboratory trials in this field is being considered.

49. *Paper-making machinery*. Extensive advice was given to the Federal Institute for Industrial Research, Nigeria, concerning the setting up and equipping of a laboratory for pulp production and evaluation.

#### Hides and Skins

50. In addition to general work on cattle hides, goat skins and sheepskins, advice was given to a Nigeria producer on the preparation and market prospects for reptile skins; information was also supplied to East Africa on the market prospects for dolphin, porpoise and moleskins.

#### Tanning Materials

51. *Mangrove Bark*. Information was supplied to the Forestry Department of the British Solomon Islands on the production of a tanning extract (cutch) from mangrove bark.

52. *Spent Tan Bark.* Advice was given to a United Kingdom inquirer on the utilisation of the waste bark remaining after the removal of water soluble tannins.

### (b) INVESTIGATIONS CARRIED OUT AT THE TROPICAL PRODUCTS INSTITUTE

53. During the year under review the Institute completed 131 investigations; 53 investigations were in hand at the end of the period. Examples of those completed are given below:—

#### Essential Oils

54. *Jasmine pomade from Kenya.* In the enfleurage process for obtaining the perfume from flowers, the flower petals are spread on layers of fat (corps) on special frames. The fat absorbs the essential oil from the flowers and the resultant solution of essential oil in fat is called a pomade. The essential oil itself may be separated from the fat by extraction with alcohol and evaporation of the alcohol yields the concentrated perfume or absolute.

Two samples of pomade were prepared in Kenya from the flowers of *Jasminum grandiflorum* grown on an estate near Nairobi. In one instance a mixture of mutton fat and lard was the basis of the corps used for the pomade whilst in the other a corps of bleached, deodorised, hydrogenated vegetable oil was used. Samples of the absolutes were prepared by extraction with alcohol in the cold, freezing out the dissolved fat and removal of the alcohol under reduced pressure. The yield of absolute from the pomade based on animal fat was considerably lower than that from the one based on the hydrogenated vegetable oil, but the quality was superior, and perfumers to whom alcoholic solutions of the absolutes were submitted agreed that the one from the mutton tallow-lard pomade most closely approached the quality of the French jasmine perfume. It was suggested, however, that further trials, in which the perfume was extracted from the flowers with purified light petroleum, should be made. This solvent extraction process is used increasingly in the perfume industry in preference to the enfleurage process.

55. *Oil of Cymbopogon afronardus.* Two samples of oil which had been distilled by the Uganda Development Corporation from the leaves and stalks of the grass *Cymbopogon afronardus*, a widespread weed in Uganda, were examined. The oils consisted principally of hydrocarbons, mainly myrcene, and the "total alcohol" contents calculated as geraniol, were 32.6 and 20.7 per cent. by weight respectively. These figures compared unfavourably with that of 84.2 per cent. "total alcohols" as geraniol found for a sample of oil distilled in Kenya from this species, and the oils were not considered to be of commercial interest. It was suggested that specimens of the grass from various parts in Uganda should be examined to find out if a variety existed which gave an oil comparable with that from Kenya since this was more likely to be of value commercially. Attention was drawn to the necessity for proper distillation and collection of the grass, since these factors could also influence the percentage of alcohols in the oil.

56. *Oils of Cinnamon leaf and bark.* At the request of the Seychelles Agricultural Department, an examination was carried out to determine

whether or not varietal differences existed amongst Seychelles cinnamon trees which could be detected from the analyses of their leaf oils. For this purpose the analytical constants of leaf oils from selected trees, of the same age growing on the same site, were determined. The constants found all fell within the usual ranges for Seychelles cinnamon leaf oils, and the differences between them were insufficient for any conclusions to be drawn.

Oils were distilled from samples of bark from the two trees whose leaf oils showed the greatest differences. In each case the sample comprised the whole crop of unscraped bark from the individual tree. The yields of oil from the unscraped barks were low, and insufficient for a full analysis, but the oils were examined by the technique of gas chromatography. This showed that they were very similar in composition, the only distinction being a small difference in the proportion of eugenol. This distinction was not considered sufficient to prove varietal differences between the trees.

Gas chromatography did reveal, however, that the oils were lacking in a constituent, which was present in oil of Ceylon cinnamon bark and also in a sample of oil of Seychelles cinnamon bark examined some years ago at the Imperial Institute. It was suggested that this fact provided support for the view that an examination should be carried out on oils distilled from barks known to be of good flavour in an endeavour to improve the quality of Seychelles cinnamon by selection based on the quality of the bark oil, rather than of the leaf oil, the latter being, in any case, of declining commercial interest.

### Spices

57. *Cinnamon*. In continuation of previous work on the quilling of cinnamon, the Department of Agriculture, Seychelles, has made considerable progress. Samples of the quills taken from small consignments forwarded to a London firm of produce merchants and examined at the Institute have shown that Seychelles cinnamon quills are now approaching the standard of the better grades of Ceylon cinnamon. The intrinsic quality of Seychelles cinnamon, however, is lower than that of the Ceylon spice, though efforts are being made to rectify this.

58. *Pepper*. It was noted in Part II (a) of the Report for 1957-58 that Sarawak black pepper had been alleged to be of abnormal composition and that this might limit the demand for this pepper, especially in the United States. A sample of Sarawak black pepper, which had been prepared to the specifications of the American Spice Trade Association, was found to conform to requirements. It was, nevertheless, undoubtedly abnormal in certain respects, and it seems possible that the allegation may be justified. Examination of further samples of Sarawak pepper, particularly of native and introduced varieties, has been suggested.

59. *Nutmegs and Mace*. Samples of nutmegs taken from crops of four successive years were examined on behalf of the Grenada Co-operative Nutmeg Association. They showed no significant differences in analytical characteristics and it was concluded, therefore, that chemical composition is no guide to the age of nutmegs.

The Association was also informed that attempts to reduce the time required for the curing of mace by treatment with ultra-violet light were unsuccessful. In the course of the work it appeared that the rate of curing was, to some extent at least, a function of temperature.

**Oilseeds, Oils and Soaps**

60. *Wild sesame oil.* The herb *Sesamum angolense* grows in Angola, the Belgian Congo, the Federation of Rhodesia and Nyasaland and East Africa. A sample of the seed received from the Department of Agriculture, Kenya, yielded on examination an oil which contained 7.75 per cent. of sesamin, a compound of value as a pyrethrum synergist. It is normally found in oil from cultivated sesame seed (*Sesamum indicum*) to the extent of only 1 per cent., and it is the high sesamin content of the wild species which constitutes its chief interest.

61. *Palm oil.* The investigation into the causes of the difficulty of bleaching Nigerian Palm oil, referred to in the Report for 1957-58, has been continued. The following tentative conclusions have been reached concerning native processing methods (by which the bulk of Nigerian palm oil is produced).

(1) Nigerian palm oil in the virgin state, has excellent bleachability. A method of extraction was devised by the Institute in which bruising the fruit, delay in processing, exposure to air and contamination with iron were minimised. Using this method, samples of oil having bleachability superior to Malayan oil were prepared.

(2) The bruising suffered by the palm fruit when it is cut from the tree, and the processing delay which usually occurs, in primitive extraction methods, result in a major deterioration in the bleachability of the oil.

(3) In some cases, deterioration in bleachability occurs during transit and handling by middlemen. It has been shown that both the mixing of oils of high and low acidity, and also oxidation which is catalysed by iron, cause deterioration in bleachability.

(4) Native-produced oil is finally purified and processed at a Bulk Oil Plant. The examination of samples drawn at various stages in the processing has shown that, in some cases, further deterioration in bleachability occurs, apparently due to oxidation of the oil.

(5) In some cases, further slight deterioration may occur during shipment.

Nigerian plantation-produced oil has been found to have bleachability similar to the native-processed oil. In plantations, damage due to bruising and delays in processing would normally be less than in native production. It seems likely that the inferior bleachability of some plantation-produced oil is due to a technology that permits oxidation, and it has been shown that oil having good bleachability is produced at plantations in the Southern Cameroons, where the processing methods used are understood to be similar to those in use in Malaya.

62. *Soap.* A sample of laundry soap from the Department of Agriculture in Antigua which had been cold processed from fatty material containing 15 per cent. tallow and 85 per cent. coconut oil, was found to comply with the British Standards requirement for hard soap except for a high free fat content. Since the colour of the soap was uneven, recommendations were made regarding the use of a more suitable type of dye, and a sample of dye was supplied. Nevertheless, considering the origin of this soap and method of manufacture, the sample was of excellent quality.

### Grain Crops

63. *Sorghum*. Following observations by the authorities in Tanganyika that some varieties of sorghum appeared to be more resistant to weevil attack than others, eight different varieties, which were stated to possess differing degrees of resistance, were examined by the Institute for hardness of seed coat and, also, for moisture, fibre, starch, non-reducing sugar, reducing sugar, wax, and combined wax and oil content. No correlation could be established between the degree of weevil resistance and any of these results.

64. *Rice from Nigeria*. In Nigeria the native varieties of red rice (*Oryza glaberrima*) are being replaced by superior varieties of white rice (*Oryza sativa*), and concern has been expressed that the nutritional diet of the Nigerian consumer would suffer as a result of this change-over. It was decided, therefore, to investigate the relative nutritional properties of the rice and two varieties of red rice and two varieties of white rice (supplied by the Federal Rice Research Station, Bodeggi, Nigeria) were analysed. No general conclusions could be made as each sample examined had certain nutritional advantages over the others, but the red varieties were found to have significantly higher nicotinic acid contents than the white ones.

### Fruit Products

65. *Lemon Juice*. In connection with the development of the citrus juice industry of Kenya, an examination was undertaken on eighteen samples of lemon juice representing six varieties of lemon, Villa Franca, Lisbon, Eureka, Meyer, Rough and Chinese Dwarf, grown at five localities with differing climatic conditions. This preliminary investigation, with which interested firms generously collaborated by providing commercial assessments of the juice samples, enabled the varieties Meyer, Rough and Chinese Dwarf to be eliminated from further consideration on account of their low acidity and the lack of flavour in the juice. The results indicated that the varieties Villa Franca and Lisbon were most promising and merited more detailed study as sources of commercial lemon juice in Kenya.

66. *Canned Pineapple Juice*. A sample of canned pineapple juice from Swaziland was examined and advice given concerning the improvement of the juice, particularly with regard to its cloud stability and colour. Experiments were suggested which could be undertaken in the cannery in order to improve the processing procedure and observations were made on pasteurisation.

### Other Foods

67. *Coffee*. The authorities in Sierra Leone have been investigating conditions for harvesting and processing coffee grown in that country. Reports were furnished to the Department of Agriculture on the quality and commercial value of numerous samples of coffee prepared using different methods of harvesting and processing, and the value of the different methods was assessed.

68. *Cocoa*. Comments on the quality and commercial value of two samples of cacao beans were made to the Department of Agriculture, Tanganyika. The beans had poor flavour and tended to be brittle. Suggestions were made for improvement of the processing technique.

69. *Carob Beans from Cyprus*. An analysis of samples of kibbled carobs from Cyprus, Greece, Portugal, Spain and Morocco, supplied by the London Office of the Government of Cyprus, and which were stated to be representative of the quality of imports into the United Kingdom from these sources, showed those from Cyprus to be superior to the others.

#### Vegetable Insecticides

70. *Pyrethrum*. Under the research scheme, financed by the Kenya Department of Agriculture, work continued on the isolation of the active constituents of pyrethrum. Further samples of pure pyrethrins and cinerins I and II were prepared and supplied to Rothamsted Experimental Station, for biological assay. It was shown that the toxicity of pyrethrum extract to the housefly (*Musca domestica*) is satisfactorily accounted for by the combined effect of these four constituents.

The search for possible new insecticidal constituents in pyrethrum also continued. It was established that the pyrethrin I fraction is homogeneous, but that the cinerin II fraction shows signs of containing a small amount of another biologically active substance. Work on these aspects is still in progress.

A study of the physiology of the pyrethrum plant has been started. The "pyrethrins" content of fertile and non-fertile seed was determined; fertile seed had the higher content of "pyrethrins", these being concentrated in the embryo. The biosynthesis of "pyrethrins" in the young seedling was also investigated.

The Institute took part in a collaborative experiment organised by the Association of Official Agricultural Chemists, Washington, D.C., on modifications to the mercury reduction method of pyrethrum analysis.

71. *Derris*. Determinations of the rotenone content of derris roots from a manurial trial were made for the Department of Agriculture, Zanzibar. Definite responses to the various treatment combinations were observed, although the variation was complex: the highest rotenone content of 11.0 per cent. resulted from the application of intermediate levels of nitrogen, phosphorus and potassium but contents of 10.6 to 10.7 per cent. were obtained by applying either the highest level of nitrogen alone or the intermediate level of potassium alone.

The Institute has continued to participate in the collaborative work on methods for rotenone determination, proceeding under the auspices of a Joint Committee set up by the Pharmaceutical Society and the Society for Analytical Chemistry.

#### Synthetic Insecticides

72. *Analysis*. Further assistance was given to the Colonial Liaison Section of the Pest Infestation Laboratory by conducting determinations of insecticide residues in various stored products; these included groundnuts from Nigeria and Gambia and rice from Trinidad, the insecticides involved being malathion and BHC. Samples of DDT, BHC and dieldrin from tropical storage trials were tested for the World Health Organisation. Examinations of samples of Jamaican grapefruit for residues of the fungicide, sodium *ortho*-phenylphenate were also made.



### Vegetable Drugs

73. *Capsaicin*. This substance is the pungent principle of capsicums and chillies, and its determination in such commodities is of considerable interest as a guide to their quality. The Institute took part in a collaborative experiment on chemical methods of capsaicin determination, proceeding under the auspices of a joint committee set up by the Pharmaceutical Society and the Society for Analytical Chemistry.

### Vegetable Fibres

74. *Jute*. A sample of *Corchorus olitorius* jute, grown experimentally in Northern Rhodesia by the Department of Agriculture, was found to be of poor quality, weak in strength and appeared to have been insufficiently retted. It was suggested that *C. capsularis* might be better suited to the local conditions.

A sample of jute received from the Director of Agriculture, Malaya, was judged to be of better quality than a sample submitted in 1953, and commercial evaluation was very encouraging.

75. *Sisal*. A firm of textile machinery manufacturers in the United Kingdom was interested in artificially increasing the moisture uptake of sisal. Preliminary experimental work at the Institute showed that the moisture content could be increased to the required value of about 16 per cent. in approximately half an hour in a saturated atmosphere at a temperature of 30° C.

76. *Abaca*. Following a suggestion made by the Institute's Consultative Committee on Vegetable Fibres in 1951, one ton of abaca fibre was submitted by the Malayan Department of Agriculture for a full commercial evaluation. The fibre was of good quality and when spun into yarn and rope, was very favourably received. It was suggested that the production of abaca in Malaya should be encouraged.

A sample of abaca fibre from the Department of Agriculture, British Guiana, was found to be weak and not well prepared. It was considered that the quality could be improved by better extraction and cleaning methods, and information on all aspects of abaca production was supplied.

77. *Fibre identification*. Considerable demands continued to be made on the services of the Institute by inquirers who submitted fibres, particularly the less common bast and leaf fibres, for identification. Among the more interesting were cotton stalk fibre (from *Gossypium* sp.) submitted by the Government Chemist and "China hemp" submitted by a firm in the United Kingdom, which proved to have been obtained from a plant belonging to the family *Asclepiadaceae*.

### Paper-making Materials

78. *Pinus species*. Pulping trials were completed on three species of pine (*P. taeda*, *P. elliotii* and *P. tabuliformis*), supplied by the Conservator of Forests, Mauritius. The results showed that *P. taeda* and *P. elliotii* pulps have similar properties to the "Southern Pine" pulps of the U.S.A., but the *P. tabuliformis* pulp was somewhat different. However, if *P. tabuliformis* were used as a minor component in admixture with the other two the difference would be masked.

79. *Hardwoods from British Honduras.* Pulping trials by chemical and semi-chemical methods are nearing completion. The woods concerned, samples of which were provided by the Chief Conservator of Forests, are *Ochroma lagopus*, *Schizolobium parahyba*, *Heliocarpus donell-smithii*, *Cecropia peltata* and *Spondias mombin*.

80. *Beating Research.* Comparative beating trials on Eucalyptus kraft pulp were carried out using the Institute's Lampen Mill and the Lampen Mills at the Department of Forests Products, C.S.I.R.O., South Melbourne, Australia. These trials yielded information invaluable to both laboratories on the techniques and practice of beating short fibred pulps.

### Tanning Materials

81. *Mangrove Bark.* Sixty six samples of mangrove bark from Sarawak, supplied through the Conservator of Forests, were examined for tanning materials. The samples represented a series of tree girth sizes from *Rhizophora conjugata*, *Bruguiera gymnorrhiza* and *B. eriopetala*. Analyses were made to ascertain the relative value of each species and the effect of tree size from the point of view of forest management, and the economics of the extract manufacturing industry.

It was shown that the tannin content of each of the three species and in particular that of *B. eriopetala* was rather low for mangrove barks. The barks of *B. gymnorrhiza* and *R. conjugata* exhibited a marked tendency for the tannin content and the tannin/non tannin ratio to increase with increasing girth size.

### Physical Chemistry

82. During the year the Physical Chemistry Section became comprehensively equipped to carry out work in the fields of absorption spectrophotometry and emission spectrography. As a result absorption spectra will be obtainable by the double-beam pen-recording system over the whole range from the far ultra-violet, using a grating instrument, to the infra-red "fingerprint" region, using a prism instrument.

The purity of olive oil samples, supplied by the London office of the Government of Cyprus was determined by applying the differential infra-red absorption method.

Investigations were made into the constitution of terpene derivatives from the essential oil of *Strobilanthesis linifolia* supplied by a planter in Northern Rhodesia, and into the composition of extracts from Kenya pyrethrum.

A large quartz/glass and a medium quartz spectrograph are used for photographing emission spectra in the ultra-violet and visible ranges, the spectra being excitable by means of a combined arc/spark source unit or, in appropriate cases, by the flame excitation method. In the interests of accuracy a recording instrument is used in making photometric determinations.

Samples for reference use in Tanganyika, in connection with sisal cultivation, were examined for the Sisal Research Station of the Tanganyika Sisal Growers' Association. Flame photometric determinations were completed on the following elements: calcium, magnesium, manganese, potassium and sodium.

Development work on a spectrochemical method for the determination of trace elements in plant material is well advanced. This method is being applied to samples of coffee leaves received from the Coffee Research Station, Department of Agriculture, Kenya.

### Publications

#### 83. (i) Publications in the *Institute's Journal, Tropical Science*.

"Pulping trials on *Pinus caribaea* wood from British Honduras. Chittenden, A. E., and Palmer, E. R., 1959 **1**, 22.

#### (ii) Publications in other Journals.

"Discovery and production of spices". Brown, E., *The Times British Colonies Review*, 1958, **30**, 8-9.

"Hides and skins of Africa", Greenwood-Barton, L. H., *The Times British Colonies Review*, 1958, **29**, 8.

"Studies on Illipe nuts from Sarawak and the Federation of Malaya". Raymond, W. D., and Ward, J. B., *Malay Forester*, 1958, **21**, 261; also reprinted in *Planter Kuala Lumpur*, 1958, **34**, 645.

"The synthesis of substituted terphenyls", Ames, G. R. *Chem. Rev.*, 1958, **58**, 895.

"The United Kingdom market for imported strawberries". Kay, Mrs. D. E., *Countryman*, 1959, January, 18-19.

"The United Kingdom market for imported tomatoes". Kay, Mrs. D. E., *Countryman*, 1959, March, 25-26.

"West Indian fishing industry". Greenwood-Barton, L. H., *The Times British Colonies Review*, 1958, **30**, 17.

### (c) WORK CONDUCTED OUTSIDE THE TROPICAL PRODUCTS INSTITUTE BUT UNDER THE DIRECTION OR WITH THE ASSISTANCE OF THE COLONIAL PRODUCTS COUNCIL

#### Colonial Microbiological Research Institute, Trinidad

84. *Microbial synthesis*. A widespread ability to synthesise the lipid substance poly- $\beta$ -hydroxybutyric acid was found among Gram-negative bacteria, including *Acetobacter*, *Rhizobium*, *Chromobacterium*, *Spirillum*, *Vibrio*, and certain pseudomonads, and ability to produce the material on suitable media should be a useful criterion in bacterial classification. The synthesis and breakdown of the substance were studied in growing cultures and yields as high as 50 per cent. of the dry weight obtained. The lipid appears to occur universally in the root nodules of leguminous plants and may comprise over 10 per cent. of the dry weight of the whole nodule.

A group of hitherto undescribed phenazine pigments, synthesised by pseudomonads occurring in Trinidad soils, were isolated in crystalline form and their chemical and biological properties are being studied.

Experiments were continued to adapt a strain of *Acetobacter*, shown to produce cellulose as a mass of small floccules in shake flasks, to large scale aerated tank culture. Unfortunately the increased rate of production is gained

at the expense of lowered yields, but the very recent acquisition of a battery of eight stainless steel 10 litre fermenters allowed reinvestigation of the problem.

No further work was possible on the microbial conversion of limonene owing to the pressure of other commitments, but the active fungi are being maintained.

85. *Plant Pathogens*. Some considerable importance is being attached by the Trinidad Ministry of Agriculture to a fatal wilt of cacao trees with a widespread distribution throughout Trinidad. The first trees brought to the Ministry's attention in July, 1958, were sampled by the Institute and by isolation, infection with reproduction of symptoms, and re-isolation, the causative agent was shown to be *Ceratostomella (Ceratocystis) fimbriata*. Isolations have since been made from all the cacao-producing areas in the island. The disease is usually associated with a varying degree of damage by shot-hole borers (*Xyleborus*, sp.) but it has not been proved that the *Xyleborus* beetle is the transmitting agent. Unfortunately clones with a high percentage of Criollo in their parentage are particularly susceptible.

Work on *Pseudomonas solanacearum* continued. In collaboration with the Trinidad Ministry of Agriculture varieties of tomato and banana were tested for their resistance to the pathogen, and protection experiments with streptomycin sulphate gave encouraging results. The biochemical basis of the host specificity of the various strains is being studied by isolation and comparison of the somatic polysaccharides and the wilt-inducing fractions in the culture filtrates from the bacteria.

86. *Antifungal Antibiotics*. The screening of actinomycetes for the production of antifungal substances led to the isolation of two promising strains, the most active being T83 (14). This actinomycete in liquid shake culture produces a mixture of at least four antifungal antibiotics. The active components are not polyenes. A crude antibiotic mixture was isolated and found not to be haemolytic. Preliminary animal tests suggested that it was non-toxic to mice. It is active against both animal (*Trichophyton* sp.) and plant (*Fusarium oxysporium* var. *cubense*, *Ceratostomella fimbriata*) pathogenic fungi.

A suitable medium was developed and work is now proceeding on ultra-violet irradiation for production of strains of increased activity. Pilot plant studies and fractionation of the active components has begun.

87. *The Hankey Culture Collection*. Routine provision of cultures and bacteriological examinations for local industries continued throughout the year. Forty-two cultures were sent overseas on request. The collection now contains over 1,000 cultures (286 bacteria, 162 yeast, 155 actinomycetes and 408 fungi).

88. *Curing of the Cacao Bean*. From knowledge obtained of the microbial and biochemical changes which take place during curing, it has been possible to put forward the following:

- (a) the minimal requirements for a successful fermentation.
- (b) a simple index that the farmer can use to determine when his fermentation is complete.
- (c) a simple laboratory method of curing very small samples of beans to determine their potential flavour quality.

The latter method was applied to pods produced by hand pollination of different clones, and assessment by a chocolate manufacturer showed that genetically determined flavour differences can be revealed by this method.

With the knowledge available pilot plant studies were started for the production of cured cacao by a method which it is hoped will prove more reliable than the traditional practice.

Work on the chemistry of cacao polyphenols continued and a method of fractionating the "complex tannins" was developed. Diphenylbenzene dioxide—2·3—quinone was shown to be an intermediate in the oxidation of catechol with polyphenol oxidase. Investigation of the peltogynols was completed.

89. *Miscellaneous Investigations.* During the year under review the Institute was called upon, as before, to assist various industries and organisations :—

- (a) *The Coconut Growers' Association Limited* : Bacteriological analyses and maintenance of cultures used in the manufacture of margarine.
- (b) *Gordon Plantations Limited* : The investigation of the decrease in bearing of the Tonka bean claimed to be due to an anthracnose but shown to be due to a beetle (*Apoia bryanti*). Practically every flower in the sample received contained the beetle at various stages in its life cycle.
- (c) *Trinidad Petroleum Development Company Limited* : Oilfield water analyses for the presence of sulphate reducing bacteria.
- (d) *Texaco (Trinidad) Incorporated* : As for (c).
- (e) *Trinidad Forestry Department* : Demonstration of mycorrhiza in a species of *Araucaria* introduced from New Guinea.
- (f) *Department of Agriculture, Antigua* : Isolation of *Alternaria* sp. and *Cercospora* sp. from damaged leaves of *Gossypium*.
- (g) *Ministry of Agriculture, Trinidad* : The isolation and identification of *Aspergillus fumigatus* from the lungs of dead chickens during a fatal outbreak of lung disease among chicks.
- (h) *The Commonwealth Institute of Biological Control* : A simple cheap medium for the growing of *Metarrhizium anisopliae*, an entomogenous fungus active against sugar cane "frog-hopper", was developed. The Institute promised to produce a sufficient amount of the material for biological control trials. However, studies showed that there was considerable variation between strains with regard to production of conidia, and the temperature and humidity range permitting their germination. It is necessary to determine whether there is a similar variation in virulence before field trials are begun.

90. *Visits.* While on leave in the United Kingdom, the senior microbiologist, Dr. W. F. Dudman, attended the International Congress of Microbiology, Stockholm. The biochemist, Dr. V. C. Quesnel, read two papers at the Seventh Inter-American Cacao Conference at Palmira, Columbia, and was elected Chairman of the Sub-Committee for the curing of cacao of the Interamerican Technical Cacao Committee.

The Director, Dr. W. G. C. Forsyth, visited London and the various islands of the West Indies for discussions with regard to the future of the Institute.

91. *Publications*. "Adsorption chromatography on silica-treated paper". Roberts, J. B., *Nature*, 1958, **181**, 338.

"A naturally-occurring isomer of the leucoanthocyanidin peltogynol". Forsyth, W. G. C., Hassall, C. H., and Roberts, J. B., *Chem. & Ind.*, 1958, 656.

"Factors influencing bacterial cellulose synthesis". Dudman, W. F. Abs. 7th Inter. Con. Microbiology, Stockholm, 1958.

"Occurrence of poly- $\beta$ -hydroxybutyric acid in aerobic gram-negative bacteria". Forsyth, W. G. C., Hayward, A. C., and Roberts, J. B., *Nature*, 1958, **182**, 800.

"Studies on cacao curing 1956-1958—A Review". Forsyth, W. G. C., and Quesnel, V. C. Proc. 7th Interamerican Cacao Conference, Palmira, 1958.

"Synthesis and breakdown of poly- $\beta$ -hydroxybutyric acid by bacteria". Hayward, A. C., Forsyth, W. G. C., and Roberts, J. B., *J. Gen. Microbiology*, (in press).

"The constitution of the leucoanthocyanidin peltogynol" Chan, W. R., Forsyth, W. G. C., and Hassall, C. H., *J. Chem. Soc.*, 1958, 3174.

"The interaction of polyphenols and proteins during Cacao curing". Forsyth, W. G. C., Quesnel, V. C., and Roberts, J. B., *J. Sci. Food Agric.*, 1958, 184.

"Cacao leucocyanidin". Forsyth, W. G. C., and Roberts, J. B., *Chem. & Ind.*, 1958, 755.

#### **British West Indies Sugar Research Scheme at the Sugar Technological Laboratory, Imperial College of Tropical Agriculture, Trinidad**

92. *Visits*. The Director, Dr. W. S. Wise, attended the 12th Session of ICUMSA in Washington in June, 1958; when in England he took part in discussions on the future organisation of the Department.

93. *Clarification Studies*. Investigations into the fundamental chemistry of the clarification process were extended to the study of juices from different varieties grown under different climatic conditions. The behaviour of the juice was shown to depend largely on the nature of the material adsorbed on the suspended particles. For most juices protein predominates at the particle surface, but in the "refractory" juices, from canes grown under drought conditions, experimental evidence suggested that the protein surface was masked by a superimposed layer of material which is probably a polysaccharide of the pectinate type.

94. *Settling Curves*. The results obtained on the settling of juices are of fundamental importance to some of the work and considerable attention has been paid to the problem of obtaining reliable and reproducible settling curves.

95. *Stability and Flocculation*. A simple technique for measuring stability was evolved by measuring the residual turbidity in a juice after flocculating and settling under definite conditions. Use of this technique gave information on some of the factors affecting the stability of the juice.

96. *Zeta Potential and Sedimentation Behaviour*. The flocs produced in the commercial clarification process consist of a large number of particles bound together in a matrix of precipitated calcium phosphate. These particles carry an appreciable negative electrostatic charge (zeta potential ca. -10 mV),

but it is possible to change the magnitude and sign of this charge by the addition of a positive or negative detergent. It was found that at the point where the particles carry no net charge the flocs have their most closely-packed structure, as shown by the fact that the juice has a maximum settling rate and minimum final mud volume.

97. *Starches as Flocculants.* The large increases in floc size and rate of settling caused by the addition of solutions of potato starch to a limed and boiled juice were shown to depend on the nature and amount of the starch added. The activity of any particulate starch could be correlated with the content of organic phosphate. It is believed that the starch is bound to the surface of the flocs through its esterified phosphate groups while the flocs are crosslinked by starch-to-starch bonds which already exist in the added starch solution. If starch is added to the juice before the calcium phosphate precipitate is formed, the individual particles are stabilised against flocculation, although flocculation can then be induced simply by mixing in a high-speed blender. In some juices it was found that the starch which occurs naturally behaves in the manner described, so that the flocculation and sedimentation is improved by high-speed blending.

The effects produced by starches may well have practical applications in sugar factories ; a range of commercially available starches is therefore being examined in the laboratory.

98. *Time Effects.* It was found that the settling behaviour of a raw juice depends on its age ; in general the settling properties are at an optimum one hour after milling, and thereafter the juice slowly deteriorates. In some juices these changes are quite large and, being influenced by the presence or absence of oxygen or carbon dioxide, may be associated with biochemical rather than chemical changes in the juice.

99. *The Dye Test.* An investigation into the adsorption in juice of two cationic dyes, Bismark Brown and Methylene Blue, showed that the Dye Test gives a measure not of the total quantity of colloids but rather of the charge characteristics of the juice particles. As this differs from juice to juice the Dye Test has little value as a method of estimating colloids.

100. *Model Cane Juice System.* Some experiments were made using as a model system an oil-in-water emulsion established by bovine serum albumin. The effect of changes in protein and oil drop concentration was studied with particular reference to the interaction of the system with metallic cations, detergents and dyes ; a study was also made of the interaction of certain polysaccharides with the protein at the droplet surface. The results of this study were used in the interpretation of the behaviour of cane juice.

101. *Precipitation of Calcium Phosphate in the Presence of Magnesium Ions.* It was found that the electrostatic charge characteristics of a calcium phosphate precipitate are changed by the co-precipitation of magnesium. Attempts to identify a new crystalline structure in the precipitates were without success, although the crystallinity was found to decrease as the magnesium content increased.

102. *Heat Transfer Coefficients of Sugar Factory Evaporator.* During operation of the new Experimental Factory, heat transfer data were measured on the triple effect evaporator.

103. *Test of the A.P.V. "Paraflow" Heat Exchanger.* The heat exchanger was installed in the College factory and found to function satisfactorily as a juice heater. The heat exchanger could be supplied by either a centrifugal or a piston pump. Only slight scaling occurred, this being insufficient to affect the capacity. However, scaling of juice heaters is never severe in the College factory owing to the comparatively few hours worked per week; the "Paraflow" heat exchanger was therefore installed in a commercial factory where its performance will be assessed under more drastic conditions that can be provided in the College factory.

104. *Observations on Steam-side Fouling.* Heat transfer tests using a specially built apparatus were made on a number of evaporator tubes received in connection with work on scale, some of them having the fouling on the steam side intact. A surprising feature of the results was the comparatively low values (0.16-0.55°F. hr. sq. ft./1,000 B.T.U.) found for the thermal resistance on the steam-side fouling; the loss of evaporator capacity caused by thermal resistances of this magnitude is hardly significant. It therefore appears that, except in exceptional circumstances, the effect of steam-side fouling is not as large as had been feared.

Some experiments were carried out on the removal of the steam-side fouling. It was found that soaking for 10 days at room temperature in 5 per cent. trisodium E.D.T.A. (which readily dissolves zinc and copper oxides) dissolved most of the fouling, and the residue could be removed by gentle rinsing in water. In cases of heavy fouling, a degreasing treatment with an organic solvent or a detergent was also required. The classic treatment, of floating kerosene on water which is then slowly drained past the tube, was found to be without significant cleaning effect.

A few experiments with pieces of clean evaporator tube subjected to various steam treatments showed that, as expected, rapid fouling was associated with oxygen in the steam.

105. *Studies on Scaled Evaporator Tubes.* In response to a request made by the Director at a meeting of the Advisory Committee, a number of factories kindly sent scaled evaporator tubes. A programme of work is now under way on the relationship between the chemical composition of the scale and its effect on heat transfer and on the efficacy of various methods of chemical solution of the scale. A new chelating agent, which is a derivative of E.D.T.A., is included in the cleaning solutions; it has the advantage of being much more soluble than E.D.T.A. in strong solutions of caustic soda.

Special attention is being given to the problem of estimating the weight of scale in an evaporator from heat transfer measurements.

106. *Use of Sodium Citrate for Cleaning Evaporators.* An experiment in which sodium citrate was used to clean a factory evaporator was less successful than had been hoped. The scale was fairly readily attacked by sodium citrate but, owing to a much heavier rate of scaling than had been encountered previously at this factory, the citrate was consumed at an uneconomic rate. With some of the heavier scales, the calcium citrate which was produced did not completely form as a suspension in the cleaning solution but collected on the tubes as a fairly adherent film not removable by flushing the tube with water; there was some evidence that this citrate layer was removed from the evaporator tube during the first day's operation of the vessel.



Another disadvantage found in the use of citrate solutions was that they very readily fermented under sugar factory conditions. The use of sodium citrate is therefore less attractive than suggested by the previous laboratory experiments, although it may have certain specialised applications.

107. *Hardboard from Bagasse*. A hydraulic press fitted with electrically heated plates was installed; it has sufficient capacity to produce 6-inch squares of experimental boards. The work which was carried out previously on 1-inch disks will be repeated and extended.

A pneumatic dryer for bagasse, made from glass tubing, was constructed and found to work satisfactorily.

108. *Publications*. "Chemical solution of evaporator scale". Schmidt, N. O., and Wise, W. S., *Ind. & Eng. Chem.*, 1958, **50**, 811-814.

"Levulinic acid. II. Some derivatives of 2-aminoethyl levulinate". Stevens, R., *J. Org. Chem.*, 1958, **23**, 301.

"The determination of calcium and magnesium in cane juice". Bennett, M. C., and Schmidt, N. O., *Inter. Sugar J.*, 1958, **60**, 225-230.

#### **Natural Products Research Unit in the Department of Chemistry, University College of the West Indies**

109. Under the supervision of Professor L. J. Haynes the unit has been investigating local plants of reputed physiological activity and particularly those having an effect on blood pressure. Twenty out of the thirty plants so far tested showed activity, a third of them actually increasing instead of decreasing the blood pressure. Some of them possessed two compounds of different stability, one increasing and one decreasing blood pressure.

#### **Makerere College, Uganda, Department of Chemistry**

110. *Constituents of Tea Leaves*. Dr. W. J. Peal continued his research on the tea sterol,  $\alpha$ -spinasterol, which he has found to be available in fair quantities (approx. 0.1 per cent.) in the four different tea sources investigated including spent leaves from normal household tea-making. The presence of  $\beta$ -amyirin as a minor constituent of tea fat was confirmed and the conversion of  $\alpha$ -spinasterol to hormone intermediates is being investigated.

111. *East African Dioscoreaceae*. The steroid and triterpenoid constituents of East African *Dioscoreas* have been under investigation; 23 specimens, 11 of which are being observed under cultivation, were collected and sent to Kew for identification. Haemolysis tests were positive for six of the yams, three yielding diosgenin under bulk extraction, but neither of the two yams in which diosgenin was detected for the first time seemed likely to provide an economic source of the sapogenin. Sterols, including  $\beta$ -sitosterol, were found in six of the specimens.

#### **Makerere College, Department of Agricultural Engineering**

112. *Methane Fermentation*. Mr. W. Boshoff has continued his investigation of methane fermentation on a pilot plant scale. Liquid from a daily ("continuously") fed digester was found to be a more successful inoculum than cow dung, whether fresh or decomposed, or liquid from a batch fed

digester. The maximum gas yield obtained by charging the 44 gallon digester with 500 g. dried elephant grass daily was 5 cu. ft. per day, a yield which was significantly increased by raising the charge to 600 g. but not by raising the charge to 700 g. The age of the elephant grass was found to have a significant effect on gas yield. The removal of exhausted residues weekly instead of daily had no significant effect on gas output.

Over a period of 40 days, the gas yield at 21-24°C was 75-85 per cent. of the yield at 32°C; over a period of 90 days, 85 per cent. of the total gas yield could be produced in the first 40 days at 32°C, and in the first 56 days at 21-24°C.

#### **The Forest Products Research Laboratory, Princes Risborough**

113. *Production of fibreboard from Colonial timbers.* An investigation on a laboratory scale was made into the utilisation of four timbers from North Borneo for production of hardboard. The timbers tested were kapur (*Dryobalanops* spp.), keruing (*Dipterocarpus* spp.), red seraya (*Shorea* spp.) and white seraya (*Parashorea malaanonan*). Timbers grown in Malaya and closely allied to two of these, viz. keruing (*Dipterocarpus crinitus*) and red meranti (*Shorea leprosula*), were included in a previous investigation, but special interest was expressed in the Borneo varieties and particularly in the possible use of mixtures of red and white seraya.

Defibration was carried out using the Asplund Defibrator process under various conditions of temperature and pressure, without any chemical treatment, and boards were pressed from the resulting pulps using a variety of pressing conditions. By pressing the boards at a suitably high temperature with rapid application of pressure, together with a hot air treatment of the boards after pressing to reduce their water absorbency to the required level, it was found possible to make boards which met the requirements of B.S. 1142 : 1953 for standard and super hardboard from each of the woods without further refining of the Defibrator pulp, and without addition of any chemicals or sizing material at the sheet-forming stage.

The appearance of boards made from kapur tended to be marred by dark coloured patches on the surface, due to deposition of water-soluble materials during evaporation of water in the press, and could be avoided by a very thorough washing of the pulp before forming the wet mat. In large-scale operation this would considerably increase the water consumption and might be considered a disadvantage in the use of this timber.

The keruing tested had interlocked grain which resulted in uneven thickness of the chips and consequent increased resistance to defibration. While the fibre produced appeared satisfactory, the power consumed in defibration may be expected to be high as a result of this characteristic of the wood.

In general, red seraya proved to be the most satisfactory of the four timbers tested, while the mixture of red and white seraya presented no special problems.

#### **Birmingham University, Department of Pharmacology**

114. *Pharmacological Testing Unit.* Dr. H. S. A. Sherratt has carried out work on the following projects.

115. *The toxicity of Ammoniated Molasses.* The toxic reactions which are often produced by feeding ammoniated molasses to cattle were found to be largely due to the 4-methylimidazole content, though the presence of another highly toxic substance(s) was indicated. While it is now considered that ammoniated molasses is not suitable for feeding to cattle as a cheap protein substitute, it may be of interest to determine the nature of the second toxic substance.

116. *The toxicity of Comirin.* Preliminary tests with the anti-fungal antibiotic comirin, showed no oral toxicity or skin reactions, but when sufficient crude comirin is available it will be incorporated into the diet for chronic feeding experiments.

117. *The possible occurrence of cardioactive substances in Pueria mirifica or Butea superba.* Examination of three fractions isolated from the roots of *P. mirifica* showed no cardioactive effects. An extract of the roots of *B. superba* has not so far been found to have any significant biological activity.

118. *The pharmacology of Crotalaria retusa.* A weak adrenaline-like action was detected in two of six fractions of *C. retusa* which were put through the routine screening procedure of pharmacological tests. This action was considered to be worth further investigation in case it should be due to the presence of small amounts of highly active substance(s) rather than larger amounts of substance(s) with lower activity.

119. *The pharmacology of Jamaican "Bush Teas".* Indigenous plants widely used in Jamaica to prepare "Bush Teas", aqueous infusions taken for the treatment of a variety of illnesses, were put through a screening procedure of standard pharmacological tests. It is hoped that these plants may provide a useful source of new pharmacologically active compounds. Of 44 extracts so far tested, a dozen appeared to be worth further investigation.

#### **Birmingham University, Department of Chemistry**

120. *Sugar Derivatives.* Mr. M. C. Keith, supervised by Dr. S. A. Barker, began work on the chemical and biochemical syntheses of new antibiotics containing amino- and deoxy-sugars. Experience in the separation and structural determination of small amounts of disaccharides was first gained by chromatography and analysis of disaccharides obtained by hydrolysis of Type XIV *Pneumococcus* polysaccharide. The rare sugar noviose was then isolated from the antibiotic Novobiocin, and a stock accumulated. Noviose, and the sugar which it is hoped to produce by the action of boron trichloride on it, are to be used as receptors in enzymic syntheses using micro-organisms.

#### **Bristol University, Department of Organic Chemistry**

121. *Strychnos toxifera alkaloids.* Mr. D. A. Yeowell, under the supervision of Dr. A. R. Battersby, has been carrying out isolation work on the alkaloids of *Strychnos toxifera* bark. Partition chromatography of mixtures of crude alkaloid chlorides yielded various fractions containing crystalline material, including hemitoxiferine—I. The fraction containing the greater part of the eluted material was re-partitioned, one of the fractions thus obtained yielding a new crystalline alkaloid, the structure of which is at present under investigation.

**Leeds University, Department of Leather Industries**

122. *Mangrove bark*. Under the supervision of Professor D. Burton and Dr. H. E. Nursten, Mr. T. Dalzell continued his study of the constituents of mangrove bark and related vegetable tanning materials. A spectroscopic study of hydrolysis products of mangrove extracts confirmed that anthocyanogens are important constituents of mangrove liquors, and a preliminary fractionation of mangrove anthocyanogens was made. Experiments are in progress to determine the optimum conditions for the production of anthocyanidins from mangrove anthocyanogens, and a preliminary separation of the anthocyanidins formed was carried out.

**Imperial College of Science and Technology, London**

123. *Chemistry of Limonin*. Working under Professor D. H. R. Barton, Mr. S. K. Pradhan was awarded the degree of Doctor of Philosophy for his research into the chemistry of limonin. From an assessment of earlier and present work in the field a partial formula for limonin,  $C_{26}H_{30}O_8$ , was fully established. This partial formula was further expanded on a speculative basis to give the complete formula for limonin which would most satisfactorily account for all its reactions; it was, however, considered that much more experimental work is necessary before this complete formula could be considered established.

**University College, Swansea**

124. *Greenheart Bark*. An assistant was provided for Professor C. H. Hassall to continue his work on the alkaloids of Greenheart (*Ocotea Rodiei*).

**The Royal College of Science and Technology, Glasgow**

125. *Steroids*. Mr. D. S. Savage who was working on the steroid content of various plants under Professor F. S. Spring had to terminate his work on being called for National Service.

**Work on Plant Materials supplied by the Council**

The Council continued its service to research workers by supplying samples of tropical plants on request; the following are examples of results achieved with them.

126. *Areca catechu*. Dr. A. Mackie of the Heriot-Watt College, Edinburgh has isolated myristic, palmitic, stearic, oleic and linoleic acids and probably lauric acid from the fat extracted from Pinang mabuk (*A. catechu*) nuts, a variety of betel nut. These acids are also found in the fat from betel nut.

127. *Dichapetalum toxicarium*. Sir Rudolph A. Peters of the Agricultural Research Council established that the toxic principle of the seeds was a fluoro-octodecanoic acid.

128. *Dioscorea hispida*. Dr. A. R. Pinder of the University College of South Wales and Monmouth continued work on dioscorine, the alkaloid of *Dioscorea hispida*. Dioscorine was degraded stepwise to an optically active ketonic base  $C_8H_{13}ON$  which on reduction yielded tropane, indicating that the compound is a ketotropane, either 2- or 6-oxotropane. Synthesis of the latter indicated that this was different from the degradation product, which must therefore be 2-oxotropane. Efforts are being made to synthesise 2-oxotropane to complete the proof of structure. A formula for the structure of dioscorine was put forward.

129. *Ganua latex*. Dr. W. Lawrie of the Royal College of Science and Technology, Glasgow was engaged in the study of constituents of *Ganua latex*. By extraction of the latex with alcohol and saponification of the extract, he isolated cinnamic acid as the main constituent of the acid fraction. Work continues on the neutral, non-saponifiable fraction which appears to contain a mixture of triterpenoids; the separation and purification of these may yield a new triterpenoid.

130. *Heliotropium indicum*. Dr. R. Schoental of the Medical Research Council's Toxicology Research Unit, has found several pyrrolizidine alkaloids and their N-oxides in low concentration in this plant.

131. *Juniperus species*. Professor H. Erdtman of Stockholm, Sweden has continued his investigation of the minor components of the wood of *Juniperus species*. The oil of *J. phoenicea* was found to contain 6 per cent of extractives soluble in light petroleum, principally thujopsene. Cedrene, cuparene, cedrol, widdrol and hinokiic acid were also present. The light petroleum soluble oil of *J. foetidissima* appeared to be of different composition from that of other Junipers so far investigated.

132. *Nyctanthes arbor-tristis*. Dr. J. H. Turnbull of the University of Birmingham who has been investigating the constituents of the seed oil of this Indian shrub, has characterised nyctanthic acid—a unique tetracyclic triterpenoid acid. This substance is of great biogenetic interest on account of the absence of an alcoholic hydroxyl group from this structure. Work on the acid is continuing.

133. *Picalima nitida*. Dr. G. F. Smith of the University of Manchester in his work on the seeds of *Picalima nitida* isolated most of the alkaloids reported by previous workers. The chemistry of the alkaloid ekuammicine was investigated and the elucidation of its structure almost completed. The other alkaloids are to be similarly investigated. The alkaloids of *Alstonia scholaris* and *Aspidosperma* and *Calycanthus* species are also under investigation.

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Committee on Colonial  
Road Research  
(1958-59)

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Road Research Laboratory,  
Harmondsworth,  
West Drayton,  
Middlesex.  
27th July, 1959.

SIR,

I have the honour, on behalf of the Committee on Colonial Road Research, to transmit to you the Fourth Annual Report of the Committee, covering the period 1st April, 1958, to 31st March, 1959.

I have the honour to be,

Sir,

Your obedient Servant,

W. H. GLANVILLE,

*Chairman.*

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

## COMMITTEE ON COLONIAL ROAD RESEARCH

## MEMBERSHIP

- W. H. GLANVILLE, Esq., C.B., C.B.E., D.Sc., M.I.C.E., F.R.S., Director of Road Research (Chairman).
- T. L. BOWRING, Esq., C.M.G., O.B.E., M.I.C.E., M.I.Struct.E., Adviser on Engineering Appointments, Colonial Office.
- 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 and Partners.
- H. GRACE, Esq., S.M., M.Sc., M.I.C.E., M.ASCE., A.M.I.W.E., Messrs. Scott & Wilson, Kirkpatrick & Partners.
- J. S. MCNEIL, Esq., M.I.C.E., A.M.I.Mun.E., Ministry of Transport and Civil Aviation.
- SIR HERBERT MANZONI, C.B.E., M.I.C.E., M.I.Mun.E., City Engineer and Surveyor, Birmingham.
- 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.
- SIR REGINALD TAYLOR, C.M.G., M.I.C.E., Engineer-in-Chief, Crown Agents and Engineering Adviser to the Secretary of State for the Colonies.
- PROFESSOR GILBERT WALKER, D.Litt., Faculty of Commerce and Social Science, University of Birmingham.
- SIR HUBERT WALKER, K.B.E., M.I.C.E. (to January 1959).
- R. S. MILLARD, Esq., Ph.D., M.I.C.E., Head of Tropical Section (ex officio).
- F. H. P. WILLIAMS, Esq., M.A., A.M.I.C.E. (Secretary).

In addition to the above members, Colonial Governments are asked to nominate delegates for each meeting. The following attended the 5th meeting held on the 8th July, 1959.

- M. S. Barnes, Esq., A.M.I.C.E., Director of Public Works, Basutoland.
- K. L. Hardaker, Esq., M.A., A.M.I.C.E., Deputy Director of Public Works, Aden.
- E. Jones, Esq., O.B.E., M.I.C.E., M.I.W.E., Deputy Director of Federal Public Works, Federation of Nigeria.
- G. P. Manners, Esq., M.V.O., A.M.I.C.E., Ministry of Works, Northern Region of Nigeria.
- N. E. R. F. Rose, Esq., M.I.C.E., Deputy Director of Public Works, Tanganyika.

**Terms of Reference**

The terms of reference of the Committee are to advise the Secretary of State for the Colonies on matters of road research for the benefit of the Colonies.



## COMMITTEE ON COLONIAL ROAD RESEARCH

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## COMMITTEE ON COLONIAL ROAD RESEARCH

### FOURTH ANNUAL REPORT

#### I. Introduction

1. The year under review has been one of expansion and of widened interests. On the 1st January, 1959, the name of the Section at the Road Research Laboratory was changed to the Tropical Section. This more accurately describes the Section's interest as the Colonial Territories with which its work is connected are to be found almost wholly within the tropics. Since the funds for the Section's work continue to be provided solely by or on behalf of the Colonial Territories the concern of the Section is to solve the road problems of these territories. In this they are being aided by increasing contacts with Commonwealth and other countries in the tropics where research is being done into road problems.

2. The Committee held its fourth meeting in July, 1958. It was attended by representatives of the following territories:—Aden, Bermuda, Hong Kong, Kenya, Nigeria (Federal), Nigeria (Northern), Nigeria (Western), Nyasaland, Northern Rhodesia, Southern Rhodesia, Singapore, Sierra Leone, Tanganyika and Uganda.

3. The Committee expressed disappointment that it had not yet proved possible to carry out its recommendation to establish a pool of materials engineers and strongly urged that it should be established at an early date. The need for such men is essential to the good use of funds available for road construction, and in view of the continuing difficulties that territories are encountering in recruiting such staff, there is no doubt that such a pool would be kept continuously employed. In this connection the Committee is pleased to note the progress that has been made in certain territories in establishing materials laboratories.

#### II. Visits

4. Dr. Millard attended a conference of road specialists organised by the Scientific Council for Africa in Lourenço Marques in August and took the opportunity to make short visits to Kenya, South Africa and Nigeria. In Kenya he reviewed with the Ministry of Works the work of the research team examining moisture conditions under roads and made plans for future investigations. In Nigeria he met officers of the Federal Public Works Department and of the Ministry of Works and Transport, Western Region, and the Ministry of Works, Northern Region, as well as consulting engineers, discussing with them a range of road and airfield problems. He was also able to meet the Federal Minister of Works, the Minister of Works for the Northern Region and the Minister of Works and Transport, Western Region, to discuss with them plans for future co-operation.

5. Mr. Williams visited Singapore, North Borneo, Brunei, Sarawak, Hong Kong and Fiji, and by invitation visited Pakistan, Malaya and Australia, in October to December. This is the first visit that has been made to Pakistan and Australia and the object was to make contact with those people working on road problems which are in many respects the same as those tackled by the Road Research Laboratory. In Malaya, which is a newly emergent

territory, the opportunity was taken to strengthen the links previously established and to observe experimental sections which had been previously laid.

6. Dr. Millard visited the Bahamas, Jamaica, British Honduras and Bermuda in February and March. In Jamaica, which has already a well-developed system of roads, plans were made to create means to cope with the growing traffic congestion in Kingston and other towns and to establish road standards which will be adequate for traffic on roads outside the towns. In British Honduras the methods of road construction and maintenance were reviewed to take greater advantage of machinery and modern techniques.

7. In addition to these liaison visits, a number of other visits overseas has been made in connection with specific research studies. This marks a new phase in the overseas work of the Laboratory. More detailed description of the work is given in the section of the report concerned with research activities.

#### *Moisture movements under roads and airfields*

8. Messrs. O'Reilly, Baker and Tanner went to Kenya in April, 1958, to begin an investigation of moisture conditions under roads in co-operation with the Kenya Ministry of Works and the Road Authority. This investigation is continuing for about 15 months to include two main rainy seasons.

9. Mr. Russam visited Southern Rhodesia during May and June to follow up previous measurements made by the Air Ministry at three airfields in that territory. Analysis of the earlier measurements showed that moisture changes of an unusual type took place at this time of the year. The investigations made during the visit enabled the probable cause of the changes, namely the movement of moisture in the vapour phase, to be deduced. On the return journey he stayed for one week in Kenya working with the Road Research Laboratory team resident there.

#### *Properties of tropical soils*

10. Also during May and June, Mr. Clare visited the Central African Federation to study the local roadmaking gravels and their utilisation. Records on colour film were obtained of the profiles in a range of gravels, for pedological classification, and for training purposes, and a cine-film record was made of the "mix-in-place" stabilisation process used for bitumen-surfaced gravel roads in Northern Rhodesia.

#### *Traffic conditions in Lagos*

11. Following a request from the Nigerian Ministry of Lagos Affairs, Mines and Power, Mr. Hillier of the Traffic and Safety Division paid a preliminary visit to Lagos in November, 1957. He returned to Lagos in April, accompanied by Mr. Tresidder, to organise a study of road traffic in the town.

#### *Traffic conditions in Hong Kong*

12. Early in the year a request was received from the Government of Hong Kong for an expert to advise on the preparation of a road plan for the urban areas of the city to meet the social and economic needs of the community there. Accordingly, Dr. Charlesworth, Head of the Traffic and Economics Section of the Laboratory, visited Hong Kong in June.

### III. Research

#### *Characteristics of traffic (Item A)\**

13. Plans are being made to examine the characteristics of traffic on selected roads in Central Africa. Records will be made of vehicle numbers, vehicle and axle loads, speeds and the transverse distribution of traffic on roads of different types. Proposals are contained in Paper CRR. 63. As a preliminary a survey has been made of the performance of automatic traffic counters on gravel- and bitumen-surfaced roads in the overseas territories. As a result an improved model of the Sykes counter will shortly be available.

#### *Economic justification for roads (Item A)*

14. Mr. Smith visited Uganda in March 1958, to examine the possibilities of investigations to determine the economic effects of feeder road construction. He was fortunate to find in the West Nile area of Uganda, a region where the only major encouragement to development had been construction of feeder roads, and where it was possible to measure the increase in cotton production which had resulted. Although there were difficulties in obtaining some of the data in the field, this investigation has shown that such a method of approach can yield results although it is desirable for the investigator to spend at least several months in the field for each investigation. A report has been prepared (CRR. 73).

#### *Traffic surveys in Hong Kong and in Lagos (Item C)*

15. As already noted, in response to a request from the Government of Hong Kong for an expert to advise on the preparation of a road plan for the urban areas of the city to meet social and economic needs of the community there, arrangements were made for the Head of the Traffic and Economics Section of the Laboratory to visit the Colony during June 1958.

16. A review was made of the administration of roads and traffic, particularly the work of the Public Works Department and the Police. Certain planning proposals for roads were examined and comments made on them. Suggestions were put forward for setting up an organisation to obtain traffic data, etc., required for preparing a comprehensive plan for the urban roads. Traffic conditions in the central area of Victoria were studied and a small pilot-scale origin and destination survey was made in this area with the help of the Police and Department of Public Works. Statistical information was obtained about accidents and suggestions put forward for improving road safety. Consideration was also given to public transport and certain recommendations regarding this were also put forward. A detailed report on the visit is contained in Paper CRR. 64.†

17. The most urgent road traffic problem of Lagos is the congestion around the crossing from Lagos Island to the mainland. After the visit in November 1957 a preliminary report (CRR. 49) was prepared embodying tentative recommendations and plans were made for a more detailed investigation. This investigation was carried out in April in close collaboration with

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\* Refers to items in the current research programme (Paper CRR. 75).

† The Hong Kong Government has agreed to the general release of this report. Copies of the report are available from the Director of Road Research, Road Research Laboratory, Harmondsworth, Middlesex, price £2 4s. 6d. each. A limited number of copies is available for short term loan without charge.

the Public Works Department, the Lagos Executive Development Board, the Lagos Police and other local bodies.

18. An origin and destination survey of traffic crossing Carter Bridge between 7 a.m. and 7 p.m. on weekdays was carried out for two weeks to supply information on the movements of private cars, commercial vehicles, pedal cyclists and pedestrians. This was supplemented by a similar survey lasting for a further week on the mainland. In addition a journey time survey gave information about traffic conditions on a network of the more important streets and approach roads. Some observations of traffic flows, pedestrian behaviour and saturation flow at traffic signals were also obtained. At the conclusion of the survey all the data were brought back to the Road Research Laboratory for analysis. The preliminary reduction of the field data is complete and a start has been made on the assessment of the effect of various measures on the traffic as a whole.

*Accident reporting (Item D)*

19. A review of methods of reporting road accidents in the different overseas territories has been prepared (Paper CRR. 57). This was discussed at the Round Table Conference on Overseas Highway Problems in June when the Deputy Inspector General of Colonial Police offered to co-operate in helping Overseas Police Forces to revise their accident reporting systems in line with the suggestions contained in the review. Subsequently, in meetings with the Inspector General and his deputies, the list of items considered for inclusion in accident report forms has been reviewed, and the revised list has been circulated to Overseas Governments and Police Forces (CRR. 68). It is hoped that all will have opportunity to examine how it can be applied to their local conditions before the middle of 1960 when it is proposed to have a meeting of all organisations concerned to consider what can be done towards adopting uniform standards of reporting.

*Roadmaking Materials (Item E)*

20. An investigation of the properties of twelve Kenya soils has been completed and a report prepared (CRR. 72). The soils comprised red clays, sandy clays, gravel-sand-clays and gravels.

21. At the request of the Ministry of Works, Kenya, tests were made to compare the strengths obtained when using Portland cement and hydrated lime to stabilize a sample of red clay, probably of volcanic origin, from Nyeri. The results confirmed those obtained by the Ministry of Works, and suggested that hydrated lime was a better stabilizing agent for this soil than Portland cement.

22. A laboratory investigation has been completed of the stabilization of five gravels from Uganda, with both Portland cement and hydrated lime and a report has been prepared (Paper CRR. 66). It was found that 4 per cent of Portland cement was more effective than a similar proportion of hydrated lime, the strengths of the lime-bound gravels only approaching after six months the strengths of the cement-bound gravels after one week. The strengths of both the cement and lime stabilized gravels were reduced only to a small extent by immersion in water.

23. A laboratory investigation has been completed of the properties of five soils from Uganda, and a report has been prepared (CRR. 70). Two of the soils were red clays, apparently of residual origin, one was a decomposed quartzitic gravel similar to those already tested at the Laboratory, and the remaining two were silty sands, one containing a high proportion of mica.

24. A laboratory investigation of two gravel-sand-clays from Ghana comprised a study of their properties and of their suitability for stabilization with Portland cement; a report has been prepared (CRR. 71). One of the gravel-sand-clays was not stabilized with Portland cement as readily as the other, and it appears that this was due to its higher organic matter content.

25. The crushing strength of the coarse particles contained in tropical gravels is being investigated. Use is being made of a new test, called the 10 per cent fines aggregate crushing test, that has been developed at the Laboratory for measuring the strength of weak aggregates. Selected tropical gravels have been tested and the results obtained showed that provided the gravel was not excessively weak (easily broken with the fingers) the "ten per cent fines test" could be successfully applied. A report is being prepared.

26. Thin sections of tropical gravels are being prepared using a technique developed at the Building Research Station. The characteristics of the gravels revealed by microscopic examination of the thin sections are to be related to their crushing strengths. It is also hoped to obtain from this study information about the way in which the gravels are formed in nature, which in turn may point to geomorphological methods of locating gravel deposits. A stereoscopic microscope has been purchased and this will greatly assist in obtaining any correlation between the physical properties of tropical gravels and their mineral constituents. Difficulties in the preparation of thin section slides for some of the tropical gravels have now been overcome and at present over one hundred slides have been prepared.

27. A study of the results of laboratory tests made by the Roads Department in Northern Rhodesia, and of other information, has suggested that tropical gravels can be broadly placed in three main groups, viz.: (i) slightly decomposed rocks, (ii) quartz gravels and (iii) nodular lateritic gravels. The extent of chemical decomposition, and the clay content increase in the order given, and there is some evidence that the sequence is associated with increasing rainfall. The nodular lateritic gravels can be stabilised satisfactorily in the field with a 4 per cent. addition of hydrated lime, and it seems probable that smaller proportions are satisfactory with the other two groups, owing to the lower content of fines.

28. A laboratory investigation of the suitability for stabilisation with Portland cement of the soils occurring in Ghana was carried out by the Central Roads Laboratory, Ghana, 1955-56. The results showed that soils from the tropical forest belt required a higher proportion of Portland cement for satisfactory stabilisation than soils from the rest of the country and it was thought that the cause was possibly the higher organic matter contents of these soils. To investigate this possibility, a detailed laboratory study is being carried out to determine the relation between the strength of the

cement-stabilised soils and the organic matter content, using a range of samples of gravels, sands and clays sent for this purpose by the Public Works Department of Ghana.

29. A laboratory investigation of three soils (one lateritic gravel and two sandy silts) from Sierra Leone is at present being carried out. The investigation will comprise classification, chemical, compaction and strength characteristics of the soils and their suitability for stabilisation with Portland cement and hydrated lime.

30. An Overseas Bulletin is being drafted on tropical gravels and their use in roadmaking.

*Pavement design and soil moisture movement (Item F)*

31. The analysis of data about the moisture content of soils from airfields in tropical and sub-tropical areas, collected by the Air Ministry, has been continued and is now almost complete.

32. During the period under review the data collected during 1953–55 from the experimental site at Habbaniya airfield, Iraq, have been analysed. This airfield is situated in the Mesopotamian valley drained by the rivers Euphrates and Tigris. The rainfall is scanty (less than 6 in. annually) but a water-table is maintained by the nearby Euphrates at a depth varying between 4 ft. 6 in. and 9 ft. below the surface according to season. The subgrade to a depth of 10 ft. is a silty clay. The measured moisture distribution was compared with that calculated from the suction properties of the soil and the position of the water-table. The agreement was close for the deeper water-table conditions but the predicted moisture contents were low compared with those measured at depths of 4–5 ft. when the water-table rose to within this region. This was probably due to compaction of the soil specimens during sampling. These results provide further evidence that the theoretical method may be applied at sites where there is a well-defined water-table within 10 ft. or so of the surface. Although large variations in temperature took place at Habbaniya it appeared that vapour movements made no significant contribution to any moisture changes in the subgrade. A report is to be issued shortly.

33. Vapour movements may however be important under certain conditions. Reference was made in the third Annual Report of the Committee to the increase in moisture under the pavement at Heany and Kumalo airfields, Southern Rhodesia, at a time when rain had almost ceased. During May and June, Mr. Russam visited Southern Rhodesia to carry out detailed measurements of soil moisture content and soil temperatures at these two sites. The results are now analysed and it appears that moisture migration in the vapour phases due to a temperature gradient is the likely cause of the wetting process. This is of interest as being the first instance of such phenomena to be measured in the field by the Road Research Laboratory. A report has been prepared for publication.

34. Not all of the airfields included in the studies were situated in Commonwealth territories and the conclusions which can be drawn from the results should apply over wide areas overseas. A full list of the airfields giving the location and soil type is given in Table I below.

TABLE I  
*Experimental sites on airfields*

Name of airfield	Location	Subgrade soil type
Khormaksar ...	The seashore of the Gulf of Aden near the Port of Aden ...	Sand
Kabrit ...	At the junction of the Little and Great Bitter Lakes in the Suez Canal Zone of Egypt ...	Sand
Kai Tak ...	The low-lying coastal region of Hong Kong ...	Clayey-sand
Tengah ...	The low-lying coastal region near Singapore ...	Silt and clay
Habbaniya...	The western Mesopotamian valley near Lake Habbaniya and the river Euphrates ...	Silty clay
Thornhill ...	Near the town of Gwelo on the high plateau of Southern Rhodesia ...	Sandy clay
Heany and Kumalo	Near the city of Bulawayo on the high plateau of Southern Rhodesia ...	Silty clay
Khartoum ...	In the Sudan close to the river Nile ...	Clayey-sand
Abu Sueir ...	The Suez Canal Zone of Egypt near Ismailia ...	Sand

35. The information will provide engineers with a useful guide to soil moisture conditions overseas and will provide a framework on which other studies, such as that now in progress in Kenya, can be based. A complete account of the airfield investigation is now being prepared for publication.

36. The field investigation to study moisture conditions under roads in Kenya was begun in March. This investigation is being undertaken in co-operation with the Ministry of Works and the Road Authority, Kenya. A team of three men from the Road Research Laboratory with three African assistants are measuring the conditions under a number of roads at monthly intervals; the measurements will extend for a period of approximately 15 months to embrace rainy seasons at the beginning and at the end. Sites have been selected which traverse typical local soils and measurements are being made in a variety of different conditions on cutting, embankment and level ground. Notes are given below of the sites and the conditions which are being examined.

TABLE II  
*Experimental sites on roads in Kenya*

Site No.	Location	Soil type	Sub-site conditions
(1)	Limuru "A" Route ...	Red clay ("Red coffee soil").	(a) Embankment (b) Cutting (c) Level ground
(2)	Thika-Sagana Road... ..	Red clay ("Red coffee soil").	(a) Level ground (b) Cutting (c) Embankment
(3)	Nairobi-Mombasa (Mile 12 from Nairobi).	Black clay ("Black cotton soil").	(a) Level ground (b) Level ground
(4)	Nairobi-Mombasa (Mile 27 from Nairobi).	Black sandy clay ... ..	(a) Embankment (b) Embankment
(5)	Nairobi-Nakuru (Mile 50½ from Nairobi).	Volcanic ash ... ..	(a) Level ground
(6)	Nakuru-Eldoret (Mile 8 from Nakuru).	Volcanic ash ... ..	(a) Level ground
(7)*	Ngong Road near Dagoretti Corner.	Black clay ("Black cotton soil").	(a) Level ground

\* Investigations on this site began in September, 1958.



37. At each site records are being made each month of the moisture conditions in the road structure and in the soil below the road. Measurements are also being made of the physical properties of the soils, and of their density and the C.B.R. values. A progress report covering the first six months of the investigation has been prepared. The interim conclusions which can be drawn to date confirm that with the flush verges, normal on roads overseas, run-off from the road surface has a considerable influence on moisture conditions near the edge of the road. At the end of the rainy season, the soils tend to be wetter under the edge of the road than under the centre.

38. A co-operative experiment is being planned with the Central Road Laboratory, Southern Rhodesia. This experiment is designed to investigate possible infiltration of water at the edges and through the road pavement and also the effect of surface run-off on the general moisture conditions.

*The control of roadside vegetation (Item H)*

39. Following a recommendation from the Round Table Conference on Overseas Highway Problems, information is being sought from overseas territories regarding the role of adjacent vegetation in road behaviour. It has emerged that certain types of vegetation are desirable on haunches and steep slopes to counter abrasion and erosion, while others are undesirable because of disruptive effects on bituminous pavements or because the tall growth obscures vision. The botanical species most commonly involved are now being identified from the replies to a questionnaire. Information from 41 sources has now been received. It is already clear that a considerable amount of experimental work is already being undertaken by Governmental and other interested organisations, and it will be useful to analyse critically the results of these experiments for their application to roadside maintenance. When this work has been completed it is proposed to consult with the industrial interests concerned to determine the form further field experiments could usefully take.

**IV. Work carried out as part of the programme of the Road Research Board which is of particular interest overseas**

40. Much of the work carried out at the Road Research Laboratory is of direct interest overseas. Selected Research Notes are circulated, as soon as they are issued, to Overseas Governments, Public Works Departments and Police Forces. A list of the Research Notes circulated during the past year is given in Appendix 1. Brief notes on some of these are given below.

*Traffic flow at roundabouts*

41. In some territories, notably in Central and East Africa, it is the custom or the rule that drivers should give way to traffic approaching from the right. Under certain conditions this appears to restrict the use which can be made of the traffic circulatory system. A series of observations has been started of the behaviour of drivers at roundabouts in Great Britain (Research Note RN/3122). Similar observations where the "give way to traffic coming from the right" rule is observed would give a measure of the effect of this rule on the traffic carrying capacity of roundabouts.

*The effects of road conditions on vehicle running costs*

42. Reports have been issued describing tests of fuel consumption on lorries on a trunk road and of fuel consumption and journey times in Greater

London. (Research Notes RN/3270 and 3272.) These illustrate some of the techniques available for examining the effects of varying road conditions overseas on the cost of operating vehicles.

#### *Soil stabilisation*

43. In the tropics there are difficulties in compacting soil cement due to the relatively rapid hydration of the cement and in hot dry climates due to the evaporation of water. An investigation has been made in the Laboratory of the effects of elapsed time after mixing on the compaction and strength of soil cement (Research Note RN/3125).

44. For field control, rapid methods of determining the cement content of soil cement are needed. The possibilities of using a flame-photometer method have been examined (Research Note RN/3205). The method is sufficiently accurate and is quite suitable for use in field laboratories.

#### *Compaction*

45. Investigations have continued of the performance of different types of compaction equipment on a range of soils and two further reports have been issued (Research Notes RN/3206 and 3219).

#### *Consolidation of Peat*

46. Model scale loading tests have been carried out to determine the effectiveness of vertical sand drains in accelerating the compression of peat under load and in reducing the excess pore water pressures set up during loading. (Research Note No. RN/3380.) The main conclusions are that the vertical sand drains did not affect the rate of compression of the peat, but that they did reduce the maximum excess pore water pressure to about one third of the value which occurred when none was used.

### **V. Meetings**

47. During the Conference on Civil Engineering Problems Overseas, which was held at the Institution of Civil Engineers in June, one morning was devoted to the construction of roads, particularly with soil stabilisation. Mr. Williams contributed a paper and Dr. Millard acted as General Reporter.

48. This conference was followed by the Round Table Conference on Overseas Highway Problems under the chairmanship of Dr. Glanville assisted by Sir Hubert Walker. A report of the conference has been published by the Institution of Civil Engineers. Amongst the items discussed was the report on Low Cost Roads prepared for the XIth meeting of the Permanent International Association of Road Congresses.

49. The Scientific Council for Africa south of the Sahara held its first conference of road specialists in Lourenço Marques, Mozambique in August. Dr. Millard was one of the four invited specialists, the others being Dr. Rigden of South Africa, M. van Heule of the Belgian Congo and M. Ferreira Mendes of Portugal. Observers were present from almost all the African territories, including Ghana, Nigeria, Uganda, Kenya, Tanganyika, Southern Rhodesia and Nyasaland. There were useful discussions on problems of road economics, methods of construction and maintenance and on mechanisation. At the conclusion of the conference a series of recommendations was framed concerning the improvement of technical co-operation between

African territories in matters concerning roads and road transport. These recommendations are being submitted to member governments for consideration. Copies have been circulated to the Committee (Paper CRR.67).

#### VI. Information services

50. During the period two further Overseas Bulletins have been issued,

Overseas Bulletin No. 8.—Notes on the cement treatment of Ghana soils. April, 1958.

Overseas Bulletin No. 9.—Lime stabilization of soils for use as road foundations in Northern Rhodesia. June, 1958.

The demand for these Overseas Bulletins is growing steadily; during the past year the circulation has increased to 490.

51. The Laboratory has continued to receive many technical enquiries concerning overseas road problems, and has received an increasing number of visitors who were concerned with roads and road transport overseas. Amongst these they were glad to welcome Chief the Hon. A. Ogedengbe, Minister of Works and Transport for the Western Region of Nigeria and the Hon. G. U. Ohikere, Minister of Works for the Northern Region of Nigeria.

52. The Section has continued to circulate to Overseas Governments, Public Works Departments and Police Forces copies of Research Notes of interest. A list of the notes circulated in the period under review is given in Appendix 1.

#### VII. Staff and accommodation

53. The numbers of staff in the Section during the period under review are shown below in Table III.

TABLE III

	Staff at 1st April, 1958	Losses during the year	Recruited during the year	Staff at 31st March, 1959	Authorised Complement at 31st March, 1959
Scientific Officers ...	8	2	2	8	13
Experimental Officers...	9	Nil	1	10	15
Assistants Scientific ...	Nil	Nil	1	1	5

54. Mr. N. D. S. Smith, economist, resigned his post in August; the post has been filled by Mr. R. S. P. Bonney who joined the staff in January. The Section continues to share with the whole Laboratory difficulty in recruiting staff, particularly engineers and physicists.

55. During the period an officer from the Western Region of Nigeria completed a period of 4 months training in the Laboratory, and he has returned to take charge of the Materials Laboratory in the Regional Ministry of Works and Transport. The Section also received a vacation student from Ghana who helped in the laboratory investigations of soils from Africa.

56. By arrangement with the Colonial Office, Mr. J. O. Tresidder, the leader of the group concerned with Overseas road traffic and safety matters

has been sent to the Institute of Transportation and Traffic Engineering, Berkeley, California, for a 9 months course in Traffic Engineering.

57. Negotiations still continue to establish the pool of Materials (Research) Engineers. At present the whole of the arrangements for research on overseas problems is under review and the proposed pool is being considered as part of the general issue.

58. The new accommodation for the Section has now been completed and was occupied in October. This accommodation was designed and planned for a very much smaller staff than that at present authorised for the Section ; extensions to the buildings are now urgently required.

### Publications

WILLIAMS, F. H. P. Soil Stabilization. A general review of experience overseas. *Conference on Civil Engineering Problems Overseas, London, 1958* (Institution of Civil Engineers) pp. 21-30, discussion, 108-30.

MILLARD, R. S. et al. Low Cost Roads. *P.I.A.R.C. XIth Congress Rio de Janeiro, 1959*. Sect. 1. Design, Construction and Maintenance of Roads and Runways. Question 4.

MILLARD, R. S. Road engineering in the tropics. The work of the Colonial Section of the British Road Research Laboratory. *Rd. Internat.*, 1958 (30), 25-31.

MILLARD, R. S. Road development in the overseas territories. *J. Roy. Soc. Arts*, 1959, 107 (5032), 270-88, Discussion 289-91.

RUSSAM, K. An investigation into the soil moisture conditions in Trinidad, B.W.I. *Geotechnique*, June, 1958. London (Institution of Civil Engineers).

WILLIAMS, F. H. P. Soil stabilization overseas, methods and machinery for varying conditions. *International Civil Eng. and Contractor*, 1958, 10 (6), 23-27.

**LIST OF RESEARCH NOTES WHICH HAVE BEEN CIRCULATED TO  
THE OVERSEAS TERRITORIES BETWEEN 1ST APRIL, 1958, AND  
31ST MARCH, 1959**

**Traffic engineering, road safety and road economics**

<i>RN. No.</i>	<i>CRR. No.</i>	<i>Title</i>
3122	—	Driver behaviour at roundabouts. (1) Western Circus, East Acton.
3230	—	An apparatus for measuring, classifying and counting the wheel loads of moving vehicles.
3242	—	The design of advance road direction signs. (A progress report).
3246	57	A review of methods of accident reporting in use in British Overseas Territories.
3270	—	The effect of road conditions on vehicle running costs. Tests of fuel consumption on lorries between London and Nuneaton. (A.5.)
3272	—	The effect of road conditions on vehicle running costs : fuel consumption and journey time tests in Greater London.
3290	—	Apparatus for testing protective helmets.
3334	68	Methods of reporting accidents in British Overseas Territories. Part II. Items suggested for inclusion in road accident report sheets.

**Road materials and methods of construction**

<i>RN. No.</i>	<i>CRR. No.</i>	<i>Title</i>
3014	31	Notes on a visit to the Caribbean area.
3125	—	A laboratory investigation into the effect of elapsed time after mixing on the compaction and strength of soil cement.
3205	—	Use of the flame photometer method to determine the cement content of cement-stabilized soil for field control work.
3206	—	Investigation of the performance of pneumatic-tyred rollers in the compaction of soil.
3219	—	An investigation of the performance of a 3½-ton vibrating roller for compacting soil.
3226	50	The movement and distribution of moisture in soils at overseas airfields. V. Heany, Thornhill and Kumalo airfields, Southern Rhodesia.
3231	56	Notes on a visit to South and Central Africa, September–October, 1957.

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328		COLONIAL RESEARCH 1958-59
3235	53	A laboratory study of the properties and suitability for stabilization with Portland cement and hydrated lime of a red clay soil from Kenya.
3249	60	The movement and distribution of moisture in soils at overseas airfields. IV. Khartoum airfield, Sudan.
3250	55	An investigation of the stabilization with hydrated lime of six Northern Rhodesian soils.
3280	—	An investigation of the performance of a prototype dropping weight soil capacitor.
3284	—	A study of the pedological classification of soils in relation to soil-cement stabilization.
3288	—	A laboratory investigation into some of the factors affecting the strength of soil-cement.
3310	—	Laboratory method for the determination of the cement or lime content of cement or lime stabilized soil.
3326	65	Notes on oiling gravel roads.
3327	66	A laboratory investigation of the stabilization of five tropical gravels from Uganda using Portland cement or hydrated lime.
3328	—	The bump integrator : its operation and maintenance.

Colonial  
Social Science Research Council  
Fifteenth Annual Report  
(1958-1959)

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London School of Economics  
and Political Science,  
Houghton Street,  
Aldwych,  
London, W.C.2.

26th November, 1959.

SIR,

I have the honour, on behalf of the Colonial Social Science Research Council, to transmit to you the Fifteenth Report of the Council, covering the period from 1st April, 1958 to 31st March, 1959.

I have the honour to be,

Sir,

Your obedient Servant,

ARNOLD PLANT,  
*Chairman.*

The Right Honourable Iain Macleod, M.P.,  
Secretary of State for the Colonies.

## COLONIAL SOCIAL SCIENCE RESEARCH COUNCIL

## FIFTEENTH 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., Vice-Principal of Newnham College, University of Cambridge.
- PROFESSOR K. E. ROBINSON, M.A., Director of the Institute of Commonwealth Studies, London.
- PROFESSOR I. SCHAPERA, M.A., D.Sc., F.R.S.S.Af., F.B.A., Professor of Social Anthropology, London School of Economics and Political Science.
- PROFESSOR R. W. STEEL, B.Sc., M.A., Rankin Professor of Geography, University of Liverpool.
- PROFESSOR SIR RALPH TURNER, M.C., M.A., Litt.D., F.B.A., formerly Director of the School of Oriental and African Studies, University of London.
- MR. A. J. PECKHAM (*Secretary*).

**Terms of Reference**

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



## COLONIAL SOCIAL SCIENCE RESEARCH COUNCIL

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## APPENDICES—Reports from the Regional Institutes:

- I.—The East African Institute of Social Research.
- II.—The Nigerian Institute of Social and Economic Research.
- III.—The Institute of Social and Economic Research, University College of the West Indies.
- IV.—The Rhodes-Livingstone Institute.

## COLONIAL SOCIAL SCIENCE RESEARCH COUNCIL

### FIFTEENTH ANNUAL REPORT

#### I. INTRODUCTION

The Council held two meetings during the year 1st April, 1958, to 31st March, 1959. There were three Committee meetings.

2. Professor Kenneth Robinson acted as Chairman of the History and Administration Committee during Professor Harlow's absence during the second half of the year and joined the Council in December, 1958.

3. C.C.T.A. held the first meeting of its Inter-African Committee on Linguistics in Brussels in June, 1958. The United Kingdom representative, Professor Guthrie of the School of Oriental and African Studies, was invited to become Chairman.

#### II. GENERAL

4. The issue of funds from the Social Sciences allocation during the four years ending March, 1959, totalled £373,675. A new grant of £5,075 was made to the East African Institute of Social Research for research on family welfare and educational wastage in Uganda. Other grants include £1,924 for a socio-economic study of Fiji and £1,143 for a sociological study of the New Hebrides.

5. The drafts of a number of the chapters of Volume I of the Regional History of East Africa were received from contributors during the year and work is proceeding on Volume II.

6. A second progress report on the Benin History, which is being jointly financed from Colonial Development and Welfare funds and from funds provided by the Carnegie Corporation and the Government of the Federation of Nigeria, was received from Professor Dike, Head of the Department of History, University College, Ibadan. Research in Benin continued under the supervision of Dr. R. E. Bradbury. Dr. P. J. Dark has continued his study of Benin art and Dr. A. F. C. Ryder has examined European sources for documentary material. A meeting of Research Fellows in the spring of 1959 discussed the writing-up of material already collected.

7. The Council held a further open competition for research grants during the year. A Selection Board, under the chairmanship of Mr. H. V. Hodson, considered applications from fifteen candidates and recommended grants of awards in two cases.

8. A number of Ford Foundation Fellows passed through London during the year on their way to undertake research in Africa and were in touch with the Secretary and various members of the Council.

#### III. REGIONAL INSTITUTES OF SOCIAL AND ECONOMIC RESEARCH

9. The reports of the regional Institutes will be found in Appendices I-IV.

10. At the Nigerian Institute of Social and Economic Research, Dr. M. G. Smith, Senior Research Fellow from the West Indies Institute of Social and

Economic Research, undertook a study of the change in the nature of government in certain Northern States of Nigeria. Preparatory work has started on a social and economic history of the Cameroons and a marriage stability survey in the Southern Cameroons is nearing completion. A conference of research workers, the sixth in the WAISER/NISER series, was held in December.

11. Research carried out by the East African Institute of Social Research included studies of Arab kinship and marriage and of relations between different tribal and cultural groups in two coastal villages. The first of the International African Seminars, which are being organised by the International African Institute with the support of the Ford Foundation, was held at Makerere in January, 1959.

12. The Rhodes-Livingstone Institute continued its programme of research. The Inter-University Council for Higher Education Overseas has undertaken to help in the recruitment of staff.

13. Work continues at the West Indies Institute of Social and Economic Research on sociological studies of various West Indian territories.

#### **IV. RESEARCH IN THE COLONIAL TERRITORIES FINANCED INDEPENDENTLY OF COLONIAL DEVELOPMENT AND WELFARE FUNDS**

14. *Sierra Leone*: A team of research workers from the University of Edinburgh, under the direction of Dr. Kenneth Little, visited Sierra Leone to undertake a study of urbanisation.

15. *Nigeria*: The Nigerian Institute of Social and Economic Research has undertaken a study of listener research on behalf of the Nigerian Broadcasting Corporation.

16. *Sarawak*: Work has proceeded on an ethnological and folklore survey financed by the Sarawak Government. A linguistic and ethnological study of links between the Visaya (Philippine) and Bisaya (Sarawak), once peoples of central Borneo, is being undertaken by the Sarawak Museum.

17. *Hong Kong*: A comprehensive programme of historical, social and linguistic research is being pursued at the University of Hong Kong.

18. *Northern Rhodesia*: As in previous years, the Rhodes-Livingstone Museum continued its work on the traditional material culture of the indigenous peoples of the territory and neighbouring Bantu and Bushmen groups and a beginning has been made with the construction of a model native village. Museum staff have also collaborated in the collection of the music of Valley Tonga who inhabit the area which is to be flooded by the Kariba Lake.

#### **V. COLONIAL DEVELOPMENT AND WELFARE PROJECTS IN PROGRESS**

##### **Projects Undertaken by the International African Institute**

19. *Handbook of African Languages*. The final volume, *Bantu Languages of Africa*, compiled by M. A. Bryan, is expected to be published by the end of 1959. The special study of certain of the languages of North-eastern Africa, by A. N. Tucker and M. A. Bryan, is nearing completion.

20. *Linguistic Survey of the Northern Bantu Borderland*. The manuscript of the final volume of the series has now been completed.

21. *Ethnographic Survey of Africa*. A volume on East and Central Africa, *The Gisu of Uganda*, by J. F. La Fontaine, was published in March, 1959.

#### Other African Projects

22. *Publication of Lord Lugard's Diaries*. Miss Perham continued work on the final volume of the diaries.

23. *Study of the Mbembe of Southern Nigeria*. Miss Rosemary Harris made a second visit to Nigeria in June-December, 1958.

24. *Study of Land Tenure and Land Usage in Swaziland*. Mr. A. J. B. Hughes continued work under the University of Natal project. Additional C.D. and W. funds have been made available for travelling and other expenses.

25. *Study of a Bamenda Chiefdom in the Cameroons*. Dr. Phyllis Kaberry returned from the Cameroons in September, 1958, and submitted a report to the Leverhulme Trustees.

26. *Study of the Somali Tribes*. Mr. I. M. Lewis has reproduced his material in book form and hopes shortly to arrange for publication.

27. *Election Studies*. Mr. T. E. Smith has visited a number of African territories and is writing up his material.

28. *Study of Land Tenure in Zanzibar*. Dr. J. F. M. Middleton, of University College, London, returned from field study in Zanzibar and Bemba and is engaged in writing his report.

29. *Study of the Samburu Tribe in Kenya*. After some months studying the Samburu, Mr. Paul Spencer of Wadham College, Oxford, has extended his study to the neighbouring Rendile, who are closely connected to the Samburu. A supplementary grant was made for this purpose.

30. *Linguistic Study of the Gwembe*. A C.D. and W. grant has been made to Mrs. J. H. Carter, whose husband is serving in Northern Rhodesia, to enable her to undertake a study of the Tonga dialects of the We and neighbouring peoples of the Gwembe area of the Zambesi Valley. Unfortunately the commencement of the study was delayed by disturbances in the area but a start was made towards the end of the year under review.

31. *The Ahmadiya Movement in West Africa*. Mr. H. J. Fisher, a successful candidate in the previous year's field grants competition, commenced his study of the Ahmadiya Movement in West Africa.

32. *Christian Missions in Northern Rhodesia*. Mr. Robert Rotberg, a United States Rhodes Scholar, visited Northern Rhodesia in December with a grant from Colonial Development and Welfare funds to investigate the influence of Christian Missions on the development of the territory.

#### Other Projects

33. *History of Aden*. Mr. R. J. Gavin, to whom a grant was made last year for the preparation of a History of Aden, visited Aden in December and submitted a preliminary report on the material available.

34. *Study of the Amerindians of British Guiana*. Dr. Audrey Butt of the Pitt Rivers Museum has published several articles on her research, and is preparing a book on Carib religion.

35. *Socio-economic Study, Fiji*. Professor O. H. K. Spate, of the Australian National University, undertook a socio-economic study of Fiji during the year.

36. *Study of the Indo-Mauritian Social Structure*. Dr. Burton Benedict has completed his field work and is writing up his report.

37. *Socio-economic Study, New Hebrides*. Mr. M. R. Allen, of the Australian National University, was appointed in October to undertake a study of the social structure of the island of Aoba in the New Hebrides.

38. *History of British Honduras*. A small grant was made to Miss N. Leon to assist in the writing of a history of British Honduras.

39. *Development of Trade Unionism in the Colonies*. Mr. Warmington, a Research Officer at the London School of Economics, is undertaking a study of the development of trade unionism in the Colonies with the assistance of Colonial Development and Welfare funds.

## VI. THE STANDING COMMITTEES OF THE COUNCIL

40. The present composition of the Standing Committees is as follows:—

### *Committee on Anthropology and Sociology*

Professor I. Schapera, F.B.A., 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.

Professor P. E. Vernon, University of London Institute of Education.

### *Committee on History and Administration*

Professor Vincent Harlow, C.M.G., University of Oxford (*Chairman*).

Mrs. E. M. Chilver, Director of the Institute of Commonwealth Studies, Oxford.

Professor G. S. Graham, University of London.

H. V. Hodson, Esq., Editor of "The Sunday Times."

Professor W. J. M. Mackenzie, The Victoria University, Manchester.

Miss Lucy Mair, University of London.

Miss Eveline C. Martin, University of London.

F. J. Pedler, Esq., United Africa Company.

Miss Margery Perham, C.B.E., University of Oxford.

Professor C. H. Phillips, University of London.

Professor K. E. Robinson, University of London.

R. E. Robinson, Esq., University of Cambridge.

### *Linguistics Committee*

Professor Sir Ralph Turner, M.C., F.B.A., University of London (*Chairman*).

Professor J. R. Firth, O.B.E., University of London.

Professor M. Guthrie, University of London.

### *Secretary of the Standing Committees*

Miss J. M. Catchpole, Research Department, Colonial Office.

## VII. PUBLICATIONS BY WORKERS ASSISTED FROM COLONIAL DEVELOPMENT AND WELFARE FUNDS

41. 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 Fourteenth Annual Report) are:—

Abraham, R. C.—“Dictionary of Modern Yoruba.” Hodder & Stoughton, 1958.

Abrahams, R. G.—“Kahama Town”: paper for the International African Seminar. January, 1959.

“Some Aspects of Nyamwezi Witch Belief”: Roneoed EAISR Conference paper. June, 1958.

Acquah, I.—“Accra Survey.” U.L.P. 1958.

Ardener, E. W.—“The Kamerun Idea.” *West Africa*, Nos. 2147 and 2148, June, 1958.

The sections: “Victoria in its setting,” “The Administrative Division,” “The Indigenous People and Their Origin,” “Society before the Impact of the West,” “The Indigenous Economy,” “The Melting-Pot of the Cameroons” in *Victorian Southern Cameroons, 1858-1958*, pp. 1-3, 10-16, 52-54, 93-95.

“The People” in *Introducing the Southern Cameroons*, pp. 17-21. Federal Information Service, Lagos, 1958.

“The Bakweri Elephant Dance,” *Nigeria*. No. 60, 1959.

Ardener, E. W., with Shirley Ardener.—“Wovea Islanders.” *Nigeria*. No. 59, 1958.

Benedict, Burton.—“Cash and Credit in Mauritius.” *The South African Journal of Economics*, Vol. 26, No. 3. September, 1958.

“Education without Opportunity: Education, Economics and Communalism in Mauritius.” *Human Relations*, Vol. XI, No. 4, November, 1958.

Butt, Audrey J.—“Secondary Urn Burial among the Akawaio of British Guiana” (*Timehri: Journal of the Royal Agricultural and Commercial Society of British Guiana*. September, 1958). To be published in *Man*.

Goody, J. R.—“Ethnohistory and the Akan of Ghana.” *Africa*. January, 1959. Vol. XXIX, No. 1.

Gutkind, P. C. W.—“Problems of African Urban Family Life: An Example from Kampala, Uganda.” *Familles alors de Monde*. Vol. XI, No. 3, September, 1958 (Summary only).

“Review of Social Implications of Industrialization and Urbanization in Africa South of the Sahara.” *Bulletin of Inter-African Labour Institute*. Vol. V, No. 2. March, 1958.

“Congestion and Overcrowding. An African Urban Problem.” Paper prepared for the C.C.T.A. Conference on Housing held in Nairobi, January, 1959.

La Fontaine, J. S.—“The Gisu of Uganda: Ethnographic Survey of Africa,” International African Institute, 1959.

- Lewis, I. M.—“Modern Political Movements in Somaliland, Part I.” *Africa*, July, 1958, pp. 244–261.
- “Modern Political Movements in Somaliland, Part II.” *Africa*, October, 1958, pp. 344–363.
- “The Godhardunneh cave decorations of North-East Somaliland.” *Man*. November, 1958, pp. 178–79.
- “The Names of God in Northern Somali,” *Bulletin of the School of Oriental and African Studies*, 1959, Vol. XXII, pp. 134–40.
- Lewis, I. M., with Dr. K. L. G. Goldsmith.—“A Preliminary Investigation of the Blood Groups of the *sab* bondsmen of Northern Somaliland.” *Man*. December, 1958, pp. 188–190.
- Lienhardt, Dr. P. A.—“Family WAQF in Zanzibar.” Roneoed Conference Paper, June, 1958.
- Middleton, J. F. M., with D. Tait.—“The Political System of the Lugbara of the Nile–Congo Divide.” *Tribes without Rulers: Studies in African Segmentary Systems*. Routledge and Kegan Paul, 1958.
- “Social Change in Northern Uganda.” *Contemporary Review* No. 1112. August, 1958.
- Morris, H. S.—“The Plural Society.” *Man*. August, 1957.
- “The Divine Kingship of the Aga Khan.” *Southwestern Journal of Anthropology*. No. 4. 1958.
- “The Indian Family in Uganda.” *The American Anthropologist*.
- Richards, A. I.—“East African Chiefs—A Study of Political Development in Some Uganda and Tanganyika Tribes.” Faber & Faber, 1959.
- Ruel, Dr. M. J.—“Kuria Generation Sets.” Roneoed Conference Paper, January, 1958.
- “Piercing.” Roneoed Conference Paper, June, 1958.
- Scott, D. J. R.—“Problems of West African Elections” published in *What are the Problems of Parliamentary Government in West Africa?* The Hansard Society for Parliamentary Government, 1958.
- Southall, A. W.—“Oedipus in Alur Folklore:” *Uganda Journal*, September, 1958.
- “A Note on Local Descent Groups.” *Man*. 1958.
- “A Survey of Changes in Urban Family Structure in East and Central Africa:” (Report for Bureau International de Recherche sur les Implications Sociales du Progres Technique), 1958.
- “An Operation Theory of Role.” *Human Relations*, Vol. XII, No. 1. 1959.
- “Kinship, Status and Neighbourhood in Kampala:” Paper for the International African Seminar, January, 1959.
- Stenning, D. J.—“Preliminary Observations on the Baldkwo Movement, Particularly among Bahima in Ankole District:” Conference Paper, January, 1958.
- “Coral Tree Hill:” Conference Paper, June, 1959.
- “Savannah Nomads.” 1959. (O.U.P.)

"Household Viability among the Pastoral Fulani" in "The Developmental Cycle in Domestic Groups" (edited J. Goody). Cambridge University Press. 1958.

Van Velsen, J.—"Some Aspects of Kumam Marriage and Family:" Conference Paper. June, 1958.

"Family, Cash and Cattle among the Kumam." Uganda Society Paper. 1958.

"Labour Migration as a Positive Factor in the Continuity of Tonga Tribal Society." International African Institute Seminar Paper. January, 1959.

Watson, W.—"Tribal Cohesion in a Money Economy." M.U.P. for Rhodes-Livingstone Institute, February, 1959.

"The Effects of Labour Migration." *Bulletin Inter-African Labour Institute*, Vol. VI, No. 1. 1959.

Wijeyewardene, G. E. T.—"A Preliminary Report on Tribal Differentiation and Social Groupings on the Southern Kenya Coast:" Roneoed Conference Paper, June, 1958.

"Administration and Politics in Two Swahili Communities." Roneoed Conference Paper, January, 1959.

#### **Papers to be Published**

Freedman, M.—"The Handling of Money: A Note on the Background to the Economic Sophistication of Overseas Chinese." *Man*. April, 1959.

Lienhardt, P. A.—"The Mosque College of Lamu and its Social Background:" *Tanganyika Notes and Records*, No. 52, June, 1959.

Watson, W.—"New Deal in Central Africa (Chapter on Politics in Northern Rhodesia)" (ed. C. Leys and C. Pratt). Heineman.

Spate, O. H. K.—"The Fijian People: Economic Problems and Prospects." Legislative Council of Fiji Paper.



## APPENDIX I

## EAST AFRICAN INSTITUTE OF SOCIAL RESEARCH

REPORT OF THE CHAIRMAN OF THE EXECUTIVE  
COMMITTEE, 1958-591. *Publications and Papers*

*Land Tenure and Social Change Among the Nyakyusa* by P. H. Gulliver  
East African Studies No. 11.

*A Short Description of Item Categories in Iraqw* by W. H. Whiteley  
East African Linguistic Studies No. 3.

The following papers, read at Institute conferences during the year, have been duplicated and issued to regular subscribers and other applicants for copies:

*Conference June, 1958:*

Some Aspects of Nyamwezi Witch Belief—R. G. Abrahams.

An Experimental Classification of Political Systems—C. H. W. Howe.

Family Waqf in Zanzibar—P. A. Lienhardt.

Piercing—M. J. Ruel.

Coral Tree Hill (A preliminary field report on land tenure in West Ankole District)—D. J. Stenning.

Some Economic Aspects of Kumam Marriage and Family—J. van Velsen.

A Preliminary Report on Tribal Differentiation and Social Groupings on the Southern Kenya Coast—G. Wijeyewardene.

The Hadza: First Impressions—J. C. Woodburn.

*Conference January, 1959:*

The Arms Trade in East Africa in the late Nineteenth Century—R. W. Beachey.

The Attack on the Supreme Court in the U.S.A.—M. Dilley.

Some Social and Economic Implications of Paternalism in Uganda—C. Ehrlich.

Administrative Aspects of the 1958 Uganda Elections—G. F. Engholm.

The Sudanese Troops in Uganda: From Lugard's Enlistment to the Mutiny, 1891-97—O. W. Furley.

Taxation Problems of Federalism—J. D. Nyhart.

Some Preliminary Reactions to Uganda's Development Plans—D. Walker.

Some Aspects of the Administration of the Belgian Congo—P. Whitaker.

Administration and Politics in two Swahili Communities—G. Wijeyewardene.

## Other papers:

R. G. Abrahams: *Kahama Town*, paper for the International African Seminar, January, 1959.

W. Elkan: "Employment of Women", *Inter-African Labour Bulletin*, Vol. III, No. 4.

"East African Trade in Woodcarvings", *Africa*, October, 1958.

"The Marketing of Cotton in Uganda", *Indian Journal of Economics*, March, 1958.

"Criteria for the Development of Industry in Uganda", *East African Economics Review*, January, 1959.

P. C. W. Gutkind: "Problems of African Urban Family Life: An Example from Kampala, Uganda", *Familles dans le Monde*, Vol. XI, No. 3, September, 1958. (Summary only).

Review of "Social Implications of Industrialization and Urbanization in Africa South of the Sahara", *Bulletin of the Inter-African Labour Institute*, Vol. V, No. 2, March, 1958.

*Congestion and Overcrowding: An African Urban Problem*, paper prepared for the C.C.T.A. conference on housing, held in Nairobi, January, 1959.

P. C. W. Gutkind and W. Elkan: *Housing in Jinja*, Ms., E.A.I.S.R. Library.

P. A. Lienhardt: "The Mosque College of Lamu and its Social Background", *Tanganyika Notes and Records*, No. 52, June, 1959.

A. W. Southall: "An Operational Theory of Role", *Human Relations*, Vol. XII, No. 1, 1959.

*Kinship, Status and Neighbourhood in Kampala*, paper for the International African Seminar, January, 1959.

J. van Velsen: *Family, Cash and Cattle among the Kumam*, paper read to the Uganda Society, October, 1958.

*Labour Migration as a Positive Factor in the Continuity of Tonga Tribal Society*, paper for the International African Seminar, January, 1959.

W. H. Whiteley: *Introduction to the Study of Gusii*, East African Literature Bureau, Nairobi, 1956.

2. Staff. At the end of March, 1959:

*Financed by:*

Chairman:

Dr. A. W. Southall, Professor of Sociology  
and Social Anthropology ... .. E.A.I.S.R.

Research Fellows:

Dr. P. A. Lienhardt ... .. E.A.I.S.R.  
Dr. J. van Velsen ... .. E.A.I.S.R.  
Mr. H. W. Ord ... .. E.A.I.S.R.  
Mr. R. G. Abrahams ... .. E.A.I.S.R.  
Mr. G. Wijeyewardene ... .. E.A.I.S.R.  
Mr. J. C. Woodburn ... .. E.A.I.S.R., Goldsmiths' Company  
and Bartle Frere Exhibition.

Administrative Secretary:

Miss G. B. Hunter ... .. E.A.I.S.R.

Publications Secretary:

Miss D. E. Jennett ... .. E.A.I.S.R.

Research Associates:

Mr. L. Gerlach ... .. U.S. Educational Commission  
(Fulbright).  
Mr. C. H. W. Howe ... .. Ford Foundation.  
Mr. J. D. Nyhart ... .. Institute of International Educa-  
tion of New York.  
Mr. J. Pilgrim ... .. Goldsmiths' Company.  
Mr. A. Sommerfelt ... .. Norwegian Research Council and  
E.A.I.S.R.  
Mr. P. Spencer ... .. C.S.S.R.C., British Council and  
William Wyse Studentship.

Dr. Lienhardt has studied Arab kinship and marriage in Zanzibar, Pemba, Lamu, Mombasa, Tanga, Moshi, Bagamoyo, Dar es Salaam and Kilwa. Dr. van Velsen has concentrated on the mixed cash and subsistence economy of the Kumam, the role of cattle, the input of labour and the costs of production in both cash and traditional terms. Mr. Abrahams did intensive work in two Nyamwezi villages, one in Kahama and one in Tabora District. He also did a brief study in Kahama town itself, and wrote a report on the development of the

northern Nyamwezi chiefdoms under traditional, German and British rule. Mr. Wijeyewardene has worked in two coastal villages, one in Kenya and one in Tanganyika, examining the relations between the different tribal and cultural groups involved and the influence of Islam. Mr. Woodburn has followed the life of Hadza hunting bands, spending most of his time on their click language as a preliminary to sociological analysis. Mr. Ord began his study of capital formation in September, working through the relevant economic literature and estimating gross capital formation in fixed assets in East Africa from published trade reports and public accounts.

Mr. M. Perlman was appointed to a Research Fellowship in March for a study of marriage and the family in Uganda, commencing with intensive work in Toro.

Mr. Gerlach started research on the Digo in October, directing his attention to the impact of Swahili culture and Islamic religion on this Coastal Bantu people, and the elucidation of their social organisation, which is both complex and variable. Mr. Howe has collected material for his study of political value-beliefs in Uganda from numerous conversations, documentary analysis, attendance at sessions of Legislative Council and special study of certain tribal areas. He has acquired a general understanding of the political situation and of the diverse points of view held on current issues. Mr. Nyhart began in November his project on the legal and financial relationships between public development corporations and their private partners, making case studies of the way they have dealt with certain specific problems. Mr. Pilgrim started in December on the study of contemporary Kipsigis social organisation in relation to both subsistence and cash agriculture and land tenure. Mr. Sommerfelt has continued work on the Konjo, studying their language, the social and economic effects of growing coffee as a cash crop, their position as a tribal minority in Toro Kingdom and their use of traditional and modern legal institutions. Mr. Spencer has studied the kinship and age organisation of the Samburu in relation to their cattle economy, their nomadic regime and some of their dominant values. He has also collected comparative material on the Ilmolo and Rendile.

### 3. *Departures.*

Mr. Gutkind left on leave in July having completed a manuscript history of administrative policy in the Kibuga or capital of Buganda in relation to problems accompanying development programmes. Mr. Ruel also left on leave in July at the end of his period of field research on the Kuria. He has taken up a post in the Department of Anthropology, Edinburgh University. In September Dr. Stenning returned to England to take up an appointment in the Faculty of Archaeology and Anthropology at Cambridge. Dr. Whiteley is to be warmly congratulated on his appointment to a Readership in Bantu Languages at the School of Oriental and African Studies, London University. He left here in December to take up this appointment. Dr. Elkan transferred to the Department of Economics of Makerere College as a lecturer in July. Mr. Mukwaya came to the end of his study of African businesses with the termination of his contract in December. Mr. Jacobs left East Africa in July, 1958, to write up the results of one and a half years' work on the Tanganyika Masai. He hopes to return and carry out a complementary study of the Masai in Kenya.

### 4. *Constitution and Finance.*

The new constitution has been working well, with the Executive Committee of the Institute consisting of Professor David Walker, head of the Department of Economics and Political Science and Professor Southall. A solution to the financial unknown facing the Institute from April, 1960, has still not been completed, but it is to be hoped that discussions and applications now in progress will bring this period of uncertainty to an end.

### 5. *International African Seminar.*

In January, 1959, the Institute had the honour of acting as host to the first of the International African Seminars which are being organised by the International African Institute with the aid of a grant from the Ford Foundation.

The Seminar was attended by eighteen participants and three observers, fifteen from various territories in tropical Africa, three from Europe and three from the United States. The subject was "Kinship, Status and Neighbourhood under Modern Economic Conditions in Tropical Africa". Papers, mainly based on field research, had been circulated beforehand as material for the sessions. Professor Southall was chairman of the Seminar and is editing the proceedings.

#### 6. *Visitors, 1958-59.*

Among the many visitors to the Institute were the following: Professor and Mrs. Julian Steward, University of Illinois; Dr. Jean Buxton, Institute of Social Anthropology, Oxford; Professor Kenneth Kirkwood, Oxford; Professor Egbert de Vries, Institute of Social Studies, The Hague; Mr. Leo Crespi, U.S.I.A., Washington; Dr. P. C. Lloyd, Ministry of Lands and Labour, Western Region, Nigeria; Dr. J. R. Raeburn, London School of Economics; Dr. R. W. M. Johnson, London School of Economics; Dr. Chaman Lal, Dharamsala, India; M. Lerquin, I.R.S.A.C., Astrida, Ruanda; M. and Mme. Lagerstrom, Bukavu, Belgian Congo; Dr. and Mrs. Hartmann, Princeton; Professor and Mrs. Horace Miner, University of Michigan; Dr. and Mrs. Sutcliffe, Sir Alexander Gibb and Partners; Messrs. A. S. Durward and J. Walton, St. Johns College, Cambridge; Mrs. M. J. F. Gregor, Social Studies Department, Edinburgh University; Professor and Mrs. E. Marcus, Brooklyn College, New York; Mr. Robert C. Keith, African-American Institute, Washington; Dr. S. N. Varma, Department of African Studies, University of Delhi; Mr. H. S. Chabra, Department of African Studies, University of Delhi; Mr. Russell Elman, The Canadian Press, Toronto; Mr. P. Simkin, Oxford University Tanganyika Expedition; Mr. Frank Kierman, Foreign Service Institute, Washington; Mr. Cyril Rogers, University College of Rhodesia and Nyasaland; Professor and Mrs. W. M. Macmillan, lately of St. Andrews University; Professor J. Hiernaux, Recteur, Université Officielle du Congo Belge, Elisabethville; Dr. V. A. Scotch, State College of Washington; Professor M. Gluckman, Manchester University; M. Gouellain, I.R.C.A.M., Yaounde, Cameroons; Mr. and Mrs. E. Ardener, N.I.S.E.R., Buea, Cameroons; Professor D. Biebuyck, Université de Lovanium, Leopoldville; Professor W. B. Schwab, Temple University, Pennsylvania; Miss Alison Izzett, Welfare Department, Lagos; Dr. D. G. Bettison, Rhodes-Livingstone Institute, Lusaka; M. Jean Rouch, Musée de l'Homme, Paris; Professor Daryll Forde, International African Institute; Dr. D. F. McCall, African Studies Program, Boston University; Professor Frank Lorimer, African Studies Program, Boston University; M. R. Devauges, O.R.S.T.O.M., Paris; M. L. Baeck, I.R.S.A.C., Belgian Congo; Professor Clyde Mitchell, University of Rhodesia and Nyasaland; Dr. Michael Banton, Edinburgh University; Mr. James Kirkman, Warden of the Historical Sites of Kenya; Mr. Barwani, Education Department, Zanzibar; Dr. M. Posnansky, Curator, Uganda Museum.

## APPENDIX II

### **NIGERIAN INSTITUTE OF SOCIAL AND ECONOMIC RESEARCH UNIVERSITY COLLEGE, IBADAN**

#### **ANNUAL REPORT 1958-59 (1st APRIL-31st MARCH)**

#### *Advisory Board*

There were some changes in membership during the year. The members as at 31st March, 1959, were:—

- (i) The Principal of the University College Dr. J. H. Parry.  
(Chairman).
- (ii) The Director.
- (iii) Two members of the Senate of the University College appointed by the Principal after consultation with the Senate.  
Professor K. O. Dike.  
Mr. A. Ogunshye.

- (iv) One member of the Council of the University College not being a member of the Academic Staff, and appointed by the Council. Dr. J. B. C. Okala.
- (v) Two members appointed by the Governor-General. Mr. C. P. Thompson (Economic Secretary to the Prime Minister). (Not yet appointed).
- (vi) One member appointed by each of the Governors of the several Regions and by the Commissioner for the Cameroons.
- |           |     |     |     |     |   |
|-----------|-----|-----|-----|-----|---|
| Cameroons | ... | ... | ... | ... | Hon. A. N. Jua, M.H.A., Minister of Social Services.  |
| Eastern   | ... | ... | ... | ... | Dr. A. I. Osakwe, Secretary to Executive Council.   |
| Western   | ... | ... | ... | ... | Mr. I. O. Dina, Permanent Secretary, Ministry of Economic Planning.   |
| Northern  | ... | ... | ... | ... | Senior Assistant Secretary (Econ.) Ministry of Finance with Assistant Secretary (Econ.) as alternate (Mr. K. D. S. Baldwin and Mallam Mai Bornu). |
- (vii) One member appointed by the Colonial Social Science Research Council. (ad hoc).
- (viii) Two members representing the business community and appointed by the College Council. Mr. L. P. Ojukwu.  
Mr. E. C. W. Howard.

### Staff

Mr. S. A. Adu was appointed as Junior Research Fellow. The appointment of Mr. K. D. S. Baldwin as Senior Research Fellow, recorded in the last Annual Report, was, at Mr. Baldwin's request and with the Institute's agreement, not taken up.

The research staff during the year was:—

Senior Research Fellow...	Dr. M. G. Smith (Anthropology). From 1st October, 1958.
Research Fellows	... Mr. E. W. Ardener (Anthropology). Mr. V. W. Hogg (Economics). From 1st September, 1958.
Junior Research Fellow...	Mr. S. A. Adu (Economics and Statistics). From 1st October, 1958.
Bursars	... Dr. R. C. Abraham (Linguistics). Terminated 31st July, 1958. Miss J. Herskovits (Social History). Terminated 11th November, 1958.

Awards of Bursaries to be taken up during 1959, were made to Miss C. Gertz (Economic History) and Mr. H. Fisher, whose work is mentioned later in this report.

Further research appointments were under consideration at the end of the year.

### Research

Dr. M. G. Smith is working in the North on a comparative study of change in the structure of government in certain Northern States in the 19th and 20th centuries. With a view to making detailed comparisons of Habe, Fulani and Kanuri governmental organisation and development, the States selected for field study are Daura, Maradi, Katsina, Bornu, Hadeija, Sokoto and Kano. Dr. Smith has so far amassed voluminous material in Katsina, Kano, Maradi and Bornu.

Dr. Smith has been invited by the Research Institute for the Study of Man, New York, and the New York Academy of Sciences to present at a forthcoming joint seminar a paper on theoretical aspects of Cultural Pluralism and the Plural Society, a subject upon which he is regarded as an authority.

A paper on "The Hausa System of Social Status" was read by Dr. Smith to the Institute's Conference.

Mr. Ardener has continued his work on a Marriage Stability Survey in the Southern Cameroons, and brought it to a stage nearing completion. A preliminary report on the findings was embodied in a paper read to the Institute's Conference in December. He has also nearly completed a first draft of "An Introduction to the Bakweri Language".

In January Mr. Ardener attended the Seminar of the International African Institute at Makerere on problems of urbanisation, and presented a paper on "Social and Demographic Problems of the Southern Cameroons Plantation Area".

A Note on Intestate Succession was written by Mr. Ardener in connection with information on this subject which the Institute is compiling.

Mr. Ardener is commencing preparatory work for a social and economic history of the Cameroons. This study will have special reference to the plantation zone, and will include a treatment of the problems of land tenure, population and economic development. The detailed use of the documentation of this subject in the German files is envisaged, and the Institute is exploring the possibility of classifying and microfilming these documents.

Mr. Hogg has begun an enquiry into the economics of road communications in Nigeria, and has been collecting information from public and commercial sources relating to capital investment in roads, maintenance expenditures, motor taxation, traffic volumes, freight rates and factors affecting the location and quality of the country's road system. He has visited Government offices concerned and has toured selected areas of Regions to examine at first hand the variations in needs and the local problems involved. Further research is to deal with vehicle operating costs, origins and destinations of traffic, road development policy and the administrative and organisational aspects of road construction and maintenance.

An exploratory paper, "Towards Assessing the Highway Needs of Nigeria" was presented at the Institute's Conference.

Mr. Adu has undertaken background study preliminary to undertaking work on factors influencing agricultural productivity.

Miss Herskovits joined the Institute for a period of four months and carried out field work for her study of aspects of the social history of Lagos in the second half of the nineteenth century.

Mr. Fisher, who was the recipient of a Colonial Office award, has worked in close association with the Institute on his study of the Ahmadiya Movement in West Africa. His research is nearing completion but as the amount of material available is greater than had been hoped he is remaining in the field for longer than originally planned, and for this purpose will become an Institute Bursar for a period during 1959.

During the year plans were made for the Institute to undertake research into factors determining industrial productivity, with special reference to labour. A scheme of finance for this work, assisted from Colonial Development and Welfare Funds, was devised in consultation with the Federal Ministry of Labour. The work is being carried out as far as possible to form part of a project (Joint Project No. 5—Absenteeism and Labour Turnover) being fostered in several countries by the Commission for Technical Co-operation in Africa South of the Sahara and the Inter-African Labour Institute. Professor F. A. Wells, Professor of Industrial Economics in the University of Nottingham, agreed to carry out investigations in the plants selected for study, which are a sawmill and a groundnut oil mill, and he commenced work towards the end of the year under review. The Institute is grateful to the managements of the firms concerned for the way in which they have welcomed and are assisting these studies.

The survey of radio listening habits and audience response in two areas of Ibadan was completed and the report delivered to the Nigerian Broadcasting Corporation. Work was superintended in the field by Mrs. B. Stapleton, the statistical material collated by Mrs. J. Ferguson, and the report drafted by these two ladies.

Further radio audience surveys in other parts of the country are being planned, with the support of the Nigerian Broadcasting Corporation and the British Broadcasting Corporation.

Dr. Abraham continued his work on an analysis and dictionary of the Ibo language.

Mr. M. P. Miracle of the Food Research Institute of Stanford University, California, was attached to the Institute as an Associate, pursuing an enquiry into the economics of the production and distribution of maize in tropical Africa.

The following research is also being carried out in close association with the Institute:—

Mr. K. W. J. Post: Electoral studies.

Mr. B. Shields: The Mobilisation and Utilisation of Voluntary Savings in Nigeria.

Mr. P. A. L. Chukwumah: The Integration of Ministries and Departments in Nigeria.

#### Publications

The following publications by present and by past members, arising out of their work at the Institute, appeared during the year or were in preparation at the end of the year:—

- |  |  |   |
|--|--|---|
| Abraham, R. C.                         | ... "Dictionary of Modern Yoruba"  | Hodder & Stoughton<br>1958.                           |
| Abraham, R. C.                         | ... "Ibo Dictionary" ... ..  | In preparation.                                       |
| Acquah, I.                             | ... "Accra Survey" ... ..  | U.L.P. 1958.  |
| Ardener, E. W.                         | ... "Lineage and Locality among the Mba-Ise Ibo".  | <i>Africa</i> , vol. xxix, No. 2, April, 1959.        |
| Ardener, E. W.                         | ... "The Kamerun Idea" ... ..  | <i>West Africa</i> , Nos. 2147, 2148, June, 1958.     |
| Ardener, E. W.                         | ... The sections: "Victoria in its setting", "The Administrative Division", "The Indigenous People and Their Origin", "Society before the Impact of the West", "The Indigenous Economy", "The 'Melting-Pot' of the Cameroons" in <i>Victoria Southern Cameroons, 1858-1958</i> , pp. 1-3, 10-16, 52-54, 93-95. | <i>Victoria Centenary Committee, Victoria</i> , 1958. |
| Ardener, E. W.                         | ... "The People" in <i>Introducing the Southern Cameroons</i> , pp. 17-21.   | <i>Federal Information Service, Lagos</i> , 1958.     |
| Ardener, E. W.                         | ... "The Bakweri Elephant Dance"   | <i>Nigeria</i> , No. 60, 1959.                        |
| Ardener, E. W. (with Shirley Ardener). | "Wovea Islanders" ... ..   | <i>Nigeria</i> , No. 59, 1958.                        |
| Ardener, E. W. and Warmington, W. A.   | A Study of Social and Economic Problems of the Plantation Labour Force of the Cameroons Development Corporation. (Probable title "Plantation and Village in the Cameroons").   | O.U.P. In Press.                                      |
| Hawkins, E. K.                         | ... "Road Transport in Nigeria" ...  | O.U.P. 1958.  |

- Hawkins, E. K. ... "Growth of a Money Economy in Nigeria and Ghana". *Oxford Economic Papers*, Vol. 10, No. 3, Oct., 1958.
- Hawkins, E. K. ... "Marketing Boards and Economic Development in Ghana and Nigeria". *Review of Economic Studies*, No. 69, Oct., 1958.
- Hogg, V. W. ... Review of "Road Transport in Nigeria", by E. K. Hawkins. *J. Transp. Hist.*, vol. III, No. 4, Nov., 1958.
- Prothero, R. M. ... 1:1,000,000 Map of Population Distribution in Northern Nigeria. *Directorate of Overseas Surveys*. In Press.
- Prothero, R. M. ... 1:1,000,000 Map of Population Density in Northern Nigeria. *Directorate of Overseas Surveys*. In Press.
- Warmington, W. A.... "A Study of the C.D.C. Workers' Union". O.U.P. In Press.
- Warmington, W. A.... "Saving and Indebtedness among Cameroons Plantation Workers". *Africa*, vol. xxviii, No. 4, Oct., 1958.
- Warmington, W. A.... "Spare Time Activities in the Cameroons Plantations" (two articles). *West Africa*, Nos. 2177, 2178, Jan., 1959.
- Warmington, W. A.... "The Cameroons and the Fiscal Commission". *West Africa*, No. 2143, May, 1958.

### Conference

A conference of research workers was held from 15th-21st December, 1958, the sixth in the WAISER/NISER series. It was attended by research workers from many different territories of West Africa and visitors from the Universities of Oxford, Edinburgh and Stanford. Twenty-seven papers were presented and discussed. The Proceedings will be published in due course.

### General Activities

Advice and information in connection with land disputes was sought from Mr. Ardener by the Southern Cameroons authorities. Mr. Ardener has been appointed a Prison Visitor. During the eruption of the Cameroon Mountain he took part in devising the emergency provisions which were to come into operation if the trunk road were cut by lava, and was assigned responsibility for assessing measures to assure indigenous food supplies.

Mr. Hogg was invited to serve on the Lagos Traffic Advisory Committee.

The Director served as chairman of the committee set up by the Federal Minister of Commerce and Industry to advise on ways and means of fostering a share market in Nigeria, and the report has been published. His arbitration reports and awards in connection with two industrial disputes in the railway and at the ports were published by the Federal Government Printer. He served as a non-official member of the Federal-Regional Joint Planning Committee. He was chairman of a Clerical Job Evaluation Panel for the electricity industry.

### Building

Discussions on the details of the Institute's new building were held with the architects periodically during the year. Working drawings are almost completed.

### Visitors

Visitors to the Institute during the year (excluding visits to attend the Conference) included:

J. O. Tresider and J. A. Hillier, Colonial Section, Road Research Laboratory, Harmondsworth, Middlesex.

Dr. Leo Crespi, Director of Research and Intelligence, U.S. Information Agency, Washington, D.C.



- Mr. Michael Young and Mr. Peter Marris, Institute of Community Studies, London.
- Mr. R. Menzies, Industrial Welfare Society, London.
- Professor Gwendolen Carter, Smith College, Mass., U.S.A.
- Dr. Sherman Adams, International Co-operation Administration, Lagos.
- Professor A. G. B. Fisher, International Monetary Fund, Washington, D.C.
- Mr. F. X. Sutton, Ford Foundation.
- Mr. Alan Pifer, Carnegie Corporation.
- Mr. R. July, Rockefeller Foundation.
- Mr. R. W. P. Cockburn, British Broadcasting Corporation, London.
- Mr. I. G. Stewart, University of Edinburgh.
- Dr. E. F. Jackson, University of Oxford.
- Mr. J. J. McGregor, Imperial Forestry Institute, Oxford.
- Dr. R. Bower, Bureau of Social Science Research, Washington, D.C.
- Mr. Mekki Abbas, Executive Secretary, U.N. Economic Commission for Africa, Addis Abbaba.
- Professor F. Lorimer, African Research and Study Program, Boston University, U.S.A.
- Mr. M. de N. Ensor, Secretary, Foundation of Mutual Assistance in Africa South of the Sahara.
- Dr. J. Saxe, Harvard University Centre for International Affairs, Cambridge, Mass.
- Mr. McCunniff, International Bank for Reconstruction and Development.
- Mr. R. K. Innes, General Manager, Nigerian Railway Corporation.
- Dr. R. Sieber, State University of Iowa.

R. H. BARBACK,  
*Director.*

### APPENDIX III

#### INSTITUTE OF SOCIAL AND ECONOMIC RESEARCH UNIVERSITY COLLEGE OF THE WEST INDIES

#### ANNUAL REPORT

April 1, 1958–March 31, 1959

#### STAFF

Director—H. D. Huggins

M. G. Smith  
L. E. Braithwaite  
G. E. Cumper  
D. T. Edwards  
C. O'Loughlin

R. T. Smith  
L. Best  
J. Brathwaite  
C. Jayawardena

#### ECONOMIC STUDIES

##### *Economic Growth*

Dr. H. D. Huggins began work on a study of the integration of the bauxite-alumina-aluminium industry with special reference to the implications of this industry for economic development.

Mr. G. E. Cumper was editor of a report on a conference on Economic Development which was held at the University College in August 1957.

*Economics of Agriculture*

Mr. D. T. Edwards worked on the revision of his monograph based on his study of the economics of small farms in Jamaica. He began a study of the structure of Jamaican agriculture which pays particular attention to differences between the estate and small farm sectors.

*Labour*

Mr. G. E. Cumper worked on the analysis of consumption and expenditure data from Barbados and British Guiana. He prepared chapters on employment and consumption for the forthcoming book on "West Indian Structure and Problems".

*Study of Tourist Expenditure*

Prof. P. Sargant Florence and Mr. G. E. Cumper collaborated on a study of tourist expenditure in Jamaica.

*National Accounts*

A project for the preparation and analysis of National Accounts of the West Indies continued to receive support from the Carnegie Corporation and some of the West Indian unit territories. Dr. C. O'Loughlin completed her estimates of the national income, balance of payments and capital formation account of British Guiana for 1952-1956. She also completed the gathering of material for similar estimates in Antigua, Montserrat, St. Kitts-Nevis-Anguilla. Appointed to work in the national accounts unit with Dr. O'Loughlin are Dr. Jeannette Brathwaite and Mr. Lloyd Best. Dr. Brathwaite, working in collaboration with the Department of Statistics in Barbados helped set up the necessary machinery for bringing the national income statistics out each year and one of the officers of the Department was trained to maintain the estimates. Dr. Brathwaite has completed estimates for 1955 and 1956 and also conducted a small scale family budget survey in Barbados. Mr. Best has begun work on a sector of the Jamaica accounts. He also prepared a contribution on "Economic Structure of Jamaica and Trinidad" for the book on West Indian Structure and Problems.

*Land Use Study, Tobago*

Mr. David Niddrie of the Department of Geography, University of Manchester, carried out three months field work on land use in Tobago, in association with the Institute.

## SOCIOLOGICAL STUDIES

*Social Structure, Jamaica, Grenada, Carriacou and St. Lucia*

Dr. M. G. Smith continued his comparative studies. He revised his monograph on "Kinship and Community in Carriacou" and his monograph on West Indian family structure. He also did preliminary statistical analysis on a study relating to social stratification in Grenada.

Dr. Beate R. Salz of the University of Puerto Rico was seconded to the Institute on a twelve-months assignment to carry out a study of the social structure of St. Lucia.

*Social Structure, British Guiana*

Immediately on his return to Jamaica from the University of California, Dr. R. T. Smith went to British Guiana on a short field trip. He continued work on his study of the social structure of British Guiana. Mr. Chandra Jayawardena continued work on his study of processes of social control amongst East Indians in British Guiana, a project which was complementary to Dr. Smith's work. Mr. Jayawardena left to continue his writing up at the London School of Economics.

*Population*

A study, undertaken in collaboration by Mr. George Roberts and Mr. Lloyd Braithwaite, got under way on the sociological aspects of population growth, emigration and fertility in Trinidad.

**Publications**

The quarterly Journal, *Social and Economic Studies*, now in its eighth volume has appeared regularly and has achieved an encouraging international circulation.

Best, L.

Comments on "Economic Planning in Jamaica", *Social and Economic Studies*, Vol. 7, No. 4, December 1958, pp. 164-169.

Cumper, G. E.

Expenditure Patterns, Kingston, Jamaica, 1954. *Social and Economic Studies*, Vol. 7, No. 2, June 1958, pp. 165-177.

Introduction to Study Conference on Economic Development in Under-developed Countries. *Social and Economic Studies*, Vol. 7, No. 3, September 1958, pp. 1-8.

Huggins, H. D. and Cumper G. E.

Economic Development in a Context of Low Population Pressure. *Social and Economic Studies*, Vol. 7, No. 3, September 1958, pp. 54-67.

Huggins, H. D. and Chang, E. R.

Rejoinder to Professor Walker. *Social and Economic Studies*, Vol. 7, No. 2, June 1958, pp. 199-200.

O'Loughlin, C.

The Rice Sector in the Economy of British Guiana. *Social and Economic Studies*, Vol. 7, No. 2, June 1958, pp. 115-143.

The Economy of British Guiana, 1952-56: A National Accounts Study. *Social and Economic Studies*, Vol. 8, No. 1, March 1959, pp. 1-104.

Smith, R. T. and Jayawardena, C.

Hindu Marriage Customs in British Guiana. *Social and Economic Studies*, Vol. 7, No. 2, June, 1958, pp. 178-194.

**Other Activities**

The Director, awarded a Guggenheim Fellowship, was invited to spend the year as a Visiting Research Professor at Yale University. While at Yale he was invited to lead seminars at Yale, the Economic Development Institute of the International Bank for Reconstruction and Development, at Harvard University and at Amherst College. He was invited to be Chairman at one of the Sessions of the Study Conference on Plantation Systems of the New World held by the Pan American Union in Puerto Rico in November, 1957.

While in the United Kingdom on study leave Mr. D. T. Edwards participated in a series of seminars on problems of development in tropical under-developed countries organised by the Institute of Commonwealth Studies.

Dr. M. G. Smith acted as Director of the Institute during the year. He has been appointed a Senior Research Fellow at the Nigerian Institute of Social and Economic Research for one year, to carry out anthropological studies among the Hausa of Northern Nigeria and left Jamaica at the end of August, 1958.

From September 1957 to June, 1958 Dr. R. T. Smith was Visiting Assistant Professor in the Department of Anthropology, University of California, Berkeley. In November, 1957, he read a paper at the Plantation Conference in Puerto Rico.

Prof. P. Sargent Florence, at the Institute's request spent three months at the College and had rewarding discussions on the various studies under way at the Institute.

Other associates with the Institute were Professors Robert L. Aronson (Fulbright Fellow), Orme W. Phelps (Fulbright Fellow) and H. Austin Peck (Social Science Research Council Fellow). These worked on research projects relating, respectively, to a study of the recruitment of the labour force of a

Jamaican alumina plant, a study of industrial relations in Jamaica and an analysis of the relation between economic development and fluctuations in the balance of payments.

Dr. Sidney Mintz, of Yale University, spent a brief period at the Institute.

#### Seminars

The Institute had under active preparation arrangements for two seminars:

- (a) A seminar of national accountants to bring together statisticians actively engaged in national income work in the West Indies. The topics to be discussed would include problems requiring a standardised approach. Some general lectures and discussions would also be included.
- (b) A seminar on economic development held by the International Bank for Reconstruction and Development (through its Economic Development Institute) and the University College of the West Indies.

#### Integration

On recommendation of the Senate, the Council agreed to integrate the Institute of Social and Economic Research into the College and into a reconstituted Department of Economics.

### APPENDIX IV

#### THE RHODES-LIVINGSTONE INSTITUTE FOR SOCIAL RESEARCH

##### DIRECTOR'S REPORT FOR THE YEAR ENDING 31ST MARCH, 1959

#### I. *Introduction* :

This Institute differs from its counterparts in East and West Africa and the Caribbean in not being attached to a University College. This means that we have not only to conduct research, but have also to bear a greater burden in ensuring that the results of such research are generally known and utilised. This was early recognised by those responsible for Institute policy.

It is the object of the succeeding paragraphs to describe how we have set about the triple task of research, the provision of fact and the dissemination of knowledge and to record the successes and failures we have met with during the past year.

#### II. *Administration* :

i. *Board of Trustees* : Up to the end of the year there has been no change in the composition of the Board of Trustees. The implications of the revised Constitution of Northern Rhodesia and the changes in personnel and procedure arising therefrom are not yet clear; nor are they reflected in the record here presented. The Board met twice during the year, once at Lusaka and once at Salisbury.

ii. *Committees and Consultants* : The composition of the Standing and Research Committees was formalised by the gazetting of Rules in January, 1959. In addition to the previously appointed members the Director became a member of both Committees. The panel of Consultants was widened by the inclusion of representatives of Anthropology, Sociology, Geography and Race Relations. The Standing Committee met on seven occasions and the Research Committee twice. In addition much business was dealt with by the circulation of papers.

iii. *Headquarters Administration* : This is the first full year's run for the post of Research Secretary, which has proved itself, through its present holder, to be invaluable. On the editorial side alone, the Institute has produced ten Reports, Communications and Proceedings, amounting to a total of 744 cyclostyled pages. In addition to this work, the Research Secretary supervised the Library in the

absence of the permanent Librarian on leave and also found time to put in eleven weeks field work amongst the Nsenga of the Eastern Province.

The administrative section had an increased burden to bear. The expanded buildings required considerable maintenance: there are now seven senior quarters, twelve junior quarters and eight servants' quarters on the site. The finances also became increasingly complex: we naturally welcome contributions and payment for work done from as many sources as possible, but with funds coming in from C. D. & W., the various Territorial Governments, the Northern Rhodesia Housing Board and certain American Foundations, each of which requires the presentation of accounts in a different form, the task of accounting involved is very considerable.

Consideration is being given to a re-adjustment of this load, which will be instituted on a trial basis in the coming year.

iv. *Buildings*: The only task undertaken during the year was the construction of a new research wing, originally designed to house the Industrial Section. The wing, comprising three studies, three stores and a seminar room, was built on a "do-it-yourself" basis, with locally engaged African artisans and labour, with only one European carpenter-foreman employed. The total cost, including furniture, was under £3,000, this sum being found from "untied" local contributions: With our own workers coming in from the field to analyse their data, with numerous "Rockefeller Students" (see below) and other undergraduates at work, and with the large number of affiliates using the studies and library, all available working space is subject to pressure and further expansion must be considered.

v. *Recruitment*: With this Institute left as the only one of its kind not directly associated with a University College, it was suggested that recruitment could best be undertaken by the Inter-University Council for Higher Education Overseas, which body most kindly accepted the task. It was found that our local organisation of Boards and Committees, combined with certain unavoidable statutory obligations, whilst admirably designed to serve the purpose of obtaining maximum advice locally, proved unduly cumbersome when linked to a well-organised recruiting mechanism in the United Kingdom. The situation is under review with a view to its streamlining. The position was aggravated by two last minute disappointments where the posts of Urban Sociologist and of Human Geographer were not taken up within a few days of departure; one by withdrawal and one by illness.

vi. *Students*: An interesting experiment was established on a three year basis, whereby the Rockefeller Foundation contributed \$3,000 to assist in the vacation employment of African undergraduates from Salisbury and elsewhere, and of sixth formers from the Secondary Schools. They work in the various departments, Library, Statistics, etc., or may be attached to field workers or affiliates. We are most grateful to the Foundation for this assistance, which is valuable in three directions. The Institute benefits from the work these young men do; they are assisted in "working their way" through school or college; but most important, an interest is stimulated in the next generation of African leaders which it is hoped will yield a dividend either in ensuring that interest is maintained in social research in the decades ahead, or by securing locally born workers fully trained and available in a future wherein the expatriate worker can expect to become less and less acceptable to the subjects of his enquiry.

### III. Finance

The situation is much as described in last year's report. As there reported, the revised Colonial Development and Welfare Scheme R698 amounted to a total grant of £51,501 over the four-year period 1956-60. The local contributions continued at the previous rate of £18,000 per annum, whilst commissioned work yielded the £8,100 anticipated in last year's report, plus additional authorisations of £9,250 to be spent over the next year or two.

With several posts unfilled, expenditure has not kept pace with income, but this does not indicate an accumulating reserve; it is in effect deferred research, temporarily banked in money form.

#### IV. Research

i. *Sociographic Section* : This section has continued its sterling work under the leadership of Dr. Bettison. His departure in June, 1959, to take up a teaching appointment at the University of Queensland, Brisbane, will be a severe loss to the Institute. In Nyasaland the planned research reached its final phase, which it was only possible to complete on the agricultural side; the industrial side had regrettably to be dropped, though plans for the future may include more work in the economic field.

At the same time as supervising the Nyasaland team and organising the analysis of the field data at headquarters, the Sociographer completed the field work at Lusaka of the enquiry undertaken for the Northern Rhodesia Housing Board. The results are at present under analysis and write-up.

ii. *Rural Work* : The Field Anthropologist, J. Argyle, continued his work amongst the Soli. In addition to work in the rural areas, attention was paid to the Soli in Lusaka, and a short period spent at the Institute in write-up and review of results to date.

The Research Secretary, Dr. R. Apthonpe, spent some time in field work amongst the Nsenga of Eastern Province, and is working up his material into a publication emphasising the importance of the clan in the Nsenga social system.

Miss Tweedie commenced work in February, 1959, amongst the Bemba of the Kasama District of the Northern Province. Her task is to ascertain, primarily by the collection of rural family budgets, the degree to which the local economy is dependent on its own subsistence agriculture, and how far it is supported by injected remittances from workers on the Copperbelt.

It was hoped that another project would be launched in the Northern area where an Institute Ecologist was due to work with the Fort Rosebery Health and Nutrition Scheme. Unfortunately, at the last moment ill-health prevented the selected candidate from taking up his post.

iii. *Urban Work* : The regrettable closure of the Industrial Section, following the termination of the appointments of Messrs. Matthews & Clack halted work in this field. Another set-back was caused when the Urban Sociologist selected to undertake studies amongst the African population of the Copperbelt failed to take up his appointment, within ten days of his planned arrival at Ndola.

Yet further difficulties arose in connection with the Africa-wide enquiry into Absenteeism and Labour Turnover organised by the Commission for Technical Co-operation in Africa South of the Sahara. When the Institute first agreed to co-operate in this task it was thought that there would exist a functioning Industrial Section which, with a little strengthening in funds and personnel would be able to take a job like this in its stride. This was not to be, but by the end of the year arrangements had been made to recruit a Local Research Officer and two Research Assistants of Higher School Standard to undertake this work. If we succeed in achieving satisfactory results in this survey it will be due to the co-operation, so readily extended, of the National Institute of Personnel Research in Johannesburg, and the Labour Departments in Lusaka and Salisbury.

iv. *European Sociology* : It was hoped to commence work on the Copperbelt in the field of European Sociology and a Research Officer was recruited to undertake this work. At the time of his arrival in March, 1959, conditions had changed and the time was not suitable for this project, so arrangements were put in train for the alternative approved project of a study of integration of immigrants into Southern Rhodesian society to be undertaken.

v. *Affiliates* : Not the least valuable service which the Institute performs for Central Africa, is the attraction it offers as a base for social scientists from other continents, encouraging them to study subjects in this area which would otherwise be neglected. They fall into two categories, Fee-paying Affiliates (hereunder designated F.A.), those who have sufficient funds from a University or a Foundation to support their project, but who wish to use and pay for our facilities, and Assisted Affiliates (A.A.), i.e. those who, with some support assured, require additional assistance to enable them to undertake the projected study. The following visits were undertaken during the year under report.

B. Floyd (A.A.), of Syracuse University, New York, studying the Implementation of the Land Husbandry Act in Southern Rhodesia, worked for a year in the field as a temporary Land Development Officer and then spent some weeks at the University College and the Institute analysing his data.

Dr. and Mme. Roumequere (A.A.) of the Sorbonne, Paris, undertaking an extensive study of the Kalanga group of Southern Rhodesia: their work should throw light on the people who built and inhabited Zimbabwe; Dr. Roumequere, a psychologist, is also interesting himself in the psychotherapeutic effects of African ritual.

R. Rotberg (A.A.) lately of Princeton, and presently a Rhodes Scholar at Oxford, is in Northern Rhodesia for a year on field work connected with his study of the part of the Missions in the development of Northern Rhodesia, 1890-1924.

Mrs. H. Carter (A.A.) lately of the School of Oriental and African Studies, and now the wife of an Education Officer, is studying the Tonga language under a C.S.S.R.C. Grant and with the assistance of Institute facilities.

R. Sutcliffe (A.A.) is due to go to Worcester College, Oxford, in October, 1959, and is temporarily with the Institute in co-operation with Voluntary Service Overseas. He is assisting in all departments to gain general experience of social research.

P. Stutley (A.A.) a District Commissioner of Basutoland, is preparing a thesis for submission to Reading University on Systems of Produce Marketing in Africa. He spent a month at the Institute studying the local systems and collecting comparative material from the Library.

Plans have been laid during the current year for the following affiliations in the period 1959-60: it will be noted that several of these will be undertaking work which the Institute has had in its programme but has been unable to afford from its own resources.

Dr. Monica Cole, of the University of North Staffordshire, arrives in June, 1959, for 4 months to undertake a study of the savannah environment of Northern Rhodesia. She has obtained assistance from the Mining Companies, and will work in co-operation with the Institute and the Northern Rhodesia Department of Agriculture.

Mr. C. La Muniere (F.A.) from Harvard has been awarded a Ford Foundation Foreign Area Training Fellowship. He and his wife will arrive in the territory in June, 1959, for an eighteen months study of the socio-economics of the fishing industry. There is an urgent need for further knowledge of this most valuable natural resource only now coming under full exploration; it provides an outlet for African enterprise and initiative and at the same time a valuable source of protein.

Professor J. B. Christensen (F.A.) of Wayne State University hopes to receive Foundation support to conduct a twelve months study of the Bisa tribe.

Professor F. W. Dotson (F.A.) of the University of Connecticut, similarly hopes for Foundation support to study the Asian communities in Central Africa for twelve months, commencing June, 1959. It may be possible for Professor Dotson to team up with Dr. Gopalakrishnan of Delhi University, who will in any case be visiting the Institute early in the year: an endeavour is being made to keep him on as an assisted affiliate to conduct some of the field work required by this study.

Other anticipated visitors to whom the Institute hopes to be of assistance are Mr. I. Richardson of the School of Oriental and African Studies, London, shortly to engage on a year's study of the Bemba language; Mr. P. Miracle, of the Food Research Institute, Stanford University, California, studying maize on an Africa-wide basis, and possibly Dr. Erich Isaac, a geographer from Temple University, Philadelphia.

vi. *Future Research Plans*: Our immediate objective must be to make up the ground lost by the non-appearance of the Ecologist and Urban Sociologist mentioned above. In addition it is hoped that savings from other sources will permit the employment of an Educationist, which project we previously hoped might receive Foundation support.

Thereafter it will be necessary to prepare plans for the next quinquennium, 1960-65, and already preliminary discussions have taken place. It is felt that a socio-linguist could profitably be employed, and that considerable work could be undertaken in the psychological field, unfortunately dropped from the "Mitchell Plan": the construction of a mental hospital at Lusaka will provide a professional staff with whom the Institute's workers could profitably co-operate to their mutual advantage. Other plans under consideration concern work by a political scientist into certain aspects of local government, and by a criminologist into the many facets of this subject which are unfortunately becoming apparent as problems in Central Africa.

#### V. *Public Relations* :

i. *Local* : It is only through its external relations and through its publications that the Institute can attain its objectives two and three, the provision of knowledge to policy makers and administrators, and the dissemination of information to the general public.

As in previous years, contact was maintained with the public—both European and African—in many ways. Broadcast talks were given, some on the European and some on the African services, by several members of the staff. The Director appeared regularly on a Brains Trust programme and together with others on the staff, provided material for "Your Questions Answered". Several newspaper articles appeared on various aspects of the Institute's work, whilst Rotary and other such gatherings were addressed.

As a result of the public's greater understanding of our work, our research workers are welcome in most circles and numerous interests demand and are willing to pay for specific services. The rapport established between our research assistants (African) and the population with whom they work is particularly worthy of mention. Although exaggerated press reports suggested that the social climate in Central Africa was such that it would be quite impossible to conduct field research of any sort, even in Blantyre-Limbe area where rioting was severe, our team was back in the field in the peri-urban areas within a fortnight, conducting their research into harvest yields and village life.

The Institute continued to function as an instrument of liaison between many groups interested in the social sciences, academic and applied. A number of meetings were held jointly under the auspices of the Institute and the Lusaka Branch of the Rhodesia University Association: it has been agreed that the Northern Rhodesia Society (which publishes the Northern Rhodesia Journal) should establish a Lusaka Section to work in closely with the Institute. The formal courses and seminars held are mentioned in the appropriate section.

The Council of Social Services continues to co-operate closely with the Institute and there is a scheme afoot whereby the Council should sponsor certain courses in the social sciences, with which the Institute would co-operate by the provision of library and similar facilities.

Another interest which has claimed our attention is the Natural Resources Board: this recently established an Education Committee and invited the Director to be chairman. This is in line with another suggestion whereby the long-planned project on the impact of mass media in under-developed areas may be brought to fruition in conjunction with International Co-operation Administration.

ii. *Overseas* : The Institute's overseas contacts continue to expand. This is evidenced by the increasing number of overseas visitors (mentioned elsewhere), by increasing enquiries from, and acceptances of, social scientists seeking Institute affiliation, and in the number of queries submitted. These last may range from an enquiry concerning the extent to which slavery is practised to-day in Mozambique, under Government auspices, to whether birth rates in societies with a matrilineal succession system are not higher than in societies with patrilineal succession.

iii. *Visitors* : As in the previous year, visitors numbered about 400; their numbers are now so great that it has been necessary to relegate the list to an appendix. In the overseas list Oxford is particularly well represented by a Profes-



sor, a Reader and a College Master. America produced two large groups, twenty-one diplomats of the African Field Seminar, and eleven school teachers under the guidance of Dr. Gwendolyn Drew, of Washington University, St. Louis. The Foundations and American academic life were also well represented on the list.

From neighbouring towns and territories it is particularly gratifying to note the close links between the Institute and the University College at Salisbury on the one hand, and the new University at Elisabethville on the other. Both in groups, as at Conferences, and on individual visits we have been delighted to welcome a very representative selection of staff and students.

The Lusaka list of visitors shows the interest which our Legislators—both European and African—the Government Departments and the officials of the Municipality show in our work. It is appropriate to mention under this head the close relations existing between the Institute and the Northern Rhodesia Government's Land Tenure Officer, Mr. C. M. N. White, M.B.E. At one time Acting Director of the Institute, Mr. White is a frequent and welcome visitor whose vast knowledge of the country is a great stimulus to newly arrived research workers. A work of his will be appearing in our Paper series in 1959.

iv. *Institute Conferences*: The Twelfth Institute Conference was held at Bulawayo on the invitation of the Municipality who proved to be excellent hosts, permitting the use of their council chamber for our meetings, laying on an official "sundowner", and providing transport for excursions to factories and elsewhere. The subject of this Conference was "*Social Relations in Central African Industry*". The Papers and discussions have been reproduced in the now standardised Proceedings series. Considering the work and organisation which so many people put into this Conference it is a matter of regret that it failed to achieve its objective.

The Thirteenth Conference was, by contrast, generally acclaimed to be the best that any of the participants had attended. The theme concerned was "*The Adaptation of Indigenous African Political Systems to Modern Circumstances*". The Papers detailed in App. II, clustered coherently round the central theme and stimulated much interesting discussion. One senior official from a neighbouring territory wrote that he found the Conference "most enlightening, full of interest and certainly guaranteed to induce reflection on many administrative problems". In doing just that, it is felt that the Institute has performed a very important function. It is anticipated that the Thirteenth Proceedings, shortly due for publication under the title "*From Tribal Rule to Modern Government*", will be in strong demand.

v. *University College of Rhodesia and Nyasaland*: Our relations with the College remained close and cordial. As previously recorded the College is represented on the Board of Trustees and on the Research Committee, whilst the Director attends the College's Social Science Research Committee meetings. The Director was invited to attend the Adult Education Conference held in June, 1958, whilst both he and Dr. Bettison were asked to address the Senior Management Course in December. The Institute's Thirteenth Conference was opened by the Principal, Dr. Adams, and attended by a number of faculty members. On other occasions visits were received from the Vice-Principal and many other of the Heads of Faculties. The barrier between Lusaka and Salisbury is thus easily and frequently surmounted by a 65 minute flight; it is for reasons of finance rather than fatigue that visits are not even more frequent.

vi. *Conferences Attended*: As in previous years, Institute personnel was in demand at numerous conferences and meetings, Dr. Bettison attended the C.C.T.A. Conference on Urbanisation and Housing at Nairobi in January 1959, as representative of the Federal Government, and was also invited to attend the International African Institute Seminar at Kampala. The Director attended and addressed the World Missionary Council's Conference at Mindolo, the Northern Rhodesia Council of Social Services' Annual Conference, and a week-end Study Conference organised by the United Northern Rhodesia Association. The papers arising out of these conferences are listed in App. II. In addition, the Director visited the Inter-African Labour Institute at Brazzaville for a meeting in connection with the C.C.T.A. Survey into Absenteeism and Labour Turnover.

vii. *Courses and Seminars*: The most important of these was the visit of the United States State Department African Field Seminar, which brought 21 American Diplomats to the Institute for three days. They were addressed by the Governor, numerous members of the Legislature and of the Institute staff, and paid visits to points of interest in and around Lusaka. Numerous courses from neighbouring training centres, the Native Authority Development Centre, and the Police School at Lilai, attended talks on specialised subjects and generally to hear about the work of the Institute. Evening seminars were well attended on such diverse subjects as the Southern Rhodesia Land Husbandry Act, by a Land Development Officer, and a New Approach to Human Relations, by an American Professor.

#### VI. *The Sir Gilbert Rennie Library*:

Associate Membership of the Institute, which confers library privileges, continued to rise. Whilst results are not spectacular we have gone a long way towards making up in paying membership the reduction of 160 in free members which was made two years ago as an economy measure. The position is shown hereunder:—

*Table of Institute Membership, 1958-59*

	At 1st April, 1958	Resigned	Joined	At 31st March, 1959	Increase or Decrease
Honorary ... ..	33	1	1	33	—
Official ... ..	196	7*	—	189	— 7
Exchange ... ..	91	—	9	100	+ 9
Paying ... ..	218	12	65	271	+53
Total... ..	538	20	75	593	+55

\* Withdrawn by the Institute in the interests of economy.

Of the total membership of the Institute, 195 are in Northern Rhodesia, 206 in the rest of Africa, 109 in Europe, 75 in America, 5 in Asia and 3 in Australia.

The Library has continued to expand considerably. This year 800 books and pamphlets have been added—this total representing 272 more books than last year. The total of 800 excludes the annual reports and other publications of Government Departments in Central and East African territories. The Library has been particularly fortunate in receiving two most generous gifts during the year, both from American sources. The first was a gift of sixty books from the American Consulate General in Salisbury, Southern Rhodesia; these books are mostly on aspects of political and industrial life in the United States. The second gift came from the Carnegie Corporation of New York, and consists of 350 books on a very wide range of interests, varying from biography and fiction to social science, folklore, philosophy and art, which have been chosen to represent 150 years of America life and thought. Arrangements have been made whereby "block borrowings" can be made from the collection by certain schools and societies in Northern Rhodesia and Nyasaland. Yet a third American benefactor from whom the Library is profiting is the Rockefeller Foundation; as part of their gift to the Institute, 500 dollars have been allocated to the Library over a period of three years. Books are on order under this scheme, and are at present on their way from America.

Some expansion is also to be reported in the periodical and newspaper sections of the Library. 232 periodicals are now taken regularly. The vernacular section of the Library has continued to expand, and now includes 34 news-letters and newspapers printed either wholly or in part in one of the vernacular languages of the Federation. It also automatically receives all the vernacular publications of the Publications Bureau of Rhodesia and Nyasaland.

A micro-film section has been opened in the Library, and a micro-reader has now arrived from the United Kingdom. The out-of-print early Papers of the Institute have all been micro-fiched, and are on sale in that form at little more

than their original cost. The Institute has details of various micro-fiche readers that are on the market. Another very welcome addition to the Library has been a collection of forty-eight gramophone records of African music, both instrumental and vocal, made by the African Music Society under the directorship of Mr. Hugh Tracey; this set has been presented through the generosity of Mr. Harry Oppenheimer. It may well prove to be the core of a section of the Library which could develop more fully in the future.

The bibliography of social anthropological and other information concerning Central Africa continues to fill many cards, and to prove useful, not only to local residents, but to associate members of the Institute in different parts of the world. It is hoped before too long to issue an enlarged and revised edition of Communication No. 7 in which form this bibliography first appeared.

#### VII. *Publications* :

The publications list is now so long that it has been removed from the body of the report. Reference to Appendix II shows that we only got out one Journal and one Paper instead of the normal two, in the course of the year, though the next Journal is proof-read and the next Paper with the printer. Our subscribers were compensated for this shortfall by increased issues in the Communications series (issued free to all associate members on request). After a period of abeyance we put out four Communications in 1957-58, and two (totally 204 cyclostyled quarto pages) in 1958-59; we have a further three, representing 174 pages, stencilled and in process of issue.

Three full length books were published by Gann, Colson and Watson, as detailed in the Appendix, and the reprint of "Seven Tribes" put in hand. Two further books, by Cunnison and Van Velsen respectively, were put into the press for publication in the coming year.

Progress was also made in formulating plans for the series on Kariba to be published jointly by the National Museum of Southern Rhodesia, The Rhodes-Livingstone Museum and ourselves. Each institution will pay for its own publications, but it is felt that under a common format it will make more accessible the unique body of knowledge collected prior to the inundation of the valley. This Institute's contribution will consist of two full-length works by Professor Colson and Mr. Scudder.

Whilst it is not possible to give an accurate financial picture—as the yearly statement from our publishers will not be prepared till July—local sales show an increase to £367, compared with £239 and £234 in the two previous years. This sum excludes £474 in subscriptions (previous year £194) of which three-quarters is credited to the publication fund. The 1957-58 publisher's statement, just received, showed that nett receipts from overseas sales for the period amounted to £1,048.

#### VIII. *Conclusion* :

It will be appreciated from the foregoing that the Institute's activities are by no means limited to social research, any more than are those of a University confined to teaching. Both types of institution have a primary duty of stimulating thought and of creating a climate in which ideas can grow and the boundaries of knowledge be expanded. In spite of set-backs and the limitations which disappointments in recruitment brought about, it is felt that the past year has seen some progress towards these objectives. If this be so it is largely due to those workers both present and past who have so devotedly continued to discover, to record, to analyse and to publish on so many aspects of the social picture, and in their day-to-day contacts to awaken a more general interest in social problems in the public of Central Africa. Not the least contribution in this regard is that of the Research Assistants (African) in stimulating the interest of their fellow countrymen in these matters so vital to their future welfare.

H. A. FOSBROOKE, *Director*.

Lusaka,  
April, 1959.  
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## APPENDIX (I)

*Visitors to the Institute*

About 400 people signed the Visitors' Book during the year, including all Members of the Board of Trustees and of the Research Committee.

From overseas, we welcomed:—

- Lord Robins, President of British South Africa Company, London, E.C.2.
- Professor Leo Silberman, Balliol College, Oxford, England.
- Professor E. de Vries, Director, Institute of Social Studies, The Hague, Holland.
- Miss H. Hodgson, Secretary, Northern Rhodesia House, London, S.W.1.
- Mr. Colin Legum, of "The Observer", London, E.C.4.
- Professor Kenneth Kirkwood, Rhodes Professor of Race Relations, St. Anthony's College, Oxford, England.
- Mr. I. C. M. Maxwell, Asst. Secretary, Inter-University Council for Higher Education Overseas, London.
- Mr. Northcott, United Society for Christian Literature, Bouverie Street, London, E.C.4.

Twenty-one Foreign Service Officers of the United States Seminar Group, who visited the Institute from 17th July—20th July, 1958, as under:—

- Mr. Fred. L. Hadsel, U.S. Embassy, London.
- Mr. Frederick Picard, U.S. Dept. of State, Washington.
- Mr. Richard Post, American Consulate General, Mogadishu, Somalia.
- Mr. William Edmondson, Africa Branch-Division of Research, Dept. of State, Washington.
- Mr. Robert Remole, Africa Branch-Division of Research, Dept. of State, Washington.
- Mr. Albert Disdier, Africa Branch-Division of Research, Dept. of State, Washington.
- Mr. Edward Holmes, Africa Branch-Division of Research, Dept. of State, Washington.
- Mr. Lewis Hoffacker, U.S. Department of State, Washington.
- Mr. Hugh Campbell, U.S. Department of State, Washington.
- Mr. Anthony Rabida, U.S. Department of State, Washington.
- Mr. Rene A. Tron, U.S. Department of State, Washington.
- Mr. Wm. H. Taft, III, U.S. Department of State, Washington.
- Mr. C. Jefferson Frederick, American Consulate General, Leopoldville, B.C.
- Mr. Frank R. LaMacchia, American Consulate General, Nairobi, Kenya.
- Mr. David Post, American Embassy, Pretoria, South Africa.
- Mr. Robert J. Allen, American Embassy, Monrovia, Liberia.
- Mr. Ray H. Grane, American Consulate General, Lorenzo Marques, P.E. Africa.
- Mr. Arva Floyd, American Consulate General, Durban, South Africa.
- Mr. Curtis Strong, American Consulate General, Salisbury, Southern Rhodesia.
- Mr. John D. Leonard, American Embassy, Accra, Ghana.
- Mr. Arthur H. Woodruff, American Consulate General, Elisabethville, Belgian Congo.
- Professor & Mrs. Roland Young, Northwestern University, Evanston, Ill.
- Mr. David A. Gottlieb, American Consulate General, Salisbury, S. Rhodesia.

The following group of American school teachers:—

- Dr. Gwendolyn Drew, Washington University, St. Louis, Mo. U.S.A.
- Miss Kathleen Parr, Detroit, Michigan, U.S.A.
- Miss Josephine Irish, Quincy, Ill., U.S.A.
- Mrs. Albert T. Bonelli, Vicksburg, Mississippi, U.S.A.
- Miss Anita Pfleger, Milwaukee, Wisconsin, U.S.A.

Miss Beatrice E. Cramer, Glouersville, N.Y., U.S.A.  
 Miss Laura MacBrown, St. Louis, Mo., U.S.A.  
 Miss Lee Baker, St. Louis, Mo., U.S.A.  
 Miss Danna Schemmer, St. Louis, Mo., U.S.A.  
 Miss Lillian Classen, St. Louis, Mo., U.S.A.  
 Miss Jean Crowder, St. Louis, Mo., U.S.A.

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Dr. Roland Oliver, School of Oriental & African Studies, University of London, W.C.1, England.  
 Sir David Lindsay Keir, Master of Balliol, Oxford, England.  
 Mr. R. L. Wishlade, Dept. of Anthropology, King's College, Newcastle-on-Tyne, Research Fellow of the International African Institute, London.  
 Dr. Walter Eder, Vienna, Austria.  
 Mr. Robert C. Keith, Washington, D.C., U.S.A.  
 Dr. S. N. Varma, Reader in Political Science, University of Delhi, India.  
 Mr. Barry N. Floyd, Dept. of Geography, Syracuse University, N.Y., U.S.A.  
 Mr. G. A. Atkinson, Colonial Liaison Officer, Building Research Station & Housing Adviser to Colonial Office, London.  
 Mr. Mason Sears, Dedham, Mass., U.S.A.  
 Mr. Elliot Berg, Cambridge, Mass., U.S.A.  
 Dr. Kenworthy Schofield, Reader in Soil Physics, Oxford University, London.  
 Mr. J. C. Morgan, Central African Department, Colonial Office, London.  
 Dr. Wendell P. Jones, School of Education, University of California, Los Angeles, California, U.S.A.  
 Mr. W. A. Sibly, Wycliffe College, Stonehouse, Glos., England.  
 Dr. Frank Lorimer, African Studies Programme, Boston University, Mass., U.S.A.  
 Mr. R. H. Kokernot, The Rockefeller Foundation, New York, U.S.A.  
 Mr. C. W. Jenk, Assistant Director-General, I.L.O., Geneva, Switzerland.  
 Mr. Peter Monkhouse, "The Manchester Guardian", Manchester, England.  
 Mr. F. A. Kienman, Dept. of State, Washington, D.C., U.S.A.  
 Dr. & Mme. P. Rouneguere, Centre Nationale de Recherches Scientifique, Paris, & The Sorbonne, Paris, France.  
 Dr. N. K. B. Robson, Royal Botanical Gardens, Kew, United Kingdom.  
 Mr. & Mrs. Lloyd A. Dunlop, Library of Congress, Washington, D.C., U.S.A.  
 Dr. & Mrs. C. L. van Doorn, World Council of Churches, Holland.

Visits from neighbouring towns and territories in Africa were received from:—

Professor Paul Renny, University of Elisabethville, Belgian Congo—with a party of 16 University students.  
 Mr. D. H. Frost, District Officer-in-charge, Messrs. I. Smith, A. L. Pons, A. A. Gibbs, R. H. Goeig, D. F. Smith, M. A. Hinds, H. T. Kirwan-Taylor, A. H. Dean, and Miss M. M. T. Sydney, being a party from the Native Authority Development Centre, Chalimbana, Northern Rhodesia.  
 Professor and Mme. Hierneaux, Rector, University of Elisabethville, B.C.  
 Rev. Peter Matthews, Secretary, Copperbelt Christian Service Council, Mindolo.  
 Mr. Robert Leaper, Social Welfare Training Organiser, Kitwe, N.R.  
 Mr. C. D. P. T. Haskard, Provincial Commissioner, Northern Province, Nyasaland.  
 Mr. W. V. Brelsford, Director, Federal Information Dept., Salisbury, S.R.  
 Rev. Father P. Kelby, R. Thompson, M. Tyrell and K. Flood, from Chikuni Roman Catholic Mission, Chisekesi, N. Rhodesia.  
 Mr. D. M. Burns, American Consulate General, Salisbury, S. Rhodesia.

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- Prof. B. A. Fletcher, Vice-Principal of Institute of Education, University College of Rhodesia and Nyasaland, Salisbury, S.R.
- Prof. J. Clyde Mitchell, Professor of African Studies, University College of Rhodesia and Nyasaland, S. R.
- Dr. C. A. L. Myburg, Chief Statistician, Central African Statistical Office, Salisbury, S.R.
- Rev. Father Rykers, W.F., St. Mary's Mission, Fort Jameson, N.R.
- Rev. Father J. Vermcerfy, W.F., Cipungo Mission, Kazimuli, Fort Jameson, N.R.
- Rev. Father F. Bovin, W.F., St. Mary's Mission, Fort Jameson, N.R.
- Mr. J. H. Chileshe, Teacher, Mkushi Upper School, Mkushi, N.R.
- Mr. G. N. Ng'umbi, Teacher, Lukona Mission, Mongu, Barotseland, N.R.
- Rev. Fr. A. S. Bockensi, F.F., Education Secretary, Roman Catholic Church, Ndola, N.R.
- Rev. Fr. A. Policarp, F.F., Assistant Education Secretary, Roman Catholic Church, Ndola, N.R.
- Brother Francis Healy, R.C. Church, Ndola, N.R.
- Mr. G. E. Mushikwa, General Secretary, N.R. African Mineworkers' Union, Kitwe, N.R.
- Mr. F. S. Derby, M.L.C. for Livingstone from 1954-1959, Livingstone, N.R.
- Mr. H. N. Parry, C.B.E., Secretary to the Federal Prime Minister and Cabinet Officer, Government of the Federation of Rhodesia and Nyasaland.
- Mr. W. J. McIndoe, Office of the High Commissioner for the United Kingdom, Salisbury, S.R.
- Mr. W. J. S. Hudson, District Officer, plus a party of 24 men on course at the Native Authority Development Centre, Chalimbana, N. Rhodesia.
- Mr. A. C. North, District Officer-in-Charge, plus a party of 8 men on Cadet Course at Native Authority Development Centre, Chalimbana, N.R.
- Mr. C. H. Walter Howe, Ford Foundation Fellow, East African Institute of Social Research, Kampala.
- Mr. C. F. Norton, plus a party of 12 police officers on the Northern Rhodesia Police Course.
- Mr. P. W. C. Clarke, Education Officer, Tabora, Tanganyika.
- Rev. David R. Wilson, Lubwa Mission, P.O. Chinsali, N. Rhodesia.
- Mr. Joseph Palmer, American Consul-General, Salisbury, S.R.
- Mr. A. E. P. Robinson, Chairman, Central African Airways, Salisbury, S.R.
- Mr. Gervase C. R. Clay, Resident Commissioner, Mongu, Barotseland, N.R.
- Mr. Roger Howman, Under-Secretary for Native Affairs, Salisbury, S.R.
- Mr. Richard Brown, Lecturer, Dept. of History, University College of Rhodesia and Nyasaland, Salisbury, S.R.
- Mr. G. Kingsley Garbett, University College of Rhodesia and Nyasaland, Salisbury, S.R.
- Professor and Mrs. Charles Frantz, Visiting Research Professor, University College of Rhodesia and Nyasaland, Salisbury, S.R.
- Dr. Walter Adams, Principal, University College of Rhodesia and Nyasaland, Salisbury, S.R.
- Professor and Mme. J. J. Maquet, Professor Ethnology, Official University of the Belgian Congo, Elisabethville, Belgian Congo.
- Dr. I. M. Lewis, Lecturer, Dept. of African Studies, University College of Rhodesia and Nyasaland, Salisbury, S.R.

- Dr. E. G. Olsen, Fulbright Lecturer in Education, University College of Rhodesia and Nyasaland, Salisbury, S.R.  
 Professor and Mme. Collete, University of Elisabethville, Belgian Congo.  
 Professor John Jacobs, University of Elisabethville, Belgian Congo.  
 Mr. James H. Decou, Information Officer, American Consulate General, Salisbury, S.R.  
 Mr. F. M. N. Heath, District Commissioner, Mongu, Barotseland, N.R.  
 Dr. Desmond Clark, Director, Rhodes-Livingstone Museum, Livingstone, N.R.

Among numerous local residents who visit the Institute and take general interest in its activities, the following may in particular be recorded:—

- George M. Patterson, Esq., O.B.E., Chief Justice of Northern Rhodesia, Lusaka, N.R.  
 Mr. P. O. Coltman, African Housing Board, Lusaka.  
 Mr. D. Fyall, African Housing Board, Lusaka.  
 Mr. T. F. Parker, Regional Director of European Education, Federal Ministry of Education, Lusaka.  
 Mr. A. E. Joubert, Assistant Regional Director of Education, Federal Ministry of Education, Lusaka.  
 Mr. J. J. Keigwin, Commissioner for Rural Development, Lusaka.  
 Mr. R. M. Merson, Lusaka.  
 Mr. W. A. R. Gorman, Deputy Director of African Education, Lusaka, N.R.  
 Lady Edith Page, Lusaka.  
 Mr. and Mrs. Hans Noak, Secretary of the United Northern Rhodesia Association, Lusaka, N.R.  
 Mr. L. G. Vincent, African Housing Board, Lusaka, N.R.  
 Mr. Hedley Roberts, Principal, Munali Secondary School, Lusaka, N.R.  
 Other Members of Munali School Staff and numerous School students.  
 Mr. & Mrs. H. H. Ferreira, Dept. of Welfare & Probation Services, Lusaka, N.R.  
 Mr. H. A. N. Barlow, The Diocesan Secretary, Diocese of N. Rhodesia, Lusaka.  
 Dr. Alexander Scott, Lilanda Estate, Lusaka.  
 Col. and Mrs. N. G. Earl-Spurr, Foxdale Estate, Lusaka.  
 The Rt. Rev. F. Oliver Green-Wilkinson, Bishop of Northern Rhodesia, Lusaka.  
 Mr. & Mrs. A. N. Prentice, Chief Agricultural Officer, Mount Makulu Research Station, N.R.  
 Mr. & Mrs. C. E. Johnson, Deputy Director of Agriculture, Lusaka.  
 Mr. C. E. Cousins, Labour Commissioner, Lusaka.  
 Mr. M. G. Billing, Provincial Commissioner, Secretariat, Lusaka.  
 Mr. John McLellan Shields, Lusaka.  
 Rev. Peter A. Musgrove, Methodist Church, Lusaka.  
 Mr. Michael Piper, Federal Broadcasting Corporation, Lusaka.  
 Mr. C. M. N. White, Land Tenure Officer, Lusaka.  
 Mr. F. B. Macrae, M.L.C. representing African interests, from 1956-1959, Lusaka.  
 Mr. W. D. Dunlop, M.L.C., Minister of Transport & Works, Lusaka.

## APPENDIX (II)

## PUBLICATIONS

## I. Publications by Workers Assisted from Colonial Development &amp; Welfare Funds.

## A. Published during the period under review (1st April, 1958, to 31st March, 1959).

## i. Full-length Books :

GANN, L. G.—*The Birth of a Plural Society : the development of Northern Rhodesia under the British South Africa Company, 1894-1914.* (Published October, 1958.)

COLSON, Elizabeth.—*Marriage and the Family among the Plateau Tonga of Northern Rhodesia.* (Published December, 1958.)

WATSON, William.—*Tribal Cohesion in a Money Economy : a study of the Mambwe People of Northern Rhodesia.* (Published February, 1959.)

## ii. Journals :

*The Rhodes-Livingstone Journal*—"Human Problems in British Central Africa," No. XXIII. (December, 1958.)

## iii. Communications :

No. 11: *The Demographic Structure of Seventeen Villages in the Peri-Urban Area of Blantyre-Limbe*, by D. G. Bettison. (December, 1958.)

No. 12: *The Social and Economic Structure of Seventeen Villages, Blantyre-Limbe, Nyasaland*, by D. G. Bettison. (December, 1958.)

## iv. Conference Proceedings :

Proceedings of the Twelfth Conference of the Rhodes-Livingstone Institute on *Social Relations in Central African Industry* ; ed. by R. J. Apthorpe and David Matthews. (January, 1959.)

## B. Publications at present in the press :

## i. Full-length Books :

CUNNISON, I. G.—*The Luapula Peoples of Northern Rhodesia.*

VAN VELSEN, J.—*The Lakeside Tonga of Nyasaland.*

A reprint of *Seven Tribes of British Central Africa.*

## ii. Journals :

*The Rhodes-Livingstone Journal*, "Human Problems in British Central Africa," No. XXIV.

## iii. Papers :

*Rhodes-Livingstone Institute Paper, No. XXIX*, "A Preliminary Survey of Luvale Rural Economy", by C. M. N. White. Foreword by Charles Johnson, Deputy Director of Agriculture, Lusaka.

## iv. Communications :

No. 13. *The Aushi Village, Northern Rhodesia*, by Elsie Richardson.

No. 14. *A Preliminary Study of the Bantu Languages of the Federation of Rhodesia & Nyasaland*, by G. Fortune, S.J.

No. 15. *Blindness in the Kawambwa District, Northern Rhodesia*, by C. M. Phillips. *African Medicine in the Mankoya District, Northern Rhodesia*, by S. A. Symon ; edited, and with an introduction, by R. J. Apthorpe.

## v. Conference Proceedings :

*From Tribal Rule to Modern Government* : based on the Rhodes-Livingstone Institute's 13th Conference, "The Adaptation of Indigenous Political Systems to Modern Circumstances" ; ed. by R. J. Apthorpe. This publication includes the following papers by members of the Rhodes-Livingstone Institute staff, though it should be noted that contributions are by no means confined to them.



Apthorpe, R. J.—*Clanship and Chieftainship and Nsenga Political Adaptation.*

Argyle, W. J.—*Soli Chieftainship and Political Adaptation.*

Bettison, D. G.—*The Official Headman and Yao Lineage Structure in Peri-Urban Areas, Blantyre-Limbe.*

Fosbrooke, H. A.—*The Application of Indirect Rule to Chiefless Societies in Tanganyika.*

Fosbrooke, H. A.—*Success and Failure in Luguru Adaptation.*

C. Works in Preparation:

*The Social System of the Valley Tonga of Northern Rhodesia*, by Elizabeth Colson. (Full-length book.)

*The Physical Environment of the Valley Tonga of Northern Rhodesia*, by Thayer Scudder. (Full-length book.)

*The Social System of the Nsenga of Northern Rhodesia*, by R. J. Apthorpe. (Articles or Paper.)

*Numerical Data on African Urban Dwellers in Lusaka*, by D. G. Bettison. (Communication No. 16.)

*Poverty in Central Africa: some Measurements, Thoughts and Observations*, by D. G. Bettison. (Paper.)

*Peri-Urban and Urban Budgets in Blantyre-Limbe, Nyasaland*, by D. G. Bettison. (Communication.)

*Sundry Topics, including papers on Marriage and Divorce in the Peri-Urban Area of Blantyre-Limbe, on African Markets, etc.*, edited by D. G. Bettison. (Communication.)

*Traditional and Modern Elements in the Social Structure of Ndirande, Nyasaland*, by D. G. Bettison and R. J. Apthorpe. (Article.)

*Municipal History of Blantyre, Nyasaland*, by V. Ellis.

II. Publications not assisted from Colonial Development and Welfare Funds:

A. Already Published:

Apthorpe, R. J.—“Comparative Analysis of Bantu Women’s Status in Rhodesia and Nyasaland.” *International Institute of Differing Civilisations, Report of the XXXIst Meeting, held in Brussels, 1958, on “Women’s Role in the Development of Tropical and Sub-Tropical Countries”*. Pp. 158-173.

Fosbrooke, H. A.—“The Effects of Economic Change on African Society.” *Proceedings of the Second Study Conference of the United Northern Rhodesia Association, held at Lusaka, October, 1958.*

Fosbrooke, H. A.—“Social Security: what is the Problem in Central Africa, and what part can the Church play in meeting it?” *Proceedings of a Conference held by the Christian Council of Northern Rhodesia in association with The World Council of Churches, at the Mindolo Ecumenical Centre, Kitwe; November, 1958.*

Fosbrooke, H. A.—“Blessing the Year: A Wasi-Rangi Ceremony”. *Tanganyika Notes and Records, No. 50, June, 1958, 21-29.*

Fosbrooke, H. A.—“A Rangi Circumcision Ceremony: Blessing a New Grove”. *Tanganyika Notes and Records, No. 50: June, 1958; 30-38.*

Fosbrooke, H. A.—“Some Historic Moshi Buildings”. *Tanganyika Notes and Records, No. 51: December, 1958; 198-205.*

B. Works in Press:

Bettison, D. G.—“The Private Domestic Servant of Blantyre-Limbe, Nyasaland”. *Nyasaland Journal.*

- Bettison, D. G.—“An Attempt to assess and evaluate the Attitude of the African to Houses and Housing”. *Paper read at the CCTA/CSA Inter-African Conference on Housing and Urbanisation, Nairobi, January, 1959.*
- Bettison, D. G.—“Kinship and Status in Blantyre-Limbe, Nyasaland”. *Paper read at the International African Institute Conference held at Kampala, January, 1959.*
- Fosbrooke, H. A.—“Social Security: A Felt Want in East and Central Africa”. *Bulletin of the Inter-African Labour Institute.*
- Fosbrooke, H. A.—“Walled Towns of the Segeju”. *Tanganyika Notes and Records.*
- Fosbrooke, H. A. and Young, R.—“Political Tension among the Luguru of Tanganyika”. Full-length book in North-western University Press *Africa series.*

Tsetse Fly and  
Trypanosomiasis Committee  
Report for 1958-1959

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The Wellcome Research Laboratories,  
Langley Court,  
Beckenham, Kent.  
19th November, 1959

SIR,

I have the honour to transmit herewith the Report of the Tsetse Fly and Trypanosomiasis Committee for the year ended 31st March, 1959.

I have the honour to be,

Sir,

Your obedient servant,

H. W. MULLIGAN,  
*Chairman.*

The Right Honourable Iain Macleod, M.P.,  
Secretary of State for the Colonies.

**TSETSE FLY AND TRYPANOSOMIASIS COMMITTEE  
REPORT FOR 1958-59**

**Membership**

- MR. W. B. L. MONSON, C.M.G., Assistant Under-Secretary of State, Colonial Office (*Chairman up to 31st December, 1958*).
- COLONEL H. W. MULLIGAN, C.M.G., M.D., D.Sc., The Wellcome Research Laboratories (*Chairman from 1st January, 1959*).
- DR. J. CARMICHAEL, C.M.G., M.R.C.V.S., Dip.Bact., formerly of the Colonial Veterinary Service (*up to 31st December, 1958*).
- PROFESSOR T. H. DAVEY, O.B.E., M.D., D.T.M., Liverpool School of Tropical Medicine.
- MR. R. N. T. W. FIENNES,\* M.A., M.R.C.V.S., The Zoological Society of London (*from 1st January, 1959*).
- PROFESSOR P. C. C. GARNHAM, M.D., D.Sc., London School of Hygiene and Tropical Medicine.
- DR. L. G. GOODWIN, B.Pharm., B.Sc., M.B., B.S., The Wellcome Laboratories of Tropical Medicine (*from 1st January, 1959*).
- PROFESSOR R. M. GORDON, O.B.E., M.D., D.Sc., F.R.C.P., Liverpool School of Tropical Medicine (*up to 31st December, 1958*).
- DR. F. HAWKING,\* D.M., M.R.C.P., D.T.M., National Institute for Medical Research.
- DR. C. A. HOARE, F.R.S., The Wellcome Laboratories of Tropical Medicine (*up to 31st December, 1958*).
- PROFESSOR D. L. HUGHES,\* Ph.D., Dip.Bact.Lond., F.R.C.V.S., Liverpool University (*from 1st January, 1959*).
- PROFESSOR W. E. KERSHAW, D.Sc., M.D., D.T. M and H., Liverpool School of Tropical Medicine (*from 1st January, 1959*).
- DR. E. A. LEWIS, M.Sc., F.R.E.S. (*up to 31st December, 1958*).
- DR. L. HARRISON MATTHEWS, M.A., F.R.S., Scientific Director of the Zoological Society of London.
- MR. W. H. POTTS, formerly of the East African Tsetse and Trypanosomiasis Research and Reclamation Organisation.
- MR. B. WEITZ, M.R.C.V.S., The Lister Institute of Preventive Medicine (*from 1st January, 1959*).
- MR. W. F. DAWSON,\* M.B.E. (*Secretary*).

\* Also a member of the Chemotherapy Panel.

**Ex-Officio Members**

The Directors of the East African Trypanosomiasis Research Organisation and the West African Institute for Trypanosomiasis Research, the Secretary of State's Deputy Chief Medical Officer, and Advisers on Agriculture and Animal Health. The Director of Colonial Medical Research. The Secretary of the Colonial Pesticides Research Committee.

It is the practice to invite the Scientific Liaison Officer for the Federation of Rhodesia and Nyasaland to attend all meetings.

**Terms of Reference**

“To consider and advise on the co-ordination of action, including research and reclamation, directed against human and animal trypanosomiasis.”

TSETSE FLY AND TRYPANOSOMIASIS COMMITTEE  
REPORT FOR 1958-1959

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## TSETSE FLY AND TRYPANOSOMIASIS COMMITTEE

### I. THE COMMITTEE

1. The Tsetse Fly and Trypanosomiasis Committee met three times during the period under review and the Chemotherapy Panel was set up by the Committee four times.

2. On the 1st January, 1959, the main Committee was reconstituted under the Chairmanship of Colonel H. W. Mulligan. In view of the growing importance of chemotherapy, the Panel members joined the Committee so that they might have the advantage of knowing all about the Committee's work and participate in it. No changes occurred in the composition of the Panel during the year.

3. The Committee were as usual called upon for advice on numerous topics but particularly the research programmes of the Regional Trypanosomiasis Research Organisations in East and West Africa. As in previous years its main preoccupation continued to be chemotherapy and chemoprophylaxis, particularly in relation to cattle trypanosomiasis, still a disease of major economic importance in Africa.

### II. FINANCE

4. The allocation of Colonial Development and Welfare money for tsetse and trypanosomiasis research over the five-year period ending 31st March, 1960, remained at £655,000. Expenditure against this allocation up to the 31st March, 1959, was £431,666.

### III. GENERAL

5. In recent years the dramatic advances which have been made in chemotherapy and chemoprophylaxis of trypanosomiasis, particularly animal trypanosomiasis, have necessitated the organisation of drug trials on an extensive scale both in the laboratory and in the field. The Committee's Chemotherapy Panel has played an important part in this work.

6. These advances have quite naturally tended to place special emphasis on the value of drugs in trypanosomiasis control, sometimes to the exclusion of other measures; it is necessary to guard against imbalance in control programmes. The ultimate aim must be to eradicate trypanosomiasis from Africa and this is unlikely to be achieved by the use of drugs alone though they will undoubtedly play an important part in the attainment of this ideal. The solution of the trypanosomiasis problem in Africa is likely ultimately to be brought about by properly planned land utilisation schemes with consequent elimination of tsetse and natural reservoirs of trypanosome infection. It is to be expected that in this process of evolution many different control measures will be involved in addition to the intelligent use of effective drugs. It follows that, for many years to come, due attention must be paid to other important aspects of the trypanosomiasis problem. For example, it is vital to obtain a clear understanding of the natural history of this group of diseases and to continue studies on epidemiology, immunology, protozoology, pathology and, not least, entomology. The value of drugs in the fight against trypanosomiasis is likely to be closely linked with such factors as the immune response of the host and the reduction, if not elimination, of the vector. It will remain an important function of the Committee to ensure that a proper balance is maintained in the research programmes which it is asked to scrutinise.

7. The Committee also has responsibility for advising the Secretary of State as to the best ways in which to apply the funds made available from C.D. and W. sources. Hitherto these funds have been disbursed mainly in the form of grants in support of the trypanosomiasis research organisations at work in the British territories in Africa. While this policy will be continued in so far as political changes in Africa permit, the Committee during the year have noted many instances where it would seem that the advances in knowledge in some aspects of the trypanosomiasis problem in Africa have reached the stage where resources available in the U.K. to tackle such problems could usefully be exploited to a greater extent than has hitherto been the case. An example is the study of immunology to which an invaluable contribution is already being made through the work of Mr. B. Weitz at the Lister Institute of Preventive Medicine. Rapid communications now make it possible for collaborative studies to be undertaken between workers in the U.K. and in Africa, and the Committee believes that invaluable service can be rendered to the various African territories by fostering and co-ordinating collaborative work of this kind. In particular, a great deal can be done, indeed has already been done, along these lines in chemotherapy and chemoprophylaxis. It would be reasonable to expect that the same approach in other directions would secure equally encouraging advances. It may be also that the encouragement of research into the fundamental problems at a chain of centres embracing the competent institutes in the U.K. will be a useful means of rendering continued scientific assistance in this field to the emergent territories.

#### IV. EAST AFRICAN TRYPANOSOMIASIS RESEARCH ORGANISATION

(Director : Dr. W. H. R. LUMSDEN, M.B., Ch.B., B.Sc., D.T.M., D.T.H.)

##### *General*

8. Until a few years ago the only measures which appeared likely to lead to control of the trypanosome diseases of Africa, sleeping sickness in man and nagana in cattle, were those directed against the insects which mainly transmitted these diseases, the tsetse flies. Thus by far the greatest part of the research effort in the last thirty years has been devoted to their study. A vast body of information has been accumulated and has been of very great use in planning control schemes as well as in helping towards a deeper understanding of the mechanisms of transmission and persistence of the diseases. Its value cannot be overestimated. However, some other advances in knowledge have recently led to a change in emphasis. Chief among these has been the coming into use of more efficient drugs.

9. In the animal sphere these drugs have, in the last ten years, opened up the possibility of keeping productive cattle in areas only lightly infected by tsetse; complete elimination of tsetse has ceased to be an absolute necessity. Interest in these drugs, and in the possibility of better ones, has increased, not only with regard to their direct action on the parasites but also in other respects—their interactions with the mechanisms of “immunity” in the host and the possibility of the appearance in nature of parasites resistant to drugs.

10. On the human side also, new drugs have improved the chances of saving the lives of many advanced cases of sleeping sickness who would formerly have been beyond cure. These drugs, together with the administrative measures which exclude from human occupation the huge, and often potentially highly productive, areas of East Africa which are infected, have reduced the immediate dangers. However, this success only brings into greater prominence the main problems—how sleeping sickness persists apparently continuously in infected areas, and under what conditions it may be expected to spread more widely in Africa. Until these mechanisms are better understood, re-occupation of infected areas, at present virtually uninhabited, will not be accomplished without great cost.

11. The considerations outlined above have decided a general reorientation of the research effort of E.A.T.R.O., away from studies specifically directed to elucidating the biology of the tsetse fly, and towards concerted studies taking into account several aspects at one time. For instance, the necessity to understand the epidemiology of the human disease dictates a combined approach in an infected area, using all the skills which can be of application—medical men, and at the same time specialists on the parasites, on the flies and on the wild animals which appear to provide the reservoirs for the persistence of the disease. Similarly on the veterinary side, studies on the efficiency of the drugs and the appearance of parasites resistant to the drugs require to be linked to studies on the reaction of the animals and on measurement of the degree to which the animals are exposed to infection—the trypanosome challenge.

12. This reorientation has begun. It is intended to concentrate all disciplines at the laboratories at Tororo, Uganda, near field areas suitable for integrated studies on both the human and animal diseases. The results of these studies will, of course, be applied or confirmed as necessary in the other East African territories. The arrangement of this Report has been changed to conform with the new approach.

13. The outstations at Morogoro and at Tinde, Tanganyika, were closed in 1958 and preparations are being made for the running down of the Entomological Research Laboratory at Old Shinyanga, Tanganyika, and transference of its staff to Tororo.

14. A considerable number of staff changes took place during the year:

Dr. K. C. Willett, Chief Protozoologist, left on transfer to the West African Institute for Trypanosomiasis Research as Deputy Director; Dr. M. T. Ashcroft, Medical Research Officer, Dr. K. R. S. Morris, Epidemiologist, Dr. J. R. Baker, Protozoologist, and Mr. F. Isherwood, Entomologist, left on completion of their contracts; Mr. A. R. Jenkins, Biochemist, resigned and was replaced by Dr. R. H. Knight, and Miss E. C. Craigie, Veterinary Research Officer, joined on recruitment.

15. Three officers attended the 7th meeting of the International Scientific Committee for Trypanosomiasis Research at Brussels. The Director attended the 6th International Congress on Tropical Medicine and Malaria, in Lisbon, as well as many committees in East Africa.



*Epidemiology*

16. Fundamental studies on the estimation of the degree to which cattle are exposed to infection—the trypanosome challenge—continued throughout the year. Some progress has been made in relating the density and infection rates of fly to the actual occurrence of trypanosomiasis in unprotected cattle; present indications are that the latter may provide an adequate measurement of the many factors involved.

17. From the histories and the “follow-up” examinations of patients treated in the E.A.T.R.O. hospital, a great deal of epidemiological information has been derived. The *T. rhodesiense* disease in the north-eastern regions of Lake Victoria is transmitted, apparently, mainly by *G. pallidipes*. The bite of an infected fly usually gives rise to a tender swelling, the chancre; 65 per cent. of these chancres occur below the knee which distribution indicates *G. pallidipes* as the tsetse fly concerned, as it habitually bites the legs. *G. palpalis*, the other possible transmitting fly, usually bites about the head and the shoulders. In the dry seasons the disease is mainly confined to fishermen and fish-traders, suggesting that the persisting infected foci are strictly coastal, but in the wet season infection extends more widely, involving people living on the inland fringe of the flybelt. The region, generally, offers a very suitable area for the study of the details of the epidemiology of the disease.

18. The main areas in East Africa which are infected by *T. gambiense* sleeping sickness, have been visited and investigated. A great deal of information has been extracted from archives and a series of reports have been prepared which give coherent pictures of the progress of the disease in the past as well as the present situation. The areas concerned are the Aswa River region, Busongora County, West Nile District and Bunyoro District, Uganda, and Nyanza Province, Kenya.

19. Sampling methods for wild tsetse populations continue to be improved. The shortcomings of the “fly-round”, in which assistants catch flies attracted to them while marching over a set route, have been increasingly recognised. New methods of subdivision of the round and analysis of results have improved the prospects of relating fly catches to environmental factors.

20. Comparison of several methods of catching by rigorous statistical designs has revealed effects due to variations in the efficiency of the catchers, coat colour of cattle, and so on.

21. Traps have been increasingly used and evidence was obtained that carbon dioxide acts as an attractant to tsetse; traps with carbon dioxide passed into them caught about 3 times as many flies as untreated traps.

22. The importance of locating resting flies has been realised in the last few years, both for deciding the most effective ways of applying insecticides and for obtaining blood-fed flies to determine the species of animal host important in affording them their food. It has been known for some years that flies disappear from their daytime resting sites on the trunks and branches of trees at about sunset. The introduction of a marking technique using reflecting paints has allowed the location of considerable numbers of flies by night—on the leaves of the trees.

23. The identification of the animals fed on by tsetse has continued and a large body of information is now available. It appears possible that tsetse may be more catholic in their choice of host than was previously thought; in Uganda in areas in which game is being destroyed, percentages as high as 60 of blood meals (*G. morsitans*) from cattle have been recorded.

24. Bushbuck was confirmed as an important host in Western Kenya, suggesting, in view of the recent evidence that bushbuck are carriers of *T. rhodesiense*, that the danger of an outbreak of sleeping sickness in such areas should not be underestimated.

25. Studies on the biting behaviour of *G. swynnertoni* revealed marked differences depending on host attacked; a warthog was mainly bitten about the head, a calf mainly on the legs and flank.

26. A considerable number (190) of wild animals have been examined for trypanosome infections. Only six were found to be infected; of interest were single leopard and lion, both infected with *T. congolense*. Other studies have been concerned with the determination of the species of wild animals likely to be of importance as reservoirs of trypanosomes, and with the species of trypanosomes occurring in tsetse flies, in Nyanza Province, Kenya.

27. Work on the structure of the sense organs in the antennae of tsetse has been pursued in concurrence with behavioural studies both in the laboratory and in the field in an attempt to throw light on the mechanism of attraction to the host.

28. Studies of the ovaries of the tsetse have been made in an attempt to arrive at a method of "ageing" flies, a matter of great importance in assessing the chances of infection; results have so far, however, not been encouraging.

29. Work on the causation of abnormalities in the wing venation of *Glossina* has been continued and it is concluded that the abnormalities are linked to high temperatures in the first half of the pupal stage. As these conditions are known also to conduce to high infectibility of flies, it is possible that the incidence of wing abnormalities may be used as a guide to infectibility.

#### *Protozoology and Immunology*

30. Further evidence has been obtained of an "immunity" conferred on cattle by repeated doses of a drug and inoculations of trypanosomes but, so far, only one trypanosome strain has been involved and whether this "immunity" will be maintained against infections with other strains is not yet known.

31. Studies on the reactions between the trypanosomes and their animal hosts have attempted to explain the variability of form of some species—the polymorphic species—and to recognise substances in the blood inimical to the parasites. The latter have been partially successful but significant advances in this field must await a more intensive attack than is at present possible.

32. A small amount of work has been done on the Soltys agglutination test for the differentiation of trypanosome species; so far the specificity of the test has been upheld.

33. Two atypical strains of the *Trypanosoma brucei* Group, isolated from *Glossina pallidipes* collected at Sakwa, Kenya, have been studied. The strains were concluded to be either of *T. brucei* or of *T. rhodesiense* but, atypically, produced chronic infections in rats until passaged through juvenile monkeys.

34. *Trypanosoma vivax* is important as a parasite of cattle in East Africa but its study in the laboratory is impeded by the fact that the usual laboratory animals, white rats and mice and rabbits, are normally not susceptible. Several avenues have been explored—the use of *Arvicanthis abyssinicus*, a common wild rat in Uganda, the simultaneous inoculation of sheep serum in white rats, and the use of embryonated eggs, so far without success.

35. The establishment at E.A.T.R.O. of a “library” of trypanosome strains, stored deep-frozen, was reported last year. This collection, of first importance to studies on strain characteristics, drug resistance, immunology and so on, has been greatly augmented during the year.

#### Control

36. A trial designed to compare the prophylactic properties for cattle of various anti-trypanosomal substances was completed in July. The drugs tested included Prothidium (Boots Pure Drug Company), two formulations of Antrycide Prosalt (Imperial Chemical Industries) and three formulations of Metamidium (May and Baker). The Metamidium compounds were promising and were considered worthy of more extensive field trials.

37. The trypanosome strains isolated from the cattle in the drug trial above are being examined for drug resistance. None of the strains is resistant to Berenil (Farbwerke Hoechst A.G.) Antrycide methyl sulphate or Matamidium chloride at high dosage levels.

38. The toxicities to cattle of new drugs under East African conditions, and of established drugs at high dosage levels, have been investigated. It appears that high dosages of the established drugs may be used in animals free from liver fluke if they are not subjected to the stress of exercise or of dehydration. Attention has been drawn to the importance of drug effects not reducing the value of the carcass as assessed at meat inspection.

39. At the instance of the Uganda Government a field experiment on “discriminative clearing” has been carried on in Ankole, Uganda, throughout the year. It is evident that by the degree of clearing previously thought to be adequate, about 8 per cent. of the area, *G. morsitans* cannot be eradicated quickly; some six months after the main clearing effort fly densities appear practically unaffected.

40. Physiological studies on the water and fat metabolism of tsetse flies have been pursued and have yielded important results in relation to the control technique of discriminative clearing. Differences in the physiological state of flies in clearing, from that in control areas, were established, but in no instance could a difference in the average age of the flies, as determined by wing-fray, be shown. It appears that discriminative clearing increases the activity of the population but that this may not always affect the population adversely, e.g., if climatic conditions are not stringent or, even if they are, if the probability of host encounter is high.

41. The predators attacking *Glossina* at all stages of its life history have been studied; in the adult stage it appears that a spider, *Hersilia*, may have an important effect on wild populations, perhaps accounting for 30 per cent. of the total daily mortality.

42. Experiments on bush clearing in Kenya indicated that a grass (*Cynodon* sp.) was the most effective "smotherer" to plant after bush clearing to reduce the regeneration which, in the absence of any such treatment, would reconstitute the thicket in as little as three years.

#### *Clinical Studies—Human Trypanosomiasis*

43. For treatment, melarsen oxide/BAL continues the drug of choice in the late stage cases where the central nervous system is involved. Although it is occasionally toxic, fatalities are rare. For cases unresponsive to this drug, investigations have shown that nitrofurazone holds promise.

#### *Miscellaneous Studies*

44. Progress has been made in the working out of methods for the maintenance of tsetse in the laboratory. Various pieces of apparatus to facilitate handling have been devised and flies have been fed successfully through membranes.

45. Some work on the parasites of economically important fish has been done in conjunction with the East African Fisheries Organisation. Trypanosomes and myxosporidia occurred; it was concluded that the type and extent of parasitization of the fish in Lake George and in Lake Victoria were similar.

46. Vegetational studies have been made at both Kingolwira and Shinyanga, Tanganyika, by means of belt transects and the plant associations have been studied mathematically.

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## V. WEST AFRICAN INSTITUTE FOR TRYPANOSOMIASIS RESEARCH

(Director: Dr. K. C. WILLETT, M.A., M.B., B.S., L.R.C.P., M.R.C.S.)

### General

47. The work of the Institute has been handicapped throughout 1958 by shortage of staff, caused partly by unfilled vacancies and partly by the absence of officers on leave. Since the last report the Institute has lost five officers; Dr. Nash, the Director, who left on retirement, in March, 1959; Dr. M. P. Hutchinson, Deputy Director at the end of 1957; Mr. W. A. Page, Entomologist; Colonel C. E. Dixon, Secretary; and Mr. W. H. Kitchen, Senior Laboratory Superintendent in 1958. Major J. G. H. Brotherton has taken over the post of Secretary. In October, Dr. K. C. Willett was appointed as Deputy Director; he has since succeeded Dr. Nash as Director. In November the vacancy for a Veterinary Research Officer was filled by Mr. A. R. Gray and in December Captain G. Brind was appointed Administrative Assistant at Vom.

48. It is pleasant to record that Dr. Nash's long and distinguished services as a tsetse entomologist in Nigeria were recognised by the award of the C.M.G. in the Birthday Honours List. The Institute has been visited by many distinguished persons during the year and also by twenty-two parties from various educational centres. The museum, or information bureau, which is of great value on such occasions, is kept up-to-date by additions illustrating the latest developments, and is designed to present exhibits which are clear enough to convey their meaning to untrained visitors and yet be of interest to experts.

49. At the request of the Managing Committee the Director prepared a paper on the work and functions of the Institute which was published in *The New Scientist* in July, 1958. Later, in November and December, he made a five-week tour of Ghana, at the request of the Government, investigating local problems of animal and human trypanosomiasis.

50. Eight papers were submitted to the Seventh Meeting of the International Scientific Committee for Trypanosomiasis Research, which was held in Brussels in August. These papers are included in the list of publications below.

### Animal Trypanosomiasis

#### *Chemoprophylaxis and Chemotherapy*

51. Work is continuing on trying to produce the ethidium-suramin complex in a form which will cause less serious injection-site reactions; various lines have been investigated, but will not be mentioned owing to the complications caused by patent rights. Nothing outstandingly promising has as yet been discovered.

52. A small-scale experiment has been carried out with the suramin complexes of Prothidium and R.D. 2902, administered at 5 mg./kg., as the original investigations suggested that both were promising. The results for the duration of prophylaxis are suspect as it is believed that the wild flies used for the challenge were harbouring drug-fast strains of trypanosomes. However, the important discovery was that, in the six animals used for the Prothidium-complex, and the three used for the R.D. 2902-complex, there were no unduly severe swellings and not a single case of skin necrosis. These complexes, in particular that of Prothidium, will be further investigated, using higher dose-rates.

53. A small trial has been undertaken on Metamidium (M & B 4404) and on M & B 4427, which is the suramin complex of Metamidium. Two beasts were treated intramuscularly with Metamidium at 10 mg./kg., but at this dose the drug is extremely toxic. Two beasts which were treated at 5 mg./kg. were protected for 242 and 204 days; the latter beast might have been protected for longer had it not died of piroplasmiasis; during the first month both beasts suffered from moderately severe swellings and some weight loss. Three animals were treated with M & B 4427 at 10 mg./kg. and three at 20 mg./kg.; the first break-throughs occurred at 105 and 128 days respectively.

54. Metamidium, administered intramuscularly at 0.8 mg./kg., has proved very effective as a curative for animals infected with strains of trypanosomes which are resistant to other trypanocidal drugs. Thus Metamidium has "cured", after a minimum observation period of 3

months, all the eight animals which were carrying trypanosomes resistant to both ethidium bromide and antrycide dimethylsulphate. But it is felt most strongly that Metamidium should never be used as a curative for such animals except in tsetse-free country. Two animals, both treated with M & B 4427 and later with Metamidium at 0.2 mg./kg., subsequently could not be cured by Metamidium at 0.8 mg./kg., thus indicating that trypanosomes can become resistant to this drug. Such trypanosomes might be propagated in the field were this drug used on a large scale, in the presence of fly, to treat cattle harbouring strains resistant to antrycide and ethidium.

55. A possible technique has been worked out for the measurement of drug resistance which depends on the fact that, in a batch of infected animals, a subcurative dose of a drug will clear the blood for a much shorter time if the strain is resistant to that drug than if it is not. Drug-resistance may therefore be measurable by comparisons of periods between treatment and relapse. Thus with trypanosome strains isolated from wild flies collected in places such as Mami, Mokwa and Ugbobigha, where there has been no mass therapeutic treatment of cattle, a dose of 0.25 mg./kg. of ethidium bromide results in cure or a long relapse period of 21 days or over; but with strains from places in Zaria Province (such as Zonkora, Gamagira and Kauru) where there has been much mass treatment of cattle, the interval between treatment and relapse is very short, usually 6 to 9 days. It must be emphasised that until these experiments have been repeated and the method proved consistent it would be premature to stress its value.

56. The distribution of Prothidium, R.D. 2902 and Ethidium in rabbits has also been studied, making use of the fact that all three drugs fluoresce under ultra-violet light. It has been found that both R.D. 2902 and Ethidium differ markedly from Prothidium in that they show affinity for the liver and thyroid; they are structurally more closely related to each other than to Prothidium. If Ethidium disturbs normal thyroid function it might account for the weight-loss, in a proportion of our beasts treated with large doses of the ethidium-suramin complex, when no other symptoms of general toxicity could be detected.

57. An experiment has just been started on the prophylactic activity of antrycide-suramin complex and antrycide chloride against *T. simiae* in pigs.

#### *Protozoological Studies*

58. The work has continued on the acute strain of *T. congolense* which, at the time of the last Annual Report, it was believed might be identical with *T. dimorphon*; however, Dr. C. A. Hoare, F.R.S., considers that it is a strain intermediate between typical *T. congolense* and *T. dimorphon*. Nevertheless, for ease of reference the Institute is continuing to call it *T. dimorphon* (?). It has been found that this trypanosome will kill cattle, three beasts having died within 37 to 71 days of being challenged. Further comparative measurements of *T. dimorphon* (?) and *T. congolense* have been made; the general picture is that *T. dimorphon* (?) appears to be longest when in dogs and shortest when in cattle.

59. Further work has also been done on the suppressive effect of cod liver oil on trypanosome infections, obtaining confirmation of the nature of the suppressive component, and showing that *T. dimorphon* (?) is particularly susceptible.



### *Immunity Studies*

60. An interesting comparison has been begun of the course of induced trypanosome infections in a Zebu calf and in an N'Dama calf which happened to be born almost simultaneously at Vom. This should throw valuable light on the relative susceptibility of these two breeds.

## **Human Trypanosomiasis**

### *Laboratory Investigations*

61. Several strains of *T. gambiense* and one each of *T. rhodesiense* and *T. brucei* have been maintained for parts of the last year; some were discarded when of no further value and the *T. brucei* strain was only isolated in May, 1958. Prolonged observation continues on the effects of syringe-passage on the morphology, virulence and transmissibility by tsetse of these strains. Two points of interest have emerged. One is that two strains of *T. gambiense* have become completely monomorphic and, though the process in one took eight years and in the other only five years, the number of passages has been very similar in the two strains—about 700. The other is that the strain of *T. brucei* we have is comparatively avirulent, an unusual finding in this species of trypanosome.

62. It has been found that the proportion of *G. palpalis* which become infected with *T. gambiense* can be greatly increased by giving the flies their infective meal within 24 hours of emergence; combined figures for 1957 and 1958 show that, out of 724 flies induced to feed during their first day of life, 7.5 per cent. developed mature infections. As it has also been found that flies can be fed anally a preliminary experiment has been done in which blood from an infected monkey was injected *per anum* into *G. palpalis*. Out of 82 injected flies which survived for 21 days, 15.9 per cent. developed mature infections; in the control group of 88 first-day flies, fed on the same monkey, the comparable figure was only 5.7 per cent. It has been shown that flies infected in this manner will infect a clean monkey. Though high mortality is still a problem when flies are fed anally, it is hoped that by refinements of technique it may be possible to reduce mortality and achieve even higher infection rates. These discoveries should greatly facilitate future work on human sleeping sickness.

63. Investigations into the behaviour of the polymorphic group of trypanosomes in mammalian hosts have been extended to include studies of *T. brucei* in white rats. Previous results had led to the belief that the long-slender forms in mammalian blood shrank during a recession in parasitaemia to become short-stumpy forms most of which died. As in the previous work, it was not at first possible to show consistently that a peak in intermediate forms occurred in between the peaks in long and stumpy forms, failures possibly being because the peaks occurred in between the once-daily observations. The frequency of examination was then raised to three times a day and marked peaks in intermediate forms were found to occur consistently between peaks in long and short forms. These peaks were, however, less conspicuous between peaks in short and long forms, perhaps because a proportion of the newly appearing long-slender forms are the products of division of those long forms which have survived the crisis.

64. Investigation has continued of the possibility that previous challenge with species of animal trypanosomes may influence susceptibility to infection by *T. gambiense*. Experiments with *T. vivax* in monkeys have, so far, shown a response to this challenge in the electrophoretic pattern of the serum proteins, but this response in no way influenced susceptibility to *T. gambiense* infection.

65. The action of various drugs on cell-free extracts of trypanosomes is also under investigation. The extracts are prepared by disrupting the organisms with ballotini beads in a Mickle shaker, and the action of a number of drugs on these extracts has been studied. It has been found that ethidium bromide, antrycide dimethylsulphate, prothidium and berenil cause a denaturation of a portion of the trypanosome protein. The denatured material appears to be an insoluble complex of the protein and the drug. Other drugs such as suramin and tryparsamide cause no such denaturation with insoluble drug-protein complex formation. The quantitative nature of this complex formation is now being studied, the action of berenil on extracts of *T. gambiense* being the subject of the initial investigation.

66. Strains of *T. gambiense* are now being made resistant to berenil. When this is accomplished the quantitative combination of berenil with protein from extracts of normal and drug-resistant trypanosomes will be compared. This experimental approach may yield valuable information on the mode of drug action and the mechanism by which trypanosomes become drug resistant.

67. Another approach to the problem of drug-resistance has been made by the electrophoresis of the proteins in homogenates of trypanosome suspensions. Early difficulties, in which movement of the trypanosome protein was difficult to obtain, have been overcome and it is intended to apply the technique to the study of the effects of acquired drug-resistance on the proteins in trypanosomes.

### Insect Vector

#### *Laboratory Investigations*

68. Breeding of *G. palpalis* on a large scale has continued and, as in previous years, has provided large supplies of pupae and flies for use in the Institute and elsewhere. For the first time it has been possible to introduce air-conditioning into the fly-room, backed by adequate service facilities, and the early results have been very encouraging. Some progress has been made with the large-scale breeding of *G. morsitans* but results still fall short of those obtained with *G. palpalis*.

69. The technique of anal feeding of tsetse flies, already proved possible, has been continued and has now, as reported in the section on Human Trypanosomiasis, been applied to the infection of *G. palpalis* with *T. gambiense*; in the first experiment a remarkably high infection rate was obtained.

70. The systematic studies by Dr. Nash and Dr. Jordan of the *fusca* group flies found in West Africa have been completed and have now been published in a guide to the identification of these species.

*Field Investigations*

71. The results of three years' investigation of the ecology of *G. palpalis* and *G. longipalpis* in the southern forest belt have been prepared for publication. One of the interesting findings, which may account for the relative scarcity of *G. palpalis* in this belt, is that, though the annual increase of population in the middle of the rains is associated with conditions of temperature and humidity very similar to those during the period of increase in Northern Nigeria, these conditions persist for a much shorter time in the south—two months as compared with four in the north.

72. As in Northern Nigeria, female *G. palpalis* appear readily to man, the percentage in the total catch being 45.5 at Ugbobigha as compared with 49.1 in the north. But hunger, as indicated by the proportion of old males found to be hungry on capture, was found to be far less at Ugbobigha—8 to 22 per cent., as compared with 24 to 43 per cent. in the north.

73. Studies on diurnal activity indicated that temperature is the dominant factor. Activity increases steadily throughout the morning, becomes greatest in the early afternoon, and then decreases until dusk; in the hotter seasons of the year the morning increase in activity is more rapid. Whereas activity is as great in overcast weather as in full sunshine, it is reduced to less than half by rain.

74. Dissection of 1,635 *G. palpalis* showed 2.1 per cent. to have mature trypanosome infections, 1.4 per cent. with *vivax* group trypanosomes and 0.7 per cent. with *congolense*; there was no difference between the infection rates in the two sexes.

75. The population of *G. longipalpis*, after becoming minimal in the early rains, then increases rapidly, but levels off in the middle of the rains, before rising again to its peak in the early dry season; throughout the dry season the population decreases to become minimal again in the early rains. Unfavourable conditions for this species of fly are associated with mean monthly saturation deficits below 2 mb. or above 7 mb.; the optimum range lies between 4 and 5 mb. The dry season evacuation of the savannah woodland and concentration in the vicinity of forest is associated with savannah saturation deficits reaching 7 mb. or over; wet season dispersal is associated with savannah saturation deficits dropping to 6 mb. or below. These findings suggest that in the laboratory *G. longipalpis* should be kept at a temperature of 77°F. (25°C.) and a relative humidity of 85 per cent.

76. It has been found that the pregnancy rate in *G. palpalis* is far lower in the southern forest belt than that previously found near Kaduna in the north. The difference is not due to lack of fertilisation but appears to be due to some factor, as yet unknown, which causes abortion in the later stages of pregnancy.

77. The main effort of the ecological research at the southern field station has recently been concentrated on the available species of the *fusca* group—*G. fusca*, *G. tabaniformis*, and *G. medicorum*, and a few *G. nigrofusca*. Ecological studies by means of bait-ox fly-rounds, in which the flies were killed for identification purposes, so reduced the fly population that techniques of marking and release had to be employed. Much has already been learnt of the seasonal fluctuations in population and the pattern of diurnal activity for the various species present. Some basic data have been obtained

on the normal sex proportion and duration of the pupal period by rearing flies in the laboratory. Infection rates of these flies with trypanosomes have already been reported but the size of the samples has since been appreciably increased though without substantial effect on the infection rates found. A small sample of *G. pallicera* has been added to the previous list and some of these were found to be carrying trypanosomes.

78. The work in conjunction with Mr. B. Weitz of the Lister Institute has been continued and blood meals, obtained at the southern field station, at a place about 180 miles to the west, and near Kaduna, have been identified. In the south, interesting differences between species in feeding habits have been revealed, some feeding mainly on Suidae and others on game, particularly bushbuck. The sample of feeds from *G. morsitans* near Kaduna has been very substantially increased but still the proportion of feeds on Suidae remains at 55 per cent. A number of interesting, and sometimes unexpected, observations have been made such as that the porcupine is quite an important secondary host for *G. tabaniformis* and that *G. morsitans* also occasionally feeds on this animal; also four feeds on aardvark have been identified. Until recently no blood meals from the ubiquitous species of duiker had been identified, but in the latest results four of these have occurred.

79. The nocturnal resting sites of *G. palpalis* have been investigated using a source of ultra-violet light to find flies previously marked with luminescent paint. Early results suggest that about half the flies rest within one foot of the ground and very few above eight to ten feet up. Most flies were located on the upper surface of small leaves, a few on slender creepers but one on a tree-trunk. Should it be found that within a period of a few days almost every fly rests on vegetation within one foot of the ground, a great economy in the use of insecticide would be possible.

### Publications

Reports and scientific papers, published or prepared for publication during the year, are listed below, by Authors in alphabetical order.

CHANDLER, R. L.—Studies on the Tolerance of N'Dama Cattle to Trypanosomiasis. *J. comp. Path.*, Vol. 68, No. 2, pp. 253-260.

CHANDLER, R. L.—Studies on Cattle Protected by Antrycide and Exposed to Regular Challenges with Trypanosomes. *J. comp. Path.*, Vol. 68, No. 2, pp. 261-263.

DESOWITZ, R. S.—The Measurement of Antibody Occurring in Human and Bovine Trypanosomiasis by a Respirometric Method, 6th Int. Congr. Trop. Med. and Malaria, Lisbon.

FAIRBAIRN, H.—The Penetration of *Trypanosoma rhodesiense* through the Peritrophic Membrane of *Glossina palpalis*. *Ann. trop. Med. Parasit.*, Vol. 52, No. 1, pp. 18-19.

GODFREY, D. G.—The Local Reaction in Man at the Site of a Fly Transmitted Infection of *Trypanosoma rhodesiense*. 7th Meeting I.S.C.T.R., Paper No. 23, Brussels.

GODFREY, D. G.—Variations in Pathogenicity amongst *congolense*-like Trypanosomes in Relation to their Morphology. 7th Meeting, I.S.C.T.R., Paper No. 35, Brussels.

JORDAN, A. M.—The Mating Behaviour of Females of *Glossina palpalis* (R.-D.) in Captivity. Bull. ent. Res., Vol. 49, Part 1, pp. 35–43.

JORDAN, A. M., PAGE, W. A., and McDONALD, D. A.—Progress made in Ascertaining the Natural Hosts Favoured by Different Species of Tsetse. 7th Meeting I.S.C.T.R., Paper No. 18, Brussels.

McDONALD, W. A., and WIJERS, D. J. B.—Anal Feeding as a Method for Infecting Tsetse Flies with *Trypanosoma gambiense*. Ann. trop. Med. Parasit., Vol. 53, No. 1 (in press).

NASH, T. A. M.—The West African Institute for Trypanosomiasis Research, Annual Report, 1957. London: Harrison and Sons.

NASH, T. A. M.—The Tsetse Fly and the Trypanosome. The New Scientist, Vol. 4, No. 87, pp. 434–437.

NASH, T. A. M.—The Effect of Different Types of Man-Fly Contact upon the Distribution of *T. gambiense* Sleeping Sickness in Nigeria. 7th Meeting I.S.C.T.R., Paper No. 19, Brussels.

NASH, T. A. M., and JORDAN, A. M.—A Guide to the identification of the West African Species of the *fusca* Group of Tsetse Flies, by Dissection of the Genitalia. Ann. trop. Med. Parasit., Vol. 53, No. 1 (in press).

NASH, T. A. M., PAGE, W. A., JORDAN, A. M., and PETANA, W.—The Rearing of *Glossina palpalis* in the Laboratory for Experimental Work. 7th Meeting I.S.C.T.R., Paper No. 33, Brussels.

PAGE, W. A.—The Ecology of *Glossina palpalis* in Southern Nigeria. (Despatched for publication.)

PAGE, W. A.—The Ecology of *Glossina longipalpis* in Southern Nigeria. (Despatched for publication.)

PAGE, W. A.—Some Observations on the *fusca* Group of Tsetse Flies in the South of Nigeria. (Despatched for publication.)

PAGE, W. A., and JORDAN, A. M.—The Economic Importance of some West African Species of *fusca* Group Tsetse Flies. 7th Meeting I.S.C.T.R., Paper No. 17, Brussels.

PAGE, W. A., and McDONALD, W. A.—An Assessment of the Degree of Man-fly Contact Exhibited by *Glossina palpalis* at Water-holes in Northern and Southern Nigeria. (Despatched for publication.)

STEPHEN, L. E.—Suramin Complexes. IV.—Ethidium bromide Complex: a Large Scale Laboratory Trial of its Prophylactic Activity in Cattle. Ann. trop. Med. Parasit., Vol. 52, No. 4, pp. 417–426.

STEPHEN, L.E., and WILLIAMSON, J.—Suramin Complexes. V.—Ethidium Complex: Attempts to Overcome the Injection Site Reaction in Cattle. Ann. trop. Med. Parasit., Vol. 52, No. 4, pp. 427–442.

WIJERS, D. J. B.—Polymorphism in *Trypanosoma gambiense* and *Trypanosoma rhodesiense* and the Significance of the Intermediate Forms. Ann. trop. Med. Parasit., Vol. 53, No. 1 (in Press).

WIJERS, D. J. B.—The Importance of the Age of *G. palpalis* at the Time of the Infective Feed with *T. gambiense*. 7th Meeting I.S.C.T.R., Paper No. 22, Brussels.

WILLIAMSON, J.—Some Factors in Determination of the Surface Tension of Saline Solutions of Blood Serum. *W. afr. J. biol. Chem.* (in Press).

WILLIAMSON, J.—Progress with Suramin Complexes in the Treatment of Animal Trypanosomiasis. 7th Meeting I.S.C.T.R., Paper No. 20, Brussels.

N.B. I.S.C.T.R., above, refers to the Seventh Meeting of the International Scientific Committee for Trypanosomiasis Research, held in Brussels in August, 1958.

## VI. ACTIVITIES OF TERRITORIAL DEPARTMENTS

80. Widespread research continued in the chemotherapy and chemoprophylaxis of trypanosomiasis, particularly in cattle. New drug formulations emerged and more effective techniques in using the older drugs were devised.

81. In Sierra Leone the Veterinary Department completed the trials with the Antrycide Suramin Complex prepared by the West African Institute for Trypanosomiasis Research for use against *T. Simiae* infection in pigs. The results indicate that a promising degree of protection was afforded to the treated animals.

82. The Veterinary Department, Northern Region of Nigeria in collaboration with the Tsetse Control Section still continue to make a significant contribution towards the testing of new drugs. Prophylactic trials with Prothidium (Boots Pure Drug Co. Ltd.), were completed and the drug was discarded owing to its delayed toxicity, marked local reaction and short prophylactic period under Northern Nigeria conditions. Curative and prophylactic trials with 4404 (Metamidium) (Messrs. May and Baker Ltd.), continue at the new stations at Marka and Dudawa. Preliminary investigations show that drug resistant strains especially against Ethidium bromide and Antrycide methylsulphate are being produced in the field and extended investigations are under way to determine their distribution and prevalence.

83. The Control Sections programme to eradicate *G. morsitans* and *G. tachinoides* for the Kanaduga Goma River in Azare by spraying tsetse resting sites with insecticide (D.D.T.) is nearing completion. The programme to eliminate *G. tachinoides* from the Moya Ime River and its tributaries, Adamawa province, proceeds satisfactorily while results of river spraying in South Zaria to eliminate *G. palpalis* were highly promising. Unfortunately, however, surveys continued to show advances of *G. morsitans* from the central fly belt, northwards into Katsina, Kano and Sokoto provinces.

84. In Nyasaland an investigation in the Lower River Districts has demonstrated that the primary cause of economic loss in the area is due to trypanosomiasis, the causal organism being *T. congolense*, the transmission being largely mechanical through biting flies. It was also observed that trypanosomes could not be demonstrated in the blood of animals which had shown a heavy parasitaemia immediately prior to death and this rapid disintegration of the parasites may well have been a reason for the low mortality attributed to the disease in past years.

85. Trials were also carried out with Dimidium and Antrycide, and although observations were limited, it was apparent that some resistance to the first drug is present and that there is a real hope of eradicating the reservoirs of mechanical transmission by the use of the second drug in its therapeutic and prophylactic forms.

86. The chemotherapy of three local strains of *T. simiae* was investigated in Northern Rhodesia. Four field experiments were started in various parts of the territory to compare the comparative prophylactic efficiency of Antrycide methylsulphate, Antrycide Pro-salt and Prothidium under conditions of natural challenge. The programme will be continued for at least another year.

87. Extensive field trials with thousands of cattle being treated have so far shown that Ethidium bromide and Novidium can be safely used in treating cattle in areas where previously there had been severe and numerous instances of toxicity following the application of Dimidium bromide. No cases of toxicity following the application of the two former drugs have been recorded.

88. Two cases of *T. brucei* infection in dogs were treated. In both instances the dogs, belonging to Game Department officials had been under Antrycide Prosalt prophylaxis. They confirmed previous observations that, when dogs contract *T. brucei* infection following administration of Antrycide, they do not respond to treatment with Pentamidine but to Melarsan, whereas experience shows that such cases without previous Antrycide treatment invariably respond perfectly to treatment with Pentamidine.

89. The Tanganyika Veterinary Department continued toxicity and field trials with newly available prophylactic drugs, the results of which have been published or prepared for publication as follows:

Robson, J.—Treatment and prophylaxis of bovine trypanosomiasis. Bull Epizoo. Dis Africa. In Press.

Robson, J., and Cawdery, M. H.—Prophylaxis against trypanosomiasis in Zebu cattle. Veterinary Record, **70**, 870.

Robson, J.—A field trial of prophylactic drugs against trypanosomiasis in Zebu cattle. Veterinary Record, **70**, 925.

Robson, J., and Cawdery, M. H.—An estimate of the trypanosome challenge to cattle in tsetse areas. In Press.

90. Steady progress was made by the Kenya Veterinary Department, particularly in the use of insecticides for the eradication of tsetse, field trials with trypanocidal drugs, and extensive laboratory tests with a special study of strains showing drug resistance and cross-resistance to different drugs and in mechanical bush clearing. Regrowth (mainly of *Euclea*) has become a very serious problem in the maintenance of tsetse barriers, as no economic method for its control has yet been devised.

91. The Kuja-Migori river system in South Nyanza which was treated with insecticides against *G. palpalis*, the vector of Gambian sleeping sickness in 1955 and 1956 has remained free of fly. The greater proportion of the Kabuoch forest has now been sprayed and the tsetse numbers greatly reduced in all the sectors treated.

92. About 600 acres of fly-infested bush in West Suk were cleared by tractors as an experiment. The agricultural settlement scheme in the Meru area is progressing very well and about 2,570 acres of bush were cleared for cultivation during the year. Progress on the Athi-Tiva scheme was satisfactory. There was a good growth of grass over the whole area and the burning programme in September proceeded very well.

93. In the Makueni settlement a strain of trypanosome resistant to Antrycide and Homidium appeared in the perimeter farms nearest the fly bush. About 1,500 head of cattle were involved and plans were made to evacuate them and to clear more bush. At Simba an experiment to discover whether *G. pallidipes* could be reduced by insecticidal spraying, in the face of heavy tsetse invasion from outside the treated area, was begun and has shown some success.

94. Studies into the blood meals of *G. longipennis* and *G. swynnertoni* were continued and it was confirmed that *G. longipennis* feeds mainly on rhinoceros and *G. swynnertoni* on warthog. A new type of trap designed to resemble a fallen log, was tested for *G. longipennis* with some success.

95. The new trypanocidal substance 4404 (Metamidium) was tested at Athi-Tiva in a comparative experiment with Antrycide Pro-salt (new formulation). This involved treating two herds of animals—one with Metamidium and the other with Antrycide Pro-salt (new formulation) at three-monthly intervals. All the animals treated have had complete protection from trypanosomiasis for twelve months. In the Lambwe Valley field trials were conducted with a breeding herd treated with Antrycide Pro-salt in a high tsetse fly density. Some of these animals, however, became infected with trypanosomiasis despite the treatment and the herd was moved into less heavily infested country.

96. The work of the Kenya Veterinary Department is indicated by the following scientific papers prepared by members of the Kenya Veterinary Research Laboratory :

Fairclough R., "Preliminary observations on a new phenanthridinium derivative with chemotherapeutic activity against bovine trypanosomiasis". 7th Meeting I.S.C.T.R.

Glover, P. E., le Roux. J. G. & Parker D. F., "The extermination of *Glossina palpalis* on the Kuja-Migori River Systems with the use of insecticides".

Weitz, B. (Lister Institute of Preventive Medicine), Langridge, W. P., Napier Bax P., & Lee-Jones F. "The Natural Hosts of *Glossina Longipennis corti* and of some other tsetse flies in Kenya." 7th Meeting I.S.C.T.R.

Whiteside, E. F. "The Control of animal trypanosomiasis in Kenya" 1958 I.A.C.E.D. Symposium.

Whiteside, E. F. "The Maintenance of cattle in tsetse infested country. A summary of four years' work in Kenya". 7th Meeting I.S.C.T.R.

97. The Uganda Veterinary Department carried out initial toxicity trials with 4404 (Metamidium) and 4427M (Metamidium suraminiate) which indicated that the latter is more likely to be of use as a protective drug to enable cattle to be held in tsetse fly infested areas. A large-scale field trial has been staged in Ankole District to test its efficiency as a prophylactic; the drug is being administered to groups of cattle in country infested with *Glossina morsitans* at three-monthly and five-monthly intervals.



Report of the Director,  
Anti-Locust Research Centre,  
on Locust Research and Control  
(1958-59)

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Anti-Locust Research Centre,  
1, Princes Gate,  
Kensington,  
London, S.W.7.  
31st March, 1959.

SIR,

As the retiring Director of the Anti-Locust Research Centre, I have the honour to transmit to you my Report on Locust Research and Control for the year 1958-59.

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, 1958-59

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## LOCUST RESEARCH AND CONTROL, 1958-59

### GENERAL

1. The year under review has been marked by various developments, reported in detail in the subsequent sections, which represent important trends in anti-locust work.

2. Firstly, there has been a notable tendency towards expanding and strengthening international co-operation both in locust control and in those lines of research which provide a basis for practical anti-locust measures. Three United Nations bodies, FAO, UNESCO and WMO, are now taking an active part in their respective spheres, working in association, or in consultation, with the Anti-Locust Research Centre.

3. Secondly, research on problems of locust biology, which is essential for developing a rational long-term anti-locust policy, has made good progress not only through the work of the Centre, but also, and to a large extent, in Universities and in other British and foreign laboratories, where the locust is now regarded as a very suitable insect for teaching and for research. As the result of this, locusts are used for many investigations of fundamental character which could not be undertaken by the Centre as they require special equipment, but which contribute greatly to our knowledge of locust biology.

### ANTI-LOCUST RESEARCH CENTRE

#### *Personnel*

4. As in the past, a number of research workers from British and international overseas locust organisations have been working for varying periods at the Centre, on attachment, or while on leave. They included: Dr. W. J. Stower and Messrs. C. Ashall, J. Roffey and H. J. Sayer of the Desert Locust Survey; Dr. D. L. Gunn of the International Red Locust Control Service; Mr. J. T. Davey of the International African Migratory Locust Organisation; and Mr. G. B. Popov and Mr. C. O. Rossetti of the FAO/UNESCO Desert Locust Ecological Survey.

#### *Locust information service*

5. There was no abatement of the Desert Locust plague in 1958, which has been marked by widespread and heavy spring breeding in the Middle East and north-west Africa, followed by particularly heavy summer breeding in northern Ethiopia, the Sudan Republic and several West African territories. There were large-scale escapes from control and by early 1959 these had spread widely throughout northern Africa and the Arabian peninsula and to some Middle East countries.

6. In April, 1958, the International Desert Locust Information Service (I.D.L.I.S.) was established by an agreement between the United Kingdom Government and the Food and Agriculture Organisation. The Service forms an integral part of the Centre and is partly financed by an FAO grant, which has made it possible to increase the accommodation and to add two people to the staff of the Geographical Section.

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7. In the course of the year, 953 reports were received from some 40 territories, and monthly summaries and forecasts have been issued by I.D.L.I.S., accompanied by maps showing the current distribution of swarms and hopper bands; the summaries are in English, and are followed by French translations prepared by FAO and sent out to those countries where that language is preferred. In early October, 1958, a special warning was issued that summer breeding in Africa was leading to exceptionally heavy escapes threatening the invasion of many countries; subsequent events have fully justified this warning.

*Conferences, tours, lectures and discussions*

8. Dr. B. P. Uvarov attended meetings of the Executive Committee of the International African Migratory Locust Organisation in Paris in April and December, the FAO Technical Advisory Committee and the FAO Desert Locust Control Committee in Rome in June, the Working Group of the FAO/UNESCO Ecological Survey in Paris in December, and the Desert Locust Committee in Nairobi in January, 1959. Dr. T. H. C. Taylor, accompanied by Dr. P. T. Haskell, visited field research workers in Ethiopia and Somaliland Protectorate and the headquarters of the Desert Locust Survey in Nairobi in February-March, 1958; in June he attended the annual session of the Council of the International African Migratory Locust Organisation in Brussels. Dr. P. T. Haskell, in the course of his tour in Africa, took the opportunity of testing new apparatus for micro-climatic research which he had designed; this portable apparatus is also being used by the African Migratory Locust Organisation. In Britain, he visited the Universities of Edinburgh, Newcastle, Manchester, Bristol, Cambridge, Oxford, Cardiff and London, lectured on "Locust Research and Control" at Queen Mary College and took part in a television programme on locusts. Dr. R. C. Rainey attended meetings of FAO Committees in Rome in June as a member of the United Kingdom delegation. He has given the following lectures: "Locusts and weather, an exercise in applied meteorology" in the extra-mural course on meteorology of London University; "The flight of locust swarms" in the extra-mural course on "Weather and flight" at Birmingham University; and "Some observations on flying locusts and atmospheric turbulence in eastern Africa" at a meeting of the Royal Meteorological Society. Miss T. Kikal attended the 4th International Congress of Biochemistry in Vienna in September and presented a paper on "Detoxication mechanisms in locusts". Miss E. Betts lectured to the Geographical Association at Nottingham on "The geographical approach to the study of locusts". Mr. A. T. Thompson lectured on locust migrations to the Littlehampton Natural Science Society and took part in a London Junior Conference of the Council for Education in World Citizenship on "Men against the Desert". Mr. P. Hunter-Jones gave a talk on "Locusts and the Desert" at a similar conference at Bolton, and visited research workers at Sheffield, Bradford and Leeds.

9. A symposium on insect cuticle, planned by Dr. Haskell, was held at Manchester University in September, with the active co-operation of Professor Dennell and his staff. It was attended by 16 specialists and the discussions concerned the structure and physiology of cuticle in relation to water balance, the mechanism of flight, pigmentation and insecticidal action; all these problems are of increasing importance for the study and control of locusts.

10. Most of the scientific officers of the Centre took part in the International Zoological Congress in London in July as its members and Dr. R. C. Rainey and Dr. P. E. Ellis read papers in the appropriate sections. Eight other papers at the Congress dealt with locusts and grasshoppers which is evidence of the growing popularity of these insects for research purposes.

11. A special scientific meeting was organised at the Centre to which members of the Congress likely to be interested were invited. About 60 persons attended the meeting, including several leading acridologists from abroad. The broad lines of the Centre's research policy were discussed and the visitors were encouraged to make suggestions with regard to the points needing investigation.

12. An exhibition illustrating various research activities of the Centre was organised and was mentioned in the printed programme of the Congress. It attracted over 100 visitors, from 20 different countries and all continents. Many visitors spent considerable time discussing exhibits with members of the staff responsible for them. It was gratifying to hear comments of foreign scientists on the comprehensive approach of the Centre to the locust problem, and the policy of promoting and sponsoring extra-mural research appealed to many of them. These visits and discussions aroused interest in locusts in several continental research workers, and locust stocks have since been supplied to them for experimental purposes.

13. Discussion meetings at the Centre during the year, attended also by many outside research workers, concerned the following topics: the ovarian mechanism and its effects on population dynamics in the African Migratory Locust; bird migration and the weather; phases in phasmatidae; gregarious behaviour in locust hoppers; visual responses of flying locusts; locust behaviour in relation to the development of control methods; biogeographical research on the African Migratory Locust; phases in Aphids; chemoreception in the Desert Locust; the FAO/UNESCO Desert Locust Ecological Survey in Sudan and Chad Territory; the use of an artificial diet in bio-chemical research on locusts.

#### *Library and bibliographical service*

14. The work of this section has continued to grow at a rate which makes it increasingly difficult for the present staff to keep up to date. Books received numbered 116 and reprints 696; of the latter, 384 dealt with acridology, the rest with more general but relevant subjects. *Acridological Abstracts* issued during the year numbered 364 (293 in 1957). Subject-indexing of old publications is approaching completion and the index is much used and appreciated by research workers. Special work undertaken by the library included checking and supplementing extensive bibliographies on the South American Locust (*Schistocerca paranensis*) for the FAO locust expert in Nicaragua, and on the Red Locust (*Nomadacris septemfasciata*) for the International Red Locust Control Organisation. About 20 other bibliographies on special subjects were prepared at the request of research workers at the Centre and elsewhere. Translations from French, German, Italian, Russian and Spanish were supplied for staff and visitors. Following a special request from the Director of the International Red Locust Control Organisation, Miss A. Blankley was seconded for 3 months to Abercorn, N. Rhodesia, to carry out reorganisation, cataloguing and indexing of the library, and training an African clerk in library duties.

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*Students*

15. Although the facilities of the Centre are neither intended, nor adequate for undertaking training, it was agreed to accept two locust officers from Ethiopia, on FAO studentships, and to give them special instructions in recording and mapping locust movements and breeding, as well as to make them conversant with the main lines of anti-locust work.

*Biogeographical and bioclimatic research*

16. The following work on Desert Locust material for the whole area has been in progress, to provide a basis for improved forecasting of plague developments :

- (a) The extraction of data on the duration of egg and hopper development in different areas and seasons (Miss Z. Waloff, with Miss J. Laszlo).
- (b) The preparation of maps of relative frequencies of swarm and hopper infestations. These maps, initially based on records for the 16-year period 1938-53, are being brought up-to-date, by incorporating the data for the following five years.

17. Studies on the Desert Locust in the Red Sea basin by Miss Z. Waloff assisted by Miss P. R. Granter have shown that, in contrast to the characteristically intermittent incidence of the Desert Locust over most of its area, swarms of this species were recorded within the Red Sea basin in 28 of the last 30 years. From the detailed examination of the data on the south-western sector of the basin, it was found that non-swarmling locusts lived there throughout the year, and that in 1950-58, for example, swarms had occurred there in 63 per cent. of the months, and had bred there on 14 occasions ; the breeding periods had lasted from one to seven months, and in several cases were sufficiently protracted to involve two or three successive generations. It thus appears that conditions in the southern part of the Red Sea basin may favour the continuous existence there of this mobile species, and might at times lead to outbreaks due to rapid building up of populations. The relevant climatic factors appear to be the proximity of the Intertropical Convergence Zone in summer and local convergence in winter, with the consequent drawing into the basin of locust populations from surrounding territories, the complex rainfall regime, and the occurrence, throughout the year, of high temperatures favouring rapid maturation and free movement between successive breeding areas.

18. The examination of the rainfall characteristics of Desert Locust breeding areas has been continued by Miss J. I. Magor who has completed the collection and plotting of the annual rainfall means for over 1,600 stations in 44 of the 46 affected territories. It has been found that although the means for the whole area vary from 3 to 2,286 mm. per annum, in the three high-frequency breeding areas—in the Sudan, in the Somaliland Protectorate and on the Indo-Pakistan borders—the rainfall means range from about 100 to 300-400 mm.

19. The study of night temperatures in the Desert Locust area has been continued by Miss P. R. Granter. The plotting of average daily minimum temperatures on 1 : 11 million maps for each month of the year has been completed, and the 20° and 25°C. isotherms have been drawn, in the African and the Middle East sections ; the work has now been extended to India

and Pakistan. Its importance lies in the fact that non-swarving Desert Locusts fly only during nights with sufficiently high temperature.

20. Miss E. Betts has completed her historical analysis of the data on the incidence of the African Migratory Locust during the 86 years, from 1871 to 1957, and the text and diagrams are being prepared for publication.

21. Dr. R. C. Rainey has continued detailed investigations on the distribution and movements of Desert Locust swarms in relation to the corresponding synoptic weather records, as a further development of his published hypothesis that the major movements of swarms take place downwind, towards and with zones of convergent surface wind flow. This has involved a systematic study of the evidence (previously secured in co-operation with Miss Z. Waloff, Mr. H. J. Sayer, Mr. D. J. McDonald and the Desert Locust Survey Airspray Unit) on the hour-to-hour and day-to-day movements of individual swarms, and on the corresponding weather conditions. Work has also begun on a day-to-day analysis of all available swarm reports from the whole Desert Locust area for a complete year of widespread infestation for comparison with the corresponding day-to-day weather in co-operation with the WMO Technical Assistance Mission (para. 54).

22. Dr. Rainey has also analysed and published the evidence, mainly from aircraft observations, of an association between atmospheric turbulence and the striking variations in density and height of flight exhibited by flying swarms and of the part played by gregarious behaviour in swarm cohesion and maintenance.

#### *Locust Laboratory research*

23. The demand for locusts for research purposes continued to increase and production was again expanded, about 2,500 locusts having been hatched every day. As before, the majority of them were *Schistocerca*, but stocks of *Locusta*, *Nomadacris* and *Anacridium* were also maintained. Stocks of albino *Schistocerca*, *Schistocerca* from South Africa, and species of *Romalea*, *Eyprepocnemis*, *Humbe*, *Pyrgomorpha*, *Caloptenopsis*, *Acrida*, *Ornithacris* and *Oedaleus* were also kept to satisfy demands for research material. Supplies of locusts and grasshoppers were sent to 43 research workers in 37 laboratories in the British Isles, and to 12 laboratories in France, N. Rhodesia, Poland, Israel, Germany and Holland. Altogether about 900 consignments were despatched during the year.

24. Facilities were provided in the laboratory for visiting scientists on a larger scale than hitherto for research and instructional purposes. Such visitors stayed for periods varying from one week to four months, and included Dr. Colombo (Italy) and his assistant, Dr. Karlson (Munich), Mr. Staal (Holland), Mr. Dudley (Cardiff), Mr. Bøggild (Copenhagen), and Mr. Woodrow (S. Rhodesia). Dr. Karlson and Dr. Colombo, both well known research workers, came to the Centre to work on specially prepared locust material.

25. Dr. P. T. Haskell has constructed a flat-bed wind tunnel in which the behaviour of locust hoppers can be studied under strictly controlled conditions of temperature, radiation and air-currents. He and Miss K. M. Becker have been carrying out detailed studies on the structure and responses to stimulation of the hairs of the aerodynamic sense organ on the locust head. Electro-physiological experiments on the function of sensory hairs on

the neck of the locust, which are involved in maintenance of balance in flight, have also been carried out.

26. Mr. P. Hunter-Jones, continuing his investigations on the factors affecting phase variation in the Desert Locust, has carried out comparative breeding of isolated and crowded lines for seven successive generations and the results show accumulation of phase characters from generation to generation. A stock of the Desert Locust from a geographically isolated non-swarming population in South-West Africa has been reared in crowded conditions for seven generations, but showed practically no changes in adult measurements such as occur in the stocks of this species from the main Desert Locust region.

27. An artificial diet for locusts, consisting of bran, dried yeast, dried milk and dried grass developed by Dr. G. F. Howden at the Imperial College, has proved to be adequate for the Desert Locust. This will be of value for any experiments in which the food has to be standardised and also for the maintenance of stocks when fresh grass is unobtainable.

28. Investigations on the life-cycles of a number of African grasshoppers were carried out by Mr. A. Antoniou, Miss P. J. Miller and Miss J. G. Lambert.

29. Mr. G. Cavanagh has completed estimations of fat in a very large number of locusts submitted to various experimental treatments, including flight during which fat is used as a source of energy.

30. Mrs. M. J. Richards has studied experimentally the factors involved in the selection of egg-laying sites by the Desert Locust and has found that females are capable of detecting very small differences in water content of the sand; she has also continued her work on the effects of photo-period on the sexual maturation and adult diapause of the Red Locust.

#### *Extra-mural research*

31. Physiological investigations, wholly or partly sponsored by the Centre, have included research on blood chemistry at Leeds University under Dr. B. Kilby; heat metabolism, by Dr. K. U. Clarke at Nottingham; locust nutrition by Dr. R. H. Dadd and olfactory sense, by Dr. W. Loher, at the Imperial College; visual responses of flying locusts by Dr. L. J. Goodman, at Queen Mary College, London; electrical responses of the locust eye, by Dr. E. T. Burt and Mr. W. T. Catton at Newcastle; and locust brain anatomy, by Dr. G. K. Wallace at Reading.

32. Dr. P. E. Ellis, with Mrs. D. A. Wort, has continued at Oxford her studies of the behaviour of locust hoppers, particularly with regard to aggregation leading to swarming.

33. Dr. J. Phipps continued his work on the reproductive cycles in tropical grasshoppers in the Fourah Bay College, Sierra Leone.

34. Professor A. Shulov, Hebrew University, Jerusalem, has extended his studies on water balance in developing eggs to all three main species of locusts.

35. In addition to the above sponsored research projects, various investigations on locust physiology and behaviour are now being carried out in many University laboratories in the United Kingdom and on the Continent,



making use of locust stocks provided by the Centre. Close contact is maintained with these independent research workers by correspondence and visits and a record of current research is kept (para. 44).

#### *Taxonomic research*

36. Dr. V. M. Dirsh, assisted by Miss J. B. Mason, has continued the preparation of keys to the genera of African Acrididae; approximately one half of the work is completed in draft and some 300 illustrations have been prepared.

37. Mr. N. D. Jago has carried out detailed studies on the genus *Calliptamus*, which includes several economically important species; a revision of a part of the genus has been completed.

#### *Statistical investigations*

38. Mr. D. E. Davies and Mr. I. B. Jones have carried out detailed statistical analyses of Dr. W. Stower's morphometric data on the Desert Locust and of laboratory data of Dr. P. E. Ellis on hopper behaviour, as well as other calculations for various research workers.

#### *Control investigations*

39. Mr. R. D. MacCuaig, at the Chemical Defence Experimental Establishment of the Ministry of Supply, has carried out studies on the comparative toxicity of dieldrin to flying and settled Desert and Migratory locusts; rates of absorption of dinitro-*ortho*-cresol by locusts; and comparative tests of different formulations of oil solutions of gamma-BHC.

40. Mr. MacCuaig also took part in experimental aircraft spraying of Desert Locusts in the Somaliland Protectorate and Ethiopia by the Desert Locust Survey Air Unit in August-October, when BHC and dieldrin were used.

41. Mr. R. D. Goodhue completed his work at the Imperial College on the susceptibility of the Desert Locust in different instars to stomach poisons.

42. Miss T. Kikal, at St. Mary's Hospital Medical School, has continued investigations on the detoxication of DNC and chlorobenzene in locusts.

#### *Field research*

43. Mr. D. J. Greathead was engaged most of the year in field work in Ethiopia, investigating natural enemies of the Desert Locust. Special attention was paid to *Stomorhina lunata*, a common egg-predator, which often appears suddenly in numbers when locust swarms are laying. The fly probably attacks not only locust but also grasshopper eggs, but no conclusive evidence on this point has been obtained. A number of other enemies of the Desert Locust have been observed and recorded.

#### *Record of current research*

44. The first issue of "Current Research on Orthoptera", including names and addresses of 218 research workers and indicating the problems they are studying, was distributed early in the year and has been very favourably commented upon. Its circulation and notices of its appearance have resulted in the receipt of over 100 more entries, which will be included in the second issue now being prepared.

**REGIONAL ORGANISATIONS***Desert Locust Survey*

45. Most of the scientific officers of the Survey have been participating in locust control operations and their research activities have been restricted accordingly and mainly concerned with studies and experiments on control methods. The Air Unit carried out with Mr. J. Roffey and Mr. MacCuaig tests of various spraying techniques and of new insecticides. Further large scale trials by Mr. H. J. Sayer of a simple attachment to a Landrover, using the pressure of the exhaust gases, for spraying vegetation with dieldrin at a very low dosage, have been carried out and have proved the low cost and practical value of this method for hopper control. Of particular interest are the results of laying spray barriers across the lines of march of hopper bands, which are poisoned as they cross the poisoned vegetation; owing to the persistent character of dieldrin, the barrier is effective for several weeks.

46. A detailed ecological survey of northern Eritrean coastal areas where locust populations are persistent has been completed by Mr. C. F. Hemming, who has also taken part in a preliminary survey of the Danakil desert area by a team of Ethiopian locust officers.

*International Red Locust Control Service*

47. Methods of numerical assessment of locust populations in the outbreak areas continued to occupy the main attention of the Service. A valuable advance has been made by the introduction of a special vehicle (Swamp Skipper), able to traverse swamps and flooded areas. The distribution of locust populations and seasonal changes in it have been investigated by Mr. C. C. Scheepers and Mr. P. M. Symmons. Effects of flooding and fire-control on locusts have been studied by Mr. D. Vesey-Fitzgerald and Mr. A. J. M. Carnegie.

48. Mr. J. H. Lloyd has completed and published a valuable review of control methods used against the Red Locust, the general conclusion being that aircraft spraying is the best method; it is the only one now used in preventive control within the outbreak areas.

*International African Migratory Locust Organisation*

49. Investigations by Mr. J. T. Davey on the seasonal movements of adult locusts within and outside the outbreak area in the Niger flood plains have been completed in the main. One of the important results was the finding that only certain parts of the plains are of importance in locust dynamics and this has permitted a considerable reduction in the areas to be regularly scouted. Studies on the incidence of night flight and the associated weather conditions continued. A general review of the ecology of the outbreak area and of the locust biology in it has been published.

**LOCUST CONTROL**

50. The non-swarming populations of the African Migratory and the Red Locust continued to be kept under survey and preventive control in their outbreak areas by the respective international organisations.

51. A somewhat unexpected development was an increase in the population of the Red Locust in the outbreak area of the Migratory Locust on the

river Niger. Some dense concentrations and swarms were formed, but the measures taken by the French authorities appear to have eliminated the danger of swarms spreading to other territories. A close watch is being kept on the situation.

52. The Desert Locust plague has continued on a very serious scale and by the end of the period under review the situation in northern Africa and the Middle East was causing great anxiety. The reasons for the relative ineffectiveness of control campaigns have been discussed at several meetings of the FAO special committees and there has been general agreement in favour of much greater and better co-ordinated efforts. The need for a review of the general strategy of Desert Locust control on an international basis has been recognised and a special expert panel appointed to work out practical proposals to this end.

### INTERNATIONAL CO-OPERATION

53. The establishment of the International Desert Locust Information Service as a part of the Anti-Locust Research Centre (para. 6) has marked the beginning of close collaboration between the FAO and the Centre. While the I.D.L.I.S. was concerned, during its first year, only with locust information, expansion of it is planned to cover also the concurrent synoptic weather data, with a view to improved forecasting. Preparatory work in this direction has been carried out by Dr. R. C. Rainey and plans for a comprehensive I.D.L.I.S. are being prepared for the consideration of FAO.

54. The Technical Assistance Mission of the World Meteorological Organisation for Desert Locust Control based on Nairobi, under Mr. C. I. H. Aspliden, was strengthened during the year by the appointment of a second meteorologist (Mr. J. A. M. Cochemé) and has continued to make good progress with the detailed synoptic analysis of all available meteorological records from the whole of the Desert Locust area and its surroundings for the year 1954-55, which has been selected as a year of widespread locust infestation. In May, 1958, Mr. Aspliden visited the Centre to discuss the comparison of his meteorological charts with the corresponding locust data. A special treatment of the latter, agreed to be necessary for this purpose, is now in progress at the Centre, with financial support from the Desert Locust Survey. Mr. Aspliden will be visiting the Centre again during 1959, to begin the detailed comparison of the completed charts of weather and of swarm distribution, in co-operation with the Centre's staff.

55. An ecological survey of Desert Locust habitats has been initiated as a joint FAO/UNESCO project, guided by a Working Group which includes the Director of the Centre and which met in London in February, 1958, to discuss the Survey's plans, personnel, etc. Mr. G. Popov, from the East African Desert Locust Survey, was appointed by FAO as the entomologist and leader and Mr. C. Rossetti was appointed by UNESCO as plant ecologist. The survey has carried out a reconnaissance of northern Ethiopia, the Sudan Republic and Chad Territory, and a report on this first tour was accepted, and plans for the next tour, in West Africa, were prepared by the Working Group at a second meeting in Paris in December, 1958.

## APPENDIX I

## ADVISORY COMMITTEE ON ANTI-LOCUST RESEARCH

**Membership**

- SIR GEOFFREY EVANS, C.I.E., M.A. (*Chairman*).
- DR. W. E. CHINA, M.A., Keeper of Entomology, British Museum (Natural History).
- DR. A. G. FORSDYKE, Assistant Director, Climatological Research, Meteorological Office, Air Ministry.
- MR. I. C. JACKSON, Colonial Office.
- PROFESSOR O. E. LOWENSTEIN, D.Sc., F.R.S., Mason Professor of Zoology and Comparative Physiology, University of Birmingham.
- MR. G. W. NYE, C.M.G., O.B.E., Colonial Office.
- MR. E. O. PEARSON, Director, Commonwealth Institute of Entomology.
- PROFESSOR O. W. RICHARDS, M.A., D.Sc., F.R.S., Professor of Zoology and Applied Entomology, Imperial College of Science and Technology.
- MR. K. F. SAWYER, B.Sc., Chemical Defence Experimental Establishment, Ministry of Supply.
- DR. T. H. C. TAYLOR, 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

CHAPMAN, R. F., 1959. Field observations on the behaviour of hoppers of the Red Locust (*Nomadacris septemfasciata* Serville). *Anti-Locust Bull.*, London, no. 33 : [2+] 51 pp., 27 figs.

LLOYD, J. H., 1959. Operational research on preventive control of the Red Locust (*Nomadacris septemfasciata* Serville) by insecticides. *Anti-Locust Bull.*, London, no. 35 : [2+] 65 pp., 16 figs.

MERTON, L. F. H., 1959. Studies in the ecology of the Moroccan Locust (*Dociostaurus maroccanus* Thunberg) in Cyprus. *Anti-Locust Bull.*, London, no. 34 : [4+] 123 pp., 44 figs.

POPOV, G. B., 1958. Ecological studies on oviposition by swarms of the Desert Locust (*Schistocerca gregaria* Forskål) in eastern Africa. *Anti-Locust Bull.*, London, no. 31 : [2+] 70 pp., 51 figs.

STOWER, W. J., POPOV, G. B. and GREATHEAD, D. J., 1958. Oviposition behaviour and egg mortality of the Desert Locust (*Schistocerca gregaria* Forskål) on the coast of Eritrea. *Anti-Locust Bull.*, London, no. 30 : [2+] 33 pp., 17 figs.

## JOURNAL PAPERS

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CHAPMAN, R. F., 1958. A field study of the potassium concentration in the blood of the Red Locust *Nomadacris septemfasciata* (Serv.), in relation to its activity. *Anim. Behav.*, London, 6 : 60-67, 1 fig.

CHAPMAN, R. F. and ROBERTSON, I. A. D., 1958. The egg pods of some tropical African grasshoppers. *J. ent. Soc. S. Afr.*, Pretoria, 21 : 85-112, 17 figs.

CHOU DHURI, J. C. B., 1956. Observations on the oviposition behaviour of the Moroccan Locust (*Dociostaurus maroccanus* Thunbg.) in Cyprus. *Saugar Univ. J.*, 1 : 123-139, 5 figs.

CHOU DHURI, J. C. B., 1958. Experimental studies on the choice of oviposition sites by two species of *Chorthippus* (Orthoptera: Acrididae). *J. Anim. Ecol.*, Oxford, 27 : 201-216, 5 figs.

DIRSH, V. M., 1958. Synonymic and taxonomic notes on Acridoidea (Orthoptera). *Eos, Madr.*, 34 : 25-32, 14 figs.

DIRSH, V. M., 1958. Two new genera of Acridoidea (Orthoptera). *Ann. Mag. nat. Hist.*, London, (12) 10 (1957) : 860-862, 9 figs.

DIRSH, V. M., 1958. Revision of the genus *Eyprepocnemis* Fieber, 1853 (Orthoptera: Acridoidea). *Proc. R. ent. Soc. Lond.*, (B) 27 : 33-45, 27 figs.

DIRSH, V. M., 1958. New Acridoidea (Orthoptera) from the Karroo region, South Africa. *J. ent. Soc. S. Afr.*, Pretoria, 21 : 323-332, 30 figs.

DIRSH, V. M., 1958. Acridological notes. *Tijdschr. Ent.*, 's Gravenhage, 101 : 51-63, 33 figs.

DIRSH, V. M., 1958. Revision of the group Portheti (Orthoptera, Acridoidea). *Eos, Madr.*, **34** : 299-400, 37 figs.

FENWICK, M. L., 1958. The production of an esterase inhibitor from schradan in the fat body of the Desert Locust. *Biochem. J.*, Cambridge, **70** : 373-381, 5 figs.

FENWICK, M. L., 1958. Intracellular particles of locust fat body. *Nature, Lond.*, **182** : 607.

GARDINER, B. G., 1958. Some observations on the respiration of young nymphs of *Schistocerca gregaria* (Forskål) in relation to phase and rearing density. *Proc. R. ent. Soc. Lond.*, (A) **33** : 159-166, 3 figs.

GREATHEAD, D. J., 1958. Observations on two species of *Systoechus* (Diptera: Bombyliidae) preying on the Desert Locust, *Schistocerca gregaria* (Forskål), in eastern Africa. *Entomophaga*, Paris, **3** : 1-22, 1 photo, 27 figs.

GREATHEAD, D. J., 1958. Notes on the larva and life history of *Cyrtotum cuthbertsoni* Duda (Dipt., Drosophilidae), a fly associated with the Desert Locust *Schistocerca gregaria* (Forskål). *Ent. mon. Mag.*, London, **94** : 36-37, 6 figs.

GREATHEAD, D. J., 1958. A new species of *Systoechus* (Dipt., Bombyliidae), a predator on egg-pods of the Desert Locust, *Schistocerca gregaria* (Forskål). *Ent. mon. Mag.*, London, **94** : 22-23.

GREATHEAD, D. J., 1958. Notes on the life history of *Symmictus flavopilosus* Bigot (Diptera: Nemestrinidae) as a parasite of *Schistocerca gregaria* (Forskål) (Orthoptera: Acrididae). *Proc. R. ent. Soc. Lond.*, (A) **33** : 107-119, 1 pl., 14 figs.

HASKELL, P. T., 1958. Stridulation and associated behaviour in certain Orthoptera. 2. Stridulation of females and their behaviour with males. *Anim. Behav.*, London, **6** : 27-42, 7 figs.

HASKELL, P. T., 1958. The relation of stridulation behaviour to ecology in certain grasshoppers. *Insectes sociaux*, Paris, **5** : 287-298.

HEARFIELD, D. A. H. and KILBY, B. A., 1958. Enzymes of the tricarboxylic acid cycle and cytochrome oxidase in the fat body of the Desert Locust. *Nature, Lond.*, **181** : 546-547.

HOWDEN, G. F. and HUNTER-JONES, P., 1958. An artificial diet for the laboratory rearing of locusts. *Nature, Lond.*, **182** : 1527-1528, 2 figs.

HUDLESTON, J. A., 1958. Some notes on the effects of bird predators on hopper bands of the Desert Locust (*Schistocerca gregaria* Forskål). *Ent. mon. Mag.*, London, **94** : 210-214.

JONES, B. M., 1958. Enzymatic oxidation of protein as a rate-determining step in the formation of highly stable surface membranes. *Proc. roy. Soc.*, London, (B) **148** : 263-277, 13 figs.

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KIKAL, T. and SMITH, J. N., 1959. Comparative detoxication. 6. The metabolism of 6-amino-4-nitro-*o*-cresol and 4:6-dinitro-*o*-cresol in locusts. *Biochem. J.*, Cambridge, **71** : 48-54, 2 figs.

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- LOHER, W., 1958. An olfactory response of immature adults of the Desert Locust. *Nature, Lond.*, **181** : 1280.
- MACCUAIG, R. D., 1958. Spray-collecting area of locusts and their susceptibility to insecticides. *Nature, Lond.*, **182** : 478-479.
- MACCUAIG, R. D., 1958. The toxicity of insecticides to adult locusts. *J. Sci. Fd Agric.*, London, **9** : 330-342, 5 figs.
- MALEK, S. R. A., 1958. The origin and nature of the ecdysial membrane in *Schistocerca gregaria* (Forskål). *J. Insect Physiol.*, London, **2** : 298-312, 7 figs.
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- NICKERSON, B., 1958. Some observations on the carmine bee-eater *Merops nubicus* Gmelin in the French Sudan. *Ibis*, London, **100** : 454-457, 1 map.
- NIXON, G. E. J., 1958. A synopsis of the African species of *Scelio* Latreille (Hymenoptera : Proctotrupoidea, Scelionidae). *Trans. R. ent. Soc. Lond.*, **110** : 303-318, 31 figs.
- PHIPPS, J., 1958. The structure of the ovaries and eggs of some Eumastacidae (Orthoptera, Acridoidea). *Ent. mon. Mag.*, London, **94** : 65-66, 1 fig.
- POPOV, G. B., 1958. Note on the frequency and the rate of oviposition in swarms of the Desert Locust (*Schistocerca gregaria* Forskål). *Ent. mon. Mag.*, London, **94** : 176-180, 3 figs.
- RAINEY, R. C., 1958. Atmospheric movements and the biology of the Desert Locust (*Schistocerca gregaria* Forskål). *Proc. Linn. Soc. Lond.*, **169** (1956-57) : 73-74.
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- SATIJA, R. C., 1958. A histological and experimental study of nervous pathways in the brain and thoracic nerve cord of *Locusta migratoria migratorioides* (R. & F.). *Res. Bull. Panj. Univ.*, Hoshiarpur, **72** (Zool.) : 13-32, 8 pls., 2 figs.

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WALLACE, G. K., 1958. Some experiments on form perception in the nymphs of the Desert Locust, *Schistocerca gregaria* Forskål. *J. exp. Biol.*, Cambridge, **35**: 765-775, 1 fig.

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

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**A. BUILDING AND HOUSING RESEARCH****Tropical Building Section, Building Research Station, Department of Scientific and Industrial Research**

1. From 1st January, 1959, the Colonial Liaison Section, Building Research Station, has been renamed the Tropical Building Section.

2. One of the more important events during the period was the Inter African Conference on Housing and Urbanisation, held in Nairobi from 19th to 30th January. Mr. G. A. Atkinson, Head of the Section, who is also Housing Adviser to the Colonial Office, attended as leader of the United Kingdom delegation. Over fifty delegates and some thirty observers attended the Conference. The aim of the Conference was to bring together practitioners and research workers on both social and technical aspects of housing and urbanisation. Nearly 150 papers including some by the Tropical Building Section were submitted, and discussion fell under Four Heads: Urbanisation; Town Planning; House Design and Construction; Technical Problems. A number of general recommendations were made and conclusions were reached on the attitude of African households to the design of dwellings built for their occupation; training of building workers, and African jobbing builders; standards and cost of water supplies and other services in housing areas; and structural design for unstable clay soils. The Inter African Committee for Housing had its fourth meeting at the end of the Conference. The Tropical Building Section agreed to complete an annotated bibliography on housing and urbanisation in Africa; also to prepare a check list of roof coverings, their properties and uses.

*Visits*

3. The Head of the Section spent three months visiting East Africa, Central Africa, Malta and Mauritius at the end of 1958 and early in 1959. The main purposes of his tour were:—

- (i) to learn about recent building developments in East and Central Africa;
- (ii) to attend the Inter-African Housing and Urbanisation Conference;
- (iii) to assist the Government of Malta further with its housing problems;
- (iv) to assist the Government of Mauritius with its housing, building and planning problems.

4. In Malta, which was visited in November, 1958, and again in June, 1959, the "second storey" housing scheme recommended in 1955 was found to be progressing successfully. Owners are helped by grants and loans to build a second storey flat on single storey houses. These are usually terrace houses with masonry walls and a flat roof (or upper floor); extension upwards is fairly easy. Advice was given on housing being built at the new community at Tarzien. But for the climate, conditions in Malta—dwellings relatively crowded, building at high densities in stone with methods which need modernisation if costs are to be reduced—have much in common with those in Scotland. Contact has, therefore, been established with the Department of Architecture, Edinburgh University, where a post-graduate housing research project has recently been started, partly under a Department of Scientific and Industrial Research Extra-Mural Contract.

5. In Central Africa, housing schemes in Nyasaland and Northern and Southern Rhodesia were visited. The increasing use of concrete blocks—in place of bricks, as the main walling material was noted almost everywhere. The Northern Rhodesia African Housing Board was using successfully an “egg-laying” type of blockmaking machine; similar machines were seen in Mombasa and Mauritius. The cement clinker crushing plant of the Nyasaland Portland Cement Company Limited, Blantyre, was visited. It uses clinker brought by rail from Southern Rhodesia, but work has started on a cement making plant.

6. On the way to Mauritius a few days were spent in South Africa visiting the National Building Research Institute's new laboratories at Pretoria and African housing schemes in the vicinity of Johannesburg. Because of the size of these schemes, and the assistance available from the National Building Research Institute, costs have been studied in great detail. Housing densities are low—plot sizes for small detached bungalows exceed 3,000 sq. ft. as compared with under 2,000 sq. ft. in East African coast towns—and transport and services are in comparison costly.

7. In Mauritius a comprehensive report on housing and building was prepared and the possibility of establishing a cement clinker crushing plant was discussed. The island at present consumes about 40 thousand tons of cement a year and East and South African cement concerns have shown an interest in this development, but it seems likely that cement will be supplied in bulk from Mombasa as an extension to plans already made to export cement in bulk to Dar-es-Salaam.

8. During a short visit to Mombasa, Zanzibar and Dar-es-Salaam on the East African coast, special attention was paid to Swahili-type housing. The houses are of traditional construction—wattle framework with thatched roofs—but are invariably improved with sheet metal roofs, coral-rag external walls and concrete floors. Particularly in Zanzibar and Dar-es-Salaam, where the Governments are providing sites for new housing and sometimes loans to buy permanent materials, the Swahili-type house is providing most of the new accommodation at low cost.

9. Ten days were spent in Uganda, advising the Government on a variety of local housing and building matters. Near Kampala a recently modernised clay brick and hollow block works was visited, where coffee husks were being used as fuel in a large continuous burning kiln. The resulting high quality products were competing locally with concrete blocks; facing bricks and hollow clay floor tiles were being exported by rail to Nairobi. Information was given on recent developments in brick design at the Building Research Station. The Tororo cement factory was also visited.

10. With the opening of a second cement works in Kenya, there is for the time being an excess of production in East Africa. Building is no longer being affected by material shortages. Novel techniques have either been abandoned or, as in the case of some using concrete, have merged into conventional practice. Attention is now rather being directed to better, yet economical house designs to meet a growing African demand for a more European-style house and to more efficient layouts to reduce service costs.

11. Mr. W. H. Ransom, the officer responsible for work on materials and methods of construction, went to Belgium in November, 1958, with the African Housing Officer, Ministry of Communications and Works, Tanganyika. An asbestos-cement products factory whose lightweight roofing sheets are used extensively, in East Africa, was visited. The manufacturing processes for these roofing sheets and for other products were seen and problems of resistance to impact damage, of mould growth, of packaging, and of fixing were discussed.

12. In April and May, 1959, Mr. Ransom visited the British Caribbean territories, Puerto Rico and Washington, D.C., to acquire first-hand experience of the building materials used and the local methods of construction. Discussions were held with many individuals and organisations and this augmented information already obtained through earlier visits to Africa and the Mediterranean which have been reported previously. Special attention was paid to flat roofs and roofs were inspected in all the Caribbean territories visited. In Washington, D.C. talks were held with officers of the National Bureau of Standards in order to acquire knowledge of American practice in tropical roofing. This data and that previously obtained by visit and by correspondence are now sufficient to enable a publication to be produced on flat roof problems.

13. Mr. P. Whiteley, the Paint Research Fellow, visited West Africa and the Caribbean. Details are given in a later section.

#### *Enquiries and Technical Investigations*

14. *Environmental aspects of tropical building.* The analysis of thermal discomfort data from Singapore has been completed and two papers on the subject are due to appear. The analysis provides a scale of physiological climate, which has been named the Singapore Index, for application in warm humid climates. A comfort graph indicates the optimum climate, at 78.7°F. on the Singapore Index, and the effect of departures from the optimum. Even at the optimum, over 30 per cent. of subjects feel thermal discomfort and a spread of climate is necessary to satisfy individual needs. Separate tables of the incidence of discomfort due to cold and to warmth are given, and a chart for the rapid assessment of a climate of the above type. Work is in progress on the extension of the Singapore Index scale to a wider range of climate, and on the variations of climate which occur in domestic buildings in Singapore.

15. *Solar water heating : air conditioning.* Advice on solar water heaters was given, among other organisations, to the Executive Architect, Windward Islands and to the Schools Building Unit, St. Kitts, Leeward Islands. Details of a solar water heater developed by the South African Building Research Institute, seen during the visit to Pretoria, have been circulated to correspondents.

16. Owing to pressure of other work, little further progress on aspects of the use of air conditioning overseas has been possible other than answering routine enquiries. Details of a Service Department specification for a unit air conditioner have been circulated to correspondents in Colonial territories.

17. *Use of local materials for building.* Samples of sand from Gibraltar and of concrete bricks made from it were examined at the Building Research Station. Suggestions have subsequently been made which should

enable better quality concrete bricks to be manufactured. Lava from Tonga was also examined and found to be a very promising aggregate for lightweight concrete. Further technical advice has been given to enable it to be used to maximum advantage.

18. Advice by correspondence and during visits has been given to Colonial government departments and others concerned with various buildings on a variety of matters relating to building materials and construction. The Section's experience and studies in this field, related when necessary to the given research work of the Building Research Station, has been incorporated in Overseas Building Notes published during the year.

19. *Tropical paint research.* Mr. P. Whiteley, Tropical Paint Research Fellow, visited West Africa in October–December, 1958, principally to prepare further exposure tests at the West African Building Research Institute. Gloss finishes, wood primers, emulsion paints and anti-corrosive paints for steel were main subjects of investigation; roof paints and putties for steel casements were also placed on test.

20. Visits were made to Kaduna, Northern Nigeria, and to Sierra Leone and the Gambia, to study local conditions and discuss paint problems with Public Works Departments and other users. The problem of efflorescence, inherent in the porous structure of emulsion paints, was seen on this tour to be of serious proportions. A research programme to study and attempt to reduce the trouble was initiated on return.

21. In May and June, 1959, the Caribbean area was visited to compare conditions and requirements with those of Africa. Paint requirements of timber buildings were studied. The problem of mould growth in the area and the use of zinc oxide paints to combat it were investigated. Two factories manufacturing paint were visited and products developed specially for local requirements were seen. It was considered that one of these, an exterior masonry finish, could find considerable application in other tropical countries.

22. On return large scale exposure testing in Florida was seen and, at the University of Louisville, the American approach to problems similar to those of the Caribbean was studied.

23. *Structural problems.* The Somaliland Protectorate Government is being helped with problems connected with the design of its new offices at Hargeisa. Owing to the low rainfall and clayey nature of the soil, as mentioned in the 1957–58 Report, foundation movements have damaged some recent buildings. Advice was given on investigations already carried out and on the need for further investigations, now being carried out by consultants.

24. Design methods and structural details for use in areas affected by earthquakes and hurricanes are being studied. Recommendations for small and medium sized buildings but not specialised structures like skyscrapers will appear in Overseas Building Notes.

25. *Design of storage structures.* Mention was made in the 1957–58 Report of the inspection made of underground wheat fossae in Malta. Advice on the waterproofing of such fossae has been given to officers of the Public Works Department, Malta, and the Pest Infestation Laboratory, Slough. As a result, a fossae in Malta has been experimentally waterproofed

and then filled with grain. The behaviour of the pit and of the stored grain is being observed. Further experimental treatments have been suggested to the Pest Infestation Laboratory. These involve the use of aluminium foil stuck to the sides of the fossae with an adhesive.

26. A note on storage problems, prepared in collaboration with the Pest Infestation Laboratory, has been issued in mimeographed form; it is to be published. Causes of deterioration of stored crops and their control are listed. Informative notes follow on sites and foundations, damp-proof materials, floors, walls, mortars and plasters, roofs, ceiling and insulating materials.

27. Advice was given to the West African Building Research Institute on the design of cold stores in the tropics.

28. *Building control.* A review of the regulations and by-laws which control building in overseas territories has shown that nearly all are in great need of revision. The present is a suitable time for the Section to help in this work as the Building Research Station has recently given much assistance on a comprehensive revision of Scottish legislation. During the year under review a draft main Building Ordinance and also a Building Code for small dwellings were prepared for St. Helena. Much preparatory work was done on collating the existing rules to help other territories.

29. *Architectural, housing and town planning matters.* The 1957-58 Report referred to studies being made on housing densities and space standards. Mr. Atkinson developed further the study described in the early report in a paper to the C.C.T.A. Housing and Urbanisation Conference, Nairobi, and in a paper for the 1959 Conference of the International Council for Building Research, Studies and Documentation (C.I.B.), at Rotterdam. From a review of recent tropical housing schemes, it appears that except in the crowded cities of Asia the majority of less well off households—not living in conditions of severe overcrowding—occupy 50-100 sq. ft. of floor space per person or 250-500 sq. ft. for a five-person family. A large number of the dwellings being built by public housing authorities are of one of two types: the one-storey, or "four square" plan, ranging in area from 280 to 470 sq. ft. in the examples noticed, and the two-storey "terrace" plan ranging from 440 to 570 sq. ft. Both resemble European minimum house plans but are smaller in area and simpler. A comprehensive study of the different plans adopted is being made, the salient information on nearly 100 plans being carded in a standard form. On the basis of this work, it should be possible to suggest guiding principles for economical small house design.

30. Besides these studies work in the field of architecture, housing and town planning has again been very diversified. Co-operation with all three Service Departments on oversea problems has continued; also consultation with the Crown Agents and Ministries of Works and of Housing and Local Government. Among the subjects on which advice has been sought are: housing, schools (elementary, secondary and technical), laboratories, hospitals and legislative chambers.

#### *Dissemination of Technical Information*

31. *Courses and visitors.* The eighth annual course for architects and engineers in the Overseas Service was held at the Station in September.

Members of the Section also gave lectures to the Architectural Association School's Department of Tropical Architecture, at the London School of Hygiene and Tropical Medicine, and to the Oversea Labour Officers' course of the Ministry of Labour and National Service. The City and Guilds Institute has been assisted in the preparation of a syllabus for courses in building construction suited to overseas needs.

32. Recent visitors have included the Minister of Works and Transport, Western Region, Nigeria, the Minister of Works, Northern Region, Nigeria, the Minister of Housing, Kenya, the Director of the West African Building Research Institute and members of his staff, the Chief Architect, Ministry of Works, Kenya, the Chief Architect, Public Works Department, Uganda and the Commissioner of Lands and Work, Gibraltar, and other officers from Housing and Public Works Departments in the Colonial territories, as well as a number of Commonwealth visitors, United Nations and Columbo Plan Fellows and representatives of United Kingdom firms with overseas interests.

33. *Publications.* Since the last Report, nine issues of Overseas Building Notes have been published:

No. 53 Housing in Africa.

No. 54 Cement and Concrete: A review of recent publications of interest to overseas builders: Rammed earth building blocks: The Cinva-ram portable block making press.

No. 55 Paint purchasing: Roof painting: Noticed in passing—algal growth; earth splash.

No. 56 Housing and planning in Singapore, 1957: The Housing Trust, Federation of Malaya: Housing in Hong Kong.

No. 57 Housing, Building and Planning in the West Indies.

No. 58 Lightweight concrete: Cement in the Colonial territories.

No. 59 Housing Surveys: Notes on the ways in which housing shortages may be assessed, with a selected list of references: Low cost housing in Hong Kong: Expandable houses.

No. 60 Economic housing, with particular reference to the Southern Rhodesia African home ownership scheme: African housing at Mufulira West.

No. 61 The Burnt-Clay Brick.

34. *Other publications.* The following publication has appeared during the year, in addition to Overseas Building Notes.

Ransom, W. H. (1959) *The deterioration of building materials in warm regions.* Building Materials Export. Vol. II, No. 1, pages 3-5, pages 59-61.

35. A paper: "Analysis of some observations on thermal comfort in an equatorial climate" has been prepared for publication in the Journal of Industrial Medicine; a note: "The Singapore Index, a climatic index for personal comfort in low latitudes" for publication in the R.I.B.A. Journal. The draft of the first of a new series of Tropical Building Studies is in the hands of Her Majesty's Stationery Office. It deals with some factors influencing the selection of housing densities.

## **West African Building Research Institute**

### *General*

36. In September, 1958, all participating governments approved the Institute's planned scheme of expansion. Recruitment of staff and the second stage of the building programme are now under way. The first meetings of the Technical Advisory and Administrative Committees were held in March, 1959.

### *Advisory Service*

37. Government Departments, Statutory Corporations, Consultants, Contractors and Manufacturers continued to seek help from the Institute and during the year approximately 610 enquiries were dealt with. These ranged over all aspects of building and civil engineering design and construction.

38. An interesting development is the increasing number of occasions when architects, with no previous experience of West African conditions, are directed by their employers, usually corporations and consultants, to the Institute in order to gather information.

39. Work on the drafting of Building Regulations was continued. The Director and Principal Scientific Officer visited the regions and territories and lectures were delivered to professional Societies.

### *Liaison and International Co-operation*

40. Contact has been maintained and exchange of publications has continued with thirty research organisations in all parts of the world which are working in the building, civil engineering and associated fields. The Director is a West African Correspondent of the Inter-African Committee on Housing of C.C.T.A. (Commission de Co-operation technique en Afrique au Sud du Sahara). He represented the Institute at the C.C.T.A. Housing and Urbanisation Conference which took place at Nairobi in January, 1959.

41. During the year the Director was accepted as a member of the International Union of Testing and Research Laboratories for Materials and Structures, and the Institute became a member of the International Council for Building Research Studies and Documentation.

### *Research*

42. Investigations have been directed towards determining the durability of materials and the functional efficiency of buildings designed and constructed by present methods. The project on alkyd type paints, which is being carried out with the co-operation of the Tropical Paint Research Fellow at the Building Research Station D.S.I.R. and manufacturers, shows promise of useful results. Work has also been started on emulsion and roof paints. Work on the stabilisation of soil with cement is now being concentrated on relating the results of laboratory tests to performance in the field and also the development of a simple and reliable test for use by builders.

43. The study of the micro-climate of buildings has been extended to cover conditions in the North of Nigeria.

44. Assessment of the natural resistance of West African timbers to attack by subterranean termites has shown that no one timber is resistant



to all species of termites in all localities. The table below lists the most resistant in order of resistance.

Botanical name	Trade Name B.S. 881
Turraeanthus Vignei ... ..	Avodire
Morus Mesozygia... ..	—
Cylicodiscus Gabunensis... ..	Okan
Khaya Anthotheca ... ..	African Mahogany
Nauclea Diderrichii ... ..	Opepe
Entandrophragma Utile ... ..	Utile
Afrormosia Elata ... ..	Afrormosia
Chlorophora Excelsa ... ..	Iroko
Piptadenia Africana ... ..	Dahoma
Entandrophragma Cylindricum ... ..	Sapele
Guarea Cedrata ... ..	Scented Guarea
Terminallia Ivorensis ... ..	Idigho
Lophira Alata ... ..	Ekki
Anopyxis Klaineana ... ..	—
Distemonanthus Benthamianus... ..	Ayan

## B. FALKLAND ISLANDS DEPENDENCIES SURVEY

45. Severe ice conditions in the Graham Land area during the Antarctic Summer 1958–59 made the relief of Bases a very hazardous and difficult operation and in spite of generous assistance given by the U.S. icebreakers *Edisto* and *Northwind*, it proved impossible to reach the three most Southern FIDS Bases in that area by sea. The personnel at bases in question, Base E, Marguerite Bay, Base Y, Horseshoe Island and Base W, Loubet coast were brought out by helicopter and new personnel were flown in to Base Y only. Bases E and W being temporarily evacuated. This closure together with the closure of Bases J and O where all useful field work had been completed brought the number of occupied bases to eight.

46. FIDS assumed responsibility for the Royal Society Base at Halley Bay on 1st January, 1959, and a continuous programme of synoptic meteorology, upper air soundings, geomagnetism, ozone measurements, radiation measurements, and seismology has been maintained since that date. Other activities at the base include a study of sea-ice formation and snow accumulation, auroral observations using the all-sky camera, and observations at the nearby Emperor penguin rookery.

At Base F on the Argentine Islands the meteorological and geophysical programme has been fully maintained. Tidal observations continue and geological fieldwork and a study on the Southern skua are in progress.

Ionospheric soundings and “whistler” recordings have been continued at Base A, Port Lockroy.

Survey and geological work has been continued and during the Antarctic summer, tellurometers were used.

47. The topographical survey programme during 1958 continued with still more emphasis on triangulation to link north and west Graham Land by one continuous scheme southwards to Marguerite Bay, and so provide control for mapping at 1:200,000 scale from the existing air photographic cover. During the winter eight surveyors using sledge transport worked on

the triangulation from five Bases in this area, while a further two carried out reconnaissance surveys in the hitherto unexplored area south east of Marguerite Bay. In the following summer continuing severe conditions in the south enabled sea-ice-borne survey work to be carried out until the relief ship arrived in March. In the north triangulation was speeded up during the summer by a further team of six surveyors using tellurometers, and supported by naval ship and helicopter to link the previously isolated triangulation scheme across the 80 mile-wide, island studded, Bransfield Strait.

48. Reconnaissance geological field mapping has been carried out in Trinity Peninsula, on the Danco and Loubet Coasts, and in southern Marguerite Bay, whereas detailed mapping of parts of the west coast of Crown Prince Gustav Channel, James Ross Island, Hanusse Bay, Lallemand Fjord, Neny Fjord, King George, Livingston and Deception Islands has been completed. The geology of Anvers Island, the Graham Coast, King George and Deception Islands, and Horseshoe Island was worked up in the laboratory and interim reports were made on the progress of the work. Palaeomagnetic studies, based on field collections in 1957-58, continued in the laboratory. Four papers relating to the geology of the Falkland Islands Dependencies were published during the year.

49. Glaciological observations were continued at South Georgia as the FIDS contribution to the I.G.Y. Most of the glaciological work done at South Georgia and King George Island during 1957 was written up for publication. A magnetometer survey of the Tabarin Peninsula is being carried out from Hope Bay.

### C. GEODETIC AND TOPOGRAPHICAL SURVEYS

#### *Staff*

50. Owing to the lack of opportunities for examination the number of recruits to the cartographic draughtsman grade fell sharply during the year under review. A small number of qualified surveyors was recruited. The total staff in post on 31st March, 1959, was the same as last year, 437, including eight Officers and Senior Other Ranks seconded from the Royal Engineers (Survey).

51. A Forestry and Land Use Section was formed by the incorporation into the Directorate of the Forest Air Survey Centre and its fusion with the existing Land Use Section.

#### *Geodetic Surveys*

52. In Kenya, observations were completed for the first-order chain running westwards from the Isiolo base to Kitale.

53. The basic framework of primary triangulation for Uganda was finished, with the observation of a first order chain west of Mount Elgon and completion of the chain linking triangulation north of Lake Victoria to the Arc of the 30th Meridian.

54. A new connection was observed between the primary triangulation of Kenya and Tanganyika and a programme of astronomical observations in Kenya, Tanganyika and Uganda was begun.

55. In the Copperbelt of Northern Rhodesia, where the primary triangulation network is nearing completion, the tellurometer has been used for measurement of side lengths, including a complete quadrilateral west of Kapiri Mposhi.

56. Work continued in the Southern Cameroons although adverse weather made progress slow.

57. In the western half of Sierra Leone reconnaissance was commenced for a primary triangulation planned to cover the territory.

58. The Jesselton-Sandakan primary chain in North Borneo was completed and good progress was made with the chain following the east coast.

#### *Minor Triangulation and Photo Control*

59. In Tanganyika control for Bohoro Flats areas was commenced and work was continued in the Kilosa-Dodoma area.

60. A large number of height control points were fixed in the Machakos area of Kenya and a network of secondary triangulation was reconnoitred and partly observed in the Kericho District.

61. Secondary triangulation and height control in the West Nile area of Uganda was completed and control for the Eastern Province was commenced.

62. Work continued in the Central Province of Nyasaland and the Fort Jameson area of Northern Rhodesia. Minor triangulation and height control was also being established for the Katanino area, south-west of the Copperbelt.

63. Observation of astro-fixes in Bechuanaland was completed for those areas, in the north and south-east, which are covered by air photography.

64. Control required for three areas of mapping in Somaliland Protectorate was finished.

65. Triangulation of Montserrat was completed.

66. A programme of triangulation and tellurometer traversing was commenced in the Bahama Islands, work in New Providence being completed.

67. Triangulation of the Falkland Islands continued and observations in East Falkland were completed. In the Dependencies the tellurometer was used to establish a connection between the South Shetland islands and Graham Land.

#### *Air Photography*

68. In the Caribbean 7,000 square miles of photography was obtained for British Guiana in addition to complete air photo cover for the Cayman Islands. Flying was in progress at the end of the year over the islands of Grand Bahama and Abaco in the Bahama Islands.

69. Under a contract covering the coastal areas of northern Kenya 3,600 square miles of photography have been claimed.

70. In West Africa a further 3,100 square miles of the Southern Cameroons and 4,930 square miles of Sierra Leone were obtained from the contracts reported last year. It is estimated that 12,000 square miles of the Southern Cameroons and 10,000 square miles of Sierra Leone have been photographed under contracts which are still in progress.

71. Sorties were flown by the Royal Air Force over Aden Protectorate, Kenya, North Borneo and Sarawak.

### *Mapping*

72. The major part of the cartographic resources continued to be devoted to 1:50,000 mapping. There was a considerable increase in fully coloured specialist maps and in mapping at larger scales, for which improved methods of photogrammetry are being evolved and experiments are being made in the preparation of drawings for reproduction at two different scales. New methods of depicting Antarctic topography were used for a fully coloured map of South Georgia at 1:200,000 which was published as a forerunner to further sheets covering the Falkland Islands Dependencies.

73. Mapping at 1:50,000, including many contoured or formlined sheets, was in progress for extensive areas of Nigeria, northern and western Uganda, south-eastern Kenya, central Tanganyika, Northern Rhodesia and Nyasaland. Planimetric mapping of Vanua Levu (Fiji) and western Sarawak continued, while preliminary work was commenced for a 1:50,000 series covering the Falkland Islands. Preparation of the contoured editions for Swaziland and Basutoland and the formlined edition for Viti Levu (Fiji) continued.

74. Good progress was made with 1:25,000 contoured maps for the Leeward Islands, the Windward Islands, Malta and Somaliland Protectorate. The fully coloured Gambia Land Use series at 1:25,000 was nearing completion.

75. Preparation of the Cyprus 1:10,000 series continued while mapping at this scale was commenced for Tobago. The revised edition of the Malta 1:2,500 series was nearing completion.

76. Mapping at 1:100,000 for the Aden Protectorate advanced steadily and further progress was made with the 1:125,000 series for Bechuanaland Protectorate.

77. Special productions included maps prepared to illustrate reports and fully coloured geological maps.

78. Work carried out by Forestry and Land Use specialists included the preparation of detailed land use information, with particular reference to changes in the area under rice between 1946 and 1956, for approximately 2,500 square miles of the Gambia. A land use survey of three swamp areas in Sierra Leone is now in progress. The distribution of stands of an important tree on Santa Ysabel and Guadalcanal in the British Solomon Islands Protectorate was mapped. Investigative work included methods of area determination from maps, systems of depicting land use and other specialist information, instrument trials and a comparative study of infra-red and panchromatic photographs of forest plantations in Kenya.

79. A full account of this work is given in the Directorate of Overseas (Geodetic and Topographical) Surveys Annual Report for the year ended 31st March, 1959.

**D. GEOLOGICAL SURVEYS**

80. The Geological Surveys in the Overseas Territories, which have grown steadily since the war, provide an ever increasing amount of fundamental geological information in the light of which questions of mineral deposits, water supplies and engineering can be judged. Certain aspects of this work must include an element of research but this of necessity has to be undertaken to arrive at a proper understanding of the basic geological background. Despite the increased numbers of geologists available only a fraction of the area concerned has been covered to a reasonable standard and much work remains to be done in the years ahead.

81. Close contact between the Directorate and the territories was maintained during the year and visits were paid by the Director and others of the Headquarters' staff to African countries and to Cyprus.

82. A photogeologist went to Nigeria at the end of the year to follow on from the work he had carried out at Tolworth, and another visited Aden and Somaliland. Geophysicists from Headquarters were responsible for surveys in Cyprus which were designed to assist in solving water supply problems. Gravity work was also undertaken in Tanganyika as part of the I.G.Y. programme. An aerial magnetometer survey was carried out under contract in Sierra Leone.

83. A monograph on gypsum was published by the Mineral Resources Division in addition to the usual issues of Overseas Geology and Mineral Resources.

84. Colonial Development and Welfare funds maintain a team of specialists at the Natural History Museum to carry out identification and description of fossils from the Overseas Territories who rarely possess palaeontologists of their own. Money from the same source was used in the employment of personnel and purchase of instruments for the Age-Determination Unit at Oxford. Assistance was also given to the work of exploration geochemistry and palaeomagnetism in the Overseas Territories.

85. A great deal of work is being undertaken by members of University staffs in several territories in Africa as well as in Fiji and the British Solomon Islands. Much of this work is written up in the publications of the countries concerned or in Overseas Geology and Mineral Resources. It is clear that this aspect of geological work in the dependent countries must be maintained in the future.

86. Several economic discoveries of importance were made in the period under review. An occurrence of coking coal was reported from Swaziland and numerous additional and promising finds of the well-known carbonatite-alkaline rock associations.

87. Geological Surveys continue to give considerable attention to water supplies and particularly to those developed from boreholes. This aspect of their work, although unspectacular in some ways, is nevertheless of immense importance to the communities concerned. Advice is also often given on the geological aspects of engineering problems.

*Vulcanological Research in the Caribbean.*

88. The Seismic Investigation Unit at the Imperial College of Tropical Agriculture, Trinidad, has continued to maintain seven seismograph stations,

and 892 earthquakes were recorded by the network. Of these 658 originated in the eastern Caribbean. During the same period 124 epicentres were determined.

89. The year has been marked by exceptional activity near Trinidad along the regional fault north of the north coasts of Trinidad and north-eastern Venezuela.

### **E. INDUSTRIAL AND ENGINEERING RESEARCH**

#### *East Africa*

90. At the East African Industrial Research Organisation investigations on the efficient use of fuel have been undertaken over a wide range of industries. Collaborative studies with a research section of the East African Railways and Harbours Administration have resulted in the successful design of a special burner for lighting up locomotive boilers, and in the introduction of modifications to engines which it is expected will result in considerable savings in fuel. Incinerators have also been designed for use by the East African Veterinary Research Organisation and the Wellcome Foot and Mouth Disease Centre in disposing of diseased carcasses.

91. Research into the mechanical drying of coffee continued and, on behalf of the National Institute of Agricultural Engineering and the Tanganyika Agricultural Corporation, the design and testing of two full-scale driers for use on fully wet groundnuts lifted and picked by mechanical harvesters was undertaken.

92. Ceramic investigations continued during the year and, in the metallurgy section, a study of the problem of eliminating arsenic from cement copper prepared from an arsenic-containing ore was undertaken.

#### *Hong Kong*

93. In the Department of Civil Engineering of the University of Hong Kong some interesting experimental studies have been undertaken for the Government on a Nullah Model for Drainage of Kai Tak. A method of analysis of indeterminate structures by successive replacement was developed. Research has also been conducted on a simplified method of analysis of reinforced concrete structures, on the effects of wind loads on tall buildings, and on electric fields near Bundle Conductors.

94. A long-term research project on composite instructures, consisting of steel I-beams and reinforced concrete slabs, was commenced in June, 1958, and investigations are being made on: (1) the effective width of slab acting integrally with the I-beams as the compression flange, (2) the behaviour of double spiral shear connectors, and (3) the effect of relative movements between the steel I-beam and the slab on the stress distribution over the cross-section of the composite I-beam.

95. The erection of a two-storey three-bay pre-stressed concrete frame has been progressing satisfactorily since the arrival of equipment from England. Thirty of the members have already been cast and the frame was scheduled for testing in January, 1959. Owing to the many advantages in the use of this system for building construction, a detailed programme of testing is being undertaken for this frame, to provide a greater insight into both the theoretical design methods required and the various economical methods of overcoming the practical difficulties involved.

96. Experimental investigation on the effect of prestressing on steel frames has been carried out with test specimens of steel portals encased in concrete.

*Crown Agents for Oversea Governments and Administrations*

97. The Crown Agents' Engineering Advisory Service continued to assist and advise Overseas Officers on a wide range of technical matters. Visits to works, study and training courses were arranged.

98. Crown Agents' officers continued to represent the Colonial Office as Assessors on the D.S.I.R. Boards of Road, Building, Water Pollution, Hydraulics and Mechanical Engineering Research. The Engineer-in-Chief is also a Member of the Colonial Road Research Committee. In this way close contact was maintained with the work at the laboratories concerned where research work of benefit to Colonial Territories is undertaken.

99. The Crown Agents continued to be represented at the World Power Conference. They were also represented at the Second United Nations Conference at Geneva on The Peaceful Uses of Atomic Energy. A senior member of their staff attended the eleventh course on reactor operation held at the Calder Hall Operation School. Visits were also made to the fuel preparation plant at Springfields near Blackpool, the Chapelcross plant and the plutonium preparation plant and ponds at Windscale.

100. A number of detailed investigations for various Colonial authorities were undertaken in collaboration with the firms or organisations concerned or arrangements were made for them to be done by the latter. These included, for various colonial railways, an enquiry into the conversion of sentinel railcars from steam to diesel motive power, an investigation into the cause of loose tyres on a certain class of locomotive, the metacone suspension unit for diamond frame bogies (in connection with coil spring breakage on this type of bogie), the fracture on vertical gusset plates on another type of bogie fitted to coal hopper wagons, and the fitting of solid wheels on C. & W. stock.

101. For other authorities overseas enquiries were made and investigations put in hand in respect of the necessary plant to cover with plastic insulation covering a quantity of .05" dia. cadmium copper wire, the processes for recovery of salts from sea water by solar evaporation and refrigeration, the inventor's claims in regard to an instrument on the principle of a divining rod named the "Revealer", and oil fired crematorium furnaces.

102. A special project dealt with during the year concerned the development of The Swamp Skipper for the International Red Locust Control Service. This was a light all purpose self propelled vehicle capable of travelling on dry land, in swamp, or over water, flotation being achieved by the large hollow drum wheels on which it ran.

## F. METEOROLOGY

103. Despite a continuing shortage of staff in 1958, local research has continued in Colonial territories together with observations in connection with the International Geophysical Year. The latter have been submitted to the World Meteorological Organisation for publication.

104. As the outcome of Dr. A. G. Forsdyke's study of research requirements into tropical meteorology, instituted in accordance with a recommendation made at the Commonwealth Meteorological Conference in 1955, a comprehensive report has now been completed and has formed the basis of further discussion at the Conference of Commonwealth Meteorologists held in London in May, 1959.

105. Work has continued in East Africa in the use of cetyl alcohol to reduce evaporation losses from reservoirs and lakes, and a study was also carried out to consider the feasibility of prevention or reduction of hail by means of cloud seeding.

106. A further large scale experiment on artificial stimulation of rainfall was planned using a new type of Italian rocket mentioned in last year's report. This rocket is self-destructive and can therefore be used in inhabited areas. Statistical analysis of rainfall data was continued throughout the year.

107. Under a programme of forecasting research commenced in Kenya in June, 1958, progress has been made in two related investigations. Firstly, a study of the usefulness of radio-sonde ascents in forecasting local rainfall, and secondly, the investigation into an attempt to provide a synoptic and dynamical groundings for forecasting using upper air charts.

108. Research continued in East Africa on the approach of meteorology to the Desert Locust problem mentioned in last year's report. Considerable progress has been made in the last twelve months in the work of analysing the weather maps covering the research period and it is hoped that the analysis will be completed for half the period by mid 1959, when it is intended to take the analysed weather maps to the Anti-Locust Research Centre in London for comparison with the maps displaying locust movements during the same period.

109. Under the auspices of the Technical Assistance Programme of the United Nations a geomagnetic survey of East Africa was commenced in January, 1959, and is expected to take eighteen months to complete. The programme consists of magnetic measurements at some 40 stations for the construction of regional magnetic data and secular change studies; an investigation of diurnal variations in Africa to study the extent of the equatorial electrojet and to provide basic information for detailed total intensity aeromagnetic mineral surveys; and a preliminary investigation of the magnitude and distribution of magnetic anomalies.

110. The West African Meteorological Service were to the fore in setting up a Technical Hydrological Committee whose main initial function is the determination and publication of adequate meteorological data of all kinds throughout the Federation. This has directly involved a substantial extension of the existing network of rainfall stations and more elaborate forms for publication of data. It has also focussed attention on the importance of satisfactory estimates of evaporation from open water surfaces, and the network of evaporation tanks has been increased and a number of radiation integrators are now being installed.

111. Two sets of planned network of three Sferices equipments for the radio location of thunderstorms have been installed at Kano and Ikeja. The ground-weather radar installed at Kano and Ikeja continues to prove indispensable.



112. Measurements of the properties of upper air over Singapore by radio-sonde and radar wind techniques continued throughout the year. Investigations by storm warning radar were also made.

113. Hong Kong completed an analysis of typhoon tracks in the Western Pacific and the China Seas for the period 1884–1953 ; this is being published. This survey contains the actual tracks of all recorded storms and also various analyses of the speed and direction of movement of storms.

114. A study was made of the corrections applied to radio-sonde observations and special radio-sonde ascents were made for this purpose during a solar eclipse, and the results published in a paper entitled “ Results of the Experimental Radio-sonde Ascents made at Hong Kong during the Solar Eclipse, April 19, 1959 ”.

115. An investigation of all recorded storm tides at Hong Kong and the effect of abnormal meteorological conditions on tides was completed and prepared for publication. Work is still continuing at Hong Kong on the analysis of surface winds at the new Hong Kong airport ; on the climatology of winds and temperatures on air routes ; on an examination of the diurnal variation of upper wind ; on a study of cold surges over South Asia during winter ; and on an examination of the effect of afforestation in increasing precipitation.

116. The Observatory Department in Mauritius continued investigations into the three dimensional structure of the atmosphere in the tropics.

117. The West Indies Meteorological Service continued to participate in the Hurricane Research Project mentioned in last year’s report by providing staff for the operation of two radio-sonde stations. Research on the material obtained is being carried out by the United States and from the information so far received valuable results are being obtained.

118. A considerable number of papers were published during the year by the East Africa Meteorological Department on such various subjects as annual rainfall, artificial stimulation of rainfall, and preliminary micro-climate study. Staff of the West African Meteorological Department prepared three technical notes on diurnal variation of surface wind speed, risk of rainfall, and harmattan haze ; while a paper on cyclones, and a paper on the West African monsoon were prepared by the staff of the Mauritius Meteorological Department. A paper on modification to lag and radiation corrections for the Kew type radio-sonde in the troposphere was prepared by a member of the staff of the Royal Observatory, Hong Kong.

## G. WATER POLLUTION RESEARCH

119. The Water Pollution Research Laboratory provided advice to Kenya on treatment of waste waters from a gold and copper mine to render them less toxic to fish, to Nigeria on the choice of sampling equipment for studying silt and suspended matter in rivers, and to Tanganyika on the design of a small sewage treatment plant.

120. Liaison with Colonial correspondents was maintained by sending them information about the Laboratory’s work.

(32581) Wt. 901—7973 K14 2/60 D.L.

