

THE
Tea Research Institute
OF
Ceylon

BULLETIN No. 26

Annual Report for the Year
1944



Published by
THE TEA RESEARCH INSTITUTE OF CEYLON.
ST. COOMBS, TALAWAKELLE.

The Tea Research Institute of Ceylon.

SCIENTIFIC STAFF.

<u>Director</u>	... Roland V. Norris, D.Sc. (Lond.), M.Sc. (Manc.), F.R.I.C.
<u>Department of Mycology.</u>	
Mycologist	... C. H. Gadd, D.Sc. (Birm.)
Assistant Mycologist	... T. E. T. Bond, Ph.D. (Cantab.) M.Sc.
Assistant,	... C. A. Loos (Reading)
<u>Department of Agricultural Chemistry.</u>	
Agricultural Chemist	... T. Eden, D.Sc. (Manc.), A.R.I.C.
Research Assistant	... Vacant
Assistant	... E. N. Perera
Field Assistants	... M. Piyasena F. P. Jayawardana
<u>Department of Biochemistry.</u>	
Biochemist	... J. Lamb, M.Sc. (Lond.), A.R.I.C., A.I.C.T.A.
Research Assistant	... H. B. Sreerangachar, M.Sc. (Bombay) B.Sc. (Mysore), A.R.I.C., A.I.I.Sc.
Assistants	V. Mendis E. L. Keegel P. R. Perera.
<u>Department of Entomology.</u>	
Entomologist	... C. B. Redman King, M.A. (Cantab.), M.C. [on military service]
Assistant Entomologist	... G. D. Austin
Assistant	... D. J. William
Field Assistant	... W. T. Fonseka
<u>Department of Plant Physiology.</u>	
Plant Physiologist	... F. R. Tubbs, Ph.D. (Lond.) D.I.C., A.R.C.S., F.L.S. (on military service)
Voluntary Worker	... Mrs. T. E. T. Bond, M.Sc. (Reading)
Assistant	... M. H. E. Koch
Field Assistant	... F. H. Kehl
<u>Small-Holdings Officers.</u>	
	R. L. Illankoon [on military service] M. B. Boange (Acting) F. D. Tillekeratne
Superintendent, St. Coombs Estate	... J. A. Rogers

NOTE.

The Laboratories of the Institute are situated at St. Coombs Estate, Talawakelle, and letters and enquiries should be addressed to the Director, Tea Research Institute of Ceylon, St. Coombs, Talawakelle. Telegraphic Address :—Research, Talawakelle ; Telephone, Talawakelle 44 (Private Exchange). It is particularly requested that letters should not be addressed to officers by name.

NINETEENTH ANNUAL REPORT

OF THE

BOARD OF THE TEA RESEARCH INSTITUTE OF CEYLON

FOR 1944

Foundation.—The Tea Research Institute was established by Ordinance No. 12 of 1925, dated the 27th October, 1925. The Constitution of the Board is laid down in that Ordinance; the personnel on the 1st day of January, 1944 was:—

Ex-Officio Members.

The Hon'ble the Financial Secretary (Hon'ble Mr. H. J. Huxham, C.M.G.).

The Director of Agriculture (Mr. E. Rodrigo, C.C.S.)

The Chairman, Planters' Association of Ceylon (Mr. N. H. Wykeham Dulling).

The Chairman, Ceylon Estates Proprietary Association (Mr. R. Mann)

Representatives of the Planters' Association of Ceylon.

Mr. R. G. Coombe.

Mr. G. K. Newton.

Mr. H. St. J. Cole-Bowen.

Representatives of the Ceylon Estates Proprietary Association

Major J. W. Oldfield, C.M.G., O.B.E., M.C.,

Mr. J. C. Kelly.

Mr. W. H. Gourlay.

Representative of the Low-Country Products' Association.

Mr. W. P. H. Dias.

Representative of the Small-Holders.

Adigar Sir T. B. Panabokke (Chairman).

Chairman.—Adigar Sir T. B. Panabokke.

Secretary.—Dr. Roland V. Norris.

Solicitors.—Messrs. Julius & Creasy.

Auditors.—Messrs. Ford, Rhodes, Thornton & Co.

Registered Office.—The Victoria Commemoration Building, Kandy.

The following changes in the composition of the Board took place during the year:—

Mr. L. J. de S. Seneviratne, C.C.S. became an *ex-officio* member of the Board as from 14th February, 1944 on his appointment as Director of Agriculture *vice* Mr. E. Rodrigo, C.C.S. vacated.

Mr. G. K. Newton on his election to the Chairmanship of the Planters' Association of Ceylon on the 31st May, 1944 became an *ex-officio* member instead of a nominated member.

Mr. R. C. Scott was nominated by the P. A. of Ceylon to fill the vacancy thus created with effect from the 31st July, 1944.

Mr. D. F. Ewen became an *ex-officio* member of the Board on his election on the 23rd August, 1944 to the Chairmanship of the C. E. P. A. *vice* Mr. R. Mann vacated.

Mr. R. Singleton-Salmon was nominated by the P. A. of Ceylon as one of their representatives with effect from the 15th September, 1944 *vice* Mr. H. St. John Cole-Bowen resigned.

Mr. F. Amarasuriya was nominated by the L. C. P. A. as their representative on the Board as from 17th November, 1944 *vice* Mr. W. P. H. Dias whose term of office had expired.

Chairmanship.—The long association of Adigar Sir Tikiri Banda Panabokke with the Institute came to an end in December when Sir Tikiri was appointed to the post of Representative of the Ceylon Government in India.

Sir Tikiri has been on the Board of the Institute since its inception in January, 1926 as the member nominated by H. E. the Governor to represent the Small-Holders in Tea. His services on the Board were recognised by his appointment as Chairman as from the 1st January, 1941. This post he held until his resignation on the 22nd December, 1944.

Sir Tikiri's activities in the Island were wide-spread and the news that the honour of Knighthood had been conferred on him by H. M. the King in the Birthday Honours List of 1944 was received with great satisfaction.

At the meeting held on the 22nd December, 1944 the Board recorded their deep appreciation of the long and valuable service Sir Tikiri Panabokke had rendered to the Institute and their pleasure that he had been selected for the important post of Ceylon Representative in India.

At the same Meeting Mr. R. C. Scott was unanimously elected to the Chairmanship.

COMMITTEES

Finance Sub-Committee.—The Chairman, T. R. I., the Chairman, Planters' Association of Ceylon; the Chairman, Ceylon Estates' Proprietary Association; Major J. W. Oldfield, C.M.G., O.B.E., M.C.; Mr. H. St. J. Cole-Bowen; Mr. J. C. Kelly and the Director, T. R. I.

Mr. R. Singleton-Salmon was elected to the Committee on the 20th October, 1944, *vice* Mr. Cole-Bowen resigned.

The Committee held two meetings during the year.

Estate and Experimental Sub-Committee.—The Director, T. R. I. (Chairman); the Chairman, T. R. I.; the Visiting Agent (Mr. H. Tonks); the Superintendent, St. Coombs; Messrs. R. G. Coombe, D. T. Richards, R. H. Horne, U. J. Craig, E. de la Mare, G. K. Newton and Dr. T. Eden (Convener).

This Committee met three times.

Medical Scheme Sub-Committee.—The Chairman, T. R. I., the Director, T. R. I.; and Mr. G. D. Austin (representing the Junior staff).

Trustees of the Junior Staff Provident Fund.—The Chairman, T. R. I., the Director, T. R. I.; Mr. R. G. Coombe and Mr. E. N. Perera (representing the Junior Staff).

Visiting Agent.—Mr. H. Tonks continued to act as Visiting Agent and paid three visits of inspection to St. Coombs during the year. The thanks of the Board are due to him for his valuable advice.

FINANCE

The total receipts amounted to Rs. 442,327 made up as follows:—

Cess Rs. 386,121, Profit on St. Coombs Estate Working Account Rs. 46,160 and Miscellaneous Receipts Rs. 10,046. Receipts were thus Rs. 63,159 higher than in 1943. This result was chiefly due to the increased profit from St. Coombs Estate but the yield from the Cess was also higher by Rs. 17,111.

Expenditure on Revenue Account, comprising Research Revenue Expenditure at Rs. 292,979, Interest Charges on the Government Loan Rs. 30,617, and Depreciation at Rs. 37,854, amounted to Rs. 361,450 against Rs. 320,209 in 1943. There was thus a surplus on Revenue Account of Rs. 80,877, the corresponding figure for 1943 being Rs. 58,959.

Capital expenditure was incurred to the extent of Rs. 60,264, this sum comprising expenditure on assets of Rs. 16,172 and Rs. 44,092 representing repayment of the Government Loan. The expenditure on assets included Rs. 11,212 expended on factory machinery.

Nett liquid assets as at 31st December, 1944, after allowing for specific liabilities, such as the accrued interest on the Government Loan and Furlough and Passages Reserve, amounted to Rs. 543,241. The liability under the Depreciation Reserve at the same date was Rs. 556,144 while the balance due to Government on Loan Account was Rs. 523,610.

ST. COOMBS ESTATE

Manure was in very short supply as no deliveries were received for the first six months of the year and the fourth quarter's manure only reached the estate after the end of the year. In contrast to 1943, however, climatic conditions in 1944 were particularly favourable for crop, rainfall though lower than normal being very well distributed. These conditions largely offset the scarcity of manure and a crop of 214,817 lbs. was obtained, a figure which has only once been exceeded. The yield for the old tea was 781, and for the 1937 clearing (20 acres) 425, lbs. per acre. Crop was thus 42,769 lbs. above that secured in 1943.

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The entire crop, with the exception of 1,754 lbs. used for local consumption, was sold to the Ministry of Food, realising 112.04 cents per lb. as against 98.21 cents per lb. in the previous year.

Cost of production at 89.68 cents per lb. (including Dearness Allowance at 19.76 cents) was 5.85 cents below the 1943 figure.

The profit on estate working account was therefore Rs. 46,160 as against Rs. 3,549 in 1943, a very satisfactory improvement.

It may be of interest to note that the 2 acres of the 1937 clearing planted on the contour (5 feet by 1½ feet) yielded 794 lbs. per acre, the figure for the 18 acres with normal planting (4 feet x 3 feet) being 384 lbs. per acre. A feature of the contour block is the way in which terraces are being gradually built up.

PUBLICATIONS

Owing to the shortage of staff and pressure of other work only two publications were issued, one part of *The Tea Quarterly* and Bulletin No. 25, Annual Report for 1943.

ACKNOWLEDGMENTS

Cordial thanks are due to the Ceylon Association in London who have as always, given the Institute much assistance. The usual close co-operation has continued with the Planters' Association of Ceylon, the Ceylon Estates Proprietary Association and other bodies concerned in the Tea Industry.

Thanks are also due to the Ceylon Chamber of Commerce and the Ceylon Tea Propaganda Board for the use of their Committee Rooms for Meetings of the Board held in Colombo.

The Audited Statements of Accounts and the Balance Sheet for 1944 are attached together with the reports of the Visiting Agent and of the Director and Scientific Staff dealing with the research activities of the Institute.

ROLAND V. NORRIS,
Secretary.

THE TEA RESEARCH INSTITUTE OF CEYLON

BALANCE SHEET AS AT 31st DECEMBER, 1944—(contd.)

LIABILITIES	Rs. Cts.	ASSETS	Rs. Cts.	Rs. Cts.
Brought forward	624,712-75	Brought forward		105,958-07
		INVESTMENTS (At Cost)		
		£2,300 3¼% War Loan Bearer Bonds	32,434-76	
		£2,063/18/1 4% Funding Loan 1960-90	29,928-06	
		£6,750 2½% National War		
		Bonds 1952-54	90,000-00	
		Rs. 30,000 3¼% Ceylon Government		
		War Loan 1957-62	29,512-50	
		Rs. 15,000 3% Ceylon Government		
		Defence Bonds 1952	15,000-00	
		Rs. 20,000 3% Ceylon Government		
		Defence Bonds 1949	20,000-00	
		Rs. 40,000 3¼% Ceylon Government		
		National Loan 1956	40,000-00	
		Rs. 50,000 2½% Ceylon Government		
		War Loan 1954	50,000-00	306,875-32
		CASH:—		
		On Current Account	37,842-13	
		„ Fixed Deposit	141,118-95	
		„ Petty Cash Account	1,563-06	
		„ N.B.I. Ltd., N'Eliya	1,854-92	182,379-06
		„ Estate—N.B.I. Ltd., Col.	16,874-24	
		„ In hand	1,057-07	17,931-31
		FUNDS OVERSPENT		
		To 31st December, 1943	32,180-48	
		Capital Expenditure, 1944	16,172-47	
		Govt. of Ceylon Loan a/c.	44,092-10	
			92,445-05	
		Less: Revenue a/c.		
		Surplus 1944	80,876-48	11,566-59
	<u>Rs. 624,712-75</u>			<u>Rs. 624,712-75</u>

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We have audited the books of the Tea Research Institute of Ceylon and have obtained all the information and explanations required by us. The allocations of Capital Expenditure and of Research Revenue Expenditure as made by the Director have been accepted by us. We are not in a position to say whether the Reserves made for for Depreciation are adequate. Subject to the foregoing reservations, the above Balance Sheet, in our opinion, is properly drawn up so as to exhibit a true and correct view of the financial affairs of the Institute at 31st December, 1944, according to the best of our information and the explanations given to us, and as shown by the books,

(Sgd.) FORD. RHODES, THORNTON & CO.,
Chartered Accountants

Colombo. 18th May, 1945

THE TEA RESEARCH INSTITUTE OF CEYLON

REVENUE ACCOUNT AS AT 31st DECEMBER 1944—(contd.)

	Rs.	Cts.	Rs.	Cts.		Rs.	Cts.
			15,686		15,686		
To PERSONAL EMOLUMENTS OF SCIENTIFIC STAFF:—						442,326	
Director	22,750	00					
Mycologist	20,250	00					
Agricultural Chemist	20,470	0					
Entomologist	17,643	74					
Plant Physiologist	17,791	27					
Biochemist	18,227	46					
Asst. Mycologist	11,337	50					
Dearness Allowance	12,000	00	140,469		140,469		
.. EMOLUMENTS OF JUNIOR & SUB. SCIENTIFIC STAFF:—							
Junior Scientific Staff	38,536	15					
Lab. Attendants & Fieldman	4,244	08					
Dearness Allowance	9,687	50	52,467		52,467		
.. LABORATORY:—							
Equipment & Genera Working Expenses			7,883		7,883		
.. LIBRARY & PUBLICATIONS:—							
Library	2,342	95					
Publications	Cr. 204	21	2,138		2,138		
.. SMALL-HOLDINGS:—							
Salaries and House Allowances	6,811	37					
Travelling & General Expenditure	3,889	18					
Dearness Allowance	1,237	20	11,937		11,937		
			230,584		230,584		
Carried over					Carried over	442,326	

THE TEA RESEARCH INSTITUTE OF CEYLON

REVENUE ACCOUNT AS AT 31st DECEMBER, 1944—(Contd).

	Rs.	Cts.		Rs.	Cts.
Brought forward			Rs. Cts.		
			230,584-04	Brought forward	Rs. Cts.
To FIELD & FACTORY EXPERIMENTS:—					442,326-91
Agricultural Chemistry ...	4,738	93			
Plant Physiology ...	249	66			
Miscellaneous Experiments ...	45	00			
Factory Experiments ...	1,317	50	6,351-09		
„ TRAVELLING OF STAFF:—					
Officers Expenses ...	1,518	10			
Insurance of Car and License ...	148	67			
Drivers' Wages ...	852	40			
Drivers' Batta ...	172	40			
Running Expenses and Repairs ...	1,623	38			
Dearness Allowance ...	386	80	4,701-75		
„ MAINTENANCE OF BUILDINGS:—					
Laboratory ...	10	63			
Six Senior Staff Bungalows ...	2,406	11			
Thirteen Junior Staff Bungalows ...	994	25			
Clerks' Bungalows ...	176	81			
Miscellaneous Lines and Buildings ...	273	15			
Guest House ...	122	86			
Replacements & Renewals Junior Staff and Clerical Staff Furniture	256	50	4,240-31		
„ GENERAL SERVICES:—					
Electric Power ...	7,303	76			
Mechanic ...	750	00			
Telephone Rent & Maintenance of Lines ...	543	50			
Roads ...	500	00			
Sanitation ...	1,395	38			
Water Supply ...	2,128	90			
Tappal, Lorry and Book Fees ...	255	00			
Nettikans & Drains ...	144	62			
Upkeep of Grounds ...	978	99			
Guest House ...	311	06			
Dearness Allowance ...	852	93	15,164-14		
Carried over			261,041-33	Carried over	442,326-91

THE TEA RESEARCH INSTITUTE OF CEYLON

REVENUE ACCOUNT AS AT 31st DECEMBER, 1944—(contd.)

	Rs.	Cts.		Rs.	Cts.
Brought forward			261,041	33	
Brought forward			Rs. 442,326	91	
To MISCELLANEOUS:—					
Incidentals	220	25			
Provident Fund, Senior Sc. Staff	12,543	78			
Do Junior Scientific Staff	5,046	60			
Do Sub-Staff	1,289	69			
Passages	6,000	00			
Ceylon Nursing Association and Fraser Nursing Home	135	00			
Medical Fees Sub-Staff	442	80			
Medical Scheme Junior Staff	1,122	00			
Insurances	3,994	83			
Watchmen and Caretakers	812	65			
Observatory Allowance	240	00			
Dearness Allowance	90	16	31,937	76	
.. GOVERNMENT OF CEYLON LOAN INTEREST ACCOUNT			30,617	30	
.. DEPRECIATION			37,854	06	
.. Balance			80,876	46	
			<u>Rs. 442,326</u>	<u>91</u>	
					<u>Rs. 442,326</u>

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ROLAND V. NORRIS,
Director.

St Coombs,

THE TEA RESEARCH INSTITUTE OF CEYLON

Dr.	CAPITAL ACCOUNT AS AT 31st DECEMBER, 1944						Cr.			
EXPENDITURE						RECEIPTS				
	To 31-12-43	Additions in 1944	Items Scrapped or sold in 1944	Total						
	Rs.	Cts.	Rs.	Cts.	Rs.	Cts.	Rs.	Cts.	Rs.	Cts.
To LAND—INCLUDING DEVELOPMENT	889,567	53	4,154	17	893,721	70				
„ BUILDINGS & LINES	947,062	03	218	75	947,280	78				
„ FURNITURE AND EQUIPMENT	82,439	30	232	18	82,671	48				
„ LABORATORY EQUIPMENT	42,786	29	591	78	43,216	29				
„ EXPERIMENTAL MACHINERY	29,705	38	—	—	29,705	38				
„ MACHINERY—ESTATE	134,530	39	11,212	37	145,667	76				
„ MOTOR ROAD ROLLER	7,386	03	—	—	7,386	03				
„ MOTOR CAR	4,025	00	—	—	4,025	00				
	<u>Rs. 2,137,501</u>	<u>95</u>	<u>16,409</u>	<u>25</u>	<u>236</u>	<u>78</u>	<u>2,153,674</u>	<u>42</u>		
							<u>Rs. 2,153,674</u>	<u>42</u>		

BY GOVERNMENT OF CEYLON:—
 Loan on Mortgage @ 5½%
 per annum
 Less: Repayments to 1944

„ REVENUE APPLIED TO CAPITAL
 PURPOSES TO 31-12-43
 do do 1944

„ FUNDS OVERSPENT TO 31-12-43
 Less: 1944 Underspent

	1,000,000	00
	<u>476,389</u>	<u>79</u>
	1,537,619	16
	<u>80,876</u>	<u>46</u>
	32,180	48
	<u>20,611</u>	<u>89</u>

1,618,495

11,568

St. Coombs,

(Sgd.) ROLAND V. NORRIS,
 Director.

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THE TEA RESEARCH INSTITUTE OF CEYLON

LOAN ACCOUNT

	Rs. Cts.		Rs. Cts.
To GOVERNMENT OF CEYLON LOAN Account	Rs. 1,000,000-00	By REPAYMENTS PRINCIPAL:—	
		To 31st December, 1943	432,297-69
		,, To 31st December, 1944	44,092-10
		,, Balance	523,610-21
	<u>Rs. 1,000,000-00</u>		<u>Rs. 1,000,000-00</u>

ANNUAL REPORT FOR 1944

(Sgd.) ROLAND V. NORRIS,
Director

REPORT

ON

ST. COOMBS ESTATE

FOR 1944

The following short report is specially written on the working of St. Coombs Estate for 1944, for inclusion in the Tea Research Institute's Annual Report for that year, and is in addition to the usual detailed reports on the property made by the Visiting Agent.

Superintendent.—Mr. J. A. Rogers.

Acreage :—

	A.	R.	P.
Tea in Bearing	264	1	06
Tea in Partial Bearing (1937)	20	0	00
Tea New Clearings (1938)	16	0	00
Tea Nurseries	1	1	08
Fuel Clearings	36	0	00
Reserve available for planting	27	1	09
Building Sites, etc.	26	2	22
Waste Land and Swamps, etc.	23	1	14
Total ...	414	3	19

Weather.—(Estate Gauge)

	Rainfall	Wet Days
Registered in 1944	87.16 ins.	244
Registered in 1943	124.68 ins.	257
Decrease :—	37.52 ins.	13

There was no drought in the early months of 1944. The very mild S. W. Monsoon was followed by a fairly normal N. E. Monsoon as regards rainfall.

87.16 inches is a very low annual rainfall for this district, but it was well distributed.

Climatic conditions were favourable for crop, more or less throughout 1944.

Crop :—

	1944	1943
Estimate	200,000 lbs.	200,000 lbs.
Total Crop harvested (including Broken Mixed)	214,817 lbs.	172,048 lbs.

The total crop for 1944 showed an increase of 42,769 lbs. as compared with the crop harvested in 1943, and it was only 7,771 lbs. less than the record crop secured in 1942:

Yield Per Acre :—(on Total Crop).

	1944	1943
Old Tea (264 acres) ...	781 lbs.	631 lbs.
Clearings (1937) — 20 acres ...	425 lbs.	269 lbs.
Total from 284 acres :—	756 lbs.	586 lbs.
1937 Clearings only :—		
18 acres 4 ft. x 3 ft.	384 lbs.	*219 lbs.
12 acres 5 ft. x 1½ ft. on Contour ...	794 lbs.	*678 lbs.

Prices and Total Crop Sold :—

Year	Total Crop Sold	Gross Average per lb.	Nett Average per lb.
1944	213,063 lbs.	113.18 cts.	112.04 cts.
1943	170,614 lbs.	99.63 cts.	98.21 cts.

Cost of Production (Revenue Account) :—

	1944	1943
Estimate ...	100.47 cts. per lb.	83.15 cts.
Actual Cost on Total Crop ...	89.68 cts. per lb.	95.53 cts.

Dearness Allowance included in above figures was as follows :—

	1944	1943
To Labourers ...	16.61 cts.	17.85 cts.
To Factory Staff ...	1.01 cts.	1.10 cts.
To Subordinate Staff ...	2.14 cts.	.91 cts.
Total	19.76 cts.	19.86 cts.

Profit on Estate Working :—

1944	Rs. 46,160
1943	Rs. 3,549

Capital Expenditure :—

1944	Rs. 15,817 or 7.37 cents per lb.
1943	Rs. 14,352 or 8.16 cents per lb.

Manuring.—No artificial manure was available for distribution from November, 1943 to September, 1944, when the third quarter's quota for 1944 was received. It was not possible to issue the ration for the 4th quarter until early in 1945, so that during the whole of 1944 only one-fourth of the rationed quota of fertilisers was actually delivered.

Out of the 275½ acres estimated to be manured only 98½ acres were actually completed (including the 1937 Clearing — No. 13, 18 acres, manure for which was in stock from 1943).

Pruning.—The programme of 83 acres was completed at a cost of Rs. 18.42 per acre, exclusive of Dearness Allowance.

Green Manuring.—All available green material was forked in together with leaf-fall in the acreage pruned. Green manure was forked in with applications of artificial manure, and in addition was also forked in 75½ acres without manure.

* Pruned in August—September, 1943

Weeding.—The whole estate continues to be gang-weeded on Estate Account, and only the Polygonum species are left to provide a ground cover.

Weeds were again very troublesome during 1944, and owing to lack of labour it was not found possible to complete monthly weeding rounds. The position became serious from July to October, after which, however, it improved and the full acreage was weeded during the last three months of the year under review.

During 1944, of the 3,360 acres estimated only 2,739 acres were actually weeded, leaving an average of 52 acres per month unweeded.

The cost of weeding showed a further considerable increase, and for 1944 it was Rs. 3.85 per acre (excluding Dearness Allowance), as compared with Rs. 2.86 per acre in 1943.

Labourers do not appear to take the same degree of care in weeding as cleanly as they did formerly. It is now becoming a frequent complaint on estates that the quality as well as the quantity of work done by weeders has deteriorated.

Supplying.—3,732 Tea Stumps were put out as supplies in No. 5.

1938 New Clearing (16 Acres) Planted on Semi-Contour 4 ft. × 2 ft.—This Clearing was manured in 1944 with 2 ozs. per plant of T. 500 Mixture. It has made excellent growth, and after it is pruned in 1945 it should be brought into partial bearing.

Labour.—At the end of 1944 there were 363 working labourers on the estate (as compared with 366 at the end of 1943), and after deducting 38, being the average number required for the Tea Research Institute's purposes, 325 were available for the estate, equivalent to 1.14 working labourer per acre on the 284 acres in full and partial bearing.

The average out-turn is very satisfactory at 81 per cent, varying between 77 per cent in July and 86 per cent in February.

Output appears to have declined particularly in regard to weeding and "sillarai" works, but it is pleasing to note that the average plucked showed an increase of 7½ lbs. over the figure for 1943.

During 1944 there was very little movement within Ceylon, only 13 labourers were paid off locally, with 5 being taken on and 8 children newly registered. However, 89 labourers proceeded to, and 87 returned from, India.

Labour actually has been found to be definitely short of requirements, largely owing to the considerably increased demands for Estate Account weeding, but there is not sufficient Line Room accommodation at present for more labour.

Lines.—There are 148 Line Rooms up to Government Standard, 7 of which are occupied by K.P.'s, Dhobies, Baas, etc. Fairly extensive repairs will be required to Drains, Ramps, Latrines, etc., when cement again becomes available, also the roofs of Lines, etc., will need repainting when paint is procurable at reasonable prices.

Factory and Machinery.—The factory building was maintained in thorough good order. The full equipment of Fire extinguishers and Fire Buckets, etc., has been installed, as also a piped supply of water to

each Withering Floor. Fire Watchers and Fire Fighting Squads are being trained and there are, I understand, regular practices carried out.

This factory is to be equipped with the Grinnell "Sprinkler System," though there is likely to be some delay in the arrival of the material which requires to be imported.

Machinery is well kept and in satisfactory order. The Sirocco Wallsend Oil Burning Equipment has been installed for the Empire Drier, etc.

A direct-fired Heater has been erected and connected to the Empire Drier by an underground duct. It will be most interesting to study and compare results from this Heater.

General.—With favourable weather conditions during 1944 crop was extremely satisfactory, and with the serious curtailment of artificial manuring, a yield of 781 lbs. per acre on the 264 acres of old tea must, I think, be regarded as excellent for this type of tea.

After a negligible profit in 1943 the profit in 1944 is only slightly less than in the record year of 1942.

The tea continues to have a healthy appearance and the estate has been maintained in good order.

Mr. Rogers deserves congratulations on the successful results in 1944.

HUBERT TONKS.

Visiting Agent.

METEOROLOGICAL OBSERVATIONS, 1944.

ST. COOMBS.

Laboratory Gauges

MONTH	TEMPERATURES						RAINFALL		RAIN DAYS		SUNSHINE		
	Mean Maximum	Difference from average 1931-1940	Mean Minimum	Difference from average 1931-1940	Adopted Mean	Mean on grass	Mean Relative humidity	Inches	Difference from average 1931-1940	Days	Difference from average 1931-1940	Hours.	Difference from average 1931-1940
January	74.4	+0.7	53.9	-1.9	64.2	47.6	72	1.94	-2.18	10	-1	225.85	+30.85
February	75.1	-1.0	57.8	+3.4	66.4	53.5	72	4.59	-1.69	17	+9	135.68	-94.84
March	76.2	-1.0	56.5	+1.2	66.4	52.5	77	8.85	+4.61	17	-5	230.40	-4.06
April	78.0	+0.7	57.0	-0.8	67.5	54.1	78	4.09	-2.21	14	-2	289.52	+35.28
May	74.6	-0.2	60.2	+0.3	67.4	60.4	84	11.66	+0.72	23	+4	120.47	+38.13
June	72.0	+1.2	59.8	-0.6	65.9	60.6	86	6.66	-5.75	24	-3	145.98	+51.70
July	70.8	+1.0	59.8	+0.3	65.3	60.2	88	6.44	-6.23	27	+1	109.73	+1.59
August	73.5	+2.5	58.9	-0.1	66.2	58.0	84	2.10	-7.59	19	-6	150.60	+30.44
September	73.2	+1.0	58.7	+0.6	66.0	58.2	84	5.23	-3.25	19	-2	139.15	-7.77
October	74.8	+1.6	58.0	+0.3	66.4	55.0	82	16.44	+7.21	22	nil	157.07	-1.26
November	73.3	+0.1	58.5	+1.1	65.9	56.1	84	10.15	+1.98	28	+8	128.85	-25.42
December	74.1	+0.4	55.3	-0.9	64.7	52.0	78	4.33	-0.60	12	-3	206.32	+20.56
Annual	74.2	+0.58	57.9	+0.24	66.0	55.7	81	82.48	-13.04	232	+10	1989.62	-1.06
Means							Totals						

REPORT

OF

THE DIRECTOR,

TEA RESEARCH INSTITUTE OF CEYLON

FOR 1944

This report is again necessarily issued in a condensed form but fuller details of technical matters will be found in the Departmental reports attached.

Finance.—Owing to an increased profit on St. Coombs Estate and a higher yield from the Cess, the receipts for 1944 were Rs. 63,159 higher than in 1943, amounting to Rs. 442,377. Expenditure on Revenue Account was Rs. 360,450 as against Rs. 320,209 in the previous year. There was, therefore, a surplus on revenue account of Rs. 80,877, the corresponding figure for 1943 being Rs. 58,959.

Capital expenditure amounted to Rs. 60,507, this including Rs. 16,409 spent on Assets and Rs. 44,092 towards repayment of the Government Loan.

Full details of receipts and expenditure will be found in the report of the Board and the Audited Accounts given earlier in this report.

St. Coombs Estate.—Figures relative to the year's working will be found in the Report of the Visiting Agent. Although no manure was received in the first half of the year, this was offset by exceptionally favourable weather conditions. As a result, a crop of 214,817 lbs. tea was obtained which has only once before been exceeded. The profit on working account was Rs. 46,160 as against Rs. 3,549 in 1943.

Labour, under the present conditions of output, was somewhat short but no accommodation is at present available for a larger force.

Staff.—Major C. B. Redman King, Entomologist, Lieut.-Colonel F. R. Tubbs, Plant Physiologist, and Major R. L. Illankoon, Smallholdings Officer, were on military service throughout the year. Dr. T. Eden, Agricultural Chemist, proceeded on leave out of Ceylon in November.

The Director continued to act as Organiser of the Fertiliser Rationing Scheme. Dr. Gadd remained in charge of the Entomological and Plant Physiology Divisions and Dr. T. E. T. Bond took over charge of the Agricultural Chemist's Department during the absence of that officer.

Fertiliser Rationing and Distribution.—Fertilisers were in exceedingly short supply in the first half of the year. While rubber received the full quota of manure due, no issues of tea manure could be made in the first and second quarters. The position then improved somewhat, but while the third quarter tea manure was distributed at the normal time, owing to shipping delays, the fourth quarter deliveries could not be started until close on the end of the year. In consequence, most tea estates only actually received 25 per cent. of their quota during the year. Fortunately, however, the outlook for 1945 is much more favourable and it is hoped it will be possible to increase the nitrogen quota allowed to tea estates.

Advisory Work.—The petrol and tyre position, together with shortage of staff, made the visiting of estates most difficult. Fortunately, however, conditions were fairly normal on most estates. Weeding and cultivation problems were the questions most frequently referred to the Institute.

Smallholdings.—Advisory work on the usual lines has continued in the Southern Province and in the Kadugannawa area. At present this is a rather uphill battle as the energies of the smallholders have naturally been very largely concentrated on the production of food. Our thanks are due to the Headmen and Village Committees in these areas for their support and assistance.

TECHNICAL.

A brief summary of the more important of the technical problems under investigation is given below. Fuller details will be found in the reports of the staff which follow.

Biological.—In the Mycological Division much time has been spent on a study of the eelworms occurring in Ceylon tea soils. As has been indicated in previous reports, the problem of eliminating these nematodes from the soil appears almost insuperable and the chief hope for the future seems to lie in the discovery of varieties or "jats" of tea which are relatively resistant to attack. In this connection the work now proceeding on tea selection and vegetative propagation may help to provide the solution.

In addition to tea, many of our most useful green manure plants are liable to attack by eelworms and in the report of the Mycologist will be found comparative figures indicating the relative susceptibility of many of these plants to invasion by *Anguillulina pratensis*.

Work on *Phloem necrosis* continues and field observations confirm the apparent absence of the disease from high "jat" bushes. This does not necessarily imply that such bushes are not attacked but the fact of practical importance is that, if attacked, the majority of these bushes show little or no evidence of the disease and, while it is possible they may act as carriers, they themselves continue to thrive and yield normally.

In the Entomological Division work has been in progress on *Macrocentrus homonae*, the parasite which controls Tortrix. Several reports of minor Tortrix attacks were received early in the year, but in every case the parasite was found to be present and it was unnecessary to do anything but leave this to do its work. Further details of the life-history of *Macrocentrus*, which is of particular interest in many respects, will be found in the report of the Entomologist.

Field work on Shot-hole Borer, which was referred to in some detail in the last year's report, has continued.

A rather unusual occurrence early in the year was a severe defoliation of Albizzias in the Hatton area. This appeared to be due to two species of mite, one the common scarlet mite of tea and one not yet identified.

Agricultural.—In addition to the permanent manurial experiments, attention has chiefly been focussed on a study of the function of green manures in promoting soil fertility. This is somewhat complex and the improvement is due to more than one factor. It is interesting to note, however, perhaps a somewhat unexpected result, that green manures seem to have but a small effect on the crumb structure of Ceylon tea soil.

In regard to manurial questions, one experiment, which may modify existing practice, has been concerned with the response of tea to phosphatic manures. This response is quite marked, though considerably less than the response to nitrogen, with applications up to, possibly, 30 lbs. P_2O_5 per acre. But whereas the response continues unchecked to much higher applications of nitrogen, in the case of phosphoric acid, while the first 30 lbs. P_2O_5 gave an average increased yield of 63 lbs. tea, the yield was raised only another 4 lbs. by the addition of a further 30 lbs. of P_2O_5 . There has been an inclination in certain quarters, though this has perhaps been modified in recent years, to use much higher applications of phosphoric acid. In view of the effect of phosphoric acid in stimulating many types of weeds, it is obvious that the whole question of the economic limits of phosphatic manuring must be reconsidered.

In Dr. Eden's report will be found some further results from the plucking experiment in which normal plucking is being compared against continuous plucking to the fish leaf. While the latter method has given a much higher yield in the period under review, the effect on wood formation cannot be overlooked. Furthermore, experimental manufacture of leaf from these plots, referred to in Mr. Lamb's Report, indicate that the average valuations of the leaf from the fish leaf plots was some four cents below that from the normally plucked plots.

Physiological.—This Department's chief concern is the work on tea selection and vegetative propagation. Preliminary yield figures are given in the report of some of the clones which were planted out in 1937/38, 1939 and 1940. It should be noted that some of the earlier clones were not selected entirely on a yield basis. Even so the figures are encouraging and better results still may clearly be expected from the material selected on a more stringent basis. One factor which is obviously of importance is the favourable effect of a free-branching habit in the clone.

All the best yielding bushes have produced teas of at least average quality.

Further notes on cover crops and weeds, particularly in regard to the effect of phosphatic manure on the latter, will be found in Dr. Bond's portion of the report

Biochemical.—At the last Tea Research Institute Conference held in 1939 the writer stressed the necessity for some improvement and simplification in manufacturing methods. The trend of modern events, all leading to increased costs of production, has made this problem even more urgent and it seems likely, in fact, that unless something can be done in this direction many relatively low yielding Ceylon estates will be unable to survive in the more severe competition which may be expected to ensue after the war.

Of the various processes of manufacture withering and rolling offer the greatest opportunities for radical changes. All present evidence suggests that little or no chemical change takes place in the leaf during withering, and this long and relatively expensive expedient is required chiefly to bring the leaf into a suitable physical condition for present rolling methods. The latter are, however, cumbrous and inefficient. The object of rolling is to bring about a partial disintegration of the leaf and by rupturing the leaf cells to bring into contact with the air and each other the cell contents and the enzymes of the leaf. By this means fermentation is initiated. Leaf cells, however, are by no means easily broken up and the time required with present rolling methods to effect even a partial disintegration is very long, and power and labour costs are, in consequence, high. Moreover, as the cell contents are only gradually set free, fermentation is not set up simultaneously throughout any one batch of tea and uneven infusions result.

Two alternatives are available as a means of disintegrating the leaf cells; one the submission of the leaf to very high pressures and the other the freezing of the leaf. Of these freezing is probably the most effective provided sufficiently low temperatures are employed. We are all familiar with the bursting of domestic water pipes during a severe frost and the effect of freezing the leaf is exactly parallel. This method has long been used in laboratory investigations as a means of extracting sap from leaf material. The cost of freezing, however, is a matter which requires much more investigation before this method can become a practical proposition.

While preliminary work on the freezing method is proceeding the Institute has concentrated chiefly on the pressure method using, of course, *unwithered* leaf.

The work is incomplete, but the outlook is most promising and it is hoped we may be able to publish details of the process in 1945. If successful, it should be possible to produce by very simple means excellent liquoring teas, the manufacture of which should not take much longer than two hours to complete. The saving in manufacturing costs would be large and the elimination of withering would have a further great advantage in removing the chief fire risk in Ceylon factories. Further details will be found in Mr. Lamb's report.

Side by side with the above work, investigations on more conventional methods are also proceeding and readers are referred to the Biochemical report for an account of work on "cone" rolling.

In addition to work at St. Coombs, work on the fundamental chemistry of tea had been proceeding in London, jointly financed by Ceylon, India and the Netherlands East Indies. This investigation has been chiefly on the chemistry of made tea and has given results of much interest. It

is particularly unfortunate, therefore, that, owing to difficulties arising from the war in regard to supervision, the work has had to be suspended for a time. This is especially to be regretted as it seemed likely that the London work would shortly be extended to investigations on green leaf which would have linked up with research work in the producing countries. It is hoped, however, that work will be resumed when more favourable conditions obtain.

Acknowledgments.—Once again we have to express our grateful thanks to the Ceylon Association in London, the Planters' Association of Ceylon and the Ceylon Estates Proprietary Association for their continued and cordial co-operation.

Particular thanks are due to Mr. R. H. Horne of Messrs. Forbes & Walker who has, as always, given us invaluable assistance and advice in regard to our experimental work on manufacture. We are also deeply indebted to Messrs. C. J. Speer, and R. C. Kerr for similar help.

As usual we have to thank Agency Firms and Superintendents for their co-operation. Messrs. George Steuart & Co., and the Superintendent of Gonakelle Estate have continued to help us in every way in regard to the Passara Sub-Station and Messrs. Leechman & Co., and their Superintendents in the Kandapolla district have afforded us every facility for the work on *Phloem necrosis*.

To Mr. H. Tonks we are indebted for his very useful and constructive advice in regard to St. Coombs Estate, both in his capacity as Visiting Agent and as a Member of the Estate and Experimental Sub-Committee.

The past year, as will be appreciated, has been a difficult one, with many unusual problems to face. The Director is therefore particularly grateful to all the members of his staff for their most loyal and efficient service.

The sectional reports of the scientific staff are appended.

ROLAND V. NORRIS,

Director.

REPORT

OF

THE MYCOLOGIST

FOR 1944

Staff.—In addition to his own duties the Mycologist was also in charge of the divisions of Entomology and Plant Physiology throughout the year.

The Assistant Mycologist continued his study of the *Phloem necrosis* disease of tea, and also carried out certain duties normally performed by the Plant Physiologist. His report on weeds, green manures and shade trees is included in the Plant Physiologist's report, and his report on *Phloem necrosis* is included here under that heading. He assumed acting charge of the Agricultural Division on November 20th when the Agricultural Chemist proceeded on leave.

Advisory.—195 letters were received and 208 were despatched. 105 consignments of diseased plants were received for examination and report; of these 90 were tea.

Publications.—The following papers have been prepared and accepted for publication:—

Bond, T. E. T.—Robert Wight (1796-1822), Dr. Freke and the "Origin of Species." *Nature*, 154, pp. 566-569.

— The "*Phloem necrosis*" virus disease of tea in Ceylon. II. Field observations and effect on yield. *Ann. Appl. Biol.* XXXI, pp. 40-47.

— Studies in the vegetative growth and anatomy of the tea plant (*Camellia thea* Link.) with special reference to the phloem. II. Further analysis of plucking behaviour. *Annals of Botany* (awaiting publication)

Loos, C. A.—Notes on free-living and plant-parasitic nematodes of Ceylon. 1. *Ceylon Journal of Science* (awaiting publication).

NEMATODES

Susceptibility—Tea.—In the Annual Report for 1942 (T. R. I. Bulletin No. 24, p. 24) evidence was given suggesting that some tea plants are more resistant than others to attack by *Anguillulina pratensis*. A pot experiment was started in June 1942 to verify those observations.

Thirty seedlings were planted, each in a 12-inch pot; fifteen pots had the soil lightly inoculated with adult eelworms; the remainder were kept free of *Anguillulina*, as controls. When the plants were two years old it was possible to distinguish most of the infested pots, but not all, by the general appearance of the plants growing in them. Four of the plants in the infested series were moribund, and the others varied from sickly to apparently healthy and indistinguishable from the control series. During the last 8 months of the experiment, plants in the control series added 2 to 15½ inches to their height, while the growth increments in the infested series varied from 0 to 8.7 inches.

When removed from the pots each control plant was found to have a good root system, fine white feeding roots practically filling the pot. The condition was approximating what a gardener might call 'pot-bound.' The root systems of the infested plants were very different. The four moribund plants had very few roots; the others had white roots varying in amount from practically none to abundant, but no plant had roots equal in quantity to the control plants.

Equally striking was the quality of the roots. The roots in the control pots were fine and pliable; those in the infested pots were thicker and more brittle. The differences in both quantity and quality are well shown in the photographs reproduced as Plate I.

The soil from each pot of the infested series was well mixed, and a small sample taken for eelworm counts. The numbers of *A. pratensis* found varied considerably; fewest were found in the pots with the best root systems and those carrying moribund plants. The largest number (about 5,000 for the whole pot) was found in a pot in which a plant with a moderate root system had grown.

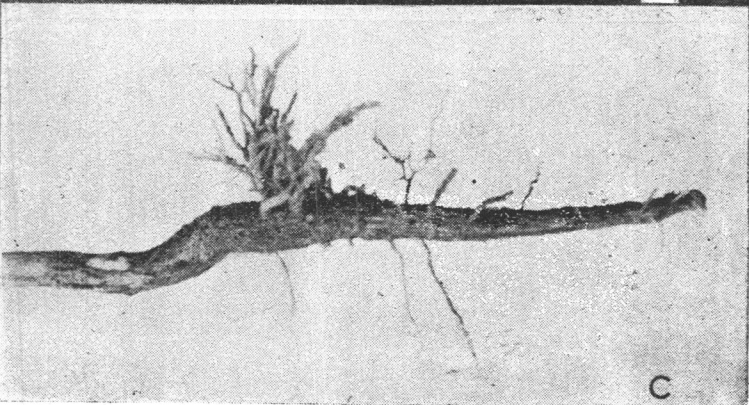
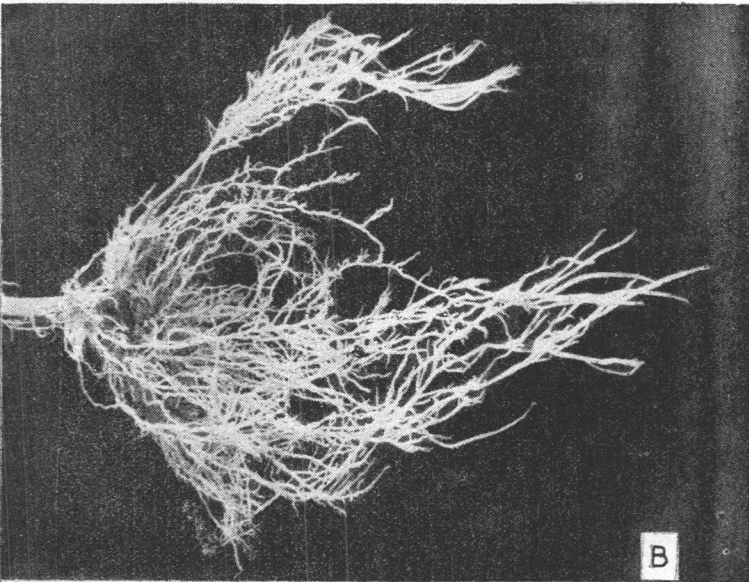
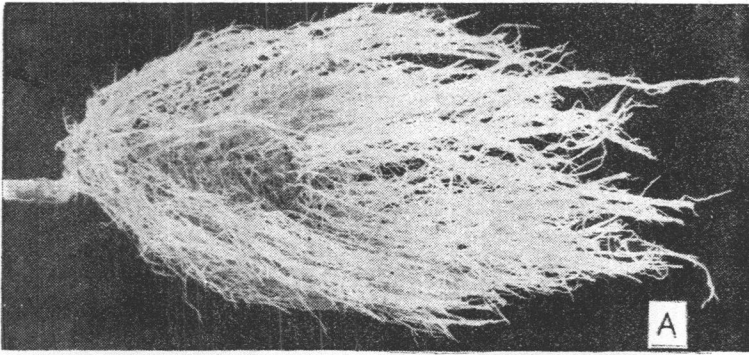
After removal from the soil the roots were placed in water. This caused some, but probably not all, of the worms to leave the roots and enabled them to be recovered. The largest number obtained from one root system, and that a poor one as regards quantity of roots, was 19,850 in five days. The smallest number was 20, from a moribund plant with no white roots. In general the smallest counts were obtained from the moribund plants and the highest from plants with relatively very poor root systems. Plants with apparently good systems, apart from their thickened condition, gave relatively few eelworms.

It will be evident from this experiment that no tea plant used was entirely resistant to *A. pratensis*. Some plants were very susceptible and were practically killed in two years. Others seemed to suffer less; their roots although invaded and abnormal, persisted, and the plants, judged from above ground, appeared to grow more or less normally. Every condition between these extremes probably exists.

The experiment also gives rise to several problems. One important question is: Will a plant which appears tolerably resistant during the first two years of its life later succumb to attack if it is continued? The correct answer to that question would answer another: Is the propagation of resistant bushes a real solution of the eelworm problem?

If the propagation of resistant bushes is advisable, and it is the only practicable solution in view at present, how can one best estimate the

PLATE I.



A—Roots of healthy tea seedling $\times \frac{1}{2}$ B—Tea seedling roots infested by *Anguillulina pratensis* $\times \frac{1}{2}$ C—Root of moribund infested seedling $\times 1$. All seedlings were of the same age

degree of susceptibility of any bush and its progeny? This is a complicated problem as it entails estimations of eelworm populations. From figures already quoted it will be evident that the great majority of *Anguillulina* are to be found *within* the roots. So far, we have not been able to obtain a reliable relationship between the number found in the roots and that of the soil population.

Other Plants.—Experiments have been carried out to determine to what extent other plants, weeds and green manures are susceptible to attack by *A. pratensis* from tea. The plants used (2 per pot) were, in most cases, seedlings grown in 6 inch pots, and when established, about 200 worms from tea were added to the soil in each pot as inoculum. Five or six months later, the plants were knocked out of the pots; their roots were separated from the soil and immersed in water for 42 hours when the specimens of *A. pratensis* found in the water were counted. The eelworms in small samples of the pot soils were also counted; but only in the pot carrying tea seedlings was an appreciable number found.

The numbers of *A. pratensis* recovered from the roots were as follows:—Tea 4,399, *Tephrosia vogelii* (3 pots) 172, 75, 64, *T. eriosemoides* 0, *T. grandiflora* 45, *T. toxicaria* 2, *Sesbania cinerescens* 24, *Mimosa bracaatinga* 1, *Cassia didymobotrya* 18, *C. divaricata* 0, *Centrosema pubescens* 27, *Cajanus cajan* 99, *Erythrina lithosperma* 15, *Crotalaria maxillaris* 0, *Albizzia sumatrana* 75, *Desmodium gyroides* 0, *Polygonum nepalense* 0, *Oxalis corymbosa* 1, *Emilia scabra* 0, *Cymbopogon confertiflorus* (Mana grass) 0, *Paspalum* grass 1, Buffalo grass 1, *Tithonia diversifolia* 2.

It is improbable that all the *A. pratensis* in the roots were recovered by immersion in water; in fact it is known that the tea roots contained many eelworms after 42 hours' immersion. The eelworms had obviously multiplied in the tea roots, and in comparison, other plants were but slightly susceptible. Even the grass roots proved poor hosts although *A. pratensis* has been found in patna soils. These results are probably influenced by the fact that the worms used for inoculation were from tea.

LIGHTNING.

It has long been known that lightning is often responsible for the death of tea bushes in patches. The patches vary considerably in size, and in severe cases, as many as a hundred bushes may be involved. The bushes do not die simultaneously, and the affected area gives the impression that a virulent root disease is active. For this reason it is not uncommon to find that where isolation trenches have been dug in an effort to stop the progress of the 'disease' they have proved quite ineffective.

This sort of damage is very different from what the layman commonly associates with lightning. To him the mention of a tree being struck may conjure up a picture of a 'blasted oak,' with stems split, branches torn off and possibly the bark hanging down in ribbons. Or, he may even envisage the tree going up in flames, as coconut trees have occasionally been reported to do, although such events are very infrequent. Surely the damage is done in a flash, instantaneously and terrible.

Lightning damage to trees however is much more extensive and more variable than is generally imagined. In 1905 *v. Tubeuf* described

"a case in which only one larch apparently had been struck by lightning and yet a considerable number of the surrounding pines and spruces began to die. The larch showed an interrupted line of splitting extending down the trunk, the top remaining green. The trees surrounding it showed no local injuries but died in a semicircle of 25 metres. Such cases have often been found." (Sorauer, 1916, p. 486).

All trees are not equally susceptible to lightning damage. Oak is more frequently injured than beech of the same height growing in the same plantation. Brockmann-Jerosch (1932) arranges certain trees according to their susceptibility as follows: For one beech damaged there are 6 firs, 37 pines and 60 oaks. Sharples (1936) has reported a difference in susceptibility to lightning even amongst rubber clones. He found that young trees belonging to clone B.D. 5 when grown in blocks contiguous with those of different clones are always the ones to suffer most severely.

Injury from lightning has been reported on a large number of agricultural and horticultural plants but the nature of the injuries varies considerably. In a citrus orchard (Fawcett and Lee, 1926) damage is caused usually to a few trees but sometimes to a large group of trees. The injury may vary all the way from sudden death of the tree to partial destruction of patches of epidermis on a few branches or twigs. The damaged patches of epidermis may be as small as one-quarter to one-half inch long, and might easily be mistaken for effects of parasitic organisms. A question which naturally arises from this great variation in injuries caused by lightning is whether some trees at times may conduct the electrical charge without suffering any visible injury. If so, there would be no record that the tree had acted as a lightning conductor unless electrical measuring apparatus were attached to the tree.

Injury to cotton more closely resembles that observed in tea fields. Smith (1938) says of cotton: "Perhaps the commonest type of injury is the killing of all vegetation in roughly circular areas with marginal intermingling of living, dead and injured plants. Quite commonly, however, little or no sudden killing occurs and exact centres of struck spots cannot be determined. This latter type of lightning injury is particularly confusing to growers, since noticeable symptoms do not appear until some time later when scattered plants commence wilting and dying. Areas 300 feet in diameter thus affected have been observed." That description is equally applicable to tea except that the affected plants are rarely scattered. Wilting and dying some little time after the electric storm is characteristic. The magnitude of the discharge, soil moisture and other physical conditions will undoubtedly determine the extent of injury and the distance of lateral spread.

Wilting suggests serious interference with the water supply either by destruction of the absorbing roots or of a part of the conducting system. Dieback in the tops of trees, *e.g.*, Hevea and Grevillea, is also more suggestive of injury to roots than of direct lightning damage. Note the immediate effect of lightning on the larch tree mentioned earlier; the lightning came in at a side and split the trunk on its way to earth, but the top above the point of entry remained green.

The writer has found little literature dealing with the nature of root injury resulting from lightning. In the annual report for 1931 (T. R. J. Bulletin No. 8, p. 18) he gave a short description of certain symptoms.

discovered on the roots of live but wilting tea bushes taken from undoubted lightning patches. The following is a short extract: "The cortex of the roots appears healthy except for long narrow streaks and small circles, dark-brown or chocolate in colour, with sharp definite boundaries. The discoloration frequently extends to the wood and in some cases the wood is discoloured to a depth of one or two millimetres." Such injuries alone would probably not cause wilting nor death of a bush, but in the writer's opinion they are indicative of much greater damage, probably to the more delicate, water-absorbing regions of the root system, more difficult to prove. Before and since writing the above mentioned account of root symptoms associated with lightning damage to tea, the writer has had numerous opportunities of testing that association. In every case yet examined whenever these root symptoms have been observed, the bush has always come from a patch of tea dying as of a lightning strike, and in many instances demonstrable proof of the strike has been obtained. No disease is known to produce identical symptoms and no cause other than lightning is known to be associated with these symptoms. These facts are emphasised in order to make what follows more intelligible.

During the year an estate reported the death of a considerable number of tea bushes which in the manager's opinion was due to a root disease, possibly originating at jak trees. The disease in some of the affected patches was spreading so rapidly that the position was considered to be serious. Two bushes were sent to the laboratory for examination. One was entirely dead but there was no evidence of a parasitic root disease on it. The other bush had living roots and some of them showed the characteristic symptoms of lightning. These symptoms together with the alarming rate at which tea bushes were dying left no doubt that the cause of the trouble was lightning; but as the jak trees were said to be healthy and to show no evidence of the lightning strike the connection between the jaks and the death of the tea bushes was not apparent. A visit was therefore paid to the estate and the observations then made are of sufficient importance to warrant their record in some detail.

Jak trees are not usually grown amongst tea but on this mid-country estate a considerable number of jaks had been allowed to grow for the benefit of villagers who were allowed to take the fruits. The trees were about 25 to 30 years of age and all appeared healthy with the exception of one, of which the upper half was dead.

The patches of dead and dying tea bushes were numerous and varied in size from 20 or 30 bushes to areas three or four times that size. Each was situated at the foot of a jak tree and although some trees had healthy tea at their bases, no patch of dying bushes was found away from the jaks. The association between the jaks and dying tea was too close to be disregarded.

Bushes from thirteen patches were uprooted for examination, and lightning symptoms were found on the roots in every case. No trace of a known root disease was discovered nor was any suspicious organism seen. Where isolation trenches had been dug to restrict the spread of the 'disease' they had failed in their purpose. All the evidence derived from the tea pointed undoubtedly to lightning as the cause of death. Yet to all appearances the jak trees under which the tea had grown were unharmed.

A simple explanation of the phenomenon is that the jak trees act as lightning conductors and bring electrical discharges (probably relatively small) safely to earth without suffering injury. The electrical charges then disperse over the earth's surface and through the soil. Tea, being very susceptible to injury by electricity suffers during this dispersal; visible injuries occur on the thicker roots and water-absorbing roots being probably destroyed.

The writer is aware that such a simple explanation probably raises more technical questions than it pretends to answer. But whatever may be the true explanation, the phenomenon is so unusual and of such technical, and may be practical, interest that this opportunity is taken of placing the observations on permanent record.

PHLOEM NECROSIS.

Dr. T. E. T. Bond has contributed the following report:—

Field Observations.—A reminder that the total range of occurrence of *Phloem necrosis* may still be increasing was afforded this year by a new estate record of the disease (the first since 1941), and by the receipt for diagnosis of a more or less heavily necrotic bush from an elevation of 3,500 feet — distinctly below the altitude at which any very easily recognisable symptoms commonly occur.

The fact that the symptoms are most pronounced during the period of recovery from pruning has long been known but no more striking instance of this has been seen than that of a bush in one of the Kandapola "rogueing" experiments which in March of this year, six months after pruning, was severely necrotic, with typical leaf curl, dwarfing and zig-zag, although recorded as healthy at consecutive, half-yearly intervals since September, 1940. While the possibility that this was the result of a new infection at pruning time or shortly afterwards cannot be excluded, it seems more likely that the bush was, in fact, "carrying" the virus already and that the stimulus of pruning (or, rather, of the subsequent recovery from pruning) was needed before the symptoms could find expression.

Considerable interest was aroused in October by the discovery of an undoubtedly necrotic 7-year-old "supply" in a Kandapola clearing. After prolonged search, and the occurrence of several apparent instances of *Phloem necrosis* in young plants, which could not subsequently be confirmed this is the first really authentic case of its kind recorded. The symptoms, both externally and internally, were quite typical of an advanced stage of the disease. The bush was at the top of the clearing, about 20 feet distant from old, heavily necrotic tea. Compared with the clearing as a whole, which is of uniform, high *jat*, and without any indications of disease, it was a distinctly "off-type" plant; in fact, in general appearance it was much the same as the common, dark leaf more or less low *jat* type of bush in this district which is so often necrotic, in the older fields. Thus, the occurrence of typical advanced *Phloem necrosis* in this single young bush need cause no undue surprise or alarm: rather, the surprising thing is that many more such instances have not already been discovered. This occurrence serves a useful purpose in bringing our young necrotic cuttings and experimentally infected material into line with the "natural" event and, moreover, it finally refutes the belief, still commonly encountered, that *Phloem necrosis* is the result of old age.

Jat Effects.—In general, the apparent absence of the disease from high *jat* bushes and its prevalence in the medium to low *jat* (but not China) types is well established both experimentally and by direct observation. Further confirmation of this is afforded by the data from the largest field plot in the Kandapola district. The plot consists of 901 mature bushes which were classified (by Mr. Loos) in 1938 as "high," "medium," and "low" *jat*. They have subsequently been examined for *Phloem necrosis* once or twice each year. Table 1 shows the actual numbers remaining consistently "healthy" in the three categories up to March of this year and the numbers, in brackets, which would be expected if the incidence of the disease had been entirely at random, *i.e.*, unaffected by the *jat* type.

TABLE 1

	Jat Type			Total
	"High"	"Medium"	"Low"	
Totals	26	740	135	901
"Healthy" in 1945	25	554	21	600
Consistently "healthy" 1938—1944	13 (3)	79 (75)	0 (14)	92

Thus, 50 per cent of the "high" *jat* bushes have escaped the disease; as compared with 11 per cent. of the "medium" and none of the "low" *jat* bushes. The designation of *jat* types being purely relative (so that a "high *jat*" bush in this plot might easily be classified as "medium *jat*" elsewhere), the figures also serve to illustrate the fact to which attention must repeatedly be drawn, namely, that *there is no guarantee that a "high jat" bush is necessarily resistant to Phloem necrosis* or, for that matter, that a "low *jat*" bush is necessarily susceptible: the only way of determining the issue with any accuracy is to test the individual bush by field observation or by experiment.

This naturally raises the question of the selection of resistant bushes and their propagation vegetatively as clones to which reference was first made in the Annual Report for 1942 (T. R. I. Bulletin No. 24, p. 27). The big plot from which Table 1 was prepared will illustrate the difficulties involved in this type of work. Of the original total of 901 bushes, only 92 were passed as "healthy" after six years. Of these, a number would be quite unsuitable for selection, at a glance; others which may appear desirable may yet become necrotic or they may prove to be unsuitable from other reasons as yet undiscovered. A preliminary choice has in any case reduced the total of likely bushes to 40, and it will not be surprising if but ten or a dozen remain for the final propagation tests. When superintendents again have time to attend to such matters, it is hoped that as much as possible of the selection work will be carried out by the estates themselves so that the value of local variations in climate, etc., may be fully exploited.

A New Manurial Experiment.—In view of the widely held belief that the losses due to virus diseases may be reduced or even eliminated by sufficiently heavy applications of organic manures an experiment has

been started on a Kandapola estate to ascertain the effect on *Phloem necrosis* of an annual 15-ton dressing of pig manure. At the same time, the opportunity is being taken of comparing the effect jointly and severally with that of a normal dressing of artificials.

The layout is that of a 2x2 experiment in three blocks. That is, the effects of pig manure and of artificials are to be compared with each other and with no manure in three replications of all the four possible combinations, as follows: (A) No manure, or control, (B) artificials only, (C) pig manure only, (D) pig manure with artificials. Each plot consists of five lines of approximately 20 bushes each, so that the total area of the experiment comprises some 1,200 bushes — about a third of an acre. The manure is to be spread once a year in each of the four middle rows. The quantities to be applied have been worked out in co-operation with the Agricultural Chemist: they are, pig manure, 15 tons yearly; artificials, a graded mixture giving an average of 45 lb. of nitrogen throughout the pruning cycle.

The plots have been laid out and the first dressing of manure given: they will be recorded for *Phloem necrosis* next February or March and thereafter at yearly or half-yearly intervals. The experiment is a long term one and will doubtless in time provide an opportunity for other observations of interest.

Mechanical Inoculations.—The experiment described in last year's Annual Report (T. R. I. Bulletin No. 25, p. 29) has still given no positive results. The possibility of mechanical transmission of the disease can now be practically excluded.

Attempted Chemical Test.—A simple, reliable chemical test for the early stages of infection is still much to be desired. The method recently described by Simonds & Bodine (1943) for the detection of the Peach Mosaic disease in the U. S. A. was tried out on necrotic and healthy tea, but failed to distinguish between them.

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Mycologist

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REPORT

OF

THE ENTOMOLOGIST

FOR 1944

Staff.—The Mycologist remained in charge of the Division during the year.

Advisory.—339 letters were received and 428 were despatched. 56 consignments of insects mainly pests of tea were received. Nettle grub was reported by 8 estates during the year; 3 are situated in the Badulla district, 3 in Passara and 2 in the Madulsima district.

Publications.—In addition to articles in *The Tea Quarterly* the following papers have been prepared and accepted for publication:—

Gadd, C. H. and Fonseka, W. T.—*Neoplectrus maculatus* Ferriere — A predator and parasite of *Natada nararia* Mo. and other nettle-grubs.—*Ceylon J. Sci.* (Awaiting publication).

Gadd, C. H. *Macrocentrus homonae*.—A polyembryonic parasite of tea tortrix (*Homona coffearia*). *Ceylon J. Sci.* (Awaiting publication).

Gadd, C. H.—Ceylon *Euplectrini*: *Metaplectrus solitarius*, nov. spec. and *Autoplectrus taprobanes*, gen et sp. nov. *Bull. Ento. Res.* (Awaiting publication).

Mites.—During the early months of the year a severe defoliation of Albizzia trees was reported in the area around Hatton. Some trees were almost completely defoliated but all affected trees could easily be recognised by the upper branches being almost bare. Leaves of affected trees were found to be infested by mites. Two species were invariably present. One was *Tenuipalpus obovatus*, the scarlet mite of tea, and the other was an undetermined species of *Tetranychus*.

In the absence of any other ascertainable cause it is suspected that these mites were the cause of defoliation. The scarlet mite *Tenuipalpus* is well known to cause defoliation of tea bushes and it has also been found associated with a defoliation of Grevillea. The *Tetranychus* species was in general more abundant than the scarlet mite, but what part it may play in causing defoliation is unknown. Attempts to maintain it in the laboratory for further study failed.

Bark-Eating Borer.—An area of about 20 acres in the Rangalla district was reported in December to be attacked by the Albizzia bark-eating borer, *Indarbela quadrinotata*. About 1,500 trees or more were affected. This pest is generally regarded as of little importance and it is unusual to find so many trees attacked simultaneously.

SHOT-HOLE BORER.

The Passara manurial experimental area was pruned in September, 1943; the bushes were tipped on December 30th, 1943 and January 20th 1944. Regular plucking was started in February 9th, 1944.

From time to time bushes were examined to ascertain when galleries could first be found in the new wood. On March 22nd, four bushes selected at random from each plot, *i.e.*, 128 in all, were carefully examined but only one new gallery entrance could be found. A month later, on April, 19th, when another 128 bushes were examined, 10 new galleries were located.

TABLE I

Mean numbers of broken branches per pluck in an area of 3.2 acres during 1944. The bushes were last pruned in September, 1943.

Month	Months from pruning	No. of plucks	Mean No. Broken branches per collection
May	8th	5	19.4
June	9th	4	88.0
July	10th	4	187.2
August	11th	5	291.8
September	12th	4	347.2
October	13th	4	472.2
November	14th	5	320.6
December	15th	4	340.2

Regular weekly collections of broken branches were started on May 3rd, when the bushes were about eight months from pruning. During that month there were 5 collections, each after plucking, and a total of 97 broken branches were recovered, giving a mean of 19.4 per collection in May. Records for the remaining months of the year are given in Table I. In general there has been an increase in the number of broken branches from month to month, as expected. The number for October seems unduly high. Manuring operations were carried out on October 13th and at the next collection on the 18th there was an unusually large number of breakages (779) which of course increased the average for the month. It probably also accounted for the smaller average in November, if the assumption that during October, branches were broken which normally would not have broken till later, is correct.

As already stated, 97 broken branches were removed from the area during May; 68 were from Block I, 18 from Block II, 7 from Block III and 4 from Block IV. It will be noted that more breakages had occurred in Block I than in the other three blocks taken together. That state of affairs continued to the end of the year. By the end of July a total of 1,198 branches had been collected of which 890 or 74 per cent came from Block I. At the end of December 8,899 had been collected of which 5,697 or 64 per cent had been removed from Block I. The corresponding figures for Blocks II, III and IV were 1,097 or 12 per cent; 817 or 9 per cent; and 1,288 or 14 per cent, respectively.

There is no obvious reason why breakages should be far more numerous in Block I, but it is of interest that something similar probably occurred during the previous cycle. Unfortunately collections were not made during the 1940-43 cycle over a period corresponding exactly to this, as the first collection was not made until January 31st, 1942. On that date 2,689 were collected, of which 1,167 or 43 per cent came from Block I. It was then assumed that that collection consisted of all branches broken since the previous pruning. Although there were more than twice as many broken branches in Block I than in any other block on January 31st, 1942, the breakages did not continue to be most numerous there as by the end of 1942 that block had the smallest number of breakages. Whether the number of breakages in Block I will follow the same trend this cycle remains to be seen, though the fall from 74 per cent, in July to 64 per cent in December is suggestive.

Detailed examinations have been made of the broken branches at three-week intervals. Conditions within the galleries appeared to be favourable for breeding and immature insects were numerous.

TEA TORTRIX.

During the early months of the year several reports of outbreaks of Tortrix were received, particularly from the Dimbula district, and fears were expressed that the parasite *Macrocentrus homonae* had disappeared. The fears proved groundless as collections of Tortrix larvae from different estates showed that the parasite was present in every instance and was working efficiently.

Macrocentrus.—A tortrix larva which has been attacked by the parasite *M. homonae* does not die immediately; it continues to feed and to grow until about the time it would normally pupate, despite the presence of numerous parasites within its body. If a large number of tortrix eggs hatch, considerable damage will be done to tea bushes, no matter whether the larvae are parasitised later or not. When the tortrix caterpillars are due to pupate, those which have been parasitised die and their bodies are consumed by the parasite larvae which then pupate. Non-parasitised caterpillars pupate normally and become moths about a week later; the females within a few days of emergence lay their eggs which take 6 to 11 days to hatch. *Macrocentrus* parasites emerge from their cocoons after 11 to 17 days and almost immediately begin their search for tortrix larvae.

A tortrix caterpillar therefore gives rise either to numerous (18 on the average) *Macrocentrus* parasites or to one tortrix moth, depending upon whether the caterpillar is parasitised or not. The more caterpillars that are parasitised in one generation the fewer are the moths to produce the next generation. The prevalence of tortrix caterpillars during the early months of 1944 suggests that the previous generation, which started as eggs in September, 1943 onwards, was not heavily parasitised. That generation attracted little or no attention and probably was not large, but if the majority of the caterpillars reached maturity the next generation, observed early in 1944, would be very much larger. The apparent outbreak can thus be accounted for; but what requires further explanation is why the *Macrocentrus* parasite became less efficient temporarily towards the end of 1943.

Unlike the tortrix moth, the parasite does not lay all her eggs within the course of two or three days. She has relatively a long adult life and may be kept alive in the laboratory for as many as

38 days if an ample supply of sweetened water is provided. How long she will live under natural conditions is not known, but it is not likely to be less than in the laboratory, provided she can obtain the food she needs. Her efficiency will depend largely upon the length of her adult life; the longer that is, the more time she has to search for tortrix larvae and the more she will locate and parasitise. She also prefers warm sunny weather for her activities.

In order to maintain the parasites in the laboratory sugar water or a split raisin has to be supplied. In the field the most probable sources of such carbohydrates are nectar of flowers and honey dew secreted by certain insects. The following experiments were carried out to determine suitable natural sources of food:—

Six *Macrocentrus* adults, not more than one day old, were used for each experiment, and two trials were made with each food source. The insects were enclosed in glass cages (old battery jars) and supplied with water and fresh flowers or other source of carbohydrate supply. Deaths were recorded daily. The results are given in Table 2 from which it may be seen that, when supplied with flowers, the insects lived no longer than when water alone was supplied. The honey dew from certain scale insects proved more satisfactory and the results obtained approximate more closely those obtained with sweetened water and split raisins.

TABLE II

Longevity of *Macrocentrus homonae* when supplied with carbohydrates from various sources.

Food Supply	Longevity		Food Supply	Longevity	
	Range days	Mean days		Range days	Mean days
Water only	1-5	3.0	Flowers.—(Contd.)		
"	1-3	2.2			
Sugar water	10-16	12.3	<i>Bidens chinensis</i>	2	2.0
"	13-19	15.8	"	2-5	3.3
Split raisin	7-11	9.2	<i>Alteranthera</i> sp.	1-3	2.0
"	12-15	13.3	"	2-3	2.2
Flowers			Scales		
Tea	2-5	3.5	Unidentified species	7-13	9.5
"	3-4	3.5	on <i>Hibiscus</i>	5-20	13.7
<i>Crotalaria anagyroides</i>	2-5	3.3	Unidentified species	5-9	8.0
"	2-5	3.3	on <i>Tecona stans</i>	4-38	17.7
<i>Tephrosia vogelii</i>	2-5	3.0	<i>Saissetia coffeae</i>	6-10	8.8
"	2-6	4.2	on Tea	5-16	11.3
<i>Erigeron mucronatus</i>	2-3	2.2	<i>Coccus viridis</i>	4-7	5.5
"	2-5	3.2	on <i>Gliricidia</i>	6-8	7.0
<i>Polygonum nepalense</i>	2-3	2.2	Aphids		
"	3-4	3.5	Unidentified species	2-4	3.0
<i>Sonchus</i> sp. (Sow Thistle)	1-3	2.2	on <i>Tephrosia vogelii</i>		
"	2-3	2.3	flowers	3-5	3.8
<i>Ricardia scabra</i>	1-4	2.5	Unidentified species	2-6	3.3
"	2-6	3.2	on <i>Gliricidia</i>	3-7	4.0
<i>Emilia scabra</i>	2-3	2.2			
"	1-5	2.7	Extra floral nectaries		
<i>Ageratum conyzoides</i>	2	2.0	Albizzia leaves	2-4	3.2
"	3-4	3.2	"	1-18	12.2
<i>Desmodium heterocarpum</i>	2-3	2.3	<i>Cassia mimosoides</i>	2-4	2.5
"	2-3	2.5	"	1-10	3.4

These experiments indicate the probability that *Macrocentrus* obtains its carbohydrate food from the honey dew secretions of certain scale insects, and not from the nectaries of flowers common near tea fields. It is to be expected therefore that climatic conditions which are adverse for the survival of scale insects will also adversely affect the efficiency of *Macrocentrus* by reducing food supplies.

The weather during the latter half of 1943 was abnormal and was notable, particularly in the Dimbula district, for the shortage of sunshine. Continuous wet weather and lack of sunshine are unfavourable for scale insects. The lack of sunshine would also cause those parasites which obtained food to be lethargic. It seems probable therefore that the outbreak of tortrix in the early months of 1944 was due largely to climatic conditions at the end of 1943 being adverse for the parasite.

It is not to be expected that *Macrocentrus* or any other parasite will eradicate tortrix entirely. The best that can be expected is that the parasite will reduce the host numbers to insignificant size, and so keep the pest under control. The host, however, does not lose its ability to multiply rapidly, so if control is relaxed for a short period a rapid increase in numbers of the pest follows.

Hyperparasites.—A species of *Ceraphron*, apparently the same as that which parasitises *Fornicia*, was obtained from a *Macrocentrus* cocoon mass at Passara, but attempts to breed the species on *Macrocentrus* in both the St. Coombs and Passara laboratories failed. An experiment at Passara demonstrated that *Hemiteles* sp. and *Goryphus variabilatus*, both parasites of *Fornicia*, could successfully attack *Macrocentrus* cocoon masses.

NETTLEGRUBS.

Occurrence.—Fortnightly observations were continued in an acre of tea on Gonakelle Estate, Passara, until June 13th when observations ceased. This area had been under regular observation since March 31st, 1942. As previously, 40 bushes selected at random were examined on each of the 12 occasions and nettlegrubs were found every time though they were never numerous. In all, 191 were seen, of which 131 were *Natada*, 42, *T. cervina*, 13, *T. recta*, 1, *Narosa* and 4 *Spatulifimbria*. Parasites were observed on 11 occasions.

Parasites.—Considerable attention has been paid to a study of the life history and habits of the hymenopterous parasites. Twenty-four per cent of the nettlegrubs examined were parasitised; the *Euplectrini* as a class accounted for 15 per cent and the Braconids, *Fornicia ceylonica* and *Apanteles* sp., for the remaining 9 per cent.

A new member of the *Euplectrini* was discovered during the year, and an account of its life history together with that of *Platyplectrus natadae*, which is similar, is in course of preparation.

The minute black Eulophid, *Tetrastichus* sp. which hitherto has been considered to be a primary parasite of *Natada* and *Narosa* was found to be a hyperparasite on *Euplectrini*. This was discovered when the parasite failed to oviposit on young unparasitised *Natada* larvae in the laboratory, but readily oviposited on *Natada* parasitised by *Platyplectrus*, the latter being in the pupal stage. The developmental period of *Tetrastichus* males on *Platyplectrus* averaged 19 days.

Although *Fornicia ceylonica* has occasionally been obtained from field collections of *Thosea cervina* and *T. recta*, it has failed to parasitise these species in the laboratory. It shows a decided preference for *Natada* and a study of its bionomics on that host is being made.

Three hymenopterons are now known to be parasitic on the pre-pupal and pupal stages of *Fornicia*, namely *Ceraphron* sp., *Goryphus variibalteatus* and *Hemiteles* sp. These hyperparasites probably limit the value of *Fornicia* in controlling nettlegrubs.

A rather large Braconid, *Spinaria* sp. was bred from a solitary specimen of *Thosea cana* from tea in the Southern Province in June. It lived in the Passara laboratory for 99 days during which time she was offered 90 nettlegrubs of various size (20 *Thosea cervina*, 39 *T. recta*, 10 *Parasa lepida*, 9 *Narosa conspersa* and 12 *Natada nararia*) but she parasitised one only, *T. recta*, in the fourth instar, when 12 days old. The egg gave rise to a male which lived in confinement for 50 days before it was accidentally lost.

ALBIZZIA

Butterfly.—Woodhouse & Henry in their Butterfly Fauna of Ceylon use the names *Eurema blanda silhetana* Wall. and *Eurema hecabe simulata* M. for the two common species of yellow butterfly commonly associated with Albizzias, instead of *Terias silhetana* and *T. hecabe* more commonly used in agricultural literature. These butterflies were very conspicuous in the Passara district from August to December. The caterpillars of *E. silhetana* caused considerable defoliation to the two shade trees *Albizzia falcata* and *A. sumatrana*, particularly the latter, whereas those of *E. hecabe*, more solitary in habit, showed a preference for the green manure plant, *Sesbania cinerescens*. The caterpillars of *E. silhetana* were never found on the *Sesbania* plants.

The butterflies *E. silhetana* were first noticed to be numerous about the middle of August. By the middle of September, the *Albizzia sumatrana* trees in certain fields were practically stripped of foliage and thousands of green caterpillars with black heads were eating the tea beneath. In October, severe attacks on both species of Albizzia were noticeable in other fields, and butterflies were extremely numerous. Throughout the period the yellow butterflies were to be seen in the fields continuously, and eggs, larvae and pupae could be found together. The butterflies disappeared towards the end of December.

Collections of pupae of *E. silhetana* were made on three occasions, September 20th, October 23rd and November 19th in order to ascertain what parasites were present.

A Chalcid, *Brachymeria megaspila* Cam. was found in all three collections. At the first collection 2.7 per cent of the pupae were parasitised; the percentages at the second and third collections were 9.1 and 8.0 respectively. Observations have been made on the life history of this parasite, and these indicate that it is a primary, solitary parasite of pupae, with a developmental period lasting from 24 to 29 days.

Unidentified Tachinids were also observed on all three occasions but the highest percentage parasitism was only 2.4 per cent, on the third occasion.

It seems unlikely from these figures that pupal parasites were solely responsible for the disappearance of the pest in December. An unidentified species of *Ichneumonid* was present in the first collection only, when 9 specimens (1 per cent parasitism) were obtained. In the laboratory, this insect showed a greater interest in pupae of *E. silhetana* parasitised by *Brachymeria* than in unparasitised pupae, giving rise to the suspicion that it is probably a hyperparasite of *Brachymeria*. No explanation can be offered as to why it disappeared from later collections.

No parasites were found in pupae of *E. hecabe*.

C. H. GADD.

Acting Entomologist.

REPORT

OF

THE AGRICULTURAL CHEMIST

FOR 1944.

Staff.—The Agricultural Chemist proceeded on furlough on November 20th, 1944.

Advisory.—Letters received numbered 175 and those despatched 126. The possibilities of systematic programmes for cultivation and manuring have again been lessened by fertilizer restriction and labour shortage. Most of the enquiries have arisen in connection with the weed problems of estates. Advisory correspondence has consequently been small.

Publications.—Studies in the Yield of Tea Part V. Further Experiments on Manurial Response with special reference to Nitrogen.—*Empire Journal of Experimental Agriculture*, 1944, Vol. 12, pp. 177-90.

INVESTIGATIONS IN PROGRESS

The Function of Green Manuring in Promoting Soil Fertility.—For some years the subject of green manuring has occupied a prominent place in the advisory and investigational work of this department, particularly the conditions under which shade trees, bush green manures and tea prunings could best be used. Coupled with this work was a survey of compost manufacture and a comparison with straightforward forking-in of green loppings. From time to time the reports of this department have provided summaries of that work mainly from the point of view of the carbon and nitrogen cycles involved in decomposition of green material. At the same time, work has been proceeding on the effect of green manuring on the soil. A brief mention of this work was made in the report for 1941. Information has been sought on the manner in which decomposing and decomposed organic matter affects the building up of crumb structure in the soil.

This type of work has been handicapped because the assessment of crumb structure in a soil is not a simple matter. Numerous methods have been suggested, but there is as yet no accepted technique for measuring the 'crumbiness' of a cultivated soil. Increasing prominence is being given to the question of soil structure in very diverse parts of the world and at present the results obtained are interesting though confusing. Recently two investigations, in East and West Africa respectively, have called in question the value of green manuring. These trials dealt with annual crops but they have some significance for perennial crops as well. It is reported from Uganda that green manuring over a period of years produced no definite benefit to soil structure. This

was in marked contrast to the effect of a grass lea of three years' duration; the effect was produced either by using fodder grasses or the natural cover which was largely *Imperata cylindrica* (Illuk.). In West Africa it was found that green manure benefited the succeeding crops but that an equally good effect could be had by burning the green manure and merely using the ashes.

Three methods of action of green manures and other organic matter have been generally put forward as responsible for soil improvement.

- (1) The modification of the structure of the soil by altering the colloid complex and promoting crumb structure.
- (2) The conservation of nitrogen and other plant nutrients by the continual process of circulation between the growing plant and the soil.
- (3) The stimulation of microbiological agencies in the soil which indirectly affect the efficiency of plant nutrition.

The work quoted seems to indicate that under the given circumstances, the benefits of green manuring lie principally in direct nutrition and not in soil-structure modification.

In these laboratories two series of experiments have been carried out on crumb structure. The methods used were different, but their principle was the same. The effect of excessive wetting of soil is to destroy its crumb structure. The experiments were designed to trace the destruction of crumbs by alternate wetting and drying of soil.

In the first series, sieved soil, all of whose particles were greater than 1 mm. and less than 2 mm. in diameter was packed into a funnel and left for 24 hours in a water-logged condition. At the end of that time the water was withdrawn by suction in such a way that the amounts so withdrawn could be measured. For each volume of water withdrawn the suction required was known. The soil was then allowed to dry naturally and the experiment repeated in some cases twice and in a few, three times. If the water destroys the crumb structure, it will cause a slaking of the soil and the size of the pores between the particles will become progressively smaller. These smaller pores will hold the water more firmly and a greater suction will be necessary to withdraw it. In general, it will be found that a soil with good crumb structure, one that is water stable, will give results showing the maximum withdrawal at low suctions, whilst a poor soil after successive wetting and drying operations will show maximum withdrawal at high suctions. An attempt was made to compare a soil poor in organic matter with one which was heavily impregnated with the decomposing leaves of (1) *Tephrosia vogelii*, (2) grass cuttings and (c) tea pruning leaf. It was hoped by this method to follow the gradual building up of stable crumbs and their resistance to destruction, and further to compare the efficiency of the three materials. The choice of the materials was based on the observation, previously reported, that the first two produce copious quantities of sticky mucus on decomposition, but the tea leaf very little. Some workers have suggested that this mucus is the active crumb former. The experiment failed in its planned purpose because the soils used, which were typical of tea soils, were so water stable at the start that even the third and fourth wetting reproduced the results

of the first. In other words the soils refused to slake under the conditions of the experiment.

The slaking of soil crumbs is brought about by the alternate swelling and shrinkage of the soil colloids which cause disruption of the compound particles. Some liquids will 'wet' a soil without the liquid being imbibed by the colloid complex, *i.e.*, without causing swelling. Advantage was taken of this in the second series. Soil was wetted in porous saucers for 24 hours and then transferred to a bank of sieves of diminishing mesh. These sieves were moved up and down slowly in a vessel of water. In this way the more easily disrupted compound particles were broken down and passed through the sieves. The operation was continued till it was evident that on each of the sieves the particles were no longer breaking up. Carried out in this manner there was a minimum of abrasion by the sieve, for the particles were supported by the water in which they became suspended. The contents of each sieve were dried and weighed and the percentage of the original weight retained on each sieve was calculated. Samples of the same soil were treated in a similar way using waste petrol which does not cause the soil to swell.

In all cases tried so far, the results from sieving in water and in petrol have been identical. It is now necessary to compare these soils with a series from temperate formations, for which these two methods were originally devised. Arrangements have been made to do this, and to extend the investigation, in the Soils, Division of the White Agricultural Research Institute, Adelaide S. Australia.

So far, although the investigation has not developed in the way that was originally contemplated, the results support the view that the types of green manure used on tea estates make little difference to the crumb structure of an already very stable soil. In practice the stability of our soils is shown daily by the fact that immediately after rain it is possible to use a cultivation implement without puddling the soil, a procedure which would be disastrous in temperate arable farming.

The Institute now has several experiments which have been in operation over a number of years. The cultivation and weeding experiment has had weeds and prunings forked in for 8 years. The factorial manurial experiment is showing marked responses to nitrogen and phosphoric acid and the different plots produce very different amounts of prunings to be forked in. From the point of view of carbon and nitrogen status of the plots there is the possibility of some useful comparisons. A start has been made on a carbon and nitrogen survey of these experimental plots, and will be extended to newer experiments on young tea and to unopened patna land. This will provide additional information on the nutritional aspect of green manuring. Single crop culture as opposed to rotation agriculture is regarded as conducive to progressive soil exhaustion. It is not fantastic to suppose that the continual burying of prunings is the safeguarding factor in preserving fertility in tea soils, and the results of the survey will be examined for information on this subject.

Phosphate Responses in Tea Experiments.—The results of the factorial experiment during the past twelve years have shown that nitrogen gives the largest response in yield, phosphoric acid comes next in order and potash has failed to show a yield effect throughout. The nitrogen doses were in increments of twenty lb. and the phosphatic doses were of thirty lb. Since the nitrogen responses have all along been proportional to dosage, it is possible to calculate responses for 30 lb. of nitrogen and compare them with the phosphatic levels (Table I).

TABLE I.

Response to 30 lb. of Nutrient.
Average of three cycles.
lb. per acre per annum.

	1st year	2nd year	3rd year
Nitrogen	39	135	151
Phosphoric acid	28	81	90
Ratio P/N	.72	.60	.60

On the average the efficiency of phosphoric acid is about two-thirds of that of nitrogen. This may be an understatement since the phosphoric acid curve for increments of the manure flattens out above 30 lb. phosphoric acid, and therefore 30 lb. may be above the optimum dose. The average response is 63 lb. per acre for the first 30 lb., and only 4 lb. for the additional 30 lb. application.

Phosphoric acid is therefore an important fertilizer for tea, but its effects in tea culture are more widespread than these yield figures indicate. In last year's report the very great increase in yield of weeds ascribable to phosphate was described, an increase much greater in proportion than is shown by the tea. In the meantime the absorption of nutrients by the weeds has been determined from the analytical figures for chemical composition of the weeds and their yields.

These figures show that weeds in a very short time take large quantities of the three main nutrients from the soil. Table II gives a comparison.

TABLE II.

Nutrient Removal by Tea (one year) and Weeds (3½ months)
lb. per acre.

	Tea	Weeds
Phosphoric acid	12	5
Nitrogen	56	11
Potash	28	21

The figures for the tea are those relating to the full year, at the end of a cycle before the weed experiment started in pruned tea. The weeds were allowed to grow unchecked, and the figures are therefore larger than if there were a monthly weeding round. By burning weeds all the nitrogen is lost, and if the ashes are not distributed over the

area a large quantity of potash too is wasted. The soil resources for potash must be particularly large to withstand this drain and still show no loss of crop when potash is omitted from fertilizer mixtures. The loss of phosphoric acid itself is not severe, but the very large increase in weeds caused by this fertilizer is at the root of the substantial losses of valuable nitrogen and potash, both of which are more expensive to replace than phosphoric acid.

A further fact has emerged from the plant analyses. Both tea and weeds increase in phosphoric acid content if increased doses are given, even when the yield is unaffected. They are therefore luxury consumers of phosphoric acid. The interim conclusion to be drawn from these facts is that in all probability tea estates are over-manuring with phosphoric acid. A new experiment (part of one to be described later) has been started to explore the range of phosphatic manuring below 30 lb. per acre. If an estimate can be made of the quantity conducive to maximum response, at a lower level than is now prevalent, it should have far-reaching effects by lessening weeds and conserving potash. At present extraneous considerations have reduced potash manuring to a minimum. The present results indicate that there is little fear of harming cropping prospects on that account unless weeds take an increasing toll of potassic nutrients from the soil.

Weed Experiments.—The foregoing serves to place the weed problem in the forefront of those which engage our attention. There is danger of a vicious circle being established in which higher manurial doses stimulate more weeds, which waste nutrients and necessitate even higher replacements. In the interests of soil erosion and tea nutrition alike, some method of using weeds and at the same time controlling them, must be sought. The method upon which the existing weeding experiment is based, that of forking in weeds 3 times a year, is unsatisfactory from a practical point of view though it has borne much fruit experimentally by clarifying the situation both as regards weed and cultivation effects. A new experiment has been laid down whose plan is as follows. A four-year pruning cycle has been divided into two periods, early and late of two years each. One quarter of the plots have weeds growing for periods of 3 months (more or less, according to climatic conditions) so as to promote a definite weed cover. This is then clean weeded and the weeds buried in pits staggered over the area. Thirty pits per acre suffice. Another quarter is clean weeded. The remaining two quarters have weeds on them treated in the aforesaid manner for two years, and are clean weeded for two years; but the times of weeding and of leaving weeds are in opposite phase on the two portions. Superimposed on these plots are phosphatic treatments of 15 and 30 lb. per acre respectively, and a comparison between no potash and a heavy dressing of 60 lb. per acre. This experiment should provide a wealth of information, on weeds, their disposal, the succession of different weed covers, and on their manurial reactions, all combined with the corresponding effects on the tea. The results must be looked at in terms of cycles rather than years in both their fundamental and practical aspects.

Experiment on Hard Plucking.—The experiment on plucking to the fish leaf throughout the whole cycle has now completed a four-year pruning cycle. The following summary of the results includes some data previously given and included again in this report so as to give a complete picture.

The effects have been very striking and are set out below —

TABLE III.

Increase (+) and Decrease (-) in Yield
due to plucking to the Fish Leaf.
lb. per acre—4-year cycle.

	Flush	Pruning leaf	Wood
Fish leaf plucking	+1,405	-1,785	-8,046
Breaking back	+674	-481	-1,538

There has been a marked increase in crop (more than 50 per cent) on the fish leaf plots, but this gain has only been achieved at the expense of a great diminution in the size of the bush. What was gained in crop was more than lost in foliage and was accompanied by a very severe check on wood formation. The increase in crop was accompanied by a great decrease in the size of the individual flush units (see Annual Report for 1942, p. 41), so that from a practical point of view the cost of plucking is greatly increased because, to produce the higher yield, the number of shoots is approximately double that on the normally plucked bushes. There is evidently a limiting factor operative and it is interesting to enquire what it is. It is not a shortage of carbohydrate reserves. During the last two years of the cycle the starch status of the roots has been recorded by a system of marks at intervals, and these have shown that the withdrawal of starch to maintain growth has been small (Table IV).

TABLE IV.

Starch Reserves in Roots.
Points scored. Maximum possible 192.

Months after pruning	Plucking to	
	Fish leaf	Single leaf
26	176	181
32	165	177
37	176	187
42	186	188
48	177	187

Only on the third and fifth occasions was it possible to distinguish reliably between the two types of plucking, and even then the differences, though statistically significant, are small. It may be that the limiting factor is nitrogen supply; the fish-leaf bushes with their diminished leaf surface being unable to synthesize sufficient nitrogen products to maintain increased number of flushing points at a normal size. Or alternatively the nitrogen economy of the bush may be so altered that it cannot absorb sufficient nitrogen for this purpose. In the forthcoming cycle information on these points is being sought by giving half the plots a specially heavy dressing of nitrogenous manure.

The figures in the table also show what effect breaking back of the normally plucked bushes has. To a smaller degree the effect is like that of hard plucking; an increase in yield and a decrease in foliage and wood. The effects are all statistically significant.

The behaviour of the plots during the next cycle will provide added interest. Observations on recovery from pruning and on starch withdrawals will be made every two months till the bushes are well in bearing.

From these results only tentative conclusions can yet be drawn, and these are only applicable to tea at high elevations. In broad terms it seems probable that fish-leaf plucking will increase yield without detriment to the future development of the bush only if it is delayed until the bush has built up a substantial frame. How long after pruning is required for this building-up is a matter for individual judgment for which fish size provides a clue. Possibly the empirical decision, now in common practice, of waiting till there is a large fish leaf; (*i.e.*, approximating in size to a foliage leaf) is a satisfactory one.

T. EDEN,
Agricultural Chemist.

Corrigenda:—

Bulletin No. 25, p. 45.

For 14 months read 26

" 20 " " 32

" 25 " " 37

REPORT

OF

THE PLANT PHYSIOLOGIST

FOR 1944.

Staff.—There has been no change of the technical staff of this division during the year. Dr. T. E. T. Bond has continued his work on weeds, cover crops and green manures and has contributed the section of this report under that heading.

Advisory.—113 letters were received and 125 despatched.

TEA SEED.

Yields.—Seeds have been collected weekly since January, 1942, from seed bearers of an Indian jat (Khorijan) planted in 1937, 10 feet apart. The records are given in Table 1. The most notable facts in the table probably are the very low crops obtained and the absence of any indication that the yields are increasing with age. Some of the trees have at times been damaged mischievously, large branches being cut out, and it is probable that children pull off some of the green fruits in play, as on one occasion in 1944 about 200 seeds, some of them crushed, were found strewn on the ground. These facts diminish the value of the observations to some extent as the effect of damage is difficult to assess, but it is very doubtful that damage would satisfactorily account for the low yields.

The greatest number of seeds harvested from any one tree was 621 (Tree F3) in 1942, 501 (F3) in 1943 and 571 (G1) in 1944. The best months for harvest are May to August, and there is usually a subsidiary crop towards the end of the year. At every weekly collection it has been possible to collect a few seeds from the area.

When the trees are in flower they give much greater promise of harvest than ever materialises. This however is not unusual. In Russia, it has been estimated that only 2 per cent. of tea flowers normally produce seed: in Java the figure 8 per cent has been given for tea flowers naturally pollinated there. Usually yields can be increased by artificial pollination, and the pollen of certain bushes has been found more satisfactory than that of others for particular bearers. The low yields of the St. Coombs bearers is probably due to lack of efficient pollination. The necessity for cross pollination will always limit the value of tea seed as a means of propagation of uniform high-quality plants.

Germination.—Each week the seeds collected were divided into 3 classes; sinkers, floaters and empties. The empties float high on water and when

broken open are found to have little or no contents; they do not, of course, germinate. As many as 15 to 18 per cent of the seed collected were empty. Germination tests were carried out each week during 1942 and 1943 and the results are shown in Table 1. The germination capacity of the floaters was considerably lower than that of the sinkers. It should be noted that these tests were carried out on freshly harvested seed, not on seed which had been stored even for a few days. On storage, sinkers become floaters, usually without loss of germination capacity if not stored too long.

TABLE 1.

Yields from Seed Bearers.

Year	No. of Bearers	S E E D			GERMINATION		
		Total	Sinkers per cent	Floaters per cent	Empties per cent	Sinkers per cent	Floaters per cent
1942	11	2,230	57	25	18	180	38
1943	12	2,243	60	25	15	187	55
1944	14	2,128	49	33	18	—	—

CLONES

1937/38 Clones.—The approximate yield of 12 clones of which two year pluckings were completed in August are given in Table 2. For calculating the yields, an acre is assumed to carry 3,000 bushes and the out-turn of made tea to be 22 per cent. Plucking was at regular 9-day intervals, i.e., 40 plucks each year. The yields from a row of seedlings of the same age is given for comparison. These clones were not all selected for high yield.

The four best yielding clones of this group are 25, 9, 23 and 21. No. 9 is a 'non-fermenter' and consequently of no commercial value. The other three clones have been well reported on as regards the quality of their made-tea, all being somewhat better than average. No. 23 probably has the best quality.

TABLE 2:

Yields of 1937/8, Clones

Clone No.	No. of bushes plucked		Yield in lbs. per acre		Mean Diameter
	1st year	2nd year	1st year	2nd year	
1	18	18	285	520	42.0
9	19	19	530	1,050	69.1
13	22	26	185	450	40.0
14	12	18	230	415	41.3
15	23	24	285	650	42.7
16	10	17	330	550	44.4
18	22	27	350	770	47.5
19	14	15	200	530	42.5
21	23	24	420	885	51.1
22	23	25	365	585	49.2
23	22	23	600	900	59.8
25	15	17	685	1,270	69.5
Seedlings	17	18	470	750	—

These bushes were pruned in August, and just before pruning the diameters of the bushes were measured. The mean measurement for each clone is shown in Table 2. A point of interest which emerges from these measurements is the close relationship between the mean size of the bushes and their yields; the larger bushes have given the higher yields. ($r=0.96$). Stated in its simplest terms the result is not surprising; the yield from Clone 25 is greatest because that clone has the largest bushes. The bushes of clone 13, with the lowest yield, were only little more than half as big (57.5 per cent) as those of Clone 25 at the time the bushes were pruned. But when we ask "Why should Clone 25 produce larger bushes than Clone 13?" the answer must be "It is the nature of the plant to make large bushes." This clone branches freely and forms a bush naturally without much training. Clones which tend naturally to branch freely during the early years of growth will be larger, and in consequence will give higher yields than others with a more restricted branching habit. Yield therefore appears to be largely a reflection of branching habit. The importance of early branching is well demonstrated among the 1941 clones which will be referred to later.

1939 Clones.—The first year pluckings of six 1939 clones were completed during the year. The yields varied from 150 lb. (No. 33) to 650 lb. (No. 45) per acre and are comparable with the first year yields of the 1937-38 clones. The best bushes have produced teas never below average quality for the season.

1941 Clones.—Eight clones of this series were brought into plucking this year when they were less than 3 years old. By the end of the year the bushes had been plucked 35 times. At the end of 20 plucks the yields approximated 270 lb. (No. 1526) to 620 lb. (No. 934) per acre per annum. The yields increased during the next 15 plucks due partially to favourable weather and ranged from 450 lb. (No. 1082) to 810 lb. (No. 934) per acre per annum. These clones were put into the field soon after roots had formed on the cuttings in 1941 and were lightly centred in 1942. In 1943 they received a pruning at 12 inches and later were tipped at 18 inches.

These clones are of particular interest because of the relatively high yields, (e.g., No. 934) obtained from 3-year-old bushes at this elevation. It has been possible to bring them into bearing in so short a time, with such little training, only because they have a natural, inherent, free-branching habit. Other clones of the same age have not responded to such light treatment and are taking much longer to form bushes of pluckable size. Obviously there is no one way of best handling all clones to bring them into plucking early; each clone has to be studied individually. It will be equally obvious that clones which can be brought into plucking early will have a higher commercial value than others which take longer to form bushes. There is no reason at present to suggest that quick yielding clones will deteriorate in cropping capacity later. These clones have been raised from mother bushes which gave yields considerably above average.

Banji.—During the second year of plucking of the 1937/38 clones the plucked shoots after each plucking, were divided into 'flush' and 'banji' depending upon the state of the terminal bud, and counted. A 'banji' bud is small and would normally go through a resting period before unfolding more leaves, whereas a 'flush' bud is in an active

stage of growth. The 'banji' shoots therefore correspond to what in planting terminology would be termed 'soft banji.' Taking all the shoots plucked during the year, 32 per cent from clone 23, and 53 per cent from clone 19 were 'banji.' These are the lowest and highest values obtained, and are much higher than expected. There is however no relationship between the amount of banji and the yield. Clone 25 which gave the highest yield during the year gave 42 per cent banji shoots.

The percentage of banji shoots harvested from any one clone varied from pluck to pluck and when one clone was giving a high value another would give a low value. It has not therefore been possible to relate 'banji' with weather conditions.

Similar counts were made for the first 20 plucks of the 1941 clones and the percentage banji of these varied from 36 to 58. The highest yielding clone (No. 934) gave 40 per cent banji. These figures are very similar to those obtained from the 1937/38 clones in their second year.

WEEDS, COVER CROPS, GREEN MANURES, ETC.

The following report has been contributed by Dr. T. E. T. Bond.

Advisory Work.—Fifty-nine enquiries were received from 41 estates. They concerned 7 species of green manure shrubs and shade trees, and 69 species of cover crops, weeds and other plants. Four items of interest arising from the advisory correspondence are described in the following paragraphs:—

(1) **Eupatorium Species.**—Interest in the introduced weed *Eupatorium riparium*, noted in last year's Annual Report, has now extended to at least two other species namely *E. conyzoides* and *E. pallescens*. These are both large, shrubby plants and the former, in particular, is widespread in certain areas of the low-country, where the names "Lampedi cheddy" (T.) and "Loka-palu-gas" (S.) have been recorded for it. We understand from Peradeniya that a special survey of the occurrence of these *Eupatorium* spp. is being conducted by the Department of Agriculture.

(2) **Shade Trees for Up-Country.**—Several enquiries have been received asking for recommendations for suitable species of high or medium shade to replace *Grevilleas* or *Acacia decurrens*. This is a problem that has never been satisfactorily solved and little advice can be given other than to become acquainted with any promising species that are being cultivated in one's own district. The question of whether or not to grow *Acacia decurrens* will always depend on one's estimate of the risk of an attack of *Cercospora* disease in its epidemic form; this, however, is a problem affecting a relatively limited number only of up-country estates. To provide an alternative for *Grevilleas*, especially for the mid and low-country districts, affects a much larger proportion of the industry. It is difficult to avoid the conclusion that local resources, particularly among our numerous leguminous forest trees, have not yet been sufficiently investigated from this point of view.

(3) **Chemical Control of Weeds.**—This possibility was raised by a correspondent who suggested the use of a sulphuric acid spray on the pruned fields and especially to control *Mikana scandens* and other weeds encroaching from the jungle boundaries. Much work has been done

in Britain and elsewhere in recent years on the use of chemical sprays against annual weeds as, for instance, charlock and wild mustard in the wheat fields and the method has now become quite well known. In this case, the function of the spray is to kill the weed and, of even greater importance, to prevent re-seeding. Against perennials, with their more or less extensive root system, and for grasses, with their upright leaves to which the spray refuses to adhere, the method has little to recommend it. But for certain special purposes, as for that which our correspondent indicates, it might prove of value. After the war, with the reduced demand for fire-fighting equipment, the provision of knapsack sprayers or similar equipment should not be unduly expensive: the question of the cost of carting water or spraying liquids to where they are needed is more likely to be the paramount consideration in determining whether or not the method will ever become widely used.

(4) **Pyrethrum Cultivation.**—The question of the suitability of Pyrethrum for intercropping with the tea after pruning was raised by an up-country estate. This, however, would definitely not be recommended, both on account of the slow growth of the plant which would soon be shaded out by the tea and from the danger of contamination and taint from the plant's strong scent. But, for estates at about 5,000 feet and above, Pyrethrum cultivation might well be adopted as a side line in the future, perhaps, on food production areas which it may no longer be profitable to maintain. The article reprinted in the *Tea Quarterly*, Vol. XVII, pp. 28-36 should be consulted.

Through the courtesy of the Deputy Director of Agriculture, the writer visited the Department's Mahacoodagalla Pyrethrum plantation in May of this year and obtained a small quantity of seed which is being grown on at St. Coombs.

T. R. I.—Herbarium.—Two hundred and thirty-eight sheets were added during the year, including 152 new species. The herbarium now contains 735 sheets of 482 species representing 299 genera in 102 families of flowering plants. An effort is being made to collect and systematise the common Tamil and English names of estate weeds, etc., and the co-operation of superintendents in the different districts who can supply us with named collections of specimens will be appreciated.

We are indebted to the Botanist, Peradeniya, for twenty identifications and for other information supplied during the year. Two specimens from the neighbourhood of St. Coombs, which could not be matched at Peradeniya have been forwarded to Kew for identification.

Weed Ecology.—The joint investigation with the Agricultural Chemist, of the weed flora of the No. 3 field manurial experiment plots has been continued during the year and the results prepared for publication in England (Eden, T., and Bond, T. E. T.—“The effects of manurial treatment on the growth of weeds in tea” — in course of publication). The following is a brief summary of the conclusions reached on the botanical side, viz:—

(1). While the total weed flora of the plots consists of 29 species of flowering plants, the vegetation is largely dominated by the single species *Polygonum nepalense* (Chunam-pillu, T.), which is protected at the normal monthly rounds as a ground cover. This state of affairs

is reflected by the figures obtained as a rough estimate of the content of viable weed seeds in the top 6 inches of soil receiving 60 lb. P_2O_5 in a total of 53 million seeds per acre, 15 million are *Polygonum*.

(2). Phosphatic manuring is easily the predominating influence on the botanical composition of the weed flora, as it is on its bulk and chemical composition. Considered in terms of the numbers of distinct species which can maintain themselves within a given area, (i.e., of a $\frac{1}{2}$ -metre quadrat), the phosphate response is positive, whereas the response to nitrogen is negative.

(3) Individual responses shown by the different species are of three types, viz. negative to all manures, (i.e., the plant is most abundant at the lowest level of manuring). N-negative and P-positive; N-Positive and P-negative, (i.e., the effects of nitrogen and of phosphate acting in the opposite direction, in both cases). These three types are exemplified chiefly by the grass, *Digitaria longiflora* ("Usi-pillu, T.) the small herb *Cardamine hirsuta* ("Mustard weed") and the grass-like, Cyperaceous weed *Stenophyllus capillaris*, respectively.

Further consideration of the chemical and agricultural aspects of this investigation will be found in the report of the Agricultural Chemist, elsewhere in this Bulletin.

New Green Manure Species.—Eighteen packets of seed were distributed during the year from St. Coombs and others from Passara. *Mimosa bracaatinga* and *Albizzia sumatrana* continue to do well at Passara and their usefulness may now be considered as established. Experience with *Sesbania cinerescens* this year has been somewhat disappointing: the plant is susceptible to the root-knot, eelworm and much loss has been experienced due to attack by this pest. The loss is appreciable only on the poorer soils or in periods of drought, and where conditions are favourable the plant has continued to make excellent headway. *Cytisus proliferus* — "tagasaste" — has this year done well at St. Coombs but has failed to grow at Passara. On St. Coombs about an acre of the 1937 new clearing has been interplanted with this as a bush green manure. The plant has produced a good bulk of green matter and stands lopping well. It is coming into flower but has not yet set any seed.

"Hard" Seeds.—*Cytisus proliferus* so far has had the highest proportion of "hard" seeds of any species studied. Thus, germination is still being observed from among a sample of 100 original, untreated seeds left on wet blotting paper since February, 1943, as shewn in Table 3.

TABLE 3
Germination of *Cytisus proliferus* seed

Months since Feb. 43	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Seed germination of 100	1	4	1	3	2	1	1	4	0	2	1	2	2	2	5	2	2	2	1	0	1	0	2
Total to date, as per cent	1	5	6	9	11	12	13	17	17	19	20	22	24	26	31	33	35	37	38	38	39	39	41

Tephrosia eriosemoides has also given consistently high proportions of "hard" seed values of about 75 to 90 per cent having been observed during the year. *Sesbania cinerescens* has not given more than 52 per cent and usually much less; the proportion in this species is apparently much affected by the conditions during ripening and at the time of harvest.

The use of hot water and acid treatments to break down "hardness" and induce even germination was mentioned in last year's report (T. R. I. Bulletin No. 25, p. 51) and the possibility of storing the treated seed without any lessening of the effect was considered. Further experiments have been carried out on these lines during the year, using the two species *Cytisus proliferus* and *Tephrosia eriosemoides*.

The experiments are summarised in Table 4. A sufficient quantity of seed was taken at the beginning of the experiment, divided into lots and treated as follows: *hot water treatments*: (1) seed immersed for an hour in water maintained at 122°F; (2) placed in a vessel with about five times its own volume of water at 160°F. and left until cold; (3) placed in a similar vessel of boiling water which was poured off on coming to the boil again, (i.e., after 30-40 seconds). — *acid treatments*: (1) 15 minutes' immersion in $\frac{1}{2}$ -strength commercial sulphuric acid, with thorough subsequent washing; (2) the same period in full strength acid. Two control series were provided, namely the normal untreated seed, and a 'nicked' seed, in which the entry of water was ensured by puncturing the seed coat with a needle (this second control is needed as a check on the viability of the seed where no question of its "hardness" arises). All lots were stored in a desiccator after treatment samples being withdrawn for testing at monthly intervals as shewn in Table 4.

TABLE 4

Percentage germination of pre-treated seed, after storage

(a) *Cytisus proliferus*. Original seed, received February, 1943
21-day tests of 50 seeds. Treated 28-1-44 * and 28-4-44

Months after treatment	Hot water treatments			Acid treatments		Controls	
	(1) %	(2) %	(3) %	(1) %	(2) %	Untreated %	"Nicked" %
0	29*	16	80	6*	8	1*	98
1	16*	8	50	6*	0	1*	100
2	11*	4	32	4*	4	1*	100
3	11*	4	24	2*	2	2*	88
4	16	6	24	12	6	4*	—
5	6	8	26	8	2	4*	—
6	22	18	30	8	4	2	—
Averages	15.9	9.1	38.0	6.6	3.7	2.1	94.5

* Figures marked with an asterisk are averages of the two experiments; the remainder refer to the second experiment only.

(b) *Tephrosia eriosemoides*. St. Coombs Seed, collected December, 1943
14-day tests of 50 seeds. Treated 28-4-44

Months after treatment	Hot water treatments			Controls	
	(1) %	(2) %	(3) %	Untreated %	"Nicked" %
0	62	76	88	12	100
1	66	78	74	24	100
2	84	94	80	18	100
3	86	94	86	24	—
4	76	100	80	18	—
5	74	94	80	10	—
6	70	96	90	14	—
Averages	74.0	90.3	82.6	17.1	100.0

The Table shows that all treatments have increased the percentage germination as compared with the controls. The poor results from the acid treatments for the *Cytisus* seed are interesting: in the first test carried out on this seed in May, 1943, the half-strength acid gave as much as 80 per cent germination; repeated two months later it gave 35 per cent; four months later 12 per cent, and in the current year (as in the Table) an average of 6 per cent only. That an increasing susceptibility to injury from the acid might be the explanation of these figures is suggested by the still lower percentage germination given by the acid at full strength, treatment (2). However, even after the latter treatment the "hard" seed that had refused to germinate was viable to at least 73 per cent as shown by further test after nicking so that a genuine increase in "hardness" would be the most likely reason for the progressive decline in response to the acid treatment.

As far as the hot water methods are concerned, treatment (3), with boiling water has given the best response on the average. The effects of storage after treatment have been negligible with *Tephrosia eriosemoides*; with the *Cytisus* there is evidence of a progressive decline in the response during storage, at any rate up to the fifth month. Further tests will be necessary to confirm the apparent increase in percentage germination in the month following. Taking averages for the three hot water treatments for both species, the percentage germination after six months' storage stands at 23 per cent as compared with the control at 2 per cent, for *Cytisus proliferus*, and at 85 per cent as compared with the control at 14 per cent. for *Tephrosia eriosemoides*.

C. H. GADD,

Acting Plant Physiologist.

REPORT

OF

THE BIOCHEMIST

FOR 1944.

Staff.—Mr. P. R. Perera, Assistant, relinquished his post on grounds of ill-health. Mr. Perera had been absent for the greater part of the previous year. The loss of his services is much regretted and has impeded work on manufacturing experiments.

Advisory.—The amount of advisory work remained at a comparatively low level, only two requests for factory visits being received during the year.

Correspondence.—180 letters were received and 187 despatched.

Electrical and Water Services.—The Biochemist has for a number of years been responsible for the Institute and St. Coombs Estate electrical and water services. Owing to war conditions and the increasing amount of upkeep due to the ageing of these installations this work is assuming considerable proportions. The routine megger testing of all electrical equipment and installations, particularly those in the factory, and the graphing of the results has enabled serious trouble to be anticipated, and major breakdown to be avoided. There has not been any serious interruption of the electrical power supply since the Institute came to St. Coombs.

The water supply has been controlled by chemical examination and during 1944 bacteriological examination was commenced. We are indebted to the Bacteriologist of the Indian Tea Association Research Department (Mr. S. F. Benton) for details of an electrical method of sterilisation involving the use of silver electrodes.

BIOCHEMICAL

Fermentation.—The discovery that the principal enzyme concerned in tea fermentation is a copper-protein compound raised many interesting possibilities in connection with the copper status of tea bushes in the field and, indirectly, the soil. Some of these were described in the report for 1943. Further points of interest which have emerged from these experiments are as follows:—

1. Cut shoots (flush with long stems) immersed in copper sulphate solutions of concentration from 50 parts per million up to toxic levels shew definite increases in the rate of fermentation.
2. The addition of copper sulphate to the crushed leaf does not cause any increase in the rate of fermentation. The copper must apparently be absorbed by the living leaf and converted to copper-protein enzyme.

3. The infusions of leaf treated as above are greener after fermentation than in the case of untreated flush. The reason for this is apparently related to an increase of the copper content of the chlorophyll which rises from 5 parts per million to 32 parts per million. The increased copper content protects the chlorophyll from oxidation by the products of the fermentation of the polyphenols (so-called tea tannin). These products (O. quinones) and their effect on chlorophyll in producing the brown colour of fermented leaf were referred to in the last annual report.
4. A row of clonal bushes was divided into two halves and one half was sprayed with a copper preparation (Bordeaux mixture). Sixteen successive manufactures of the leaf from the two halves were carried out at intervals of 9-10 days. There was a significant rise in the copper content of the treated bushes and this was maintained in the new growth of flush which was free from spray residue. The Tasters reported a marked increase of colour in the treated leaf which was apparently related to a slight decrease of quality.

	Colour Marks (possible 10)	Quality Marks (possible 10)
Control	7½	8½
Treated	8	8

(Average of sixteen experiments).

At the present moment there is no suggestion of a copper deficiency in St. Coombs Estate soils; but since copper is clearly an essential element the possibility of such deficiencies arising must be borne in mind. In this connection it is interesting to recall that when certain areas of East Africa were first planted the leaf refused to ferment. The difficulty was eventually overcome by spraying with copper preparations. We understand that it was subsequently discovered that the surface soils in these areas were deficient in copper. When the bushes matured and pushed their roots into the sub-soil the fermentation became normal.

The discovery of the copper-protein enzyme at the T. R. I. in 1942 explains the reason for the effect of copper deficiency.

There is a suggestion that the root system of different strains of tea vary in their ability to absorb copper. We have a clone which will not ferment unless sprayed with copper although other bushes growing in the same soil are normal. Grafting experiments are being carried out to settle this point. The manufacture and quality evaluation of clonal material which is carried out before the clones are propagated on any considerable scale, will eliminate strains which lack the ability to absorb copper and to ferment normally.

Oxygen Uptake.—A simple method of measuring the oxygen uptake of fermenting leaf has been tried out and applied to measure the effect of different types of rolling, the effect of differences in clone, etc. Such a method may prove to be a valuable aid in rolling experiments because it may be assumed that the more effective the rolling, the more rapid will be the uptake of oxygen. Further experiments are desirable before the results can be interpreted.

ANALYTICAL.

The availability of clonal material is being taken advantage of, and clones of distinctive character such as rapid or slow fermenters are providing material for analytical work. The analytical data previously available suffer from the great disadvantage of referring to heterogeneous material. In these circumstances the sampling error is often larger than the variations due to the factors under investigation.

The analysis of leaf from a number of clones is being followed over the course of the seasons and by next year some interesting results may become available.

CHEMISTRY OF TEA INVESTIGATION IN LONDON.

In 1937 we were greatly concerned by the lack of knowledge of the constituents of green leaf. This concern was showed by Chemists in India and Java and a joint scheme for an investigation was formulated. Facilities in the East for the type of chemical research were severely restricted and it was eventually agreed that the investigation should be carried on in London. In 1938 Dr. Bradfield was appointed to conduct the investigation. It had been the hope of those working out in the East that these investigations would commence with research on green leaf. For reasons which need not be discussed here the London Advisory Committee considered it necessary however to start work on made tea.

Dr. Bradfield, with a collaborator Miss E. Penney, has now published an account of the investigation. Much highly skilled and painstaking work has been put into this investigation. The chemical changes taking place in made tea are however so complicated that it has not been possible to form any very clear picture of the chemistry of the process. Dr. Bradfield came ultimately to the conclusion that the chemistry of green leaf must first be elucidated before the changes which ultimately lead to the formation of black tea can be fully understood. He was able to proceed some distance with this purpose before, owing to war conditions, the work had to be suspended.

Dr. Bradfield is to be congratulated on his handling of the problem put to him and we most sincerely hope that the investigation will be continued before long. There is little doubt that rapid progress will be made with the chemistry of green leaf and this should link up with the biochemical work carried out in Ceylon and India and open the way to a deeper insight into the whole process of manufacture.

Looking back over the last decade it is possible to discern much progress and enlightenment on the chemistry of tea. Progress has been sufficient to engender confidence that the fundamental process of tea fermentation will be, (and we hope before the elapse of another decade), understood in the way that the chemistry of say, brewing or bread making are understood today.

MANUFACTURE.

Most of the work so far undertaken by research organisations on tea manufacture has been of an analytical character. Energies have been directed towards discovering the reason for each step and attempting to measure changes. On the whole the methods have been taken for granted and improvements in detail only have been attempted. The industry has not shewn any great enthusiasm for changes and research

workers have been left to work out their own lines of approach. Seldom, if ever, has a demand been made for investigation of a particular point or aspect except in the case of minor changes necessitated by Food and Drug Regulations. When it became necessary to eliminate all lead contamination the industry at once demanded a solution and research was quick to respond.

In Ceylon the results of research along these lines has been by no means unfruitful and few planters will deny the fact that manufacture has been systematised, organised and controlled in a manner which is in very marked contrast to the conditions of, say, fifteen years ago. Even ten years ago when I formed my first impressions, the manufacturing process in many factories was entirely haphazard in marked contrast to conditions in sugar factories in the West Indies with which I was then freshly acquainted. The Tea Research Institute had, some years previously, introduced the moisture content balance but complaints of deterioration of teas in transit and storage were still common. In one of my earliest reports I remarked on the fact that we were *never* (without a single exception) asked to investigate deterioration of teas when moisture balances were in use. In one case where we were asked to visit a factory in connection with complaints of deterioration a moisture balance was actually available, but it was frankly admitted that it was not in use. At that time driers were frequently found to be badly out of adjustment and badly equipped with regard to thermometers, a factor which made control very difficult. It is now very rare to find a drier out of adjustment and most machines are very well equipped with controls. Firms supplying driers now take much more interest in maintenance and carry out careful tests on new machines before handing them over to the estate. Much more interest is taken in fuel economy and many driers are now equipped with induced draught.

Since Mr. F. J. Whitehead's paper on tea factory organisation at our 1937 Conference, the haphazard methods of knocking down withered leaf, then rolling, and firing, without any close correlation between the three operations have largely disappeared and many or most factories are now organised in a manner which compares well with other industries. Records have also been greatly improved and confined to keeping figures with some meaning and utility. I do not mean to infer that research is responsible for all these changes although the existence of a research centre, resultant personal contacts and interchange of ideas as well as publication, conferences, etc., are undoubtedly stimulating. The efforts of individual planters and competition amongst engineering firms (in which the Tea Research Institute to some extent referees) are also most important factors. The united efforts of research, planters and engineers may provide the channels for improvement but the flow of improvements is not maintained unless there is a driving force. The driving force is undoubtedly economic necessity.

The driving force behind the changes already discussed was clearly the last economic "slump." Its power has however been dwindling and at the present moment it may be said to be spent. Since the entire tea crop has been purchased by Government interest in manufacture has subsided and there are signs that tea manufacture is slipping back to haphazardness. Shortage of superintendents and the increased duties of those remaining on estates must, of necessity, impede progress, but

factory organisation if maintained makes the task of the superintendent much simpler and arrests any tendency to backsliding. There is no possible excuse for lack of interest in factory organisation.

Without attempting to assume the role of the prophet we may anticipate a further application of the economic goad in the course of the next few years. During the last slump we received little more than a gentle prod, next time we shall be lucky if it is not much more severe, for meanwhile the cost of production has risen and there is little hope of reduction except by drastic changes in our methods.

It is now worth reviewing present methods of manufacture from as long a view as we can take. A quotation from the Report of the Commission of Enquiry on the Scientific Department of the Indian Tea Association 1935-36 is revealing, representing as it does a well-informed independent view of the tea industry. "We have found many planters, especially those with engineering knowledge possessed of a strong general feeling that the use of machinery for tea making is in a sadly undeveloped state. They feel that paralysis has laid hold of it and that in place of the new ideas which abound in the use of machinery in industry at large, there has in the tea machinery been for years no greater ambition than to increase the efficiency of customary types."

This is indeed a shrewd estimate of the general state of affairs. The plain fact is that present methods are mere mechanised versions of the original hand manufacturing methods. Our clumsy inefficient tea rollers are really mechanised versions of the process of rolling leaf by hand, using the bare thigh as a roller table. The basic difficulty is that the appearance of this original hand-rolled product has become traditional and that any attempt to break away from it has so far proved unsuccessful. The present rollers are probably a fairly efficient way of twisting tea-leaf although I have more to add to this later. The point is that twisting is only one way, and an inefficient way as that, of extracting juice for fermentation and production of liquors which constitute the *beverage we sell*

For some strange reason the tea trade, as distinct from the consumer, has placed an entirely fictitious value upon the appearance of the black leaf which does not on the whole concern the consumer. It is true that in certain instances the consumer has learned to relate appearance to cupping quality but it is ultimately the liquoring characteristic which is of interest. For instance we are informed that in certain districts of Ireland it is the practice to buy only the best golden (flowery) types of pekoe. These teas are purchased loose in ½-oz. or 1 oz. lots and ½-oz. goes straight into the teapot. The teapot is then filled with hot water and put on the hob. As soon as it becomes empty of liquid it is refilled with water. Tea is thus on tap all day long and the ½-oz. may last 2 or 3 days before it is finally exhausted. Now obviously a dust would not stand up to this treatment but is ideal for quick strong brews at coffee stalls or for the urn trade where it is enclosed in a linen bag before infusion. We gather that Australians like the brownish rather small and flaky teas which are associated with strength, but in every case it is the liquoring character and not the actual appearance which really matters. With the consumer the cup is the criterion of chief concern. With the increasing trade in blended teas and the influence of "Pool" teas or standard blends under five or six years of war conditions it should be possible to break away from the appearance fetish

and to introduce radical changes into tea manufacture, provided that liquors are not adversely affected and the consumer gets the particular type of liquor which appeals to his palate. "We are convinced" wrote the Commissioners quoted above "great boldness should be shown in the Scientific Department's investigations of the individual stages of manufacture and no less boldness in the outlook of the makers of tea machinery."

Discretion is said to be the better part of valour and before being bold we have deemed it wise to build some foundation on which to stand our weapons of attack. In 1936 the Commissioners whom I have quoted freely said "Ignorance" — some of our witnesses have used this word — most truly defines the real problem of the industry in regard to manufacture. The nature and effects of the factors chiefly influencing each process are very imperfectly known."

Since 1936 we have remedied many of these defects. Our investigation on fermentation (on which seven papers have been contributed to the *Biochemical Journal*) have given us an insight into fundamental processes and what is more important — confidence. We are now working in the light — dim as it may be at present, instead of complete darkness. Our experiments on rolling and firing (a good deal of which has been published in the *Tea Quarterly*) have defined our problems and we have decided that it is time to be bold. In fact a preliminary display of boldness in 1938 when in collaboration with Mr. C. H. Meares we experimented with the Clivemeare Roller, was quite encouraging but the advent of the war with all its restrictions, made it impossible to continue experiments on a commercial scale. Military service caused further interruptions until 1944 when we were able to continue research. By this time the conviction that radical changes in manufacture would become necessary was fixed. Radical changes are the order of the day and there is little justification for the employment of inefficient methods in order to maintain traditional appearance.

Since 1944 our experiments have certainly not lacked boldness and our main object has been to find the simplest possible process consistent with the production of good liquors. In this search a considerable measure of success has already been achieved with a method which eliminates withering and greatly shortens the time of manufacture. These experiments have of course been carried out on a very small scale and trials with much larger quantities of leaf and with leaf from different districts and elevations will be necessary before the final characters of teas made in this way can be assessed.

We hope to publish preliminary details of this process during 1945. The appearance of the dry leaf is highly unorthodox but it may be worked up into several quite attractive forms such as a product resembling shotty pekoe or into tablets. It is impossible at the moment to forecast the reaction to such products and it would be most unwise to anticipate a revolution in tea manufacture but the possibilities of adopting such a method as a counter measure to rising costs of production cannot be completely discounted.

Parallel to what may be termed exploratory research we have continued work on existing methods, the object of which has again been simplification and reduction of cost of production but avoiding any radical changes of appearance. There are two obvious points of attack.

1. The withering process which is expensive from the point of view of capital outlay, maintenance, fire insurance and especially in labour. The cost of large volumes of conditioned air is by no means inconsiderable.
2. The rolling process which is inefficient and wasteful in power. Tea rollers are the principal power consumers and have awkward peak requirements. They require a lot of attention, and labour is wasted by such operations as filling, pressure application and "sweeping in." The method of working in batches is much less efficient generally, than continuous or line processes.

The remainder of the section is an outline of the work we have done on these two problems.

1. WITHERING.

(a) **Freezing.**—This has been mentioned in previous annual reports and last year an account was given of some detailed experiments on the disruption of leaf by freezing. Attempts have been made to work on a larger scale and to assess the feasibility of the method from an economic point of view. The only available plant however proved unsuitable but we hope to overcome these difficulties in 1945. Apart from the great difficulties of importing refrigerating machinery, it is most desirable that we should define the exact conditions required before attempting any large scale experiments. Refrigerating machinery is made for specific purposes and the type best suited to our purposes must be ascertained before attempting to import machinery for even semi-commercial scale experiments.

(b) **Withering Machines.**—Although in the past several withering machines have been introduced by engineering firms and proved failures (at least under Ceylon conditions) the possibilities of this type of machinery have not been exhausted. Living leaf has a natural resistance to withering which may be overcome by freezing which, under certain conditions "kills" the leaf but does not affect the enzymes and the chemical constituents. Leaf may also be "killed" by heat as in the case of green tea but in this case the enzymes are also destroyed. If the conditions necessary to "kill" the leaf without destroying the enzymes can be found, it will be possible to effect a rapid wither and still carry out fermentation after rolling.

The enzyme system has been intensively studied as mentioned in the earlier part of this report and our attention has been turned to utilising its moderate temperature stability. It has been found that short blasts of high-temperature-air will in fact "kill" the leaf and leave the enzymes fairly active. Following this treatment, 21 minutes in a drier at 100°F. approximately will effect quite a reasonable wither. We have investigated a large range of temperatures to find the most suitable conditions but are not yet satisfied that the process is suitable for commercial use. In any case an accurately controlled machine will have to be devised to implement the process. Failure means that green teas instead of black teas are turned out.

Incidentally it appears possible to make quite reasonable green teas by this means without all the usual apparatus for steaming. The process would be much cleaner than the normal green leaf process. If the present interest in green tea manufacture is maintained, it may be worth while following this up.

2. ROLLING.

In the *Tea Quarterly*, September, 1938 I published a detailed account of our approach to the problem of tea rolling. I stated that it was our intention to study the rolling process in detail before embarking on exploratory or revolutionary methods. An account of the special equipment used for this purpose was given together with some of our earliest results. Although the investigation has been long and progress slow it has been well worth while. One of the objects of the investigation was to make some sense out of the many available types of batten. In my annual report for 1940 I reported under "Rolling Experiments." "The most striking point emerging is the very high proportion of rolling effect which takes place at the centre of the table. Battens on the outer part of roller tables are practically ineffective and it is hoped that we shall be able to use these facts to develop a type of rolling table superior to existing patterns." Military duties impeded progress but in 1940-41 a number of arrangements were tested. During 1942-44 work was virtually suspended. Since 1944 considerable progress has been made but the difficulties of getting mechanical alterations carried out has made the work slow and tiresome.

We have refrained from publishing details of this work because although we are convinced that a simple fitting in the centre of the table may be developed to increase effect and efficiency, we are aware of snags which make premature publication most undesirable. The factors yet to be related with accuracy are:—

1. Size of the fitting.
2. Crank throw of the roller.
3. The distance between the jacket and the fitting at their nearest approach.

Factor No. 3 is most critical and much tearing and cutting result if the gap is too small. If the gap is too large, the arrangement becomes inefficient. This gap is intimately related to the crank throw and diameter of jacket and if the dimensions of the battens are out of proportion to the crank throw, again the leaf may be either torn to shreds or idly churned round with little rolling effect. Although it is very easy to design an arrangement which produces a high proportion of dhool it is not by any means an easy matter to ensure a correct twisting action. We are not certain that one single type can be designed which is satisfactory for the whole of the rolling operation. Where very low big-bulk percentages are required it may be necessary to employ a cutting arrangement in the third roll.

The pressure cap is dispensed with in this type of rolling. In our earliest experiments we began to suspect the pressure cap on account of the way in which it impedes circulation. It must be remembered that the essential action of the normal roller is twisting the leaf. This depends entirely on circulation and anything which impedes this action is deleterious to the effect of the process.

The history of tea roller and battens is a matter of interest. The very earliest type of rollers apparently had very similar arrangements to those with which we are now experimenting. Battens are a comparatively recent introduction and were a retrograde step. They have been a happy hunting ground for patentees and the introduction of the pressure cap was a further retrograde step, presumably designed to increase the dhool out-turn of inefficient battens. Possibly also, the demand for smaller grades and the decline in popularity of large leafy grades and orange pekoe have had their effect on batten design. If careful research and tests had been carried out at the time that table battens were introduced, they would have been rejected and the pressure cap would probably never have been fitted.

It should be mentioned that experiments on these lines by various private individuals have been in progress for some years and we have recently been afforded a much appreciated opportunity of seeing a note outlining some of the results obtained. Also, at least two Engineering Firms have now put fittings on to the market. One of the fittings has been tested on one of our experimental small-scale rollers and found highly satisfactory. Another commercial type is under test on an experimental roller but I have also seen some full scale production with this particular arrangement and thought it most successful.

It is hoped that the most efficient arrangements will be developed as rapidly as possible but we would warn casual experimenters that there are many pitfalls. Casual estate experiments sometimes give a bad impression when unsuccessful and it would be a pity if progress is prejudiced by immature adoption of unsuitable apparatus.

In conclusion, it is of interest to outline the advantages which we expect to accrue from these improvements in roller design.

1. The removal of the pressure cap greatly facilitates roller charging.
2. As there is no manipulation of pressure caps to be carried out, a labourer can control more than one roller especially in view of advantage No. 1.
3. With a plain, smooth, outer table the jacket may be lowered so that the clearance is small enough to prevent throw-out. This accentuates advantage No. 2.
4. Rolling effect is accelerated and three twenty-minute rolls appear sufficient. This means a larger out-turn per roller and per rolling room labourer.

The advantages must be regarded more from the point of view of economy and efficiency than actual improvement in the teas manufactured. Naturally, there will be much prejudice against any methods which lower quality but if quality can be maintained, whilst increasing efficiency and lowering cost of production, much will have been achieved.

Manufacture of Clonal Leaf.—A number of clonal rows came into bearing during the course of the year and leaf from these has been manufactured. The high quality of selected bushes propagated up to clonal rows has been maintained.

Manufacture of Leaf from Field Experiments.—Leaf from the plucking experiment was manufactured during the course of the year. The object of the experiment has been described in the Annual Reports of the Agricultural Chemistry Department (*vide* 1942 and 1943). Last year the Agricultural Chemist remarked that "the diminution of flush size on the fish leaf plots is so marked that there may be repercussions in the quality of the manufactured leaf." These fears have apparently been realised. The small leaf withered very rapidly and gave larger dhool out-turn than the normal leaf but the quality was markedly poorer. The average valuations to date have been:—

	B.O.P. cts.	F.P. cts.	Fannings cts.
Tea from normal plots ...	98	96	98
Tea from fish leaf plots ...	94	92	94

The colour of the teas from the small leaf has increased but strength and quality have suffered a marked decline. This is an interim report and the Agricultural Chemist will report the final conclusions of the experiment.

ACKNOWLEDGMENTS.

Mr. R. H. Horne of Messrs. Forbes & Walker has continued to give us unstinted assistance which has in particular been of inestimable value to us during the war period when we have been unable to continue "team" tasting arrangements. Mr. Horne has tasted all the clonal teas manufactured at St. Coombs and has contended with all sorts of difficulties arising from unusual characters. The accuracy of his opinion is most remarkable and on the rare occasions on which we have doubted a result and resubmitted samples under another number and amongst another series of teas he has invariably confirmed his findings. Experimental teas are made in small batches in average experiments, and are easily tainted. Also leaf from, say, single bushes manufactured under unusual conditions may be very unorthodox. Mr. Horne's long association with the T. R. I. has enabled him to allow for difficulties of this nature and to assess the merits of samples according to the particular information we require. We also rely on Mr. Horne for explanation of market conditions and factors which we do not understand. There is considerable danger, especially in the tea industry of a reasearch organisation getting out of touch with market requirements. Lastly, Mr. Horne has been exceedingly good natured and tolerent, as scientific workers trained to rely on measurements of accurate instruments are naturally highly suspicious of operations such as tasting. We send samples under numbers and in batches containing samples from different experiments and normally without information which a taster might reasonably expect to be submitted with the samples. As a result of all our precautions we have ample evidence that a trained and experienced palate can match many scientific instruments for accuracy and beat most in speed of operation.

To Mr. C. J. Speer and Mr. R. C. Kerr of Messrs. the Colombo Commercial Co., Ltd. Tea Department we are also deeply indebted for a similar services and we hope they will be able to give us assistance as continuously as Mr. Horne.

J. LAMB,
Biochemist.

REPORT

OF

THE SMALL-HOLDINGS OFFICER,

BADDEGAMA, FOR 1944

Working Areas.—During the year there was no improvement in the conditions mentioned in my Annual Report for 1943. As a matter of fact conditions worsened during this period. In addition to the difficulties mentioned earlier, abnormal floods and an alarming increase in crime complicated matters. In one area where much enthusiasm was shown during the 1940 Tea Small-Holdings Competition, the incidence of crime was most marked. The Village Headman, who was of the greatest help, was fatally shot at night. In another case, one of the most progressive small-holders was shot at and seriously injured. Trap gun incidents were frequent and advisory tours in the area had to be done with a good deal of circumspection. The Chairman of the Village Committee, who gave strong support during the 1939 and 1940 Tea Small Holdings Competitions, fell ill during the period and was obliged to give up office.

Administration.—In all areas the Mudaliyars are being replaced by District Revenue Officers. The Mudaliyar who gave strong support during the 1939 and 1940 competitions, and is one of the few Chief Headmen still remaining, is now in charge of Talpe Pattu, where the 1941 Competition was held. He continues to give maximum support.

Travelling.—There was no change in the petrol ration allowed. The tyre position, till very late in the year, was most precarious. Bad tyres, on still worse roads made car maintenance very expensive. Car repairs and replacements alone cost Rs. 706.15 during the year. The petrol and tyre position did not permit of intensive visiting, so necessary to keep up interest among small holders.

Competitions.—Owing to prevailing conditions, it has not been possible to work off the scheme of competitions envisaged for this area. Competitions in connection with Food Production, offering attractive prizes, have also come into being. The prizes offered in connection with Tea Small Holdings Competitions are on a pre-war scale. In order to stimulate interest, it would appear necessary to raise them substantially, at least to the level of the prizes offered in connection with Food Production Schemes.

Advisory Visits.—During the period, 1,225 advisory visits were paid. On these visits, 328 demonstrations, on various aspects of tea cultivation, were carried out. 82 of the visits were to small estates.

Progressive Small Holders.—Those small holders who participated actively in the Tea Small Holdings Competitions so far held continue to take some interest in their holdings. The lessons learnt by them have not been altogether forgotten.

Some small-holders, who got new planting permits, applied the lessons learnt to their new clearings. One of them who got a permit for opening up about three acres planted it on the contour. This particular small-holder won a prize in the 1941 competition. A maund of tea seed, costing Rs. 103.50, was also obtained for him.

Plucking.—Estate factories, taking small holders' leaf, continued to pay the stipulated prices for good leaf. Advisory duties during the year was directed to persuading small holders to keep to a better standard of plucking.

Pruning.—Progressive small holders, for the most part, tried to adhere to the pruning methods taught them. But the tendency to resort to clean pruning still prevails.

Instructional Leaflets.—Leaflets containing advice on the management of small holdings were sent to small holders in all the tea areas. Owing to petrol rationing it was not possible to visit these areas.

Correspondence.—37 letters were received and 256 sent out.

F. D. TILLEKERATNE,
Small Holdings Officer, Baddegama.

REPORT

OF

THE SMALL-HOLDINGS OFFICER,

ARAMBEGAMA, FOR 1944

Weather.—Weather conditions during the year were favourable, there having been an even distribution of rain during the 12 months. The total rainfall registered at Arambegama was 176.38 ins.

Advisory Work.—1,248 small holdings were visited. 207 of these which were abandoned during the previous year and brought into condition during this year have proved to be very good holdings. There are yet a large number of abandoned small holdings in Kandukara Ihala and Ganga Ihala Korales in Udapalata and Ambegamuwa and Pasbage Korales in Uda Bulatgama. This is partly due to scarcity of labour. These are however gradually being brought into condition.

Demonstrations.—16 pruning demonstrations were given. Lung pruning has gained popularity.

Meetings.—Six meetings were held; at these the correct method of plucking, supply of suitable green leaf to factories and compost making were explained. The importance of regular weeding and cultivation of the soil was stressed. At these meetings the small holders were informed of the minimum price of green leaf payable by each factory in the locality.

Supplying.—It is encouraging to note that most of the abandoned small holdings which have since been brought into condition have fully supplied their vacancies and some of them present the appearance of new plantations.

Soil Conservation.—I was invited to Diyatilleke Udagama village in Uda Hewaheta in connection with the opening of a number of new plantations under permits on patna lands. Opportunity was taken to bring home to these small holders the advisability of adopting contour drainage system in this hilly part of the district. Their response to the advice has been remarkable.

Paspalum grass roots distributed among 30 small holders in the previous year have been multiplied and further supplies from these were issued among a large number of small holders.

Tea Seeds.—A number of applications were received for tea seeds and plants, the applicants were informed where reliable seeds and plants were available. In two deserving cases 30 lb. of tea seed were supplied free of cost.

Green Manures.—Contour hedges of sunflower have been established in a number of small holdings where roots of tea bushes had been exposed due to soil wash. These were regularly cut and forked in.

Shade and Green Manure Trees.—Several applications had been received from small holders for supplies of Albizzia seed. Small quantities of seed obtained from serious sources from time to time were issued. These were raised in nurseries and planted out.

Due to the great demand for Albizzia planks for making tea chests, most of the standing trees on small holdings have been felled and every effort is being made to replant these to fill the vacancies.

Gliricidias on small holdings have been badly lopped and used as cattle food. Small-holders were advised on the method of training these trees and using loppings as green manure.

Food Production.—Stress was laid in all my visits to small holdings and at meetings on the necessity of producing more food. Responses to this has been very satisfactory and many of the abandoned small holdings continued to grow cassava, yams and other food crops. The cultivation of cereal crops among tea is dying out. Food production leaflets issued by the Agricultural Department were distributed and explained to small holders on my visits and at meetings.

Miscellaneous.—The scarcity of labour in villages is still acute due mainly to the military employing large numbers. The estates absorb a fair percentage of the available village labour; the small holder is thus unable to employ sufficient labour at the high rates of wages at present demanded.

Headmen.—I attended Divisional days of the Chief Headmen, Yatinuwara and Uduuwara, Udalalata and Uda-Bulatgama and gave talks on various items. I thank the Ratemahatmaya Yatinuwara and Uduuwara, Divisional Revenue Officers of Udalalata and Uda-Bulatgama for their continued support.

Village Committees.—I attended a number of meetings of Village Committees where addresses of an advisory nature were delivered.

Office.—68 letters were received and 215 were sent out. 52 calls were made by small holders for advice.

M. B. BOANGE,
Small Holdings Officer, Arambegama.

The Tea Research Institute of Ceylon.

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