INDIAN LAC RESEARCH INSTITUTE

NAMKUM, RANCHI, BIHAR, INDIA

ANNUAL REPORT

FOR THE FINANCIAL YEAR 1956-57

1958

CONTENTS

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NAMKUM, RANCHI, BIHAR

ANNUAL REPORT FOR THE FINANCIAL YEAR 1956-57

ADMINISTRATIVE AND GENERAL

General — The Institute pursued its research and other activities as usual under the supervision of Dr. S. V. Puntambekar, its Director.

During the period a three-man reviewing committee appointed by the Government of India and consisting of Dr. H. S. Pruthi, former Plant Protection Officer, Government of India, Dr. S. L. Kapur, Assistant Director, Plastics & Polymer Division, N.C.L., Poona and Shri D. Kalra, Director, A. M. Jordan of Calcutta inspected the Institute in August 1956 reviewing the work done by it during the last four and half years. The Committee recommended certain changes in the existing organizational set-up as well as in the research programme in force. The Indian Lac Cess Committee has already taken a number of decisions on the basis of these recommendations: the Committee's decisions are awaiting the Government of India's endorsement.

A notable event during the period was the inauguration, as part of the celebration of the Indian Lac Cess Committee's Silver Jubilee, of a mobile exhibition of lac and lac products, which was opened at the Institute on September 19, 1956 by Shri R. R. Diwakar, Governor of Bihar. The exhibition was largely attended on the day of inauguration and also on the few days it remained open thereafter at Namkum. The exhibition was later on moved successively to Ranchi, Patna, Delhi, Bombay, Calcutta and Poona, and everywhere attracted numerous visitors.

Apart from the exhibition, a two-day symposium on lac was organized at the Institute to mark the occasion. Scientists from various parts of India took part in the symposium, reading and discussing papers: discussions were tape-recorded. The papers and discussions are to be shortly published.

Persons from outside attending and taking part in the deliberations of the symposium were as follows:

1. Shri S. S. Prasad, I.F.S., Chief Conservator of Forests, Bihar
2. Shri B. P. Jayaswal, M.Sc., M.I.S.E., B.L., Honorary Magistrate and Member, Advisory Board, I.L.C.C., Jhalda
3. Shri B. N. Prasad, Working Plan Officer, Northern Circle, Forest Department, Bihar
4. Shri P. Jagannathan, Assistant Meteorologist, Meteorological Office, Poona
5. Shri S. P. Shahi, Conservator of Forests, Bihar
6. Shri Srivastava, Deputy Director of Agriculture, Bihar
7. Prof. P. Sen, Khaira Professor of Agriculture, University of Calcutta
8. Dr. A. C. Sen, Entomologist to the Government of Bihar
9. Shri Bazle Karim, Shellac Industries, Calcutta and Member, G.B., I.L.C.C.
10. Dr. G. K. Seth, Department of Sanitary Engineering, All-India Inst. of Hygiene and Public Health, Calcutta
11. Prof. N. R. Kamath, Dept. of Chemical Technology, Bombay University
12. Shri B. L. Singh, Member, Governing Body, I.L.C.C.

13. Shri T. B. Jambulingam, Forest Utilization Officer, Chepauk, Madras
14. Shri B. K. Sahay, Research Officer, Ranchi
15. Dr. B. K. Ganguly, Asstt. Director (Chemicals), Small Industries Service Inst., Calcutta
16. Shri C. Ramchandran, A.S.D., Kirkee, Poona
17. Shri R. H. Richard, Principal, Agricultural College, Sabour
18. Shri R. C. Roy, Principal, Agricultural College, Ranchi
19. Dr. A. C. Sinha, Principal, Extension Training Centre

As usual, the Institute continued to attract throughout the year a considerable number of visitors from all over India, and a few also from abroad. A few distinguished visitors are named below:

U. V. Lat Maung, Secretary, Burma Lac & Katha Association, Burma

Pandit Binodananda Jha, M.L.A., Bihar and Member of G.B., I.L.C.C.

E. Mironov, Trade Representative of the U.S.S.R., Calcutta

T. Ryjov of U.S.S.R.

A. F. Morley, Deputy High Commissioner for U.K., Calcutta

T. Gultab, Officer-in-Charge, Information Centre, New Delhi

Dr. D. Mahant, Secretary, National Research Development Council (N.R.D.C.), New Delhi

C. N. Ghorpad, Deputy Chief Export Promotion, Govt. of India

E. A. R. Banerji, Jt. Director of Agriculture, West Bengal, Calcutta

Masaki Kusuhara, Representative of a Japanese Firm, Tokyo

Shri R. R. Diwakar, Governor of Bihar visited the Institute on 19-9-56 during the inauguration of the exhibition of lac and lac products. The following members of the Indian Lac Cess Committee also visited the Institute during the period: Shri K. Raman, I.C.S., Mr. A. M. Arathoon, Shri Sukhdeo Agarwal, Shri Bazle Karim, Mr. R. W. Aldis, Shri B. L. Singh and Shri R. D. Sharma. In addition the following members of the Advisory Board of the I.L.C.C. who attended a meeting of the Board in October 1956 at Namkum also visited the Institute: Dr. L. C. Verman, Chairman, Advisory Board, Shri S. S. Prasad, Shri B. P. Akhoury, Dr. R. N. Mathur, Dr. E. S. Narayanan, Mr. J. W. Webber and Shri Badri P. Jayaswal.

Roads and Buildings — Annual whitewashing and minor repairs to laboratory buildings and staff quarters were carried out by the C.P.W.D. as usual. A portion of the roadway was tar-macadamized for the first time while the rest was repaired as usual, where necessary, with a new top dressing. A few service latrines in existence so long were replaced by sanitary latrines.

No new constructions were undertaken during the period.

As decided already, a number of buildings, the property of the Lac Products Ltd., Namkum, were taken on lease from 1-1-57: these buildings are to be utilized mostly as lecture-halls and hostels for trainees, a large number of whom are expected to be deputed to the Institute *apropos* of the Second Five Year Plan by the various development units under different States. These buildings have been repaired, and provided with electricity; some minor alterations, however, still remain to be carried out.

Water-supply — The erstwhile installation of 4 in. cast-iron pipe-line from the river-bed well to the overhead tank in the Institute premises has eased the position of water-supply to some extent: but the relief afforded still falls far short of expectation because the existing distributing lines, which had been laid long back, are choked in places, greatly impeding the flow of water through them. However, it has already been decided to replace the old

distributory lines as early as possible. A new factor, however, has arisen in the meantime, which may virtually cut down supply even after the lines have been renovated: the Lac Products Buildings are about to be given water connections from the existing source, and since the number of persons to be accommodated in that area will be comparable to the Estate's existing population, shortage in supply is apprehended.

Library — Books and journals continue to be received regularly. The number of books and bound volumes of journals accessioned during the period is 140; in addition some 65 pamphlets and miscellaneous scientific publications were received.

In addition to some 4,100 publications mailed to various parties in India and abroad, over 3,000 propaganda publications were distributed and nearly 100 publications sold during the period.

Training — There were on the roll at the commencement of the year eight trainees in lac cultivation, one each from Pepsu, U.P., Orissa, and S.O.L.C.'s establishment and four from Bihar. 19 trainees had joined the course during the period, of whom one left after attending the course for 2½ months only, and two after 8 months. All told, ten trainees successfully completed the course, so that at the end of the period there were left sixteen trainees only in lac cultivation.

In the Chemical Section, three trainees were admitted to the 6 months' course of training in the industrial uses of lac, of whom two only completed the course. In addition, there were two casual trainees in analysis of lac, deputed by two shellac factories.

Staff — Shri Y. Sankaranarayanan, Shellac Utilization Officer, left India on 28-2-57 for the U.K. on a 6 months' deputation *cum* training under the Colombo Plan: He will work mainly at the Paint Research Station, Teddington, England.

Shri A. Bhattacharya, Research Assistant in the Entomological Section who had been away to the U.K. for about 2½ years for advanced studies under the Colombo Plan, returned to the Institute on 3-3-57. Shri Bhattacharya has obtained a diploma of the Imperial College of Science and Technology, London, and a Ph.D. degree of London University.

Other details regarding staff will be found in Appendix IV.

Staff Club — Till now, the cut in the grant to the staff club has not been restored, and as a result, the club continues to function with its amenities greatly reduced.

ENTOMOLOGICAL SECTION

(Dr. S. Krishnaswami, Ph.D., Entomologist)

I — RESEARCH AND INVESTIGATIONS

1. Improving Crop Production on *Palas* (*Butea monosperma*) by Partial Artificial Defoliation

(i) *Large-scale experiment on preserving* Baisakhi *broodlac on* palas *by partial artificial defoliation at Kundri forest of the Bihar Forest Department*

Cultivation of lac according to improved methods is being carried out as usual in Kundri forest. Since this place is extremely hot in summer, partial artificial defoliation is adopted on a large-scale for the preservation of broodlac in the *Baisakhi* crop. By this method it has been possible to produce surplus broodlac in summer for infection of increased number of trees from year to year and thus bring the entire forest with over 40,000 trees under regular cultivation. As against 11,526 trees in Coupé III last year, 16,651 trees in Coupé I have been infected for the year 1956-57 *Baisakhi* crop.

Cultivation operations — 17,306 trees in Coupé I meant for 1956-57 *Baisakhi* crop infection were pruned in April 1956, and *ari* sticklac amounting to 4,822 lb. was reaped from these from self-infected lac crop. In June-July, 8,229 trees in Coupé III were partially cropped, yielding 10,906 lb. of surplus broodlac. Of this, 3,783 lb. were used to infect 3,056 trees in Coupé II.

In April and June-July a total quantity of 7,864 lb. of sticklac were obtained.

In September-October, 14,917 trees in Coupé I were partially artificially defoliated before infection. A total quantity of 60,880 lb. (742 mds. 17 seers made up of 593 mds. 13 seers from Coupé III and 149 mds. 4 seers from Coupé II) of broodlac and 21,864 lb. (266 mds. 25 seers made up of 225 mds. 33 seers from Coupé III and 40 mds. 32 seers from Coupé II) of rejected lac were harvested from the total of 20,046 trees in *Katki* 1956 season. Of this 14,618 lb. (178 mds. 11 seers) of broodlac were used to infect 18,076 *palas* trees in Coupé I and 66 *ber* trees as well.

A surplus quantity of 21,925 lb. (267 mds. 35 seers) was sold to surrounding villages for a total amount of Rs. 5,367.50 at a nominal price of Rs. 20.00 per maund. The rejected lac, the excess broodlac and the *phunki* lac obtained from broodlac used for infection were scraped and a total of 6,548 lb. (79 mds. 24 seers) of sticklac was obtained.

Thus a total quantity of 14,288 lb. (or 173 mds. 36 seers) of sticklac was produced and sold in addition to 21,925 lb. (or 267 mds. 35 seers) of broodlac sold during the year. This brought in a net profit of over Rs. 7,000 to the forest department.

Experimental:

At Kundri — With a view to work out the economics of the practice of partial artificial defoliation for the preservation of broodlac in hot localities like Kundri, three groups of trees, namely (i) trees partially artificially defoliated at the time of infection, (ii) trees without defoliation and (iii) trees cultivated according to the villagers' method were compared. There are nearly 200 trees are under each group. Trees under treatments I and II were infected in October-November 1955 and partially harvested in June-July 1956 to remove surplus broodlac and completely cropped in September-October. In the case of treatment III, the trees were infected in October-November 1955 according to the villagers' method and most of the lac was cropped as *ari* in April leaving some for self-infection in June-July. In September-October again they were partially cropped, thus allowing the trees to be under continuous infection without any rest period.

At Namkum — Only two sets of trees with 16 trees each under (i) undefoliated and (ii) partially defoliated treatment are being compared for their capacity to produce brood in *Baisakhi* season. The trees were infected in October-November, partially cropped in June-July and completely harvested in October-November.

The crop data of the experiment at both the places are summarized in Table I.

TABLE I — CROP DATA FOR EXPERIMENT ON PRESERVATION OF BROODLAC IN *BAISAKHI* SEASON ON *PALAS* BY PARTIAL ARTIFICIAL DEFOLIATION

Locality	Treatment	No. of trees	Brood used in lb.	Crop yield in lb.				Total wt. of brood-lac crops in July & Oct.	Total wt. of rejected scraped lac obtained in July & Oct.	Brood to brood ratio	Brood to yield ratio
				Mostly cut as *ari* in April	Partial harvest in June-July		Cropped in Oct.				
					Brood-lac	Rejected lac					
KUNDRI:	Defoliated	188	143·5	—	153·2	—	—	857·8	—	1 : 6	—
			(9·2)	—	(8·5)	(12·4)	(41·4)	—	(62·3)	—	(1 : 8·5)
	Undefoliated	185	307·5	—	262·4	—	—	714·1	—	1 : 23	—
			(17·7)	—	(27·8)	(76·5)	(26·8)	—	(131·1)	—	(1 : 7·4)
	Villagers' type	155	594·5	1035·3	—	—	—	293·4	—	—	—
			(26·4)	(173·9)	—	—	(18·6)	—	(192·5)	—	(1 : 7)
NAMKUM:	Defoliated	16	17·5	—	10·5	2·5	83·8	23·3	—	1 : 1·33	—
			(4·4)	—	—	—	(16·4)	—	(19·3)	—	(1 : 4·4)
	Undefoliated	16	22·0	—	27·0	10·5	106·5	52·3	—	1 : 2·4	—
			(6·1)	—	—	—	(21·4)	—	(27·6)	—	(1 : 4·5)

Note — Figures within brackets give the weights of scraped lac whereas those without brackets give the weights of lac sticks.

It may be seen from the figures that in the case of experiment at Kundri, with 143·5 lb. brood used on 188 trees, a total quantity of nearly 858 lb. of broodlac was obtained from defoliated trees with a brood to brood ratio of 1 : 6 as against 714 lb. obtained with 307·5 lb. of brood used on 185 undefoliated trees, the ratio being only 1 : 2·3. From the point of view of scraped lac, it is seen that the more is the broodlac used for infection, the more the yield obtained.

For Namkum, where the summer is not so severe as at Kundri, defoliation does not seem to have any advantage over " undefoliation ".

At Kundri, 25 twigs from 25 trees at random were collected and the number of cells living and dead due to heat were counted. It was observed that as against 19·6 per cent of cells living in the case of undefoliated trees, 28·2 per cent were alive in the case of the defoliated trees, thus further corroborating the good effect of the defoliation treatment on the survival of lac cells.

(ii) *Residual effect of repeated partial defoliation of* palas *on crop production*

In order to assess whether repeated partial artificial defoliation carried out for the preservation of broodlac will in any way affect the yielding capacity of the host trees an experiment was undertaken in October 1955 and two sets of comparable trees of which one had been subjected to this treatment repeatedly for over 10 years, while the other had not at all been given this treatment, were compared for their maximum yielding capacity. There were 100 trees under each set and they were infected fully in October 1955 and the lac was cut immature in April 1956. The results are given in Table II.

TABLE II — CROP DATA FOR EXPERIMENT ON RESIDUAL EFFECT OF REPEATED PARTIAL DEFOLIATION OF *PALAS* ON LAC PRODUCTION

Treatment	No. of trees infected	Brood used in lb.	Scraped lac from brood used in lb.	*Ari* sticklac yield in lb.	Ratio of brood to yield (scraped lac)
Trees repeatedly partially defoliated for over 10 years	100	325	16·56	244·0	1:14·8
Trees not at all defoliated	100	328	15·44	241·85	1:15·6

Obviously the repeated partial defoliation treatment has not affected the yielding capacity of the trees in any way.

2. ECONOMICS OF UTILIZING *Palas* (*Butea monosperma*) FOR *Baisakhi* CROP ONLY AND *Ber* (*Zizyphus mauritiana*) FOR *Katki* CROP

This is the second year of the experiment and it is being continued on 10 trees each of the two species, namely *ber* and *palas*. The trees were infected in October-November 1955 and the crop was cut as *ari* in April leaving some living lac on good shoots to mature and serve as broodlac for self-infection for *Katki* crop in June-July 1956. The crop was completely harvested in the month of October 1956. The crop data obtained are furnished in Table III.

TABLE III — ECONOMICS OF UTILIZING *PALAS* FOR *BAISAKHI* AND *BER* FOR *KATKI* CROP

Host	No. of trees	Lac stick				Scraped lac			
		Brood used		Total yield	Brood to yield ratio	Brood used		Total yield	Brood to yield ratio
		lb.	oz.	lb. oz.		lb.	oz.	lb. oz.	
Palas	10	13	8	B 32 0 K 30 8	B 1: 2·37	3	8	B 6 4 K 5 1	B 1: 1·73
				B & K 62 8	B & K 1: 4·63			B & K 11 5	B & K 1: 3·23
Ber	10	14	0	B 45 0 K 31 0	B 1: 3·21	3	8	B 9 4 K 5 6	B 1: 2·64
				B & K 76 0	B & K 1: 5·43			B & K 14 10	B & K 1: 4·18

Note — "B" stands for *Baisakhi* and "K" for *Katki*.

It may be seen from the results that *ber* has done better than *palas* from the point of view of production at the time of both *ari* cropping in April and total harvesting in October.

3. COMPARATIVE PRESERVATION OF BROODLAC ON *Ber* BY PARTIAL PRUNING BEFORE AND AFTER INFECTION

It has been previously established that partial pruning of *ber* trees in October-November at the time of infection or in December-January after infection is helpful in the preservation of broodlac in the *Baisakhi* crop. Now with a view to ascertain as to which

of the two times of pruning will give better results, an experiment with three treatments as follows has been laid out, and is in progress since 1954-55 season.

Treatment A — Partial pruning in October-November before infection (pruned on 19-10-55).

Treatment B — Partial pruning in December-January after infection (pruned on 7-1-56).

Treatment C — Control (no partial pruning).

There are five trees under each of the treatments and they were cropped partially in June, leaving enough broodlac on the trees for raising the succeeding *Katki* crop by self-infection. The crop, however, was harvested completely in October 1956. The yield data are given in Table IV below.

TABLE IV — PRESERVATION OF BROODLAC ON *BER* BY PARTIAL PRUNING, BEFORE AND AFTER INFECTION, IN THE *BAISAKHI* CROP

Particulars		Treatment A lb.	Treatment A oz.	Treatment B lb.	Treatment B oz.	Treatment C lb.	Treatment C oz.
Brood used for infection		5	0	6	0	6	4
Scraped lac from brood used		1	1	1	4	1	5
Brood obtained	B	4	8	2	0	12	8
	K	1	8	3	8	6	0
	B & K	6	0	5	8	18	8
Total yield of lac sticks	B	24	2	18	12	43	9
	K	7	8	13	8	14	12
	B & K	31	10	32	4	58	5
Scraped lac from total yield	B	3	8	3	0	8	7
	K	1	3	2	2	2	4
	B & K	4	11	5	2	10	11
Ratio of brood to yield (lac sticks)	B	1 : 4·82		1 : 3·12		1 : 6·96	
	B & K	1 : 6·32		1 : 5·37		1 : 9·33	
Ratio of brood to yield (scraped lac)	B	1 : 3·29		1 : 2·40		1 : 6·43	
	B & K	1 : 4·41		1 : 4·10		1 : 8·14	
Percentage of selected broodlac	B	18·65		10·67		28·13	
	B & K	18·97		17·05		31·72	

Note — "B" stands for *Baisakhi* and "K" for *Katki*.

According to the above data, treatment A seems to be better than treatment B but unlike in previous years, treatment C is better than either A or B this year, which may be attributed to unusually good season we had this year.

4. FINDING OF, AND TRIALS AS BROOD PRESERVERS OF, LAC HOSTS FOR *Baisakhi* CROP INCLUDING CERTAIN *Ficus* AND *Albizzia* SPECIES AND ALSO TRIALS OF HOSTS SIMILAR TO THOSE FOUND USEFUL IN THAILAND

The experiment is being conducted on a few species of trees found in the Namkum plantation. *Albizzia lucida* (*galwang*), *Ficus cunia* (*porho*) and *Ougeinia dalbergioides*

(*sandan*) were infected with both *palas* and *ber* brood to grow the *Baisakhi* crop. The results of the trials are given in Table V.

TABLE V — COMPARATIVE YIELD OF SUMMER BROOD FROM VARIOUS HOSTS

Particulars	Kind of brood used				
	Palas			*Ber*	
Host species and number of trees	*Albizzia lucida*	*Ougeinia dalbergioides*	*Ficus cunia*	*Albizzia lucida*	*Ougeinia dalbergioides*
	7	7	2	4	4
	lb. oz.	lb. oz.	lb. oz.	lb. oz.	lb. oz.
Brood used					
Lac sticks	7 0	14 12	5 4	2 4	7 4
Scraped lac	1 4	2 12	1 2	0 10	2 0
Brood obtained					
Lac sticks	15 12	23 8	9 0	3 0	15 8
Scraped lac	2 2	5 12	1 2	0 6	3 5
Total yield					
Lac sticks	27 4	36 4	17 0	7 8	22 12
Scraped lac	3 0	9 10	1 12	0 10	5 7
Percentage of selected brood	57·80	62·67	52·29	40·0	68·13
Brood to yield ratio					
Lac sticks	1 : 3·89	1 : 2·49	1 : 3·24	1 : 3·33	1 : 3·14
Scraped lac	1 : 2·40	1 : 3·50	1 : 1·56	1 : 1·00	1 : 2·72
Ratio of brood used to brood yield	1 : 2·25	1 : 1·59	1 : 1·71	1 : 1·33	1 : 2·13

It is seen that both brood to yield ratio and percentage of selected broodlac are quite satisfactory and better in the case of *Ougeinia dalbergioides* than in the case of the other two hosts. But as brood preservers all the three hosts have given satisfactory results for the *Baisakhi* crop.

5. Determination of Brood-carrying Capacity of the Major Lac Hosts

The experiments are being carried out both at Hesel and Namkum on the four major lac hosts, namely *kusum*, *palas*, *ber* and *khair*. During the year under report *Baisakhi* crop was grown on *palas* and *ber* and *Katki* crop on *palas*, *ber* and *khair* at Namkum, while the *Jethwi* and *Aghani* crops were grown on *kusum* both at Namkum and Hesel.

The results of yield data are given in Table VI.

The brood yields were not found satisfactory during the year except in the case of *palas* in the *Baisakhi* season, for which the brood used to brood yield ratio was 1 : 3·24.

TABLE VI — BROOD-CARRYING CAPACITY OF MAJOR LAC HOSTS

Locality	Crop	Host and No. of trees	Brood used for infection		Broodlac yield		Ratio of brood used to brood yield
			lb.	oz.	lb.	oz.	
NAMKUM	*Baisakhi* 1955-56	*Palas* (10)	18	4	59	2	1: 3·24
	Baisakhi 1955-56	*Ber* (10)	14	4	21	4	1: 1·49
	Katki 1956	*Palas* (10)	14	4	4	4	1: 0·29
	Katki 1956	*Ber* (10)	11	12	16	8	1: 1·40
	Katki 1956	*Khair* (10)	20	0	17	8	1: 0·87
	Jethwi 1956	*Kusum* (10)	21	4	16	8	1: 0·77
	Aghani 1956	*Kusum* (10)	20	0	14	8	1: 0·72
HESEL	*Jethwi* 1956	*Kusum* (20)	162	12	138	0	1: 0·84
	Aghani 1956-57	*Kusum* (10)	106	12	83	12	1: 0·78

6(a). PROPER TIME OF HARVESTING FOR MAXIMIZING YIELD

The experiment had not been taken up so far. As a preliminary attempt to start the experiment *palas* has been infected for the *Baisakhi* 1956-57 crop.

6(b). DETERMINATION OF OPTIMUM DENSITY OF LARVAL SETTLEMENT ON VARIOUS HOSTS

During the year, the experiment was conducted on *palas* and *ber* both in the *Baisakhi* and in the *Katki* seasons. The *kusum* crops could not be grown due to brood shortage.

Three treatments with three brood rates as follows are under comparison.

Treatment A — Used one-third of the actual quantity of broodlac required in each tree.

Treatment B — Used one-half of the actual quantity of broodlac required in each tree.

Treatment C — Used fully the actual quantity of broodlac required in each tree.

There were five blocks with three trees each for the three treatments.

The crop yield data are given in Table VII (p. 10).

In terms of brood to yield ratio (scraped lac) it is seen that treatments A and B are generally better than treatment C except for *palas* in the *Baisakhi* season. For *ber* in both the seasons, B was slightly better than A and both of them were superior to C. For *palas* in the *Katki* season the performances of the treatments were in the order A, B, C but in the *Baisakhi* season it was completely reversed.

7. CRITICAL STUDY OF THE EFFECT OF CHANGE OF HOST PLANT ON LAC CULTIVATION

In order to ascertain how alternation of hosts affects the crop yields, and to find out suitable hosts for alternating with the main lac hosts for the maintenance of the vigour of the strain of the lac insect, this experiment is being conducted at Namkum. Owing to the limited number of hosts available in the plantation, the experiment could be carried out only on a small scale.

Rangeeni strain — The experiment with *palas* broodlac was started in 1951 to grow the *Baisakhi* crop on *Albizzia lucida*, *sandan* and *porho* trees and ever since, these hosts are being alternated with *palas*, in the *Baisakhi* and *Katki* seasons respectively. It has been possible to carry on cultivation successfully under this alternation of hosts.

TABLE VII — DETERMINATION OF OPTIMUM DENSITY OF LARVAL SETTLEMENT ON VARIOUS HOSTS

Host	Crop and yield particulars	Treatment A		Treatment B		Treatment C	
		Yield of crop lb. oz.	Brood to yield ratio	Yield of crop lb. oz.	Brood to yield ratio	Yield of crop lb. oz.	Brood to yield ratio
Palas							
	Baisakhi 1955-56						
	Lac sticks	19 10	1 : 5·23	43 2	1 : 7·67	51 2	1 : 4·5
	Scraped lac	3 2	1 : 3·84	6 4	1 : 4·58	7 8	1 : 5·8
	Katki 1956						
	Lac sticks	12 12	1 : 3·40	24 0	1 : 4·26	19 8	1 : 1·73
	Scraped lac	2 6	1 : 3·80	4 2	1 : 3·30	3 8	1 : 1·60
Ber							
	Baisakhi 1956-57						
	Lac sticks	17 6	1 : 4·63	30 6	1 : 5·40	31 4	1 : 2·78
	Scraped lac	2 6	1 : 1·90	4 8	1 : 2·44	6 0	1 : 1·71
	Katki 1956						
	Lac sticks	16 12	1 : 4·46	27 0	1 : 4·80	35 4	1 : 3·13
	Scraped lac	3 0	1 : 3·20	4 14	1 : 3·54	5 3	1 : 2·18

A similar experiment with *ber* broodlac was started in 1955 and *ber* in *Katki* season is being alternated with *A. lucida* and *sandan* in the *Baisakhi* season. In this case also the results so far achieved have been satisfactory and there does not seem to be any adverse effect due to such alternations on crop production.

Kusmi strain — This experiment with *kusum* broodlac was started in 1953 to grow *Aghani* crop on *pakur, khair* and *ber* trees and the brood obtained is being alternated with *kusum* in the *Jethwi* season. This alternation continued without a break on *ber* and *khair* up to 1955 and in *Aghani* 1955-56, the cross strains survived only on *pakur*. Hence only with this cross strain, *Jethwi* 1956 and *Aghani* 1956-57 could be raised in this year. The general indications are that these alternations are not so successful as in the case of the *Rangeeni* strain.

8. Determination of the Most Suitable Pruning Methods and Seasons for *kusum* (*Schleichera oleosa*)

In order to evolve a pruning method that would produce shoots suitable for infection in the shortest possible time without at the same time affecting the vitality and normal yielding capacity of the host, two types of pruning, namely 'apical pruning' and 'surface pruning' are under investigation. Under these two types of pruning, the trees are allowed rest for varying periods from 6 months to 18 months, thus making four treatments as follows:

Treatment I — Apical pruning with 18 months' interval of rest.

Treatment II — Apical pruning with 12 months' interval of rest.

TABLE VIII — DATA RELATING TO THE FOUR COMPARABLE TREES MEANT FOR STATISTICAL ANALYSIS

Treatment No.	Interval of rest and type of pruning	*Jethwi* 1956		*Aghani* 1956-57	
		Tree No.	Brood to yield ratio	Tree No.	Brood to yield ratio
I	18 months: 'Apical'	172	1 : 1·56	19	1 : 0·41
		173	1 : 1·55	22	1 : 0·82
		175	1 : 2·10	25	1 : 1·78
		176	1 : 1·20	27	1 : 1·13
		Total	6·41		4·14
		Mean	1·60		1·03
II	12 months: 'Apical'	159	1 : 0·00	4	1 : 1·40
		162	1 : 0·19	35	1 : 2·08
		164	1 : 1·09	38	1 : 1·20
		223	1 : 0·68	41	1 : 1·77
		Total	1·96		6·45
		Mean	0·49		1·61
III	12 months: 'Surface'	189	1 : 0·25	31	1 : 1·27
		192	1 : 0·44	43	1 : 3·28
		193	1 : 0·34	48	1 : 0·42
		198	1 : 0·00	50	1 : 1·42
		Total	1·03		6·39
		Mean	0·26		1·60
IV	6 months: 'Surface'	203	1 : 1·50	60	1 : 0·55
		207	1 : 0·08	63	1 : 4·00
		208	1 : 0·83	67	1 : 2·83
		209	1 : 0·75	72	1 : 2·15
		Total	3·16		9·53
		Mean	0·79		2·38

Treatment III — Surface pruning with 12 months' interval of rest.

Treatment IV — Surface pruning with 6 months' interval of rest.

Shoot study — With a view to studying the response to pruning, the number and growth of shoots from January-February 1956 to January-February 1957 were recorded, the observations being taken at weekly intervals on three comparable branches of 4, 3, 3 and 2 trees under the above four treatments respectively. The results are furnished in Table IX on p. 13.

The general indications are that March-April and August-September are the months of active growth, growth being more vigorous in March-April. Primaries and secondaries up to 6 months and to some extent one year old showed linear growth while older primaries and secondaries showed hardly any linear growth. Secondaries and tertiaries usually appeared from primary or secondary shoots 6 to 12 months old respectively.

Yield data — The yield figures for the *Jethwi* and *Aghani* crops harvested in June-July 1956 and January-February 1957 respectively are given in Table X on p. 15.

It may be seen from the yield figures that the crop yields have been very unsatisfactory in the *Jethwi* season, for which apical pruning has done better than surface pruning. In the *Aghani* season, however, the treatments II and IV have given better yields than treatments I and III.

For purposes of statistical analysis of the yield data, 4 comparable trees under each of the treatments are considered. The yield figures for those trees are given in (Table VIII, on page 11). As the experiment has not been laid out on proper lines, the Statistical Advisor opined that no useful purpose would be served by analysing these data. Hence Statistical analysis was not carried out.

9. Growing of Lac Hosts Under Crop and Bush Conditions

Since some of the lac host species lend themselves to be trained into bushes grown like crop plants, attempts are being made to cultivate lac on such species so that the cost of operation may be kept low and the yield per unit area increased.

Under crop conditions — A large number of *arhar* plants (*Cajanus cajan*) were raised in the plantation and of these 200 plants of good growth were infected with *Rangeeni* broodlac for growing *Baisakhi* (1955-56) crop. Although the settlement and development were good in the initial stages, the plants started drying in summer due to excessive heat and therefore *ari* cutting had to be resorted to. Out of 200 plants only 30 survived till maturity of the lac crop. The quality of brood obtained from these was quite good. The details of crop data are given below:

No. of plants infected	200
Quantity of brood used	25 lb. 12 oz.
Brood yield from 30 plants	9 lb.
Total yield of lac sticks	79 lb.
Ratio of brood used to yield (lac sticks)	1: 3·07
Ratio of brood used to yield (scraped lac)	1: 2·02

In the *Katki* season 50 *arhar* plants were infected in June-July with broodlac obtained from the *arhar* plants of the *Baisakhi* season. The crop which progressed satisfactorily till the end of August, however, suffered heavily due to very severe parasite and predator damage.

Under bush conditions — *Flemingia congesta, Inga dulce, Albizzia lucida, rose* and *ber* are being raised as bushes in the plantation. Newly raised plants of *ber* and *A. lucida* have not yet grown sufficiently to be able to take infection. Only *rose* and *Flemingia congesta* were therefore infected with *Rangeeni* broodlac to produce *Baisakhi* 1955-56 crop. While the lac larvae did not survive on rose bushes, they developed satisfactorily on *Flemingia* species.

The crop data for these species are given below:

No. of plants infected	50
Quantity of brood used	13 lb. 2 oz.
Brood yield	10 lb.
Total yield of lac sticks	50 lb.
Ratio of brood used to yield (lac sticks)	1: 3·81
Ratio of brood used to yield (scraped lac)	1: 2·03

10. Collecting Pests of Host Trees, Noting Their Parasites and Control Operations Against Various Pests

Pests of palas — Coptosoma ostensum *Dist.* (*Family* Pentatomidae, *Sub-family* Plataspidinae) — Work on the life-history of the pest and its enemies was continued. The results of the life-history study on the pest showed that the egg stage varies from 3 to 8 days during March to May, the average being 5·4 days for 9 observations. During the colder months of

TABLE IX — RESULTS OF SHOOT STUDY FROM JANUARY-FEBRUARY 1956 TO JANUARY-FEBRUARY 1957

(Average for 3 branches in each tree)

Tree No.	Date of cropping	Primaries			Secondaries			Tertiaries			Larval settlement and lac encrustation
		Buds sprouted and developed into shoots %	No. of shoots	Average length in inches	Buds sprouted and developed into shoots %	No. of shoots	Average length in inches	Buds sprouted and developed into shoots %	No. of shoots	Average length in inches	
1	2	3	4	5	6	7	8	9	10	11	12
					Treatment I						
14	19-1-55	88·46	23/3	3·41	60·00	12	4·28	83·33	10/3	1·75	*Tree No.* 14 — *Cropped in Jan.* 1957 Encrustation on 3 secondaries (secs.) scattered on others no lac encrustation because lac larvae that had settled and died at earlier stage. Sparse and patchy encrustation on few tertiaries.
124	28-6-55	75·00	12	3·42	71·43	40/3	3·45	77·27	17/3	1·79	
134	6-2-56	80·00	4	11·71	100·00	1/3	1·75	—	—	—	*Tree No.* 124 — *Infected in Jan.* 1957 No larval settlement on primaries (prs.) very good and continuous settlement on 2 secs. on others sparse and in patches. No settlement on tertiaries.
180	5-7-56	59·26	16/3	4·67	100·00	1	1·17	—	—	—	
					Treatment II						
36	28-6-55	69·56	16/3	5·58	79·31	23/3	6·28	100·00	1/3	1·25	*Tree No.* 36 — *Cropped in Jan.* 1957 Only on 1 pr. was lac encrustation good and continuous. Continuous encrustation on majority of the secs. but mostly damaged by predators on 4 secs. Sparse and patchy encrustation but well-developed cells on secs.
114	27-1-56	83·33	16/3	3·71	70·59	4	2·04	—	—	—	
161	4-7-56	80·95	17/3	3·62	100·00	1	3·42	—	—	—	*Tree No.* 114 — *Infected in Jan.* 1957 Larval settlement found to be very good and continuous on majority of the shoots. All the secs. have very poor and patchy settlement. No settlement on tertiaries.
					Treatment III						
42	1-7-55	56·25	3	3·69	100·00	4/3	3·62	75·00	3	5·83	*Tree No.* 42 — *Cropped in Jan.* 1957 Very good and continuous lac encrustation on 2 prs. and on others sparse. Scattered encrustation with well-developed cells on secs.
128	27-1-56	72·72	8/3	2·09	70·00	2	1·75	—	—	—	*Tree No.* 128 — *Infected in Jan.* 1957 The prs. have continuous settlement throughout — very good. No larval settlement on secs.
190	7-7-56	78·57	11/3	3·43	100·00	1/3	3·00	—	—	—	
					Treatment IV						*Tree No.* 70 — *Cropped in Jan.* 1957 Only one pr. has very good continuous encrustation and on others scattered and in patches.
214	8-7-56	85·71	2	3·46	75·00	2	2·04	—	—	—	*Tree No.* 214 — *Infected in Jan.* 1957 Very poor settlement on prs. only 2 secs. have settlement at the mid-region of the shoots.
70	27-1-56	80·00	4/3	1·75	100·00	1/3	0·50	—	—	—	

TABLE X — CROP DATA FROM THE PRUNING STUDIES ON *KUSUM*

Treatment No.	Interval of rest and type of pruning	*Jethwi* 1956			*Aghani* 1956-57			*Jethwi & Aghani* comb.		
		No. of trees	Brood to yield ratio		No. of trees	Brood to yield ratio		No. of trees	Brood to yield ratio	
			Lac sticks	Scraped lac		Lac sticks	Scraped lac		Lac sticks	Scraped lac
I	Apical pruning and 18 months' rest	20	1 : 1·85	1 : 0·88	12	1 : 1·81	1 : 1·65	32	1 : 1·24	1 : 1·14
II	Apical pruning and 12 months' rest	19	1 : 0·45	1 : 0·23	7	1 : 2·27	1 : 2·04	26	1 : 0·97	1 : 0·69
III	Surface pruning and 12 months' rest	15	1 : 0·36	1 : 0·13	10	1 : 2·10	1 : 1·72	25	1 : 0·91	1 : 0·52
IV	Surface pruning and 6 months' rest	14	1 : 0·42	1 : 0·19	6	1 : 2·44	1 : 2·51	20	1 : 1·07	1 : 0·70

December to early February the average egg period was 11·5 days for 51 observations, the variation being from 10 to 16 days.

The pest has usually 4 instars but at times there are either 3 or 5 instars during its nymphal period. The total nymphal period lasts for 48 to 53 days with an average of 51·1 days for 9 observations during June-July, while it varies from 41 to 63 days with an average of 50·2 days for 11 observations during January to March.

Observations on the life-history and the larval feeding of the Coccinellid, *Synia melanaria*, a predator of *Captosoma* bug, were also taken. Out of 5 observations made on the life-history in the month of March, the average egg, larval and pupal periods were 3·2, 12 and 4·6 days respectively. The average total life-cycle was 19·8 days. The predatory larva on an average consumed 29·2 nymphs of the bug in May, 72·2 nymphs in June (average of 4 observations) and 50·8 nymphs in March (average of 5 observations). Out of 8 grubs under observation from the time of hatching three moulted four times and five only thrice during the months of May-June.

Telenomus species — The eggs of *Coptosoma* bugs are heavily parasitized by these species. It appeared that freshly laid eggs were more easily parasitized than the ones in which the embryo had developed. The parasite takes 9-11 days to complete its life-cycle in May, the average being 7·67 days for 6 observations. During February-March, however, the life-cycle was prolonged, the variation being 11-25 days and the average 18·2 days for 5 observations.

11. Determination of the Various Races, Strains and Species of Lac Insects, Performance, Selection of Good Strains and Cross-infection

Collection of lac stick samples through correspondence in the past having resulted in receiving samples of lac from the progeny of brood sent from Namkum, fresh attempts are being made to obtain lac samples, from crop raised from local brood.

For want of staff no serious work could be taken up on this item.

12. Influence of Various Environmental Conditions on the Lac Insect

The purpose of this study is to ascertain how the climatic factors, in particular the temperature conditions affect the growth and development of the lac insects. For this, observations on growth and development and life-history are being taken on two sets of

insects propagated on potted plants, namely (i) under controlled low temperature below 20°C. and (ii) under controlled optimum temperature above 24°C. These are being compared with observations on insects on potted plants kept in the open under natural conditions.

Both *Rangeeni* and *kusmi* strains are under study and were used for infecting *Acacia farnesiana* and *kusum* potted plants respectively.

Due to the refrigerators going out of order, the observations on *Baisakhi* 1955-56 and *Jethwi* 1956 could not be taken. Even the experiment, started in July for the *Katki* crop in the newly erected air-conditioned room at 27°C., had to be discontinued due to temporary failure of the air-conditioning plant.

The *Baisakhi* 1956-57 and *Jethwi* 1957 crops have been started afresh and the observations made are given below:

Rangeeni strain — At controlled temperature of about 25°C. and relative humidity (R.H.) range of 52-87 per cent, the males and females on two pots under observation reached the third instar and adult stages respectively but later on they completely died. Under the field conditions of average mean temperature of 18·9°C. and R.H. range of 24-100 per cent, all the insects developed into females and no males were met with in the case of one pot. The female, however, died after reaching the adult stage. In two other pots the males completed their life-cycle in an average period of 138·8 and 151·0 days respectively, while the females have reached the adult stage and are continuing to live. Under controlled temperature of about 18°C. and R.H. range of 29-82 per cent, all the insects died after completing the first instar stage.

Kusmi strain — Under controlled temperature of about 25°C. and R.H. range of 65-84 per cent, the male insects completed their life-cycle in 47 days on an average, while the females are continuing to live after having reached the adult stage. Under field conditions of average mean temperature of 19°C. and R.H. of 24-100 per cent, the development was rather slow and only one insect had completed the first instar stage. Under controlled low temperature of about 18°C. and R.H. range of 32-90 per cent the females completed second instar stage while the males only the first instar stage till the end of March.

Generally it was observed that the rate of development of the insects at the different temperatures was in the following descending order: (i) controlled high temperature (above 24°C.), (ii) fluctuating field temperature, (iii) controlled low temperature (below 20°C.).

13. Survey of Lac Enemies and Their Parasites

(i) *Caging of lac samples* — During the period under report the response from States was poor regarding procurement of samples of lac for caging purposes. Even the very few samples received were in such small quantities that most of them could not be utilized for caging. However, in all 18 samples were under observation during the year and no new enemy or parasite was encountered.

(ii) *Predatory enemies* — Both the species of *chrysopa* (namely *C. madestes* and *C. lacciperda*) were met with in a mild form on the lac crops during April to September.

(iii) *Non-insect enemies* (birds, squirrels and other rodents).

At Kundri — Investigations on the two new enemies, namely birds and squirrels were continued for the third year. The extent of damage by these new enemies to lac crop in Kundri was assessed on the same lines as in the last year in the *Baisakhi* crop. In the *Katki* season the damage being only stray was not assessed.

At the time of harvesting the *Baisakhi* crop, the assessment was made on 25 trees selected at random from each of two groups, namely trees with better survival of lac insects and those with poor survival. Out of a total of 2,052 lac-bearing twigs from the former group lac insects were completely dead on 18·47 per cent of twigs and of the remaining twigs bearing both dead and living insects, damage due to birds and squirrels was noticed on

34·01 per cent. In the other group of trees with poorer survival of lac insects, out of a total of 1,104 lac-bearing twigs, lac insects on 30·5 per cent of the twigs were completely dead and of the remaining having both dead and living insects, 18·9 per cent showed damage by squirrels and birds. When all the 50 trees are taken together as representing the entire coupé under infection, it was found that out of a total of 3,156 lac-bearing twigs examined, 22·69 per cent showed lac insects completely dead on them and of the remaining having both dead and living lac cells, 29·26 per cent showed damage by these agencies.

The assessment was carried out on the basis of the lac cells as well. Three twigs selected at random from each of the 50 trees of the two groups were examined for dead, living and damaged cells. Out of a total of 12,501 cells on 75 twigs from 25 trees having better survival of lac insects, 37·45 per cent were dead due to heat and of the remaining (living) cells, 40·6 per cent had been damaged. Similarly, out of a total of 16,929 cells on 75 twigs from the other group of 25 trees with poor survival of lac insects, 73 per cent were dead due to heat, and of the remaining (living) cells, 19·43 per cent were found to be damaged. Taking all the 150 twigs from the 50 trees together as representing the entire area, it is seen that while 57·9 per cent of the cells were dead due to heat of the living cells, as much as 32·8 per cent of cells were found to be damaged by the squirrels and birds.

Our previous assumption that these animals are forced to take to lac insects as food, out of scarcity conditions of food and water was proved to be false this year, by the fact that these two factors were available in plenty at the time the damage began to be observed.

At Hesal-Berwari — The damage was also noticed in the case of broodlac used for infection of *Aghani* (*kusum*) crop in June this year at Hesal-Berwari. Damage to the broodlac was also assessed in 15 *kusum* trees at the time of *phunki* removal. Out of a total number of 914 *phunki* bundles recovered from 15 trees, 65·9 per cent showed damage due to these agencies. Assessment made on the basis of length of encrustation of broodlac eaten up showed that of a total length of 205 in. of broodlac stick (25 sticks) examined 54·32 per cent was found damaged.

(a) *Stomach-content examination of birds and squirrels* — During the period under report, 24 birds shot and collected in June 1955, 10 birds in October 1955 and 9 squirrels in October 1955 were dissected and their stomach contents examined for the presence of lac insects and other associated insect species. The results are given in Table XI.

The data reveal that of the birds collected in June 1955, no adult female lac insect could be traced from any specimen. In the October specimens, however, the two species of woodpeckers and the red vented *bulbul* showed the presence of lac female adults in their stomach contents. Out of the 9 specimens of squirrels collected in October 1955, lac adult female insects were traced only in three cases and even these were in fewer numbers as compared to the number traced in specimens of June in the previous years (1954-55). There was also evidence that the squirrels were more after the predatory enemies of lac, as 5 specimens out of the 9 examined showed these enemies consumed as food in their alimentary canal.

(b) *Rats* — In *Jethwi* 1957 season at the time of infection, a very widespread damage to broodlac was observed at Hesal, Berwari and Mahespur-Sirka areas. A careful search for the agents responsible for this severe damage revealed for the first time conclusively that rats were the chief culprits. Rat holes were searched and broodlac bundles and even wire-net baskets, containing broodlac were recovered up to 15 in number in one case. In the tree hollows, brood sticks devoid of encrustation were picked in large numbers along with masses of lac encrustation detached from the sticks. In one instance up to 180 gms. of loose lac encrustation was recovered. Wherever lac sticks and encrustations were seen, the faecal castings of the rats were also found which were red in colour due to the presence of lac dye and which in fact gave the clue to the rats being responsible for this damage.

Eight rats were caught from the Berwari area of which four were dissected for stomach-content analysis. Only lac larvae and a few resin bits were recovered but not any adult female lac insects. The absence of the adults may be due to either the rat specimens

TABLE XI — EXAMINATION OF CONTENTS OF ALIMENTARY CANAL OF SQUIRRELS AND BIRDS SHOT AT KUNDRI

Serial No.	Name of specimen	Date of collection	Lac insects and resin bits				Termites	Ants	Other insects, etc.
			Resin bits	Lac larvae	Lac adult females				
					Entire or almost entire	Fragments			
June 1955 — Specimens									
1	Small minivet	13-6-55	—	—	—	—	—	some	1 bug and some beetles
2	,,	13-6-55	—	3	—	—	290	7	1 beetle
3	,,	17-6-55	—	2	—	—	—	—	3 beetles
4	,,	17-6-55	—	3	—	—	—	—	5 ,,
5	,,	17-6-55	—	—	—	—	—	—	Few beetles
6	,,	17-6-55	—	—	—	—	—	—	Few beetles and 1 grasshopper
7	Common *mynah*	19-6-55	—	—	—	—	—	—	Some beetles
8	,,	23-6-55	—	—	—	—	—	7	2 grasshoppers
9	Common *lora*	19-6-55	—	—	—	—	—	—	Some beetles
10	Golden whole	19-6-55	—	—	—	—	—	—	—
11	King crow	17-6-55	—	—	—	—	—	—	Some beetles
12	,,	20-6-55	—	1	—	—	—	—	,,
13	,,	19-6-55	—	1	—	—	—	—	,,
14	House sparrow	20-6-55	—	—	—	—	—	—	—
15	,,	20-6-55	—	—	—	—	—	—	—
16	,,	19-6-55	—	—	—	—	49	—	—
17	Crow pheasant	19-6-55	—	—	—	—	—	some	1 grasshopper and a lizzard
18	Rupus backed shrike	17-6-55	—	3	—	—	—	—	2 grasshoppers
19	,,	23-6-55	—	1	—	—	—	—	2 beetles and 1 grasshopper
20	,,	20-6-55	—	5	—	—	—	—	5 grasshoppers
21	Red vented *bulbul*	19-6-55	—	—	—	—	10	—	—
22	Common weaver bird	20-6-55	—	—	—	—	—	—	—
23	,,	18-6-55	—	—	—	—	—	—	Few grasshoppers and a beetle
24	,,	20-6-55	—	—	—	—	—	—	,,
October 1955 — Specimens									
1	Golden backed woodpecker	16-10-55	31	157	2	9	609	16	1 beetle
2	,,	20-10-55	6	13	—	1	—	—	—
3	Mahratta woodpecker	14-10-55	31	3	3	19	—	—	2 *Eublemma* larvae and 4 beetles
4	,,	20-10-55	some	—	—	—	—	—	1 adult, 32 larvae and 12 pupae of *Eublemma*, 3 *Elasmus* pupae
5	Red vented *bulbul*	15-10-55	18	—	3	2	—	—	—
6	Common *lora*	21-10-55	—	—	—	—	—	—	Few beetles
7	Copper smith	21-10-55	—	—	—	—	—	—	—
8	,,	13-10-55	—	—	—	—	—	—	—
9	,,	16-10-55	—	—	—	—	—	—	3 caterpillers
10	,,	16-10-55	—	—	—	—	—	—	1 caterpiller

TABLE XI — EXAMINATION OF CONTENTS OF ALIMENTARY CANAL OF SQUIRRELS AND BIRDS SHOT AT KUNDRI (*Contd.*)

Serial No.	Name of specimen	Date of collection	Lac insects and resin bits				Termites	Ants	Other insects, etc.
			Resin bits	Lac larvae	Lac adult females				
					Entire or almost entire	Fragments			
		October 1955 — Specimens of squirrels							
1	Common five-striped squirrel (*Funambulus pennanti*)	13-10-55	—	—	—	—	182	—	—
2	„	14-10-55	15	—	1	1	138	—	32 larvae and 3 pupae, 2 *Eublemma* and 22 larvae of *Holcocera*
3	„	21-10-55	10	some	3	4	452	—	1 *Eublemma* larva
4	„	16-10-55	—	—	—	—	52	—	2 *Eublemma* larva and 1 beetle
5	„	14-10-55	10	—	6	1	—	—	—
6	„	15-10-55	—	—	—	—	28	—	8 *Eublemma* larvae and 2 *Holcocera* larvae
7	„	15-10-55	—	—	—	—	24	—	3 *Eublemma* larvae and 1 *Holcocera* larva
8	„	19-10-55	—	11	—	—	132	2	—
9	„	19-10-55	—	5	—	—	75	—	—

having been collected rather late in the season or the mode of feeding of the rats on heavily encrusted *kusum* broodlac. The specimens, however, indicated the red lac dye colouring of the digestive tract, the mouth and teeth and the paws and belly surface.

The extent of damage was assessed both on 25 broodlac bundles collected at random from 25 trees at Berwari and Mahespur-Sirka areas where the broodlac used for infection was naked. The damage was found practically on all the bundles indicating the severity of the damage met within this season. On the basis of length encrustation damaged, it was noticed that 227 in. out of 323 in. examined was damaged (70·05%) at Berwari and 131 in. out of 262 in. (50%) at Mahespur-Sirka.

14. Cultural and Preventive Methods of Control of Lac Enemies

(i) *Proper storage and quick disposal of lac to avoid infestation by enemies*

(a) *Comparison of emergence before and after scraping* — One of the methods of keeping down the incidence of enemy insects is to adopt cultural measures that will help to destroy them before they emerge out and escape back into the infected areas to start new infestations. It is therefore important that all rejected lac not fit for use as brood should be immediately scraped so that most of the enemies are destroyed before they could emerge. In order to assess the extent to which emergences are checked by the timely scraping, known quantities of lac sticks as they are harvested and stick lac scraped immediately

after harvest were caged and the subsequent emergences from the two were recorded. The emergence data are furnished in Table XII for *palas* (*Katki* season) and *kusum* (*Aghani* season).

TABLE XII — COMPARISON OF EMERGENCE BEFORE AND AFTER SCRAPING LAC STICKS

Crop	Quantity of lac caged	Emergence of insects			Beneficial insects
		Enemy parasites (*chalcids*)	Enemy predators		
			Eublemma	*Holcocera*	
Katki 1956	10 lb. *palas* lac sticks	512	64	13	—
	4 lb. 4 oz. of scraped lac obtained from 10 lb. of *palas* lac sticks.	333	32	20	—
Aghani 1956-57 (*kusum*)	10 lb. of *kusum* lac sticks	186	317	383	125
	7 lb. 8 oz. of scraped lac obtained from 10 lb. of *kusum* lac sticks	415	151	122	113

It may be observed from the above table that the population of insects emerging from the scraped lac is smaller than that from the unscraped lac. It is particularly evident in the case of the large-size predatory enemies which are destroyed to the extent of over 50 per cent by scraping.

(b) *Loss due to enemy infestation in storage* — With a view to assess the loss due to damage by enemy insects during storage, two lots were compared, of which one was fumigated with CS_2 and the other kept as it was without any treatment. The daily emergences as well as the weekly weight of the quantity of lac stored were recorded regularly till the emergence ceased and the weight became constant. In the case of the lot fumigated, no insects emerged and whatever loss in weight was there was due to loss of moisture; on the other hand in the case of the control lot the loss also includes damage by enemy insects.

This experiment was carried out both on lac sticks and scraped lac in the *Katki* 1956 and *Aghani* 1956-57 seasons.

The results of weight recorded are tabulated below:

It is seen from the above table that loss in weight was more in the case of control lots than in the case of fumigated lots. The difference gives the damage due to insect enemies in storage, and loss amounting to 0·3 to 10·2 per cent in weight seems to occur.

(ii) *Infection of broodlac in wire-gauze baskets with a view to controlling the enemy insects*

As preventive measure to keep down the incidence of enemy insects in the field, use of 60- or 80-mesh wire-net baskets is being recommended for enclosing broodlac at the time

TABLE XIII — LOSS DUE TO ENEMY INFESTATION DURING STORAGE

Crop and treatment	Initial weight of lac caged	Date of caging	Final weight	Date of clearing cage	Loss in weight %
***Katki* 1956**					
Palas lac sticks					
(i) Untreated control	10 lb.	14-10-56	5 lb. 4 oz.	2-4-57	47·5
(ii) Fumigated with CS_2	10 lb.	14-10-56	5 lb. 8 oz.	2-4-57	45·0
Palas scraped lac					
(i) Untreated control	4 lb. 4 oz. (10 lb. lac sticks scraped)	14-10-56	2 lb. 12 oz.	2-4-57	35·2
(ii) Fumigated with CS_2	4 lb. (10 lb. lac sticks scraped)	14-10-56	3 lb.	2-4-57	25·0
***Aghani* 1956-57**					
Kusum lac sticks					
(i) Untreated control	10 lb.	17-1-57	7 lb. 6 oz.	3-4-57	26·3
(ii) Fumigated with CS_2	10 lb.	17-1-57	8 lb. 2 oz.	3-4-57	18·8
Kusum scraped lac					
(i) Untreated control	7 lb. 8 oz. (10 lb. lac stick scraped)	17-1-57	6 lb. 2 oz.	3-4-57	18·3
(ii) Fumigated with CS_2	7 lb. 10 oz. (10 lb. lac stick scraped)	17-1-57	6 lb. 4 oz.	3-4-57	18·0

of infection. This will result in the enemy insects getting trapped inside the baskets, while the tiny lac larvae are able to come out and settle on trees unhindered. In order to ascertain the number of insects trapped in wire-net baskets during the course of infection, 25 baskets collected at random from the *Baisakhi* 1955-56, *Jethwi* 1956, *Katki* 1956 and *Aghani* 1956-57 infection were examined immediately after *phunki* removal and the insects trapped recorded. Later, the *phunki* lac from the wire-net baskets was caged for noting further emergence of the insects. The results are given in Table XIIIA (p. 22).

It is seen that more insects were trapped during infection within the baskets than on emergence from the *phunki* lac.

Besides recording captures of insects within the wire-net baskets, the effect of the use of baskets on the prevalence of enemy as well as beneficial insects in the resulting crop produced was also assessed. For this, equal quantities of lac sticks obtained from crops produced with and without the use of wire-net baskets for infection were caged immediately after harvest for noting the emergence of insects from these samples. The data are presented in Table XIV on p. 23. Thus these data establish that the prevalence of both enemy and beneficial insects can be reduced in a crop through the use of wire-net baskets.

15. Control of Enemies of Lac by Use of Insecticides and Fumigants

Experiments are being conducted under two sets of conditions (a) under field conditions and (b) under storage conditions.

TABLE XIIIA — CATCHES OF INSECTS IN WIRE-NET BASKETS FROM BROODLAC DURING INFECTION AND COLLECTION OF INSECTS FROM THE SAME AFTER INFECTION IS OVER

Name and number of insects	*Baisakhi* 1955-56 25 baskets containing 2 lb. 5½ oz. of *palas* lac sticks		*Jethwi* 1956 25 baskets containing 3 lb. 11 oz. of *kusum* lac sticks		*Katki* 1956 25 baskets containing 2 lb. 13 oz. of *palas* lac sticks		*Aghani* 1956-57 25 baskets containing 3 lb. 12 oz. of *kusum* lac sticks	
	During infection	From *phunki*	During infection	From *phunki*	During infection	From *phunki*	During infection	From *phunki*
Chalcid:								
Marietta javensis	—	—	—	—	—	—	—	—
Tetrastichus purpureus	24	8	14	4	35	16	10	—
Eupelmus tachardiae	13	5	4	10	3	5	26	—
Parechthrodrynus clavicornis	6	—	12	—	19	—	8	—
Erencyrtus dewitzi	53	—	13	—	9	4	16	—
Tachardiaephagus tachardiae	47	—	125	—	50	—	45	—
Cocophagus taschcirchii	—	—	—	—	9	—	2	—
Tachardiaephagus somervilli	—	—	—	—	—	—	13	—
Euritoma palidiscapus	—	—	—	—	—	—	—	—
Braclyveria tachardiae	—	—	—	—	—	—	—	—
Elasmus claripennis	—	—	—	—	—	—	—	—
Braconidae:								
Bracon greeni	—	1	1	—	4	—	8	—
Apanteles fakhrulhajiae	1	—	—	—	—	—	37	—
Apanteles tachardiae	4	—	7	—	3	—	26	—
Chellonus cyclopyra	2	—	—	—	1	—	—	—
Ichneumonidae:								
Pristomerus testaceicollis	1	—	—	—	9	7	3	—
Bethylidae:								
Perisieriola pulveriae	—	—	—	—	—	—	—	—
Predators:								
Eublemma amabilis	3	—	100	3	—	—	—	—
Adults	348	15	169	34	44	119	154	4
Larvae	—	—	1	—	49	1	3	—
Pupae	—	—	2	—	4	—	3	—
Eggs	—	—	—	—	—	—	18	—
Holcocera pulverea (adults)	280	43	109	130	29	100	207	14
Larvae	16	—	29	—	317	—	29	—
Eggs	—	—	—	—	—	—	4	—
Chrysopa sps.	—	—	—	—	—	—	2	—
Other insects:								
Beetles (adults)	59	42	34	60	112	31	16	8
Grubs	2	—	—	—	—	—	—	—
Tinidae	—	—	1	—	—	—	1	—

TABLE XIV — PREVALENCE OF INSECTS IN LAC PRODUCED WITH AND WITHOUT THE USE OF WIRE-NET BASKETS

Details of crop sample	Amount of lac caged	Emergence from lac samples enemy insects			Beneficial insects	Miscellaneous insects
		Eublemma	*Holcocera*	*Chalcids*		
***Aghani* (1955-56)**						
Kusmi lac: Experimental	20 lb.	87	196	192	192	27
Control	20 lb.	170	320	795	436	53
***Jethwi* (1956)**						
Kusmi lac: Experimental	10 lb.	116	225	1168	182	20
Control	10 lb.	121	228	2354	185	19
***Baisakhi* (1955-56)**						
Palas lac: Experimental	20 lb.	67	198	2306	37	14
Control	20 lb.	193	458	4307	81	75
Ber lac: Experimental	20 lb.	56	235	736	27	22
Control	20 lb.	135	359	4047	70	39
***Katki* (1956)**						
Palas lac: Experimental	20 lb.	252	351	6734	378	129
Control	20 lb.	300	693	7221	558	237
***Aghani* (1956-57)**						
Kusmi lac: Experimental	10 lb.	95	285	516	224	8
Control	10 lb.	97	250	2027	360	81

(a) *Under field conditions* — The chemical treatments were being given either once only during the life of the crop or at weekly intervals throughout the crop period. Treatment once only during life of the crop having given no encouraging results over two years, experiments were modified in the *Katki* season of 1955 on the following lines with the following treatments.

Treatments		*Interval of treatment*
D.D.T. dust 5%	×	Once in a week
D.D.T. spray 0·1%		Once in three weeks
D.D.T. spray 0·3%		Once in six weeks
B.H.C. spray 0·3%		
Control		

i.e. $(4\times3)+1=13$ treatments in all.

In the *Baisakhi* season (1955-56), there were two *palas* trees under each treatment. In the *Katki* season, however, B.H.C. 5 per cent dust was substituted for D.D.T. 0·1 per cent spray and there were 6 trees under each of these 13 treatments. Examinations of sticks (three 3-in. samples) (9 in. total length) was made as usual about the time of male emergence and at crop maturity for mortality of lac insects due to parasites and predators and other causes as well.

At the time of harvest, the yield figures were collected for comparison of the effects of the various treatments. Also 2-lb. samples of lac sticks obtained from the resulting crops under the various treatments were caged soon after harvest for noting emergences of enemy as well as friendly insects.

Table XV (p. 25) records the stick examination results, crop yield figures and insect emergences from the samples caged.

It is seen that while stick examination data and yield figures do not reveal that any good effect has been bestowed due to the treatments, emergence from treated samples indicate that they were less in the case of samples treated at more frequent intervals.

(b) *Insecticides under storage conditions* — Lac sticks immediately after harvesting, and freshly scraped (stick) lac at crop maturity were treated separately with insecticidal sprays and dusts, and they were caged for emergence of enemy as well as friendly insects with a view to determining if carry-over of enemies from the harvested crop to the next crop could be prevented.

The chemical treatments employed were the following with 'no treatment' as control.

Treatments:

(i) D.D.T. dust 5%
(ii) D.D.T. spray 0·1%
(iii) D.D.T. spray 0·25%
(iv) B.H.C. dust 5%
(v) B.H.C. spray 0·1%
(vi) B.H.C. spray 0·25%
(vii) Control

A definite quantity of lac sticks and scraped lac were treated and caged for noting emergence of insects. The dusts were mixed with lac in the ratio of 1: 100, while just sufficient quantity of spray fluid was used to treat the lac. Table XVI (p. 26) records the data relating to emergence of insects from lac samples treated with insecticides.

It is seen from the figures that all the treatments have had some effect and that the emergences are comparatively less from the treated lots than from the controls. In general, treatments appear to be better than D.D.T. treatments under storage conditions and between sprays and dusts the former seem to be more effective.

Fumigants — Just as under the experiments with insecticides, the treatments with fumigants were given to lac sticks immediately after harvest and freshly scraped lac at crop maturity and such treated lac was caged for noting emergencies of enemy and friendly insects. There were three fumigants namely, carbon tetrachloride, carbon disulphide and ethylene dichloride-carbon tetrachloride with a 48-hour-period exposure and a control. The dosage used for the various fumigants and the results of the experiment are given in Table XVII on p. 27.

It may be seen that 48 hours' exposure to the dosages used were effective in the case of all the fumigants and no insects including lac larvae emerged from the mature fresh lac, while emergences were quite heavy from the control lots.

16. Biological Control

(i) *Life-history studies and developing breeding technique*

(a) *Apanteles tachardiae* (Braconidae) — The breeding technique, evolved in July 1955 was further improved and it proved to be quite satisfactory on the alternative host *Corcyra cephalonica*. First instar larvae of this species were settled in a thin layer of coarse wheat flour spread at the bottom of 4″×4″ battery jars for about a day or two to be exposed for parasitization by the mated adult

TABLE XV — INSECTICIDAL TRIALS — RESULTS OF STICK EXAMINATION OF THREE 3″-SAMPLES (TOTAL LENGTH 9″) AND CROP YIELD DATA AND EMERGENCE OF INSECTS FROM TREATED SAMPLES

Treatment	Intervals of application	Percentage mortality						Crop yield data		Emergence of insects from 2 lb. lac stick samples of yield				
		About the time of male emergence			At crop maturity			Brood to brood yield ratio (lac stick)	Brood to total yield ratio (scraped lac)	Enemy insects			Friendly insects	Total
		Natural	Due to enemies	Total	Natural	Due to enemies	Total			*Eublemma*	*Holcoceva*	*Chalcids*		
***Baishaki* 1955-1956**														
DDT dust 5%	Once in a week	22·9	—	22·9	19·1	22·6	41·7	1 : 3·5	1 : 2·0	138	17	344	2	501
	Once in 3 weeks	21·5	0·6	22·1	26·3	9·4	35·7	1 : 5·7	1 : 4·2	135	58	504	27	724
	Once in 6 weeks	25·9	8·41	34·3	19·8	36·6	56·4	1 : 3·0	1 : 3·3	160	71	764	2	997
DDT spray 0·1%	Once in a week	53·0	0·5	53·5	22·1	10·8	32·9	1 : 2·1	1 : 0·7	1	3	17	—	21
	Once in 3 weeks	27·2	10·7	37·9	27·0	16·3	44·2	1 : 1·9	1 : 4·9	73	13	559	—	645
	Once in 6 weeks	33·7	1·2	34·9	24·8	10·4	35·2	1 : 4·3	1 : 3·0	45	10	254	7	316
DDT spray 0·3%	Once in a week	35·6	7·8	43·4	18·6	7·6	26·2	1 : 2·3	1 : 0·6	—	—	—	—	—
	Once in 3 weeks	41·5	1·3	42·8	31·9	10·4	42·3	1 : 6·7	1 : 5·2	—	—	47	—	47
	Once in 6 weeks	25·8	0·4	26·2	25·3	13·4	38·7	1 : 2·7	1 : 2·0	2	4	55	—	61
BHC spray 0·3%	Once in a week	30·6	1·0	31·6	28·3	31·0	57·3	1 : 1·8	1 : 0·8	—	—	36	—	36
	Once in 3 weeks	41·0	0·07	41·07	27·4	33·0	60·4	1 : 2·6	1 : 1·8	94	27	344	7	472
	Once in 6 weeks	16·6	2·0	18·6	29·5	13·3	42·8	1 : 1·9	1 : 0·63	50	35	368	—	453
Total		38·3	0·5	38·8	39·8	22·6	62·4	1 : 5·0	1 : 4·2	320	64	578	21	983
***Katki* 1956 — Percentage mortality**														
DDT dust 5%	Once in a week	34·6	20·3	54·9	63·1	34·7	97·8	1 : 0·86	1 : 0·94	16	—	994	1	1011
	Once in 3 weeks	34·4	22·0	56·4	40·7	51·7	92·4	1 : 1·31	1 : 3·0	114	13	1611	—	1738
	Once in 6 weeks	52·3	7·7	60·0	58·1	34·8	92·9	1 : 0·65	1 : 1·94	165	18	3946	—	4129
DDT spray 0·3%	Once in a week	34·3	8·9	43·2	61·7	23·4	85·1	1 : 0·88	1 : 2·44	1	—	—	—	1
	Once in 3 weeks	60·3	10·5	70·8	44·0	45·4	89·4	1 : 0·63	1 : 1·92	51	1	234	—	286
	Once in 6 weeks	57·9	6·7	64·6	63·4	25·1	88·5	1 : 0·61	1 : 1·80	184	29	659	—	872
BHC dust 5%	Once in a week	57·2	15·3	73·5	70·8	18·2	89·0	1 : 0·48	1 : 1·63	11	—	—	—	11
	Once in 3 weeks	62·8	9·8	72·6	68·0	22·2	90·2	1 : 0·44	1 : 0·76	41	9	257	—	307
	Once in 6 weeks	69·6	10·5	70·1	70·1	23·3	93·4	1 : 0·38	1 : 0·84	20	—	201	1	222
BHC spray 3%	Once in a week	63·4	17·0	80·4	69·6	19·6	89·2	1 : 0·30	1 : 0·65	11	2	27	—	38
	Once in 3 weeks	53·1	13·6	66·7	69·6	18·9	88·5	1 : 0·29	1 : 0·80	66	3	331	—	40
	Once in 6 weeks	54·0	9·8	63·8	59·0	31·7	90·7	1 : 0·5	1 : 1·1	24	10	321	—	355
Control	No treatment	73·8	9·8	83·6	72·7	20·9	93·6	1 : 0·50	1 : 0·38	178	59	4986	—	4323

TABLE XVI — COMPARATIVE DATA ON THE EMERGENCE OF INSECTS FROM LAC SAMPLES TREATED WITH INSECTICIDES

Lac samples	Quantity caged	Insecticides treatment	Emergence of insects Enemy insects				Beneficial insects
			Eub.	*Hol.*	*Chalcids*	Total	
Palas lac sticks	2 lb.	DDT dust 5%	54	19	219	292	3
	2 lb.	DDT spray 0·1%	81	19	160	260	5
	2 lb.	DDT spray 0·25%	40	3	113	156	9
	2 lb.	BHC dust 5%	47	6	67	120	6
	2 lb.	BHC spray 0·1%	53	11	226	290	4
	2 lb.	BHC spray 0·25%	23	—	111	134	6
	2 lb.	Control	159	41	332	532	19
Palas scraped lac	2 lb.	DDT dust 5%	30	11	164	205	9
	2 lb.	DDT spray 0·1%	13	6	86	105	7
	2 lb.	DDT spray 0·25%	18	4	90	112	5
	2 lb.	BHC dust 5%	16	7	32	55	—
	2 lb.	BHC spray 0·1%	21	4	59	84	6
	2 lb.	BHC spray 0·35%	12	4	29	55	6
	2 lb.	Control	42	386	250	678	22
***Katki* 1956**							
Palas lac sticks	10 lb.	DDT dust 5%	70	80	258	408	—
	10 lb.	DDT spray 0·1%	171	42	3	216	—
	10 lb.	DDT spray 0·25%	36	16	13	65	—
	10 lb.	BHC dust 5%	178	49	17	244	—
	10 lb.	BHC spray 0·1%	123	8	—	131	—
	10 lb.	BHC spray 0·25%	23	17	4	44	—
	10 lb.	Control	185	417	1313	1815	9
Palas scraped lac	6 lb.	DDT dust 5%	—	—	367	367	3
	6 lb.	DDT spray 0·1%	3	—	—	3	—
	6 lb.	DDT spray 0·25%	1	2	—	3	—
	6 lb.	BHC dust 5%	—	2	6	8	—
	6 lb.	BHC spray 0·1%	—	—	—	—	—
	6 lb.	BHC spray 0·25%	—	1	3	4	—
	6 lb.	Control	12	3	336	381	—
***Aghani* 1956-57**							
Kusum lac sticks	10 lb.	DDT dust 5%	137	91	57	285	29
	10 lb.	DDT spray 0·1%	57	10	—	67	1
	10 lb.	DDT spray 0·25%	92	23	8	123	3
	10 lb.	BHC dust 5%	87	43	6	136	1
	10 lb.	BHC spray 0·1%	—	18	—	18	—
	10 lb.	BHC spray 0·25%	—	5	21	26	—
	10 lb.	Control	182	262	273	717	86
Kusum scraped lac	6 lb.	DDT dust 5%	51	14	17	82	5
	6 lb.	DDT spray 0·1%	30	5	8	43	2
	6 lb.	DDT spray 0·25%	31	1	2	34	1
	6 lb.	BHC dust 5%	89	12	8	109	2
	6 lb.	BHC spray 0·1%	—	3	—	3	—
	6 lb.	BHC spray 0·25%	—	—	—	—	—
	6 lb.	Control	32	184	96	312	106

TABLE XVII — COMPARATIVE DATA ON THE EMERGENCE OF INSECTS FROM LAC SAMPLES TREATED WITH FUMIGANTS

Samples	Quantity caged	Fumigant and dosage used	Emergence of insects Enemy insects				Beneficial effect
			Eub.	*Hol.*	*Chalcid*	Total	
***Katki* 1956**							
Palas lac stick	10 lb.	CCl_4 at 30 lb./1000 cu.ft.	—	—	—	—	—
	10 lb.	CS_2 at 6½ lb./1000 cu.ft.	—	—	—	—	—
	10 lb.	E.D.C.T. mixture at 25 lb./1000 cu.ft.	—	—	—	—	—
	10 lb.	Control	290	241	184	715	3
Palas scraped lac	6 lb.	CCl_4 at 30 lb./1000 cu.ft.	—	—	—	—	—
	6 lb.	CS_2 at 6½ lb./1000 cu.ft.	—	—	—	—	—
	6 lb.	E.D.C.T. mixture at 25 lb./1000 cu.ft.	—	—	—	—	—
	6 lb.	Control	18	22	14	54	—
***Aghani* 1956-57**							
Kusum lac sticks	10 lb.	CCl_4 at 30 lb./1000 cu.ft.	—	—	—	—	
	10 lb.	CS_2 at 6½ lb./1000 cu.ft.	—	—	—	—	—
	10 lb.	E.D.C.T. mixture at 25 lb./1000 cu.ft.	—	—	—	—	—
	10 lb.	Control	94	285	145	524	255
Kusum scraped lac	6 lb.	CCl_4 at 30 lb./1000 cu.ft.	—	—	—	—	—
	6 lb.	CS_2 at 6½ lb./1000 cu.ft.	—	—	—	—	—
	6 lb.	E.D.C.T. mixture at 25 lb./1000 cu.ft.	—	—	—	—	—
	6 lb.	Control	59	211	74	344	150

females. Best environmental conditions were about 27°C. and 90 per cent R.H. for successful breeding. Under these conditions up to 7 generations were bred continuously from October 1956 to March 1957 and further generations are being continued. The data relating to life-history studies for five generations completed during the period are given below:

TABLE XVIII

Generation	No. of adults caged		Longevity		No. of hosts offered	No. of parasites bred			Percentage parasitism	No. bred per female	Per cent of females	Total life-cycle period	
	Male	Fem.	Male V/A	Female V/A		Male	Female	Total				Male V/A	Female V/A
First	9	12	(Adults caught from field)		190	61	26	87	—	—	21·8	22-43 / 32	22-42 / 33
Second	19	10	1-8 / 3	2-16 / 6	1085	242	73	315	29	31·5	23·0	19-45 / 27	22-39 / 28
Third	22	10	1-13 / 4·3	6-13 / 10	1470	242	267	509	34·6	46	52·5	19-50 / 26·5	20-46 / 28
Fourth	64	23	2-18 / 9·8	6-19 / 13·6	3270	722	523	1245	38	54	42·0	18-44 / 24·6	18-41 / 26·4
Fifth	22	9	8-14 / 11·75	12-14 / 13	600	135	133	268	44·6	30	49·6	16-48 / 24·3	19-48 / 27·4

It is seen that the total life-cycle as well as the longevity is slightly more in the case of females than in the case of males. The percentage parasitism varied from 29 to 44·6 and the number bred per female parasite from 30 to 54 in the five generations. The percentage of females bred per generation varied from 29·8 to 52·5.

(b) *Elasmus claripennis* (chalcidae) — With the parasite becoming available in the field the life-history study was started in the laboratory from 20th August 1956. During August and September 54 pairs were under study in separate cages for oviposition. In no cage egg-laying could be observed. The average longevity of the female and male parasites were 3·3 days and 7·1 days respectively during the period under observation.

(c) *Perisierola pulveriae* (Bethylidae) — Having concluded the life-history study of this parasite, attention was concentrated on the mass-breeding of the parasite. Cages started in battery jars 4″×4″ were not very successful from the point of view of parasitization and oviposition. Hence smaller ones were tried such as cavity blocks and petri-dishes. It was observed that oviposition and percentage parasitism were more in smaller cages, the best results being obtained in $2\frac{1}{2}\times\frac{1}{2}$ petri-dishes.

A summary of the results is given below in Table XIX.

TABLE XIX — MASS-BREEDING OF *PERISIEROLA PULVERIAE*

Containers	Host offered and number	Percentage parasitism	No. of adults bred per host	Percentage of females
(i) 4″×4″ battery jars	*H. pulveriae* (46)	6·5	3·6	54·5
(ii) 2″×2″ Cavity blocks	*H. pulveriae* (137)	30·6	3·8	50·3
	C. cephalonica (32)	30·7	2·7	21·8
(iii) $2\frac{1}{2}''\times\frac{1}{2}''$ petri-dishes	*H. pulveriae* (262)	84·35	2·4	52·7
	C. cephalonica (22)	81·8	4·3	48·7

Hence use of petri-dishes as cages for oviposition was adopted for further mass-breeding of the parasite and 3,398 parasites were bred under laboratory conditions, the total number of *H. pulveriae* hosts offered being 3,378. The percentage of parasitism, percentage of females and number of parasites bred per host were 59·53, 66·9 and 1·68 respectively.

Now for improving the mass-breeding technique, ecological studies already initiated are in progress.

(ii) *Mass-breeding and large-scale liberation of* Bracon greeni *in the field and estimation of the effect of these liberations*

(a) *Mass-breeding of* B. greeni — Mass-breeding of the parasite was carried on under the laboratory conditions on *Etiella zinkenella* during April and May 1956 in the absence of the availability in large numbers of the natural host. The average percentage parasitization for the period was 10·08 and the number of adults bred per host 1·0.

TABLE XX — MASS-BREEDING OF *B. GREENI*

Months	No. of adults introduced			Condition of host	No. of larvae						No. of days in contact	No. of adults living			% of females	No. of adults bred per host
	Male	Female	Total		Presented	Parasitized	%	Living	Dead	Pupated		Male	Female	Total		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Breeding under Laboratory condition on *E. zinckenella*																
April 1956	647	788	1,435	Tissue domes	1,200	208	17·3	490	487	15	3 days	70	102	172	59·3	0·8
May 1956	592	716	1,308	do	1,240	38	3·06	602	581	19	do	27	50	77	64·9	2·0
TOTAL	1,239	1,504	2,743		2,440	246	10·08	1,092	1,068	34	do	97	152	249	61·0	1·0
Breeding under controlled condition in A.C. room at 26·6°C. on *E. amabilis*																
June 1956	499	641	1,140	do	1,200	663	55·2	264	268	5	do	708	950	1,658	57·2	2·50*
July 1956	1,247	1,857	3,104	do	2,040	1,418	69·5	352	260	10	do	923	1,186	2,109	56·2	1·4*
Aug. 1956	645	794	1,439	do	1,240	614	49 5	328	286	12	do	195	241	436	55·2	0.71*
Sept. 1956	772	943	1,715	do	1,200	704	58·6	272	224	—	do	818	1.045	1,863	56·7	2·6*
Oct. 1956	1,004	1,360	2,364	do	1,240	758	61·1	103	379	—	do	548	2,041	2,589	78·8	3·4
Nov. 1956	1,103	1,509	2,612	do	1,200	808	67·3	115	277	—	do	481	828	1,309	63·2	1·6
Dec. 1956	908	1,365	2,273	do	1,240	608	49·03	207	425	—	do	182	562	744	75·5	1·22
Jan 1957	494	718	1,212	do	1,240	590	47·7	284	364	2	do	227	429	656	65·3	1·11
Feb. 1957	516	814	1,330	do	1,120	587	52·4	266	267	—	do	462	662	1,124	58·8	1·9
Mar. 1957	554	2,257	2,811	do	1,240	805	65·0	111	324	—	do	390	907	1,297	69·9	1·6
TOTAL	7,742	12,258	20,000		12,960	7,555	58·2	2,302	3,074	29		4,934	8,851	13,785	64·2	1·82

*Attack of mites

After constant temperature and humidity room was installed, the breeding work was carried out at 78°F. and 70 per cent R.H. from June onwards on the natural host. The rate of breeding was quite encouraging under these conditions, the maximum parasitism recorded being 59·57 per cent in July 1956 and the maximum number of adults bred per host being 2·6 in September 1956. The average parasitism and number of adults bred for the period June 1956 to March 1957 were 58·2 per cent and 1·82 respectively.

The results of mass-breeding of the parasite are given in Table XX on p. 29.

(b) *Large-scale liberation in the field and estimation of the effect of these liberations* — For this experiment two new areas have been taken, one at Berwari with 316 *kusum* trees in 1955-56, and another at Mahespur-Sirka with 1,937 *kusum* trees in 1956-57. The two areas were brought into working for taking up regular cultivation from coming June onwards. The trees were pruned in some coupés and unpruned trees infected in certain others. Two working sheds at Berwari and 4 at Mahespur-Sirka were also constructed.

Berwari — During the period under report two *kusum* crops were raised. For the first time *Jethwi* was infected on 36 unpruned trees but the crop proved to be almost a failure. For the succeeding *Aghani* season 49 pruned *kusum* trees were infected using one-year-old shoots and a fairly good crop was obtained. The crop data are given in Table XXI.

TABLE XXI — CROP DATA FOR *AGHANI* 1956-57 AT BERWARI

Particulars of yield	Lac sticks	Scraped lac
Brood used	304 lb. 8 oz.	86 lb. 6 oz.
Brood yield	568 lb.	194 lb. 12 oz.
Total yield	1,407 lb.	538 lb. 12 oz.
Brood to yield ratio	1 : 4·60	1 : 6·24
Percentage of selected broodlac	40·52	—

During January 1957, infection was done on 73 pruned *kusum* trees with one-year-old shoots to grow the *Jethwi* 1957 crop. Unfavourable weather conditions during, and after, infection have considerably affected the crop in this season and the crop is expected to be very poor.

Mahespur-Sirka — In one of the coupés 70 unpruned trees were infected for the first time to grow the *Aghani* 1956-57. The crop progressed satisfactorily and a good harvest was reaped. The crop data for the *Aghani* crop are given in Table XXII.

TABLE XXII — CROP DATA FOR *AGHANI* 1956-57 AT MAHESPUR-SIRKA

Particulars of yield	Lac sticks	Scraped lac
Brood used	201 lb. 4 oz.	71 lb.
Brood yield	398 lb. 12 oz.	176 lb.
Total yield	1,000 lb. 8 oz.	533 lb.
Brood to yield ratio	1 : 4·92	1 : 7·34
Percentage of selected broodlac	40·20	—

In January 1957, 233 unpruned trees were infected to grow *Jethwi* crop and this crop was also severely affected because of very unfavourable weather conditions prevailing during, and after, infection just as at Berwari. The effect of this bad season has been experienced throughout Chotanagpur in all the *kusum* lac growing areas.

II — INSTITUTE PLANTATION

The general up-keep of the plantation was attended to and young trees and seedlings were manured with chemical fertilizers and farm yard manure. Hoeing and weeding were carried out for keeping down the weeds. Young plants of several lac hosts were raised in the nursery beds both for planting in the pots for laboratory experiments and in the plantation. *Palas, khair, ber* and *kusum* seeds were also directly sown in some of the plots to fill up the gaps. During the year, *arhar, F. congesta* and *A. lucida* plants were raised on a large scale for growing lac on them under bush conditions. The newly raised *A. lucida* and *F. congesta* have shown satisfactory growth. *Crotolaria saltiana* was also raised regularly with a view to collecting pod borers of this plant for use as an alternative host for breeding *B. greeni* in the laboratory. During the period under report 595 trees were infected to grow the various crops.

A statement showing lac produced and its disposal is given in Table XXIII.

TABLE XXIII — A STATEMENT OF LAC PRODUCED AND ITS DISPOSAL FROM THE INSTITUTE PLANTATIONS DURING THE YEAR 1956-57

Crop and locality	Scraped or broodlac and its disposal														
	Produced			Under use in department			Driage			Supplied to Chemical Section			Sold		
	Md.	sr.	ch.	Md.	sr.	ch.	Md.	sr.	ch.	Md.	sr.	ch.	Md.	sr.	ch.
Baisakhi 1955-56															
Namkum plantation	2	4	3*	—	—	—	—	21	7*	1	22	12*	—	—	—
Jethwi 1956															
Namkum plantation	—	11	—*	—	—	15*	—	1	5*	—	8	12*	—	—	—
Hesal plantation	—	10	—†	—	10	—†									
	1	11	12*	—	—	—	—	—	15*	1*	10	13*	—	—	—
Berwari plantation	—	16	15*	—	—	—	—	—	12½*	—	16	2½*	—	—	—
Aghani 1956-57															
Namkum plantation	—	22	7*	—	11	10*	—	1	11*	—	9	2*	—	—	—
Hesal plantation	2	1	6*	—	—	—	—	8	—*	—	32	14*	1	—	8*
Berwari plantation	6	28	9*	—	—	—	—	21	12*	2	16	5*	3	30	8*
Mahespur plantation	6	19	9*	—	—	—	—	23	8*	1	38	9*	3	37	8*
Katki 1956															
Namkum plantation	2	34	6½*	2	23	10*	—	10	12½*	—	—	—	—	—	—

† indicates broodlac sticks

* indicates scraped lac

III — REGIONAL FIELD RESEARCH STATIONS

The scheme for setting up regional field research stations, at Jhalda, near about Pakur, in Uttar Pradesh and in Madhya Pradesh having been sanctioned, suitable areas were searched and surveyed. A *kusum* area near Jhalda has been fixed up and about three hundred trees were surveyed and enumerated in June 1956. The Forest Department of West Bengal has now finally agreed to settle these trees to us for setting up the station at Jhalda. Other areas were also surveyed during the year. The one near Whndhamgunj was not found suitable and further areas will have to be searched for in Uttar Pradesh. Near Pakur three areas have been surveyed and if no better area is available, one from the three surveyed will be taken. A *ghont* area near Damoh in Madhya Pradesh has been surveyed and selected, and negotiations are under way with the M.P. Forest Department to have them settled to us for the field station work.

The Scientific Officer and other Senior research staff for this schemes are yet to be recruited and trained before they could be posted at various stations.

IV — TRAINING AND ADVISORY SERVICE

During the period under report there were in all 27 trainees under training in lac cultivation. Of these 8 (one each from PEPSU, U.P., Orissa and the establishment of the Lac Extension Officer and four from Bihar Forest Department) completed their training and left. One trainee from the Rehabilitation Department of Assam Government left in the middle of the course. Two from the Punjab Government Community Project Administration completed an eight months' course and were relieved in January 1957. Towards the end of the year sixteen (eight from Assam Government and 8 from U.P. Forest Deptt.) were on the roll and are continuing their course.

During the year, a scheme was prepared for training Village Level Workers of the National Extension Service through the Instructors trained at the Institute and for training special subject supervisors who are to be posted in important National Extension Service areas of the major lac growing States. Part of the scheme has been sanctioned and accordingly a training section under the Entomology Division is being organized.

Advisory Service

Help was rendered to Mr. Angalett, an American Entomologist stationed in India to rear *B. greeni* parasites in large numbers at Namkum and ship them to United States for establishing these parasites against cotton boll worms in the U.S.A.

Various Institutions and Government organizations from different parts of the country, and individuals interested in lac cultivation were given the necessary advice.

A very large number of enquiries from the Community Project and National Extension Service Administrations were received and advice on technical matters and help as far as possible in other matters were given.

A large number of lac samples and wire netting were examined and necessary advice given to the special officer for lac cultivation. In addition, technical queries were also answered for the S.O.L.C.

Publications of the Institute were sent either free of cost or at nominal price to those interested in lac cultivation.

A lac crop competition scheme on an All-India basis was drawn up to enthuse lac cultivators in a drive for increased production of lac.

Exhibits were sent on request to a large number of educational and other institutions and to exhibitions in rural and urban areas. In some exhibitions active part was taken and actual demonstrations of various improved methods of cultivation were given.

Special lectures on lac cultivation were arranged to be delivered in some of the Agricultural Schools and Exhibition Training Centres in Bihar.

RECEIPTS

	Quantity Md.	sr.	ch.	Rough weight lb.	oz.	Value Rs.	as.	ps.
Scraped lac:								
By supply of scraped lac to Chem. Sec. from Namkum plantation (*Baisakhi* 1955-56) ...	1	22	12	128	8	86	4	6
By supply of scraped lac to Chem. Sec. from Namkum plantation (*Jethwi* 1956) ...	0	8	12	17	8	17	8	0
By supply of scraped lac for use in the dept. from Namkum plantation (*Jethwi* 1956) ...	0	0	15	1	14	1	14	0
By supply of scraped lac to Chem. Sec. from Hesal plantation (*Jethwi* 1956)	1	10	13	101	10	101	10	0
By supply of scraped lac to Chem. Sec. from Berwari plantation (*Jethwi* 1956) ...	0	16	2½	32	5	32	5	0
By supply of scraped lac for use in the dept. from Namkum plantation (*Katki* 1956) ...	2	23	10	207	4	155	7	0
By supply of scraped lac to Chem. Sec. from Namkum plantation (*Aghani* 1956-57) ...	0	9	2	18	4	13	2	0
By supply of scraped lac for use in the dept. from Namkum plantation (*Aghani* 1956-57) ...	0	11	10	23	4	16	11	6
By supply of scraped lac for selling from Hesal plantation (*Aghani* 1956-57) ...	1	0	8	81	0	58	3	6
By supply of scraped lac to Chem. Sec. from Hesal plantation (*Aghani* 1956-57) ...	0	32	14	65	12	47	4	0
By supply of scraped lac for selling from Berwari plantation (*Aghani* 1956-57) ...	3	30	8	301	0	216	5	6
By supply of scraped lac to Chem. Sec. from Berwari plantation (*Aghani* 1956-57) ...	2	16	5	192	10	138	7	3
By supply of scraped lac for selling from Mahespur plantation (*Aghani* 1956-57) ...	3	37	8	315	0	226	6	6
By supply of scraped lac to Chem. Sec. from Mahespur plantation (*Aghani* 1956-57) ...	1	38	9	157	2	112	15	0
TOTAL	20	20	½	1,640	1	1,224	7	9
						= Rs. 1,224/48 N.P.		
Brood lac:								
By supply of broodlac for use in the dept. from Hesal plantation (*Jethwi* 1956)	0	10	0	20	0	36	4	0
						= Rs. 36/25 N.P.		

CHEMICAL SECTION

I. FUNDAMENTAL

1. Chemical Constitution of Shellac

(i) *Separation of aldehydic acid from* Kusmi *seedlac* — Work on the separation of the aldehydic acid was continued. *Kusmi* seedlac was hydrolysed at room temperature for 24 hours with 0·5*N* alcoholic (50%) caustic potash solution in presence of sodium sulphite. The hydrolysed product was decomposed with dilute hydrochloric acid in the presence of ether and two distinct layers were obtained. The ethereal layer was repeatedly extracted with water till free from the aldehydic acid. All the aqueous portions were taken together and the aldehydic acid separated either by direct precipitation as its 2, 4-dinitrophenyl-hydrazone or by extraction with ethyl acetate after concentration. It was found that concentration was always attended with the precipitation of a soft mass which responded to aldehyde test and did not harden even on drying for a long time. The aqueous liquor left after exhaustive extraction with ethyl acetate still contained aldehydic acid which, however, could be precipitated as its 2, 4-dinitrophenyl-hydrazone.

On replacing alcoholic (50%) caustic potash solution by an aqueous one, three layers were obtained after hydrolysis and decomposition. In between the ethereal and aqueous layers there formed another layer which appeared mainly to consist of a mixture of colouring matter, aleuritic acid and other acids.

The total amount of obtainable acid from aqueous liquor was nearly 67 per cent when alcoholic (50%) potash was the hydrolysing medium and nearly 46 per cent when aqueous potash was the hydrolysing medium.

When the aldehydic acid was directly precipitated as its hydrazone, the yield of the derivatives was within 32-39 per cent on the weight of seedlac which in terms of the aldehydic acid was 21-26 per cent. Hence it appears that a good amount of acids other than the aldehydic acid is left in the aqueous liquor.

Similar results were obtained with Angelo's dewaxed decolourized shellac and *Kusmi* shellac.

In the course of the experiments it was further observed that sodium sulphite was not at all necessary during saponification with 0·5*N* alkali for the complete isolation of the aldehydic acid.

Esterification and oxidation of extracted acid — The methyl ester of ethyl acetate-extracted acid, obtained from *Kusmi* seedlac, was a solid melting with decomposition at 105°C. while the precipitated acid, obtained during concentration of the aqueous liquor, gave both a solid methyl ester, m.p. 66-67°C. and a liquid ester. Similarly ethyl acetate-extracted acid from Angelo's shellac gave a solid ester, m.p. 66-67°C. as well as a liquid ester.

Mild oxidation of the precipitated acid with silver oxide yielded a soft acidic mass only.

Subjecting the acidic fractions as obtained from the aqueous liquor to paper partition chromatography, two to three spots could be detected in almost all cases. One of them appeared to be due to aleuritic acid.

From the observations noted so far it seems that the water-soluble acidic fraction is not a single substance but a mixture of acids. To study the constitution of this aldehydic acid, attempts are being made to get it in the pure form.

(ii) *Paper chromatography* — With a view to ascertaining the number of constituent acids present in shellac by paper chromatography, some preliminary work was undertaken. *Kusmi* seedlac, taken as the starting material, was severally hydrolysed with (I) 0·5*N* alcoholic (50%) caustic potash in presence of sodium sulphite, (II) 0·5*N* aqueous caustic

potash in presence of sodium sulphite, (III) 0·5*N* aqueous caustic potash and (IV) 5*N* aqueous caustic potash. The volume of the hydrolysed solution was diluted with water to contain 2 per cent resin and spotted on Whatman No. 1 filter paper. Very dilute hydrochloric acid was applied on the spots to liberate the shellac acids and then after drying developed by the descending technique as usual. The solvents used were (A) *n*-butanol saturated with 2*N*-ammonia solution and (B) carbonyl-free alcohol (95%): liquor ammonia (100 : 4). The dried chromatograms were sprayed with 0·04 per cent alcoholic bromocresol green indicator solution, adjusted to blue with caustic soda solution, and the shellac acids revealed as yellow spots while sodium ion as deep blue spots on pale blue background. The R_f values of the different acidic spots thus obtained are given in Table I.

TABLE I — R_f VALUES OF DIFFERENT ACIDS SEPARATED FROM HYDROLYSED SEEDLAC SOLUTIONS

Sr. No. of acid spots	Solvent A				Solvent B			
	I	II	III	IV	I	II	III	IV
1	0·09	0·09	0·10	0·09	0·15	0·14	0·15	0·14
2	0·16	0·16	0·18	0·17	0·45	0·44	0·43	0·41
3	Very faint spot	0·21	0·23	0·22	0·49	0·49	0·49	0·49
4	0·28	0·29	0·30	0·30	0·57	0·57	0·56	0·56
5	0·42	0·42	—	0·41	0·64	0·63	0·63	0·62
6	Very faint spot	Very faint spot	0·49	0·47	0·69	0·70	0·70	0·70
7	Very faint spot	Very faint spot	0·59	0·60	0·73	0·74	0·75	0·76

The spots nos. 1, 5 & 7 in A and 2 & 3, 5 & 7 in B appear to be due to aldehydic and shellolic acids, aleuritic acid and butolic acid respectively. The aldehydic and shellolic acid spots were very prominent. It has been noted that the presence of sodium salt caused interference and also retarded the R_f values (cf. *I.L.R.I. Annual Report*, 1954-55, p. 52). It has been observed further that if the spots applied on the paper are developed without decomposition with hydrochloric acid, then spot nos. 1, 2 & 3 of Table I are conspicuous by their absence. Hence removal of sodium in the solution is essential for getting correct chromatograms; further work is in progress.

2. Physico-chemical Studies

(i) *Polymolecularity of the polyesters of* 9 : 10 *Dihydroxy-hexadecane* 1 : 16-*dicarboxylic acid* — The fractionations of three polyesters of the above di-acid by adding non-solvent to a solution of polyesters, have been completed and data obtained. The solvent used for all the three polyesters, i.e. of low, medium and high degree of polymerization was acetone and fractionations were carried out by adding water as non-solvent at room temperature. The fractions separated were weighed carefully and its D.P. (=Degree of Polymerization) determined. From the data, plots were obtained as the percentage of fraction in solution against D.P. showing integral curves of fractionations. From this graph, $\frac{dG}{dD.P}$, i.e. the rate of increase of amount of material with D.P. was obtained and plotted against D.P., giving differential chain-length distribution curves. These methods were extended to each of the three polyesters of different D.P. levels. An attempt is being made to find the Number Distribution Functions from the data obtained.

(ii) *Heat polymerization of shellac* — Earlier work on the heat polymerization of shellac indicates that shellac undergoes a sort of progressive 'condensation' polymerization with evolution of water. In order to make a detailed study of this, different types of shellac were heated at 160°C., 150°C., 120°C. and 100°C. for varying periods till it polymerized; the properties of these heat-polymerized samples were then examined.

To start with, *Kusmi* shellac was heated at 160°C. and 150°C. and some of its properties tested as shown in the following table.

TABLE II — PROPERTIES OF SHELLAC HEATED AT 160°C. AND 150°C. FOR VARYING PERIODS

Kusmi *shellac heated at* 160°C. (*life under heat at* 160°C.-40 *minutes*)
(H.A.I. = Hot Alcohol Insolubles)

Time	H.A.I. %	Acid value	Sap. value
Control	0·550	69·25	220·7
20 mins.	0·558	68·87	221·2
30 mins.	0·620	66·19	221·6
40 mins.	0·616	63·45	220·0
50 mins.	could not be filtered	58·92	220·7

Kusmi *shellac heated at* 150°C. (*Life under heat at* 0°C.-58 *minutes*)

Control	0·550	69·25	220·7
30 mins.	0·560	68·93	220·4
40 mins.	0·615	67·18	220·0
50 mins.	0·610	66·73	220·8
60 mins.	0·618	65·02	221·2
70 mins.	could not be filtered	63·82	220·6

The -OH values, rates of filtration, etc., of these as well as other samples are being determined.

3. Standardization, Grading and Analysis

(i) *A rapid method for the determination of the bleach index of lac* — The possibility of reducing the time of determination of the bleach index of lac by carrying out the bleaching operation at a higher temperature (37·5±1°C.) (*I.L.R.I. Annual Report*, 1954-55) was further investigated. As many as 50 seedlac samples conforming to all possible grades and having bleach indices ranging from 56 to 154 were tested and the values obtained by allowing the bleaching to proceed for different periods of 1, 1½ and 2 hours and the actual bleach indices of the respective samples recorded.

An analysis of the differences between the observed bleach indices for the three periods of contact and the actual bleach index of the respective sample shows that the values for one hour come closest to the actual with 70 per cent agreement within the usually recognized limits of ±5 cc. accuracy. Moreover, all the observed values except four were higher than the actual bleach index. This, therefore, would suggest a constant correction to be applied to the observed values in order that they may come reasonably close to the actual.

The average (mean) difference in the values for one hour contact for all the 50 samples works out to be 3·4. As fractions are generally not recognized in the bleach index values, a constant correction of either −3 or −4 may therefore have to be applied to the observed values to obtain the actual bleach index. The modified values after applying the correction

of −3 agree well with the actual ones. Thus, in 48 out of 50, i.e. 96 per cent of the cases, the two values agree with each other within 4 cc., i.e. 1 cc. better than the recognized limit of variation for bleach index determination. In the remaining two cases also, the difference is only −6 cc. If −4 is used as the correction, agreement within 5 cc. is observed only in 46 cases. Therefore, correction of −3 is to be preferred.

In other words, when the bleaching is carried out only for one hour at 37·5±1°C., the values obtained are higher than the actual bleach index of the sample by only 3 cc. on an average. Hence bleach index determination can be carried out by conducting the bleaching operation for only one hour at 37·5±1°C. (instead of overnight bleaching at 27±2°C.) and the actual bleach index under the procedure is to be obtained from the observed values by subtracting 3, *if the original curve is used.* Alternatively, a new curve for one hour contact may also be drawn which will naturally have the same shape as, and be parallel to, the original curve and will be away from it by the equivalent of 3 cc. for any value of the colour ratio.

The two curves in semi-logarithmic scale are shown in Fig. 1. The recommended procedure for the determination of bleach index by the *new rapid* method is detailed below:

Procedure — The sample of lac is coarsely powdered so as to pass through a 10-mesh sieve and rolled on paper to ensure uniformity. This powder (37·5±0·1 gm.) and anhydrous sodium carbonate (3·7±0·1 gm.) are weighed into a 400 cc. tall beaker and mixed

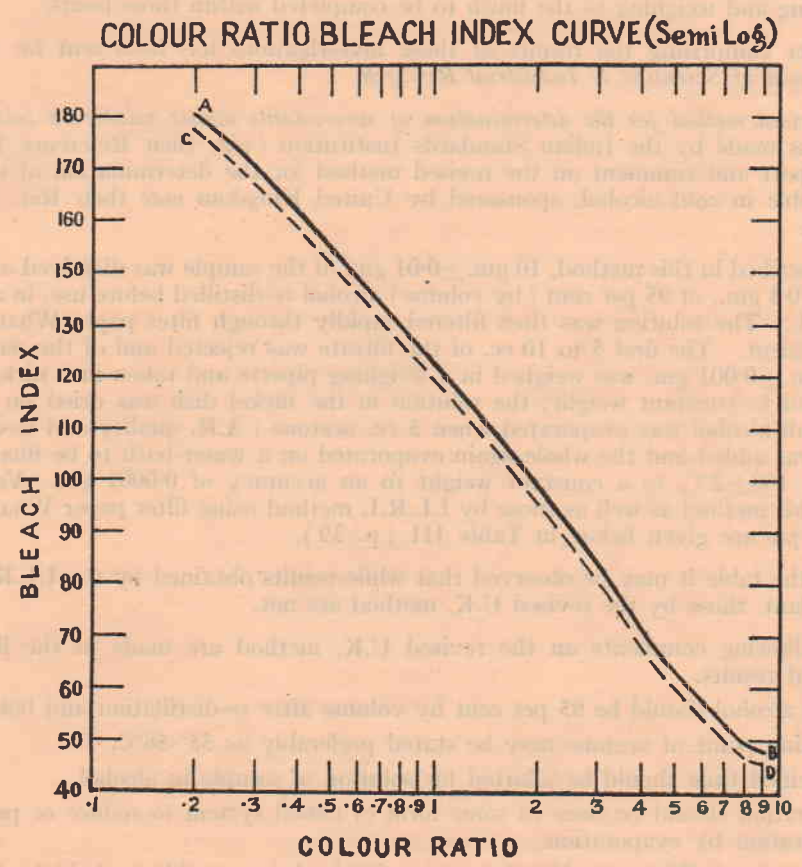

FIG. 1

with 110 cc. of hot distilled water. The beaker with its contents is then quickly transferred to a boiling water-bath. The contents of the beaker are kept stirred with a glass rod, by hand, vigorously at first till the initial frothing is over, and thereafter only occasionally. After exactly half an hour, the beaker is removed from the water-bath and 25 cc. of hot distilled water are run down the sides and well mixed. The extract is strained through a copper or brass 100-mesh wire-gauze filter into a 500 cc. graduated cylinder. The beaker and the residue are washed with hot water, taking care that the filtrate and washings together do not exceed 250 cc. This is then cooled and made up to 280 cc. with distilled water. It is then drained into a beaker and allowed to stand in a thermostat maintained at $37{\cdot}5\pm1$°C. for 10 minutes. Bleach liquor (95 cc.) having an available chlorine content of $3\pm0{\cdot}5$ per cent and preferably between temperature of 25°-30°C. is now added gradually and with stirring. The solution is thereafter stirred only occasionally. After one hour, a small portion is filtered through a dry filter paper, the first 1 or 2 cc. of the filtrate being rejected, as this is likely to be cloudy. The colour of the subsequent clear filtrate is then determined by matching against $N/1000$ iodine in potassium iodide solution in a Dubosque colorimeter. The colour-ratio is then calculated and the bleach index directly read from the colour-ratio vs. bleach index curve (Fig. 1 C, D). (This curve has been drawn by applying the correction of -3 to the curve AB which is the original bleach index vs. colour-ratio curve for use when the bleaching is allowed to proceed overnight at 27 ± 2°C.)

The above recommended procedure enables the entire bleach index determination from grinding and weighing to the finish to be completed within three hours.

A paper comprising the results of these investigations has been sent for publication in the *Journal of Scientific & Industrial Research.*

(ii) *Revised method for the determination of non-volatile matter soluble in cold alcohol* — Request was made by the Indian Standards Institution (*vide* their Reference ISO/TC 50-Lac) to report and comment on the revised method for the determination of non-volatile matter soluble in cold alcohol, sponsored by United Kingdom *vide* their Ref. ISO/TC 50 (U.K.-11).

As prescribed in this method, 10 gm.$\pm$0·01 gm. of the sample was dissolved at 20°$\pm$5°C. in 90 gm.$\pm$0·1 gm., of 95 per cent (by volume) alcohol re-distilled before use, in a stoppered conical flask. The solution was then filtered rapidly through filter paper Whatman No. 4 or its equivalent. The first 5 to 10 cc. of the filtrate was rejected and of the remainder 2·5 gm. to 3 gm.$\pm$0·001 gm. was weighed in a weighing pipette and taken in a nickel dish previously dried to constant weight; the solution in the nickel dish was dried on water-bath till nearly all alcohol was evaporated when 5 cc. acetone (A.R. quality and re-distilled before use) was added and the whole again evaporated on a water-bath to be finally dried in an oven at 100 ± 2°C. to a constant weight to an accuracy of 0·0001 gm. Values determined by this method as well as those by I.L.R.I. method using filter paper Whatman No. 1 and a bell jar are given below in Table III (p. 39).

From the table it may be observed that while results obtained by the I.L.R.I. method are concordant, those by the revised U.K. method are not.

The following comments on the revised U.K. method are made in the light of our experimental results.

1. The alcohol should be 95 per cent by volume after re-distillation and before use.
2. Boiling point of acetone may be stated preferably as 55°-56°C.
3. Specified time should be allotted for solution of sample in alcohol.
4. Filtration should be done in some form of closed system to reduce or prevent concentration by evaporation.
5. Filter paper Whatman No. 4 is not suitable, being unable to hold back lac wax, which passes through it.

TABLE III — COLD ALCOHOL-SOLUBLE NON-VOLATILE MATTER IN LAC DETERMINED BY I.L.R.I. AND U.K. METHODS

Expt. No.	Sample	% Impurities (moisture-free basis) I.L.R.I. method	% Impurities (moisture-free basis) Revised method U.K.
1.	Seedlac	I 6·508 II 6·480	I 7·850 II 7·790
2.	Seedlac	I 8·612 II 8·582	I 9·57 II 8·91
3.	Seedlac	I 19·60 II 19·36	I 19·21 II 19·37
4.	Seedlac	I 9·126 II 9·143	I 9·49 II 9·03
5.	Shellac Lemon I	I 4·580 II 4·568	I 5·55 II 6·78
6.	Shellac *Standard* T.N.	I 5·311 II 5·276	I 6·91 II 7·06
7.	Button lac	I 3·612 II 3·505	I 3·30 II 3·23
8.	Bleached lac Regular	I 4·222 II 4·229	I 5·21 II 4·99
9.	Bleached lac Regular	I 3·861 II 3·926	I (a) 4·92 (b) 4·19 II (a) 5·42 (b) 5·34
10.	Shellac	I 5·147 II 5·168	I (a) 5·03 (b) 4·87 II (a) 5·70 (b) 5·36
11.	Bleached lac Regular	I 4·063 II 4·002	I (a) 3·77 (b) 4·10 II (a) 4·81 (b) 4·72
12.	A.B.T.N.	I 3·949 II 3·920	I (a) 3·47 (b) 4·10 II (a) 3·95 (b) 3·80
13.	Shellac	I 8·205 II 8·108	I 9·604 II 8·406
14.	Shellac	I 7·426 II 7·506	I 7·842 II 7·988
15.	Bleached lac	I 4·625 II 4·438	I 4·986 II 5·178
16.	Bleached lac	I 4·088 II 4·186	I 4·488 II 4·728
17.	Bleached lac Regular	I 3·256 II 3·342	I 4·106 II 4·246

II — APPLIED

1. Varnishes, Lacquers and Paints

(i) *Ageing properties of shellac-linseed oil paints* — It is now over 9 years since the wood and steel work of the Institute buildings and staff quarters were painted with shellac-linseed oil paints; the painted surfaces indoors have not shown any sign of deterioration so far.

(ii) *Shellac-based anti-corrosive and anti-fowling paints* — After further actual sea-water immersion tests of shellac compositions supplied from the Institute, the Indian Naval Chemical and Metallurgical Laboratory, Bombay, reported that the results were not encouraging. Further work has been suspended in the face of this information.

(iii) *Shellac-rosin-glycerine varnish* — It was mentioned in the last *Annual Report* that a clear baking oil-insulating varnish based on shellac-rosin-glycerine linseed oil composition prepared in the laboratory had passed all the tests required under the B.S. specification No. 119-1930 and the corresponding Indian specification, whereas a sample from a larger batch of the same composition prepared in a commercial factory failed because of poor oil resistance. A fresh sample of the varnish prepared in the laboratory was again sent but this time it was reported that it failed to satisfy the oil resistance (clause 11 of B.S. 119) test.

(iv) *Lac*-kamala *oil combination* — As already reported (*I.L.R.I. Annual Report*, 1955-56), the monoglycerides of *kamala* oil were prepared, starting with fatty acids of the oil and glycerine. The product obtained had an acid value of about 4 and was soluble in alcohol. When heated with dewaxed shellac in different proportions, it gave a clear resinous material but the films from alcohol solutions were soft and hazy with no improvement even on baking for a few minutes.

As the lac monoglycerides of *kamala* oil combinations could not stand heating for a sufficiently long time, catalysts such as para-toluene sulphonic (P.T. sulphonic acid) acid were tried, 0·5 per cent of the catalyst having been used on the basis of the oil. Heating equal amounts of *kamala* oil monoglycerides and lac, with 0·5 per cent of the catalyst (P.T. sulphonic acid) at 180±5°C. yielded a very tacky product; the films of this material from alcohol toluene mixtures were clear, hard and wrinkled, but had a very poor water resistance. The use of P.T. sulphonic acid as catalyst enables the heating to be continued for about 2 hrs. without gellation occuring.

The very great degree of tackiness of the lac-*kamala* oil monoglycerides combination may be due to the presence of residual hydroxyl groups. In order to reduce those hydroxyls to a minimum, this product was reacted with acid such as phthalic anhydride. Using phthalic anhydride, a product with a very low hydroxyl number was obtained but the properties of the films obtained from alcohol toluene mixture were not satisfactory even though they were tack-free. It could not be treated for more than 2 hrs. as it gelled after that period.

As it was difficult to plasticize lac with *kamala* oil or fatty acids and monoglycerides, the work was discontinued.

(v) *Incorporation of lac into linseed oil* — Shellac, though incompatible with drying oils under usual varnish making conditions, dissolves in drying oils like linseed oil either at very high temperatures (360°C.) or at lower temperatures when some catalysts or incorporating agents are used. The resulting lac-linseed oil varnishes possess most of the desirable features expected of oil varnishes, but lack the full hardness; besides the gloss is transient and there is a slight but persistent tackiness. They do not thus compare very favourably with the best synthetic or natural resin oil varnishes. It is, however, possible that a

knowledge of the chemical reactions taking place during the incorporation of lac in oil at very high temperatures would point the way out of these difficulties and hence the following investigation was taken up.

Shellac (50% on the basis of oil) was dissolved in linseed oil at different temperatures to find out the most suitable temperature for incorporation without catalyst. It was found that at 360°C., shellac dissolves in linseed oil without the help of catalysts. During incorporation there was considerable foaming and frothing which shows that some reaction between lac and oil was taking place. A reddish-dark brown tacky material was obtained. The incorporation required 30-45 mins. The acid and the hydroxyl values of the combination were found to come down with increased time of heating up to 2½ hrs., after which there was a rise. The acid value and hydroxyl number after 2 hrs. were 32·33 and 3·59 respectively. The product dissolved in the usual solvents such as white spirit, benzene, toluene, turpentine, etc., and the films from the above solvents which were clear, glossy and coloured, dried very slowly with slight tackiness persisting. The films when kept in water for testing water resistance, softened in about 4 hrs., blushed in 6 hrs. and regained the original state in about 4 hrs. when dried.

With a view to reducing the acid value the above combination was reacted with calculated amounts of glycerine. Shellac (50% on the basis of oil) was dissolved in linseed oil at 360°C. and heated for 1½ hrs. and then calculated amounts of glycerine on the basis of acid value of the lac oil combination (after 1½ hrs.' heating) were added and heated at 240°C. for about 3 hrs. The acid and hydroxyl values of the combination were found to come down with increased time of heating up to 2½ hrs. after which there was a rise. Even though the hydroxyl value was found to come down, still it was much higher than the one before addition of glycerine. This may be due to unreacted glycerine left behind. The acid and the hydroxyl values after 2½ hrs.' heating following the addition of glycerine were 4·11 and 55·50 respectively. The product dissolves in benzene and toluene but with slight turbidity in white spirit and turpentine. During the reaction a pungent smelling condensate was collected which has a very high acid value. This shows that either of the reactants, i.e. shellac or linseed oil was undergoing a chemical change before combination between themselves occurs. To know which of the reactants were undergoing changes, both lac and linseed oil were heated separately. As shellac cannot be heated for a longer time alone, some inert solvents were used.

Certain high boiling solvents, e.g. tricresyl phosphate, triphenyl phosphate, triacetin, etc., can be used as inert solvents for shellac linseed oil combinations at lower temperatures (*vide I.L.R.I. Bulletin*, No. 12). A mixture of about 10 parts of linseed oil, 8 parts of solvents (triacetin) and 8 parts of shellac was heated until the solvent had evaporated and the shellac remained in solution in the linseed oil. The same experiment was repeated but this time without linseed oil, using only triacetin and lac. The acid and hydroxyl values of the samples of shellac heated in triacetin were found to come down with increased time of heating up to 2 hrs. after which there was a rise. The acid value and the hydroxyl number at 2 hrs. were 5·93 and 59·59 respectively. The product was soluble in benzene, toluene and butyl acetate but not in white spirit. The triacetin could not be removed completely by heating and had to be removed by steam distillation. Further work is in progress.

Similarly linseed oil was heated alone at 360°C. in a closed vessel. There were lots of fumes and the condensate separated into two layers, one ether-soluble and the other ether-insoluble. The ether-soluble one was yellow in colour with a very pungent odour and had high acidity. The acid values of heat-treated linseed oil were found to increase with increased time of heating up to 1½ hrs., after which it came down to a minimum of 2·6 within 5 hrs. But the hydroxyl number first came down and then increased even though the change was not appreciable. The acid value and hydroxyl number on 4 hours' heating with linseed oil, were 4·77 and 4·71 respectively. Further work is in progress.

2. Lac-Dimethylol Urea Moulding Composition

The work done on the above subject and reported in several previous annual reports was rounded off by making a comparative study of the lac-dimethylol-urea composition and the standard L-U-F (lac-urea-formaldehyde) composition, and of their moulding properties. The results are given below:

	L-U-F composition	*Lac-dimethylol urea composition*
Sp. Vol. of moulding powder	47 cc.	48 cc.
Impact strength	4·80 cmkg./cm.^{2}	4·2 cmkg./cm.^{2}
Heat resistance	82°C.	82°C.
Water absorption	0·97% (24 hrs.)	1·2% (24 hrs.)

Both the compositions were made with the same type of shellac and in both cases, jute stick dust (80-110 mesh) was used as filler. It will be seen that L-D-U composition is not superior to L-U-F in any way: the former, however, could be produced at less cost. A paper comprising all the results obtained so far is being prepared for publication.

3. Improvements in the Manufacture of Seedlac, Shellac, Bleached Lac, etc.

(i) *Shellac by alkali extraction method* — As reported earlier, shellac sheets prepared by the above process had a tolerable life and flow but an unsatisfactory colour. Further experiments were continued to improve the colour.

A Japanese patented method (*Chem. abs.*, **49**, 1955) for preparing orange shellac by dissolving seedlac in borax solution and suspending the acid-precipitated lac in a dilute solution of acetic acid and NaOCl was tried. But lac obtained by this method also had poor life and flow.

Further experiments were based on the observation that the colour of the precipitated lac varies a little with the strength of the acidic solution in which it is precipitated. Hence lac was precipitated from alkali solution by different amounts of acid and keeping the final solution (1) slightly alkaline, (2) neutral (by adding the exact amount of dilute H_2SO_4 required for Na_2CO_3 added) and (3) slightly acidic. The precipitated lac though different in colour initially, developed the same amber colour on melting. Small quantities of sodium perborate, potassium dichromate or Al-powder (which is supposed to react with erythrolaccin) were added during the process of alkali dissolution, but had no effect on the colour of the final shellac sheets.

It was noticed that if the process of alkali dissolution and final precipitation with acid were carried out in an atmosphere of CO_2, the colour of the final shellac sheet is improved being very nearly, though not exactly, the same as that of samples made by the country process.

It was noticed repeatedly that whenever the filtered solution from the acid-precipitated lac was colourless, the colour of the resulting shellac sheets was almost near to that of ordinary shellac.

One member of the reviewing committee (1956) was interested in the shellac sheets made by alkali dissolution in CO_2 medium and took samples of the same with a view to exploring its marketibility. The life and flow of this sample were reported by him to be comparable to those of shellac made by the country process.

Several lac merchants who were supplied with this type of shellac suggested the adoption of this method for the recovery of shellac from several types of lac wastes (e.g. *Patti, Molamma, Kiri*, etc.), some of which have no market and are sold at a very low price inspite of their high lac content. Amber-coloured shellac sheets made from these samples are supposed to compete favourably with garnet lac made from some of these wastes. Experiments are in progress with different types of wastes.

(ii) *Making of seedlac of low bleach index* — The work on the washing of lac with chemicals was continued. Since a mixture of caustic soda and borax gave encouraging results, mixtures containing different proportions of these were tried.

Results of experiments are given below. In each experiment 10 srs. of crushed lac were washed.

TABLE IV — WASHING OF LAC USING CHEMICALS

Quality of lac	Chemical used	Yield of seedlac		Bleach Index	Colour ratio
		Sr.	Chs.		
Fresh *Ari Rangeeni* from Ranchi	Nil	6	0	110	9·5
do	Borax: NaOH=5: 1	5	12	80	6·0
Baisakhi Phunki dry from Ranchi	Nil	7	10	111	9·5
do	Borax: NaOH=5: 1	7	6	82	7·0
Rangeeni Phunki, Ber from Ranchi	Nil	7	12	95	9·0
do	Borax: NaOH=5: 1	7	7½	77	7·0
do	NaOH (2 ch. total)	7	0	74	7·0

A further set of experiments were conducted with 1000 gms. of crushed lac, using borax and NaOH by themselves, as also admixed in various proportions. For this quantity of sticklac, 6 gms. of the mixture made up of borax 5 gms. and NaOH 1 gm. gave the best result, the yield, the bleach index and colour being respectively 715 gms., 78 and 8; these figures, when no chemicals had been used, were respectively 770, 108 and 9·5.

So the optimum proportion of the mixture of borax to caustic soda may be taken as 5 : 1. Furthermore, for 1000 gms. of crushed lac, 6 gms. of the mixture appear to be essential. It has also been observed that the natural gloss of the lac grains is not lost by the washing.

A few experiments were done with the above determined quantities of the mixture, using different qualities of sticklac. In each experiment 10 srs. of crushed lac were washed. The results are as follows:

TABLE V — WASHING OF LAC USING CHEMICALS

Quality of lac	Chemicals used	Yield of seedlac Srs.	Chs.	Bleach Index	Colour Index
(a) Fresh *Ari Rangeeni* from Ranchi	Nil	6	0	110	9·5
do	Borax — 50 gms. + NaOH — 10 gms.	5	12	80	6·0
(b) *Baisakhi Phunki* dry from Ranchi	Nil	7	10	111	9·5
do	Borax — 50 gms. + NaOH — 10 gms.	7	6	82	7·0
(c) *Rangeeni Phunki* from Ranchi	Nil	7	12	95	9·0
do	Borax — 50 gms. + NaOH — 10 gms.	7	7½	77	7·0

From the above results it may be concluded that a mixture of borax and caustic soda in the proportion 5 : 1 is quite satisfactory for all types of lac, but that the quantity of the mixture itself may have to be varied depending upon the quality of sticklac.

(iii) *Separation of sand from seedlac* — As reported earlier (*I.L.R.I. Annual Report*, 1955-56) a bigger plant had been fabricated. This was used in preparing samples of which the ash contents were determined. Results follow in Table VI.

TABLE VI — ASH CONTENT %

Sample No.	Before treatment	After treatment	Hand-picked
1	1·523	0·836	0·818
2	1·500	0·602	0·600
3	2·302	0·735	0·711

So the machine appears to be about 100 per cent efficient in removing sand from seedlac.

It was noted that while the separation of sand goes on in the machine, a vortex is formed at the centre due to the movement of the stirrer. The lighter particles (woody matters and uncrushed lac cells commonly known as *ghonghi*) accumulate in the vortex, and these can be easily removed by a sieve with a handle.

Three experiments were done and the H.A.I. (hot alcohol insolubles) contents were determined and compared with those of the controls. The samples were obtained from a commercial factory just after washing in a barrel. The results are given in Table VII.

TABLE VII — HOT ALCOHOL INSOLUBLES %

Sample No.	Before treatment	After treatment	Hand-picked
1	17·184	6·568	3·484
2	12·824	4·136	3·241
3	14·200	7·320	3·288

The difference in insoluble contents between the hand-picked and the machine-treated samples is due to the presence of some black insect bodies in the lac, which could not be separated by the machine.

Evidently this machine will be of much use to the manufacturers employing washing barrels.

(iv) *Making of shellac by autoclave* — A stainless steel steam-heated cooking pan is now being used for drying the lac from the autoclave. This has definitely helped to improve the colour of the product.

Further experiments showed that if seedlac is moistened before being put into the sieves, the time of melting is reduced, and the colour of the final product is also better.

Samples of seedlac sent by 5 firms were converted to shellac by the autoclave. The prepared shellac and *kiri* were taken away by the parties to ascertain the market reaction.

A few firms have taken sketches of the autoclave for their use. No reports regarding marketability of the products have yet been communicated to us.

(v) *Disposal of lac factory waste water* — It is known that the water which flows out from a lac factory after lac washing, putrefies within a few hours giving a very bad smell. This water contains some fine lac particles, lac wax, albuminous and nitrogenous matters, lac dye, etc. This work is being conducted to find out means of stopping putrefaction of the waste which causes public nuisance, and recovering useful materials.

TABLE VIII — TREATMENT OF LAC FACTORY WASTE WATER WITH VARIOUS CHEMICALS

	Chemicals used	Concentration of the Chemical	Remarks
1.	Nil	—	Putrefies after 24 hrs.
2.	Formaldehyde	0·01% in total volume	Putrefies after 48 hrs.
3.	Phenol	0·01% in total volume	Putrefies after 24 hrs.
4.	Lime	1% in total volume	Putrefies slightly after 96 hrs., and ppt. settles down.
5.	Bleaching powder 35% Cl.	1% in total volume	Does not putrefy.
6.	Sulphuric acid	0·1% in total volume	Does not putrefy and every thing ppts. and settles down.
7.	Oil creosote	1% in total volume	Does not putrefy but no ppt. settles.
8.	Phenyl	0·1% in total volume	Putrefies after 24 hrs.
9.	Copper sulphate	0·1% in total volume	Does not putrefy and ppt. settles down.
10.	D.D.T.	0·1% in total volume	Putrefies after 48 hrs.
11.	Gammexane	0·1% in total volume	Putrefies after 48 hrs.
12.	Common salt	1% in total volume	Putrefies after 24 hrs.
13.	Lime water	1% in total volume	Putrefies after 24 hrs.

The above results suggest sulphuric acid to be the best because of its low price and easy mixing. A few experiments were also done to find out the minimum quantity of the acid required for a certain volume of the lac washed water. From the experiments it was found that 0·1 per cent H_2SO_4 on the total volume of water is just sufficient to stop its putrefaction and complete precipitation. This result was confirmed by a few experiments wherein 100 lb. of lac washed water were treated thus: the water did not putrefy even after 10 days.

It has also been found in laboratory experiments that the lac washed water after precipitation with H_2SO_4, if decanted, can be re-used in preliminary washing of lac, though it has a red colour. This red colour is due to the water-soluble dye which may be precipitated by addition of lime water.

The problem of collecting the precipitate due to the addition of H_2SO_4 to lac washed water has been taken up, and the work is in progress.

Investigations about yield of bleached lac — There are very few data available about the yield of bleached lac obtained from shellac or seedlac. Venugopalan (*J. Indian Inst. Sci.*, **11A,** 1928, p. 21) recorded a yield varying between 93-95 per cent on the amount of lac resin from *Jallari* seedlac, which left a soda-insoluble residue of 8-10 per cent. This works out to a yield of about 85 per cent on the crude lac. Gidwani and Kamath (*Ind. Chem.*, **22,** 1946, 415) recorded a yield varying between 80-85 per cent on the weight of seedlac and recent work at this Institute confirms this finding (*I.L.R.I. Annual Report*, 1954-55, p. 77). The undissolved material during the extraction of seedlac with soda generally constitutes 3-5 per cent, thus accounting for a total of only about 90 per cent at the maximum. The yield is surprisingly low, leaving about 10 per cent of the material unaccounted for. Experiments were, therefore, undertaken to investigate the matter systematically.

In the first instance, experiments were carried out with shellac so as to eliminate the losses due to undissolved materials. The loss incurred in the process of precipitation of shellac by acid from its sodium carbonate solution was investigated as follows:

Shellac (100 gms.) was dissolved in a solution of anhydrous sodium carbonate (10 gms.) in 400 cc. water by heating in a boiling water-bath for half an hour. The solution was cooled and made to 2 litres to form a 5 per cent lac solution with ice and water so as to bring down the temperature to 20°C. The lac was precipitated with normal sulphuric acid (10 per cent excess on weight of sodium carbonate used) under efficient stirring, and the time of contact with acid varied. Precipitated lac was filtered, repeatedly washed with water till free from acid and dried.

It was found that on an average 1 per cent loss as calculated on moisture-free basis took place. Further time of contact with acid had no effect on loss.

To ascertain how much loss takes place on bleaching, shellac samples of different bleach indices were bleached. The extract was prepared in exactly the same manner as already described. After cooling down the extract to room temperature and making to 1 litre, the calculated amount of bleach liquor (from bleach index) of 3 per cent available chlorine was added in several lots, the successive additions being made only when the previous lot had been consumed. After bleaching was complete, temperature was brought down to 20°C. with the help of ice and water, and the volume made up to 2 litres. The normal acid was added 20 per cent in excess, unlike 10 per cent when lac was precipitated without bleaching to account for free alkalinity present in bleach liquor. Bleached lac was washed free of acid over Buchner-funnel and dried.

It was found that the loss incurred on bleaching is much more as compared to the loss estimated when lac is precipitated without bleaching. Also loss increases with an increase in bleach index.

In order to confirm if the loss incurred on bleaching depends upon the amount of bleach liquor added and also how much loss takes place when seedlac is bleached, a number

of further experiments were undertaken. The insolubles obtained after filtering the extract of seedlac were dried and weighed in each case and taken into account.

Following conclusions were drawn:

(1) Loss of lac incurred while bleaching depends upon amount of bleach liquor used for bleaching and goes on increasing with increasing quantity of bleach liquor used.

(2) The loss is more in the case of seedlac than in that of shellac. This is perhaps due to the presence of insect bodies associated with seedlac which do not get separated even by filtering the seedlac extract. This confirms the observation made earlier (*I.L.R.I. Annual Report*, 1950-51, p. 30).

(3) The loss in bleaching varies from 4 to 8 per cent for lack of bleach index varying from 60 to 120. Accounting for 3 to 5 per cent insolubles in seedlac, the yield of bleached lac obtainable is between 87 to 93 per cent on the weight of seedlac.

(a) In order to see the difference in yield if bleached lac when bleaching is carried out in a laboratory and on a larger scale, i.e. pilot plant scale, a number of experiments were carried out. The yield was lower by 2 to 3 per cent when bleaching was carried out on a pilot plant scale. The difference is obviously due to bad equipment and handling losses.

(b) To see if any modification in our standard process of bleaching can result in lowering the loss, a number of experiments were undertaken in which various factors, e.g. amount of sodium carbonate and water used for extraction, temperature of extraction, alkalinity of bleach liquor, effect of adding all bleach liquor at once and in lots, temperature of water used for washing bleached and precipitated lac were studied. Following observations were made:

(i) Increasing the amount of sodium carbonate beyond 10 per cent on the weight of lac results in more loss. From 7 to 10 per cent loss is nearly the same.

(ii) Using more than 300 cc. water for extraction for 100 gms. of lac results in more loss and also a darker product.

(iii) With increased temperature of extraction the loss increases. A temperature of 80°C. is recommended for extraction.

(iv) Alkalinity of bleach liquor should be kept between 0.02-0.04*N*. Increased alkalinity results in a slightly lower yield and darker product.

(v) Yield is same if bleach liquor is added in lots or all at once but the resultant product has better appearance in the former case.

(vi) If cold water is used for washing bleached and precipitated lac, a somewhat higher yield is obtained.

Our standard process for making bleached lac fulfils all the above conditions excepting temperature of extraction. However temperature up to 95°C. as used by our method does not lower the yield appreciably (up to 1 per cent only).

It is proposed to continue the investigation about yield of bleached lac by separating the hard and soft portions of the resin and studying their behaviour towards bleaching.

4. Miscellaneous Uses of Lac Including *ad hoc* Work

(i) *Cements and adhesives* — As a result of shellac exhibitions having been held in Calcutta, Bombay, Madras, Delhi and Patna in connection with the Silver Jubilee celebrations of the Indian Lac Cess Committee, a large number of enquiries were received regarding the details of

applications of shellac in several industries as cements and adhesives. Some of the applications were well known but the details of application had to be worked out and in some cases suitable compositions were found out after comparing with standard samples available in the market

(a) *Adhesive for micanite* — The composition of adhesive for micanite, reported earlier, had been found to be very satisfactory by M/S B. M. Singh & Sons of Calcutta, who are now using the adhesive for making micanites on a semi-commercial scale.

(b) *Carpenters' abrasive stones* — Several enquiries were received for a suitable composition by using which carpenters' abrasive stones could be manufactured on a cottage industry scale without the use of hydraulic press or other costly equipments.

To start with, an abrasive stone (Elephant brand) was obtained from the local market and analysed with the following results:

Resin content — 15.4 per cent

The resin was soluble in alcohol and on testing was found to be lac.

Rosin was not found.

Sp. gr. of abrasive stone (after alcohol extraction) — 2.64.

Garnet stone powder with which we have been making similar stones so far, had a sp. gr. of 3.93 and the abrasive effect was found to be less than that of the commercial sample. A sample of abrasive powder obtained by grinding a particular type of local rock (this had been supplied by Lalpur Shellac Factory) was found to have a sp. gr. of 2.58 and was found to be similar to the abrasive powder used in the commercial sample. 100 parts of this powder were mixed with 15 parts of shellac and rectangular grinding slabs were moulded with this composition in modified moulds where the pressure was applied by cored screws and nuts. The mould was heated in a sand-bath at 120°-130°C. for 20 minutes. Moulded slabs thus obtained have been found to be better than our previous samples as regards both bond strength and efficiency in abrasion. Samples supplied to some local carpenters have proved to be satisfactory and similar in performance to commercial samples available in the market.

(ii) *Dry mounting tissue papers* — The bulk of dry mounting tissue papers consumed in India, had so far been mostly imported. Recently owing partly to import restrictions and partly to rapid industrialization of the country, several enquiries were received for the details of its manufacture in India on a cottage industry scale.

Foreign-make compositions for such papers are known to contain nitrocellulose resin, shellac, rosin, etc. A standard commercial sample obtained from local market on extraction with alcohol was found to contain equal amount of resin on the weight of paper. Different concentrations of shellac solution were therefore tried and it was found that tissue papers dipped in a 20 per cent alcoholic solution on air drying retained equal amount of resin on the weight of paper. In order to bring down the manufacturing cost, different proportions of rosin were mixed with shellac and tissue papers dipped in 20 per cent solution of such mixtures were tried for fixing papers on mounts. The maximum amount of rosin that could be incorporated was found to be one-third the weight of shellac; higher amounts had adverse effect on the adhesive properties of the paper. Several samples of tissue papers dipped in a 20 per cent alcoholic solution of dewaxed shellac and dewaxed shellac-rosin mixtures have been supplied to a local photographer for trial.

(iii) *Marking ink for mica* — Enquiries were received from the Indian Standard Institution (Calcutta Branch) and the Geological Survey of India for a suitable shellac-based marking ink for mica which will stand water immersion and rough handling. Several compositions were tried and finally the following one was found suitable.

Dewaxed lac ...	... 20 gms.	A
Spirit	... 100 cc.	
Dewaxed lac ...	... 20 gms.	B
Ammonia (0.880) ...	... 25 cc.	
Water	... 100 cc.	

Equal proportions of solutions A and B were mixed in a mortar with suitable quantities of dyes and pigments to give the desired shade. This ink was found to be quick drying and yet suitable for writing with an ordinary pen. Mica flakes marked with this ink have been found to stand 24 hours' water immersion and rough handling. Samples of mica flakes marked with this ink have been sent to the above parties for trial and report.

(iv) *Polishing wooden scales* — A firm had requested to work out some method to reduce the labour cost of polishing wooden scales. They were using seedlac and some natural resin for polishing and had to give seven coats to get a satisfactory finish. So bleached lac varnishes were tried to get a satisfactory finish with minimum number of coats. The scales were very porous and so a primer coat with baratyes in 10 per cent bleached lac varnish was given and then a few coats of varnish of various strengths were given to get the required finish. Bleached lac (Regular) varnishes of different strengths were used to find out the minimum number of coats necessary to get the required finish. Four coats were necessary, with 10 per cent bleached lac solution for the primer and 30 per cent or 40 per cent bleached lac solution for the rest of the three coats to get a satisfactory result. An interior lac-oil varnish was also tried. Here also a primer coat was given as in the case of bleached lac varnish, otherwise the varnish was absorbed in the pores of the scales. All the results of the experiments were sent to the firm and their report awaited.

5. Experimental Testing Laboratory

The scheme has been in existence since 2-4-55.

During the period under report, 151 samples for 245 tests were received from 25 parties, which comprised the following:

Hot alcohol insolubles ...	... 113
Bleachability and bleach index	... 36
Rosin	... 19
Colour index ...	... 21
Orpiment	... 1
Cold alcohol insolubles ...	... 4
Life under heat ...	... 15
Flow	... 15
Wax	... 19
Ash	... 2

The results of these analyses were sent to the various parties. Although it was made clear that they were required to communicate to the Institute the test reports for those samples from commercial analysts as soon as they received ours, our request had been complied with only in the case of 17 samples for hot alcohol insolubles test. Of the 17 results received by us, 7 agreed with ours within $\pm 0{\cdot}2$ per cent while the rest differed by more than $\pm 0{\cdot}4$ per cent.

III. PROPAGANDA AND PUBLICITY

The most important activity under this head during the period under report was the comprehensive exhibition of lac and lac products organized as part of the Silver Jubilee celebration of the Indian Lac Cess Committee. This exhibition was inagurated by His

Excellency Sri R. R. Diwakar, Governor of Bihar, in the precincts of the Indian Lac Research Institute, Namkum, where it was kept open to the public for four days. Thereafter it was moved successively to Ranchi, Patna, Delhi, Bombay, Calcutta and Madras. A total of more than 60,000 visitors saw the exhibition which was very much appreciated everywhere. The general impression appeared to be that this was the most comprehensive exhibition so far organized for any one commodity in this country. Besides several members of the Indian Lac Cess Committee, many notable personalities visited the exhibition among whom were:

1. H.E. Dr. Rajendra Prasad, President of India
2. H.E. Sri Shri Prakasa, Governor of Bombay
3. Shri A. John, Governor of Madras
4. Shri V. T. Krishnamachari, Vice Chairman, Planning Commission
5. Shri M. P. Sinha, Minister of Industry, Bihar
6. Shri J. N. Panja, Minister, West Bengal
7. Justice V. Ramaswami, Chief Justice, Patna High Court
8. Justice Naqui Imam, Judge, Patna High Court
9. Dr. M. S. Randhawa, Addl. Secretary, Govt. of India
10. Dr. B. N. Uppal, President, Indian Lac Cess Committee
11. Dr. B. B. Dey, Director, Central Electric Chemical Laboratory, Karaikudi
12. Shri J. Roy, Director, Regional Handicrafts Design Centre, Bombay
13. Shri Suniti Chatterjee, Chairman West Bengal Legislative Council
14. Shri B. C. Patel, Dy. Minister, Bihar

In order to encourage handicrafts based on shellac and induce its greater utilization, a competition on an All-India basis was also held for articles received for the Exhibition. The prize winners were given an opportunity to visit the exhibitions at their nearest centres and receive the prizes in person. The Shellac Utilization Officer was in attendance at all the exhibitions and available for discussions as also for answering enquiries from interested visitors.

A neatly got up "Guide to Shellac Exhibition" with covers glazed with lac varnish was printed in four versions, English, Hindi, Bengali and Tamil and distributed free to visitors.

Consumption of lac in India — At about the time of the exhibition, an I.L.C.C. subcommittee while considering the question of holding an industry-wide conference on lac resolved that the Shellac Utilization Officer should make enquiries and submit a report about the utilization of lac in this country and the problems and difficulties of the consumers. Taking advantage of his presence at the various centres in connection with the exhibition and also by visiting nearby areas a preliminary report was prepared by him which is reproduced below. As this officer had to leave for the United Kingdom immediately after the conclusion of the exhibition, these enquiries had to be suspended at that stage.

Consumption of Lac in India — A preliminary report — It is generally agreed that the actual consumption of lac in India is only a small proportion of the quantity cultivated in the country, the rest of the produce being exported to overseas markets. Normally this would have been considered a highly satisfactory state of affairs but the peculiar circumstances of lac and the constant threat of its replacement by synthetics in individual applications have given rise to the imperative necessity for developing a substantial local consumption lest a sudden replacement in any one or more of its multifarious applications should result in a serious setback to the industry.

The consumption of lac in India has sometimes been estimated to be only about 5 per cent of our production while some would rate it as high as 15 per cent. Eight to ten per cent, however, is the generally accepted figure and is perhaps nearer the mark. It

may be pointed out, however, that these figures have not been arrived at as a result of systematic surveys but were only based on "impressions". An attempt was made in 1953-54, perhaps for the first time, by the then Shellac Utilization Officer, Sri M. Venugopalan, to collect actual figures by correspondence as well as by personal visits to important consumers. The following tentative figures were arrived at with some data yet to come.

Shellac consumption

Product or industry		Quantity consumed per year
Paints, varnishes, polishes and lacquers	...	25,500 mds.
Gramophone records	...	6,500 ,,
Sealing wax	...	500 ,,
Adhesives and Cements	...	300 ,,
Rubber mixings	...	50 ,,
Art inks	...	50 ,,
Lacquering on brass and other materials	...	1,000 ,,
Wooden turnery	...	1,000 ,,
Miscellaneous which include pyrotechnics, bangles, jewellery fittings, etc.	...	1,000 ,,
		35,900 mds.
	say	36,000 ,,

Principal uses of lac — Apart from a number of minor uses, the principal uses to which lac is put in the world today are (i) furniture and floor polish and quick drying paints (ii) the gramophone record industry (iii) the electrical industry and (iv) the felt hat industry. With our electricity industry still at its infant stage and no felt hat industry, the major consumers of lac in India are the furniture trade and the gramophone record industry. In addition substantial quantities of lac are also used in handicrafts such as lac bangles, metal enamelling, grinding wheels, wood turnery, etc.

Furniture polish — This industry perhaps is the largest consumer of lac in India. Enquiries at the principal cities of Delhi, Bombay, Calcutta and Madras have shown that the quantity of lac consumed in this industry in Delhi, Bombay and Calcutta is about 2,000 to 3,000 mds. each and at Madras about 700 mds. These figures were given by some of the wholesalers in the respective cities and require further checking up. Even so, at the lowest, the consumption of lac for this purpose is about 6,700 mds. per year and with approximately an equal amount for the rest of the country the annual consumption of lac for furniture polishing in India may be safely put at about 13,000-14,000 mds.

The actual form of lac used in these cities, is however, surprisingly different. For example in Delhi seedlac is the material generally used while in Bombay it is mostly orpimented lac, in Calcutta button lac and in Madras a locally processed form of lac known as *aval arakku* which in reality is a flattened form of seedlac, sometimes dyed a faint pink with rosin. In Patna shellac is the material mostly used.

As the time available was extremely limited only a few prominent wholesale dealers and cabinet makers could be contacted. The general impression gathered was that these were the forms traditionally used in the respective areas and the consumers are reasonably satisfied with the performance of the respective materials. Some of them were even unaware of the existence of other forms and almost none of them had heard of bleached lac.

The general complaint is that the quality of the material obtained in the local markets is not consistent. Price is not considered a serious handicap although cheaper shellac would certainly be welcome.

Regarding spirit, the chief solvent, its availability is difficult especially for the smaller polishers in the prohibition areas. Larger cabinet makers and other manufacturers get their quota under permit. Smaller consumers have, therefore, to purchase ready made "French Polish" marketed in various grades costing from Rs. 1/8 to Rs. 3 per (pint) bottle. High grade shellac is mostly used for the costlier varieties while dark coloured lac mixed with rosin and "chandus" are used for the less expensive ones.

For colourless finishes, chandus is being generally used although the cabinet makers realize it is not entirely satisfactory. Bleached lac was very much welcomed, some of the parties seeing it or even hearing of it for the first time. It appeared a good market could be created for the product through wide contacts and advertisements, and meeting regular demands.

Bangle making — Another very large consumer of lac in India possibily the largest if the local estimates are to be accepted, is the bangle making industry spread over the whole of the State of Rajasthan with Jaipur as the Capital. This city was visited and a few prominent bangle makers and large scale dealers of lac contacted. Discussions were also held with the Deputy Director of Industries (the Director was away on tour) and the Secretary of the recently formed *Rajasthan Hastha Kala Samiti* of which Shri Ram Kishore Vyas, Home Minister of the State was the Chairman. The estimated consumption of lac in the State by different persons who have been in the trade for long varied widely. One put the figure as low as 2,500 mds. whereas at an informal meeting of about a dozen dealers and bangle makers arranged by the Secretary, *Rajasthan Hastha Kala Samiti*, the general view was about 30,000-40,000 mds. The Dy. Director of Industries and the Secretary, *Rajasthan Hastha Kala Samiti* were requested and they have kindly agreed to collect and report to us more reliable statistics about shellac consumption in the industry. At any rate it was quite clear that the bangle industry is a substantial consumer of lac.

The chief difficulties complained about were: (i) the poor quality of lac often obtained (ii) admixture of lac with rosin (iii) the high price and (iv) the difficulty of obtaining "Chetons", i.e. imitation gems used in large numbers to fix on the lac bangles. Bangle makers are generally poor and are not well organized. It is understood that there is good demand for these bangles in overseas markets and a flourishing export trade can be developed if these bangles could be made less breakable.

Apart from Rajasthan other bangle making centres are Banaras and Hyderabad.

Gramophone record industry — The gramophone record industry continues to use only shellac; so far attempts by one factory in Western India to use synthetics for making conventional 76 RPM records do not appear to have met with any success and are, therefore, reported to have been discontinued.

Sealing waxes — Manufacturers of sealing wax appear to be fully aware of the superior quality imparted by shellac when used in sealing waxes. The better grades of sealing waxes produced, therefore, contain varying amounts of shellac. However the market appears to be very competitive and there are sealing waxes on the market ranging in price from Rs. 8/8 per dozen one lb. boxes to Rs. 30. While the latter grades contain substantial quantities of shellac former are entirely free from it. Cheaper shellac appears to be the only possible inducement for increased utilization of lac in this field.

Adhesives and cements — In Jaipur there is a specialized industry, namely that of gem cutting and polishing carried out on cottage industry scale. Imported artificial gems are cut and polished for which purpose grinding wheels made from shellac are used. Over five thousand men are reported to be employed in this industry and the annual consumption of shellac is estimated to be about 250 mds. Similar industries are also slowly developing at Poona and in Tiruchinapalli in Southern India. Shellac is used by

gold and silver smiths as an adhesive as well as for filling hollow jewellery. Metal turners also use shellac for fixing metalware to their lathes for turning.

Metal enamelling — Shellac is used in appreciable quantities for enamelled art metal ware. Moradabad used to be the chief centre of this industry and hence the name Moradabadi work for this enamelling. Jaipur and a few other centres in Northern India are also engaged in this industry. It was learnt that the industry is on the decline as a result of dwindling overseas demands due to poor quality products produced in recent years. Adulterated lac was complained to be the main cause for the fall in quality. At present the annual consumption was estimated at about 150-200 mds. only although in past years it was much higher. Easy availability of unadulterated good shellac will help this industry considerably.

Wood turnery — Shellac is used in wood turnery in a number of centres in India: in Rajasthan, Bihar, Madhya Pradesh, Andhra and Mysore. Channapatna in Mysore perhaps consumes the largest quantity, about 300 mds. per year. This place was visited and dealers in lac as well as artisans engaged in the industry contacted. Button lac is chiefly used and the lightest coloured unadulterated lac is preferred. They would like to use bleached lac if possible because a colourless finish is highly desired. Chief among the articles produced are stationary goods such as pen holders, pin cushions, paper weights, rulers, etc. If Government Departments could be prevailed upon to purchase products of this cottage industry, it is understood they could at least double their output thereby increasing lac consumption to that extent. Price of lac according to them is not of much consideration because very little lac goes into each article produced. Nevertheless reduction in the price of lac will be appreciated.

Improvements are desired in the lasting qualities of the shellac polish because it has been found that on storage, lacquered articles gradually lose their shine. There is also a tendency for packing material to leave a print on the lac finish when the packed articles are transported especially during summer. In short the heat resistance of the finish has to be improved. Channapatna being rather far away from the lac manufacturing centres rail transport difficulties also often cause annoyance.

Electrical industry — The amount of lac used in the electrical industry in India is very limited. Air drying insulating varnishes are generally based on shellac and there is at least one firm (in South India) which is marketing shellac-based oil baking type varnish. Its production at present is about 2,500 gallons per year with hopes of improvements. If the price of lac comes down there is hope for further improvements.

Shellac in the defence service — Only one institution, viz. the ammunition factory at Kirkee could be visited. Discussion with the Superintendent, T.D.E. Military explosives indicated that although they are also keen on using as much shellac as possible and are making every endeavour to do so, the chances of increasing the consumption of shellac in Military Explosives are not appreciably very bright. Other T.D.E. establishments will have to be contacted for ascertaining the prospects in their respective departments.

Other uses of lac — Apart from the above, shellac is also used for leather finishes mirror backing, decorating bedstead legs, gasket shellac compound, printing inks, cloth printing, etc., but the quantity used is small.

Lastly it may be pointed out that due to extreme preoccupation with the Silver Jubilee Exhibition at the Centres, only a limited number of parties could be contacted and enquiries made. For the same reason only the principal cities and one or two nearby places could be visited. Although every effort was made to obtain as much and as accurate an information as possible, the above observations are only very preliminary and further detailed enquiries will be necessary before they can be confirmed.

Besides the above activities, a number of technical enquiries concerning various aspects of utilization of lac was also attended to.

Varnishes and paints — Samples of shellac linseed oil combinations had been distributed to several varnish and paint factories and consuming organizations for the assessment of equality. But the response from these parties was not encouraging. The Dy. Director (Projects) Ministry of Defence reported that the compositions were not suitable for defence requirements.

Rgearding "Empire" cloth, all efforts to persuade a prominent manufacturer in the Bombay area failed although in the early stages they evinced interest in the project. Another electrical firm in Calcutta is making 6 in. wide cloth from shellac composition and using the product in their manufactures. The firm is trying to fabricate an equipment for making empire cloth of the usual width, viz. 36 in. Contact is being maintained with this firm. Several further enquiries were also received on this subject which were answered. The Secretary of the National Research Development Corporation visited this Institute for discussion about the manufacture of empire cloth. The present position was explained to him and full details given about the electrical and other characteristics of the varnish we had developed for the purpose. He is contacting some parties and trying to induce them to take up the manufacture.

Oil cloth — Attempts to persuade a large scale manufacturer of Bombay to use shellac composition made some headway when they promised to produce about 1,000 yds. as an experimental measure and put it into the market for studying public response to the material. But a combination of factors including a mishap among the management resulted in the upset of the whole plan. The firm is now no longer interested. The Secretary, N.R.D.C. also expressed the view that it is not worth persuing.

Adhesives and cements — (a) *Micanite varnish* — A modified shellac varnish for hard and moulding micanite supplied to a firm of electrical insulator manufacturers in Calcutta was reported as quite satisfactory for their purpose. They placed an order for five gallons of the varnish for a bulk trial which was supplied. It has now been reported that they are entirely satisfied with the product and that they would like either regular supplies of the varnish from us or information regarding the process of its manufacture. Details of the composition were supplied.

(b) *Bulb capping cement* — Modified bulb capping cements based on shellac were supplied to several firms and although the preliminary reports were encouraging, the final reports were not.

(c) *Gasket shellac cement* — A modified gasket cement based on shellac and hydrolysed lac had been supplied to the Technical Development Establishment — Ministry of Defence. This sample was reported to have been found suitable as a substitute for "Jointing compound Hermatite". Details of the composition and possible sources of its availability have been supplied.

Bleached lac — The demand for bleached lac is improving steadily although slowly. Every party to whom samples were supplied approved the quality and asked for larger supplies. The recent shellac exhibition appears to have given greater impetus and more and more enquiries are being received from all parts of the country. All these requests are being met. The samples prepared in our laboratory are now being used for furniture, for fixing Kymograph records, for polishing wooden scales, for coating on gold thread and for the coating of medicinal pills.

Details about the modified method of bleaching evolved at this Institute were provided to a few interested parties.

Inland and Foreign Exhibitions — Apart from the Silver Jubilee Celebrations the Institute also took part in a few exhibitions held in this country and sent samples and publicity literature to a few others inland and some overseas.

Monograph on lac — In connection with the publication of a monograph on lac, about one thousand abstracts bearing on the chemical literature on lac have been compiled.

Book on chemistry of lac — Final revision of the draft has been undertaken.

IV. METEOROLOGICAL REPORT 1956-57

Months and years	Mean wind speed		Mean maximum temperature	Mean minimum temperature	Mean dry bulb temp. in (°F.)	Mean humidity in %	Mean sunshine in hrs.	Total rainfall in inches	Highest maximum temp. in °F.	Lowest minimum temp. in °F.
	Miles/day	Miles/hour								
April 1956	38·43	1·61	101·53	71·80	86·60	34·53	10·60	0·10	107·0	63·0
May 1956	56·03	2·33	101·38	89·60	89·00	50·08	8·75	1·17	111·0	67·0
June 1956	79·66	3·31	88·40	73·10	80·40	74·90	3·40	7·21	95·0	71·0
July 1956	52·00	2·15	92·40	71·80	80·51	79·30	1·56	14·32	97·0	68·0
Aug. 1956	58·45	2·43	92·50	68·50	76·06	79·50	1·65	12·51	95·0	69·0
Sept. 1956	56·96	2·37	92·80	65·80	79·30	68·20	1·78	5·27	97·0	67·0
Oct. 1956	30·09	1·25	93·51	64·16	77·16	67·41	7·27	6·43	92·0	58·0
Nov. 1956	21·41	0·89	76·73	54·06	70·56	58·46	8·40	Trace	82·0	48·0
Dec. 1956	26·03	1·08	75·77	54·09	68·41	62·12	9·00	0·32	82·0	43·0
Jan. 1957	36·06	1·50	73·90	51·77	65·20	90·42	7·42	1·90	81·0	43·0
Feb. 1957	43·92	1·83	77·57	50·32	67·50	44·37	9·00	1·72	86·0	42·0
March 1957	55·97	1·80	83·90	59·60	75·30	41·89	7·87	2·08	95·0	47·0

The highest maximum temperature recorded in between the period April 1, 1956 to March 31, 1957 was 111°F. on May 5, 1956 and the lowest minimum of 42°F. on February 13, 1957, which is higher than the usual minimum temperature attained. The total rainfall amounted to 53·03 in. in course of the whole year and 39·31 in. only during the monsoon period. There was no hailstorm on any day of the year. The highest wind speed recorded for 24 hrs. was 225 miles on September 14, 1956.

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APPENDIX I

Tabulated Statement of Progress of Investigations

ENTOMOLOGICAL

Item	Year of commencement	Progress	Remarks and future work proposed
I. Research & Investigations			
1. Improving crop production on *palas* by partial defoliation			
(i) Large scale defoliation experiments	1948-49	At Kundri, it has been possible to increase the number of trees cultivated from year to year despite the extreme heat there, through large scale partial defoliation for preservation of broodlac. At present the entire area with nearly 40,000 trees has been brought under cultivation. In the 1956-57 *Baisakhi* season 16,651 trees in coupé I were infected. About 174 mds. of sticklac and 268 mds. of broodlac produced as excess were sold during the year which brought in a net profit of over Rs. 7,000 from the area.	To be continued as a demonstration of the method
	1952-53	Partial defoliation is being compared at Kundri with cultivation practices without partial defoliation and according to the villagers' method as regards their efficiency in brood preservation. The ratio of brood used to brood produced was best for defoliated trees, fair in the case of undefoliated trees and poorest for trees exploited as per villagers' method. At Namkum, however, defoliated trees did not give particularly better results than undefoliated ones.	
(ii) Residual effect of repeated partial defoliation	...	Results obtained with 100 trees defoliated for over 10 years and with 100 undefoliated trees do not indicate any adverse effects from defoliation.	A new experiment to be started from Oct. 1957
2. Economics of utilizing *palas* for *Baisakhi* crop and *ber* for *Katki* crop	1955-56	10 trees of each species were under observation and from the point of view of production, *ber* had done better than *palas*, the brood to yield ratio (scraped lac) for the two species being 1:4·14 and 1:3·28 respectively for the two crops taken together.	To be continued
3. Comparative preservation of broodlac on *ber* by partial pruning before and after infection	1955-56	Partial pruning before infection was better than partial pruning after infection from the point of view of brood preservation but unlike in the previous year, the control	To be continued

APPENDIX I (*Contd.*)

ITEM	YEAR OF COMMENCEMENT	PROGRESS	REMARKS AND FUTURE WORK PROPOSED
		appeared to be better than the two partial pruning treatments, this perhaps being attributable to very favourable season we had this year.	
4. Finding of, and trials as brood preservers, of lac hosts for *Baisakhi* crop including certain *Ficus* and *Albizzia* species and also trials of hosts similar to those found useful in Thailand	1945-46	*A. lucida, F. cunia* and *O. dalbergioides* were tried with both *palas* and *ber* broodlac. Best results were obtained with *O. dalbergioides*, the percentage of selected brood being 62·67 and 68·13 for *palas* and *ber* brood respectively. The other two species were also good as brood preservers.	To be continued
5. Determination of brood-carrying capacity of the major lac hosts	1952-53	The experiment was conducted on *palas* and *ber* in the *Baisakhi* season, and on *palas*, *ber* and *khair* in the *Katki* season. On *kusum* it was conducted in both *Jethwi* and *Aghani* seasons. The yields in general were poor except in the case of *palas* in the *Baisakhi* season.	To be discontinued and taken up later when regional field stations are set up
6. (i) Proper time of harvesting for maximizing yield	1956-57	The experiment was started only this year and infections have been carried out in October 1956.	
(ii) Determination of optimum density of larval settlement on various hosts	1953	Different brood rates for infection, i.e. usual (actual) quantity required, ½ and ⅓ of this are being compared for yield performance. The experiment during the year was conducted on *palas* and *ber* in both *Baisakhi* and *Katki* seasons. Half and one-third of the usual quantity of brood required in general seemed to give better results than the full usual quantity except in the case of *palas* in the *Baisakhi* season when the reverse was found to be true. For *ber*, half the quantity seemed to give the best results.	To be continued
7. Critical study of the effect of change of host plants on lac cultivation	1952	Alternation of *A. lucida, O. dalbergioides* and *F. cunia* in the *Baisakhi* season with *palas* and *ber* in the *Katki* season has been found satisfactory and encouraging. With *kusum* strain, however, the alternation of *pakur, khair* and *ber* in the *Aghani* season with *kusum* in the *Jethwi* season, was not found to be as good as in the case of *Rangeeni* strain.	To be continued for maintaining the continuity of the crosses
8. Determination of the most suitable pruning methods and seasons for *kusum*	1951	Four treatments, namely (i) Apical pruning with 1½ years' rest and (ii) one year's rest and (iii) surface pruning with one year's rest and (iv) six months' rest were under	To be concluded shortly

APPENDIX I (*Contd.*)

ITEM	YEAR OF COMMENCEMENT	PROGRESS	REMARKS AND FUTURE WORK PROPOSED
		investigation. Measurement of growth of shoots indicated that the main growing periods are March-April and August-September during the year and that growth was more vigorous during March-April than in August-September. Primaries and secondaries showed linear growth only in the first, 6 or 12 months. Secondaries and tertiaries usually appeared from 6 months to 1 year old primary and secondary shoots respectively. Yield data revealed that apical pruning with 1½ years' rest gave the best yields, in *Jethwi* 1955 crop while surface pruning with 6 months' rest gave best results in the *Aghani* 1956-57 season.	
9. Growing of lac hosts under crop and bush conditions	1952-53	In the *Baisakhi* season 200 *arhar* plants were infected of which only 30 survived till maturity of the crop. The ratio of brood used to yield (scraped) was 1: 2·02. In the *Katki* season 50 plants were infected but the crop suffered heavily due to enemy attack. Under bush condition, rose and *F. congesta* were infected but the larvae on rose died after settlement. On 50 plants of *F. congesta*, the crop progressed satisfactorily in the *Baisakhi* season and brood to yield ratio (scraped lac) was 1: 2·03.	To be continued
10. Collecting pests of host trees, noting their parasites and control operations against various pests	1950	The life-history of *Coptosoma ostensum* Dist. a pest of *palas* and its predator *Synia melanaria* (coccinellid) and the egg parasite *Telanomus* species were studied.	To be continued
11. Determination of the various races, strains and species of lac insects, performance, selection of good strains and cross-infection	...	Only samples continued to be collected. Work not taken up for want of staff.	Work yet to be taken up
12. Influence of various environmental conditions on the lac insect	1952-53	The effect of temperature on the life-history and development of the lac insect is being studied. Due to the refrigerators, where constant temperatures are being maintained, going out of order, observations on *Baisakhi* 1955-56, *Katki* 1956 and *Jethwi* 1956 could not be taken. In *Baisakhi* 1956-57 season none of the male and female insects survived to complete their life-cycle at controlled temperature of 25°C. and 18°C. The males, in two pots,	To be continued

APPENDIX I (*Contd.*)

Item	Year of commencement	Progress	Remarks and future work proposed
		however, completed their life-cycle in an average period of 138·8 and 151 days respectively under field conditions.	
		In *Jethwi* 1957 season only males completed their life-cycle in an average period of 47 days at controlled temperature of 25°C., while at 18°C. and field fluctuating temperature the growth was slow and the males and females are yet to complete their life-cycle.	
13. Survey of lac enemies and their parasites			
(i) Caging of lac samples	1950	In all 18 small samples were caged and no new enemy insects were encountered.	To be continued
(ii) Predators		Both *Chrysopa madestes* and *C. lacciperda* appeared in fair numbers during April-September.	
(iii) (a) Non-insect enemies: Squirrels and birds	1954	In the *Baisakhi* 1955-56 crop, assessment of damage caused by these agencies indicated that out of 3,156 twigs from 50 trees examined, 22·69 per cent showed damage by squirrels and birds. The damage on the basis of lac cell was 32·8 per cent.	
(b) Rats	1957	At the time of *Jethwi* 1957 infection, rats were recorded for the first time to be doing considerable damage to broodlac. Brood bundles of lac sticks were recovered from the rat holes in large numbers. The *phunki* lac was found to be considerably damaged. On the basis of length damaged, up to 50 to 70·05 per cent damage was noticed on the *phunki* lac.	
14. Cultural and preventive methods of control of lac enemies			
(i) Proper storage and quick disposal of lac to avoid infestation	1956-57	The effect of immediate scraping of lac not required for infection purposes, on reduction of enemy insects was assessed and it was found that the predators can be destroyed to the extent of nearly 50 per cent by this timely operation. Investigation as to the loss due to enemy insects revealed that it ranged from 0·3 per cent to 10·2 per cent.	To be continued
(ii) Infection of brood lac in wire-gauze baskets with a view to control the enemy insects	1954	Large number of enemy insects remained trapped behind in the baskets and much less emergence was noticed from the caged *phunki* lac,	To be concluded shortly

APPENDIX I (*Contd.*)

ITEM	YEAR OF COMMENCEMENT	PROGRESS	REMARKS AND FUTURE WORK PROPOSED
		indicating that emergence is more during infection. An examination of crop obtained with and without the use of wire-net baskets during infection showed that the emergence of both harmful and beneficial insects from the former was smaller.	
15. Control of enemies of lac by use of insecticides			
(i) Under field conditions	1954	*Under field conditions* — DDT dust 5 per cent and spray 0·1 and 0·3 per cent and BHC spray 0·3 per cent were used once in a week, once in three weeks and once in six weeks in *Baisakhi* crop. In the *Katki* season BHC 5 per cent dust was substituted for DDT 0·1 per cent spray. The treatments did not improve the crop yield excepting that crops comparatively free from enemies were obtained.	
(ii) Under storage	...	*Under storage conditions* — Lac sticks immediately after harvest and freshly scraped lac were dusted with 5 per cent dust and sprayed with 0·1 and 0·25 per cent spray of DDT and BHC and emergences from treated lac were noted. Both DDT and BHC treatments had some effect but BHC treatments seemed to be better than DDT under storage conditions. Also between sprays and dusts the former gave better results. All the three fumigants tried, namely CS_2, CCl_4 and E.D.C.T. mixture gave efficient control at the dosages tried in 48 hrs.' exposure period.	
16. (i) Life-history studies and developing breeding technique	1954	The breeding technique for *Apanteles tachardiae* was perfected and the generations are being continuously reared. The life-history stages and life-cycles are being studied. The breeding method for mass multiplication has been developed for *Perisierola pulveriae* and work on ecological factors has been taken up. Much progress could not be made with *Elasmus claripennis*.	To be continued
(ii) (a) Mass-breeding of *B. greeni*	1952	The mass-breeding work was continued and the natural host gave better results than the alternative hosts.	To be continued

APPENDIX I (*Contd.*)

ITEM	YEAR OF COMMENCEMENT	PROGRESS	REMARKS AND FUTURE WORK PROPOSED
(b) Large scale liberations, in the field and estimation of the effect of these liberations	1956	Two areas at Berwari and Mahespur-Sirka with *kusum* trees have been taken up and are being brought under regular cultivation for starting the work in 1957-58. *Aghani* 1956 infections were successful but the present *Jethwi* crop has not progressed well.	
II. INSTITUTE PLANTATION	...	Maintained as usual. *Palas, ber, khair* and *kusum* seeds sown to fill up gaps. *C. saltiana* raised with a view to using its pod borer as an alternative host for B. *greeni*	
III. REGIONAL FIELD STATIONS	...	Several surveys in U.P., M.P., Bihar and West Bengal were made. A *kusum* area at Jhalda and a *ghont* area at Damoh have been fixed.	
IV. TRAINING AND ADVISORY SERVICES	...	During the year, 27 trainees in all were undergoing training in lac cultivation, of whom 10 completed the course. One left in the middle and the rest are continuing. Advisory Service continued to be given to all interested.	

CHEMICAL SECTION

I. FUNDAMENTAL

1. Chemical constitution of lac

(i) Separation of aldehydic acid	1955	An aldehydic acid was separated from the water-soluble portion of hydrolysed lac (after decomposition) as 2, 4-dinitrophenyl hydrazone. Aldehydic acid was also obtained as an ethyl acetate extract which on esterification yielded a solid as well as a liquid ester. Paper chromatography of hydrolysed *Kusmi* seedlac indicates the presence in lac of aleuritic, shellolic, butolic and aldehydic acids.	To be continued

2. Physico-chemical studies

(i) Polymolecularity of the polyesters of 9: 10 dihydroxy hexadecane 1: 16 di-carboxylic acid	1955	Three polyesters of the diacid were fractionated by adding non-solvents to their solution in acetone. Degrees of polymerization as well as the differential chain-length distribution of the various fractions were determined.	To be continued
(ii) Heat Polymerization of shellac	1955	As a preliminary to the study of heat polymerization (condensation polymerization with evolution of water) shellac was heated at 150°C. and	To be continued

APPENDIX I (*Contd.*)

Item	Year of commencement	Progress	Remarks and future work proposed
		160°C. for periods varying from 20 to 70 mins., and the hot alcohol-insolubles, A.V. and S.V. of the products were determined.	
3. Standardization and grading			
(i) Rapid method for the determination of the bleach index of lac	1952	The whole process of determination has now been shortened from 24 to nearly 3 hours by carrying out bleaching at 37·5°C.±1°C. instead of at 27°C.±2°C. The old curve (bleach index *vs.* colour ratio) with a constant correction factor,3 may be used or a new appropriate one drawn and used.	
(ii) Revised U.K. method for the determination of non-volatile matters soluble in cold alcohol	1956-57	A comparative study was made of a method recently sponsored by the U.K. and the one already developed by this Institute: the U.K. method has certain deficiencies, which have been specifically pointed out.	Concluded.
II. Applied			
1. Varnishes, lacquers and paints			
(i) Ageing properties of lac-linseed oil paints	1946	Indoor wooden and iron surfaces painted over 9 years back have not so far shown any marked deterioration.	
(ii) Shellac-based anti-corrosive and anti-fouling paints	1953	Compositions developed did not prove satisfactory on sea-immersion tests.	
(iii) Shellac-rosin-glycerine varnish	1953-54	Samples prepared in the laboratory satisfied all the tests; but a large batch prepared in a factory proved rather deficient in oil-resistance.	To be continued
(iv) Lac-*kamala* oil combination	1955	Monoglycerides of *kamala* oil combined with lac to give a clear resin, of which films were not good. Use of catalysts in course of heating gave a product with poor water-resistance. Reaction with pthalic anhydride with a view to reducing -OH numbers did not result in any improvement.	Not to be continued
(v) Incorporation of lac into linseed oil	1956	Incorporation by heating at 360°C. without using catalysts or incorporating agents, but inert agents to prolong heating time is being attempted. Heating in closed vessel gave an ether-soluble and an ether-insoluble product which are under study.	To be continued

APPENDIX I (*Contd.*)

Item	Year of commencement	Progress	Remarks and future work proposed
2. Moulding composition: Lac-dimethylol urea (L.D.U.) moulding composition	1946	The work was rounded off by a comparative study of L.D.U. and lac-urea-formaldehyde (L.U.F.) moulding compositions: the L.D.U. did not prove to be superior to L.U.F.	Not to be continued.
3. Improvements in the manufacture of seedlac, shellac, bleached lac, etc.			
(i) Shellac by alkali extraction method	1953	Precipitation of alkali-dissolved lac, if carried out in an atmosphere of CO_2, gives a product with good colour, which is otherwise satisfactory too.	Concluded
(ii) Making seedlac of low bleach index	1954	A mixture of borax and soda (proportion 5:1) used in washing, greatly improves the colour of the product. Actual quantity of mixture to be used depends on the type of sticklac.	
(iii) Separation of sand from seedlac	1955	A somewhat big plant fabricated and tried for the purpose proved completely satisfactory.	
(iv) Making of shellac by autoclave	1950	Use of a stainless steel (steam-heated) cooking pan greatly improves the colour of shellac. Moistening of seedlac before being put into sieves shortens the melting period, as also results in a better colour of the final product.	
(v) Disposal of lac factory waste water	1956-57	The waste water treated with H_2SO_4 (0·1 per cent on the wt. of water) does not putrefy even on 10 days' standing.	
(vi) Yield of bleached lac	1955	Shellac dissolved in alkali and precipitated back with acid shows 1 per cent loss in wt. on moisture-free basis. Soda-insoluble portion in seedlac amounts to 3-5 per cent. The yield of bleached lac on the wt. of seedlac is 87 to 93 per cent, hence considerable loss occurs during bleaching. Conditions affecting the yield were studied and specified for adoption in actual bleaching to reduce loss.	May be continued
4. Miscellaneous uses of lac including *ad hoc* work			
(i) Cements and adhesives			
(a) Adhesive for micanite	1955	Composition for micanite developed already reported to be satisfactory.	
(b) Carpenters' abrasive stones	1956	Successfully formulated using a local rock instead of garnet stone, used in previous formulation.	

APPENDIX I (*Contd.*)

Item	Year of commencement	Progress	Remarks and future work proposed
(ii) Dry mounting tissue papers	1956-57	Satisfactory results obtained by dipping the paper in a 20 per cent alcoholic solution of shellac and rosin (proportion 3:1).	
(iii) Marking ink for mica	1956-57	A composition suitable for applying with a pen formulated.	
(iv) Polishing wooden scales	1956-57	Using a primer coat with barytes in 10 per cent bleached lac spirit varnish, followed by 3 coats of 30 to 40 per cent bleached lac spirit varnish gives satisfactory results. A lac-oil varnish, preceded by a primer coat as in the case of bleached lac solution also ensures good results. A manufacturing firm had been using 7 coats of seedlac spirit solution.	
5. Experimental testing laboratory scheme	1955	245 tests on 151 samples received from 25 parties were carried out.	
III. Propaganda and publicity	...	Carried out by S.U.O. on usual lines. A report on lac consumption in India compiled, and a number of exhibitions held. Contacts with actual and potential consumers of lac maintained.	

APPENDIX II

Papers and pamphlets published during 1956-57

1. Annual Report of the Indian Lac Research Institute (1954-55).
2. Bulletin No. 88 — Annotated list of some of the insect pests of host trees of lac and the control, by B. P. Mehra.
3. Note on the use of photo-electric colorimeter in the determination of bleach index of lac (*J. sci. & indus. Res.*, Vol. **15B**, No. 7), by B. B. Khanna & Y. Sankaranarayanan.
4. Bulletin No. 89 — Method of manufacturing seedlac of improved quality: Part I — Use of alkaline reagents, by A. K. Ghosh & T. Bhowmik.
5. Bulletin No. 86 — Note on the polyesterification of polyhydroxy-polybasic acid: Part III — Solution characteristics, precipitability and solubility (*J. sci. & indus. Res.*, 1956, Vol. **14B**, No. 9).
6. Guide to exhibition of lac and lac products (in English, Hindi, Bengali and Tamil).
7. Uses of shellac in adhesives (*Composite Wood*, Vol. **3**, Nos. 5 & 6, 1956), by M. Venugopalan.
8. Note on the intrinsic viscosity and degree of polymerization of the polyesters of 9:10 dihydroxy hexadecane — 1:16 dicarboxylic acid, (*J. sci. & indus. Res.*, Vol. **15B**, No. 12), by P. R. Bhattacharya.
9. Notes on breeding technique and life-history of *Apanteles tachardiae*, Cam. an endoparasite of lac predator, *Holcocera pulverea*, Meyr. (*Proc. Ind. Sci. Congress Assn.*, 1957), by N. S. Chauhan & S. Krishnaswami.

APPENDIX III

Statistics of sticklac production in India during 1956-57 (in maunds)

Year	*Baisakhi*	*Jethwi*	*Katki*	*Aghani*	*Total*
1956-57	6,83,000	17,000	4,50,000	64,000	12,14,000
1955-56	8,13,000	41,000	2,93,000	61,000	12,08,000
1954-55	6,00,000	45,500	2,29,000	1,58,000	10,33,000

APPENDIX IV

Appointments, resignations, etc. of staff in I.L.R.I.

1. Shri M. Venugopalan, M.Sc., Shellac Utilization Officer, proceeded on leave preparatory to retirement, on 16-6-56. He retired finally on 15-12-56
2. David Toppo, Daftry, retired on superannuation on 1-7-56

The following promotions were given during the period:

1. Dr. S. Krishnaswami, Biologist (Temporary), promoted as Entomologist *vice* Shri P. S. Negi, retired with effect from 16-3-56
2. Shri Y. Sankaranarayanan, Scientific Officer (Chemical Section), as Shellac Utilization Officer with effect from 13-8-56 *vice* Shri M. Venugopalan, retired
3. Shri K. C. Chatterji, Fieldman, as Junior Research Assistant, on 16-8-56
4. Shri M. K. Choudhury, Fieldman, as Junior Research Assistant, on 16-8-56
5. Shri Monoranjan Sen, Fieldman, as Junior Research Assistant, on 17-8-56
6. Shri S. K. Deogharia, Laboratory Assistant, as Museum Assistant *cum* Insect Setter, on 12-6-56
7. Martin Beck, Peon, as Daftry, on 1-7-56

The following appointments were made during the period:

1. Shri P. S. B. R. James, M.Sc., as Research Assistant (Entomological Section), on 31-12-56
2. Shri V. B. Venkatakrishnan, B.Sc., as Analyst, on 11-4-56
3. Shri. N. Mazumdar, B.Sc., as Junior Research Assistant (Entomological Section), on 18-8-56
4. Shri Amal Banerji, B.Sc., as Exhibition Assistant, on 18-8-56
5. Shri Parimal Sen, B.Sc., as Junior Research Assistant (Entomological Section), on 20-9-56
6. Shri B. B. Banerji, as Fieldman (Entomological Section), 28-6-56
7. Shri Elias Tirkey, as Fieldman (Entomological Section), on 26-6-56
8. Shri S. N. Sharma, as Fieldman, on 1-7-56
9. Kumari Chitra Hazra, as Laboratory Assistant (Chemical Section), on 18-6-56
10. Shri Bhikha Oraon, as Junior Clerk, on 1-6-56
11. Shri Alois Lakra, as Laboratory Assistant, on 1-3-57
12. Shri Md. Ali Ansari, as Laboratory Assistant, on 1-3-57

13. Shri N. Lakra, as Laboratory Assistant, on 1-3-57
14. Shri Sant Kumar, as Fieldman, on 1-3-57
15. Shri U. P. Choudhury, as Fieldman, on 1-3-57
16. Shri Nityananda Biswas, as Junior Clerk, on 20-3-57

The following members resigned their posts during the year:

1. Shri R. P. Dubey, B.Sc., Exhibition Assistant, on 14-7-56
2. Shri G. Patra, Research Assistant (Chemical Section), on 15-9-56
3. Shri V. S. Gupta, Research Assistant (Chemical Section), on 30-6-56
4. Shri V. B. Venkatakrishnan, Analyst, on 18-12-56
5. Shri Badal Chandra Lahiri, Junior Research Assistant (Entomological Section), on 21-10-56

The following temporary appointments, followed by discharge, were made. In one case, (3) the person discharged was re-appointed.

1. Shri Samuel Sangha, Turner (in a leave vacancy), appointed on 29-6-56 and discharged on 28-8-56
2. Shri Chinmoy Sen Gupta, Laboratory Attendant (in a leave vacancy), appointed on 16-3-56 and discharged on 29-5-56
3. Gandur Singh, Peon (in a leave vacancy), appointed on 20-3-56 and discharged on 20-6-56 and re-appointed on 1-7-56.

PRINTED AT THE CATHOLIC PRESS, RANCHI, INDIA