INDIAN LAC RESEARCH INSTITUTE

NAMKUM, RANCHI, BIHAR, INDIA

ANNUAL REPORT

FOR THE FINANCIAL YEAR 1950-51

1952

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ANNUAL REPORT FOR THE YEAR 1950-51

ADMINISTRATIVE SECTION

General — The Institute pursued its research and other activities under the general guidance and supervision of its Director, Dr. P. K. Bose. He had been out to Thailand on a three-week deputation during May-June 1950 to study the conditions of lac cultivation and trade in that country. Mr. M. Venugopalan, Scientific Officer, Chemical Section, held charge of the Institute during the Director's absence.

The supply position in respect of chemicals improved during the period; but procurement of apparatus and machinery continued to be difficult. One or two items of special apparatus, on order for over four years, could be procured during the year.

As usual, a large number of persons from various walks of life visited the Institute during the period. A few of these, deserving special mention, are named below:

1. His Excellency Shri M. S. Aney, Governor of Bihar
2. Hon'ble Shri Thirumala Rao, Deputy Minister, Food & Agriculture, Government of India
3. Hon'ble Shri Jaglal Chowdhury, Minister, Bihar
4. Dr. H. C. Yin, Field Scientific Officer, UNESCO, New Delhi
5. Shri S. C. Lall, Secretary, Legislative Department, Bihar
6. Mr. S. C. Downhem of Messrs W. F. Rhodes & Co., London
7. Dr. E. Ivanov, Central Cotton Research Institute, Tasscent, Uzbek S.S.R.
8. Dr. I. Evstropov, Academy of Science, Institute of Zoology, Baku, Azerbaijan S.S.R.
9. Dr. I. Trouschcovsky, Faculty of Biology, Moscow University

The last three visitors from Russia were Russian delegates to the International Locust Conference held in India.

Following a directive of the Central Government, the Institute celebrated the *Vana-mahotsava* festival on 4th July 1950. His Excellency the Governor of Bihar graced the occasion with his presence, and, to symbolize his interest in lac, planted a lac host (*kusum*) in the Institute's plantation. The staff also co-operated in the celebration by planting seedlings in the premises of their respective quarters.

Roads and Buildings — No new construction was undertaken during the year. The work of constructing the proposed trainees' hostel and staff quarters has not yet commenced. Presumably, the plans submitted by the Central P.W.D. are still being considered by the Government of India.

The pilot-plant shed in the factory premises, in a bad state of repair for some time past, was reconstructed during the year by the Central P.W.D. Annual whitewashing and minor petty repairs, as usual, were carried out under departmental supervision. Roads were given minor surface dressing here and there.

Water Supply — The break down during the year of the river-bed pump of the Institute waterworks, resulting in a partial stoppage of water supply for over a week to the laboratories and the staff quarters, called for a thorough examination of the existing system of the waterworks, which were installed some 25 years back. A report submitted

by the Director on the subject was considered by the Committee which directed that the whole matter should be examined by the Public Health Department of Bihar. As a result, the waterworks were inspected by the Chief Engineer and the Executive Engineer (Ranchi) of the Public Health Department. A preliminary report is now under consideration by the Government of India.

Library — British and American journals are being procured respectively through the High Commissioner, London, and India Supply Mission, Washington. Procurement of German journals, which does not come within the purview of the new system, was proving difficult. But very recently, after a series of protracted enquiries, orders for these journals have been placed with an Anglo-German firm in London, and supply of current numbers together with available back numbers may be expected any moment.

93 volumes of books and bound journals were accessioned during the period. During all these months and also for several months before, the library functioned under a great handicap, inasmuch as ever since the retirement of Shri S. N. Sahay in December 1949, the Institute has been without a librarian. No recruitment could be made to fill the vacancy, firstly, because of delay in settling the scale of pay for the post, and secondly, because of the restriction that all recruitment has to be done through the local Employment Exchange (E.E.). However, the E.E. having failed to send up suitable candidates for the post, the post was advertised, but the response was poor. It is hoped, however, that a new librarian may be recruited in the near future.

It may be mentioned that in the absence of the librarian, Shri B. Mukhopadhyay, Director's Technical Assistant, who happens to be a trained librarian also, has been looking after the library, in addition to performing his normal duties.

Medical Aid to Staff — In view of the mounting expenses under this head, particularly after the extension of the benefit of free medical aid to the families of staff, a new and economical scheme for administering medical aid to the staff was drawn up and put into operation from October 1950. Under this new arrangement, a physician has been appointed who visits the Institute once every day, and a dispensary has been opened in the premises of the Staff Club. A compounder has also been appointed for serving prescriptions.

Intensive Demonstration Scheme — Work on the demonstration of improved methods of lac cultivation was continued as before in the three States of Bihar, West Bengal and U.P. During the year, Madhya Pradesh joined the scheme for the first time on the same terms and conditions as applying to other States. A field station was opened in West Bengal during the period.

Further, with a view to improving the working of the scheme in Bihar, the demonstration staff in the State has been enlarged by the addition of two Lac Inspectors whose duties include supervision and co-ordination of the work of the Supervisors and Demonstrators in the State. One of the two Inspectors completed his period of 6 months' training towards the close of the year. The office of the Inspector is, for the time being, located in the Entomological Section of the Institute, although extreme congestion in the Section calls for urgent transfer of the Inspector's office elsewhere.

For further details, reference may be made to the report under the Entomological Section.

Extension of Lac Cultivation Scheme — Work was carried on under the scheme; reference may be made to the report of the Entomological Section for details.

Staff — The following appointments were made during the period:

1. Dr. A. P. Kapur, M.Sc., Ph.D., Entomologist, on 16-1-51
2. Shri N. K. Roy, M.Sc., Research Assistant (Chemical Section), on 22-4-50
3. Shri B. P. Mehra, M.Sc., Research Assistant (Entomological Section), on 3-6-50
4. Shri M. Goswami, B.Sc., Junior Research Assistant (Chemical Section), on 19-4-50

5. Shri M. K. Chowdhury, Museum Assistant & Insect-setter (Entomological Section), on 18-8-50
6. Shri H. N. Biswas, Junior Clerk (in a leave vacancy), on 1-9-50
7. Shri E. Heber, Artist and Photographer, re-appointed after superannuation on 1-7-50
8. Shri S. C. Dass, Instrument Maker, re-appointed after superannuation on 16-3-51
9. Shri Ban Singh, Tindal, on 24-1-51

There was just one case of resignation, namely by Shri M. Goswami, B.Sc., Junior Research Assistant, with effect from 1-7-51. Shri E. Heber and Shri S. C. Dass, who had retired from the services of the Committee on 30-6-50 and 15-3-51 respectively on their attainment of the age of superannuation, were re-appointed on dates as given above.

It is noted with deep regret that Durga Lohar, Tindal, who had been in the employ of the Institute since 1938, expired on 21-11-50.

Training — Altogether 29 persons were under training during the period, 28 receiving training in the improved methods of lac cultivation and 1 in the industrial uses of lac. Of these, 7 trainees completed their course on lac cultivation and took charge of demonstration centres in various States. The trainee taking his course in the industrial uses of lac left after three months, before completing his full course.

For further details, the report of the Entomological Section may be consulted.

The Staff Club — The Staff Club maintained its usual activities during the year. In view of the growing financial difficulties of the Club, the Lac Cess Committee agreed to increase its annual grant to the Club from Rs. 600/- to Rs. 900/-. Towards the close of the financial year, however, a directive came for the grant to be reduced to the previous years' figure of Rs. 600/-. The question of finally revising the grant was being mooted at the time of preparing this report.

ENTOMOLOGICAL SECTION

(Dr. A. P. Kapur, Entomologist)

1. INTRODUCTION

The permanent Entomologist, Dr. A. P. Kapur, took over from the Acting Entomologist, Shri P. S. Negi, on the 16th January 1951, the latter reverting to his substantive appointment as Scientific Officer, Entomology Section, from the said date. The posts of a Research Assistant and a Museum Assistant and Insect-setter were filled up in June and August respectively. The Artist and Photographer, who had retired in June, was re-employed for a term of three years from July. A newly sanctioned post of an Assistant (Arboriculturist) for the Institute's plantation remained vacant during the period under report.

As lac cultivation in the Institute's plantation has been suspended, the want of suitable field stations has been keenly felt.

The Section, which had already been suffering from lack of adequate accommodation, was further congested by the housing of the Bihar Lac Inspector's office in one of its rooms. Attempts are being made to find alternative accommodation for the Lac Inspector's office.

A programme of research has been drawn up following the suggestions of the Inspectors (1949) and in consultation with the two entomologist members of the Committee, namely Dr. E. S. Narayanan, Head of the Division of Entomology, Indian Agricultural Research Institute, New Delhi, and Dr. M. L. Roonwal, Forest Entomologist, Forest Research Institute, Dehra Dun. Their help is gratefully acknowledged. The proposed programme together with the staff and other requirements for its implementation will be separately submitted to the Committee.

2. RESEARCH AND INVESTIGATIONS

(a) LAC CULTIVATION

(i) *Preservation of* Baisakhi *Broodlac by Artificial Partial Defoliation of* Palas (Butea monosperma) — The importance of preserving broodlac from the summer crop (*Baisakhi*: October-July) against the effect of heat on such hosts as shed their leaves during the hot weather cannot be over-emphasized. Results of earlier experiments had indicated that the method of artificially defoliating a proportion of the infectable branches of *palas*, prior to infection, helps in preserving the broodlac and is also economical. Demonstration of this method on a large scale as well as the cultivation of lac by coupé system is being carried out in the *palas* Reserve Forest at Kundri, Palamau Division, Bihar, by the Forest Department under the technical guidance of this Institute. An all-round progress of the work was maintained during the year under report. In October 1949, 4,730 *palas* in coupé III (alternate *Baisakhi*) were infected after partial defoliation, and the resulting crop gave 126 mds. 23 srs. of broodlac plus a substantial quantity of broodlac left on trees for self-infection. The broodlac reaped was used to infect 2,425 trees in coupé II for growing the *Katki* 1950 crop which gave 36 mds. 35 srs. of broodlac. The alternate *Baisakhi* coupé I was infected in October 1950 and the standing crop is very satisfactory. Henceforth, if properly managed, Kundri could be expected to yield sustained supplies of broodlac and sticklac crops. The *Katki* crop was, in general, poor in Chotanagpur, and in the north-western part of Palamau, where Kundri is situated, there was little standing crop outside the experimental area.

(ii) *Preservation of* Baisakhi *Broodlac by Employing Suitable Hosts* — Certain lac hosts that bear *Baisakhi* crop but do not completely shed their leaves during the hot weather were tried with a view to determining their brood-preserving capacity and the quality of lac they yield. At present, owing to the lack of field research stations, only a limited number of trees of a few such species of hosts are being kept under observation. *Baisakhi* broodlac survived under Namkum conditions on *Albizzia lucida* (normally grown in Assam) and

TABLE I — RESULTS OF SHOOT STUDY FROM JAN

Tree No.	Date of pruning (P) or cropping (C)	Primaries			Secondaries			Tertiaries			S
		Buds sprouted and developed into shoots, %	No. of shoots	Length (inches), average	Buds sprouted and developed into shoots, %	No. of shoots	Length (inches), average	Buds sprouted and developed into shoots, %	No. of shoots	Length (inches), average	Buds sprouted and developed into shoots, %
1	2	3	4	5	6	7	8	9	10	11	12
											Treatment I (Control) — 18 Mon
14	28-1-49 (C)	50·0	5	4·6 (2·75-8·0)	60·0	6	4·3 (0·25-8·75)	31·2	5	5·1 (2·0-9·5)	90·9
124	25-6-49 (C)	100·0	12	3·9 (0·5-21·0)	60·7	17	6·3 (0·25-21·5)	7·6	3	3·3 (1·0-5·5)	No
134	17-1-50 (C)	50·0	5	4·4 (1·0-9·0)	100·0	2	1·25 (1·0-1·5)		No tertiaries		No
180	23-6-50 (P)	*	6	5·6 (1·0-11·5)	*	2	1·25 (1·0-5·0)		No tertiaries		
Average				4·44			5·23			4·42	
											Treatment II — 12 Months'
36	23-6-49 (C)	36·8	7	6·0 (0·75-18·0)	100·0	9	11·4 (1·0-18·0)		No tertiaries		
114	17-1-50 (C)	45·0	9	3·4 (0·75-9·0)	100·0	4	1·06 (0·5-3·25)		No tertiaries		
161	29-6-50 (C)	44·4	12	5·2 (0·25-16·75)	81·8	18	2·72 (0·25-6·25)		No tertiaries		
Average				4·42			5·02				
											Treatment III — 12 Months'
42	24-6-49 (C)	75·0	12	6·4 (0·5-25·0)	30·0	6	5·12 (0·5-21·0)	10 buds appeared but no shoot developed from th			
128	18-1-50 (C)	80·0	4	4·25 (1·25-6·5)	62·5	5	1·1 (0·25-2·25)	100·0	1	1·0	
190	10-7-50 (P)	100·0	2	6·0 (5·0-7·0)	No secondaries						
Average				5·82			3·29				
											Treatment IV — 6 Months' I
70	14-1-50 (C)	100·0	4	4·6 (1·5-9·5)	100·0	1	2·0		No tertiaries		
214	10-7-50 (P)	59·6	4	2·0 (1·25-2·75)	100·0	1	1·0		No tertiaries		
Average				3·3			1·5				

ARY-FEBRUARY 1950 TO JANUARY-FEBRUARY 1951

b-tertiaries		Sub-sub-tertiaries			Remarks about various types of damage to shoots	Remarks about lac settlement and encrustation
No. of shoots	Length (inches), average	Buds sprouted and developed into shoots, %	No. of shoots	Length (inches), average		
13	14	15	16	17	18	19
ıs' Interval 'Apical' Pruning						
10	2·6 (0·5-4·0)	50·0	2	0·5 (0·5-0·5)	Primaries — Accidental breakage of shoots and natural drying. Secondaries — Tip damage by insects. Breakage due to wind and natural drying. Tertiaries — Tip damage due to breakage. Sub-Tertiaries — Natural drying of tip.	Only 1 *palas* encrustation comprising 2 to 3 cells. Only 1 secondary has good encrustation of the upper half of the shoot. Only 2 tertiaries have poor encrustation of 2 dozen scattered cells. Only 1 sub-tertiary has good encrustation. Cropped in Feb. 1951.
ıub-tertiaries					Primaries — Natural drying of tips and broken tip. Secondaries — Natural drying of tips and broken tip. Tertiaries — Broken tip due to wind.	Infected in Feb. 1951. Very good settlement on primaries excepting P1, which is 2½" in girth. Only 9 secondaries have very good settlement.
ıub-tertiaries		Original main branch under observation did not 'respond' to pruning, hence another branch with primaries, etc., was selected. Therefore, no figures could be given for the number of buds that appeared on primaries and secondaries.			Primaries — Insect damage and broken tip. Secondaries — Tip damaged by insects. Primaries — Not noted. Secondaries — Broken shoot by wind.	
ıterval 'Apical' Pruning						
					Primaries — Mainly drying and tip damage by wind. Secondaries — Mainly drying. Primaries — Tip damage by wind and drying. Secondaries — Arrested growth. Primaries — Shoot damage by insect and accidental breakage. Secondaries — Tip damage by wind and tip drying.	No encrustation on primaries practically. 50 per cent of secondaries have partial encrustation. Cropped in Feb. 1951. Infected in Feb. 1951. All primaries are settled with lac as well as all secondaries.
ıterval 'Surface' Pruning						
ım.					Primaries — Tip drying and insect damage. Secondaries — Drying and arrested growth.	Encrustation on 5 primaries — scattered and in patches with healthy and undeveloped and dead cells. Encrustation on only 3 secondaries with individual scattered cells. Cropped in Feb. 1951.
					Primaries — Broken tip due to wind, drying up of shoots, insect damage. Secondaries — Shoot drying. Accidental breakage and insect damage. No damage.	Partial settlement on 3 primaries. No settlement on secondaries. Infected in Feb. 1951.
terval 'Surface' Pruning						
					Primaries — Tip drying. Secondaries — Tip drying.	One primary has partial encrustation at the upper 3" and another has good encrustation but not complete and throughout. One secondary has very few cells near the base. Cropped in Feb. 1951.
					Primaries — Coccid attack, shoot damage by wind and buffaloes. Secondaries — No damage.	All 4 primaries have settlement complete and throughout. Infected in Feb. 1951.

Ougeinia dalbergioides (in Bihar generally found in hilly tracts) without any artificial treatment. The results are as follows:

Albizzia lucida — 13 trees

Ratio of broodlac used to yield of broodlac = 1: 1·8
Ratio of scraped lac from brood used to yield of scraped lac = 1: 4·0

Ougeinia dalbergioides — 52 trees

Ratio of broodlac used to yield of broodlac = 1: 1·4
Ratio of scraped lac from brood used to yield of scraped lac = 1: 2·4

The results from *A. lucida* were better than those from *O. dalbergioides*; the former had better foliage also. These trees do not stand cutting of the thick branches and since the latter also get infected and sustain lac on them, it becomes necessary to cut them at the time of cropping. Means to infect only thinner branches must be found if a continued use of these species is to be made for broodlac cultivation.

Critical observations on the above-mentioned lines are in progress for *barh* (*Ficus bengalensis*), *dumber* (*F. glomerata*) and *siris* (*Albizzia lebbek*) at Kundri Reserve Forest, and detailed crop results would be reported after the harvest. The crop seemed to be promising on *barh* and *siris*.

(b) Pruning: Determination of Most Suitable Pruning Methods for *Kusum* at Hesal

As stated in the earlier Reports (1947 onwards) the main object of this study is to evolve a pruning method by which suitable shoots for cultivating lac on them would be produced in the shortest possible time. Normally shoots resulting from apical pruning are infected after an interval of 18 months. In one of the treatments tried in the experiment, this interval has been reduced to 12 months. Another kind of pruning, called ' surface ' pruning (*Annual Report*, 1947-48), was evolved to see if suitable number and quality of branches could be obtained at shorter intervals of 12 and 6 months.

(i) *Shoot Study : Growth* — Observations on the growth of shoots produced as a result of the above-mentioned four treatments were taken at regular intervals and the data are given in Table I.

Since, during January-February there is little growth of shoots on *kusum*, the data given are also for the period January-February 1950–January-February 1951.

It will be seen that the ' primaries ' (first shoots sprouting from the main branch) in the first three treatments had nearly the same average rate of growth, but in the fourth treatment, i.e. surface pruning at 6 months' interval, their growth was distinctly poorer ; growth of primaries is relatively better in the case of treatment III (12 months: surface pruning) than in the case of treatment II (12 months: apical pruning). As regards the secondary shoots, however, apical pruning with 18 and 12 months' intervals was superior to surface pruning at 12 or 6 months' intervals.

(ii) *Yield of Lac Crop from Apically and Surface Pruned Trees* — The ratio of broodlac used to yield of lac (based on the weight of scraped lac in either case) obtained in the case of the above-mentioned four treatments was as follows:

TABLE II — YIELD OF CROP ON *KUSUM* AT HESAL

Treatments		*Jethwi* crop		*Aghani* crop	
No.	Age of shoots in months and type of pruning	No. of trees	Ratio of broodlac used to yield (scraped to scraped)	No. of trees	Ratio of broodlac used to yield of brood (scraped to scraped)
I	18 months: apical	22	1: 0·07	2	1: 1·20
II	12 ,, ,,	21	1: 0·22	2	1: 1·10
III	12 ,, surface	18	1: 0·31	4	1: 0·51
IV	6 ,, ,,	19	1: 0·21	5	1: 0·63

Owing to the non-availability of broodlac in July 1950, only a few trees could be infected for the *Aghani* crop. The results obtained are inconclusive and in order to avoid any future risk of the experiment suffering from scarcity of broodlac, this part of the experiment was modified as follows in February last. In each of the 12 coupés 4 trees of as nearly equal size as possible under field conditions were selected for critical estimate of the crop results. The broodlac used for infection of these trees was also equitably distributed on the basis of infectable branches on each tree. The 48 trees thus selected would continue to have the same treatment as the other trees in each coupé, namely apical pruning at 1½ years' interval, apical pruning at one year's interval, surface pruning at one year's interval and surface pruning at 6 months' interval.

(c) Pests of Host Trees

(i) *Tessaratoma javanica Thunberg* (*Rhynchota : Pentatomidae*) — This large-sized (26-28 mm. long and 15-16 mm. wide) pentatomid bug has been reported to occur as a sporadic pest of *kusum*; during July-August 1932, it was said to have affected 1,300 trees (*Annual Report*, 1932-33, p. 15). During June-September 1950, this bug was observed in fairly large numbers on *kusum* both at Hesal and Namkum and possibly occurred there earlier, as it was again first seen in the field on 3rd March 1951, on *kusum* at Namkum. Since this pentatomid also feeds on tree sap, as is done by the lac insect, it is desirable that in the years when it is found in large numbers it should be controlled. Besides, as the bug appears in the field at a time when fresh shoots come out on the trees, it is suspected that *T. javanica* (also found on the fresh shoots) may be responsible solely or in part for the dying of the tips of such shoots. In order to estimate the nature and extent of damage caused by it and to find means of controlling it, life-history studies were commenced last summer. Its eggs are laid in clusters usually of 14 each. The eggs are rather globular, 2·0-2·5 mm. in diameter, and usually hatch in 10 days in July. A chalcid parasite, *Anastatus sp.*, has been bred from the eggs.

(ii) *Termites* — The mound-building species, *Odontotermes obesus* (Rambur), is the commonest species which is found associated with various lac hosts in the Institute's plantation and other parts near Ranchi. It seems to be worst on *palas* and *ber* and least injurious to *kusum* which is a hardy tree. The termites become most active after the first showers of rain and construct mud covering as far upwards as the places where infectable thin branches are present. When the mud covering is washed off or removed, the surface of the bark that has been eaten is easily seen. By employing this criterion and by the actual presence of termites or the mud galleries when present, an estimate was made, during February 1951, of the number of *palas* trees thus affected in the Institute's plantation. Out of a total of 3,588 trees, 249 trees were completely dead; the cause of their death could not be ascertained. In 897 trees, whereas the main stem was dead, 75·3 per cent of the new shoots that had come out were showing signs of termite attack. Of the remainder 2,502 trees, both the medium- and small-sized trees were attacked; on 43·6 per cent of these trees the attack was heavy and on 39·6 per cent light. Further studies on the exact nature of damage, etc., and the means to eradicate them in the plantation are being made.

(d) The Lac Insect

The dry and spirit-preserved collection of specimens of the lac insect and its various strains and their "crosses" were rearranged and catalogued. A systematic study of these will be initiated.

(e) Insect Enemies of Lac: *Chrysopa sp.*

Larvae of a lace-wing fly (*Chrysopa sp.*) were found preying upon various stages of lac insect at Namkum, Hesal (Ranchi), Kundri, Oreya (Palamau Division) and several other parts of Bihar. Samples of lac received from Karnal (Punjab) had also a few empty egg-shells of the lace-wing, thereby indicating a wider distribution of this kind of predator.

Locally it was found attacking both the *rangeeni* and *kusmi* strains, its eggs, larvae and pupal cocoons having been collected from *Katki* (1950) crop on *ber* and *palas*, *Baisakhi* (1951) on *ber* and *pandan* (*Ougeinia dalbergioides*) and *Aghani* (1950) and *Jethwi* (1951) on *kusum*. It has not yet been possible to get specific identification of this species or that of certain other species of *Chrysopa* collected from other trees.

Eggs, oval in shape, 0·75-1·04 mm. long and 0·33-0·4 mm. wide, are supported on stalks of varying lengths. When freshly laid these are light green or yellowish, later turning greyish, after which change they soon hatch. Length of stalk is shortest when the eggs are laid on thorns of *ber* (max. length 4·0 mm., min. 0·4 mm., average for 30 eggs — 1·8 mm.) and longest when laid on leaves or plain surface (max. 13·0 mm., min. 0·16 mm., average for 320 eggs — 6·6 mm.). The larva emerges out of the egg-shell with the aid of an egg-buster, climbs down the stalk and immediately commences feeding on lac insect by inserting its long pair of mandibles usually through the anal, and occasionally through the brachial, apertures. The larva passes through three instars and, as usual in chrysopids, it conceals its body by covering it with wax filaments (secreted by the lac insect) and debris. The duration of development of various stages of the species is given in the following table:

TABLE III — DURATION IN DAYS OF THE VARIOUS STAGES OF *CHRYSOPA SP.*

Stage	Oct. 1950		Nov. 1950		Dec. 1950		Jan. 1951		Feb. 1951		March 1951	
	No.	Days	No.	Days	No.	Days	No.	Days	No.	Days	No.	Days
Egg (in field)	74	1·9* (1-7)	13	4·6 (1-6)	14	3·7 (1-6)	...	...	1	1	1	3
Egg (in Lab.)	...	...	...	...	81	7·9 (4-12)	2	4·5 (4-5)	...	...	...	...
Larva: I instar (in Lab.)	30	4·5 (2-8)	1	5·0	15	13·0 (9-19)	3	18·3 (8-24)	...	...	...	...
II instar	30	3·6 (2-8)	3	5·6 (3-10)	3	5·3 (3-10)	5	13·8 (4-27)	1	16	...	...
III instar	13	10·2 (6-13)	6	9·5 (3-14)	1	34	5	21·0 (12-28)	...	...	...	...
Pupa (in Lab.)	8	6·1 (6-7)	11	9·5 (3-14)	...	...	...	...	4	12·5 (7-16)	...	...

*Average duration; figures in brackets give the minimum and maximum duration.

The number of mature female lac cells fed upon or damaged by the larvae in various instars is given below:

TABLE IV — FEEDING RECORDS OF *CHRYSOPA* LARVAE

Larvae		No. of female lac cells		No. fed per day by single larva		
Instar	No. observed	Offered	Fed	Min.	Max.	Average
I	16	915	186	0·70	8·56	2·66
II	17	995	247	1·25	12·50	4·65
III	20	1,406	558	1·20	15·00	7·57

(f) Cultural Methods of Control of Insect Enemies of Lac: Use of Wire-net Baskets as Broodlac Containers during Infection

Preliminary results, as given in the 1949-50 Report (p. 5), showed that the method is very helpful in eliminating the enemies of lac insect and in preventing wastage of sticklac. In order to work out the economics of this device it would be necessary to give it large-scale trials in isolated areas which might be otherwise identical in respect to lac cultivation. If the experiment is done in the same or two closely situated areas, an obvious defect in the experiment would be that the insect enemies from the trees where the brood baskets were not used would fly or otherwise spread to those trees where the baskets were actually used. No suitable areas have yet been provided for the purpose. However, in Oreya Reserve Forest, where lac is being grown on *kusum*, certain preliminary trials on larger scale were made in this respect and, in spite of the disadvantage referred to above, the broodlac used to yield of broodlac ratio was higher in the case of trees where the wire-net brood baskets were used. The results are summarized below:

TABLE V — COMPARATIVE YIELD DATA FROM *KUSUM* TREES IN OREYA RESERVE FOREST INFECTED WITH AND WITHOUT WIRE-NET BASKETS DURING JANUARY-FEBRUARY AND JUNE-JULY 1950

Crop	Wire-net baskets used for infection		Direct infection from lac sticks	
	No. of trees	Broodlac used to broodlac obtained	No. of trees	Broodlac used to broodlac obtained
Jethwi 1950	48	1 : 1·5	35	1 : 0·64
Aghani 1951	42	1 : 1·5	60	1 : 0·84

Examination of crop in many instances where wire-net baskets had been employed at the time of infection showed that insect enemies of lac, namely *Eublemma amabilis* and *Holcocera pulverea* and several parasitic Hymenoptera, were either absent or scarce. In some cases when present, they appeared fairly late in the season after the lac crop had well established itself. At Hesal, 1,123 wire-net baskets, each containing 2 chhataks of broodlac, were used for infecting 39 *kusum* trees during February 1951. At the end of the infection operations, 29 baskets were found missing and 147 got somewhat damaged, and after the latter are repaired, all the baskets will be used again in subsequent operations in order to determine the useful life of such baskets for the purposes of working out the economics of their use. After the above-mentioned infection was completed, 183 baskets from 9 trees, chosen at random, together with the used brood (swarmed out or *phunki*) contained in them, were examined and the insect fauna collected from them identified as far as possible. The results of these observations are tabulated in Table VI. It will be seen that a large number of lepidopterous predators and chalcid parasites of lac were trapped.

(g) Biological Control of Lac Predator, *Eublemma amabilis* Moore: To Discover Suitable Alternative (Unnatural) Host for Breeding *Bracon greeni* in Laboratory Condition

It has been known that *B. greeni* is a specific ecto-parasite of *E. amabilis* and that it would lay eggs on certain other caterpillars if the latter are placed in domes similar to those made by *amabilis* larvae in their advanced stages. In order to breed the parasite on a large scale, it would be necessary to ensure adequate supply of such unnatural hosts. In this connection several kinds of larvae have been under trial for some time past, but the difficulty has been that none of the suitable species of larvae could be had in sufficient quantities throughout the year. *Etiella zinckenella* Treit, which had been found suitable

TABLE VI — RESULTS OF EXAMINATION OF *PHUŃKI* SHOWING THE PARASITES AND PREDATORS TRAPPED IN WIRE-NET BASKETS (IN FEBRUARY-MARCH 1951)

Tree No.	No. of baskets examined	Chalcids*	*Bracon greeni*	*Apanteles tachardiae*	*Apanteles fahrrulhajiae*	*Pristomerous testaceicollis*	Bethylidae	*Eublemma amabilis*					*Holcocera pulverea*					Teneidae	Coleoptera	Other miscellaneous insects
								Egg	Larva	Pupa	Moth	Total	Egg	Larva	Pupa	Moth	Total			
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
133	22	172	30	20	×	13	×	14	11	7	106	138	×	14	×	86	100	11	×	
105	35	241	26	11	22	34	3	×	3	3	65	71	×	9	×	103	112	1	15	
130	17	97	3	2	12	9	×	×	×	5	18	23	×	5	7	33	45	×	×	
116	12	167	24	11	9	10	2	×	×	3	44	47	×	10	6	49	65	×	7	
118	15	389	9	×	57	19	×	×	3	7	81	91	×	9	2	108	119	×	10	
114	29	325	61	×	63	4	×	×	14	4	201	219	×	25	3	252	280	×	×	
207	30	325	10	×	43	27	×	×	×	×	88	88	×	×	×	114	114	×	×	
233	15	337	13	×	51	22	25	×	5	2	41	48	×	2	×	74	76	×	×	
131	8	182	4	×	23	7	86	×	1	×	16	17	×	1	×	29	30	×	6	Ants 18 Spider 1
Total	**183**	**2,235**	**180**	**44**	**287**	**145**	**116**	**14**	**37**	**25**	**660**	**736**	×	**75**	**18**	**848**	**941**	**12**	**38**	

* The chalcids include the under-mentioned species which could not be properly identified as most of them were damaged and broken: *Tetrastichus purpureus* Cameron, *Eupelmus tachardiae* Howard, *Parechthrodryinus clavicornis* Cameron, *Erencyrtus dewitzi* Mahdihassan, *Tachardiaephagus tachardiae* Howard, *Coccophagus tschirchii* Mahdihassan, *Tachardiaephagus somervilli* Mahdihassan.

for oviposition by the *greeni* and had hitherto been collected in February-March on peas, has now been found to infect a number of other plants grown for the purpose in the Institute's plantation. These are *jheri* (*Crotolaria saltiana*), *jhunjhunia* (*Crotolaria sericea*) and *boga* (*Tephrosia candida* = *Boga medalore*) and were successfully cultivated under local conditions throughout the year and likewise gave fruits which in turn provided the *E. zinckenella* larvae for breeding purposes. The work, especially in regard to the longevity, fecundity and other related aspects, in the life-history of the parasite when it is bred on *zinckenella* larvae was lately initiated. The rearing of the parasites on other hosts which had been under investigation earlier was also continued and the data presented in the following table.

TABLE VII — RESULT OF MASS BREEDING OF *BRACON GREENI* ON UNNATURAL HOSTS AND ON *E. AMABILIS* (THE NATURAL HOST) UP TO 31ST MARCH 1951

Host and number introduced	Percentage parasitism	Number of *B. greeni* bred	Percentage of females bred	Number of adults bred per parasitized host.
Eublemma amabilis, 2,440	33·08	357	70·01	0·44
Etiella zinckenella (from *Boga medalore*), 840	26·19	113	66·40	0·51
Etiella zinckenella (from *Crotolaria saltiana*), 26,560	28·80	3,738	72·90	0·50
Etiella zinckenella (from *jhunjhunia*), 600	15·50	39	69·20	0·41
Etiella zinckenella (from pea), 720	13·30	29	68·90	0·30
Trachylepidia fructicassiella (*amaltas* pod-borer), 4,597	6·80	165	66·00	0·52
Platyedra gossypiella (cotton seed-borer), 4,370	27·86	1,134	70·40	0·93
Leucinodes orbonalis (brinjal borer), 129	10·90	4	50·00	0·28

3. TRAINING AND ADVICE

(a) Training

In all 28 persons were under training during the period under report. Of these 23 were undergoing one year's course in lac cultivation. After the examinations held at the end of their completing the course, 7 out of 8 candidates came out successful. The successful candidates have since taken up duties in their respective States as follows:

1	Forest Range Officer ...	...	Bombay
2	Lac Demonstrators ...	...	Bihar
3	Lac Demonstrators ...	...	West Bengal
1	Lac Demonstrator ...	...	Uttar Pradesh

Six Demonstrators from Bihar, 1 Demonstrator each from U.P. and West Bengal, 1 Forest Range Officer and 4 Dy. Rangers from Madhya Pradesh are still under training. One Supervisor (Bihar) resigned and one Demonstrator (Bihar) unfortunately died. Efforts are being made to regularize admissions to remove inconveniences caused by admitting trainees at all times of the year. Short courses of training of varying duration were given to 5 persons as follows: 1 Lac Inspector, Bihar (6 months); 2 Foresters, U.P. (6 weeks). One Lac Inspector (Bihar) resigned during the course of training and another, recruited in his place, is under training for 6 months.

(b) Advisory Service

To lac cultivators from different parts of India, information and advice were given by correspondence and personal contacts, as also through our taking part in various exhibitions. The Publicity and Co-operative Departments of Bihar State were also contacted for the purpose. Exhibits and various publications on lac cultivation were supplied to various institutions and museums in the country. Schemes for lac cultivation were prepared for the respective Forest Departments of Bombay, U.P. and the Punjab.

(c) Supply of Pruning Instruments and Broodlac

Pruning instruments were supplied to trained staff employed under the Intensive Demonstration Scheme of various States. In Bihar one standard pruner and two roll-cut secateurs were exchanged for the same number of unserviceable ones. In West Bengal eight standard pruners and four roll-cut secateurs were supplied free.

Broodlac was supplied free under the Intensive Demonstration Scheme as also under the recently inaugurated scheme for the Extension of Lac Cultivation. To certain other parties it was sold at cost price. The following statement gives particulars regarding the broodlac supply:

Type of broodlac	Scheme, or name of party	Quantity supplied, Mds. srs.	Free or sale
Baisakhi 1950	Intensive Demonstration (I.D.) Scheme, Bihar	13 30	Free
	I.D. Scheme, Bihar: Forest Dept., Mako	1 0	,,
	Intensive Demonstration Scheme, U.P.	5 5	,,
	Intensive Demonstration Scheme, West Bengal	4 25	,,
	Extension Scheme: Forest Dept., Bhopal	31 34½	,,
	Co-operative Dept. Scheme, Khunti, Bihar	9 10	,,
	Forest Dept., Ambala, Punjab	1 10	Sale
	Forest Dept., Karnal, Punjab	1 20	,,
	Forest Dept., Bombay	0 20	,,
	Forest Dept., Jhansi, U.P.	10 0	,,
Jethwi 1950	I.D. Scheme, Bihar	2 5	Free
	I.D. Scheme, U.P.	0 28	,,
	Extension Scheme, Forest Dept., Bhopal	4 0	,,
	Forest School, Betla, Bihar	1 20	,,
	Forest Dept., Bangalore	1 37	Sale
Katki 1950	Basic School, Kanke, Bihar	0 10	Free
	Supdt., Agr. Res. Station, Guntur, Madras	0 25	Sale
	I.D. Scheme, Bihar	15 1	Free
	I.D. Scheme, West Bengal	4 38	,,
	I.D. Scheme, U.P.	15 11	,,
	Extension Scheme, Khunti, Bihar	7 35	,,
Aghani 1951	I.D. Scheme, Bihar	5 25	,,

4. INTENSIVE DEMONSTRATION SCHEME

(a) General

The main objects of the Scheme, as stated in the previous Report, are as follows:

(i) Exploitation of lac hosts in rotation by grouping them in coupés and thus providing for their periodic rest so that these may yield better and regular crops.

(ii) Using *kusum* on 1½ year's rotation by dividing the total number of trees into four equal coupés and practising complete cropping and thus also pruning it at the same time.

(iii) Adopting three-coupé system for *ber* and *palas*. Of these, one coupé is to be reserved solely for *Katki* and the other two for *Baisakhi* in alternate years; the *Katki* coupé to contain one-seventh the total number of trees and each of the alternate *Baisakhi* coupés three-sevenths. Only partial cropping of thick shoots bearing lac to be done in June-July in the *Baisakhi* coupé and an additional *Katki* crop allowed to develop on the same trees. The October cropping, on the other hand, must always be completely done so as to avoid self-infection in that season.

(iv) Discouraging the general practice of cutting immature (*ari*) lac which normally causes chronic shortage of broodlac.

(v) Adopting suitable methods for the preservation of broodlac during summer crop by partial pruning of *ber* and partial defoliation of *palas*.

(vi) Exclusive use of *palas* for *Baisakhi* and *ber* for *Katki* crop.

(vii) Discouraging mixed cultivation of *kusmi* and *rangeeni* strains of lac in the same locality to avoid transference of injurious insects from one type of crop to the other.

(viii) Encouraging co-operative and collective cultivation of lac.

The Intensive Demonstration Scheme is being worked at present in the States of Bihar, U.P., West Bengal and Madhya Pradesh. Details of working follow.

Bihar — Nine centres are being run by 7 Supervisors and 20 Demonstrators, while 1 Supervisor and 4 Demonstrators are under training. One Lac Inspector took up duties in June 1950, and 2 Demonstrators in June and December 1950. Additional staff of 1 Supervisor and 3 Demonstrators sanctioned for the new centre, opened in Hazaribagh district last year, has not so far been recruited, with the result that the work of this centre was shared by the Demonstration staff of the Chandwa and Latehar centres. A large number of transfers were effected during the year.

Uttar Pradesh — Two centres, one at Wyndhamgunj and the other at Mirzapur, are being worked by 2 Supervisors and 2 Demonstrators. One more Demonstrator is under training while the posts of 3 Demonstrators remain vacant.

West Bengal — Two centres, one each in the districts of Malda and Murshidabad, are being run by 2 Supervisors and 5 Demonstrators, and 1 more Demonstrator from West Bengal is under training. The work of the field station, opened in Murshidabad district in July 1950, is also being carried out by the staff of the Demonstration Scheme.

Madhya Pradesh — This State has recently joined the Scheme and 5 officers of the Forest Department who are under training are due to be relieved in June 1951.

(b) Crop Results

A summarized report on the various lac crops obtained from the trees of cultivators in different States, as a result of the activities of the Demonstration Scheme, is furnished below.

Bihar

Baisakhi 1950 *Crop* — Demonstration was given in 49 areas; 747 partially defoliated and 1,368 undefoliated *palas* trees were infected. In the case of partially defoliated trees brood yield for every hundred trees was on an average 133·6 srs. while that for the

undefoliated trees only 50·9 srs. In the case of *ber*, demonstration work could be carried out only in one centre where broodlac had been more successfully produced on partially pruned trees.

Jethwi 1950 *Crop* — In 26 areas, 250 *kusum* trees were infected. Although *Jethwi* crop failed practically all over Chotanagpur, the ratio of broodlac used to sticklac obtained was on an average 1: 1·3 in the demonstration areas. In two centres the cultivators sold 1 md. 23 srs. of broodlac, this being the quantity in excess of their own requirements.

Katki 1950 *Crop* — 29 areas were being worked under the Scheme for this crop; 580 *palas* and 3 *ber* trees were infected with 25 mds. of brood and a crop of 54 mds. obtained. 51 mds. 6½ srs. of the latter were broodlac, of which 40 mds. 16 srs. were used in the area and 10 mds. 30 srs. sold by the cultivators, giving them an income of Rs. 600/- from this sale alone.

Aghani 1951 *Crop* — In 23 areas, 80 *kusum* trees were infected with 10 mds. 15½ srs. of broodlac, of which 7 mds. 38½ srs. came from the area itself. The resulting crop gave 16 mds. 27½ srs. Owing, however, to the danger of thefts, 5 mds. 9 srs. were cut as *ari*, 6 mds. 22½ srs. reaped as broodlac and the rest was scraped. The average brood used to yield ratio (based on scraped lac) was 1: 2·5.

West Bengal

Baisakhi 1950 *Crop* — Both in Malda and Murshidabad districts in 11 areas 581 *ber* trees were infected for the *Baisakhi* crop, but the cultivators for some reason unknown to us did not follow the method of partial pruning with the result that they could not obtain any broodlac. The ratio of brood to yield of sticklac on crop maturity was 1: 3·1. All these areas have since been given up and new ones taken up under the Scheme for the next crop.

Katki 1950 *Crop* — 35 *ber* trees in 5 new areas were infected with 3 mds. 16 srs. of broodlac and the total yield obtained was 13 mds. 21 srs., out of which 11 mds. 26 srs. could be used as broodlac. The ratio of broodlac used to yield was 1: 3·4 based on lac sticks and 1: 6·9 on scraped lac.

13 *ber* trees at the field station at Pratapgunj (near Nimtita) were infected with 2 mds. 15 srs. of broodlac and yielded 9 mds., thereby giving a brood to yield ratio of 1: 3·8. Half the quantity produced went to the owner while of the other half, 1 md. 5 srs. not being suitable as broodlac, was scraped and the rest used as broodlac at the field station and in the demonstration areas.

Uttar Pradesh

Baisakhi 1950 *Crop* — Mirzapur: 61 *palas* trees in these areas were infected with 2 mds. 8 srs. of broodlac. In spite of the partial defoliation prior to infection the crop failed in one area while in the other two areas it was left for self-infection. Wyndhamgunj, Dudhi: 337 *palas* trees were infected with 14 mds. 25 srs. of broodlac; the resulting crop was not reaped in July 1950 but allowed to produce *Katki* crop by self-infection. The combined yield resulting therefrom was 61 mds. 18 srs. giving the ratio of broodlac to yield as 1: 4·4 based on lac sticks and as 1: 8 based on scraped lac.

Katki 1950 *Crop* — At Wyndhamgunj additional 111 *palas* trees were infected in 11 areas with 4 mds. 22 srs. of broodlac giving a yield of 7 mds. 39 srs. of broodlac.

(c) Improved Cultivation in Forest Areas

(i) *Palamau Division, Bihar* — In Kundri Reserve Forest, nearly 32,000 *palas* trees are being used by the Forest Department for lac cultivation under the technical advice of this Institute. The general progress of the work was maintained during the period under report; the data on the yield have been given already (*vide* p. 4). At Oreya nearly 900 *kusum* trees are being worked at by the Forest Department. 83 trees were infected for the

Jethwi 1950 crop. Even though both the *kusmi* crops were poor in Chotanagpur, Oreya produced a good crop with the result that it was possible to sell 1 md. 20 srs. surplus broodlac in July 1950 and 11 mds. 6 srs. in January 1951 from the area, fetching a revenue of Rs. 2,150/-. At Mako a small number of *kusum* trees are being maintained for lac cultivation pending further development regarding the planting of host trees in the area. 428 *khair* (*Acacia catechu*) were infected for the *Katki* 1950 crop and 8 mds. 13 srs. of broodlac were produced which was used to infect 311 trees of *pandan* (*Ougeinia dalbergioides*), *palas*, *ber* and *dumber* (*Ficus glomerata*) to propagate the *rangeeni* strains.

(ii) *Saranda and Chaibasa Division* — Lac cultivation on *kusum* trees is being carried out on the lines advocated by the Institute and it is expected that the areas would soon attain self-sufficiency in respect of broodlac.

5. NAMKUM PLANTATION

As desired by the Committee, the Forest Department, Bihar, was approached to direct the re-stocking of ten acres of land with suitable lac hosts. The Forest Research Officer of the said Department visited the plantation in March 1951 for the purpose and his report is awaited at the time of writing this report. Meanwhile, every effort has been made to maintain its general upkeep and build pathways round the main plots. Sugarcane, certain vegetables and other plants such as *Boga* and *Crotolaria sp.* (valuable also for green manuring) were grown for procuring alternate hosts for the rearing of the parasite *Bracon greeni*. Lac cultivation on a large scale in the plantation has been stopped for the last ten years or so. However, a small number of *palas*, *pandan*, *Albizzia lucida* and *porho* (*Ficus cunia*) were infected with a view to keep going various strains which were found particularly useful for preserving *Baisakhi* broodlac. 173 trees produced 9 mds. 22 srs. of broodlac, of which 8 mds. 34 srs. were sold. A total revenue of Rs. 1,699-0-9 was obtained from the plantation produce.

6. EXTENSION OF LAC CULTIVATION

Work under this Scheme was continued with the survey of idle lac hosts all over the country and exploitation of idle hosts located already. As a result over 2,80,000 new hosts were located and some 1,40,000 new hosts infected with lac during the period. This brings the total of hosts surveyed so far to nearly 8·5 million, and the total of idle hosts brought under cultivation to nearly 2,90,000.

Extensive tours had been undertaken in connection with the Scheme severally by the Director, the Entomologist and the Officer in charge of the Intensive Demonstration Scheme, a few of the States visited being Bombay, U.P., Orissa, the Punjab (I) and Madhya Pradesh. It is largely as a result of personal contacts made during such tours that the Madhya Pradesh Government have now joined the Intensive Demonstration Scheme and the Orissa Government agreed to start half a dozen broodlac farms in their forests. Further, the Forest Departments in Bombay, Punjab and U.P. have started lac cultivation in some of their forest areas, although well-defined plans such as may be worked by trained staffs have yet to be adopted by them.

Lac Extension Officer and his staff have not been recruited as yet and consequently the progress under the scheme has been necessarily slow.

CHEMICAL SECTION

1. VARNISHES AND LACQUERS

The Chemical Section could not work with full complement of staff. One Scientific Officer was on leave throughout the period and the post of a Junior Research Assistant remained unfilled since February 1949.

Lac-linseed Oil Paints — Observations on the weathering properties of lac-linseed oil paints, which were applied on the iron- and wood-work of the Institute buildings and staff quarters about two years back, indicate that these paints stay remarkably well indoors and on surfaces not directly exposed to the sun and rain. As a control experiment, in one of the buildings one set of doors and windows were painted with the shellac-oil paint and an adjacent set with a reputed commercial high-gloss oil paint intended for interior use. After well over two years now the shellac painted surfaces appear to be just as good as, if not better than, the surfaces painted with the commercial product. The outdoor performance of shellac-oil paints, however, is extremely poor which is in conformity with our earlier findings.

Samples of shellac-linseed oil paint varnishes have been supplied to a well-known firm of paint manufacturers for exhaustive tests and report.

Oil-cloth — Samples of " oil-cloth " prepared from shellac-linseed oil compositions more than two years back do not show any deterioration regarding their flexibility or gloss; they are also entirely free from any sign of after-tackiness. Laboratory samples continue to receive appreciation from the visiting public.

Samples of these compositions were supplied to two manufacturers in Calcutta who appear to be interested in the manufacture of oil-cloth from shellac compositions. They were also shown the process of making these compositions both in our laboratories and in their factories. Their reports are awaited.

2. MODIFICATION OF LAC AND ITS DERIVATIVES

(a) Lac Esters as Resin Plasticizers for Nitrocellulose

Several samples of leather-cloth were prepared using film scrap and butyl or fusel oil ester of shellac as plasticizer. Control samples were prepared using castor oil in place of the shellac ester. The composition used was as follows.

TABLE I

Material	First coat	Intermediate coat	Finish coat
Film scrap	100 gm.	100 gm.	100 gm.
Acetone	150 c.c.	150 c.c.	...
Methylated spirit	300 ,,	300 ,,	200 gm.
Ethyl acetate	...	...	200 ,,
Butyl acetate	20 c.c.	20 c.c.	...
Shellac ester	250 gm.	250 gm.	100 gm.
Pigment	...	80 ,,	...

The samples using shellac ester, when freshly prepared, appeared to be superior to those using castor oil, particularly regarding appearance, feel and absence of any odour. But with time, and especially during winter (when temperature and humidity were low), the samples

based on shellac ester showed a tendency to crack whereas those with castor oil remained practically unaffected. The shellac ester, however, did not sweat out from the film surface either on heating or during storage.

(b) Butyl or Fusel Oil Ester of Shellac and Polyvinyl Chloride (PVC)

Experiments were undertaken to study the possibility of using shellac ester as a plasticizer for polyvinyl chloride for the production of coated fabrics. For this purpose the coated fabrics were prepared as follows:

The shellac ester was ground with the requisite quantity of pigment to form a thick paste. This paste was then mixed with PVC (" Corvic ") and a little methylated spirit to form a thick uniform dope. This was spread on to the surface of the cloth as a thin film by means of a suitable spreader and then dried at 80°-90°C. Three to four such coats were applied, depending upon the film thickness desired. The coated material was finally gelled by exposure to radiant heat, followed by immediate cold-calendering. The films so obtained were quite glossy, hard and flexible, and had satisfactory adhesion. On standing, however, the ester gradually oozed out of the film rendering it greasy and dull. Not much improvement was noticed even when the shellac ester was used in conjunction with varying proportions of tricresyl phosphate.

Attempts were also made to use shellac itself along with PVC in the presence of tricresyl phosphate as common plasticizer. The pigment was ground in tricresyl phosphate and the resulting paste together with PVC taken up in a solution of shellac in methylated spirit to form the coating material. This was then spread on the cloth, dried, gelled and cold-calendered as described above. The composition showed a marked tendency to soak through the fabric. Further, the film obtained, though homogeneous and flexible, was not glossy and its solvent- and water-resistances were poor.

(c) Esterification of Shellac

Apart from the consideration of cost, there are two other major difficulties in the way of general adoption of lac esters as plasticizers. These are (i) high viscosity and (ii) colour. With regard to (i), i.e. their high viscosity, this is unavoidable since the products are esters of a resin and thus embody the characteristics of both resin and plasticizer. With regard to colour, however, improvement should be possible. The claim (*Paint Manufacture*, April 1945, pp. 93-97) that bleached lac could be used to produce pale-coloured esters could not be confirmed. In fact, esters of bleached lac produced under the conditions recommended (loc. cit.) were found to be much darker than those prepared from the palest commercial decolourized lacs.

To see if a changed procedure would eliminate the darkening effect of bleached lac, experiments were undertaken to esterify bleached lac (i) in the cold using the minimum amount of catalyst and also (ii) by refluxing in the absence of any catalyst and under such conditions that the water produced during the reaction was continuously removed from the sphere of reaction. In either case, the rate of esterification was extremely slow, e.g. the A.V. of dry bleached lac in fusel oil in the presence of 1·5 per cent concentrated sulphuric acid had dropped from 77 to only 31·46 in the course of 16 days at laboratory temperature. Similarly, on refluxing in the absence of catalyst, the A.V. dropped from 71·15 to only 57·73 in 24 hours. Refluxing the bleached lac solution in the presence of catalyst invariably darkens the solution.

With decolourized lacs, however, better results were obtained. In a typical experiment, 50 gm. dewaxed super-blonde lac were dissolved in 150 c.c. of fusel oil-toluene constant-boiling mixture and treated with 0·5 c.c. concentrated sulphuric acid. The product was subjected to refluxing under such conditions that the water separating from the condensate was removed.

After about 24 hours of such refluxing, the catalyst was eliminated by boiling the reaction mixture with about 2 gm. of precipitated calcium carbonate. The resulting ester was steam-distilled to remove the volatile solvents and finally dried by heating to about 140°C. to eliminate the last traces of moisture. It was thus possible to obtain an ester of A.V. 3·87 starting with lac of A.V. 71·55. Further work is being done.

(d) Modification of Lac with Polyhydric Alcohols and Polybasic Acids

The properties of resins obtained by the combination of lac with pentaerythritol (PE) with varying proportions of the latter under different experimental conditions were briefly reported in the last Annual Report. It was mentioned therein that all the products of different combinations, while possessing low acid values, were uniformly soft, plastic and hygroscopic, and that unless further modified to raise their softening point and to overcome their sensitivity to water, their practical importance would be very much limited. It was noticed that the hygroscopic nature of the substances was due mainly to an increase in the number of hydroxyl groups brought about by the combination of PE (it is a tetrahydric alcohol) and it was thought that if these added hydroxyls were neutralized with acid groups, the resulting products might have desirable properties.

A few preliminary experiments made on the combination of lac-PE compounds with maleic anhydride (MA) did not meet with success, as the resin polymerized before appreciable combination took place. Experiments were then made to react the two in a solvent medium, but the ultimate resin obtained was soft and sticky as before, with the difference, however, that films made from it on baking at 120°-130°C. for 2 hours were hard, glossy and water-resistant and also possessed good adhesion and elasticity. Such resins may, therefore, find use in the coating industry.

With a view to obtaining hard and high melting resins, possessing, if possible, thermo-hardening characteristics, experiments were planned to combine directly lac, PE, maleic and/or phthalic anhydrides severally or simultaneously under suitable conditions. Before doing this it was thought worth while to study the action of these polybasic acids alone on lac for finding out the nature of the chemical changes brought about in the lac molecule by such combinations. The results of such a study carried out during the period under review are briefly reported here.

As a first step, the combination of lac with phthalic anhydride (PA) was undertaken. Dewaxed lac and PA in different proportions were reacted at 150°-160°C. on an oil bath for varying periods and the changes brought about in the acid value and other physical properties were noted. The results are given in the following tables (II to IV).

TABLE II

Temp. ... ... 150°-160°C.
PA ... ... 3 mols.
Lac ... ... 1 mol.

Time (hrs.-mins.)	Acid value	Appearance	Remarks
1-0	187·4	Hard, clear	...
1-30	187·3	,,	...
2-0	165·7	,,	Calculated acid value would be 178·0 if 3(OH) of lac condense with 3(COOH) of PA leaving the other 3(COOH) free + A.V. of lac
2-10	...	Polymerized	...

TABLE III

Temp. ... ... 150°-160°C.
PA ... ... 4 mols.
Lac ... ... 1 mol.

Time (hrs.-mins.)	A.V.	Appearance	Remarks
1-0	232·9	Hard, clear	...
3-0	215·6	,,	...
3-45	214·6	,,	Calculated A.V. would be 227 if 3(OH) of lac react with 3(COOH) of PA leaving the other 5(COOH) free + A.V. of lac
3-50	...	Polymerized	...

TABLE IV

Temp. ... ... 150°-160°C.
PA ... ... 5 mols.
Lac ... ... 1 mol.

Time (hrs.-mins.)	A.V.	Appearance	Remarks
1-0	243·4	Hard, clear	...
3-0	243·0	,,	...
5-0	245·3	Slightly tacky, clear, brittle	Calculated A.V. would be 243·4 if 4(OH) of lac react with 4(COOH) of PA leaving the 6(COOH) free + A.V. of lac
5-30	236·2	Tacky, clear	...
5-40	...	Polymerized	...

The rate of combination of lac with PA (1: 5 mols.) was also studied at a higher temperature, namely 200°C., and it was found that the reaction could not be carried on for more than 40 minutes. The final product, which had an acid value of 231·0, was soft and tacky. Its hydroxyl value was found to be nil, which showed that all the hydroxyl groups of shellac had participated in the reaction. Attempts to reduce the acidity of the product by direct combination with the requisite quantity of PE met with little success, as the resin polymerized before appreciable reduction in A.V. took place.

In another set of experiments, attempts were made to combine lac, phthalic anhydride and PE successively in different proportions at temperatures varying from 150° to 170°C. In a typical experiment, 1 mol. of lac and 5 mols. of PA were at first heated to 150°-160°C. for one hour; 3·68 mols. of PE were then added and heating was continued for another hour at 170°C.; this was about the maximum period for which the melt could be heated without undergoing polymerization. The melt was then poured out and cooled when a clear brittle product almost like rosin in its physical characteristics, with a melting point 97°-98°C., was obtained. Its A.V. was, however, found to be 211·4, and it was completely soluble in alcohol, acetone, toluene-butyl-acetate mixture, etc. The acid value of the resulting product still being high, further experiments were conducted to reduce the acidity by increasing the proportion of PE. The resulting product, however, was soft and showed a tendency to tackiness. For example, 1 mol. of lac, 5 mols. of PA and 10 mols. of PE could be combined at 200°-220°C. to give a clear but slightly tacky resin having an

acid value 104·0. The use of maleic anhydride in place of PA under the same condition resulted in a clear product of increased softness and tackiness possessing an acid value of 110·0. Further examination of these products is in progress.

It would be clear from the above experiments that necessary reduction in the acid values of the products could not be accomplished as either the conditions of reaction or the nature of the materials involved did not permit sufficient time for complete esterification to take place. It was thought that if in place of PE, which is a short-chain tetrahydric alcohol, long-chain polyhydric alcohols, such as ethylene glycol, diethylene glycol or triethylene glycol, were used for combination with phthalic or maleic anhydride, the reaction might be carried on for a sufficiently-long time to yield products of low acidity. Further experiments were, therefore, undertaken using ethylene glycol and diethylene glycol in place of PE. At first ethylene glycol and diethylene glycol esters of lac were prepared by direct combination of the two constituents in requisite proportions using sulphuric acid as catalyst. These esters were invariably viscous and possessed acid values ranging from 12 to 15. They were, moreover, sensitive to water by virtue of the large number of hydroxyl groups present in them. Attempts to neutralize these hydroxyl groups with phthalic or maleic anhydride did not succeed as the resin always polymerized before any appreciable reduction in acid value took place.

Modifying the experiments, lac at first was combined with polybasic acids and the acid resin thus obtained was reacted with polyhydric alcohols. In this way products of low acidity could be obtained. In a typical experiment, phthalic anhydride-treated lac (obtained by heating 1 mol. of lac with 5 mols. of PA) was reacted with requisite proportion of ethylene glycol at 190°-200°C. for 6 hours using 0·5 per cent *p*-toluene sulphonic acid as catalyst. The resulting product was then poured into cold water, washed free from excess glycol and catalyst, and vacuum dried; a clear viscous resinous ester with A.V. 13 was obtained. This was soluble in alcohol, acetone, butyl acetate-acetone-toluene and butyl acetate-toluene mixtures. The resin when used by itself to coat metal sheets gave hard, elastic, glossy films after baking at 140°-150°C. for 1 hour. Besides, it had no " greening " effect on copper, which suggests that it might be useful in electrical industries. If in place of phthalic anhydride, maleic anhydride is used for treating lac beforehand, then products of improved elasticity and adhesion with quicker drying properties are obtained. This may be due to the presence in the molecule of a greater number of unsaturated groups, which are known to hasten polymerization.

Apart from phthalic and maleic anhydride, succinic anhydride was tried for combination with lac and subsequent esterification. The final product, unlike the previous ones, though viscous in the initial stage, becomes thin on slight warming, which makes its application easy as such without the help of solvents. Thus it may be used for solventless coating. The coatings, however, have to be baked for short periods (10-15 minutes) at 160°-170°C. to obtain hard, elastic films. Such resins may find application with canning and other allied industries. Further work on the combination of lac with other polybasic acids like adipic, sebacic, citric, etc., and subsequent esterification with polyhydric alcohols is in progress.

From a study made so far on the effect of combination of lac with different polybasic acids either severally or in combination and their further modification with different polyhydric alcohols, it would be clear that the ultimate products are all plastic, soft and sticky and as such could be useful in coating industries and/or as plasticizers and adhesives. None of these were found suitable for making plastic moulding compositions.

3. FUNDAMENTAL RESEARCHES

(a) Chemical Constitution of Lac

The work on the constitution of shellac was continued. The acid, m.p. 54°-55°C. (*Annual Report*, 1949-50, p. 20), henceforth to be named as " butolic acid ", was further studied. The name " butolic acid " was selected, following the practice of naming the acids

already isolated from shellac after their botanical or entomological source. In this particular instance the name " butolic acid " is derived from *Butea monosperma*, syn. *frondosa* (*palas*), a major lac host.

The product obtained by chromic acid oxidation (loc. cit., p. 21) on recrystallization melted at 68°-69°C., and gave a crystalline semicarbazone melting at 128°-129°C. and decomposing at 185°C. The nitrogen content of the semicarbazone was determined indirectly by the Jamieson (*Volumetric Iodate Methods*, p. 36, New York, Chemical Catalogue Co., 1926) method as follows. A weighed sample of the semicarbazone was refluxed for 2-3 hours with 30 c.c. of hydrochloric acid (A.R.) to hydrolyse the compound. After cooling, the precipitated acid was filtered off and the flask washed with 300 c.c. of distilled water, which in its turn was used for washing the precipitate on the filter paper. The filtrate with the wash liquor was taken in a 250 c.c. well-stoppered bottle, and 20 c.c. of pure chloroform added to it. It was then titrated with decinormal potassium iodate solution till the violet colour (due to the liberation of iodine with the first addition of KIO_3) in the chloroform layer just vanished.

Results of analysis of the semicarbazone indicated 13·32-13·60 per cent N, the calculated value for $C_{16}H_{31}O_3N_3$ being 13·42 per cent N.

The precipitated acid obtained from the hydrolysis of the semicarbazone was nothing but keto-butolic acid, and it melted at 69·5°-70°C.

Keto-butolic acid is free from OH groups. The acid value and the molecular weight (Rast) were found to be 226·3 and 255·7 respectively. The calculated acid value and molecular weight for keto-palmitic acid, $C_{16}H_{30}O_3$, are 207·8 and 270 respectively, while those for keto-pentadecanoic acid, $C_{15}H_{28}O_3$, are 219·1 and 256 respectively.

Butolic acid did not decolourize a dilute bromine solution in chloroform and was optically inactive. The microanalytical data for carbon and hydrogen and the molecular weight were determined. The values are given below together with the calculated values for $C_{14}H_{28}O_3$, $C_{15}H_{30}O_3$ and $C_{16}H_{32}O_3$ acids.

TABLE V

Acid	Carbon, %	Hydrogen, %	Molecular weight
1. Butolic	69·4, 69·6	11·5, 11·4	256·6, 261·7, 263·2 (Rast)
2. Monohydroxy myristic ($C_{14}H_{28}O_3$)	68·85	11·48	244
3. Monohydroxy pentadecanoic ($C_{15}H_{30}O_3$)	69·77	11·63	258
4. Monohydroxy palmitic ($C_{16}H_{32}O_3$)	70·59	11·76	272

Butolic acid was then reduced to the parent saturated acid according to the method of Harries and Nagel [*Wissensch. Veröffl., Siemenskonsern*, I (1922), p. 178] as follows:

3·34 gm. of freshly distilled hydroiodic acid and 0·01 gm. of freshly washed and dried red phosphorus were added to 0·5 gm. of butolic acid. The whole was then refluxed on a sand bath for 5 hours and allowed to stand overnight. A liquid separated on the surface which did not solidify even on keeping in the cold for a long time. This was extracted with ether and the ethereal solution was washed with sulphurous acid to remove excess of iodine, and finally with water. On removal of ether, a colourless liquid was obtained which was dissolved in methyl alcohol and 1 gm. of zinc dust was added to it. It was next refluxed for 3 hours with occasional additions of concentrated hydrochloric acid. After the specified time, water was added and the whole allowed to stand overnight. Some liquid globules

separated which solidified in the cold and melted during filtration. This was saponified, and the saponified product on decomposition gave a colourless solid weighing only 0·1 gm. and melting at 45°-46°C. On recrystallization from petroleum ether it melted at 48°-49°C. The acid value of the purified acid was found to be 230·1 and the molecular weight (Rast) 243·4 and 246·0.

In a similar way aleuritic acid was also reduced. 1 gm. of aleuritic acid on reduction gave 0·33 gm. of reduced acid melting at 62°-63°C. The mixed m.p. with pure (E. Merck) palmitic acid (m.p. 61·6°-62·6°C.) was 62°-63°C.

The mixed m.p. of the two reduced acids mentioned above was 46°-47°C.

From the analytical data of butolic acid and its reduced product, the acid seems to be monohydroxy-pentadecanoic acid. The respective data for this acid and the probable monohydroxy acids as well as their parent saturated acids are given below.

TABLE VI

Acid	M.P., °C.	Acid value	Mol. wt.	Hydroxyl value	Carbon, %	Hydrogen, %
1. Butolic	54-55	210·6	260·5 (Rast)	217·0	69·5	11·45
2. 11-Hydroxymyristic	51-52	229·9	244·0	229·9	68·85	11·48
3. 11-Hydroxypentadecanoic	63·5-64	217·1	258·0	217·1	69·77	11·60
4. 11-Hydroxypalmitic	67·5-68	206·0	272·0	206·0	70·6	11·76
5. Reduced acid from butolic acid	48-49	230·1	244·7 (Rast)	...	...	...
6. Reduced acid from aleuritic acid	62-63	217·6	254·9 (Rast)	...	...	...
7. Myristic	53·5-54·4	245·6	228·4	...	...	...
8. Pentadecanoic	51-52·1	231·5	242·4	...	...	...
9. Palmitic	62·5-63·1	218·8	256·4	...	...	...

It was first thought that butolic acid might be identical with convolvulinolic acid, m.p. 51°-52°C., an acid constituent of the resin from the root of *Ipomea purga* (jalap), identified by Asahina and Akasu (*J. Pharm. Soc. Japan*, 1925, **45**, 779) to be 11-hydroxy-pentadecanoic acid. Recent studies of Kawasaki (*Proc. Jap. Academy*, **25**, No. 10, p. 15), however, proved convolvulinolic acid to be 11-hydroxymyristic acid.

Comparative data on the melting points of the butolic, synthetic 11-hydroxy-pentadecanoic, convolvulinolic acids and their derivatives are given below.

TABLE VII

	Butolic acid, m.p., °C.	Synthetic pentadecanoic acid, m.p., °C.	Convolvulinolic acid, m.p., °C.
1. Acid	54-55	63·5-64	51-52
2. Methyl ester ...	27-28	29-32	31-32
3. Keto acid	69·5-70·5	70-71	63-64
4. Reduced acid ...	48-49	...	49·5
5. Ketonic acid semicarbazone	128-29	126	104

The mixed melting point of butolic and convolvulinolic acid* was found to be 45°-47°C. All these seem to indicate that butolic acid is not identical with convolvulinolic (11-hydroxy-myristic) acid but is most likely a hydroxy-pentadecanoic acid.

Oxidative Degradation of Butolic Acid — To obtain further insight into the constitution of butolic acid, attempts have been made to oxidize it by potassium permanganate as follows:

0·512 gm. of butolic acid was dissolved in 2·5 c.c. of 1 *N*-KOH by gentle heat. Then 8·5 c.c. of 3 per cent potassium permanganate solution were added with constant stirring during a period of two hours and a half, keeping the temperature of the reaction mixture at 50°C. After cooling, sulphurous acid solution was added to decompose excess permanganate. The precipitated manganese dioxide was removed by filtration and the filtrate was just acidified with dilute sulphuric acid and steam distilled. The distillate was extracted with ether. The ethereal extract, on drying and evaporation, gave a liquid acid (0·016 gm.), smelling like rancid butter. The solid acid, remaining in the distillation flask, was filtered and washed, and on drying weighed 0·4655 gm. (m.p. 49°-50°C.).

In another experiment, the temperature was maintained at 80°-85°C. The solid acid, in this case, melted at 47°-48°C. Attempts to fractionate this solid acid did not succeed.

The Ether-soluble Liquid Acid — The ether-soluble liquid acid (*Annual Report*, 1949-50, p. 21) seemed to be a mixture as, on repeated treatments with hot petroleum ether, some solid substance could be separated leaving a semi-solid residue on complete removal of the solvent. Attempts were made to separate the different acids by the following method:

The liquid acid was repeatedly extracted with hot petroleum ether. The insoluble residue was saponified with aqueous alkali by heating for several hours on a water bath. After cooling, it was brought to almost complete neutrality with dilute hydrochloric acid and a few drops of ammonia, and then calcium chloride solution was added. The precipitated calcium salt was filtered off and, on decomposition, gave a liquid acid together with a very small amount of solid acid.

The filtrate containing water-soluble calcium salt, on decomposition, gave a solid acid. The solid acid was allowed to stand overnight in the cold with 30 per cent potassium hydroxide solution when the potassium salt of a fatty acid separated. Decomposition of this potassium salt gave a colourless crystalline acid melting at 97°-98°C. The alkaline filtrate, after the separation of the solid potassium salt, on decomposition, gave a coloured liquid acid.

Acid Melting at 95°-96°C. — The acid (loc. cit., p. 21) was recrystallized twice from boiling water. The crystals melted at 96°-97°C. and were homogeneous, but seemed somewhat different in shape from aleuritic acid crystals obtained under the same condition. The acid was melted in a wide melting-point tube and a few crystals of aleuritic acid (m.p. 100°-101°C.) were added, keeping the temperature of the bath at 97°-98°C. The melted acid did not solidify, but instead aleuritic acid crystals gradually melted at that temperature. The mixture remelted at 97°C. This disproves the dimorphic nature of the two acids.

The acid was optically inactive. On microanalysis, carbon, hydrogen and molecular weight (Rast) were found to be 63·4 per cent, 10·6 per cent and 305·2 respectively. These correspond well with the respective calculated values for aleuritic acid, $C_{16}H_{32}O_5$, namely 63·1 per cent, 10·5 per cent and 304.

Acid Melting at 65°C. — The acid melting at 65°C. (loc. cit., p. 21) was assumed to be an inter-ester of the trihydroxy acid melting at 96°-97°C.

Found: C, 63·3 per cent; H, 10·55 per cent
Calc. for $C_{32}H_{62}O_9$: C, 64·51 per cent; H, 10·51 per cent
Calc. for $C_{32}H_{62}O_9$, H_2O : C, 63·16 per cent; H, 10·52 per cent

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* Pure samples of convolvulinolic acid were kindly supplied by Dr. Shoji Shibata, University of Tokyo, and by T. M. Sharp, Chief Chemist, Wellcome Laboratories, London. We take this opportunity of record ing our deep gratitude for this kind gift.

From the percentage of carbon it might be assumed that the inter-ester had retained a molecule of water as water of crystallization. The determination of water of crystallization, if any, was carried out in a drying pistol at the boiling point of chloroform, but there was practically no loss in weight. Afterwards chloroform was replaced by toluene and the loss in weight was found to be 1·17 per cent, the calculated loss of water for $C_{32}H_{62}O_9$, H_2O being 2·96 per cent. It seems that moisture is tenaciously retained. Further work is being done.

(b) Constitution of Soft Lac Resin

Pink Sodium Aleuritate — After extraction with petroleum ether, 10 gm. of finely powdered salt (*Annual Report*, 1948-49, p. 20) were suspended in water, and decomposed with dilute hydrochloric acid. The precipitated acid, after washing and drying, weighed 5·2 gm. and melted at 90°-91°C. On decolourization, and recrystallization from boiling water, it gave long, thin, narrow plates melting at 100°-100·5°C. It was optically inactive. The mixed melting point with aleuritic acid showed no depression.

Pink Zinc Salt — 10 gm. of the petroleum ether-washed salt (loc. cit.) were decomposed. The following acidic fractions have so far been isolated from the acid mixture:

1. Butolic acid, m.p. 54°-55°C. ... ... 0·46 gm.
2. Liquid acid(s) ... ... 5·18 ,,
3. An acid, m.p. 148°-49°C., granular in structure 0·12 ,,

(c) Methyl Ester of Lac

Although lac esters have been prepared by many workers and its possible use as a plasticizer has been studied, sufficient attention does not appear to have been given to its chemical nature and its reaction. It was thought desirable to study this ester with a view to throwing further light, if possible, on the complex molecule of shellac. The ester was prepared in the usual manner and freed from acids by washing with 10 per cent sodium carbonate. Finally it was dried at 55°C./190 mm. The percentage of methoxyl groups was determined by micro-Zeisel method. From the results, the number of OMe-groups in the molecule was calculated. Similar experiments were carried out with the methyl esters of hard and soft resins. The number of carboxyl groups in the resin was also calculated on the assumption that one methoxyl corresponds to one carboxyl in the esters. The results are given below in Table VIII.

TABLE VIII

Substance	CH_3O, %	No. of CH_3O in 1 mol.	No. of COOH in 1 mol.
Shellac (average m.w. 1,000)	nil	nil	...
Methyl ester of shellac	12·08	3·84	4
Soft resin (S.R.) (average m.w. 500)	nil	nil	...
Methyl ester of S.R.	11·40	1·9	2
Hard resin (H.R.) (average m.w. 1,900)	nil	nil	...
Methyl ester of H.R.	13·69	8·9	9

If the acid values be now calculated from the calculated carboxyl values, it is found that the acid values correspond to the observed saponification values. This will be evident from the following table.

TABLE IX

Substance	No. of COOH in 1 mol.	A.V. calculated	S.V. determined
Shellac	4	224	230
Hard resin	9	264	256
Soft resin	2	225	220

(d) Hydroxyl Groups in Lac and Constituents of Lac

Hydroxyl groups have been determined by many workers according to Norman's method (*Chem. Umschau*, 1912, **19**, 205). This method is not very reliable as traces of acetic anhydride are likely to be retained by acetylated products, thus giving a higher hydroxyl value. Cottrel's method (*Paint Technology*, 1944, **9**, 73) is free from this defect and hence hydroxyl values of shellac and some of its constituents were re-determined by this method. The results are given in the following table.

TABLE X

Substance	Hydroxyl value	No. of hydroxyl groups in 1 mol.	Average
1. Aleuritic acid	536·6	2·89	
	556·9	2·99	2·94 (theoretical 3)
2. *Kusmi* shellac (fresh)	263·1	4·7	
	255·8	4·5	4·6
3. Dewaxed blonde shellac (Angelo)	264·4	4·7	
	257·7	4·6	4·65
4. Decolourized shellac	230·8	4·12	
	233·8	4·15	4·13
	231·2	4·13	
5. Hard resin (A.V. 62) from *kusmi* shellac (2) (ether process)	215·4	7·3	
	211·2	7·1	7·2
6. Hard resin (A.V. 66) (ether process) from decolourized lac (4)	264·4	8·9	
	272·0	9·2	9·1
7. Soft resin (A.V. 95) (ether process) from decolourized lac (4)	116·9	1·1	
	116·1	1·0	1·05
8. Bleached lac from fresh *kusmi* seedlac	232·5	4·15	
	232·0	4·05	4·1
9. Bleached lac from 2-year old *kusmi* seedlac	247·5	4·4	
	247·5	4·4	4·4

Values now obtained are slightly lower than those recorded previously.

(e) Catalytic Polycondensation of Aleuritic Acid

The work on the polycondensation of aleuritic acid was extended to a detailed study of the process under the influence of catalysts. The reaction was carried out under two conditions: (1) at different temperatures, namely 140°, 160°, 180° and 200°C., the concentration of the catalyst *p*-toluene-sulphonic acid remaining constant at 1 per cent and (2) at different concentrations of the catalyst, namely 0·3, 0·5, 0·75 and 1·0 per cent, the temperature of the reaction being maintained constant at 140°C. Results obtained, in either case, could be explained on the basis of kinetic considerations. As expected, the reaction proved to be a second order one under both conditions. In the first case, the reaction gradually became faster as the temperature of reaction increased. In the second case, with a gradual increase in the catalyst concentration, the reaction no doubt became faster judging by the time required to reach a certain level, but the increase in speed was not proportionate to the increase in catalyst concentration. The energy of activation was calculated in the first case, and also the frequency of collisions. It could be seen by actual calculation that increased speed of the reaction is due to an increase in the number of effective collisions between the reactants.

(f) Polyesterification of 9:10 Dihydroxy Hexadecane, 1:16 Dicarboxylic Acid

Thermal polyesterification of the dibasic acid, obtained by oxidizing the terminal CH_2OH group of aleuritic acid by Nagel and Marten's method, was studied with the idea of gaining an insight into the thermal polyesterification of shellac (*Ber.*, 1936, **69**, 2050). The acid was heated at different temperatures above its melting point till the melt neared the infusible stage. On investigation, the reaction was found to be one of inter-esterification with slight formation of anhydrides near the gelling stage. The gelling point was attained rather quickly as the temperature of the reaction was increased. The energy of activation was calculated from the data given in the following table.

TABLE XI

Temp., °C.	$\frac{I}{T}$	t for 40% conversion (in mins.)	log t	E in K.cal./mol.
160	0·00282	105	2·0212	
180	0·00222	45	1·6532	15·81
195	0·002137	21	1·3222	

The activation energy was found to have the characteristic value of normal esterification. There was no evidence of esterification. The order of reaction was anomalous. From the velocity constant, the reaction appeared to be approximately of the third order. The products were hard at the beginning, waxy at the middle of the reaction and soft and rubbery towards the end. Further properties of the polyesterified products of this di-acid are being studied.

(g) Bleaching of Lac: Factors Affecting Bleaching

In the last Annual Report it was mentioned that investigations had been started to find out, if possible, relations between the absorption of bleach liquor by lac and each of the many factors on which this absorption depends. During the period under review, studies on the absorption of chlorine bleach by lac and its various constituents were undertaken. At first, the effect of different amounts of bleach liquor of the standard strength only (viz. $3 \pm 0{\cdot}05$ per cent available chlorine) upon seedlac solution of a particular concentration was observed. A 10 per cent solution of fresh, good quality *kusmi* seedlac was prepared in 1 per

cent Na_2CO_3 solution according to the I.L.R.I. method (*A Handbook of Shellac Analysis*, p. 96). Five samples of this solution, each containing 150 c.c. (i.e. 15 gm. of seedlac), were taken in five 500 c.c. tall beakers. To each beaker different amounts of bleach liquor were added and bleaching conducted at 35° ± 1°C. until all the chlorine was consumed. The solutions were then acidified, and the precipitated lac, after washing with distilled water to remove adhering mineral acid, was dried first in open air for about 12 hours, and subsequently in a vacuum desiccator for 24 hours.

Acid and saponification values of these samples of precipitated lac were then determined as usual. The acid value of the samples was observed to undergo a slight increase (by about 7 per cent) as the amount of bleach liquor was increased. This may be seen from the following table.

TABLE XII

Sample No.	Bleach added in c.c.	Acid value
1	0	76·45
2	15	77·25
3	25	77·78
4	30	80·44
5*	30	81·51

* No. 5 solution was prepared just like No. 4 solution, but it was kept in a stoppered flask for 5 days at room temperature, before being bleached.

When saponification values were determined, some unexpected results were obtained. For example, when a sample of bleached lac was refluxed for 2 hours with 0·5 *N*-KOH (alcoholic), its saponification value was found to be higher by only a few units than that of seedlac precipitated from 1 per cent Na_2CO_3 solution as the following table shows.

TABLE XIII

Sample No.	Saponification value	True saponification value, i.e. after correcting for the chlorine present in the bleached lac
1. Unbleached seedlac precipitated from soda soln.	231·8	231·8
3. Bleached	254·1	241·8
4. Bleached	247·1	234·8

But when the time of refluxing was increased to 24-25 hours (refluxing being done either continuously or at two stretches each of about 12 hours with an interval of 12 hours in between during which the solution was kept at room temperature, 24°-26°C.) the sap. value was always found to be higher than those recorded by Murty (*I.L.R.I. Bulletin*, No. 29, p. 4).

Bleaching of Hard Resin and Soft Resin — Hard and soft resins were prepared from a sample of seedlac of known bleach index according to the method of Palit (*I.L.R.I. Tech. Note*, No. 7). The solutions were prepared as in the case of seedlac, i.e. a 10 per cent solution of the sample in 1 per cent Na_2CO_3, and it was filtered through filter paper before bleaching.

The hard resin required a volume of bleach liquor proportionate to its percentage weight in seedlac. For example, 20 gm. of a seedlac required 40 c.c. of standard bleach in 4-5

hours to attain the $N/2,000$ iodine standard colour. 5 gm. of the hard resin prepared from this seedlac required 10·2 c.c. of standard bleach in 7·5 hours. If we take hard resin to constitute 70 per cent by weight of the seedlac, 5 gm. of it should require 10 c.c. of the bleach which is very close to the observed value, namely 10·2 c.c.

The appearance of the bleached hard resin was very similar to that of bleached seedlac or shellac. Acid value also increased by a few units as in seedlac. For example, a sample of hard resin having A.V. 56·5 after bleaching gave an A.V. 59·5, i.e. there was an increase of 5·3 per cent which is very near to that in the case of seedlac.

But the rate of consumption of bleach was decidedly much slower for hard resin than for whole seedlac. It was still slower in the case of soft resin. 4 gm. of soft resin required 14·8 c.c. of standard bleach liquor to attain the standard colour in about 10 hours whereas the time required for seedlac was only 4-5 hours.

The volume of bleach liquor required by soft resin was much higher than the theoretically calculated volume. The soft resin from the same seedlac, which required 40 c.c. of bleach liquor for 20 gm., required 14·8 c.c. of bleach for 4 gm. If seedlac consisted of 30 per cent soft resin, 4 gm. of soft resin should have consumed 8 c.c. of bleach out of a total of 40 c.c. The above results are summarized in the following table.

TABLE XIV

Sample	Weight of sample, gm.	Vol. of standard bleach required to attain standard $N/2000$ I_2 solution colour, c.c.	Time required for bleaching, hours
Kusmi seedlac, S 105	20	40	$4\frac{1}{2}$
Hard resin from	5	10·2	$7\frac{1}{2}$
seedlac, S 105	14	28·56*	...
Soft resin from	4	14·8	10
seedlac S 105	6	22·2*	...
Seedlac equivalent to	20	50·76*	...
70 per cent of hard resin+30 per cent soft resin	(i.e. 14 gm. hard resin + 6 gm. soft resin)		

* Calculated values.

It was difficult to precipitate the soft resin from alkaline solution after bleaching was over. It separated in the form of a fine suspension which passed easily and rapidly through filters. But after allowing it to stand for a long time (48-72 hours) in cold, or centrifuging, it separated in the form of a cream-coloured soft mass. Further study is being made.

Influence of Insect Bodies on the Bleaching of Lac — A quantitative study of the influence of dead insect bodies on the bleach index or bleachability of lac was undertaken during the period.

Different amounts of dead young lac insects were dried at 50°C. in a vacuum desiccator, weighed accurately, and mixed with samples of *kusmi* seedlac. Amounts of bleach ($3 \pm 0{\cdot}05$ per cent available chlorine) liquor required to bleach the samples so prepared according to the bleaching method of I.L.R.I. (*A Handbook of Shellac Analysis*, p. 96) were then determined. In each case, unless otherwise mentioned, 20 gm. of seedlac, either alone or mixed with insect bodies, were added to 2 gm. of Na_2CO_3 (anhydrous) and 150 c.c. hot water, heated up in boiling water for an hour, filtered at a temperature of 60°-65°C.

and the solution was made up to 200 c.c. In the final solution to be bleached there were no insoluble insect debris bodies. Table XV shows the results of some experiments.

TABLE XV

Sample No.	Material bleached	Bleach required to attain N/2,000 I_2 standard, c.c.	Time to attain standard, hours
1	20 gm. seedlac	40	4·25
2A	20 gm. seedlac + 0·2 gm. insect	43	5·25
2	20 gm. seedlac + 0·4 gm. insect	48	5·0
3A	20 gm. seedlac + 0·6 gm. insect	55	10·0
3	20 gm. seedlac + 0·8 gm. insect	55	10·25
4	20 gm. seedlac + 1·2 gm. insect	66	14·5
5	20 gm. seedlac + 2 gm. insect	78	18·25
A	0·2 gm. of insect in 40 c.c. of 1 per cent Na_2CO_3 soln. and diluted to 150 c.c.	5	7·0
B	2 gm. of insect in 200 c.c. of 1 per cent Na_2CO_3	38	23·0

It is clear that insect bodies not only consume an appreciable quantity of bleach liquor (roughly 20 c.c. per gram), but, admixed with lac, also lower the rate of absorption of bleach with increasing proportions.

The yield of bleached lac as well as its colour is influenced by the presence of insect bodies. The presence of a larger quantity of insect bodies not only requires more bleach liquor, but reduces the yield of bleached lac also by 2·5 to 6 per cent, besides imparting a pale yellowish colour to the product. The intensity of colour, however, did not show any definite correlation with the amounts of insect bodies present.

The acid and saponification values of the bleached lac showed slight increase with the increasing amount of insect bodies present in the samples (*see* Table XVI). But this may be due to the fact that more bleach liquor has to be used when bleaching such a sample.

TABLE XVI

Sample No.	Insect bodies, %	Acid value	Saponification value
1	Nil	83·6	252·8
2	2	84·4	256·9
3A	3	86·4	259·9
3	4	85·8	...
4	6	86·8	...
5	10	86·0	256·2

The increased consumption of bleach liquor in presence of insect bodies may be due to two factors: (1) water-soluble lac dye present in the insect body and (2) other constituents of the insect body. To determine the relative importance of these two factors, bleaching was conducted with samples of seedlac containing washed and dried insect bodies. Weighed amounts of insect bodies were washed with water, by keeping in contact with water for a long time (48-96 hours), and changing the water 3-4 times until the wash-liquid was colourless.

The mass of insect bodies was filtered and dried at first in air and further by being kept for 4 hours in a vacuum oven at 50°C. and finally for 48 hours in a vacuum desiccator. Samples of seedlac, with which these washed dried insects were mixed, were brought into solution as usual. The loss in the weight of the insect bodies on washing was fairly constant, namely 15-16 per cent, and the amount of bleach liquor ($3 \pm 0{\cdot}05$ per cent available Cl_2) to decolourize the coloured washings was also in proportion to the amount of insect bodies, namely 1·2 c.c. per gram of insect bodies.

But the most striking fact is that although as expected the value of bleach required to decolourize the same seedlac mixed with the same quantity of washed insect to the same standard colour was lower, the value plus the volume of bleach required by the coloured washing does not equate to the amount of bleach required for seedlac containing unwashed insect bodies. This may be seen from Table XVII below.

TABLE XVII

Sample No.	Insect, %	Volume of bleach for 20 gm. sample containing unwashed insect and time to complete bleaching		Volume of bleach for 20 gm. sample containing washed insect and time to complete bleaching		Volume of bleach for washed colour, c.c.	Total of 4(a) & 5 (bleach liquor), c.c.
		c.c.	hours	c.c.	hours		
1	2	3(a)	3(b)	4(a)	(4b)	5	6
1	Nil	40	4-5	40	4-5	...	...
2	2	48	5	44	5	0·5	44·5
3	4	55	10·25	48	5	1·0	49·0
4	6	66	14·5	53	6·75	1·5	54·5
5	10	78	18·25	58	7	2·5	60·5

This indicates that comparatively more bleach is consumed by imperfectly washed seedlac and time required for completion of bleaching is also higher.

The acid and saponification values of lacs precipitated from bleached solutions of seedlac containing washed insect bodies, however, were not observed to vary, beyond experimental limit, from those containing unwashed insects.

(h) Bleach Index

The bleach index or bleachability of seedlac is the most important characteristic of this commodity. There exists, however, considerable divergence of opinion on the subject, particularly in regard to the conditions of extraction of the seedlac, determination of the end point and evaluation of the bleaching number. A comparative study of the various methods available was begun during the period with a view to combining all the satisfactory features of the different methods into one complete and convenient whole. To begin with, conditions were determined for the preparation of a satisfactory bleaching liquor starting from caustic soda as this would form a much more convenient starting material than particular brands of bleaching powders. As a result of a series of experiments it has been found that a satisfactory bleach liquor can be prepared by direct chlorination of ice-cooled caustic soda (1·5 to 2 *N*) solution to such an extent that the final liquor has a free alkalinity of between 0·02 and 0·05 *N*. Further work is in progress.

(i) High Voltage Test

A large number of high voltage tests were carried out as usual during the period under review on the performance of certain improved insulating varnishes, empire cloth substitutes

and moulding compositions. Some *ad hoc* tests were also undertaken on some plastic compositions formulated from molasses by the Indian Institute of Sugar Technology, Kanpur.

4. MAKING OF SHELLAC BY AUTOCLAVE

Making of Shellac by Autoclave Method — A pilot plant to melt 30 srs. of seedlac per charge has been designed and its fabrication ordered with a Calcutta firm.

5. *AD HOC* RESEARCHES

(a) Carbon-type Moulded Resistances from Lac

It was mentioned in the last Annual Report that preliminary trials to produce carbon-type moulded resistors from lac having proved successful, detailed investigation regarding the various steps leading to their manufacture would be undertaken. During the period under report, a systematic investigation was carried out to see the effect of varying the different ingredients of the moulding composition, in particular the effect of using different types of commercial carbon powders available in the market. Of the various carbon powders tried, lamp black gave the best result, so far as uniformity in the hot roller mixing was concerned. Finest grain carbon black also gave comparable result, but graphite powder gave a dull grey appearance to the resistors, and was otherwise unsatisfactory. Leaving aside the effect of carbon powders, it was also found necessary to reduce the proportion of filler in the lac moulding composition to obtain better performance. But the greatest difficulty to be overcome lies in the lack of uniformity in the values of the resistors. Even with lamp black or finest grain carbon black, moulded resistors from any particular composition varied widely in values in spite of the most careful hot roller mixing of the powder. It was considered probable, however, that by keeping the moulding conditions, namely temperature, pressure and time, absolutely constant, some improvement might be effected in this respect. Since the big hydraulic press of the Institute was being used for these experiments in absence of a small laboratory press, in which finer adjustment of pressure is possible, this point could not be immediately verified. Experiments will be conducted with a small hydraulic press as soon as it is available in the laboratory.

Resistors, as made now, have to be graded according to value and accuracy. Ageing has been observed to have practically no effect so far on the constancy of values of resistors thus made. But very recently a drawback has been noticed while carrying out a few practical tests. If the leads are short, and unduly heated for the purpose of soldering in the electric circuit assembly, sometimes the original value of the resistor is disturbed and cannot be restored on subsequent cooling. In such cases the altered value naturally is higher than the original, and does not change unless the sample is again subjected to a drastic heat treatment. This is a defect, and efforts are being made to remedy it. So far, simple heat curing in an oven at 50°-60°C. has been observed to have a beneficial effect.

The problem now is to standardize the process for the manufacture of these resistors so that any one composition may yield resistors of a particular nominal value only within reasonable limits of accuracy, say within ± 10 per cent of the rated value, so that the number of rejects from any group becomes as few as possible. Even then grading may have to be resorted to, particularly where greater accuracy is demanded.

It is intended to try, in the near future, the technique of injection moulding employing some suitable lac moulding composition for the purpose, since this is expected to reduce substantially the cost of production due to a quicker time cycle of the process.

(b) Sealing-wax

The making of sealing-wax, following known recipes, does not always succeed. This is due to the fact that shellac used for the purpose is not always of the right quality. The

following investigation was undertaken to determine what particular type of shellac is most suitable as an ingredient of sealing-wax. Two properties were considered, viz. (a) life under heat (150°C.) and (b) flow (Westinghouse). The formula for making sealing-wax in the present investigation was as follows:

Shellac	...	...	...	45 parts
Rosin	...	...	...	15 ,,
Turpentine	...	...	...	5 ,,
Barytes	...	...	...	35 ,,
Vermilion	...	...	...	5 ,,

The fluidity of sealing-wax while hot and the quality of the seals (impression) obtained with them were noted and the results are given below.

TABLE XVIII

Sample No.	Shellac used		Sealing-wax prepared	
	Life, mins.	Flow, secs.	Fluidity	Quality of seal
1	20	Nil	Very bad	Seal could not be made
2	40	108	Good	Good
3	60	240	,,	,,
4	35	800	Bad	With pin holes
5	47	44	Very good	Very good
6	39	345	Bad	Bad
7	53	295	,,	,,
8	42	180	Good	Good
9	17	Nil	Could not be melted	...
10	26	200	Good	Good

Experiments were done to improve the quality of sealing-wax made from sample Nos. 1, 4, 6, 7 and 9 by increasing the proportion of rosin and turpentine. Sample Nos. 1 and 9 could not be improved by increasing these ingredients even by 100 per cent; the other samples improved in fluidity, but not otherwise; in fact, the quality of the seals deteriorated as more rosin made them brittle and less heat resistant, and too much turpentine made them oily, so much so that oil marks were visible on the other side of the paper on which seals had been stamped. For these tests, kraft paper was used.

To determine the heat-resisting property, seals with fine details were made on paper and placed in an air oven at 55°C. for 5 hours. These were then compared with a control one under microscope.

From the data given in the above table, it may be seen that shellac of sample No. 5 type, which is a fresh one, is the best. Shellac of the types of sample Nos. 2, 3, 8 and 10 are satisfactory. So, it may be concluded that at least one of the two properties of shellac, viz. life and flow, must be good in order that it may be suitable for using in the preparation of sealing-wax. But to avoid possible failure, it is advisable to use fresh shellac.

(c) Coating for Earthenware Pots Used for Collecting Palmyra Juice

Arising out of an enquiry for an impervious coating on earthenware pots used for storing palmyra juice, investigations were undertaken to evolve a suitable composition from shellac. As a result of few experiments done in collaboration with an officer from the Central Palm Gur Training School, Cuddalore, it was found that a simple aqueous ammoniacal solution of shellac (strength 20-25 per cent) could give a suitable coating composition, but that the

coated articles have to be baked at 130°-135°C. for 3-4 hours to make the coating sufficiently resistant to moisture and bacterial attack. Application of the varnish may be made by dipping, brushing or spraying. To obtain best results, it is necessary to give 3 or 4 successive thin coats allowing sufficient time for each coat to dry before another coat is applied; this should be followed by air or sun drying for 24-36 hours, after which baking may be done. It is inadvisable to use only one or two thick coats or to use a thicker varnish as the coating then not only takes longer time to dry thoroughly, but the films also show a tendency to crack and peal off from the surface.

Incidentally, it has been found that earthenware coated and baked in the manner described above resist hot water, 2-3 per cent soap solution, salt, mineral and vegetable oils, organic and dilute mineral acids. Consequently such vessels can be used for storing domestic articles like salt, sugar, *gur*, pickles, oils, etc.

(d) Cement for Electric Lamps

An enquiry was received from a firm of electric bulb manufacturers in Calcutta for a transparent adhesive suitable for fixing small metal caps to glass bulbs. The adhesive should be able to stand a temperature of 120°-125°C. for half an hour. A composition from aleuritic acid developed earlier with further modifications was suggested. A small quantity of the prepared cement was also sent to the firm for trial. A report from them is now awaited.

6. DEMONSTRATION AND PUBLICITY

Work under this head was continued, although to a reduced degree. Information was supplied mostly through correspondence to interested parties in answer to various enquiries from them. Such enquiries mainly related to source and suitability for particular uses of various types of lac and effects of storage under different conditions, improvements in French polish and methods of preparation, prevention of darkening of such polishes in metal containers, insulating varnishes, etc. A number of enquiries regarding moulding compositions, impregnation of jute with shellac, "oil-cloth" varnishes, adhesives and cements based on lac were also received, and answered to the satisfaction of the parties concerned.

Large samples of coating compositions suitable for making leather-cloth, book-binding cloth and rexine-like materials were sent to industrial firms in Bombay and Saharanpur for large-scale trials and report. Practical demonstration of making such materials was also given to two firms in Calcutta.

A report was received from the Military Stores Wing in Dehra Dun that the radio knobs, moulded out of lac compositions, though otherwise satisfactory, were developing fungus growth under tropical tests. Accordingly, a fungicide was incorporated in the composition, and a number of knobs made out of this were supplied to Dehra Dun for further test and report. The party has reported that the improved lac composition is also suitable for making binocular eye cups.

Details regarding the composition and methods of preparation of the adhesive for preparing waterproof emery papers, cloth, etc., were supplied to the Technical Development Establishment Laboratory (Stores), Kanpur. An adhesive composition suitable for making and fixing paper cones to metal frames was suggested to the Radio Engineer, Government of Madras, and to a private party in Sholapur.

Advice was given to an electrical firm in Calcutta regarding an insulating compound to be used as a filler between the metal component and porcelain or plastic base used in telephone and radio appliances.

Particulars regarding the making and specifications of various grades of sealing-wax were supplied to a Government Department in Bihar. Certain jail authorities are understood to have started a fairly large-scale production of these accordingly.

On a request from the Central Palm Gur Training School (Ministry of Agriculture, Government of India) in Cuddalore, the suitability of shellac compositions for coating palm juice pots was investigated. Plain shellac was found suitable for the purpose, and the coating schedule developed is being given field trial at Cuddalore. The All-India Village Industries, Association, Wardha (M.P.), also found the method useful and are giving it a trial in their pottery section. An officer on deputation from Cuddalore was also trained on the practical side.

A gramophone record manufacturing firm in Bombay was given information about the type of lac to be used in making gramophone records, and also the source from where the requisite type could be obtained.

A few interested Indian parties were shown the process of making shellac by the " autoclave process ".

Data regarding the approximate production of *kiri* and availability of the same in the country for manufacturing garnet lac were given to the Secretary, Board of Scientific & Industrial Research, New Delhi.

Exhibits on lac and lac products were sent to India House, London, in connection with an exhibition held there to popularize Indian raw materials. In addition, samples of exhibits were also sent to various exhibitions held in the Indian Union during the year and also to some museums.

7. METEOROLOGICAL REPORT

The average meteorological data for each month during the period are given in the following table.

TABLE XIX

Month		Wind speed (miles/hr.)	Max. temp. (°F.)	Min. temp. (°F.)	Dry bulb temp. (°F.)	Relative humidity	Sunshine (hrs./day)	Rainfall (inches)
April	1950	2·60	100·6	68·1	86·4	19·4	10·7	0·80
May	1950	2·65	103·5	73·0	87·5	47·0	8·7	2·32
June	1950	2·90	93·0	74·8	91·5	75·5	4·8	13·54
July	1950	2·40	86·6	73·2	77·8	90·0	3·1	21·52
Aug.	1950	2·00	87·0	72·2	78·5	80·4	3·6	13·97
Sept.	1950	1·80	87·6	71·1	79·1	79·5	6·7	8·08
Oct.	1950	1·20	86·2	63·6	75·9	63·0	8·0	0·97
Nov.	1950	1·30	79·7	52·3	69·4	46·8	8·1	0·30
Dec.	1950	1·10	76·4	45·5	64·9	42·0	9·9	0·10
Jan.	1951	1·10	72·9	43·8	62·3	51·5	9·8	1·15
Feb.	1951	2·00	82·0	50·7	69·7	28·0	10·5	...
March	1951	3·75	86·7	60·5	77·7	37·1	8·4	2·75

The highest maximum temperature attained during the period was 108°F. and was recorded on 1st, 2nd, 4th, 5th, 8th and 15th May 1950. The lowest minimum temperature was 38°F. and was recorded on 2nd, 3rd, 24th and 25th January 1951. The monsoon rainfall was rather high this year being 57·11 inches compared with the average of approximately 46 inches for the last three years. The total rainfall, viz. 65·50 inches, was, however, slightly less than the last year's figure of 68·59 inches.

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APPENDIX I

A Statement of Lac Produced and Its Disposal (during 1950-51)

Crop and locality	Scraped or broodlac produced and its disposal																							
	Produce			Under use in Dept.			Driage			Supplied to Chem. Sec.			Sold			Distribution (free)		
	Md.	sr.	ch.	Md.	sr.	ch.	Md.	sr.	ch.	Md.	sr.	ch.	Md.	sr.	ch.	Md.	sr.	ch.
Baisakhi 1949-50	... 8	34	0†		...			...			...		1	20	0†	7	14	0†
Namkum	... 1	13	14*	0	2	0*	0	15	2*	0	36	12*		...			...	
Jethwi 1950 Hesal ...	... 0	18	12*	0	2	0*	0	1	0*	0	15	12*		...			...	
Katki 1950 (Namkum)	3	38	0†	3	38	0†		...			...			...			...	
	0	2	8*		...		0	0	8*	0	2	0*		...			...	
Aghani 1950-51 Hesal ...	... 0	13	½*	0	13	½*		...			...			...			...	

RECEIPTS

	Quantity, Md. sr. ch.	Value, Rs. as. p.
1. By supply of broodlac for use in the Entomological Section from Institute plantation	3 38 0	296 4 0
(a) By supply to free distribution of broodlac from Institute plantation	7 14 0	624 12 0
(b) By sale of broodlac from Institute plantation ...	1 20 0	127 8 0
TOTAL of (a) & (b)	8 34 0	752 4 0
2. By supply to Chemical Section of scraped lac from Institute plantation	1 14 8	103 3 6
3. By supply of scraped lac for use in the Entomological Section	0 17 ½	33 13 0
4. By supply of scraped lac from purchased lac		
(a) to Chemical Section (*Jethwi* 1950)	0 2 8	5 0 0
(b) to Entomological Section (*Aghani* 1950-51) ...	0 3 14½	7 13 0
(c) to Entomological Section (*Katki* 1950)	2 0 0	130 0 0
TOTAL of (a), (b) & (c) ...	2 6 6½	142 13 0

* Scraped lac. † Broodlac.

APPENDIX II

Tabulated Statement of Progress of Investigations

Item	Commd.	Progress	Future work proposed
1	2	3	4
1. Lac Cultivation			
(i) Large-scale experiments on and demonstration of improved crop production on *palas* by artificial partial defoliation and preservation of *Baisakhi* brood: Kundri forest area (Palamau)	1948-49	Though there was general scarcity of broodlac all over Chotanagpur, particularly in Palamau, Kundri produced over 126 maunds of *Baisakhi* broodlac, and about 37 maunds of the *Katki* crop (broodlac). *Katki* crop was poor all over Chotanagpur. Kundri also served as a good training ground for trainees at the Institute.	To be continued for 2 years at least.
(ii) Preservation of *Baisakhi* broodlac by employing suitable hosts	1945-46	*A. lucida* at Namkum gave better results than *O. dalbergioides*. Several hosts, e.g. *barh*, *dumbar* and *siris*, also tried.	A thorough investigation would require suitable field stations. To be continued.
2. (i) Determination of most suitable pruning methods for *kusum*	1941	Apical and surface pruning being tried at respective intervals of 6, 12 and 18 months.	To be continued.
(ii) Shoot study: growth	...	Growth of primaries poorest in the case of surface pruning at 6 months' interval. Growth of secondaries best in the case of surface pruning at 12 or 6 months' interval.	To be continued.
(iii) Yield of lac crop	...	No conclusive results could be obtained owing to shortage of brood supply, etc.: the design of the experiment has been modified.	To be continued.
3. Pests of Host Trees			
(i) *Tessaratoma javanica*	1950	This is a pest of *kusum* and might be affecting shoot growth. Its incidence, nature of damage and life-history are being studied.	To be continued.
(ii) Termites	...	Damage due to termites found to occur. Study commenced.	To be continued.
4. Lac Insect			
Lac insects	1950	Collection of preserved specimens of lac insect and its strains rearranged and catalogued as a prelude to its systematic study.	To be continued.
5. Survey of Enemies of Lac			
(i) *Chrysopa sp.*	1950	It is one of the predators of lac insect. Its incidence on *ber*, *kusum* and *palas* recorded. Life-history being studied.	To be continued.
6. (Preventive) Methods of Control			
(i) *Cultural Methods:*			
Use of wire-gauge baskets as brood containers during infection, as control against enemies of lac	1945	It has given good results in Palamau (Bihar), Bhopal, Karnal (Punjab) and Madras. Economics of the process being investigated to a limited extent.	To be continued; for large-scale trials it is necessary to have suitable field stations.

APPENDIX II (*contd.*)

ITEM	COMMD.	PROGRESS	FUTURE WORK PROPOSED
1	2	- 3	4
(ii) *Biological Control:*			
(a) *B. greeni:* ecto-parasite of *E. amabilis*	1942	It has been possible to get all-the-year-round supplies of *Etiella zinckenella* [an alternative (unnatural) host of *B. greeni*] by cultivating its various hosts at Namkum.	...
(b) To discover suitable alternative hosts to breed *B. greeni* in laboratory for mass-scale breeding of the parasite	1942	*Etiella zinckenella, P. gossypiella, T. fructicassiella, L. orbonalis* were collected. Study of the life-history of *B. greeni* as tried on *E. zinckenella* commenced with a view to breeding it on large scale.	To be continued.
7. Training and Advisory Service			
(i) Training	1940	In all 28 persons were under training from Bihar, Madhya Pradesh, U.P. and West Bengal.	To be continued.
(ii) Advisory service	...	Advice was given to lac cultivators all over India.	...
8. Supply of pruning instruments and broodlac	...	Broodlac was supplied free under demonstration and extension schemes and sold to outside parties. Pruning instruments were given to demonstration staff.	To be continued.
9. Intensive Demonstration			
(i) On cultivators' trees	1940	Institute methods gave good results in practically all Demonstration Centres.	To be continued.
(ii) In forest areas	1943	Oreya yielded good *kusmi* crop when there was a general failure of crop all over Chotanagpur. Cultivation going on in Mako, Saranda and Chaibasa division.	To be continued.
10. Namkum Plantation	...	Research Officer of the Forest Department, Bihar, visited the plantation to give advice on the re-stocking of lac hosts in selected plots. His report is awaited. 173 trees yielded 9 mds. 22 srs. of broodlac. Total revenue of Rs. 1,699-0-9 obtained.	The Assistant for plantation has not yet been recruited.
11. Extension of Lac Cultivation	1948	Schemes were drawn up for Bombay, U.P., M.P. and Punjab. In some forests of these states cultivation has been started.	Requires proper consideration by States concerned.
12. Varnishes & Lacquers			
(i) Lac-linseed oil paints	1948	Compositions used to paint iron - and wood-work of the Institute buildings and staff quarters. Surface keeps well indoors, but not out of doors.	Complete.

APPENDIX II (*contd.*)

Item	Commd.	Progress	Future work proposed
1	2	3	4
(ii) "Oil-cloth" composition	1944	Samples prepared more than 2 years back found to retain gloss and flexibility. No after-tackiness developed.	Two commercial firms supplied with large samples for test and report. To be continued.
13. Modification of Lac & Its Derivatives			
(i) Lac esters as resin plasticizers for nitrocellulose	1949	Coated surfaces show poor ageing properties. Control samples using castor oil instead of lac esters are good.	Complete.
(ii) Lac esters and polyvinyl chloride	1949	Films hard, glossy and flexible. Ester oozed out. Partial substitution of PVC by shellac does not improve the film.	To be continued.
(iii) Esterification of lac	1949	Esters of lac have a high viscosity and a rather dark colour. Use of decolourized (not bleached) lacs improves colour. Viscosity cannot be reduced.	To be continued.
(iv) Lac derivatives with pentaerythritol, maleic and phthalic anhydrides and other polybasic acids	1948	Resulting resins are soft, although baked films are hard and glossy; may prove useful in the coating industry or as plasticizers.	To be continued.
14. Fundamental Researches			
(i) Constitution of shellac	1947	Several degradation products (acids) isolated and in some cases tentatively identified. An acid now named as 'butolic acid' has been separated. Position of hydroxyl group being determined.	To be continued.
(ii) Constitution of soft lac resin	1947	Degradation products (acids) studied.	To be continued.
(iii) Methyl ester of lac and constituents	1950	OMe contents determined and carboxyl number calculated.	To be continued.
(iv) Hydroxyl values of lac and constituents	1950	OH number re-determined by a recent method. Values slightly lower than those recorded before.	To be continued.
(v) Polycondensation of aleuritic acid	...	Polycondensation at different temperatures and at various catalyst concentrations studied.	To be continued.
(vi) Polyesterification of dibasic acid obtained from aleuritic acid	...	Activation energy calculated, and course of reaction studied.	To be continued.
(vii) Bleaching of lac and its constituents	1950	Various factors, such as amounts of bleach liquor, the effect of insect bodies, studied.	To be continued.
(viii) Bleach index	1951	Work started to evolve an improved process for determining bleach index or bleachability.	To be continued.

APPENDIX II (*contd.*)

Item	Commd.	Progress	Future work proposed
1	2	3	4
15. Improvements in the Manufacture of Shellac, Seedlac, etc.			
Making of shellac by autoclave method	1947	A pilot plant to melt 30 srs. of seedlac per charge designed and fabrication ordered.	Economics to be studied.
16. *Ad hoc* Researches			
(i) Carbon-type moulded resistances from lac	1949	Resistors prepared are satisfactory excepting that their standardization with the machinery at disposal has not been possible. Changes in value occur when soldering in leads.	To be continued.
(ii) Coating of palmyra juice pots (earthen)	1950	A coating schedule using shellac has been developed. It is being given field trials in several areas.	Work to be continued to extend the use of such coated pots.
(iii) Sealing-wax	1950	Type of lac suitable for use in making sealing-wax determined.	Work complete.
(iv) Moulding composition for radio knobs, etc.	1950	The composition proved satisfactory; Incorporation of fungicides done to prevent fungus growth. Binocular eye cups to be made out of the composition.	To be continued.

APPENDIX III

Papers Published during the Year 1950-51

1. *Bulletin No.* 79. *Determination of Moisture in Lac by Infra-red Heating*, by G. N. Bhattacharya & S. C. Mukherji (*J. Ind. Phys.*, 1950, **24**, pp. 131-136).
2. *Bulletin No.* 80. *Studies on Aleuritic Acid — Part II: Catalytic Polycondensation*, by P. R. Bhattacharya & P. K. Bose (*J. sci. industr. Res.*, 1951, **10B**, pp. 51-56).
3. *Ari Lakh Katne se Haniya* (a leaflet in Hindi).
4. *Lac — the Multipurpose Resin*, by G. N. Bhattacharya (*Manufacturer*, 1951, **11**, No. 12, pp. 1-6).

APPENDIX IV

Statistics of Sticklac Production in India in Maunds

Year	*Baisahki*	*Jethwi*	*Katki*	*Kusmi*	*Total*
1950-51	6,88,050	5,000	2,49,500	40,800	9,83,350
1949-50	6,03,500	1,02,750	3,30,300	1,24,000	11,60,550
1948-49	5,40,000	10,000	1,73,000	82,000	8,05,600

APPENDIX V

Progress Report of the Work Done under the Scheme of Intensive Demonstration of Improved Methods of Lac Cultivation in Bihar for the Period from 1st April 1950 to 31st March 1951

INTRODUCTION

The Scheme on Intensive Demonstration on lac has now completed six years of its life in Bihar, but this period cannot be said to be sufficient to completely change the outlook of the cultivators with regard to giving up the old, indigenous and crude practices of cultivation; nevertheless, the success achieved so far is encouraging. The suspicious outlook of the cultivators towards improved methods has undergone a change to a very great extent. They have now been realizing the superiority and advantages of the improved methods as compared to the indigenous ones. They have in actual practice adopted the methods of lac cultivation advocated by us, and we are also receiving greater measure of co-operation from them. Although the success achieved so far is quite remarkable, yet it needs to be pushed up with still more vigorous effort. In the best interest of work, it is essential that the Scheme should be expanded as the existing strength of the staff is too meagre to undertake anything of the sort which may be of real importance.

STAFF

During the year the office of the Lac Inspector started to function with its headquarters at Namkum. The primary duty of the Lac Inspector is to rectify the mistakes of the lac demonstration staff and to exercise closer supervision of the work and movements of the staff. The said office of the Lac Inspector came in operation in the month of June 1950 with the following strength:

One Lac Inspector	...	Shri R. Ansari
One Lac Clerk	...	Shri T. P. Mandal
One Lac Peon	...	Md. Israfil

There was no change in the personnel of the staff except at a few centres. Shri Francis Lakra, Lac Demonstrator, Chandwa, was transferred to Khunti in the chain of Shri A. Jha, Lac Demonstrator, transferred. Shri Tej Rai, Lac Demonstrator, Jhalda, was discharged as per order of the Entomologist, Bihar, for negligence of duty and overstay. Shri Deolakhan Lal Mishra, Lac Demonstrator, Chatra, was also discharged for the same reason. Shri Chandra Sekhar Mishra, Lac Demonstrator, Jorapokhar, was transferred to Bundu in place of Shri J. S. Runda (Burhan Uraon) as the former was not considered to be efficient to carry out the routine work of the Lac Supervisor.

SURVEY

Special efforts were made to survey the lac hosts, both in the forest compact areas and the idle hosts scattered in the neighbourhood of the villages, in order to bring them under lac cultivation, for carrying on intensive demonstration work successfully. A special feature of this work during the year under report has been to make a preliminary survey of a number of jungles besides the villages for which a separate statement is being enclosed herewith in Table II.

PROPAGANDA

Propaganda, as usual, was done throughout the year on improved methods of cultivation, as advocated by the Institute. The idea was to educate the villagers to know:

1. Insect enemies of lac and their control.
2. To prune trees properly before infection.
3. To cut lac as broodlac as near to the swarming time as possible.

TABLE I — Consolidated Statement Showing the Number of Demonstration Areas Worked, Different Host Trees Operated, Amount of Brood Used and Yield Obtained in Various Lac Centres under Intensive Demonstration Scheme, Bihar, for the Year 1950-51

Centres	No. of sites	Brood used			Name and Nos. of host operated				Total yield			Brood to yield ratio	Remarks
		Md.	sr.	ch.	*Kusum*	*Khair*	*Palas*	*Ber*	Md.	sr.	ch.		
Panki	26	10	32	8	...	...	424	...	17	11	8	1 : 1·59	*Baisakhi* 1950-51 crop in progress and to be reaped in June-July 1951. 99 trees have been defoliated.
Chatra	25	30	10	11	...	...	1,088	...	21	8	6	1 : 0·70	*Baisakhi* 1950-51 in progress. 151 trees have been defoliated. Left for self-infection in *ber* 1949-50 due to poor crop.
Jhalda	18	15	17	4	35	...	656	40	14	3	0	1 : 0·91	*Baisakhi* 1950-51 and *Jethwi* 1951 in progress. 105 trees defoliated. No infection of *Aghani* 1950-51 due to non-availability of brood-lac. *Jethwi* failed.
Chandil	25	49	17	0	7	...	1,083	...	38	20	0	1 : 0·77	*Baisakhi* 1950-51 and *Jethwi* 1951 in progress. 873 trees defoliated. No infection of *Aghani* 1950-51 due to non-availability of brood-lac. *Jethwi* failed.
Bundu	48	33	16	0	101	...	512	...	42	11	0	1 : 1·26	*Baisakhi* 1950-51 and *Jethwi* 1951 in progress.
Palkote	35	28	14	0	94	...	...	598	19	35	0	1 : 0·70	do
Jorapokhar	37	27	2	8	419	...	...	...	6	24	4	1 : 0·24	*Jethwi* 1951 in progress. *Jethwi* 1950 left for self-infection due to poor settlement. *Aghani* 1950-51 failed due to climatic factors.
Latehar	19	30	16	0	28	...	725	12	62	12	8	1 : 2·04	*Baisakhi* 1950-51 and *Jethwi* 1951 in progress.
Chandwa	31	28	3	8	43	...	1,082	...	36	20	0	1 : 1·30	*Baisakhi* 1950-51 and *Jethwi* 1951 in progress.

TABLE II — STATEMENT SHOWING NOS. OF FORESTS AND VILLAGES SURVEYED DURING THE YEAR 1950-51

Centre	Nos. of forests and villages surveyed		Trees surveyed				Remarks
			Kusum	*Palas*	*Ber*	*Khair*	
Bundu	Forests	5	2,900	1,900	1,900	Nil	...
	Villages	8	3,700	Nil	Nil	,,	...
Jhalda	Forests	9	6,488	6,661	351	,,	...
	Villages	...	...	...	...	,,	No survey of villages was carried out during the year
Chatra	Forests	4	Nil	6,200	300	6,000	...
	Villages	15	6	23,000	198	40	...
Panki	Forests	29	326	19,710	Nil	1,93,440	...
	Villages	33	50	23,981	1,505	1,045	...
Chandil	Forests	...	...	...	...	...	No survey of forests was done during the year
	Villages	5	78	1,700	80	Nil	
Jorapokhar	Forests	3	500	Nil	Nil	250	...
	Villages	11	1,678	1,700	,,	Nil	...
Latehar	Forests	9	1,340	2,000	35	600	...
	Villages	22	736	27,400	1,602	1,220	...

4. Cropping of the host trees by rotation to ensure maximum yield with minimum labour.
5. To remove broodlac from trees after two-three weeks, and sooner if the trees are sufficiently covered with larvae.
6. To avoid *ari* cutting and natural infection as much as possible.
7. To reap lac from the trees as soon as it is cut and to destroy all the caterpillars seen therein.
8. Use of only healthy and pest-free lac as brood.
9. Partial pruning of *ber* and defoliation of *palas* for the preservation of broodlac against scorching heat and drought of the summer season. These things were propagated by actual demonstration and also by delivering lectures.

A copy of letter No. F. 4-3/50-Com. dated 16th Dec. 1950 issued from the Government of India, Ministry of Agriculture, regarding immature cutting of lac was forwarded to all the staff concerned. A vigorous propaganda was launched by our staff to discourage *ari* cutting by the cultivators which has been in vogue from generation to generation.

HELP GIVEN TO THE CULTIVATORS

The cultivators of the intensive demonstration areas were supplied with pruning instruments and with free broodlac by the Indian Lac Research Institute, Namkum, with a view to developing and increasing the number of intensive demonstration areas and to obtain maximum yield. This has helped in gaining confidence of the cultivators as well as ensuring better yield. A list of the progeny of brood and type of instruments that were distributed amongst the cultivators is given separately in Table III. Besides, booklets regarding improved methods of cultivation, published by the Lac Research Institute, were distributed amongst them.

TABLE III — STATEMENT SHOWING QUANTITY OF BROODLAC SUPPLIED DURING THE YEAR 1950-51

Centre	Quantity of brood supplied			Remarks
	Md.	sr.	ch.	
Bundu	12	17	0	Supplied in January, June and October 1950
Jhalda	3	20	0	Supplied in June and October 1950
Chatra	4	23	0	do
Panki	5	27	8	do
Chandil	7	35	0	do
Jorapokhar	12	30	4	Supplied in January 1951
Palkote	13	19	4	Supplied during June and October 1950
Latehar	9	35	0	...

INTENSIVE DEMONSTRATION AREAS

The main object of the Intensive Demonstration is to avoid defective and faulty methods followed by the cultivators and to persuade them to take up the cultivation of lac in a systematic way with a view to ensuring greater measure of production of lac. The actual data showing number of sites, number of hosts, amount of brood used, yield obtained and the brood to yield ratio of the respective centres are presented in Table I, Appendix V, which will speak for itself as to how far progress has been made in this direction. Further, visits to the casual demonstration areas were also paid by our lac staff from time to time so as to help the cultivators in adopting the cultivation in a systematic and better way.

Sabour
The 23rd July 1951

ENTOMOLOGIST
Bihar

APPENDIX VI

Progress Report of the Work Done under the Scheme for Intensive Demonstration of Improved Methods of Lac Cultivation in the Uttar Pradesh for the Period from 1st April 1950 *to 31st March* 1951

STAFF

The sanctioned strength of the staff under the Scheme included 2 Supervisors (Rs. 75-6-120) and 6 Lac Demonstrators (Rs. 25-1-40) of which 2 Lac Supervisors and 1 Lac Demonstrator worked in the Scheme in Mirzapur district throughout the period under report. Two Lac Demonstrators were under training at the Indian Lac Research Institute, Namkum, Ranchi, one of whom completed his training towards the end of the year under report and was posted at Mirzapur on the 22nd March 1951. Three posts of Lac Demonstrators remained vacant.

AREAS UNDER INTENSIVE DEMONSTRATION

The intensive demonstration areas were confined to Mirzapur and Dudhi subdivisions of the Mirzapur district with headquarters at Mirzapur and Wyndhamgunj respectively. The work in Dudhi subdivision was extended by opening a new centre at Muirpur in September 1950.

MIRZAPUR SUBDIVISION

Intensive demonstrations of various operations of lac cultivation on improved lines, as recommended by the Indian Lac Research Institute, Namkum, Ranchi, were carried out in eight villages, viz. Jhelumpur, Kakrod, Malua, Bahera, Bami, Rajpur, Maukalan and Tikhore. The work in the last five villages was started from October 1950. For various reasons, no pruning operations for the 1950-51 *Baisakhi* crop and cropping of the 1950 *Baisakhi* crop could be carried out. The total number of lac host trees on which lac was actually cultivated for demonstrative purposes during the period under report was 293, comprising 288 *palas*, 3 *ber* and 2 *pipal* trees. 72 *palas* trees were artificially infected with 2 mds. 35 srs. of broodlac received from the Indian Lac Research Institute, Namkum, Ranchi, and 51 *palas* trees were self-infected in July 1950, for the 1950 *Katki* crop which developed normally except for some damage by parasites and predators in Jhelumpur area. In October-November 1950, apart from the above 123 *palas* trees which were left for self-infection, 165 *palas*, 2 *pipal* and 3 *ber* trees were artificially infected with 10 mds. of broodlac, 9 mds. 10 srs. of which were received from the Indian Lac Research Institute, Namkum, Ranchi, and 30 srs. were of local produce, for the 1950-51 *Baisakhi* crop which developed normally.

DUDHI SUBDIVISION

1. *Wyndhamgunj Centre* — Intensive demonstrations of improved methods of lac cultivation were carried out in fourteen villages, viz. Mundisemar, Hernakachhar, Kolinh-duba, Kewal, Berkher, Jorookhar, Patriha, Jampani, Jantajua, Mahuli, Dhorpa, Fulmena, Bome and Mangardeh. In April 1950 a total of 465 *palas* trees were pruned for infection during October 1950 for 1950-51 *Baisakhi* crop. Operations in connection with *ari* cutting were carried out on 400 *palas* trees during May 1950, and the weight of *ari* lac so cropped was 10 mds. In July 1950, 90 *palas* trees were artificially infected with 5 mds. 7 srs. of locally produced broodlac for the 1950 *Katki* crop, development of which was normal. Work of *phunki* removal on these infected trees was done during August 1950. During October 1950, 386 *palas* trees were artificially infected with 29 mds. 30 srs. of broodlac, produced locally, for 1950-51 *Baisakhi* crop, development of which was satisfactory. *Phunki* lac from these trees was removed in November 1950. During February 1951, 171 *palas* trees were pruned for infection during July 1951 for the 1951 *Katki* crop.

2. *Muirpur Centre* — The centre was started from September 1950, and comprised 17 villages, namely Muirpur, Baliari, Sooyachuan, Baghnandwa, Phatpakhna, Bhalhi, Devri, Kachan, Karhiya, Kirwil, Kusmha, Agarpani, Nadhira, Babhani, Navatela, Parni and Kundadih. In October 1950, with 25 mds. 25 srs. of broodlac of local produce, 669 *palas* trees were artificially infected for 1950-51 *Baisakhi* crop, development of which was satisfactory. Removal of *phunki* lac from these trees was done in November 1950. In February 1951, 123 *palas* trees were pruned for infection in July 1951 for the 1951 *Katki* crop.

CASUAL DEMONSTRATION AREAS

Casual demonstrations of improved methods of lac cultivation were carried out in nineteen villages of Mirzapur district and one village of Banaras district from Mirzapur centre. The quantity of 1949-50 *Baisakhi* and 1950 *Katki* sticklac collected from these areas was 40 mds. and 196 mds. 33 srs. respectively.

HELP GIVEN TO CULTIVATORS

67 mds. 16 srs. of broodlac, 12 mds. 5 srs. of which were supplied by the Indian Lac Research Institute, Namkum, Ranchi, and the remaining of local produce, were supplied free to cultivators in the intensive demonstration areas. Pruning instruments were given to deserving cultivators for the time of pruning operations only.

CROP YIELDS

The yields of scraped *ari* lac and of broodlac from 1950 *Baisakhi* crop in Wyndhamganj circle were 10 mds. and 3 mds. 1 sr. respectively. The total yield of scraped *phunki* lac in all the three circles of Mirzapur, Wyndhamgunj and Muirpur was 8 mds. 34 srs. from 1,397 *palas* trees during August and November 1950. The yield of 1950 *Katki* broodlac was 35 mds. 2 srs. in Wyndhamgunj circle and 30 srs. in Mirzapur circle.

SURVEY

Forty-six villages of Mirzapur district and one of Banaras district were surveyed with a view to locating idle lac host trees.

K. B. LAL
Entomologist to Government
Uttar Pradesh, Kanpur

Kanpur
The 28th September 1951

APPENDIX VII

Report on the Working of the I.D. Scheme in Madhya Pradesh during the Year 1950-51

Beyond sending the candidates for training and purchase of broodlac out of the grant of Rs. 5,000/- given by the Indian Lac Cess Committee, nothing worth mention was done in the year 1950-51 in connection with the Intensive Demonstration Scheme. How far the State Government can participate in the Scheme in demonstration work is still under consideration.

CONSERVATOR OF FORESTS
Madhya Pradesh

Nagpur
The 29th September 1951

APPENDIX VIII

Progress Report of the Work Done under the Scheme of Intensive Demonstration of Improved Methods of Lac Cultivation in West Bengal for the Period from 1st April 1950 *to* 31*st March* 1951

OBJECT OF THE SCHEME

To demonstrate improved methods of lac cultivation as advocated by the Indian Lac Research Institute, Namkum, Ranchi, in the lac-growing areas of West Bengal.

AREA OF OPERATION

District Murshidabad: Subdivision Jangipur, Thana Samergunj, Suti and Farakka.
District Malda; Thana Manickchalk, Ratua and Kaliachalk.

STAFF

The sanctioned strength of the staff under the Scheme consists of 2 Lac Supervisors and 6 Lac Demonstrators. The following Demonstrators, on completion of their training from Indian Lac Research Institute, were posted at centres as mentioned against their names:

(a) Shri Anil Kumar Das — Reported for duty on 19-9-1950 and posted at Alamsahi (Murshidabad).

(b) Shri Salil Ranjan Majumder — Reported for duty on 19-9-1950 and posted at Ratua in Malda.

(c) Shri Atul Behari Karmaker — Reported for duty on 16-9-1950 and posted at Murshidabad.

Another Demonstrator is under training.

SURVEY

Survey of idle lac hosts was conducted throughout the year in the lac-growing areas of the districts of Malda and Murshidabad.

In response to the desire of the Ministry of Agriculture, Government of India, for extending the cultivation of lac, survey of Bankura district was made this year. This survey reveals that this district has all-round possibility for extension of lac cultivation. This is the only district in West Bengal where lac is cultivated both on *ber* and *palas*; also in this district we have some *kusum* trees. This area has now been included (May 1951) within the orbit of Intensive Demonstration Scheme and 1 Demonstrator will soon be posted there. The areas where lac hosts are still lying idle were surveyed, and new intensive demonstration centres were opened in those areas.

This year the Forest Department was contacted for extending lac cultivation in forest areas. The Forest Department was promised all possible assistance in this matter by the Section of Entomology.

PROPAGANDA

The effect of heat and abnormal early emergence of the lac insects adversely affected the *Baisakhi* crop of 1949-50. But *Katki* crop of 1950 turned out quite successful. This year special attention was given to partial pruning, after infection in *Baisakhi* crop. Demonstration was given by the lac staff throughout the lac-growing areas about the method of partial pruning. The cultivators were advised to infect some trees, lightly in *Baisakhi* crop, so that broodlac for infection in the next season may be available from their own stock. Film on " lac " was shown extensively in the lac-growing areas along with other interesting sound films which attracted attention of all local lac cultivators.

INTENSIVE DEMONSTRATION

The object of intensive demonstration is to show the cultivators the superiority of scientific methods of cultivation as compared with the faulty village methods. In intensive demonstration centres, all operations are carried out according to methods advocated by the Institute, so that cultivators get practical acquaintance with such methods; in new areas, broodlac was supplied free of charge to the cultivators and the yield returns went to them for disposal in whatever way they liked.

Number of trees pruned by scientific methods for different crops:

Murshidabad	...	3,500
Malda	...	7,937

Number of Intensive Demonstration Centres:

Malda	...	6
Murshidabad	...	9

Number of villages where casual demonstrations of scientific methods were given:

Malda	...	75
Murshidabad	...	94

EXPERIMENTAL FIELD STATION

An experimental field station was started at Alamsahi in Murshidabad where a demonstrator has been posted. Meteorological apparatus, such as maximum and minimum thermometers, humidity recorder, rain gauge and wind direction recorder, have been installed in the field station. Daily observations of the different meteorological factors are being made with a view to assessing their effect on the lac crop recorded. Also the incidence of predators and parasites and their effect on lac crop are being studied by periodic examination of the sticklac, taken at random from the field station crop. From three years' data of the field station, we hope to be able to find out the cause of early emergence and other factors which are responsible for the deteriorating condition of the present lac cultivation in West Bengal.

CONDITION OF THE STANDING CROP

70 per cent of the lac hosts are bearing the standing *Baisakhi* crop which is quite promising. This year, abnormal early emergence has not taken place and the lac insects did not show any abnormal behaviour. The out-turn from the crop is expected to be satisfactory.

SUGGESTIONS FOR IMPROVEMENT

(a) Cutting of cultivable lac hosts should be made illegal and punishable by law.

(b) Cutting of immature crop (*ari*) for sale or for preserving as brood (*Kakri*) should be prevented.

(c) Establishment of a State Broodlac Farm for supplying broodlac, for infection, to the local cultivators will remove the chronic scarcity of broodlac which is one of the main discouraging factors in lac cultivation.

Calcutta
The 29th June 1951

ENTOMOLOGIST
Government of West Bengal

PRINTED AT THE CATHOLIC PRESS, RANCHI