INDIAN LAC RESEARCH INSTITUTE

NAMKUM, RANCHI, BIHAR, INDIA

ANNUAL REPORT

FOR THE FINANCIAL YEAR 1951-52

1953

CONTENTS

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ADMINISTRATIVE SECTION

General — The Institute pursued its research and other activities as usual under the general guidance and supervision of its Director, Dr. P. K. Bose. Director had been on short leave towards the end of September, and Dr. A. P. Kapur, Entomologist, held charge, carrying out Director's routine duties.

Supply position in respect of foreign equipment and apparatus continued to be tight. One or two items on order for a long time were, however, received during the period. A new UNESCO Coupons (scientific materials) Scheme, similar to the Book Coupon Scheme already in existence, was initiated during the period and the Institute was allotted dollar coupons under the scheme. This will prove very helpful in procuring scientific materials from hard currency areas.

As usual, the Institute attracted a large number of visitors from all walks of life. A few of them, deserving special mention, are:

1. Shri H. C. Chowdhury, Commissioner, Income Tax, Bihar and Orissa
2. Shri T. Gonsalves, Deputy Secretary, Ministry of Natural Resources and Scientific Research, Government of India, New Delhi
3. Shri N. Prasad, Chief Mining Officer, Bihar
4. Dr. H. S. Pruthi
5. Dr. S. S. Joshi
6. Mr. J. P. Young

The last three were the members of a three-man Reviewing Committee, appointed by the Government of India/I.L.C.C. to review and present a comprehensive report on the activities of the Institute.

Roads and Buildings — Maintenance and repair of buildings in the Institute premises, so long carried out under departmental supervision, were entrusted to the Central Public Works Department (C.P.W.D.) during the year under review and will henceforth continue to be the responsibility of the C.P.W.D. Urgent leak repairs and minor carpentry work had accordingly been carried out by C.P.W.D. before monsoon, and annual whitewashing of the residential quarters, except in few cases, finished by the end of March 1952. The roadways of the Institute also received surface dressing where necessary.

The construction of a trainee's hostel and a number of staff quarters sanctioned some time back has not yet been undertaken by the C.P.W.D. This has naturally rendered the problem of staff accommodation rather acute.

Allotment of Quarters — A new set of rules for allotment of quarters was framed by the President and put into force from November 1951. Re-allotment of quarters on the basis of these new rules was done shortly thereafter and shifts from one to another quarters in consequence thereof were practically complete by March 1952.

Water Supply — As reported already (*Annual Report*, 1950-51), the Public Health Department of Bihar took up the question of renovating the water-supply system of the Institute. A preliminary report was prepared and submitted by the Department for the Government of India's scrutiny. Government of India, however, decided that the

renovation of the waterworks should be entrusted to the C.P.W.D. The latter completed inspection of the waterworks following a directive from the Government, and is understood to have submitted its report already.

Library — It was reported before that procurement of German scientific literature was proving extremely difficult since the start of World War II. It was only during the period under review that, as a result of protracted correspondence with various likely sources, an Anglo-German firm in London could at last be contacted which agreed to undertake necessary supply. Supply position is now satisfactory, and in several cases, back numbers of journals have also been obtained. Supply of other foreign journals was quite regular, except for a few American journals, orders for which had reached the publishers rather late, presumably because necessary orders had to be routed through several channels. It may be mentioned in this connection that the system of centralized purchase of foreign periodicals through a common Governmental purchase agency, in force since 1949, has been abolished from January 1952. Hence, orders for journals have been placed through ordinary trade channels, but the change-over has not been altogether smooth, owing to certain unexpected factors.

The UNESCO Book Coupon Scheme, in which the Institute has been participating since its very inception, proved very convenient for obtaining books from U.S.A.

The post of Institute Librarian continued to remain vacant throughout the period, and Shri B. Mukhopadhyay, Director's Technical Assistant, continued to carry out the duties of the Librarian in addition to his own. He was, however, afforded some relief by the appointment of a temporary Library Clerk towards the end of January 1952.

The Library registered a total accession of 210 bound volumes, including journals. In addition, a vast number of pamphlets and stray receipts which had hitherto remained in a somewhat scattered condition were duly entered in a register.

The Institute also issued some 5,000 copies of publications of its own during the period.

Medical Aid to Staff — Free medical aid to the staff and their families continued to be rendered as before, by the Committee's physician. Prescriptions were mostly served from the Committee's dispensary, for the present located in the staff club, by a qualified compounder.

Extension of Lac Cultivation and Intensive Demonstration Schemes — The work under the Intensive Demonstration Scheme was carried on in the States of Bihar, Madhya Pradesh, West Bengal and U.P.

The work of surveying idle lac hosts and, where possible, their exploitation for lac cultivation was also continued as before, though sufficient time could not be devoted for this purpose.

Special Officer for Lac Cultivation (S.O.L.C.) joined about the middle of November 1951, and the recruitment of his staff followed shortly thereafter. Since then, all work in connection with the running of the State Demonstration Schemes, as well as extension of lac cultivation hitherto done by the Director, the Entomologist and the Liaison Officer, has devolved on S.O.L.C. The work of training the Demonstrators and Supervisors, however, continues to be the responsibility of the Entomologist. S.O.L.C.'s office has for the time being been located in the factory building.

Details of work under these schemes will be found in a separate report.

Training — In all 22 persons, all employees of the various State Governments participating in the I.D. Schemes, were receiving training in the improved methods of lac cultivation. Of these 13 (including two on a short course of 6 months) completed their training during the period and reported for duty to the respective States.

Only one candidate joined and completed the course of training in the industrial uses of lac.

Reviewing Committee and the Inspection of the Institute — Following a decision of the Committee that the Institute should be inspected as a whole and not sectionwise as hitherto, a three-man Reviewing Committee was appointed by the Government, with membership as follows: (1) Dr. H. S. Pruthi, Plant Protection Adviser to the Government of India, Chairman; (2) Mr. J. P. Young, Member, Governing Body, I.L.C.C., and (3) Dr. S. S. Joshi, Principal, Science College, Banaras Hindu University. The Reviewing Committee carried out a five-day inspection in January 1952, and submitted its report thereafter. The report was considered by the Indian Lac Cess Committee in its March 1952 meetings.

Staff — With the appointment of Special Officer for Lac Cultivation, a separate office has come into existence under the Indian Lac Cess Committee. Shri S. N. Gupta, Liaison Officer under the I.D. Scheme, has been transferred to this new establishment.

The following cases of appointments, resignations and retirements occurred during the period under report:

1. Shri S. Ranganathan, Scientific Officer, on leave preparatory to voluntary retirement since 4-4-50, finally retired on 7-12-51.
2. Shri N. K. Roy, M.Sc., Physical Chemist, resigned with effect from 25-3-52.
3. Shri M. Bose, Head Clerk, retired on 23-1-51 having attained the age of superannuation.
4. Shri E. Heber, Artist and Photographer, who had been re-appointed some time back after superannuation, resigned his post with effect from 14-3-52.
5. Shri J. N. Maitra was appointed as Stenographer (temporary, in a leave vacancy) on 4-6-51 and discharged on 16-11-51.
6. Shri B. V. Somayajulu, M.Sc., was appointed as Junior Research Assistant (Analyst) on 24-11-51.
7. Shri P. C. Ghosh, B.Sc. (Hons.), appointed as Junior Research Assistant on 14-12-51.
8. Shri Subir Chatterji, appointed as a temporary Junior Clerk in a leave vacancy on 26-12-51, was transferred to the post of Library Clerk (temporary) on 1-4-52.
9. Shri N. K. Sahu was appointed as Library Clerk (temporary) on 29-1-52 and discharged with effect from 1-4-52.

Staff Club — The Indian Lac Cess Committee's annual grant, enhanced from Rs. 600/- to Rs. 900/- in 1950-51, was reduced back to Rs. 600/- in the same year, following a scrutiny by the Government of India. The grant for the period under review (1951-52) was proposed to be further curtailed to a *per capita* grant of Rs. 2/- per annum, which works out at about Rs. 100/- a year. The final position regarding the grant, however, remains a little uncertain and the Club did not receive any grant during 1951-52, pending settlement of the issue.

The Club met Hon'ble Shri Thirumala Rao, Deputy Minister, Food and Agriculture, and the President, I.L.C.C., in a tea-party on 26-10-51, which was attended by some members of the Committee and other officials.

The activities of the Club in providing such amenities to its members as sports, reading materials, etc., had to be greatly curtailed on account of progressive deterioration of the Club's financial position.

ENTOMOLOGICAL SECTION

(Dr. A. P. Kapur, Entomologist)

1. INTRODUCTION

The Intensive Demonstration Scheme for improved methods of lac cultivation and the work on Extension of Lac Cultivation, which hitherto formed a part of the activities of the Entomology Section and of the Institute, were transferred to the charge of Special Officer for Lac Cultivation from November 1951.

Shortage of staff was felt during the period under report. Shri P. S. Negi, Scientific Officer, remained on leave for nearly nine months during the year. The Artist and Photographer (Shri E. Heber) also remained on leave for a few months and ultimately resigned and was released in March 1952. The newly sanctioned post of Arboricultural Assistant also remained vacant throughout the period under report.

2. RESEARCH AND INVESTIGATIONS

(a) LAC CULTIVATION

(i) *Preservation of* Baisakhi *broodlac by partial defoliation of* palas (Butea monosperma) *and demonstration of improved methods of lac cultivation* — Cultivation of lac by the coupé system, and large-scale trial of the method of preserving broodlac from *Baisakhi* crop by partial defoliation of *palas* are being carried out by the Bihar Forest Department at Kundri Forest Reserve (Palamau District) under the technical assistance of this Institute. The area is divided into a *Katki* (smaller; coupé No. II) and two *Baisakhi* (larger; Nos. I and III) coupés, the last two being exploited in alternate years. In coupé I, 8,017 *palas* trees had been partially defoliated in October 1950 prior to their being infected with broodlac and yielded satisfactory *Baisakhi* crop in July 1951. 104 maunds and 29 seers of selected broodlac were obtained and a substantial quantity of the same left on such trees as had infectable shoots with a view to get extra broodlac in October 1951.

Out of the above-mentioned quantity of broodlac 78 maunds and 25 seers were used in July 1951 for infecting 2,167 trees in *Katki* coupé No. II, and a small quantity sold for supply to the cultivators under the Intensive Demonstration Scheme. The surplus broodlac, the rejected lac and the *phunki* (used broodlac) gave a total of 56 maunds and 16 seers of scraped lac.

Of the *Katki* crop obtained in October 1951, about 18 maunds were sold as selected broodlac and the remainder, nearly 98 maunds, utilized for infecting the *Baisakhi* coupé No. III. The extra broodlac from coupé No. I referred to above was also used in coupé III where the standing crop is in a satisfactory condition. The scraped lac obtained from the *phunki* and the rejected lac from the *Katki* crop amounted to 43 maunds 19 seers. Thus an all-round progress was maintained at Kundri. The above experiment clearly shows that large-scale partial artificial defoliation of *palas* can be successfully practised.

(ii) *Preservation of* Baisakhi *broodlac by employing suitable hosts* — With a view to determine their brood-preserving capacity, trials were continued on certain lac hosts (usually classed as minor hosts) which bear *Baisakhi* crop but do not completely shed their leaves during very hot part of summer. The leaves provide shade which affords protection to the lac insects against heat. Owing to lack of field stations, only a limited number of trees of a few such species of hosts could be kept under observation.

At Namkum *Albizzia lucida, Ougeinia dalbergioides* and *Ficus glabella* were under trial and the results obtained are as follows:

Particulars	*A. lucida* (12 trees)	*O. dalbergioides* (25 trees)	*F. glabella* (3 trees)
1. Ratio of broodlac used to yield of broodlac	1: 3·9	1: 2·93	1: 1·91
2. Ratio of scraped lac from brood used to yield of scraped lac	1: 4·8	1: 7·93	1: 0·70
3. Percentage of selected broodlac in the total yield of lac	53·84	47·72	58·36

The results were on the whole superior in the case of *A. lucida* to those of *O. dalbergioides* or *Ficus glabella*. Both thin and thick branches get infected in the case of *A. lucida* and the encrustation is fairly thick. The case of *O. dalbergioides* is similar except that only thinner branches get encrusted with lac. In the case of *F. glabella* the infestation is sparse and the quality of brood, therefore, not as satisfactory as in other two cases. Also at Namkum, *Baisakhi* crop obtained from two trees of *Ficus cunia* (*poroh*) contained selected broodlac to an extent of 94·77 per cent out of a total yield of 22 seers and 11 chhataks.

At Kundri preliminary trials on two *barh* (*Ficus bengalensis*), one *dumber* (*F. glomerata*) and one *siris* (*Albizzia lebbek*) showed that in spite of the apparently good condition of the crop in April-May the final condition of the crop (reaped in July) was rather poor. The yield of lac and the percentage of selected brood obtained in each case were as follows — *barh*: selected brood = 23·07-25·2 per cent of the total yield (1 md. 24 srs.); *dumber*: selected brood = 14·28 per cent of the total yield (2 mds. 8 ch.); *siris*: selected brood = 13·85 per cent of the total yield (8 srs. 2 ch.).

(b) Pruning of *Kusum*: Determination of Most Suitable Methods and Seasons for Pruning

As stated in the last year's Report, 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. Four treatments are being tried for the purpose: first, 'Apical' pruning, i.e. cutting a branch near the apex, with 18 months' interval of rest between pruning and infection. In the second treatment this interval has been reduced to 12 months. Another kind of pruning called the 'Surface' pruning (*vide Report*, 1947-48) had been evolved to see if suitable number and quality of branches could be produced. In the third and fourth treatments surface pruning was practised with 12 and 6 months' intervals of rest respectively.

(i) *Shoot study: Number and growth of shoots* — Observations were taken fortnightly on the number of buds that appeared and developed into shoots on a previously marked branch to be referred to as the "main branch shoot". Length and girth of these shoots were also recorded at fortnightly intervals and a summary of the observations on the growth of shoots is given below and in the accompanying Table No. I.

RESULTS OF *KUSUM* SHOOT STUDY FROM JANUARY-FEBRUARY 1951 TO JANUARY-FEBRUARY 1952

Treatment I — 18 months' interval of rest — 'Apical' pruning — For this treatment 4 trees are under observation, two being pruned/cropped in January-February and two in June-July each year. In the former set of trees (Nos. 14 and 134) the primary buds appeared from the beginning to the last week of February and the majority of buds occurred on the portion which had been left uncut to serve as the main shoot, and which had been one of the primaries in the previous interval. Primaries continued to grow in length up to the end of March or the first week of April. The maximum length was generally attained within a fortnight. In the set of trees (Nos. 180 and 124) which were pruned/cropped in June-July, primary buds appeared by the middle or end of July. Here also most

of the buds came out on the new portion of the main shoot which had been left uncut as in the above set. The primary shoots continued to grow up to the end of August after which the growth ceased. Sometimes when the primaries got damaged, the secondaries appeared in early March and the growth ceased by the end of March or first week of April. It was noted that in the set of trees which were pruned/cropped in January-February, new growth took place mainly in March-April and again in the following March-April and not during the intervening period. In the set of trees pruned/cropped in June-July and in which the first active period of growth from July to September was followed by a period of another activity beginning from March, it was observed that sometimes the growth period extended to the month of July and almost merged with the period of growth from July to September. In the latter case though the growth was slow, the net results were better as the majority of shoots produced were longer than was the case in the former.

Secondary and tertiary shoots mostly appeared during March-April. If they happened to develop during the period from July to September, they did not grow in length but mostly remained as such until the next period of growth, i.e. March-April or a little earlier (mid-February). In tree No. 180 only one sub-tertiary developed in the middle of July and reached the maximum length of 6¾ inches.

Treatment II — 12 months' interval of rest — 'Apical' pruning — In this treatment 3 trees are under observation. In the trees (No. 36) which had been pruned in February 1951, primary buds started developing in the beginning of March and after about a fortnight shoots were fully formed. By the end of March damage to shoots was noticed. Growth continued slowly in the case of a number of shoots up to the end of April and stopped till the middle of second week of May when the shoots started to grow again. Again there was a lull in the growth for nearly a month and from the middle of June the rate of linear growth was rather quick for almost all the shoots. In June the secondaries appeared and by the middle of July all growth stopped. By the end of September, buds giving rise to secondaries began sprouting but did not make much progress in growth. In the other set, i.e. those cropped/pruned in June-July, the conditions were somewhat different. In the case of the tree (No. 161) which was cropped a year earlier (1950), primaries and secondaries developed by the middle of September and first week of October 1950 respectively. These did not grow further for the year. Another period of active growth was noticed in March 1951 when a new batch of secondaries and tertiaries developed; by the end of first week of May all growth stopped. Some sub-tertiaries and sub-sub-tertiaries appeared in April. Of the sub-tertiaries, 23 developed to an average length of 4·03 in., the range of length being 0·25-15 in. And from these tertiaries 11 sub-sub-tertiaries developed to an average length of 3·36 in., the range of length being 0·5-11·5 in. In the other tree (No. 114) the primaries had attained their maximum growth by the middle of August 1951; the secondaries started to sprout in September, but did not develop further.

It will be noticed that in common with tree Nos. 180 and 124 (treatment I) tree No. 161 too had its secondaries appear during the usual period of activity lasting from July to September, but then while the growth of the secondaries was comparatively slow in the former, it was normal in the latter.

Treatment III — 12 months' interval of rest — 'Surface' pruning — In this treatment also 3 trees are under observation. Tree (No. 42) which had been cropped in February 1951 developed primaries by the end of March and these continued to grow up to the first week of April; further growth started in the middle of June and continued up to the first week of August when driage at tips of shoots and insect damage followed. A batch of secondaries was noticed in June; this was followed by another batch of secondaries which, however, were damaged in the very early stage with the result that a third batch of secondaries came up in the middle of October; about this time some tertiaries also appeared on the older secondaries (1st batch). A fourth batch of secondaries developed in the middle of November, but these did not develop into shoots. Growth continued up to middle of December for those shoots which had come out in October.

Tree No.	Date of pruning (P) or cropping (C)	Primaries			Secondaries			Tertiaries			Remarks about lac settlements and encrustations (Ps=primaries; Ss=secondaries)
		Buds sprouted and % developed into shoots	No. of shoots	Length in inches, average range	Buds sprouted and % developed into shoots	No. of shoots	Length in inches, average range	Buds sprouted and % developed into shoots	No. of shoots	Length in inches, average range	
1	2	3	4	5	6	7	8	9	10	11	12
					Treatment I						
14	3-2-51 (C)	100·0	5	6·55 (2·25-12)	62·5	5	1·7 (0·25-3·0)	Buds started coming out towards the end of February			Will be infected in June-July 1952.
124	4-7-51 (C)	45·7	16	4·36 (0·75-10·5)	No secondaries			No tertiaries			*Cropped in July* 1951 — 5 Ps have excellent encrustation; 9 Ss with encrustation as on Ps, but 1 has partial and scattered. Tertiaries and sub-tertiaries do not have any encrustation.
134	17-1-50 (C)	50·5	5	4·4 (1·0-9·0)	54·1	13	3 (0·5-6·0)	50·0	3	0·81 (0·5-1·5)	*Cropped in Jan.* 1952 — 4 Ps have poor encrustation consisting of scattered immature dead cells. 9 Ss have very poor encrustation.
180	23-6-50 (P)	...	6	5·6 (1·0-11·5)	75·0	14	5·73 (1·0-21·5)	75	6	3·46 (1·0-10·0)	*Infected in Jan.* 1952 — Only 4 Ps with lac larvae settled on them. On 10 Ss there is good settlement. 3 tertiaries and 1 sub-tertiary with good larval settlement.
Average		52·0	8	4·94	62·5	13·3	3·99	64·2	4·5	2·57	
					Treatment II						
36	1-2-51 (P)	66·6	8	11·9 (0·75-23·0)	66·6	2	8·85 (1·0-16·75)	No tertiaries			*Infected in Jan.* 1952 — 6 Ps have fairly good settlement of lac larvae and 1 S has also lac insect settled on it.
114	5-7-51 (C)	21·05	8	3·37 (1·0-8·0)	Only 2 buds	No growth of secondaries		No tertiaries			*Cropped in July* 1951 — 5 Ps have scattered immature and dead cells, not satisfactory. 1 P has good encrustation. None of the Ss and tertiaries has encrustation.
161	29-6-50 (C)	44·4	12	5·2 (0·25-16·75)	64·2	20	3·37 (0·25-8·25)	67·8	40	4·29 (0·25-18·25)	*Cropped in Jan.* 1952 — Practically no encrustation on Ps. On 3 Ss encrustation good, on 3 poor. On 6 tertiaries encrustation good and on 3 poor. 6 sub-tertiaries have sparse encrustations of mostly dead and immature cells.
Average		36·2	9·3	6·59	64·7	11	3·8	67·8	40	4·29	
					Treatment III						
42	3-2-51 (C)	100·0	5	9·9 (3·5-15·5)	50·0	7	2·4 nearly (0·5-5·5)	100·0	2	5 (4·25-5·75)	*Infected in Jan.* 1952 — Ps have lac larvae sparsely settled on them. Only 2 Ss and 2 tertiaries have sparse and partial settlement.
128	8-7-51 (C)	100·0	2	5·37 (2·25-8·5)	100·0	1	2·25	No tertiaries			*Cropped in July* 1951 — Encrustation on 2 Ps of dead and immature cells. None of the Ss have any encrustation.
190	10-7-50 (C)	100·0	2	10 (5·0-15·0)	100·0	3	2·58 (1·5-4·25)	No tertiaries			*Cropped in Jan.* 1952 — Both the Ps and 1 S have fairly good encrustation.
Average		100·0	3	8·91	61·1	3·6	2·43	100·0	2	5·0	
					Treatment IV						
70	4-2-51 (C)	100·0	2	7·5 (5·5-9·5)	100·0	1	6	No tertiaries			*Cropped in Jan.* 1952 — Encrustation on 1 P only, rather scattered, with well-developed, mature, dead cells. On the S there are about half a dozen immature cells.
214	5-7-51 (C)	58·3	7	2 (1·0-6·0)	Only 5 buds	No growth					*Infected in Jan.* 1952 — Settlement of lac larvae on all Ps. *Cropped in July* 1951 — Only 2 Ps had scattered encrustation with mostly dead and immature cells. No encrustation on Ss.
Average		64·2	4·5	3·2	100·0	1	6·0				

In the other set, i.e. those cropped/pruned in June-July, the growth was as follows: Tree No. 190: One primary appeared towards the end of July 1950 and continued to grow up to the middle of August. Its growth re-started early in October when it increased in length. The other primary as well as one secondary appeared in March 1951 and the older primary again increased in length up to the end of March. Towards the middle of May the secondary shoots started to grow again and two new secondaries appeared, but did not grow beyond 2 in. by July 1951 when the tree was infected. Tree No. 128: After pruning in early July 1951, only 2 primaries developed by the end of the month and continued to grow up to the middle of August. At this time one primary got damaged at the tip with the result that secondary buds started to appear; by the end of August only one of these developed into a small secondary shoot; its rate of growth, however, was very small, a length of 2¼ in. only having been attained towards the end of November after which no further growth took place for the period under report.

Treatment IV — 6 months' interval of rest — 'Surface' pruning — In this treatment, 2 trees are under observation; one of these gets pruned/cropped every year in January-February and the other in June-July. In the tree which had been cropped in early February 1951 (tree No. 70) primaries started to develop in the first week of March and growth stopped by the middle of the same month. Due to damage to the larger primary, one secondary shoot appeared on it in the later half of June, which stopped growing after attaining about 6 in. length; there was no further growth in any of the shoots.

In the other set, cropped in early July 1951 (tree No. 214), primaries started to develop towards the end of July. By the middle of August their growth stopped. There was much damage by certain leaf-minors. Secondary buds began to sprout profusely in the second week of September but some buds were again damaged at a very early stage with the result that another group of secondary buds appeared towards the end of October. Their growth was, however, arrested, the buds remaining in the same condition up to the end of January when the tree was infected.

It will be seen that the primaries (first shoot sprouting from the main branch) in treatment No. III (12 months: surface pruning) had on the average the best growth, and in treatment II (12 months: apical pruning) it was better than in treatments I and IV. This year also the observed growth of primaries in treatment IV, i.e. surface pruning at 6 months' interval, is distinctly poorer as was reported last year. As regards the secondaries apical pruning with 18 and 12 months' intervals of rest was superior to surface pruning at 12 and 6 months' intervals.

(ii) *Yield of lac* — The ratio of broodlac used to yield of lac (based on weights of scraped lac in each case) obtained from the trees receiving the above-mentioned four treatments is given below:

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

Treatment		*Jethwi* (1951) crop		*Aghani* (1952) crop	
No.	Interval of rest and type of pruning	No. of trees	Ratio of broodlac used to yield	No. of trees	Ratio of brood used to yield
I	18 months: apical	9	1: 2·96	18	1: 6·38
II	12 months: apical	11	1: 0·79	21	1: 6·12
III	12 months: surface	9	1: 1·5	12	1: 8·78
IV	6 months: surface	10	1: 1·6	19	1: 8·52

Owing mainly to improvement in brood production from the area itself, 39 and 70 trees could be infected for *Jethwi* and *Aghani* crops respectively. The latter was a bumper crop and gave a ratio between broodlac used to yield of lac (weights of scraped lac in either

case) which was the highest ever obtained since the start of the experiment in 1946 at Hesal, and was perhaps mainly due to favourable climatic conditions.

As stated in the last *Annual Report*, a similar experiment with statistical layout was commenced in February 1951. The results together with their statistical analysis, kindly undertaken by the Crop Statistician of the Indian Lac Cess Committee, are given below:

TABLE III — CROP COMPARISION ON THE BASIS OF YIELD

Treatment		*Jethwi* (1951) crop		*Aghani* (1952) crop	
No.	Interval of rest and type of pruning	Tree No.	Ratio of broodlac used to yield (scraped to scraped)	Tree No.	Ratio of broodlac used to yield (scraped to scraped)
I	18 months: apical	87	1: 1·61	142	1: 7·08
		88	1: 2·00	143	1: 7·85
		89	1: 3·93	148	1: 4·15
		90	1: 2·98	151	1: 5·95
		Total	10·52	Total	25·03
		Mean	1: 2·63	Mean	1: 6·26
II	12 months: apical	113	1: 1·26	159	1: 2·75
		115	1: 0·85	162	1: 6·79
		117	1: 0·58	164	1: 5·23
		118	1: 0·71	223	1: 6·17
		Total	3·40	Total	20·94
		Mean	1: 0·85	Mean	1: 5·24
III	12 months: surface	129	1: 1·44	189	1: 6·75
		130	1: 0·65	192	1: 8·88
		131	1: 0·82	193	1: 9·69
		133	1: 1·03	198	1: 2·75
		Total	3·94	Total	28·07
		Mean	1: 0·98	Mean	1: 7·02
IV	6 months: surface	203	1: 1·13	61	1: 9·74
		207	1: 0·25	63	1: 1·59
		208	1: 2·00	75	1: 1·95
		209	1: 1·16	79	1: 7·81
		Total	4·54	Total	21·09
		Mean	1: 1·13	Mean	1: 5·27

Jethwi 1951

ANALYSIS OF VARIANCE

	S.S.	D.F.	M.S.	F.
Between treatments	8·2314	3	2·7438	6·107
Within treatments (error)	5·3910	12	0·44725	
Total	13·6224	15		

Conclusion: Treatment effects are highly significant. The S.E. of difference between mean of any two treatments = 0·4732. Treatment No. I is significantly superior to all other treatments at the 1 per cent level. The others do not differ significantly among themselves even at 5 per cent level. At 5 and 1 per cent level: I, IV, III, II.

ANALYSIS OF VARIANCE

	S.S.	D.F.	M.S.	F.
Between treatments	8·8171	3	2·9390	<1
Within treatments (error)	97·1077	12	8·0923	
Total	105·9248	15		

Conclusion: Treatment effects are not significant even at 5 per cent level. The S.E. of difference between mean of any two treatments = 2·005. Difference between the mean of III and II, i.e. highest and lowest = 1·78.

$$\therefore\ t = \frac{1{\cdot}78}{2{\cdot}005} < 1$$

Hence none of the differences are significant even at 5 per cent level: III, I, IV, II.

(iii) *Yield of broodlac: Proportion of broodlac to total yield of crop in the four treatments* — Successful pruning aims at producing such shoots as would not only yield more lac crop but also more broodlac, because any shortage of brood in one crop would seriously affect the production in the next crop. It has been often noticed that if tender shoots are infected the encrustations towards the apex contain mostly dead insects and the resulting crop yields a relatively low proportion of broodlac. In order to judge the effect of the four different pruning treatments from the above-mentioned point of view, careful selection of broodlac was made from the total crop treewise; the data obtained together with the results of statistical analysis are as follows:

Treatment No.	Percentage of selected brood from each tree				Total	Mean
I	53·7	75·5	44·1	86·3	259·6	64·9
II	46·8	49·7	69·7	65·1	231·3	57·8
III	77·1	84·2	79·2	41·5	282·0	70·5
IV	62·8	25·9	44·0	72·8	205·5	51·4
Total	240·4	235·3	237·0	265·7	978·4	—

ANALYSIS OF VARIANCE

	S.S.	D.F.	M.S.	F.
Between treatments	832·365	3	277·455	<1
Within treatments (error)	395·775	12	329·148	
Total	4783·14	15		

Conclusion: Treatment effects are not significant even at 5 per cent level. The standard error of difference between mean of any two treatments = 12·81. Difference between the means of III and IV, i.e. the highest and lowest = 19·1.

$$\therefore\ t = \frac{19{\cdot}1}{12{\cdot}81} < 1$$

Hence none of the differences are significant even at 5 per cent level: III, I, II, IV.

It will, however, be observed that whereas in the matter of crop yield for the same season treatment No. IV has third place, in the matter of broodlac it occupies fourth place. Further observations for succeeding crops would be continued.

(c) Pests of Host Trees

(i) Tessaratoma javanica *Thunberg* (*Rhynchota: Pentatomidae*) — Observations on the incidence, nature of damage and life-history of this bug were continued. Its incidence on *kusum* was much less at Hesal and Namkum this year than was the case last year. However, the peak period of their activity remained the same as last year, i.e. June-July, when a large number of nymphs as well as adults are seen on new and young shoots of *kusum*. Attempts made at various intervals to breed the bug on other major lac hosts including *palas* on which it was reported to have occurred (*Annual Report*, 1932-33) met with failure. However, it was possible to rear it on *litchi* (*Nephelium litchi*). Owing to the occurrence in larger numbers of this bug and the appearance of new young shoots of *kusum* at about the same time (June-July), it was suspected earlier that this pentatomid may be responsible for drying up of some of the young shoots at their tips. Trials were made to investigate this point, by confining *Tessaratoma* nymphs and adults on apparently healthy and young shoots in field cages at various intervals during June-September 1951, but from none of the six cages tried, the results obtained were conclusive.

In the field the drying up of the young and usually the central shoot seems to be caused by the agency of several insects. The young shoots are attacked by bugs, weevils and caterpillars of certain microlepidoptera, some of which bore into the young shoots and cause the central shoots to dry up while others defoliate the leaves. In the majority of cases the drying was caused by the boring caterpillars of a Tincid (?) moth which has not yet been identified. In several other cases of drying, however, these borers were apparently not responsible. Trials with *Tessaratoma* mentioned above will need to be repeated.

Brief observations on the life-history of the pentatomid were continued on *kusum* at Namkum. Although in nature the bug or any of its stage was not seen between 21st November 1951 and 10th January 1952, in field cages it was possible to keep these bugs alive apparently without any difficulty. As stated above, the peak period of activity for the bug was June-July and naturally this activity diminished with the approach of cold season.

During 1951, first batch of 14 eggs was collected on 22nd April at Namkum and in 1952 first two batches of 14 and 15 eggs were collected on 29th March. Total life-history period of the bug from the egg to the adult stage varied considerably with the season. From the eggs laid on the 10th-28th January 1951 adult bugs were obtained after 63-86 days (average duration for 6 being 80·6 days); for eggs laid on 23rd August likewise the duration was 84-117 days (average for 6 being 101·6 days); for those laid on 28th August likewise the duration was 135-229 days (average for 5 being 201 days). However, eggs laid on 8th September took much shorter period to develop into bugs: the maximum, minimum and average for 8 cases being 92, 76 and 70·1 days respectively. The duration of development instarwise was also noted and it was found that generally speaking the last two instars lasted longer than the earlier instars. Out of 6 pairs of males and females that had emerged on various dates between September and December 1951, in the field cages only two pairs laid one batch each of 14 eggs on the 28th March 1952. It appeared that there was only one complete generation in the year and the bugs over-wintered in various stages in its life-history.

(ii) *Miscellaneous insects* — (a) The termite, *Odontotermes obesus* (Rambur), caused mild damage to nursery beds of *palas* shortly before the time of transplanting, which work was hastened to prevent further damage. Gammexane dust was used in cases of other young plants where the termite attack became imminent. (b) *Sathrophyla rugusa* (Orthoptera: Tettigoniidae) appeared as a sporadic pest of *palas* during May-July in Namkum plantation and caused characteristic injury by biting holes and large patches through leaves and nibbling bark of young shoots. (c) *Myllocerus cardoni* Marshall (Coleoptera: Curculionidae) and another weevil (awaiting identification) caused general damage to *kusum*. (d) Leaves of *kusum* were damaged by the leaf roller *Hieromantis foxysta* Meyrick (Lepidoptera: Schreckstineidae) both at Hesal and at Namkum, especially during

June and July. (e) Another yet unidentified microlepidopteron caterpillar was observed to make tunnels through tender shoots of *kusum* causing the central young shoots to dry up.

(d) The Lac Insects

A systematic study of the lac insects and of the family Lacciferidae in general has been initiated. Further material of the lac insects is being collected and added on to the reserve collection. A catalogue of the lac insect is nearing completion.

(e) Insect Enemies of Lac

(i) Chrysopa *spp.*— Larvae of the lace-wing fly (*Chrysopa* sp. average wing-expanse 24 mm.; body length 7 mm.), reported upon in the last year's Report, continued to appear on both the *Rangeeni* and *Kusumi* strains and was collected from *Baisakhi* (1951) crop on *ber* (*Zizyphus jujuba*), *Baisakhi* 1952 on *Ougeinia dalbergioides* and *ber* and from *Jethwi* and *Aghani* (1952) crops on *kusum*. The following table gives duration of the various stages in its life-history:

TABLE IV — DURATION OF VARIOUS STAGES IN THE LIFE-HISTORY OF *CHRYSOPA* SP. (1)

No.	Dates (1951) of		Duration in days					
	Egg laying	Emergence of adults	Egg to adult	Egg stage	1st instar	2nd instar	3rd instar	Pupa
1	4.VII	30.VII	26	2	7	5	6	6
2	6.VII	30.VII	24	4	2	6	5	7
3-4	14.VIII	5.IX	22	2	4	5	4	7
5	16.VIII	4.IX	19	4	3	2	4	6
6	16.VIII	6.IX	21	4	3	3	4	7
7	18.VIII	11.IX	24	4	3	2	9	6
8	27.VIII	23.IX	27	2	5	4	6	10
9	28.VIII	24.IX	27	3	4	4	6	10

What may probably be a different species of *Chrysopa* (average wing-expanse 32 mm.; body length 12·5 mm.) appeared on *Kusumi* (*Jethwi* 1951 and *Aghani* 1952) crops during July and August at Hesal. From the eggs laid in the laboratory, its life-history was studied during August 1951. The following table gives the duration of its various stages:

TABLE V — DURATION OF VARIOUS STAGES IN THE LIFE-HISTORY OF *CHRYSOPA* SP. (2)

Stage	August 1951		
	No.	Range (days)	Average
Egg	96	2-4	2·3
1st instar	11	3-7	3·8
2nd instar	10	2-4	2·2
3rd instar	3	6-9	7·3
Pupa	14	4-11	7·5

Chrysopidae (lace-wing flies) are on the whole useful species which destroy numerous harmful insects like the aphids and coccids. However, as was pointed out in the last year's Report, these chrysopids are harmful from the point of view of lac cultivation. These species have not yet been identified although the specimens have been sent abroad for the purpose. Steps regarding their control could be considered only after the identifications have been received.

(ii) *Population of the life-history stages of* Eublemma amabilis *and* Holcocera pulverea *in mature* Kusumi (Aghani 1952) *crop at Hesal* — Four samples of one seer each of selected broodlac from the *Aghani* crop were examined for the number of larvae, pupae and empty pupal cases of the above-mentioned predators separately in January 1952. As the examination ended, the scraped lac from each sample was weighed the same day. Likewise examination was made of four samples of rejected lac, i.e. the lac-bearing sticks which could not be regarded as broodlac for various reasons such as heavy mortality of lac insects, sparse encrustations and heavy damage by predators, etc. As regards the egg population, it was not practical to examine such large samples, hence only one seer of selected broodlac was examined and it was found to contain 61 hatched and 7 unhatched eggs of *E. amabilis* and 85 hatched eggs of *H. pulverea*. The data given below relate to the larval and pupal population:

TABLE VI — POPULATION OF VARIOUS STAGES OF PREDATORY MOTHS, *EUBLEMMA AMABILIS* AND *HOLCOCERA PULVEREA*, IN MATURE *KUSUMI* (*AGHANI* 1952) CROP AT HESAL

Life-history stages of the predator	Average number present per seer			
	Broodlac (selected)		Rejected lac	
	With sticks	Scraped	With sticks	Scraped
Eublemma amabilis				
Larva	12·0	15·13	2·75	7·82
Pupa	13·5	17·02	0·75	2·13
Pupal case (empty)	0·75	0·94	Nil	Nil
Holcocera pulverea				
Larva	78·5	98·99	65·6	186·3
Pupa	13·75	17·33	7·5	21·33
Pupal case (empty)	Nil	Nil	Nil	Nil

It will be seen that in so far as *E. amabilis* is concerned, the population of larvae and pupae (and empty pupal cases) is much less in the case of rejected lac than in the case of (selected) broodlac. Compared on the basis of scraped lac also, this position holds good. In the case of *H. pulverea*, the relative population figures for the broodlac and rejected lac were, however, different when compared on the basis of the weights of scraped lac. Whereas for one seer of scraped broodlac the number of larvae came to 98·9, it was 186·3 in the case of rejected scraped. Similarly the number of pupae for *pulverea* was 17·3 and 21·3 respectively for the scraped brood and scraped rejected. This is as would be expected of these two species of moths which though occurring together have different feeding habits. *E. amabilis* feeds on lac insects mostly and would, therefore, not be found in larger numbers in rejected lac where the mortality of the lac insect would be high. On the other hand, *H. pulverea* feeds even on lac encrustations that are dead and would, therefore, be found even in such parts where the encrustations are poor.

(f) Cultural Methods of Control of Insect Enemies of Lac

(i) *Use of wire-net baskets as brood containers during infection* — Preliminary results as given in the two preceding *Annual Reports* showed that the use of wire-net baskets as

brood containers during infection is helpful in trapping enemies of lac insects and in preventing wastage of sticklac. As stated earlier, the economics of this use of wire-net baskets could be worked out when the trees in two similar areas are infected during the same season, one with the help of baskets and the other without. No such areas have been available. However, at Hesal wire-net baskets are being used since July 1950 and it has been possible to know the extent to which these baskets get damaged by successive use. Of the 1,196 baskets used for one season, 2·4 per cent were damaged; of 1,233 baskets used for two seasons, 19·3 per cent got damaged; of 385 baskets used for three seasons, 27·3 per cent got damaged. Further observations on the life of these baskets would be continued.

The results of examination for trapped parasites and predators from 12 baskets, each of which contained 2 chhataks of locally produced broodlac, are given below:

	NAME OF INSECT AND NUMBER TRAPPED	
Chalcids:	*Coccophagus tschirchii* Mahd.	5
	Erencyrtus dewitzi Mahd.	11
	Eupelmus tachardiae Howard	46
	Eurytoma pallidiscapus Cam.	15
	Parechthrodryinus clavicornis Cam.	99
	Tachardiaephagus tachardiae Howard	1,115
	Tachardiaephagus somervilli Mahd.	9
	Tetrastichus purpureus Cam.	25
Braconids:	*Apanteles tachardiae* Cam.	15
	Bracon greeni Ashm.	1
	Chelonella sp.	2
Ichneumonids:	*Pristomerus testaceicollis* Cam.	7
Bethylidae:	(div.)	9
Predators:	*Eublemma amabilis* Moore	
	Eggs	207
	Larvae	Nil
	Pupae	Nil
	Moths	198
	Holcocera pulverea Meyr.	
	Eggs	11
	Larvae	6
	Pupae	6
	Moths	84
Miscellaneous insects:		
	Coleoptera	170
	Other orders of insects	35

(ii) *Use of hollow bamboo pieces and wire-net as brood containers* — The object of this experiment was to test the efficacy of the brass wire-net baskets which are costly (each costing about 10 annas) and if possible to substitute these with cheaper but equally effective brood containers. It is a matter of common observation that the young larvae of the lac insect are attracted towards light. Thus it was thought that if short bamboo (or tin tubes used in the laboratory stage of the experiment) of 9-12 in. length and 2-3 in. in diameter were filled up with suitable quantities of broodlac and the openings of the tubes covered with 60-mesh brass wire-net, about 4 in. square, it should be possible for the larvae to come out freely and leave the predators and parasites trapped behind. Two chhataks of *Kusumi* broodlac were put on the 30th January 1952 in each of the two wire-net baskets (control) of the type already in use in the field, in two tin tubes 7 × 3 in. and another tin tube 9 × 3 in., and emergence of larvae was noted daily. These containers were placed on sheets of paper and at a suitable distance, a thick line of sticky material made of rosin and castor oil, was put all round with a view to trap all the larvae

that came out of the containers. The papers were changed when necessary. The emergence of larvae contained for 22-25 days and in one case when on the 16th February the broodlac was transferred from the tin to a bamboo tube no difference was observed in the number of larvae, in the rate or duration of emergence. No difference either in the number or the rate of larval emergence was noticed between the various containers comprising the brood baskets and the tubes with opening on either ends. However, in the case of the bamboo tube with one end closed, the results were not as satisfactory because in this case a certain number of dead larvae were found inside it at the end of the experiment. Also from the point of view of providing suitable aeration and of avoiding any chance of rain-water collecting in the containers, it was considered necessary to use tubes open at both ends. The cost of a bamboo tube and two pieces of wire-net would be about $3\frac{1}{2}$ annas compared to 10 annas of a wire-net basket. It is hoped that bamboo tube containers would be given a field scale trial next season.

(g) Biological Control of Lac Predator *Eublemma amabilis* Moore

(i) *To find out suitable alternative host for breeding* Bracon greeni *under laboratory conditions* — It was stated in the last year's Report that by cultivating *Crotolaria saltiana*, etc., it was found possible to get an all-the-year-round supply of the caterpillars of *Etiella zinckenella* for the purpose of breeding *Bracon greeni* in the laboratory. During the period under report *C. saltiana* was cultivated at suitable intervals and regular supplies of the caterpillars were obtained for the purpose. Caterpillars of *Trachylepida fructicassiella* (the *Cassia fistula* pod-borer) were also used for the same object but were available in smaller numbers. The results of breeding *B. greeni* on these alternative (unnatural) hosts are given in Table VII. All the host larvae were presented in tissue domes sprinkled with crushed lac and the adult parasites fed on 5 per cent sugar solution in cotton wads.

The maximum parasitization recorded was as follows:

1. *E. zinckenella* bred on *Crotolaria saltiana* = 46·75 during January 1952
2. *E. zinckenella* bred on *Crotolaria sericea* = 11·92 during April 1952
3. *T. fructicaciella* bred on *Cassia fistula* = 54·0 during March 1952

The maximum number of *B. greeni* bred per host was as follows:

1. *E. zinckenella* bred on *C. saltiana* = 1·26
2. *E. zinckenella* bred on *C. sericea* = 1·0
3. *T. fructicaciella* bred on *Cassia fistula* = 3·2

(ii) *Development of* B. greeni *in relation to its natural and alternative (unnatural) hosts* — The object of such studies was to know whether the behaviour and development of the parasite *B. greeni* is affected by its being continuously bred on its alternative host *Etiella zinckenella*. The details of the experiments as well as the results obtained with regard to the longevity of adults, pre-oviposition and oviposition periods, and the fecundity of the parasite are given in Table VIII. It will be seen that though the fecundity of the parasite decreases when it is bred on the unnatural host it shows an increase as soon as the natural host (*E. amabilis*) is offered to the parasites which had for over six generations or so been bred on unnatural host (*E. zinckenella*).

3. TRAINING AND ADVISORY SERVICE

(i) *Training* — In all 22 persons have been receiving training in lac cultivation during the period under report. Of these two were for a short-period (6 months) course and the rest for the full one year's course. One Lac Demonstrator from Bihar left before completing the course. Eleven candidates completed their course and came out successful in examinations held at the end of their training and have since taken up duties in their respective States as follows:

Madhya Pradesh:	Forest Range Officer	1
	Dy. Forest Range Officer	4

TABLE VII — MASS-BREEDING OF *B. GREENI* ON ALTERNATIVE HOSTS (APRIL 1951 TO MARCH 1952)

Month		No. of host larvae						Host and parasite contact (in days)	Males	Females	Total	% of females	Adults emerged per host
		Introduced	Parasitized		Living	Dead	Pupated						
			No.	%									
1		2	3	4	5	6	7	8	9	10	11	12	13
		Etiella zinckenella — Pod borer of *Crotolaria saltiana*											
Apr.	1951	1760	153	8·6	748	816	43	3	19	60	79	75·8	0·5
May	1951	1070	35	3·27	580	402	53	3	16	18	34	52·9	0·9
June	1951	1100	45	4·09	582	413	60	3	7	33	40	82·5	0·8
July	1951	1130	253	22·3	388	468	21	3	101	218	319	68·3	1·26
Aug.	1951	1140	357	31·3	248	532	3	3	126	218	344	63·37	0·96
Sept.	1951	1100	345	31·56	175	580	—	3	72	183	255	71·7	0·73
Oct.	1951	1140	368	32·3	147	623	2	3	38	174	212	82·07	0·37
Nov.	1951	1100	470	42·72	85	532	13	3	59	339	398	85·17	0·84
Dec.	1951	1130	495	43·8	54	578	3	3	76	302	378	79·8	0·76
Jan.	1952	1140	533	46·75	18	589	—	3	177	219	396	55·3	0·74
Feb.	1952	1060	425	40·09	29	598	8	3	76	221	297	74·4	0·79
Mar.	1952	1140	419	36·7	39	682	—	3	121	209	330	63·3	0·78
TOTAL		14010	3898	27·82	3093	6813	206	3	888	2194	3082	71·1	0·89
		Etiella zinckenella — Pod borer of *Crotolaria sericea*											
Apr.	1951	390	43	11·02	181	158	8	3	5	9	14	64·2	0·3
May	1951	80	2	2·5	48	28	2	3	1	1	2	50·0	1·0
TOTAL		470	45	9·57	229	186	10	3	6	10	16	62·5	0·35
		T. fructicaciella — Pod borer of *Cassia fistula*											
Apr.	1951	200	1	0·5	104	91	4	3	No emergence				
May	1951	100	1	1·0	54	32	13	3	No emergence				
June	1951	100	13	13·0	46	35	6	3	1	10	11	90·9	0·8
July	1951	110	20	18·1	62	28	—	3	17	48	65	73·8	3·2
Aug.	1951	100	37	36·9	47	16	—	3	21	16	37	43·2	1·0
Sept.	1951	100	21	21·0	52	27	—	3	3	9	12	75·0	0·5
Oct.	1951	100	26	26·0	49	25	—	3	13	31	44	70·4	1·6
Nov.	1951	100	37	37·0	50	13	—	3	11	24	35	68·5	0·94
Dec.	1951	110	51	46·3	37	22	—	3	6	14	20	70·0	0·39
Jan.	1952	100	40	40·0	24	36	—	3	13	21	34	61·7	0·85
Feb.	1952	100	50	50·0	22	28	—	3	8	24	32	75·0	0·64
Mar.	1952	100	54	54·0	8	38	—	3	28	43	71	60·56	1·3
TOTAL		1320	351	26·59	555	391	23	3	121	240	361	66·4	1·02

TABLE VIII — DEVELOPMENT OF *B. GREENI* IN RELATION TO ITS NATURAL AND ALTERNATIVE (UNNATURAL) HOSTS

History and generations of the host of parasite and food of the adult parasite	Period of observation	No. of pairs	Longevity (days)		Pre-oviposition period (days) average range	Oviposition period (days) average range	No. of eggs laid average range	Adults emerged			
			Male average range	Female average range				Male	Female	Total	% of females
1	2	3	4	5	6	7	8	9	10	11	12
I. *Eublemma* × *Eublemma*											
A. Fed on sugar solution											
1st gen. bred in lab.	7.VI.51-10.VII.51	2	21 19-23	25 17-33	7 7	19 10-28	42 36-48	17	27	43	60·4
2nd gen.	22.VI.51-8.VII.51	2	18·5 17-20	22 19-25	4 3-5	13·5 5-22	54·5 25-84	52	9	61	14·7
3rd gen.	11.VII.51-5.VIII.51	2	16 14-18	16 14-18	2·5 2-3	13 12-14	59·5 13-106	50	0	50	0·0
B. Fed on honey solution											
1st gen.	23.VI.51-8.VII.51	4	20 14-34	23 16-26	7 5-12	10 2-15	43·75 23-77	37	42	79	53·16
2nd gen.	15.VII.51-11.VIII.51	1	17	27	6	9	54	6	22	28	78·57
3rd gen.	1.VIII.51-3.IX.51	1	9	33	21	10	35	7	17	24	70·8
4th gen.	2.IX.51-25.IX.51	2	21·5 20-23	20 18-20	2 1-2	13 10-17	44·5 37-52	9	37	46	80·43
II. *Eublemma* × *Etiella*											
A. Fed on sugar solution	14.VII.51-6.X.51	9	23·3 11-38	27·2 14-38	8·7 2-17	13·6 2-33	21·4 6-51	23	29	52	55·76
B. Fed on honey solution	11.VI.51-11.VIII.51	2	9 7-11	24·5 22-27	6·5 6-7	7 3-11	12 8-12	16	0	16	0·0
III. *Etiella* × *Etiella*											
Fed on sugar solution											
1st gen.	12.X.51-23.XI.51	5	23 9-25	25·2 9-42	10·2 8-17	7·4 1-21	11·6 3-27	6	16	22	72·7
2nd gen.	4.XI.51-7.I.52	5	30 13-49	35·6 27-55	8·2 5-12	22·2 3-49	46·6 28-74	19	34	53	64·1
3rd gen.	4.XII.51-23.I.52	8	26·5 19-36	37·3 31-45	13·5 7-28	14·75 1-25	17·37 1-43	25	8	33	24·2
4th gen.	13.I.52-15.III.52	5	37·8 31-46	42·6 28-57	20·2 9-30	9 1-22	7·8 1-17	11	10	21	47·6
5th gen.	23.I.52-1.IV.52	3	32·6 30-36	34 33-36	20·3 10-29	6·3 1-14	13·3 11-20	12	8	20	40·0
IV. *Etiella* (*over 6th gen.*) × *Eublemma*											
Fed on sugar solution	23.VII.51-18.IX.51	2	16 13-19	15·5 13-18	2·5 1-4	10 9-11	51 30-72	17	46	63	73·0

Bihar:	Lac Inspector (6 months' course)	1
	Lac Supervisor	1
	Lac Demonstrator	2
Uttar Pradesh:	Lac Demonstrator	1
West Bengal:	Lac Demonstrator	1

At the end of March 1952, eleven trainees were on the rolls: 5 each from Bihar and Madhya Pradesh and one from Uttar Pradesh

(ii) *Advisory service* — To lac cultivators, the State Forest and Agricultural Departments and other institutions in the country, information and advice concerning lac cultivation were given whenever asked for. Assistance on technical matters was also rendered to the Special Officer for Lac Cultivation. General public and school parties visiting the Institute were taken round the Museum and explained the broad outlines of lac cultivation. Advantage was taken of an All-India Exhibition, held in Bombay, to interest the public in broad aspects of lac cultivation.

(iii) *Supply of brood and wire-net brood containers* — Broodlac was supplied to various parties interested in lac cultivation, either at cost price or free under the schemes for Intensive Demonstration for Lac Cultivation and Extension of Lac Cultivation. Table IX gives particulars regarding the supply made by the Entomology Section during the period under report.

It will be of interest to note that 2 maunds of *Kusumi* broodlac were air-lifted from Calcutta to Bangalore with excellent results and the succeeding crops were reported to have been doing well. Special bamboo baskets with light crates were employed for transporting it. This seems to be the first attempt made for air-lifting brood for use within the country. Air transport would, it seems, be of great help in future in the extension of lac cultivation in the country.

4. INTENSIVE DEMONSTRATION SCHEME

These schemes were being run under the technical guidance of the Entomological Section until the middle of November 1951 when with the joining of Special Officer for Lac Cultivation under the Indian Lac Cess Committee, work was passed on to him and at the same time the Liaison Officer was also transferred under him. In order that a consolidated account of the scheme for the year be available to those interested, the activities under this scheme would be found in the report from the Special Officer referred to above. However, the experimental work of the field station at Alamshahi (Nimtita, District Murshidabad, West Bengal) remained under the care of the Section and a report on the work of this is as follows.

FIELD STATION (ALAMSHAHI)

The field station was started at Alamshahi in October 1950, and *Baisakhi* 1950-51 and *Katki* 1951 crops have so far been grown; the results are reported below:

Baisakhi 1950-51 *crop* — It was cultivated on 21 unpruned *ber* trees situated in an upland area in Alamshahi designated as " dry land " and on another 21 trees in a low lying area at Chandnidoha designated as " wet land " with a view to find out if there was any difference in the response of the trees in respect of lac growth under the two sets of conditions mentioned above. The results are tabulated below:

Area and No. of trees	Brood used	*Phunki* lac		Yield		Brood to yield on stick ratio	Total scraped lac	Brood to yield ratio (scraped to scraped)
		On sticks	Scraped	Brood	Rejected			
Dry land, 21	1- 2-0	0-21-0	0-7-0	0-2-0	14-20-0	1 : 13·8	2-38-8	1 : 16·2
Wet land, 21	0-30-0	0-19-0	0-6-0	—	7-30-0	1 : 10·1	1-12-8	1 : 8·7

TABLE IX — DETAILS OF BROODLAC AND PRUNING INSTRUMENTS SUPPLIED (FROM 1ST APRIL 1951 TO 31ST MARCH 1952)

Type of brood, pruning instruments and party		I.D. Scheme		Extension of lac cultivation		Sold		
		Weight	Cost	Weight	Cost	Weight	Cost	
		Md. sr. ch.	Rs. as. p.	Md. sr. ch.	Rs. as. p.	Md. sr. ch.	Rs. as. p.	
Broodlac								
Baisakhi 1951	Bihar*	5 10 0	339 0 0	0 0 0	0 0 0	3 5 0	194 6 0	D.F.O., Bundelkhand, Jhansi, U.P.
Baisakhi 1951	U.P.*	2 0 0	40 0 0	0 0 0	0 0 0	0 10 0	18 12 0	D.F.O., Avadh, and Land Management Forest Division, Lucknow, U.P.
Baisakhi 1951	West Bengal*	1 17 0	146 12 0	0 0 0	0 0 0	0 0 0	0 0 0	
Jethwi 1951	Bihar	2 35 0	443 10 0	0 0 0	0 0 0	2 0 0	310 0 0	Forest Research Chemist, Bangalore
						6 0 0	930 0 0	Forest Research Officer, Ranchi, Bihar
Katki 1951	Bihar†	2 23 0	146 10 6	0 0 0	0 0 0	0 3 0	4 3 6	Sold to the Farm Manager, Patratoli, Namkum, Ranchi
Aghani 1952	Bihar†	5 20 0	660 0 0	0 5 0	15 0 0	—	—	Hisuli plantation, Nadia Dist., West Bengal
				1 0 0	120 0 0			D.F.O., South Coimbatore
						4 30 0	570 0 0	Forest Research Officer, Ranchi, Bihar
	TOTAL	19 25 0	1,776 0 6	1 5 0	135 0 0	16 8 0	2,027 5 6	

Empty Wire-gauze Baskets Supplied:

		Cost
D.F.O., Lucknow, in June 1951	1,200 @ -/10/- each	Rs. 750 0 0
Hisuli plantation, Nadia Dt., West Bengal, January 1952	40 ,,	25 0 0
D.F.O., South Coimbatore, in January 1952	300 ,,	187 8 0
D.F.O., Karnal, in March 1952	315 ,,	196 14 0
D.F.O., Avadh, in March 1952	300 ,,	187 8 0
	2,155	Rs. 1,346 14 0

* Local purchase in the areas are included in Bihar, U.P. and West Bengal for *Baisakhi* (1951) crop.
† Local purchases are not included in this for the areas for *Katki* (1951) and *Aghani* (1952) crop.

The infection was heavy and mortality was noticed to have come up very high in May and June 1951 and no broodlac was then obtained. The summer weather conditions and the unpruned state of branches aggravated the mortality which is reported to be due to south-westerly winds in those months.

Meteorological Data from Alamshahi

1951	Maximum temp.		Minimum temp.		Wet bulb		Dry bulb		% Humidity		Rain-fall (cent.)
	Var.	Avg.	Var.	Avg.	Var.	Avg.	Var.	Avg.	Var.	Avg.	
Apr.	78-108	96·9	68-82	72·9	72-94	83·3	64-75	72·8	31-93	58·6	0-50
May	92-111	102·9	70-84	79·7	76-100	84·9	72-90	72·8	45-89	72·9	2-6
June	92-104	98·3	74-83	76·0	82-93	86·5	76-86	81·4	64-96	81·1	3-14
July	82-102	89·2	72-86	79·6	78-88	84·3	78-85	81·4	76-100	54·0	10-36

From 17th to 22nd May the maximum temperature varied from 108 to 111°F. and the south-west wind blew hard. Mortality in lac reached its peak and the leaves of trees were found scorched by heat. In June 1951 the lac softened during the noon and mortality was 98·6 per cent in spite of rains in May and June 1951.

Katki 1951 *crop* — Seven trees each in the " dry " and " wet " land areas which had been pruned in February 1951 were infected for the crop, 2 seers of broodlac from the " dry " land and 37 seers of purchased broodlac having been used for infection of these 14 trees. *Phunki* recovered from sticks was 26 seers 6 chhataks and the scraped lac obtained was 6 seers 6 chhataks. The total yield which was fit for use as broodlac weighed 2 maunds and 10 seers. Scraped lac obtained from the *phunki* was 17 seers. The ratio between broodlac used and yield of broodlac came to 1: 2·30 and as such the broodlac obtained from the *Katki* crop is satisfactory.

5. INSTITUTE PLANTATIONS

Namkum — General upkeep of the plantation was maintained; pathways round the plots were made and all the main plots of about 10 acres each were divided into sub-plots of convenient sizes.

Hoeing and weeding operations round the younger plants were regularly done. Extensive cultivation of *Boga* (*Tephrosia candida*) was carried out throughout the plantation for the dual purpose of green manuring and suppressing wild grasses. A small nursery was raised for meeting the plantations' and laboratory's requirements for young plants. *Crotolaria saltiana* (also valuable for green manuring) was cultivated periodically throughout the year for the purpose of supplying larvae of *Etiella zinckenella* (used as alternative host in breeding *Bracon greeni*) which attacks its pods. Cultivation of local and Assamese varieties of *arhar* (*Cajanus indicus*) was undertaken on a small scale for purposes of lac cultivation on experimental basis. For the same purpose a small number of various lac hosts were infected and the statement showing the yield of lac from Namkum and from the (leased) plantation at Hesal are given in Appendix I.

As desired by the Committee the Bihar Forest Department was approached for advice on improving the plantation and proposals were put forward for the purpose. The Reviewing Committee, keeping in view the depleted nature of the soil, recommended that only such acreage as was absolutely necessary for experimental work of the Entomology Section should be re-stocked and looked after. Necessary steps would be taken for the purpose. Necessity for a couple of watchmen was keenly felt and the creation of these posts has been approved by the Committee lately.

CHEMICAL SECTION

The posts of Analyst and of two Junior Research Assistants remained vacant for most of the period. The Physical Chemist also resigned towards the end of the period.

1. VARNISHES AND LACQUERS

Lac-linseed oil paints — It is now over four years since the iron and wood work of the Institute buildings and staff quarters were painted with lac-linseed oil paints. The painted surfaces indoors have remained remarkably well without showing any signs of deterioration in their protective or decorative properties. The outdoor performance of these paints is, however, poor as has been pointed out earlier.

Samples of lac-linseed oil paint vehicles, using dewaxed lac as well as ordinary shellac, had been supplied to a prominent firm of paint manufacturers for critical examination and report. This firm was contacted personally during the year and in the course of discussions it was reported that comparative tests on our samples along with the compositions made according to the firm's standard formula indicated that the hardness of lac-linseed oil vehicles has still further to be improved. The lac vehicles also deteriorated Chinese blue rapidly. These will now be investigated.

Oil-cloth — A laboratory coating machine capable of coating cloth having a maximum width of 36 in. has now been fabricated and set up. Experiments will be continued to prepare such wide samples for large-scale tests.

2. MODIFICATION OF LAC AND ITS DERIVATIVES

Modification of lac with polyhydric alcohols and polybasic acids—Work on this problem was continued during the period under review. Some of the results obtained on the modification of lac with pentaerythritol (PE), ethylene glycol, diethylene glycol, etc., with maleic anhydride, phthalic anhydride, succinic anhydride, etc., either severally or in combination, both under dry conditions and in solvent medium, were briefly reported in the last *Annual Report*. It was stated therein that except in a few cases ultimate products of these combinations were plastic, soft and sticky and as such could be useful in coating industries and/or as plasticizers and adhesives. The properties of such of the compositions as gave promise of being useful in the formulation of improved varnishes were examined. Three compositions were chosen, namely those obtained by reacting lac respectively with (1) ethylene glycol and phthalic anhydride, (2) diethylene glycol and maleic anhydride, and (3) ethylene glycol, phthalic anhydride and succinic anhydride. The resins obtained from all the three reactions were plastic and sticky at room temperature, and soluble in a mixture of solvents such as ethyl alcohol-acetone, ethyl alcohol-ethyl acetate-toluene, butyl alcohol-butyl acetate-toluene. Varnishes were made using mixed solvents and their film properties studied by coating glass, copper foil, aluminium, etc. All the films had, however, to be baked at 140-150°C. for at least an hour to give tack-free films. The dried films were glossy, hard and possessed good water resistance, elasticity and adhesion. There was no greening effect on copper which suggests that these may be used as baking varnishes and for coating tin sheets in the canning industry. They were also found resistant to the action of dilute alkalis and acids.

A few modified lac resinous compositions, obtained by the simultaneous combinations of lac with adipic or sebacic acid and ethylene glycol or diethylene glycol, were found to possess interesting properties. It was observed that though viscous in the initial stage, these compositions became thin, easy flowing liquids on slight warming and as such could be used for hot melt applications without the help of any solvent. Further properties of these resins are being examined.

Mention was made in the last *Annual Report* of a clear brittle resinous product (m.p. 97-98°C.) resembling rosin obtained by condensing lac with pentaerythritol and

phthalic anhydride. Attempts made to use this resin for moulding compositions did not meet with success as the moulded articles could not be ejected hot and moulds had to be cooled down before the articles could be removed. The compositions were not thermo-hardening.

3. FUNDAMENTAL RESEARCHES

(a) Chemical Constitution of Shellac

The work on the constitution of shellac was continued. It has been indicated (*Annual Report*, 1950-51, p. 24) that "butolic acid" is not identical with convolvulinolic acid but is probably some other monohydroxypentadecanoic acid.

The mixed melting point of ketobutolic acid (m.p. 69·5-70·5°C.) and keto acid* (m.p. 70-71°C.) from synthetic 11-hydroxypentadecanoic acid was found to be 63-64°C. indicating that butolic acid is not also identical with 11-hydroxypentadecanoic acid.

Oxidative degradation of butolic acid—The solid acid, m.p. 47-48°C. (*Annual Report*, 1950-51, p. 24) obtained by permanganate oxidation of butolic acid at 80-85°C., was dissolved in 30 per cent caustic potash solution and kept in the cold for three days. A small amount of potassium salt separated, which on decomposition gave an acid melting at 60-61°C. The filtrate, on decomposition, gave an acid melting at 54-55°C. which did not depress the melting point of butolic acid.

Oximes from ketobutolic acid—Hydroxylamine hydrochloride (1 g.) was dissolved in water (2 c.c.) and added to aldehyde-free alcohol (100 c.c.) containing caustic potash (0·5 g.). The solution was allowed to stand overnight and filtered from the potassium chloride formed. The filtrate was then refluxed for six hours with ketobutolic acid (0·202 g.) on a water bath and the whole was poured into water but no solid separated even when kept in the cold. It was then extracted with ether and the extract, after washing with water, was dried over anhydrous sodium sulphate. On removal of ether, a liquid oxime was obtained.

Beckmann transformation of the oximes—To the liquid oxime concentrated sulphuric acid (2 c.c.) was added and the whole heated on a water bath for a very short period (1½ min.). It was immediately poured into cold water. Gradually, there separated a solid substance which on recrystallization from dilute methyl alcohol melted at 67-68°C. (0·15 g.). The mixed melting point with ketobutolic acid was not depressed.

Hydrolysis of the Beckmann transformation product—The product (0·14 g.) was taken in a monax test tube and 48 per cent hydrobromic acid solution (4 c.c.) added. The open end of the tube was sealed and heated at 150-160°C. for six hours. The contents of the tube were taken out and filtered. The black solid residue on the filter was washed free from mineral acid. After decolourization and recrystallization from dilute methyl alcohol two crops (0·02 and 0·037 g.) were obtained, melting respectively at 70-71°C. and 69·5-70·5°C. The two crops were identical as their mixed melting point showed no depression.

The mixed melting point of this product with ketobutolic acid was 69·5-70·5°C. showing no depression. It seems, therefore, that somehow most of the oxime must have been hydrolysed giving the original keto acid during its transformation and hydrolysis.

The investigation is being repeated. Methyl ester of butolic acid has been oxidized to give a liquid kotoester.

Reduction of ketobutolic acid—Ketobutolic acid (0·05 g.) was dissolved in glacial acetic acid (3 c.c.) and Adams platinum oxide catalyst (0·025 g.) was added. It was then hydrogenated with hydrogen for a period of ten hours with continuous shaking. The catalyst was removed and washed with glacial acetic acid (2 c.c.). The filtrate with the washing

* We express our gratitude to Dr. T. Kawasaki, University of Kyushu, Japan, for his kind gift of a sample of 11-ketopentadecanoic acid.

was poured into cold water and the precipitate formed was separated and washed free from acetic acid. The substance (0·042 g.) on drying melted at 62-63°C. It had a hydroxyl value (H.V.) of 20 only (H.V. for butolic acid being 217). The mixed melting points with ketobutolic and butolic acids were 62-63°C. and 52-53°C. respectively. The results show that a partial reduction has taken place.

Acid melting at 95-96°C.—A part of the acid was dissolved in methyl alcohol, and water was added till turbid. Then a few drops of dilute hydrochloric acid were added and the whole allowed to stand in the cold. There formed some granular product, which after separation and drying melted at 70°C. (A.V. 122·5 and S.V. 188·0). The filtrate, on further keeping, gave a second crop melting at 60°C. (A.V. 95·5 and S.V. 187·0). An interester of two molecules of (isomeric) aleuritic acid would require A.V. 95 and S.V. 185 respectively.

Under identical conditions, aleuritic acid (m.p. 100-101°C.) also gave two crops. The first melted at 97-98°C. while the second at 92-93°C. The acid and saponification values of the products were between 185·0 and 186·1. This shows that it did not undergo any transformation in the same way as the acid, m.p. 95-96°C., which seems to be more reactive and consequently different from aleuritic acid.

DERIVATIVES

(i) *Phenacyl ester of aleuritic acid* — Sodium aleuritate (1 g.) was dissolved in water (5 c.c.) and mixed with phenacyl bromide (1 g.) dissolved in 98-99 per cent alcohol (10 c.c.). The mixture was refluxed for one hour and a half on a water bath and allowed to stand overnight. The phenacyl ester separated and was washed twice with 10 c.c. portions of aqueous alcohol (1:1) and then thrice with 10 c.c. portions of water. The ester, $C_{15}H_{28}(OH)_3.COO.CH_2.CO.C_6H_5$, on recrystallization from dilute alcohol melted at 100-101°C. (A.V. nil); yield 1·25 g.

In a similar manner the following esters were prepared:

(ii) *p*-bromophenacyl ester of aleuritic acid, $C_{15}H_{28}(OH)_3.COO.CH_2.CO.C_6H_4.Br$, m.p. 125-126°C., A.V. nil.

(iii) *p*-phenyl phenacyl ester of aleuritic acid, $C_{15}H_{28}(OH)_3.COO.CH_2.CO.C_6H_4.C_6H_5$, m.p. 111-112°C.; A.V. nil.

(iv) phenacyl ester of acid (m.p. 95-96°C.), $C_{15}H_{28}(OH)_3.COO.CH_2.CO.C_6H_5$, m.p. 96-97°C.; A.V. nil.

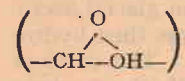
(v) *p*-bromophenacyl ester of acid (m.p. 95-96°C.), $C_{15}H_{28}(OH)_3.COO.CH_2.CO.C_6H_4.Br$, m.p. 120-121°C.; A.V. nil.

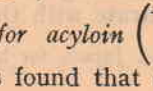
The mixed melting points were as follows:

i + iv — 95-96°C.
ii + v — 119-120°C.

The melting points and mixed melting points of the derivatives also indicate that the two acids (aleuritic acid, and acid, m.p. 95-96°C.) may be different.

Test for aldehydic group in shellac — Decolourized shellac was dissolved in aqueous ammonia and Tollen's silver nitrate solution was added. The solution was heated in a clean test tube in boiling water for a long time. The reagent was not reduced showing the absence of aldehydic groups in shellac.

This test also eliminated the possibility of the presence of any ethylene oxide  grouping in shellac.

Test for acyloin  *group in shellac* — Rigby (*J. Chem. Soc.*, 1951, p. 793) has found that acyloins are smoothly oxidized to 1: 2-diketones by heating them

with bismuth oxide in solutions containing acetic acid, the oxide being reduced to metal. According to him, the reagent is specific and the reaction often virtually quantitative. The test for acyloins in shellac has been performed according to Rigby's method as follows:

Decolourized shellac was dissolved in glacial acetic acid, and bismuth trioxide added. The whole was heated on a water bath for a pretty long time with occasional stirring. Precipitation of black metallic bismuth was not noticed. The solution was added to water and a soft mass was obtained. The soft mass was washed free of acetic acid and dissolved in pure methyl alcohol; to this was added a solution of semi-carbazide hydrochloride and sodium acetate in water. After some time, there formed a slight precipitate and on addition of a little water some solid separated. The solid matter was washed well and on drying melted at 80-85°C. Nitrogen, by the Jamieson method, was found to be 1·5 per cent.

The experiment has been repeated once more. In this case, the final product was finely powdered and repeatedly washed with water to remove any semi-carbazide present.

Found: Nitrogen 1·98 per cent.

Further work is in progress to confirm the above results.

Oxidation of shellac with periodic acid — The outstanding characteristic of periodic acid oxidation lies in its selective oxidation, by cleavage of the carbon-carbon bond, containing two hydroxyl groups or a hydroxyl group and an amino group. Carbonyl compounds in which the carbonyl group is adjacent to a second carbonyl or hydroxyl group are oxidized also. Taking into consideration that no aldehydic or ketonic or acyloin group is present in the shellac molecule, then the only oxidizable adjacent groups in shellac are the two secondary hydroxyl groups of aleuritic acid. With a view to finding out whether the adjacent hydroxyl groups of aleuritic acid are free in shellac and if so, what is the percentage of the dihydro compound in shellac, the periodic oxidation of shellac has been undertaken.

The procedure for the periodic acid oxidation has been adopted from the method of Pohle, Mehlenbacher and Cook (*Oil & Soap*, 1945, **22**, 115), which was developed to determine the existence of monoglycerides in oils. In order to find out the optimum conditions of oxidation, a series of experiments were carried out and the effects of varying the time of reaction and the weight of shellac, as also of the quantity of reagent, on the reaction were studied.

Briefly the method consisted in dissolving a known amount of shellac in a known volume of glacial acetic acid, adding a known volume of the reagent and keeping in the dark for a known period of time with occasional shaking. The excess of the reagent was then determined iodometrically by adding potassium iodide solution and titrating the liberated iodine with standard thiosulphate solution. A blank was also run, without shellac. The percentage of dihydroxy compound was calculated from the following expression:

$$\frac{A \times N \text{ thiosulphate} \times \text{mol. wt. of dihydroxy compd.} \times 100}{\text{Gram sample} \times 2 \times 1000} = \text{per cent dihydroxy compound}$$

where A = c.c. of thiosulphate required for blank — c.c. of thiosulphate required for sample.

The results, obtained so far, showed a fairly constant value (13·36-14·3) for the percentage of dihydroxy compound when 0·10 g. of shellac, dissolved in 5 c.c. glacial acetic acid, was treated with 20 c.c. of the reagent [0·5 per cent periodic acid in water-glacial acetic acid (1:4) mixture] for 30-180 min. When the reaction was allowed to proceed for six hours and onwards up to five days, the value gradually increased from 15·7 to 40·1 per cent. This might be due to the fact that acetic acid liberated more —OH groups adjacent to each other, present in bound condition in shellac.

Further work is in progress.

(b) Search for Higher Fatty Acids in the Bark of Lac Hosts

Several higher polyhydroxy fatty acids have been reported to be present in cork [A. Guillemonat *et al.*, *Bull. Soc. Chim. Fr.*, (V), 1949, **16,** 792; (V), 1950, **17,** 860; E. Seoane and I. Libas, *Anales real Soc. espan. Fis. y quim.*, 1951, **47B,** 61-66]. One of these fatty acids is 9: 10-dihydroxyoctadecane-1 : 18-dicarboxylic acid. Shellac is said to consist of several polyhydroxy polybasic acids, and 9: 10-dihydroxyhexadecane-1: 16-dicarboxylic acid is obtained by oxidizing the terminal CH_2OH group of aleuritic acid by the method of Nagel and Mertens (*Ber.*, 1936, **69,** 2050). The lac insects derive their nutrition from the young barks of the lac host trees. It was, therefore, thought that possibly the barks might contain some of the higher fatty acids similar in nature to those obtained from shellac. With a view to finding out this, *kusum* and *palas* barks, old and new, have been investigated.

The barks were treated according to the method adopted by Guillemonat (loc. cit.) in the case of cork which is as follows:

250 g. of powdered bark were added to 3·35 litre of water containing 62·5 g. of sodium hydroxide, stirred well and kept at room temperature for four days with occasional stirring. 45·3 c.c. of concentrated sulphuric acid (sp. gr. 1·84) in 250 c.c. water were added to the alkaline solution. Then 90 g. of calcium carbonate were gradually added with stirring. The whole was then heated on a water bath for an hour and filtered hot. The residue was extracted several times with 2·5 litre boiling water. The washings were combined with the original coloured filtrate. It was then just acidified with sulphuric acid and kept in the cold for several days, but no fatty acids separated.

(c) Polyesterification of 9: 10-dihydroxyhexadecane-1: 16-dicarboxylic Acid

In continuation of the work on the polyesterification of 9: 10-dihydroxyhexadecane-1: 16-dicarboxylic acid, reported already (*Annual Report*, 1950-51), some physical and chemical properties of the polyesters were studied. Besides the determination of acid value, saponification value, refractive index and molecular weight, viscosity and fractionation of these samples were studied.

Refractive index — It was determined by the Abbé refractometer which had an arrangement for heating the prism by hot-water circulation. The determinations were, however, restricted to products with m.p. below 98°C. as the prism could not be heated above that temperature. The table below gives the data including the refractive index values of samples drawn at different intervals during the polyesterification of the dibasic acid.

No. of sample drawn	Time interval in min.	A.V.	S.V.	% E.V.	Refractive index
Diacid	0	352·2	—	—	—
1	15	314·8	339·8	7·20	m.p. above 98°C.
2	30	303·1	338·5	10·46	1·4625
3	45	291·8	338·8	13·88	1·4628
4	60	271·9	339·1	19·82	1·4630
5	75	245·6	338·6	27·47	1·4632
a*	15	318·6	339·8	6·24	m.p. above 98°C.
b*	30	300·0	339·2	11·55	1·4624
c*	80 (just before gelation)	220·6	339·3	34·98	1·4532

* Sample Nos. a, b and c comprise different runs of polyesterification under identical conditions.

The increase in the value of refractive indices with the progress of polyesterification as shown in the above table conforms to the mode of reaction as observed in the cases of glycerine-phthalic acid (anhydride) (Kienle, Menlen, Petke, *J. Amer. Chem. Soc.*, 1931, **61**, 2258).

In the table which follows, the calculated acid value and molecular weight have been given for compounds when more than one unit of diacid combines to form simple interesters. In the next table, the values of A.V. and mol. wt. of different polyesters found experimentally have been given. From these tables we find that molecular weights of polyesters agree within the limits of experimental error with those of esters with specific number of unit-linkages, as calculated. This agreement between the values of molecular weights shows that the reaction follows mostly a course of simple interesterification until the heat-polymerized diacid reaches the stage of gelation.

Calculated A.V. and Corresponding Average Mol. wt. of Esters Based on Simple Interesterification of Diacid

No. of units in interester	A.V.	Mol. wt.
1	352·2	318·0
2	271·8	618·0
3	243·7	918·0
4	229·9	1218·0
5	221·3	1518·0

Observed A.V. and Average Mol. wt. (Rast Method) of Experimental Samples

Sample No.	A.V.	Mol. wt.
1	314·8	512·4
3	291·8	602·3
4	271·9	632·3
5	245·6	945·0
C	220·6	1415·0

Viscosity — Measurements of the viscosity of various polyesters (10·0 per cent solution in acetone C.P.) were carried out in a water bath, thermostatically maintained at 35±0·02°C. The following are the results:

Sample No.	A.V.	Viscosity $\eta \times 10^5$ poises	Relative viscosity	Specific viscosity
1	314·8	285·3	1·027	0·027
2	303·1	289·7	1·042	0·042
3	291·8	294·5	1·059	0·059
4	271·9	300·2	1·079	0·079
5	245·6	317·7	1·142	0·142

The studies of viscosities show a gradual increase in specific viscosity, the rise being very pronounced as the sample approaches gelation. Theoretically it seems to indicate

that this sudden increase is due to a change in molecular complexity near about the acid value 271·9. Before this, the molecules are comparatively small and linear; beyond this, as A.V. diminishes further, large and cross-linked molecules begin to form, giving rise to higher specific viscosities. Such rises in viscosities were also observed by Kienle and Race (*Trans. Electrochem. Soc.*, 1934, **65**, 231) and subsequently by Kienle *et al.* (*J. Amer. Chem. Soc.*, 1939, **61**, 2264).

Fractionation — 20 c.c. of each polyester in acetone of concentration 5·0 per cent has been titrated with a non-solvent, namely water. The results are given below in the table in which the nature of precipitates formed has also been mentioned:

A.V.	Water used in c.c.	Character of ppt. formed
318·6	68·3	Colloidal
314·8	65·2	Colloidal
303·1	60·1	Granular
300·0	58·7	Granular
291·8	52·5	Granular
271·9	49·3	Granular
245·6	30·1	Granular
220·6	25·3	Granular

It is known already that the amount of non-solvent required to bring about the precipitation, as also the character of the precipitate, depends upon the extent of polyesterification undergone by the particular sample. That is to say, a particular polyester, polymerized for a longer time (as indicated by a lower acid value) will be precipitated earlier with less amount of non-solvent to give a granular precipitate as compared with a sample of high A.V. which requires a larger volume of non-solvent and yields a somewhat colloidal or gummy precipitate. This is observed in the present case also. In the table given above we see that the fraction with A.V. 200·6, which had obviously undergone the longest time of esterification, tolerated only 25·3 c.c. of water, whereas for the earlier samples with higher A.V.s, larger volumes of water were necessary to bring about precipitation. This supports the generally accepted theory that in a bulk system of homologue polyesters composed of several fractions with varying degrees of polymerization, it is always the members of higher degree of polymerization that are most insoluble in a solvent. Hence they are precipitated first with addition of non-solvent leaving the fractions of lower degree of polymerization in solution.

(d) Possibility of Preparation of Macrocyclic Lactones from Products of Polycondensation of Aleuritic Acid

Spanagel and Carothers (*J. Amer. Chem. Soc.*, 1936, **58**, 654) prepared lactones having large rings by depolymerization of some linear polyesters of aliphatic ω-hydroxy acids. Of these some have musk-like odours. To see if polyesters of aleuritic acid would also behave in a similar manner some preliminary experiments were conducted. The polyesters have so far yielded none of the expected compounds under the conditions under which Spanagel and Carothers obtained their lactones. Attempts were also made to prepare macrocyclic lactones of aleuritic acid by application of the dilution principle, first utilized by Reeggli (*Ann.*, 1912, **92**, 392) but without success. A charred mass was obtained by refluxing aleuritic acid (5 g.) in 300 c.c. xylene with 5 c.c. concentrated phosphoric acid for 48 hours.

(e) BLEACHABILITY OF SEEDLACS

Experiments on the study of bleachability of seedlacs were continued.

(i) *Extraction of seedlac by sodium carbonate* — Conditions for the extraction of the seedlac with sodium carbonate recommended in the different methods at present in use for the determination of bleach index or bleachability are as follows:

Method	Temperature	Stirring	Duration
Angelos'	65±2°C.	Mechanical	1 hour
I.L.R.I.	Boiling water	Hand	1 hour
U.S.S.I.A. (Bleach index)	Boiling water	Hand	1 hour
U.S.S.I.A. (Bleachability)	Boiling water	Mechanical	½ hour

Seedlacs were extracted under all the above conditions. It was found that in the case of extracting at 65±2°C. using mechanical stirring, the foam did not settle down within one hour. Further, most of the wax was left over on the filter as residue during filtration. When the extraction was carried out at boiling water temperature and with mechanical stirring the solution often boiled over the sides of the beaker thus spoiling the experiments. Hand stirring was found to be quite efficient and suitable. Complete dissolution of the soluble matter took place in half an hour at about 100°C. with hand stirring. Extraction for a longer time (say 1 hour) is, therefore, unnecessary. Moreover, this results in further darkening of the extract.

(ii) *Condition of the seedlac* — Different degrees of fineness to which the sample is to be ground have been recommended for the different methods for bleach index and bleachability determinations. They are as follows:

Method	Degree of fineness	
	Kusumi	*Baisakhi*
Angelos'	Free or to be coarsely ground to 10 mesh if blocked	
I.L.R.I.	40 mesh	40 mesh
U.S.S.I.A. (Bleach index)	40 mesh	40 mesh
U.S.S.I.A. (Bleachability)	40 mesh (for Grade I)	10 mesh (for Grade II)

Angelo Bros. have already explained the reason for adopting the coarser particle size of 10 mesh (instead of 40) which, as they observe, is that when the seedlac is ground finer and then extracted, more of the nitrogenous matter passes through the filter resulting in a greater consumption of bleach liquor. Repeated experiments have confirmed this observation. This extra bleach consumed, though not much in the case of *Kusumi* seedlacs, is considerable in the case of *Baisakhi* samples amounting sometimes up to 20 c.c. (of 3 per cent available chlorine for 30 g. seedlac). To eliminate this trouble and especially to maintain uniformity, a uniform particle size of 10 mesh is to be recommended for all grades of seedlacs. In actual practice also coarsely ground or free seedlacs are used.

(iii) *Limit of bleaching* (*end point of bleach test*) — There is again divergence of opinion as to the limit to which seedlacs are to be bleached. In other words, views differ as to what

should be the end point of bleaching. Thus the Angelos' method determines the limit of bleaching from the *rate of consumption of bleach*, while the I.L.R.I. and U.S.S.I.A. methods determine the actual volume of bleach required to bleach the sample to a definite end colour. The I.L.R.I. method recommends the shade of $N/2000$ iodine (in KI) for this purpose, whereas the U.S.S.I.A. method recommends the simultaneous bleaching of a "standard" sample of seedlac (obtainable from them) along with the samples whose bleach indices are to be determined. All these methods involve repeated additions of bleach liquor in small quantities at a time till the end point is reached. Such a process is at once time-consuming and tedious. The recent U.S.S.I.A. bleachability test, however, marks a considerable improvement over all these inasmuch as these repeated additions of bleach and comparisons of the colours are altogether avoided. The need of a standard sample is still there and it was considered that elimination of this also, if possible, would go a long way towards simplifying the method.

It was sought to eliminate the need for the standard sample by fixing the shade (end colour) in terms of $N/1000$ iodine, in view of the fact that this standard is easily reproduced in any laboratory anywhere. Moreover, the different shades produced by bleaching different samples of seedlacs could easily be determined in terms of this single standard by filtering off the bleached solutions through dry filter paper and matching the clear filtrate against the standard in a Dubosque (cup and plunger type) colorimeter.

Moreover, in the bleachability tests the idea is to add definite volumes (80, 100, 115 or 140 c.c.) of bleach liquor so as to finally obtain the fully bleached shade. This procedure will require a previous knowledge as to what particular grade the sample is likely or claimed to belong to. As such information may not always be available, it was considered that it might be interesting to find out the relationship of the bleach index of any sample and the shade produced by bleaching the same sample with a definite known volume (say 80 c.c. per 30 g. of seedlac) of the bleach.

With this end in view, experiments were continued to determine the shades produced on bleaching a number of samples of seedlacs under conditions as recommended for the bleachability test, with only such modifications as were considered advantageous in the light of the above experience. The method* as finally adopted may be briefly described as follows:

The sample of seedlac was first coarsely ground to pass through a 10-mesh sieve. $37{\cdot}5 \pm 0{\cdot}1$ g. of this material and $3{\cdot}7 \pm 0{\cdot}01$ g. of sodium carbonate (anhydrous) were then weighed into a 400 c.c. beaker, and 110 c.c. of distilled water at 70 ± 1°C. added. The beaker with contents was then quickly placed in a boiling water bath. The contents were vigorously stirred by means of a glass rod, taking care to mix thoroughly any specks of seedlac that may be sticking to the sides of the beaker. The solution at first frothed rapidly but settled down again within 3-5 minutes. After this period the solution was occasionally stirred with the glass rod. After a total period of half an hour's heating in the boiling water bath, the beaker with contents was removed. 25 c.c. hot water at 70 ± 1°C. were run down the sides of the beaker, and after mixing, immediately strained through a 100-mesh copper or brass wire-gauze filter cone into a 500 c.c. graduated cylinder and washed with water at 70 ± 1°C., taking care that the filtrate and washings did not exceed about 220 c.c. This extract in the graduated cylinder was then cooled to laboratory temperature in a stream of cold water and made up to 280 c.c. with distilled water. It was then transferred to the 400 c.c. beaker. 95 c.c. of bleach liquor (of $3 \pm 0{\cdot}05$ per cent available chlorine and 0·02-0·04 N free alkalinity) were now stirred in, and after occasional stirring for half an hour, allowed to stand overnight in a water bath at 27 ± 2°C.

Next morning, the wax that had floated up was cautiously stirred in without disturbing the sediment at the bottom and 300 c.c. transferred to a 400 c.c. beaker. A further 4 c.c. of the same bleach liquor were now added and after thorough mixing, the solution was

* This method is the same for all samples of seedlacs irrespective of grade or variety.

allowed to stand undisturbed for half an hour. It was then filtered through a dry filter paper and the first 1-2 c.c. of the filtrate rejected. The colour of the subsequent clear filtrate was then determined by matching against 1 cm. (or any other convenient length) of a $N/1000$ iodine solution in the Dubosque comparator. The ratio of the length of the column of the filtrate to that of the iodine solution was then calculated. This figure was found to be indicative of the bleaching grade of the sample.

(iv) *Bleach liquor* — The bleach liquor required for the experiments was prepared by the direct chlorination of an ice-cold caustic soda solution (approximately 1·5 N). The chlorination was continued up to the stage at which about 2 c.c. of the liquor when tested with 1 drop of phenolphthalein gave a distinct pink colour which did not persist for more than 5-10 seconds. Such a solution had a free alkalinity of 0·02-0·04 N and was of reasonable stability and satisfactory bleaching efficiency. Samples of bleach liquors so prepared were preserved in stoppered narrow-mouthed brown bottle, one in a refrigerator and another at the laboratory temperature. The changes in the available chlorine content with time of a typical sample (of free alkalinity 0·032 N) are indicated below:

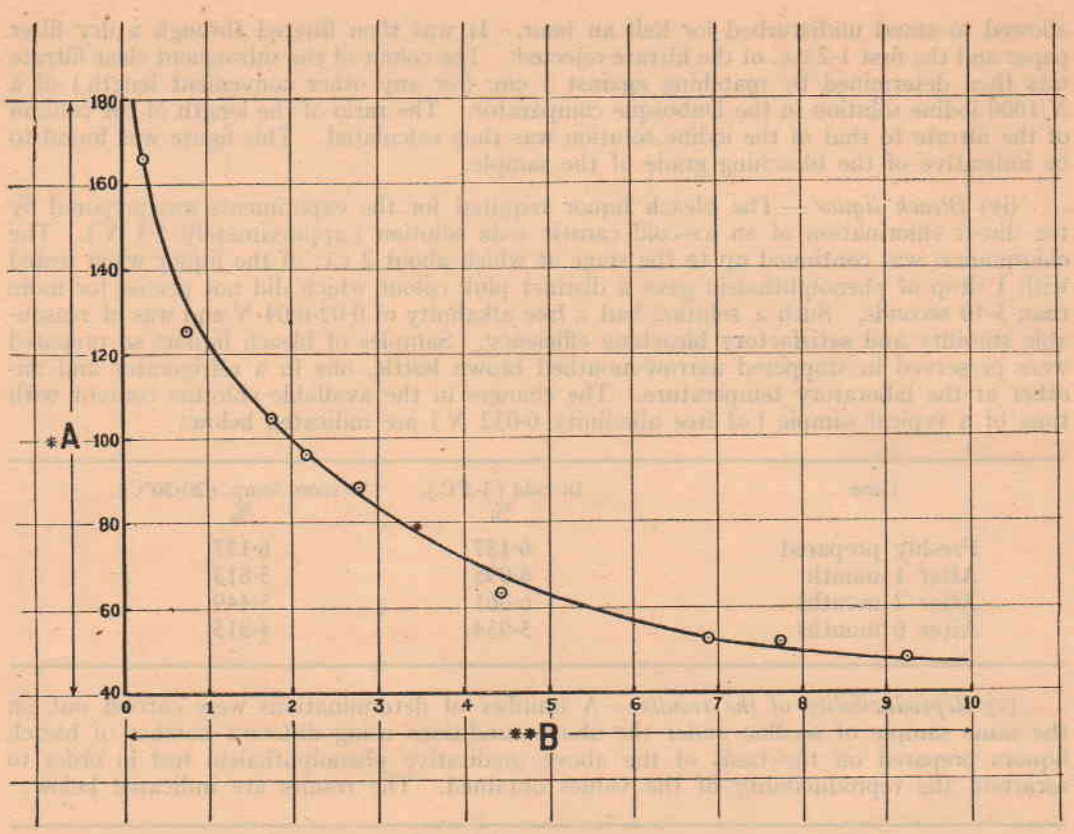
Time	In cold (3-5°C.), %	At room temp. (20-30°C.), %
Freshly prepared	6·137	6·137
After 1 month	6·095	5·813
After 2 months	6·061	5·449
After 6 months	5·954	4·815

(v) *Reproducibility of the results* — A number of determinations were carried out on the same sample of seedlac under the above conditions using different batches of bleach liquors prepared on the basis of the above qualitative phenolphthalein test in order to ascertain the reproducibility of the values obtained. The results are indicated below:

I	Expt.	1	2	3	4	5	6	7	8
	Result*	0·26	0·28	0·25	0·25	0·29	0·28	0·30	0·29
II	Expt.	1	2	3	4	5			
	Result*	7·69	6·66	6·58	6·59	6·73			

* The length of the column in cm. of filtered bleached solution which matched in colour with 1 cm. of $N/1000$ iodine.

Bleachability grade — An American standard seedlac of bleach index 80 c.c. gave the ratio of 3·0-3·6 when tested according to the above-described method. Obviously seedlacs of lower bleach indices will give a higher ratio (as they will be overbleached when 80 c.c. of the bleach liquor are used) and those with higher bleach indices will give a ratio lower than this figure of 3-3·6. It was, therefore, considered probable that this ratio might be of use in interpreting the bleaching characteristic of the sample. A number of samples of seedlacs of known bleach indices were, therefore, tested according to this method and the ratios determined. A curve was drawn plotting these ratios against the respective bleach indices. A fairly smooth curve was obtained (reproduced as in Figure 1). A few new samples of seedlacs were again tested according to this method and on the basis of the ratios obtained and with reference to this curve their bleach indices were predicted. When the samples were subjected to bleaching under the same conditions with the equivalents of this bleach index, the ratio of the shade of the resulting solutions to that of $N/1000$ iodine was within the range of 3-3·6. This would seem to indicate that this ratio may be used as an index of the bleaching characteristic of the sample. It is recognized that a considerably larger number of samples will have to be tested and verified



* A — Bleach index (volume in c.c. of bleach liquor to completely bleach 30 gms. lac sample).
** B — Colour ratio (the ratio of the length of the column of filtered bleached solution matching with that of iodine when 80 c.c. of bleach liquor is used for 30 gms. lac sample).

FIG. 1 — BLEACH INDEX (LENGTH IN CM. OF BLEACHED SOLUTION COLUMN TO MATCH 1 CM. OF *N*/1000 IODINE SOLUTION)

before the accuracy of this curve can be vouchsafed. Experiments in this direction are in progress.

(vi) *Influence of the free alkalinity of the bleach liquor on the above test* — It is well known that excessive alkalinity of the bleach liquor militates against the success of the bleach test. It has already been pointed out (*Annual Report*, 1950-51) how a bleach liquor with a free alkalinity of 0·02-0·05 *N* was found to be satisfactory both as regards stability as well as bleaching efficiency. The effect of excessive free alkalinity of the bleach liquor used in the above method was now investigated. For this purpose the test was carried out using the same sample of seedlac but bleach liquors of different free alkali contents. The results of a typical experiment are indicated below:

	I	II	III	IV
Free alkalinity	0·0354 *N*	0·0747 *N*	0·120 *N*	0·1678 *N*
Colour ratio of the bleached solution	1·86	1·39	1·07	1·04
Bleach index on the basis of the curve	100	110	118	119

Thus it will be seen that increase in the free alkalinity enhances the bleach index.

Relevant details of these results have been communicated to the Indian Standards Institution for consideration at ISO TC/50 Lac meeting at New York to be held in June 1952.

(f) Bleaching of Hard and Soft Resins

Preliminary investigations have been made on the changes brought about in hard and soft resins by the action of hypochlorite bleach.

As a result of bleaching, the acid value of hard resin shows a slight increase (in one sample, from 56·5 to 59·5). This increase is due to retention by the bleached sample of some quantity of labile chlorine. For example, it has been found that the sample referred to above had 1·17 per cent chlorine (as determined by Stepanov's method). This is equivalent to 18·5 mg. KOH per gram of bleached material. On titration with alcoholic potash in cold, potassium chloride equivalent to 3 mg. KOH was formed. This seems to indicate that nearly one-sixth of chlorine present in bleached hard resin is labile. Incidentally, the presence of labile chlorine contributes to a rise in the acid value of bleached hard resin.

The effect of hypochlorite bleach on soft resin varies with the time of bleaching as well as the rate of addition of bleach to the alkaline solution of soft resin. Prolonged action of hypochlorite probably brings about some decomposition of the soft resin molecules. The bleached solution of soft resin, on acidification, gave a white emulsion, which on long standing coagulated to a creamy soft mass. The acid value of this precipitate was found to be much lower than that of the original soft resin (A.V. original soft resin 107, that of bleached product 88). On the other hand, a solution of soft resin that had been bleached in a much shorter time by adding almost the total amount of hypochlorite necessary at a time, gave on acidification, a product which had almost identical acid value with the parent substance (A.V. of original soft resin 101·1, A.V. of bleached soft resin 101·9). This needs confirmation by further experiments.

(g) Peroxide Values of Seedlac and Shellac

Many natural oils and fats possess what are known as peroxide values (P.V.). This is determined by the iodine liberated from a given quantity of material on treatment with potassium iodide. The peroxide value is associated with some form of unsaturation and since lac is also an unsaturated material, it was of interest to see if lac would give any peroxide value. Preliminary experiments have shown that seedlacs have P.V.s of the order of 8 while in the case of shellac this value varies from 2·4 to 3·7.

(h) Heat Resistance of Shellac Plastics

It is important to know what temperature a thermoplastic material will stand without distortion or deformation in order to determine its suitability under different working conditions. For this purpose a standard test is usually called for. An ideal test for this purpose is one which reproduces the actual working conditions for a particular job. But it is neither always possible nor easy to obtain actual working conditions in a laboratory since these obviously admit of too many variables. Hence the necessity for a standard method of test. For shellac plastics Marten's oven test (or the V.D.E. or German test) is being applied for a long time at this Institute, but for the sake of comparison with other plastics these data are often compared with those obtained by the A.S.T.M. or E.R.A. method of heat distortion or plastics yield test. In absence of results of test on shellac plastics by these three principal methods, it is difficult to say to what extent we are wrong if such comparison is made. With this end in view a comparative study of the heat resistance of shellac plastics by the above three methods has been undertaken. The study has assumed added importance in view of the recent compilation of standards on plastics products in this country.

The apparatus required for the three methods mentioned above are different. Even the dimensions of standard bars required for each method are different. The moulds for these three standard bars have been made at the Institute machine shop. The apparatus for the A.S.T.M. method has been set up inside an electrically heated oven. The rate of rise of temperature in the oven is different for different methods. So the temperature regulating device, controlled by the clockwork, which is available in our laboratory, has been made use of to obtain a uniform rate of temperature rise. Since the bending of the standard bar under load in the American method is very small, a correction for the expansion of the metal rod-support has been considered necessary. Preliminary experiments have shown that there is a difference of 15-16°C. between the results obtained by this A.S.T.M. method and those of the V.D.E. method now being used by the Institute for shellac plastics. Further work on all the three principal methods is being continued.

4. MAKING OF SHELLAC

(a) Making of Shellac by Autoclave

The pilot plant ordered from a Calcutta firm has been received and is being installed.

In the meantime, some further experiments were done for making sheets directly from the lac obtained from the autoclave. In previous experiments (*Annual Report*, 1950-51), moist molten lac obtained from the autoclave was first dried in a steam-heated pan and then made into sheets. In the present experiments, attempts have been made to eliminate the preliminary heating to dry the moist lac. Towards this end the moist lac obtained from the autoclave was straightaway put into the sheet-making hot box and sheets were drawn. The sheets thus prepared were kept spread on a floor and raked from time to time (A). A part of the same moist and molten lac was heated in a steam-heated pan and made into sheets as before (B) for comparison. Moisture contents of both the samples of shellac were determined and found to be 1·34 and 1·42 per cent respectively. The sample obtained under (A) had a dull appearance and looked like orpimented shellac. This was due to occluded air bubbles, as revealed under the microscope.

(b) Recovery of Waste Shellac from the Wash Water of the Lac-melting Bag

After recovery of Pessewa by boiling *Danti* (that is, the bags with adhering lac left after melting seedlac for making shellac), the bags are further boiled with excess of soda to recover any residual lac as also to clean them for subsequent use. This wash water is usually drained out as waste.

An investigation was started, at the request of a shellac manufacturer at Ranchi, to recover the residual lac in the waste wash water. Preliminarily, lac contents in the samples of *Danti* were determined by extracting in soxhlet with denatured spirit and was found to be 40-45 per cent on the weight of the *Danti*. About 80-85 per cent of this lac content is recovered from the bags by simple boiling with water. The problem was to recover the remaining portion which accounts for $\frac{1}{8}$ to $\frac{1}{4}$ seer lac per maund of seedlac converted to shellac. Three samples of washings obtained during the cleaning of the bags in soda solution were collected from the factory of the above manufacturer, and examined for their lac contents by precipitating with sulphuric acid. The results obtained with 2-gallon batches are as follows:

Sample No.	Yield of recovered material (dry) in g.	Conc. H_2SO_4 (sp. gr. 1·73) required in g.	Conc. H_2SO_4 required per 100 lb. of recovered material, in lb. (calc.)
1	506	142	28
2	200	52	26
3	365	98	26·5

So, for recovering 100 lb. of lac 26-28 lb. of concentrated sulphuric acid are required, irrespective of the dilution of the washings. This is due to the fact that for washing the bags the manufacturers use a fixed quantity of soda for a definite weight of *Danti*.

Some large-scale experiments were also done in the above factory taking 100 gallons of wash water at a time. The results obtained practically corroborated the results of the laboratory experiments.

The recovered material was, however, not as hard as shellac. This could form an ingredient of bangle-making composition.

5. *AD HOC* RESEARCHES

(a) Shellac-moulded Carbon-type Resistors

A large number of moulded carbon resistors have been made from different compositions during the year under report. They were cured in the oven as described before (*Annual Report*, 1950-51) and used in some electrical circuits. Surfaces of these resistors, especially of those with low values of resistances, were, however, found to be conducting in some cases. This was a disadvantage. This could, however, be overcome by applying a coat of insulating varnish made from lac. There was no change in the value of resistance on application of this varnish and on drying the resistors. The effect of ageing on these varnish-coated resistors was also carefully studied, but no adverse effect could be found on storage for more than six months.

(b) Cement for Electric Lamps

Arising out of an enquiry from the Indian Lamp Factories Association, Calcutta, for a suitable cementing composition from lac for fixing brass caps to electric bulbs, three types of cements were prepared and tested at the Bengal Electric Lamp Manufacturing Co. Ltd. All the three types were found suitable for fixing electric bulbs of 100 watts and below; they also satisfied all requirements as regards adhesion (as judged by the torque test 25 lb. per sq. in. with ordinary bayonet caps and 45 lb. per sq. in. with Goliath caps), ageing and life (continuous burning for 1,000 hours). The cements, however, could not be used for lamps of more than 100 watts, as the heat developed during the burning of such lamps softened the cements with the result that the caps got loose and came off the bulb. Another practical difficulty encountered was that the cements remained soft and did not set hard at the end of 4 minutes' cure which necessitated the cooling of the bulbs a little before they could be taken out from the capping machine. This naturally slowed down the rate of production and is to be considered as a disadvantage from the commercial point of view. In the case of bakelite cement, however, no recourse to cooling was necessary. Attempts were, therefore, made to improve the heat resistance of the cements by effecting certain changes in the composition and the methods of their preparations. Four types of cements were evolved and these were tested at the Bengal Electric Lamp Works according to the factory technique both as regards application of the cement to the brass caps and their subsequent fixation to the glass bulbs under heat in the capping machine. All the lamps came out well-set from the capping machine. No cooling was necessary before the lamps were taken out from the machine and there was also no flow of the cement inside the flare tubes of the lamps — a defect which was noticed with the earlier cements. Lamps of different wattages ranging from 25 to 200 watts were fixed, in all 72 in number. All the lamps were then subjected to various tests and the results obtained are given below:

(i) *Torsion test* (25 lb. per sq. in.)

No. of cement Type VI	25-watt 230-volt lamps	...	all O.K.
	60-watt 230-volt lamps	...	all O.K.
	200-watt 230-volt lamps	...	all O.K.

Type VII	25-watt 230-volt lamps	...	all O.K.
	60-watt 230-volt lamps	...	all O.K.
	200-watt 230-volt lamps	...	all O.K.
Type VIII	25-watt 230-volt lamps	...	all O.K.
	60-watt 230-volt lamps	...	all O.K.
	200-watt 230-volt lamps	...	one opened, rest O.K.
Type X	25-watt 230-volt lamps	...	all O.K.
	60-watt 230-volt lamps	...	all O.K.
	200-watt 230-volt lamps	...	one opened, rest O.K.

(ii) *Ageing test*

Type VI	...	all O.K.
Type VII	...	one 60-watt leaky, rest O.K.
Type VIII	...	one 25-watt bad vac., rest O.K.
Type X	...	one 25-watt bad vac., rest O.K.

(iii) *Life test* (heat-withstanding capacity)

Total number of lamps tested — 36

	Observation after ½ hour's burning	Observation after 1,000 hours' burning
Type VI	all O.K.	all O.K.
Type VII	all O.K.	all O.K.
Type VIII	one 200-watt became soft; rest O.K.	all O.K. (excepting one 200-watt initially softened)
Type X	all O.K.	one 60-watt soft; rest O.K.

(iv) *Moisture absorption test* — All the lamps were put in several open square cardboard boxes and placed in a damp room to see whether any of the above cements absorb moisture thereby developing loose caps in course of time. At the end of 7 weeks, all the lamps were put to torsion test. Results are given below:

Type VI	200-watt	...	2 pieces opened, rest O.K.
	25-watt	...	1 piece opened, rest O.K.
Type VII	200-watt	...	1 piece opened, rest O.K.
	25-watt	...	1 piece opened, rest O.K.
	60-watt	...	1 piece opened, rest O.K.
Type VIII	200-watt	...	1 piece opened, rest O.K.
	60-watt	...	1 piece opened, rest O.K.
	25-watt	...	2 pieces opened, rest O.K.
Type X	25-watt	...	1 piece opened, rest O.K.

(v) *Corrosion test* — Twelve pieces of copper electrodes were coated with each of the four types of cement (3 pcs./type); the electrodes thus coated were then baked and subsequently kept in a closed container to see whether the cements would show any corrosive action on the electrodes in course of time. Observations made at the end of 7 weeks did not disclose any corrosion effect of those cements on the electrodes.

It appears, therefore, that though the general performance of all the types of cements may be considered good, yet they fail to satisfy all the requirements of a perfect cement, particularly with regard to heat-stability and moisture-absorption tests. Attempts are being made to overcome these defects so as to make the cements universally applicable to all grades of lamps.

(c) Shellac Coating for Earthenware Pots

Mention was made in the last year's *Annual Report* about the development of a lacquer coating from shellac for finishing earthenware pots. It was stated therein that when such pots are coated with plain ammoniacal solution of shellac (20-25 per cent strength) and subsequently baked, their surfaces become impervious to moisture, fats and oils and resistant to corrosive action of salt, vegetable and dilute mineral acids, etc. When the process was adopted in large-scale field trials, for example, in the coating of earthenware pots used for collecting and storing palmyra juice, it was found that the films on some pots cracked and peeled off from the surface. It was later discovered that these defects were due to the alkalinity of the surface of these pots, because it is well known that shellac films do not adhere well on such surfaces, particularly those containing lime, potash, etc. At first it was thought that leaching of the pots with water would remove this surface alkalinity, but it was not so. A change in the coating composition was, therefore, considered necessary to make it applicable to alkaline surfaces as well.

As a result of a series of trials, it has been found that the addition of 5-10 per cent extra liquor ammonia to the original lac-ammonia solution and refluxing the same or heating in a closed container on a water bath for a certain time would give a varnish free from any defects of the earlier composition. The films from such varnishes are found to possess good gloss, flexibility and adhesion to any kind of porous surface, irrespective of whether such surfaces are alkaline or otherwise. No cracking or peeling off of the films from such varnishes could be detected. This is possibly due to the slight saponification of lac brought about by the extra ammonia thereby increasing slightly the acidity of the lac resin which would have a neutralizing effect on the alkaline surface.

The modified varnish is prepared as follows:

100 g. of shellac are at first dissolved in a mixture containing 10 c.c. of liquor ammonia (sp. gr. 0·88) and 300 c.c. of water preferably by soaking overnight and then warming to 60°C. on a water bath the next day. An extra 5-10 per cent of liquor ammonia is added to this solution and then refluxed or heated in a closed container on a boiling water bath for 6-8 hours. The solution is then cooled and any wax separated may be removed by filtration or straining. The solution is then ready for application. The articles after the usual coating are dried and baked at 130-140°C. The baking time, however, has to be increased to 5-6 hours from 3-4 hours, recommended in the case of the earlier solution.

By mixing suitable dyes and pigments in the solution various attractive surfaces could be obtained.

A note on the lacquering of earthenware pots is under publication.

(d) Sealing-wax

The effect of varying the relative proportions of rosin and shellac in the preparation of sealing-wax according to the standard formula (*Annual Report*, 1950-51) was studied qualitatively. The results are given below:

1. Shellac 45 parts, rosin 15 parts (as in standard formula). Sticks came out easily. Adherence to paper was good.
2. Shellac 35 parts, rosin 25 parts. Sticks stuck to the mould. Castor oil was applied to the mould. This did help to release the sticks easily. But the surface became tacky. Adherence to paper was good.
3. Shellac 25 parts, rosin 35 parts. Sticks were as in (2). Adherence also as in (2).
4. Shellac 15 parts, rosin 50 parts. Sticks could not be released from mould even after application of castor oil. Adherence to paper was poor.
5. Shellac 10 parts, rosin 50 parts. Sticks were as in (4). Adherence to paper as in (4).

6. Shellac 5 parts, rosin 55 parts. Sticks were as in (4). Adherence to paper as in (4).
7. Shellac 0 part, rosin 60 parts. Results similar to (4).

In the cases of 3, 4, 5, 6 and 7, talc was applied in the mould to secure easy release from mould, but results were not satisfactory. So, it appears that to prepare sealing-wax of good quality, shellac content should not be lowered below 45 parts.

Elastic sealing-wax — At the request of Shellac Information Officer, London, two samples of elastic sealing-wax were prepared by incorporating 1 and 0·5 per cent rubber in solution in turpentine.

Seals prepared from these sticks had more flexibility than those from sealing-wax made according to standard formula. Heat stability of rubber-containing sealing-wax was, however, less as compared with that of ordinary rubberless samples.

(e) YIELD OF SEEDLAC AND SHELLAC

It was reported from the Palamau Shellac Association that the yields of seedlac and shellac from the sticklac obtained from the markets of the Palamau district are not as per figures given in the *Report on the Marketing of Lac in India* published by Government of India in 1943. At the request of the President of the Association an officer was sent to collect sticklac samples of *Katki* available at the time from the Daltongunj market and examine them for their seedlac and shellac contents. After careful processing the yields of seedlac and shellac from three samples were as follows:

Yield of Seedlac and Shellac from 1 Md. Sticklac

Sample No.	Seedlac (before winnowing), Sr. ch.	Seedlac cleaned, Sr. ch.	Shellac T.N., Sr. ch.	Shellac fine, Sr. ch.
1	16 4	13 8	12 8	11 0
2	15 8	13 5	12 4	11 2
3	17 0	14 0	13 0	11 14

The sticklacs were found to be highly adulterated.

6. DEMONSTRATION AND PUBLICITY

Work under this head was continued during the period under review to the extent that was possible by supplying information mostly through correspondence to the interested parties in answer to various enquiries from them. Information sought for covered quite a number of topics and included, among other things, such items as the best method of bleaching lac and storing bleached lac, preparation of good quality sealing-waxes, quick-drying coating compositions capable of giving hard and glossy finishes, recovery and utilization of lac wax, improvement in the manufacture of seedlac, shellac, etc. Statistical enquiries regarding the yields of seedlac and shellac from various kinds of sticklacs were also answered.

Samples of lac-oil compositions for making oil-cloth, resin-like materials, book-binding cloth, etc., were sent to a firm in Calcutta engaged in making such materials, for commercial trials. A report on their trials is awaited.

Lac compositions recommended for coating earthenware pots used for collecting and storing palm juice are being given large-scale field trials near and around Bombay by an officer of the Central Palm Gur Training School. Lac-coated pots are being tried at

present for storing " Neera " (fresh palm juice) used for drinking as such in the Bombay area.

Further particulars regarding the composition and preparation of black adhesive tapes for electrical insulation purposes, " empire cloth ", etc., were supplied to a firm in Saharanpur. This firm after a successful commercial exploitation of our process of manufacturing waterproof abrasive papers from lac-based compositions has shown readiness to utilize its resources for making products mentioned above as also oil-cloth, book-binding cloth, etc. The firm has gone so far as to set apart Rs. 5,000/- for co-operative research in its factory and has, besides, agreed to devote two days in the week for developing and manufacturing several products based on lac. It is intended to take full advantage of this co-operation to give trials to such of the lac products as are worthy of commercial exploitation.

In response to an enquiry from the Indian Lamp Factories Association, Calcutta, for an adhesive for fixing brass caps to electric bulbs, as also metal strips to glass tubes, suitable cementing compositions were made from lac and sent to the Association for trials by its member-firms. A practical demonstration on the application of such cements was also given at the Bengal Electric Lamp Manufacturing Co., Calcutta. All the compositions were found to be quite good for low wattage lamps, but for higher wattage bulbs, e.g. 100 watts and above, they were found to be unsuitable as the heat developed by such lighted bulbs softened the cement. Modifications in the compositions are being tried to increase the heat resistance.

At the request of the Technical Development Establishment (T.D.E.) of the Armed Services Wing, Dehra Dun, about five pounds of improved lac-moulding composition were sent for making fine types of radio-knobs. These were also found suitable for making binocular eye cups required by the Establishment. Two dozen binocular eye cups were also made and sent to T.D.E. for examination and report.

Exhibits of various types of lac and articles made from lac were sent to the following places during the period under review:

1. National Chemical Laboratory, Poona
2. All-India Industrial-*cum*-Agricultural Exhibition, Madhya Bharat, Indore
3. Principal, Lawrence School, Lovedale, South India
4. Forest Officer, Jagdalpur, Madras State

Exhibition — Following a directive received from the Ministry of Agriculture, Government of India, the Institute took part in the International Industries Fair held in Bombay in January-February 1952. Various commercial forms of lac as well as articles and compositions made out of lac were exhibited in a stall in the Agricultural Ministry's Pavillion. The Institute publications were also kept on show. The stall was visited by a vast number of visitors including several prominent personalities and was well appreciated. The film " Lacs from Lac " was also screened at the Agricultural Ministry's Cinema auditorium on a number of days. A small booklet entitled *Lac and Lac Products*, specially printed for the purpose, was distributed free to interested enquirers and several personal enquiries were answered on the spot.

A note on the " Improved coating from lac for Palmyra Juice pots " was sent for publication in the Government of India's proposed newsletters.

7. MISCELLANEOUS ACTIVITIES

Symposium — In response to an invitation, received from the organizers, Shri Y. Sankaranarayanan was deputed to attend on behalf of the Institute, a symposium on Paints and Varnishes that was held at the National Chemical Laboratory, Poona, on the 6th and 7th March 1952. He read a paper on " Shellac as a varnish resin " on the

occasion and also took part in the general discussion that followed. This paper and discussions have been published in *Paintindia*, April 1952.

8. METEOROLOGICAL REPORT

The average meteorological data for each month during 1951-52 are given in the following table:

Month	Dry bulb temp. (°F.)	Max. temp. (°F.)	Min. temp. (°F)	Relative humidity (%)	Sunshine (hr./day)	Wind speed (miles/hr.)	Rainfall (in.)
Apr. 1951	82·5	91·8	67·1	37·9	9·5	3·4	3·04
May 1951	91·4	102·7	75·4	34·0	9·6	2·4	1·42
June 1951	84·2	94·4	74·8	67·1	6·7	2·8	9·30
July 1951	79·3	85·1	72·0	83·0	5·3	3·1	11·95
Aug. 1951	79·7	86·1	73·2	82·8	6·0	1·5	11·86
Sept. 1951	80·8	87·8	70·7	75·0	8·5	1·4	8·95
Oct. 1951	79·7	88·9	68·4	73·7	8·7	1·1	3·16
Nov. 1951	71·1	83·6	55·2	61·6	9·3	0·6	0·10
Dec. 1951	64·5	77·6	47·4	51·2	9·8	0·7	Nil
Jan. 1952	65·4	80·0	49·0	49·6	9·7	0·7	0·13
Feb. 1952	70·2	84·7	55·3	43·9	8·7	1·6	0·30
Mar. 1952	75·0	89·1	60·1	37·9	9·2	1·8	1·59

The highest maximum temperature during the year under report was 110°F. and was recorded on 15th and 21st May 1951. The lowest minimum temperature was only 42°F. and was recorded on 22nd December 1951 as well as on 13th and 19th January 1952.

The total rainfall during the year was 51·80 in. and the monsoon rain 42·06 in. against 65·50 in. of total rainfall and 57·11 in. of monsoon rainfall last year. The rainfall figures were thus much less than the previous year's figures.

Dated, the 24th July 1952

P. K. Bose
Director
Indian Lac Research Institute
Namkum, Ranchi, Bihar

APPENDIX I

A Statement of Lac Produced and Its Disposal from 1st April 1951 to 31st March 1952

Crop and locality	Scraped or broodlac produced and its disposal					
	Produced	Under use in Dept.	Driage	Supplied to Chem. Sec.	Sold	Distributed
	Md. sr. ch.	Md. sr. ch.	Md. sr. ch.	Md. sr. ch.	Md. sr. ch.	Md. sr. ch.
Baisakhi 1951 (Namkum)	1 24 0*	—	—	—	1 24 0*	—
	0 24 3†	0 11 5†	0 4 14†	0 8 0†	—	—
Jethwi 1951 (Hesal)	0 1 4*	0 1 4*	—	—	—	—
	3 13 13½†	0 2 0†	0 24 14½†	1 36 0†	—	—
				0 30 15†		
Katki 1951 (Namkum)	0 27 15½†	0 27 15½†	—	—	—	—
Aghani 1952 (Hesal)	3 16 10*	1 11 10*	—	—	—	1 0 0* To Forest Research Officer, Ranchi, Doranda
	20 7 0†	20 7 0†	—	—	—	1 0 0* Sent under I.D. Scheme, Bihar, at Bundu
						0 5 0* Sent under extension of lac cultivation (W. Bengal), Hisuli plantation, Nadia

Receipts

	Quantity Md. sr. ch.	Value Rs. as. p.
1. By supply of broodlac for sale from Institute plantation (*Baisakhi* 1951 crop)	1 24 0	80 0 0
By supply of broodlac for use in the department from Hesal plantation (*Jethwi* 1951 crop)	0 1 4	4 13 6
By supply of broodlac for free distribution from Hesal plantation (*Aghani* 1952 crop)	1 0 0	120 0 0
By supply of broodlac for free distribution from Hesal plantation (*Aghani* 1952)	1 0 0	120 0 0
	0 5 0	15 0 0
By supply of broodlac for use in the department from Hesal plantation (*Aghani* 1952)	1 11 10	154 14 0
TOTAL	5 1 14	494 11 6
2. By supply of scraped lac to Chemical Section, I.L.R.I., from Institute plantation (*Baisakhi* 1951 crop)	0 8 0	20 0 0
By supply of scraped lac to Chemical Section, I.L.R.I., from Institute plantation (*Jethwi* 1951 crop)	1 36 0	190 0 0
By supply of scraped lac to Chemical Section, I.L.R.I., from Institute plantation (brood) (*Jethwi* 1951 crop)	0 30 15	77 5 6
TOTAL	2 34 15	287 5 6
Carried over		782 1 0

*Broodlac. †Scraped lac.

APPENDIX I (*contd.*)

RECEIPTS

	Quantity Md. sr. ch.	Value Rs. as. p.
Brought forward		782 1 0
3. By supply of scraped lac for use in the department from Namkum plantation (*Baisakhi* 1951 crop)	0 11 5	28 4 6
By supply of scraped lac for use in the department from Hesal plantation (*Jethwi* 1951 crop)	0 2 0	5 0 0
By supply of scraped lac for use in the department from Namkum plantation (*Kathi* 1951)	0 27 15½	69 14 9
By supply of scraped lac for use in the department from Hesal plantation (*Aghani* 1952)	20 7 0	1,008 12 0
TOTAL	21 8 4½	1,111 15 3
4. By supply of scraped lac to Chemical Section, I.L.R.I., from Hesal plantation (*Aghani* 1951)	1 24 8	161 4 0
By supply of scraped lac to Chemical Section, I.L.R.I., from Institute plantation from miscellaneous lac	0 1 4	3 2 0
By supply of scraped lac to Chemical Section, I.L.R.I., from purchased (used at Hesal) lac (of *Jethwi* 1951)	0 33 1	82 10 6
By supply of *Ari* (scraped) lac for use in the department from purchased lac (of *Aghani* 1951)	0 3 0	7 8 0
TOTAL	2 21 13	254 8 6
5. Revenue from other sources such as grass, *Boga* seeds, etc., from Namkum plantation	—	202 2 0
GRAND TOTAL		2,350 10 9

APPENDIX II

Tabulated Statement of Progress of Investigations

ITEM 1	COMMD. 2	PROGRESS 3	FUTURE WORK PROPOSED 4
1. Lac Cultivation			
(i) Preservation of *Baisakhi* brood by partial defoliation of *palas* and demonstration of improved methods of lac cultivation	1948-49	8,017 trees infected in Oct. 1950 yielded over 104 mds. of brood *plus* brood left for self-infection *plus* nearly 56½ mds. of scraped lac in coupé I. 2,169 trees in coupé II infected in July 1951. Over 116 mds. of broodlac plus 43 mds. 16 srs. of scraped obtained in Oct. 1951 from rejected lac. Large-scale artificial partial defoliation shown practicable. Kundri also served as a good training ground for trainees at the Institute.	To be continued.
(ii) Preservation of *Baisakhi* broodlac by employing suitable hosts	1945-46	*A. lucida* at Namkum gave better results than *O. dalbergioides* or *F. infectoria*. Yield from *F. cunia* consisted of about 95 per cent good brood. *F. bengalensis*, *F. glomerata* and *A. lebbek* tried in Kundri gave results below expectation.	A thorough investigation would require suitable field stations. To be continued.

APPENDIX II (*contd.*)

Item	Commd.	Progress	Future work proposed
1	2	3	4
2. Determination of Most Suitable Pruning Methods and Seasons of *Kusum*	1941	Apical and surface pruning being tried at respective intervals of 6, 12 and 18 months.	To be continued.
(i) Shoot study: number and growth	...	Growth of primaries best in the case of surface pruning with 12 months' rest and poorest for surface pruning with 6 months' rest. Growth of secondaries better for apical pruning with 18 months' intervals than for surface pruning with 12 and 6 months' intervals.	To be continued.
(ii) Yield of lac crop (iii) Yield of broodlac	...	Apical pruning with 18 months' interval gave best result in the case of *Jethwi* crop: No significant difference noted in the case of *Aghani* crop.	To be continued.
3. Pests of Host Trees			
(i) *Tessaratoma javanica*	1950	This is a sporadic pest of *kusum* and might be affecting shoot growth. The incidence, nature of damages and life-history of this bug are under study.	To be continued.
(ii) Miscellaneous insects	...	Termites caused mild damage to nursery beds. Found to damage *palas* and *kusum* trees. Some insects identified.	...
4. Lac Insect			
Lac insects	1950	Collection of preserved specimens of lac insect and its strains rearranged and catalogued as a prelude to systematic study which has just been commenced.	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. Duration of various instar stages was studied. Specimens sent abroad for identification.	To be continued.
(ii) *E. amabilis* and *H. pulverea*	...	An observation on the population of the life-history stages of these insects in mature *Kusumi* (*Aghani* 1952) was made.	...
6. (Preventive) Methods of Control			
(i) *Cultural Methods*:			
(a) Use of wire-gauze as brood containers during infection as control against enemies of lac	1945	Number of non-lac insects trapped in wire-net baskets were counted, and in some cases indentified. Number of cages damaged in course of successive use were also noted.	To be continued; for large-scale trials it is necessary to have suitable field stations.
(b) Wire-gauze and bamboo containers	...	Cylindrical tubes of bamboos or tin closed at ends with wire-nets were designed, and will be tried, these being cheaper.	To be continued.

APPENDIX II (*contd.*)

Item	Commd.	Progress	Future work proposed
1	2	3	4
(ii) *Biological Control*:			
(a) *B. greeni*: ecto-parasite of *E. amabilis*: to discover suitable alternative hosts to breed *B. greeni* in laboratory	1942	*Etiella zinckenella, P. gossypiella, T. fructicassiella, L. orbonalis* were collected. Breeding of *B. greeni* on *E. zinckenella* and *T. fructicassiella* was done. 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; experiments on parasitation were continued.	To be continued.
(b) *B. greeni*: development in relation to natural and alternative hosts	...	Study has been just commenced. Bred for six generations on unnatural hosts, the fecundity of the insect remains unchanged when supplied with natural hosts for oviposition.	...
7. Training and Advisory Service			
(i) Training	1940	In all 22 persons were under training from Bihar, Madhya Pradesh, U.P. and West Bengal. Of these, 13, including 2 on short course of 6 months, completed training during the period.	To be continued.
(ii) Advisory service	...	Advice was given to lac cultivators all over India. Popular lectures arranged in some places. Exhibits sent.	To be continued.
8. Supply of Pruning Instruments, Broodlac and Wire-net Baskets (I.D. Scheme)	...	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	1940	Institute methods were followed in all demonstration centres. Reports so far received show good promise.	To be continued.
10. Field Station (Murshidabad)	1950	Hosts in dry and wet grounds infected for comparison.	...
11. Namkum Plantation	...	General upkeep of the plantation was satisfactory. Small-scale experiments were continued. Among other things, Assamese variety of *arhar* (*Cajanus indicus*) grown for lac cultivation.	The Assistant for plantation has not yet been recruited.
12. Extension of Lac Cultivation	1948	Over 36,500 idle hosts were located and nearly 6,500 hosts hitherto unexploited brought under lac.	Requires proper consideration by States concerned.

APPENDIX II (*contd.*)

Item 1	Commd. 2	Progress 3	Future work proposed 4
13. Varnishes and Lacquers			
(a) Lac-linseed oil paints	1948	Compositions were used to paint iron and wood work of the Institute buildings and staff quarters. Surface keeps well indoors, but not out of doors (4 years). Commercial trials show the paint vehicle to be rather soft; besides it deteriorates in contact with " Chinese blue ".	To be continued.
(b) " Oil-cloth " composition	1944	Samples prepared more than 3 years back found to retain gloss and flexibility. No after-tackiness developed. A coating machine capable of coating samples of maximum width of 36 in. has been set up.	To be continued.
14. Modification of Lac and Its Derivatives			
(a) Lac derivatives with polyhydric alcohols and polybasic acids	1948	Some derivatives have good adhesion on wood and metal besides being resistant to water, dilute acids and alkalis; no greening effect on copper. Some found suitable for solventless hot-melt application. Resins not found suitable for moulding.	To be continued.
15. Fundamental Researches			
(a) Constitution of shellac	1947	(i) Several degradation products (acids) isolated and in some cases tentatively identified. An acid now named as " butolic acid " has been separated and its constitution is being studied. (ii) Shellac tested for presence of aldehyde and acyloin groups. (iii) Oxidation of shellac with periodic acid was studied.	To be continued.
(b) Separation of higher fatty acids (if any) from the bark of lac host trees	...	No fatty acids could be separated so far.	To be continued.
(c) Polyesterification of dibasic acid obtained from aleuritic acid	...	Physico-chemical properties (e.g. viscosity, refractive index, molecular weight, fractionation, etc.) of the polyesters studied.	To be continued.
(d) Polycondensation of aleuritic acid	...	Polycondensation studied to see if macrocyclic lactones would be formed.	To be continued.
(e) Bleach index	...	An improved process for determining bleachability has been worked out. Details communicated to Indian Standards Institution for consideration in ISO meeting in New York.	To be continued.

APPENDIX II (*contd.*)

Item 1	Commd. 2	Progress 3	Future work proposed 4
(f) Bleaching of lac and its constituents	1950	Hard resin found to retain chlorine in the form of labile chlorine.	To be continued.
(g) Peroxide value of seedlac and shellac	...	Preliminary experiments conducted.	To be continued.
(h) Heat resistance of shellac plastics	...	Comparative study by various methods started; necessary apparatus fabricated and set up.	To be continued.
16. Improvements in the Manufacture of Shellac, Seedlac, etc.			
(a) Making of shellac by autoclave method	1947	A pilot plant to melt 30 srs. of seedlac per charge has been received and is being installed. Experiments made to prepare shellac directly from lac obtained from the autoclave.	Economics to be studied.
(b) Recovery of waste shellac from the wash water of the lac-melting bag	...	Lac recovered is soft and suitable for bangle making.	...
17. *Ad hoc* Researches			
(a) Carbon-type moulded resistors from lac	...	Resistors observed to have surface conductivity in actual use. This could be overcome by applying lac varnish. Storage for over six months does not show any deterioration.	To be continued.
(b) Cement for electric lamps	...	Lac-based cement for fixing brass caps to glass bulbs found suitable for use in bulbs of 100 watts and less. Modified compositions worked out to remove the defects were tried: though improved, compositions call for further modification.	To be continued.
(c) Coating of palmyra juice pots (earthen)	1950	A coating schedule using shellac has been developed. Original composition has been slightly modified to widen its scope of usefulness. Field trials are going on.	Work to be continued to extend the use of such coated pots.
(d) Sealing-wax	...	Relative proportions of rosin and lac determined. A formula for elastic sealing was worked out.	Work complete.
(e) Yield of seedlac and shellac from bazar samples of sticklac	...	Investigations undertaken at the requests of manufacturers revealed high adulteration of sticklac, resulting in very poor yields.	...
18. Demonstration and Publicity and Miscellaneous Activities during 1951-52	...	A short account given in the report.	...

APPENDIX III

Papers Published/Completed during the Year 1951-52

1. " Constituents of Shellac : Part I — Butolic Acid ", by S. C. SEN GUPTA & P. K. BOSE (communicated to the Press).
2. " The use of shellac for coating earthenware vessels ", by M. VENUGOPALAN & P. K. BOSE (communicated to the Press).
3. " Shellac as a Varnish Resin ", by Y. SANKARANARAYANAN (a paper presented before a symposium on Paints and Varnishes held at National Chemical Laboratories, Poona).
4. " A Note on the Preparation of sealing-wax ", by T. BHOWMIK (completed).
5. " Polyesterification of Polyhydroxy-polybasic acid : Part I — 9: 10 Dihydroxy-hexadecane-1: 16 dicarboxylic acid " (completed).

APPENDIX IV

Estimated Production of Sticklac in India (in maunds)

Year	*Baisakhi*	*Jethwi*	*Katki*	*Kusumi*	Total
1951-52	8,81,400	9,000	2,65,500	63,500	12,19,400
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

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