INDIAN LAC RESEARCH INSTITUTE

NAMKUM, RANCHI, BIHAR, INDIA

ANNUAL REPORT

FOR THE FINANCIAL YEAR 1958-59

1960

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INDIAN LAC RESEARCH INSTITUTE

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ANNUAL REPORT FOR THE FINANCIAL YEAR 1958-59

ADMINISTRATIVE AND GENERAL

General — Dr. S. V. Puntambekar, Ph.D. (Ill.), F.A.Sc., who had joined the Institute as its new Director in November 1954, retired from his post on 31st March 1959 handing over charge to Dr. S. Krishnaswami, Ph.D., Entomologist, who is to officiate in the post till a permanent Director is appointed.

The projected reorganization of the Institute partially came into effect during the year. Under this, an altogether new section, called the Arboricultural Section, has been created out of the existing unit of the Entomology Division, which is to function as a close adjunct to the Entomology Division; its chief work will be to intensify study, and tackle problems, regarding the actual and potential lac hosts of the country which hitherto had been done in the Entomology Division. Of the three ancillary officers' posts under the changed set-up, the post of the Physical Chemist has been filled by selection, while the posts of the Organic Chemist and the Arboricultural Officer still remain vacant.

An important new development during the year was the starting of a Production Unit as part of the Chemistry Division. Sanctioned temporarily for three months, a detailed scheme has subsequently been sanctioned for three years. However, staff to work the scheme have not been recruited yet, and hence although a few items such as photomounting tissue paper, bleached lac, and ammoniated lac are being produced in small quantities to meet the pressing demands from various quarters, a full-scale launching of the scheme has to wait for some time more.

The most important practical results achieved during the year are the use of lac in making photomounting tissue papers, and the formulation and application of water-soluble lac by the Chemistry Division, and the successful exploitation of *Moghania macrophylla* a bush plant, as an excellent alternative host of *Kusmi* lac by the Entomology Division. It is to be noted, however, that while the two findings of the Chemistry Division are already finding practical applications through the Production Unit, the exploitation of *M. macrophylla* outside the Institute's own field research stations cannot but take considerable time to materialize on a large scale.

During the year, a Field Research Station at Damoh and a Regional Testing Laboratory at Gondia were opened. The former is meant to study the lac hosts and methods of lac cultivation prevailing in the region and suggest improvements in these wherever possible. The Field Research Station is also to examine how far methods developed in Namkum or elsewhere might have to be modified to suit local conditions as regards climate and cultural practices. The Gondia laboratory is to test samples of processed lac submitted by local manufacturers to enable them to see how far their products conform to the current standards and specifications. Since it started functioning towards the end of July 1958, 263 samples received from the trade have been analysed in the laboratory. The services of both these units are greatly in demand already.

As reported last year, periodical seminars continued to be held separately in the Chemistry and Entomology Divisions; there were also a number of joint sittings in which

the Lac Extension Officer and his staff also participated. The local Entomological Society, sponsored by the Entomology Division, also continued its activities, although in a small way.

Visitors — As usual, the Institute continued to attract throughout the year large numbers of visitors, including a few from foreign countries. A substantial proportion of persons to be shown round, interestingly enough, was made up of students and trainees from various career colleges and Government Institutions, which indicates a growing measure of realization by the Institutions concerned of the importance and the educative value of getting first-hand acquaintance with lac, a singular Indian product. A few visitors deserving special mention were:

1. Shri P. L. Verma, Member, U.P.S.C., Delhi
2. Mr. Alberto A. Virtusio, Community Development Centre College, Philippines
3. Mr. Avelio H. Banh, Regional Community Development Office, Philippines
4. C. E. Suter of A. F. Suter & Co., London
5. Mr. Charles Hutchinson, Chairman, London Shellac Trade Association, London

Dr. B. N. Uppal, President, Indian Lac Cess Committee, visited the Institute twice. Other members of the Lac Cess Committee to visit the Institute were: Dr. L. C. Verman, Dr. K. Venkatraman, and Shri K. P. Sagreiya.

Exhibitions — The Institute participated in a number of exhibitions, big and small, including the ' India 1958 ' exhibition at New Delhi and the exhibition at Damoh during the inauguration of the Field Station. The Institute organized on its own a month-long exhibition of lac and lac products at Bombay, which was greatly appreciated as much by the lay public as by the business community: the effect of the exhibition in stimulating a practical interest in lac among the industrialists proved to be very satisfactory.

Roads and Buildings — The annual repairs to roads and buildings were carried out by the C.P.W.D. as usual.

The construction of the solvent godown appears to have been completed and the C.P.W.D. is expected to hand it over to the Institute soon.

One of the big halls in the Lac Products Area has been converted into the Trainees' Hostel, hence the building previously in use as Trainees' Hostel has been vacated by the trainees and is now being utilized as Staff Hostel: it may be recalled that owing to shortage of staff quarters, a couple of staff quarters have beenf unctioning as a Staff Hostel for a number of years now.

Lac Extension Officer's office continues to be located in one of the staff quarters: the premises of the Lac Products Area are not yet ready to accommodate his office.

The two annexes, one each to the Entomology Division and the Library, have been completed, which, however, still lack water and electricity connection and hence have not been handed over to the Institute by the C.P.W.D.

Construction of the Administrative Block was started during the year and appears to be proceeding apace.

No staff quarters were constructed during the year.

Water Supply — The water-works has already undergone renovation in several respects: a new cast-iron pipe-line now joins the river-bed well to the Institute's settling tank and the old pumps have been replaced by modern centrifugal pumps. Even so, the position of water supply is far from satisfactory, especially during the summer, first by reason of increased demand caused by the expansion of the Institute to include the Lac Products Area, and secondly, because of the distributory lines having got choked and almost completely worn

out. A new element requiring immediate attention is the old overhead tank, which is leaking and considered to be beyond repairs. During the year, the C.P.W.D. has prepared a detailed estimate for replacing the tank and the distributory lines, which work, it is expected, will be taken up in the coming year.

Library — In view of the completion of the proposed annexe which is expected to be shortly commissioned, a new lay-out of the shelves has been worked out with the assistance of the I.C.A.R. expert and is being given effect to.

An important new decision has been taken by the Indian Lac Cess Committee, under which, in fulfilment of the ministry's plan to centralize sales of publications by the various commodity committees, publications for sale will be transferred to the I.C.A.R. which body, with suitable addition of staff at the expense of the various commodity committees, will function as both a sales agent and a clearing house for technical information obtainable from various research institutes under the Committee.

Books and bound volumes of journals accessioned during the year numbered 219. Miscellaneous scientific pamphlets received numbered 55.

The Institute sold some 250, distributed over 1,800 and transferred to the Lac Extension Officer 245 (priced) publications of its own during the year.

Training

(a) *Lac cultivation* — There were 10 trainees at the commencement of the year. During the period 5 trainees, including 2 from Burma (under the Colombo Plan), joined the course. Eleven trainees completed their course during the period.

(b) *Industrial uses of lac* — Only one candidate deputed by the West Bengal Government took the 6 months' course. A few casual trainees also received training in selected items.

Staff — A fairly large number of staff were recruited during the year: there were also some resignations.

Details will be found in Appendix F.

Staff Club — The Club continued to function as usual.

ENTOMOLOGY DIVISION

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

I—GENERAL

Introduction — During the year under report experimental work in the two newly established field research stations at Jhalda (West Bengal) and Damoh (Madhya Pradesh) as part of the Second Five Year Plan were initiated, all the preliminary work connected with the marking, coupéing, pruning, etc., having been completed previously. Most of the field experiments redesigned on sound statistical lines last year were continued for the second year.

Staff — Of the Research Assistants recruited to fill the vacancies in the Division, only a few joined, and the rest of the posts continued to be vacant. Thus, although the staff position slightly improved, the general shortage continued to be there. The Research Assistants for the two field stations joined their respective headquarters only towards the end of the year under report.

Season — The seasonal conditions were quite favourable for the *Jethwi* 1958 crop, but the prolonged drought during the summer was not at all helpful for the *Baisakhi* 1957-58 crop which suffered from a rather heavy mortality of lac. Heat mortality was evident even on the *Jethwi* crop as well. The *Katki* (1958) crop was generally good and the progress of *Baisakhi* (1958-59) crop has been so far satisfactory. Similarly, a good crop was obtained in the *Aghani* (1958-59) season and the following *Jethwi* (1959) crop is making satisfactory progress.

The incidence of enemy insects was generally low in all the crops except *Katki* (1958).

II—RESEARCH AND INVESTIGATIONS

1. Improving Crop Production on *Palas* by Partial Defoliation

(i) *Large-scale defoliation experiments*

A total number of 13,510 *palas* trees were pruned in Coupé No. I in April-May 1958 which yielded 55 mds. 12 seers (2056 kg.) of scraped lac. The lac crop in Coupé III matured rather late towards the end of July 1958, due to the prolonged spell of drought during summer. Heavy and continuous rain at the time of harvesting hampered the reaping and inoculation operations. In all 3,795 trees were partially cropped to remove dead and surplus broodlac after leaving sufficient broodlac for self-inoculation. This gave 20 mds. 24 seers of broodlac (768·8 kg.) and 120 mds. 18 seers (4495·2 kg.) of rejected lac sticks. With about 17 mds. 6 seers (640 kg.) of selected broodlac, 385 *palas* (in Coupé II), 20 *ber* and 8 *khair* trees were inoculated for raising the *Katki* crop by artificial inoculation.

In October-November 1958, in all 6,810 trees were cropped which yielded 293 mds. 7 seers (10941·3 kg.) of lac sticks, of which 238 mds. 37 seers (8916·7 kg.) was broodlac and 54 mds. 10 seers (2017·6 kg.) was rejected lac. With 184 mds. 23 seers (6888·3 kg.) of selected broodlac, in all 10 *ber* and 10,986 *palas* trees were inoculated. Out of these, 4,310 *palas* trees had been partially artificially defoliated prior to inoculation under the large-scale defoliation experiments. From the above quantity of broodlac used for inoculation, 18 mds. 4 seers (675·5 kg.) of scraped lac was obtained. In the month of February 1959, 8 *ber* and 699 *palas* trees in Coupé II were pruned. During the year, 101 mds. 19 seers (3787·0 kg.) of sticklac and 55 mds. (2052·6 kg.) of broodlac produced from the area were disposed of, which yielded a total revenue of Rs. 6,159.48 nP. as against the cultivation expenses of Rs. 4,342.11 nP. inclusive of guarding charges.

(ii) *Effect of partial defoliation of* palas *on brood preservation*

This experiment was redesigned on sound statistical basis and was laid out in the *Baisakhi* (1957-58) season in Coupé III at Kundri. There are two treatments, namely (i) partial artificial defoliation of trees and (ii) control, i.e. without any defoliation. They are laid out in randomized block design with 10 replications. Since the treatment of defoliation is likely to alter the climatic environment of the plots, sufficient border was provided. Hence in each plot there are 25 trees, of which the central 5 trees are to serve as the experimental trees.

The experimental details were as follows:

Treatments		*Replications*		*No. of experimental trees in each plot*
1. Partial artificial treatments 2. Control (no defoliation)	×	10	×	5 Total number of trees =100

Crop data and the analysis of variance are presented in Table I (Appendix A).

The ratio of brood used to brood yield was 1: 1·43 for the defoliated group and 1: 0·23 for the control (undefoliated) group.

Mortality of the lac insects due to heat was also assessed on two twigs selected at random from each of the experimental trees at the time of crop harvesting. The results are summarized below:

Treatments	*No. of twigs examined*	*Total length*	*Total No. of female insects present*	*No. of living insects*	*Percentage survival*
1. Defoliated	1000	148′ 11″	23,127	3561	15·40
2. Control	100	168′ 0″	45,546	1207	2·65

From the above as well as the analysis of variance of yield data it is clear that in this season defoliation has definitely proved beneficial in the preservation of broodlac.

2. Economics of Utilizing *Palas* for *Baisakhi* Crop only and *Ber* for *Katki* Crop

The trials are being conducted both in the experimental plantation at Namkum and at the Kundri forest. The lac crops were raised on 10 trees of both *palas* and *ber* in the *Baisakhi* 1957-58 and *Katki* 1958 seasons. The crops were completely reaped on maturity and the yield data were compared. (Data are presented in Table II, Appendix A.)

A reference to the table will show that *ber* failed to produce any broodlac at all in the *Baisakhi* season at both Namkum and Kundri, whereas *palas* produced some broodlac at Kundri and fairly satisfactory amount of broodlac at Namkum. In the *Katki* season, however, the performance of *ber* was better than that of *palas* at Kundri both in respect of brood and crop production. At Namkum, the *ber* crop suffered right from the start due to unsatisfactory larval settlement. Further, both the *palas* and *ber* crops were damaged by enemy infestations to a considerable extent and the crop yields were generally poor, making comparisons of data not possible.

3. Comparative Preservation of Broodlac on *Ber* by Partial Pruning Before and After Inoculation

This experiment was relaid in the 1957-58 *Baisakhi* season in randomized block design with three treatments replicated 10 times. The three treatments were: (i) A — Partial pruning in October-November before inoculation, (ii) B — Partial pruning in December-January after inoculation and (iii) C — Control.

The experimental details are given below:

Treatments	*Replications*	*No. of trees per plot*	*Total No. of trees*
1. A — Partial pruning in October-November 2. B — Partial pruning in December-January 3. C — Control	× 10	× 1	= 30

The crop data are given in Table III (Appendix A)

It may be seen that none of the treatments was helpful in the preservation of broodlac. The crop data were not analysed statistically as no quantity of broodlac was obtained as yield.

Observations on the crop progress were made at periodical intervals through stick examination of one 3 in. sample per tree (30 samples in all). Results of stick examination are given in Table IV (Appendix A).

At crop maturity, mortality due to heat was also estimated on a larger sample of 1 foot twig per tree and the results are recorded in Table V (Appendix A). From Tables IV and V it is evident that the partial pruning treatments either before or after inoculation have not been successful in the preservation of broodlac. As a matter of fact, there has been slightly better survival in the case of control trees.

4. Finding of, and Trials as Brood Preservers on, Lac Hosts for *Baisakhi* Crop Including Certain *Ficus* and *Albizzia* Species and also Trials of Hosts Similar to Those Found in Thailand

In the 1957-58 *Baisakhi* season, trials on a few trees of *Albizzia lebeck* (5 trees), *Ficus glabella* (3 trees) and *Ficus glomerata* (3 trees) found in Namkum estate were undertaken; the trees, though unpruned, had good infectable shoots. Observations made on the crop progress showed that though there was good and satisfactory larval settlement on the shoots, by about the second moult most of the larvae had died, the mortality ranging from 70 to 90 per cent. Towards crop maturity only a very few cells were found surviving and even these showed only a very poor development. These cells left for self-inoculation did not yield any satisfactory crop at all.

5. Proper Time of Harvesting for Maximizing Yields

The large-scale experiments on *palas* initiated in 1955-57 at Kundri were continued during the year 1957-58 in the *Baisakhi* season. There were four treatments as follows with 50 comparable *palas* trees under each :

I. Initial heavy inoculation and *ari* cutting in April.

II. Initial heavy inoculation and *ari* cutting in May.

III. Initial heavy inoculation and cropping at maturity.

IV. Initial light inoculation after partial defoliation and cropping at maturity.

The crop data are given in Table VI (Appendix A).

The results show that better ratios of brood used to crop yield were obtained when the crop was scraped as *ari* in April or May than at crop maturity. These are in conformity with the results of the last season.

6. Determination of Optimum Density of Larval Settlement on Various Hosts

This experiment was conducted during *Katki* (1958) on *palas* and during *Jethwi* (1958) and *Aghani* (1958-59) seasons. Since there is the local practice of *ari* cutting in the case of *palas* in the *Baisakhi* season, the experiment for the *Baisakhi* crop was combined with the experiment on the proper time of harvesting and is reported separately under item 7.

There were three treatments, namely A, B and C, as follows:

Treatment A — Half the normal requirement of brood.

Treatment B — Normal requirement of brood.

Treatment C — Double the normal requirement of brood.

(Normal brood rate is taken as the quantity required to give satisfactory settlement over 25 times the length of broodlac sticks used for inoculation.)

The lay-out of the experiments was randomized block design with 8 or 10 replications, the number of trees per plot being one each.

The crop data and the experimental lay-out and the statistical analysis of the data for *palas* (*Katki* 1958) crop are summarized in Table VII (Appendix A).

The data show that although in terms of ratio of brood used to yield obtained the treatments B and C are more or less similar, treatment C is definitely better than B and A in terms of yield of sticklac per tree.

Crop data and experimental details and statistical analysis of the data for *kusum* (*Jethwi* 1958) crop are summarized in Table VIII (Appendix A).

Although the statistical analysis of the yield data does not indicate any significant difference among the treatments, the yield per tree is considerably higher in the case of treatment C, in spite of the comparatively smaller brood to yield ratio.

Crop data, statistical analysis and experimental details for *kusum* (*Aghani* 1958-59) crop are summarized in Table IX (Appendix A).

Although the yield data in terms of ratio of brood used to yield obtained are not significantly different, the yield per tree is significantly higher for treatment C than for treatment A.

Hence the results of the three experiments in the three seasons would favour the use of double the quantity of the estimated ' normal ' requirement of broodlac for inoculation.

Stick examination carried out with samples collected from the season's crop after larval settlement and at male emergence indicated a general trend of decreased mortality of larvae and increased male population respectively as the density of larval settlement increased.

7. Determination of Optimum Density of Larval Settlement and Proper Time of Harvesting for Maximizing Yield on *Palas* in *Baisakhi* Season

Under this experiment two factors have been combined, namely the different brood rates and different times of harvesting. Under each factor there were three different

treatments. The experiment thus contains 9 treatments in all and is laid out under randomized block design, with four replications in the *Baisakhi* 1957-58 season.

The experimental details are as follows:

Treatments	*Replications*	*No. of trees per plot*		*Total No. of trees*
Time of harvesting and brood rates:				
1. Reaping *ari* in April and half normal brood rates 2. Reaping *ari* in April and normal brood rates 3. Reaping *ari* in April and double normal brood rate 4. Reaping *ari* in May and half normal brood rate 5. Reaping *ari* in May and normal brood rate 6. Reaping *ari* in May and double normal brood rate 7. Reaping at maturity and half normal brood rate 8. Reaping at maturity and normal brood rate 9. Reaping at maturity and double normal brood rate	×4	× 1	=	36

The crop data given in Table X (Appendix A) indicate that cropping at maturity yields more lac and so also the use of heavier brood rates.

Similar results as under item 6 were obtained from stick examination results, namely less larval mortality and an increased percentage of males were observed with an increased density of larval settlement.

8. Growing of Lac Crops Under Crop and Bush Conditions

During the year, attention was concentrated on the growing of lac crops on *Arhar*, *Moghania macrophylla* (Syn. *Flemingia congesta*) and *Albizzia lucida*

(i) *Under crop condition* — In the *Baisakhi* 1957-58 season, 25 *Arhar* plants (6 months old) were inoculated and in spite of patchy larval settlement, the crop progressed well till April 1958. Thereafter the extreme heat and drought killed the insects as well as most of the plants. Fifty plants were infected with 7 lb. 14 oz. (3·6 kg.) *palas* brood in July for the *Katki* crop. The initial larval mortality was only 20-30 per cent. But later, *Chrysopa* and *Eublemma amabilis* and *Holcocera pulveria* attacks became very severe resulting in the crop yield being reduced to 1: 0·93 as compared to the broodlac used for inoculation.

Inoculation of *Arhar* plants with *Kusmi* brood in both *Jethwi* 1958 and *Aghani* 1958-59 was also tried. Here again the *Jethwi* crop failed after April due to heat and the *Aghani* crop due to predatory enemy insects. The development of cells was generally poor with the *Kusmi* strain.

It appears that successful lac crops can be taken on *Arhar* plants in the wet season if only the crops could be saved from the attack of predatory enemies. Trials have been planned on these lines for the next year.

(ii) *Under bush condition* — *Moghania macrophylla* (Syn. *Flemingia congesta*) proved to be a successful host for raising both *Rangeeni* and *Kusmi* strains of the lac insect. 171 plants were inoculated very lightly with 21 lb. (9·5 kg.) of *palas* × *M. macrophylla* brood for the *Baisakhi* 1957-58 crop. The crop suffered slightly due to extreme summer heat, but a good number of lac cells survived the summer. The ratio of brood used to crop yield was 1: 2·6.

In the *Katki* 1958 season 80 plants were inoculated rather heavily with 20 lb. (9·1 kg.) of *palas* broodlac, which finally gave a yield of 1: 1·4 in terms of the ratio of (sticklac) brood used to yield obtained.

Trials with *kusum* brood in the *Jethwi* 1955 season showed that fairly satisfactory crop can be obtained if the plants can be irrigated during the hot summer months. In spite of the irrigation, the development of the lac cells was rather poor. 65 plants inoculated with 6 lb. (2·7 kg.) of *kusum* brood gave a yield of 1: 1·1 in terms of (sticklac) brood used to yield obtained.

The performance of this species in the *Aghani* 1958-59 season was quite satisfactory; 80 bushes were inoculated with 16 lb. 14 oz. (7·65 kg.). The larval settlement was somewhat patchy, but the crop showed satisfactory progress throughout and a yield of 1: 2·1 in terms of (sticklac) ratio of brood used to yield obtained was recorded. If the larval settlement had been better, then the yield could have been more.

The crop data of the experiments in the various seasons are summarized in Table XI (Appendix A).

An analysis of lac samples of the *Kusmi* strain grown on this host also indicated that the quality is definitely better than that of the *Rangeeni* strain and is almost as good as *kusum* lac itself.

9. Influence of Various Environmental Conditions on the Lac Insect

As in the past years, the effects of temperature on the growth and development of the lac insect continued to be studied at constant temperatures of 18°, 22°, 27° and 30°C. and were compared with the development under field conditions. Potted plants of *Acacia farnesiana* and *kusum* inoculated with the lac insect were employed in the studies inside incubators and refrigerators. The results of the experiments are summarized below.

Rangeeni strain

At 18°C. — The second generation progeny were under study, having been propagated on 15-5-58. There was heavy initial mortality of the larvae and only two female cells continued to live for 24 hours. The first generation had taken 195 days for larval emergence.

At 22°C. — The second generation progeny propagated on 4-3-58 took 125 days to complete the life-cycle, while the previous generation had taken 124 days. The male emergence was in evidence after 55 days in the second generation and after 48 days in the first generation.

At 27°C. — The first generation started on 31-10-58, did not survive till the end, although the insects, both males and females, reached the adult stage all right after 43 days and 49 days respectively.

At 30°C. — Two first generation pots, started in the *Katki* season (1-7-58) and *Baisakhi* season (31-10-58), were under study. The progeny died prematurely in the *Katki* crop pot, while that in the *Baisakhi* crop pot reached the adult stage, but afterwards that also failed. The male and female insects took 40 days and 44 days respectively to reach the adult stage.

Under field conditions, the *Baisakhi* and *Katki* crop pots (controls) developed normally according to the usual durations.

Kusmi strain

At 22°C. — The first generation propagated on 7-2-59 in the *Jethwi* season took respectively 73 and 78 days for the males and females to reach the adult stage.

At 30°C. — The first generation pot started on 14-7-58 showed a considerably faster rate of development, the males and females taking 38 days and 45 days respectively to reach the adult stage. Thereafter the progeny died out.

Under field conditions, the *Aghani* (1958-59) crop started on 14-7-58 took 5 months and 21 days to complete its life-cycle.

From the above it can be concluded that the rate of development of the insect is faster at higher temperatures and slower at lower temperatures within the optimum range under study.

10. Proper Storage and Quick Disposal of Lac to Avoid Infestation by Enemies

(a) *Comparison of emergence of enemy and beneficial insects from scraped and unscraped lac*

The effect of timely scraping of freshly harvested lac on the reduction of the insect enemy population in the store was assessed by comparing emergence of insects from lots of lac scraped and unscraped. Two lots of known quantity of lac sticks were caged for the purpose, one as it is without scraping and another after scraping. The daily emergences of insects from these two lots were recorded till there was no further emergence. The experiments were conducted with lac obtained from *Katki* (1958), *Baisakhi* (1957-58) and *Aghani* (1958-59). The emergence figures are given in Table XII (Appendix A).

Results show that scraping has considerably reduced the emergence of insects from the caged lots of lac except in the case of enemy parasite insects in the *Aghani* crop. These results are similar to those obtained last year; so scraping will be helpful in preventing the migration of enemy insects from harvested lac to new crops in the field.

(b) *Loss due to enemy infestation*

The experiment was conducted on the same lines as in previous years. Two lots of lac were under comparison, of which one was fumigated with carbon disulphide at 6 lb. (2·7216 kg.) for 1,000 cu.ft. exposed for 48 hours with the object of destroying all the enemy insects and the other was kept as control without any treatment. Besides noting the emergence of enemy as well as beneficial insects from these two lots, the weight of lac was also recorded periodically till the emergence in the control lot ceased and the weights became constant. The percentage loss in weight due to the activity of the enemy insects was assessed from the difference in weights of the two lots. Both lac sticks and scraped lac were under observation, and there were four replicates for each treatment, except in the *Baisakhi* crop lot where there were only two replicates.

The results of the experiment are furnished in Table XIII (Appendix A).

It may be observed from the data that the loss in weight has always been more in the case of control lots as against the treated lots except in the case of the scraped lac of *Aghani* crop lot. The difference in percentage loss in weights, which can be attributed to the enemy insects, ranges from 2·2 to 10·6 in the case of lac sticks and from 0·2 to 1·8 in the case of scraped lac.

11. Control of Enemies of Lac During Storage by the Use of Insecticides

As in previous years, the experiment was carried out as follows:

Known quantities of lac sticks and scraped lac obtained from similar quantities of lac sticks were treated with the following insecticides and fumigants immediately after the harvest. There were suitable controls for comparison. The treated and control lots were caged and emergence of insects recorded daily till emergence ceased. The experiment was conducted with lac from *Baisakhi* (1958-59), *Katki* (1958) and *Aghani* (1958-59) crops. The insecticides and fumigants used were the following:

Insecticides:

Dusts

(i) Aldrex 2 per cent
(ii) Aldrex 5 per cent
(iii) Dieldrex 1·5 per cent
(iv) Endrex 1 per cent
(v) Ekatox 2 per cent

} Mixed with lac in the ratio of 1: 100.

Wettable powders and emulsion concentrates

(vi) Aldrex 40 per cent wettable powder
(vii) Dieldrex 50 per cent wettable powder
(viii) Ekatox 20 per cent wettable powder
(ix) Endrine 20 per cent emulsion concentrate

} Sprayed at 0·1 per cent strength

Fumigants

(x) Trichlorethylene at 1½ lb. (0·68 kg.) per 1,000 cu.ft.
(xi) Ethylene dibromide at 600 cc. per 1,000 cu.ft.

} Exposed for 48 hours

The data on the emergence of insects in the control and treated lots are furnished in Table XIV (Appendix A).

From a comparison of the data in all the three seasons the following conclusions can be arrived at: Among the dusts, Aldrex 5 per cent is about the best, followed by Ekatox 2 per cent and Endrex 1 per cent dusts. Among the sprays (at 0·1 per cent strength), Aldrex 40 per cent wettable powder appeared to be good, with Endrex 20 per cent emulsion concentrate and Ekatox 20 per cent wettable powder closely following. Between the two fumigants ethylene dibromide gave consistently satisfactory results, while trichlorethylene was ineffective at the dosage tried.

12. Biological Control

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

Work on the above aspects with *Apanteles tachardiae* and *Perisierola pulveriae* was completed last year and research papers are being prepared.

During the year, the breeding of *Bracon greeni* continued to be difficult and efforts were concentrated on improving the breeding technique already developed a few years ago, but without much success.

(b) *Mass breeding of* Bracon greeni *and* Apanteles tachardiae

As mentioned above, the breeding of *B. greeni* could not be carried out successfully in spite of attempts made through change of food, environment, method of presenting the host larva for oviposition, etc. Further, the natural host *Eublemma amabilis*, the alternative host *Etiella zinckenella* as also the adult parasites in the plantation were scarce and due to this also the breeding programme received a set-back.

The mass breeding of *Apanteles tachardiae* on *Corcyra cephalonica* was successfully carried out almost throughout the year and in all 38,364 parasites were bred.

The data on the breeding are given in Table XV (Appendix A).

(c) *Large-scale liberation in the field and estimation of the effect of the liberation*

The experiment laid out on sound statistical basis was initiated with the *Jethwi* 1958 crop. There were four treatments in all, namely (i) A — Release of *A. tachardiae* alone, (ii) B — Release of *B. greeni* alone, (iii) C — Combined release of *A. tachardiae* and *B. greeni*,

and (iv) D—Control, laid out in randomized block design with 5 replications at Mahespur-Sirka and Berwari. The plots are separated by at least two furlongs from each other so that interference due to flight of parasites may be avoided. In each plot there are 24 *kusum* trees, subdivided into 4 coupés of 6 trees each, to be exploited by rotation.

Jethwi (1958) crop — During *Jethwi* 1958 season, only four blocks could be inoculated with limited supply of broodlac. Further, the release of parasites was also confined to only *A. tachardiae* as the *B. greeni* could not be bred in large numbers for release. During this crop, in all 5,625 parasites (3,578 males plus 2,047 females) were released from April to June.

Periodical stick examination of samples 3 in. in length collected at random was done. First, a preliminary round of samples, one stick from each tree, was taken. Later two subsequent rounds of samples were collected at the rate of three sticks (representing poor, fair and good larval settlement) per tree. The population of the predators, beneficial parasites and extent of damage were assessed through stick examination. The results showed no significant difference between the release and control plots.

The crop data are given in Table XVI(A) (Appendix A).

Aghani (1958-59) crop — This crop was grown in all the five blocks and only *A. tachardiae* was released, since *B. greeni* was not available for release. In all 2,769 parasites (1,381 males plus 1,388 females) were released from September to November. The stick examination, as indicated already (under *Jethwi* crop), was carried out. The results once again were not clearly indicative of any beneficial effect due to the release of the parasites.

The crop data for this season are given in Table XVI(B) (Appendix A).

13. Regional Field Research Stations

Jhalda (W. Bengal)

(a) *Spurious emergence of lac larvae* — The experiment on the determination of the causes of spurious emergence of lac larvae on *kusum* trees was initiated. Apart from the possible influence of weather conditions, it is likely that admixtures of *Rangeeni* and *Kusmi* strains or alteration of hosts may lead to the early spurious emergence of lac larvae. These aspects were investigated and the experiment was laid out with the following treatments:

A — Inoculation of *kusum* trees with *kusum* (pure strain) brood.
B — Inoculation of *kusum* trees with *ber* brood.
C — Inoculation of *kusum* trees with *palas* brood.
D — Inoculation of *kusum* trees with *ber* and *kusum* brood mixed in equal proportions.
E — Inoculation of *kusum* trees with *palas* and *kusum* brood mixed in equal proportions.

After the initial inoculation as above in the first season, the progenies are to be continued on the *kusum* tree itself to see how the progenies behave as regards larval emergence.

During *Aghani* 1958-59 season, treatments under A, C and E were under observation, since inoculations with *ber* brood could not be carried out. Although *palas* brood gave good settlement, the survival was very poor and the development very little, with the result that no crop could be reaped. On 7th November 1958, some of the leaf stalks that had shed showed larval emergence from cells. Careful observation made on all inoculated trees showed that larval emergence had occurred on one or two branches of 8 trees in the area, and that, too, from a very few cells. Early larval emergence was noticed on 6 *kusum* trees, one *palas* tree and one *Ficus infectoria* tree inoculated with *kusum* brood. The survival from this early emergence was also poor.

Further, the crop at Jhalda matured by the third week of December, clearly a month ahead of the crop in the Ranchi area, although they were propagated about the same time, indicating that the climate of a locality plays an important role in the maturity of crops and development of the cells.

(b) *Alternative lac hosts for* kusum — Investigations to find out alternative lac hosts capable of taking the *kusum* strain of the insect were carried out with *Bursera serrata, Dalbergia sissoo, Ficus infectoria, ber, Cassia fistula, Croton oblongifolius*, etc. The *Aghani* crop did not give any satisfactory results on any of the above species tried. Poor crops were, however, obtained from *Bursera* and *Dalbergia* species.

Besides research investigations, general work on the gradual improvement of the field area was also carried out.

Damoh (M.P.)

(a) *Response of ghont to pruning* — Two experiments were laid out last year for evolving suitable pruning methods for *ghont* for raising the *Katki* and *Baisakhi* crops. The experimental details are as follows:

Katki crop

Treatments: A — Pruning in the first week of December.
B — Pruning in the second week of February.
C — (i) and (ii) in the second week of May.
Number of trees under each treatment: Five comparable trees.
Number of replications: Ten.
Lay-out: Randomized replicated block design.

Baisakhi crop

Treatments: A — Pruning in the second week of April.
B — Pruning in the third week of April-May.
Number of trees under each treatment: Five comparable trees.
Number of replications: Ten.
Lay-out: Randomized and replicated block design.

After the pruning treatment had been given, 10 trees from each of the treatments were under observation and the shoots were measured at fortnightly intervals.

The results obtained can be summarized as follows:

Katki corps — Trees pruned in February 1958 did not respond well in putting forth shoots and the shoots were not fit for inoculation by July 1958.

Trees pruned in May 1958 responded well, putting forth vigorous shoots, and they were sufficiently grown by July of the same year. The trees were better than February-pruned trees in regard to both number and length of shoots.

Trees pruned in December 1958 were, however, observed to develop buds towards the end of January 1959, and the growth was generally slow.

Baisakhi crops — Trees pruned in April 1958 gave larger number of shoots as compared to the trees pruned in May, although the average length of shoots was less in the former than in the latter.

(b) *Introduction of new hosts for brood preservation* — Apart from the studies on pruning and the rate of brood application for inoculation, attempts are being made to introduce new hosts like *Albizzia lucida* and *Ougeinia dalbergioides* which have proved better preservers of broodlac. Seedlings raised from nursery were planted in the rainy season throughout the field area of the Damoh Station.

Trials on other local species of plants are also being initiated.

(c) *Investigation on the preservation of broodlac* — Preliminary trials were conducted on the use of different brood rates for inoculation in the *Baisakhi* season to see whether lighter

inoculation will lead to better survival of broodlac. Applications of brood at such rates as to give a coverage of larval settlement in the ratio of 1: 25, 1: 50 and 1: 100 of the length of brood stick to length of twigs covered were under comparison and it was generally observed that lighter inoculation (i.e. 1: 100 ratio) leads to better survival of broodlac.

Comparison of performances of trees situated in open tract and those in shaded areas along tank *bunds* also indicated that brood survival was better in the latter area under comparatively less droughty conditions.

14. Plantation at Namkum

General maintenance of the plantation was looked after. New irrigation pipe-lines have been laid to facilitate irrigation of certain plots, particularly those where annuals and bushes are raised. Regular breeding and hoeing were carried out to keep down the weeds and provide good soil mulch condition. Pits have been prepared in the *kusum* plot for planting *Moghania macrophylla* in the coming rainy season for large-scale trials as this host has shown great promise as a suitable alternative host for *kusum*. A large number of seedlings of the different lac hosts were raised in nurseries both for filling up gaps in the plantation and for potted plants required for experimental studies in the laboratory. *Crotolaria saltiana* was also continuously raised for a constant supply of the pod borer (*Etiella zinckenella*) for the laboratory breeding of parasites.

Termites infesting plantation area were also systematically eradicated.

15. Training and Advisory Service

(a) *Training* — In the beginning of the year there were 10 trainees on the roll for the regular one-year course in lac cultivation (3 lac demonstrators from Assam Forest Department, 5 stipend holders from Relief and Rehabilitation Department, Assam, and one ranger and one forester from Madras Forest Department). During the year, three more joined the course, one each from Bihar, West Bengal and Orissa Governments.

Two trainees from Burma, sponsored under the Colombo Plan, also joined the training course for a period of 6 months.

Of the above, 11 trainees completed their course successfully and were relieved, and 4 are still continuing to receive training.

Under the scheme of training of Instructors from the Extension Training Centre in a short course for about a month, 5 Instructors were deputed for training (3 from Madhya Pradesh Government and one each from Uttar Pradesh and Bihar Governments).

Lectures in improved methods of lac cultivation were delivered to two batches of Forest Guard Trainees at each of the Forest Guards School at Betla and Mohilong in Bihar.

Extension lectures in lac cultivation were delivered for three batches of refresher course officers of the Eastern Zone States at the Kanke Agricultural College.

(b) *Advisory* — As usual technical advice on lac cultivation was given to both private individuals and Government Institutions. A large number of samples of lac from the various agencies including the Lac Extension Officer, I.L.C.C., were examined and recommendations on technical points were made. The lac cultivation areas of Madras were visited and a report on the working of the lac schemes was submitted to the Madras Forest Department.

Exhibits and literature on lac cultivation were sent to a large number to interested parties.

A large number of visitors including student parties were shown round the working and activities of the Entomology Division.

Part was taken in a large number of exhibitions including the one organized at Damoh on the occasion of the formal opening of the Field Research Station for lac at Damoh for popularizing the scientific methods of lac cultivation.

A STATEMENT OF LAC PRODUCED AND ITS DISPOSALS FROM THE INSTITUTE PLANTATION DURING THE PERIOD, 1st APRIL 1958 - 31st MARCH 1959

Crop and locality	Produced	Scraped or broodlac and its disposals											
		Under use in the Dept.		Driage		Supplied to Chemical Section		Supplied to the Lac Extension Officer		Supplied free of cost		Sold	
	md. sr. ch.	md. sr. ch.		md. sr. ch.		md. sr. ch.		md. sr. ch.		md. sr. ch.		md. sr. ch.	
Baisakhi 1957-58 lac crop													
Namkum Plantation	2 28 7½*	— 12 11½*		— 15 7*		2 — 5*		— — —		— — —		— — —	
	=101·1983 kg.	=11·8720 kg.		=14·3991 kg.		=74·9321 kg.							
Jethwi 1958 lac crop													
Namkum Plantation	— 5 4*	— — —		— — 4*		— 5 —*		— — —		— — —		— — —	
	=4·8987 kg.			=0·2337 kg.		=4·665 kg.							
Berwari Plantation	7 25 —**	— — —		— — —		— — —		7 25 —**		— — —		— — —	
	=284·565 kg.							=284·565 kg.					
	9 23 1*	5 14 —*		— 38 9*		3 10 8*		— — —		— — —		— — —	
	=357·4034 kg.	=199·670 kg.		=35·9759 kg.		=121·7575 kg.							
Hesal Plantation	3 — —**	— — —		— — —		— — —		3 — —**			—	— — —	
	=111·96 kg.							=111·96 kg.					
	8 5 5*	3 23 12*		1 1 1*		3 20 8*		— — —		— — —		— — —	
	=303·5171 kg.	=134·1262 kg.		=38·3134 kg.		=131·0875 kg.							
Maheshpur-Sirka Plantation	5 17 —**	— — —		— — —		— — —		5 17 —**		— — —		— — —	
	=202·455 kg.							=202·455 kg.					
	3 20 5*	— 7 4*		— 30 1*		2 23 —*		— — —		— — —		— — —	
	=130·9122 kg.	=6·7687 kg.		=28·0484 kg.		=96·105 kg.							
Katki 1958 lac crop													
Namkum Plantation	— 25 —**	— 25 —**		— — —		— — —		— — —		— — —		— — —	
	=23·325 kg.	=23·325 kg.											
	1 21 12*	1 6 8½*		— 8 11½*		— 1 —*		— — —		— 5 8*		— — —	
	=57·6162 kg.	=43·4167 kg.		=8·1419 kg.		=0·935 kg.				=5·1325 kg.			
Aghani 1958-59 lac crop													
Namkum Plantation	— 6 2*	— — 11½*		— 1 4½*		— 4 2*		— — —		— — —		— — —	
	=5·7168 kg.	=0·6720 kg.		=1·1979 kg.		=3·8568 kg.							
Hesal Plantation	5 17 4*	4 34 4*		— 23 —*		— — —		— — —		— — —		— — —	
	=202·6987 kg.	=181·2338 kg.		=21·465 kg.									
Berwari Plantation	1 29 3*	1 21 8*		— 2 3*		— — 8*		— — —		— 5 —*		— — —	
	=64·5602 kg.	=57·3825 kg.		=2·0452 kg.		=0·4675 kg.				=4·665 kg.			
Maheshpur-Sirka Plantation	2 10 8*	2 4 14*		— 5 10*		— — —		— — —		— — —		— — —	
	=84·4375 kg.	=79·1982 kg.		=5·2493 kg.									

N.B. — *Indicates scraped lac. **Indicates broodlac.

CHEMISTRY DIVISION

1. Separation and Study of the Constitution of the Various Components of Shellac

The present work on the constitution of shellac was started in 1947. Up till now, by the application of various techniques such as alkaline hydrolysis, fractionation through formation of complexes, paper chromatography, etc., two new acid constituents, viz. butolic acid and an aldehydic acid, have been isolated. A simpler method for the separation of shellolic acid has also been worked out.

(i) *Improved method for the preparation of shellolic acid*

From hydrolysed shellac, using 5*N* alkali, sodium aleuritate was separated and then barium, cold and hot water-insoluble zinc, and alcohol-insoluble and soluble lead salts were successively separated [*J. sci. industr. Res.*, **11B**, (1952)]. The alcohol-insoluble lead salt was esterified with methyl alcohol and HCl. From the esterified mixture dimethyl shellolate, m.p. 150°-151°C. (1·7 per cent on lac), and a liquid ester (1·6 per cent on lac) were separated from solution. Regeneration of shellolic acid from the ester and further study of the acid are to be continued.

(ii) *Separation of the aldehydic acid*

One of the constituents of hydrolysed shellac appears to be an aldehydic acid (to an extent of about 25 per cent). The impure acid could not be crystallized from any solvent and its purification through regeneration from its 2: 4-dinitrophenyl hydrazone (m.p. 232°C. decomp.) was also not successful. The barium, zinc and lead bisulphite compounds of the aldehydic acid were found to be water-soluble. Attempts were, therefore, made to isolate the pure acid through the above compounds, and of these, the lead bisulphite compound appeared to be the most convenient. The acid thus obtained was found to be contaminated with acetic acid (from lead acetate used in the preparation of the compound), which could be removed by steam distillation. The isolated aldehydic acid was only partly soluble in water. Attempts are being continued to purify the acid further for studying its properties and constitution.

(iii) *Fractionation of aleuritic acid*

Aleuritic acid as obtained from hydrolysis of lac and recrystallization from boiling water or aqueous alcohol has an m.p. of 100°-101°C. This could be resolved through cold methyl alcohol into two fractions melting at 102·5°C. and 97·5°C. respectively (*I.L.R.I. Annual Report*, 1955-56, p. 42) and from boiling water or hot chloroform into two fractions melting at 101·5°, 98·5° and 102°, 100°C. respectively.

With a view to ascertaining the difference between the two components, the parent aleuritic acid as well as the two fractions form methyl alcohol was oxidized with potassium permanganate at boiling water temperature. The oxidized dibasic acids are being indentified.

(iv) *Fractionation of shellac: Shellac-urea complexes*

Shellac is known to be composed of an ether-insoluble portion (pure resin) and an ether-soluble portion (soft resin). It has been shown, however, that more than two components can be obtained by the use of different solvents. Thus, dewaxed, decolorized shellac could be easily fractionated into three solid complexes with urea from acetone, methyl ethyl ketone, methyl alcohol, a mixture of ethyl acetate and ethyl alcohol, or butyl acetate and butyl alcohol by boiling under reflux. The first two complexes are almost insoluble in all common organic solvents at room temperature, but dissolve in butyl alcohol

when boiled under reflux. The third is soluble in alcohols and ketones in the cold, but not in ether. The properties of these products were reported earlier (*I.L.R.I. Annual Report*, 1957-58, p. 31).

Properties of shellac-urea complexes

(a) *Carbonyl values* — The carbonyl values of the fractions as well as of the whole shellac complex were found to be nil. The shellac regenerated from the complex by complete removal of urea (by repeated boiling with water) had, however, the same carbonyl value as the parent shellac. This suggests that urea reacts with the free aldehydic group of shellac.

It has been further found that only about 3 per cent of urea actually combines with the lac and not 7-8 per cent as has been reported by earlier investigators [VENUGOPALAN, M., SEN, H. K., *Chem. & Ind.*, **57** (1938), 371; BHATTACHARYA, G. N., *Ind. Lac. Res. Inst. Bull. No.* 42, 1940].

It has been mentioned earlier that a coating on wood from the whole complex lacked gloss. It was interesting to note that the lac regenerated from the complex exhibited the usual full gloss of unreacted shellac.

A note on the determination of the carbonyl values of shellac will be found in Appendix C.

(b) *Thermosetting properties* — The first fraction also behaved as a true thermosetting resin, when moulded at about 170°C. under a pressure of 1½ to 2 tons/sq. in. A brittle product was obtained. It was not possible to remould it (after powdering) even at a higher temperature and pressure.

The industrial possibilities of the complexes and the constitution of the individual fractions (after removal of urea) will be studied.

(c) *Film-forming properties*: *possible uses as varnish* — The films from the first two fractions were found to be far superior to those from original shellac in respect of water-resistance. These were also resistant to dilute acid and mild alkali (up to 2 per cent caustic soda).

A varnish made from either the first or the second fraction or the whole complex in hot butyl alcohol, thinned with methylated spirit and applied to wooden surfaces left a coating which lacked gloss. This could be improved by addition of about 10 per cent of dibutyl or sextol phthalate. The varnish from the fraction was resistant to lactic acid (up to 20 per cent), spirit (up to 95 per cent) and the temperature of boiling water. This fraction is thus much superior to the parent shellac and may, therefore, have wider industrial use.

(c) *Urea complexes of seedlac, garnet lac, etc.* — In a similar manner seedlac, garnet lac and bleached lac were fractionated into three fractions, each having nearly identical properties with those described earlier for dewaxed, decolorized shellac.

2. THERMAL POLYMERIZATION OF SHELLAC: CARBONYL VALUE

It was indicated by Kamath *et al.* [*J. sci. industr. Res.*, **148** (1955), 272] that polymerization or deterioration of shellac on storage involves the carbonyl group. This was in view of their observation that in all the usual grades of shellac, definite carbonyl values are obtained, but polymerized and deteriorated lacs or even resins regenerated from such lac do not have any carbonyl value. Investigation was, therefore, undertaken to study the changes in carbonyl values of lac during thermal polymerization. Shellac (dewaxed, decolorized) was heated at 125°C. in an oil bath and samples were collected at intervals of 10 minutes. Thus seven samples could be collected after which the lac reached its usual infusible stage.

In determining the carbonyl values, usually the sodium sulphite method is adopted using thymolphthalein as an internal indicator. Considerable difficulties were experienced in actually spotting the end-point, more so of coloured samples of shellac polymers, and therefore it was considered that electrometric titrations would be more helpful. So potentiometric titrations were carried out using Tinsley's potentiometer with the following cell combinations, as used previously by Murty *et al.* (*I.L.R.I. Bulletin No.* 25):

Antimony	Alcoholic solution of shellac	LiCl Agar-Agar Bridge	LiCl-calomel electrode in 95 per cent alcohol

Though by this means acid values were obtained correctly which confirmed our previous data [BHATTACHARYA, P. R., *Proc. of Symposium on Lac and Lac Products, I.L.R.I.* (1955), p. 77) the carbonyl values could not be determined because sufficient displacement was not obtained in the lamp-and-scale arrangement to measure the deflection. Next Hydrogen Electrode-Saturated LiCl cell was tried, but without any success. The method as reported by Kamath *et al.* (loc. cit.) using an electronic *p*H meter with glass-calomel electrodes was finally adopted. Two glass electrodes were used, one for *p*H 0-9 and another, a high alkalinity glass electrode, for *p*H 9-14 range. But even this did not give a sharp inflexion in the plots to indicate a definite end point. Experiments are being continued.

3. Nature and Kinetics of Thermal Polymerization of Shellac

After the preliminary investigation on the thermal polymerization of lac [BHATTACHARYA, P. R., *Proc. of Symposium on Lac and Lac Products, I.L.R.I.* (1955), p. 77], a detailed study of the probable nature and kinetics of polymerization has been undertaken. Shellac (decolorized, dewaxed) was heated in an oil bath at the temperatures of 125°, 135°, 150° and 175° under strictly isothermal conditions and samples at regular intervals were withdrawn. All the samples were powdered and passed through 100 B.S. sieve, dried for 6 hours at 42°C. and left in a vacuum desiccator over $CaCl_2$ overnight. Viscometric studies of these solutions are to be undertaken.

4. Bleached Lac

(i) *Optimum conditions for bleaching lac*

(a) As already reported, the Institute has improved the existing process of making bleached lac whereby its keeping quality is very much bettered. Bleached lac made by the improved method usually keeps well for 8-10 months. However, during examination of old bleached lacs it was found that some samples prepared about 4 years back were still soluble in alcohol. A study of their chemical constants was made to find out if the keeping quality could be correlated with any determinable constants. It was not found possible to correlate any of the chemical constants, e.g. acid value, saponification value, percentage of chlorine and ash, with the keeping quality as there was no significant difference in any of these. The data are given in Table I (Appendix B).

The keeping quality of bleached lac samples prepared by bleaching the same sample of the lac with different amounts of bleach liquor is recorded in Table II (Appendix B). It can be seen from the table that as the amount of bleach liquor is increased or as the percentage of chlorine that goes into combination with lac increases, the keeping quality progressively deteriorates.

Further experiments were, therefore, directed towards determining conditions for effecting the maximum of bleaching with minimum of chlorination. Bleaching at temperatures lower than usual was considered a possible solution, and this was examined.

Bleaching was conducted at 35°, 25° and 20°C., and in each case to the same shade as determined by colour-ratio by comparison against *N*/1000 iodine. It was found that

the quantity of bleach liquor required at 25° and 20°C. was about 80 per cent of that required at 35°C. and the chlorine that went into combination with lac was also lower by 20 per cent. Results are given in Table III (Appendix B).

All the bleached lac samples preserved under laboratory conditions in paper bags have shown good keeping quality up till the time of being tested, i.e. when these were 8 months old.

(b) Bleached lac, although superior to ordinary shellac in colour, lacks the other desirable properties such as flow and life under heat. In order to investigate the possibility of making bleached lac of improved flow and life under heat, a variety of conditions were tried. Some of the treatments given included making use of different amounts of sodium carbonate for dissolution of lac, precipitating and collecting bleached lac by portionwise addition of the mineral acid, immersing the bleached lac in different concentrations of sodium bicarbonate to remove the last traces of mineral acid if any present, treatment with sodium hydroxide to remove loosely combined chlorine if any present, and bleaching in the absence of light. Some of the properties of bleached lacs obtained are tabulated in Table IV (Appendix B). Cold alcohol-insolubles of these samples are being determined periodically to see if any of the treatments improves the keeping quality. The flow and life under heat of these samples are being examined.

(ii) *Pilot plant for the manufacture of bleached lac*

It was reported (*I.L.R.I. Annual Report*, 1957-58) that a pilot plant capable of producing 80 lb. of bleached lac per batch had been designed. Orders have been placed for most of the equipment required. It is expected that the plant will start functioning by the end of 1959.

(iii) *Carbonyl value of bleached lac*

Carbonyl value of bleached lac was determined adopting the method of Bhatt *et al.* [*J. sci. industr. Res.*, **14B**, (1955), 273]. The end-point was not sharp and the colour changed from colourless to dirty green, greenish blue and finally slowly to blue. The end-point was taken at the greenish blue stage. Although the determination of the end-point was not so easy, still a comparative study of carbonyl value of the different bleached lacs could be made after some practice, and this was done.

Carbonyl values of lacs bleached with different amounts of liquor are tabulated in Table V (Appendix B).

It can be seen from the table that carbonyl value shows a decrease when lac is precipitated from alkaline solution indicating removal of a portion of aldehydic nature. The value then increases gradually as the amount of bleach liquor for bleaching is increased. The increase or decrease in carbonyl value corresponds nearly to the increase or decrease in saponification value.

In the case of sample No. VI (Table V, Appendix B) the carbonyl value shows a decrease. The alcoholic solution of the sample filters slowly showing the start of polymerization. Carbonyl value shows a decrease indicating the possibility of the carbonyl group taking part in polymerization.

5. Aqueous Lac Varnishes: Water-soluble Lac

As reported already (*I.L.R.I. Annual Report*, 1957-58) mere exposure of lac flakes to ammonia vapour makes them water-soluble. Experiments to determine the optimum conditions for the exposure were continued.

Nitrogen content and solubility — A number of samples of dewaxed lac were exposed to ammonia in a desiccator for different periods and then kept in the open till there was

no smell of ammonia. The nitrogen contents of the samples were then determined. It was found that although the maximum nitrogen content was about 2·63 per cent (after 18 hours' exposure), lac became soluble in water after exposing only for 3 hours (N content 1·213 per cent), but this solubility was lost soon. About 24 hours' exposure was found necessary for the treated lac to retain its solubility for a long time. A sample so produced, after storage for about a year, is still soluble.

Film properties — Clear as well as pigmented films obtained from these aqueous solutions of lac were examined. As mentioned in the previous report, the clear varnish when applied to porous materials like earthenware gives good adhesion and gloss, although on glass the film cracks and peels off even on air-drying. A number of further experiments were carried out by baking shellac-coated earthenware at 200°C. for different periods. It was found that although air-drying for a few days gave quite satisfactory results as far as general utility was concerned, baking for about half an hour at 150°-160°C. did improve the gloss, appearance and water-resistance appreciably.

With a view to investigating whether this improvement can be brought about in the cold by using accelerators or curing agents, water-soluble accelerators like urea, ammonium tartrate, etc. (1-5 per cent on the weight of lac) were tried. Three to five per cent of urea improved the water-resistance of the films considerably, but adhesion was poor. The viscosity of the varnish also increased gradually, the varnish ultimately becoming a gel in about 3 days. Ammonium tartrate was found to be unsatisfactory in that it reduced the water-resistance. With a view to accelerating the elimination of ammonia from the film, the air-dried articles were kept immersed in 4*N* hydrochloric acid for 15-20 minutes. This treatment improved the water-resistance appreciably. Further work is in progress.

6. Shellac Wash Primers

It has been reported already (*I.L.R.I. Annual Report*, 1957-58) that for a single-pack shellac etch primer the optimum concentration of (85 per cent) phosphoric acid is 30-40 per cent on the weight of lac. The effects of storage and natural weathering of wash primers made accordingly were studied during the year.

(a) *Storage stability of the primer* — Within the twelve months so far there has been no thickening or hard caking. Films produced on aluminium panels from the same primer at intervals of one month were found to be practically alike in respect of hardness and adhesion, indicating that there has been no deterioration in these respects also.

(b) *Weathering tests* — Four panels each of aluminium, copper, mild steel and galvanized iron were first cleaned free from grease, and then the wash primers, using shellac and dewaxed lac, were applied with brush and allowed to dry for 24 hours. Then to one panel of each of the above metals a high-gloss shellac spirit paint and to another set of panels an oil enamel were applied by brush over the wash primer. All the panels were allowed to dry for a further period of seven days.

For exterior weathering one set of the primed panels, with and without the spirit paint, were exposed in a stand over the roof of the laboratory: the panels faced south, inclined at an angle of 45° to the vertical. Another set of similar panels were retained inside the laboratory as control. After twelve months the panels indoors showed no signs of deterioration either in gloss or in hardness, only a slight decrease in flexibility was observed. Primer films on the panels kept on the roof were also quite unaffected.

Regarding the oil enamel though, on outdoor weathering, there was loss of gloss, the adhesion was quite unaffected. The spirit paint, however, had deteriorated badly, the gloss was lost within a few days and the paint started cracking and flaking off within a month, showing poor outdoor resistance even over a shellac etch primer.

As the weather resistance of the wash primer was satisfactory, arrangements have been made with the S.E. Railway authorities to try this on aluminium railway coaches to watch its performance in actual service.

7. Improvement in Analytical Methods (Grade *cum* Specifications)

(i) *Hot alcohol-insolubles test*

Owing to the great importance of this test for the assessment of quality of lac, several methods have been adopted. Some methods like that of the U.S. Government and Stillwell suggest filtration through elaborately prepared asbestos beds, while the British Standards Institution and British National Committee of the International Electro-technical Commission suggest only hot extraction. The removal of most of the shellac by a preliminary filtration of the hot solution is a speedier method of removing all the soluble lac. The method of the United States Shellac Importers' Association has been adopted by the Indian Standards Institution and International Standards Organization with slight modifications. This method gives sufficiently accurate results for routine analysis, but suffers from two drawbacks, viz. (a) it is time-consuming and (b) it requires use of costly thimbles. The present work was started to ascertain whether the analysis cannot be expedited and ordinary filter papers used in place of the costlier thimbles.

To start with, two filter papers were employed for the filtration in place of the thimble, other details remaining the same. The filter papers were placed in an air oven at 105°C. for 30 minutes and then weighed by counterpoise in separate weighing bottles. One of these filter papers was used for filtration, the other being used to wrap it before placing in the Soxhlet apparatus. After extraction for one hour and drying, they were again weighed by counterpoise in their respective bottles to find out the insoluble matter. The whole experiment required about 6 hours to complete. The average difference (8 observations) between the two sets of percentage of impurities was *c.* 0·015.

The results obtained so far by this method as well as the method A of U.S.S.I.A. on the same samples are given in Table VI (Appendix B).

(ii) *Rapid method for assaying resin content of sticklac*

(a) *By measuring volume* — Attempts were made to assess the lac content of sticklac by measuring the volume of water displaced by immersion of a known weight of finely (20-mesh) powdered samples of sticklac in water, but without success, as the solubles and insoluble wax and woody matter made the readings difficult. Enclosing the powdered samples in a metal cage did not improve matters. To eliminate interference from the soluble portion, an innocuous liquid like kerosene was tried with no better results.

(b) *By specific gravity* — When lac dissolves in spirit the specific gravity of the solution increases with increase of the lac content, and this increase, it was hoped, might be taken advantage of for assessing the lac content of sticklac.

Specific gravities of a shellac solution in spirit determined by using a Hare's hydrometer and cathetometer are given in Table VII (Appendix B). The readings obtained using either shellac or sticklac could not be fitted into a smooth curve, and hence this method also proved unsuccessful.

(c) *By acid value* — Experiments were then carried out to correlate, if possible, the acid values of the solution with its lac content. Ten gm. of the powdered (40-mesh) sample were dissolved in 100 cc. of alcohol by stirring in the cold for 45 minutes. The solution was then allowed to settle for 15 minutes and 5 cc. of the clear solution pipetted out and titrated against a standard $N/10$ alcoholic potash using thymol blue as external indicator; side by side, the seedlac yield and hot alcohol-insolubles of each sticklac sample were also determined.

About twelve seedlac and thirty sticklac samples were similarly examined. The results are given in Tables VIII(A), (B) and (C) (Appendix B). Taking the acid value of pure shellac as 70, a theoretical straight line plot of acid value *vs.* percentage of lac content was

drawn from which results corresponding to actual acid values of samples were read out and compared with values of lac contents as determined by Hot Alcohol (H.A.) Insolubles method. The agreement between the values by this method and those by the direct H.A. Insolubles method was quite close, the maximum divergence between the two sets of values on the percentage basis not exceeding 4·5.

With some of the samples, e.g. Nos. 45, 66, 70, etc. (Table VII, Appendix B) it was observed that the samples were old and did not go into solution in cold alcohol. Hence, these needed warming and constant shaking for a long time. The volume was corrected afterwards.

8. Improvement in the Manufacture of Seedlac, Shellac, etc., and Utilization of By-products

(i) *Sand separating machine*

Our sand separating machine was taken to Gondia and demonstrated there in lac factories. Its work was highly appreciated and the machine is still being used in one of the Gondia factories.

(ii) *Autoclave shellac*

The main points of difference between autoclave shellac and that manufactured by the country process are the former's high colour index (15-17), less flow, and low wax content (2·5 per cent). The darker colour of the autoclave shellac, perhaps due to contamination with iron, could be reduced from 15 to 9 by adding 0·1-0·2 per cent of oxalic acid to the molten lac, while it is dried in the steam-heated pan, before sheeting. The flow of shellac was improved by mixing 2 cc. of formaline (40 per cent) in 10 cc. of water to each 1,000 gm. seedlac before charging in autoclave and it changed to 126 sec. from 220 sec. The flow of this shellac was equal to that of shellac produced from the same seedlac by the country process. The lower wax content of autoclave shellac as compared with the usual commercial grades of regular shellac (4·5-5 per cent) is considered to be a deficiency. Attempts were made to increase its wax content as follows:

Kiri from the autoclave contains hot alcohol-insolubles up to 78-80 per cent, of which 17-18 per cent is lac wax. Such a *kiri* was coarsely crushed to the grain size of seedlac (5-10 mesh), and 1,000 gm. of this *kiri* was mixed with 2 cc. of formalin along with the *required* amount of water. This was then charged into the autoclave in a separate sieve along with seedlac put on other sieves in the proportion of *kiri* 1 kg. to seedlac 10 kg. During the subsequent heating the wax and some resin of the *kiri* flows out along with the molten lac from seedlac. The shellac produced in the usual manner from these mixtures had more wax content. Incidentally a portion of lac in *kiri*, which would have been otherwise lost, is also reclaimed thus. The results of a set of experiments are given in Table IX (Appendix B).

(iii) *Economic utilization of 'refuse lac'*

Kiri, molamma and other refuse lac are by-products accumulating in large quantities in indigenous shellac manufacturing factories. These contain substantial proportions of lac. Apart from a portion, used as such for the manufacture of cheap bangles, etc., most of these 'refuse' lacs are subjected to a process whereby their lac content may be recovered; the solvent process is usually employed which involves dissolving out the lac in spirit, filtering off the insolubles and distilling off the spirit. Dilute solutions have to be made to facilitate filtration. It would obviously be advantageous if sufficiently concentrated lac solutions could be produced out of these and used as such. A few experiments were carried out with this end in view.

(a) *French polish from kiri* — Attempts are to be made shortly to popularize ready-made french polish. A satisfactory composition for such a polish is to contain 25 per cent of lac by weight, as stipulated by Indian Standards specifications. Experiments were done to produce 25 per cent solutions of lac from *kiri* chiefly by sedimentation and decantation, so that need for filtration could be reduced to the minimum or altogether avoided. A system of sedimentation and decantation using the counter-current principle achieved the purpose and 25 per cent of lac solutions could be conveniently made and the residues easily filtered off after the third extraction. The lac solutions obtained could be dewaxed with the aid of white spirit, or by filtration which was comparatively easy. The varnishes produced served quite well as french polish and the colour was not appreciable. Larger batches using metal equipment are being investigated.

The residue was found to contain very little lac, but was rich in wax (12 per cent) which may be recovered.

(b) *Bleached lac from molamma* — *Molamma* contains varying amounts of lac in very fine (dust) form. This could be conveniently extracted by any solvent including aqueous alkali. *Molamma* was, therefore, investigated as a starting material for bleached lac, the first operation of which is the extraction of the lac with aqueous soda solution. A sample investigated had a lac content of 63 per cent (hot alcohol-solubles). Bleaching presented very little difficulty except in the filtering operation which had to be carried out in two stages instead of one. The bleached lac obtained was of good colour and the yield 35 per cent on the weight of the *molamma*. The alcoholic solutions, however, darkened on storage. This needs looking into.

9. Separation of Lac Dye

This investigation was undertaken in 1956-57 as one of the items for economic disposal of lac factory wastes. As reported already, the wash water from seedlac manufacture was treated with sulphuric acid, when lac dye in crude form along with other impurities settled down. This crude dye was crystallized from hydrochloric acid and the crystals separated after seven days. Though this method gives a very pure product, filtration of the hot acid and reusing the mother liquor were rather inconvenient, hence it was modified.

The crude dye was a mixture of some resin, wax, dye insect bodies, etc. The resin and wax were separated first by dissolving them in hot industrial spirit. The dye from the residue was extracted with different dilute alkaline solutions. As a result of a series of experiments it was ascertained that 100 cc. of 1 per cent borax solution was just sufficient for extracting the dye completely in the cold from 5 gm. of the spirit-extracted crude dye. The dye could be recovered from this solution as a powdery mass by precipitation with sulphuric acid. The material was tested and found to have a dye content of 65-70 per cent. Though the dye thus isolated is quite usable, a substantial amount of it is wasted as it goes into solution in the spirit from which it is not recoverable.

So an alternative selective solvent had to be tried which should be cheaper and leave out the dye undissolved. White spirit was found suitable for removing the wax from the crude dye; the process is described below:

100 gm. of the crude dye was gradually added to 4,000 cc. of gently boiling white spirit with stirring. After the addition was complete, the solution was filtered hot and the residue dried. The filtrate was cooled, when the wax settled. This was filtered off and the mother liquor reused for dewaxing a fresh lot and so on. 50 gm. of wax was obtained from 1,000 gm. of crude dye.

1,000 gm. of the dewaxed crude dye was dissolved in 20 litres of borax solution containing 200 gm. of borax by stirring for one hour at room temperature. It was then allowed to settle and filtered. The filtrate was treated with dilute sulphuric acid, where-

by the dye was precipitated. This was collected and dried. Yield, 20-30 per cent with a dye content of 65-68 per cent. The alkali used here (borax) is so mild that it has no effect on the resin and other materials. This dye was used for dyeing wool, etc., and found to work satisfactorily. The work is in progress.

The method of making crude dye was demonstrated at Gondia, Umaria, Daltonganj and Bundu.

10. Adhesives

(i) *Substitute for 'Miracle glue'*

A sample of imported rubber adhesive, commercially known as 'Miracle glue' and used for fixing rubber parts on aluminium surfaces in railway coaches, was received from the Integral Coach Factory, Perambur (Madras), with a request to formulate a substitute for the same from indigenous materials. 'Miracle glue' composition was found to have very good adhesive properties and contained quick-drying solvents. When applied to any surface it was found to dry within a few minutes leaving a very thick rubbery substance.

Several compositions were prepared and tested; the following composition was found to have adhesive properties comparable to those of the sample received:

Dewaxed lac	60 gm.	Refluxed on water-bath for 2½-3 hours
Acetone	60 cc.	
Methyl alcohol	60 cc.	
Furfural	3·6 gm.	
Concentrated HCl	1-2 drops	

After refluxing, 120 cc. of the above composition were intimately mixed with 20 gm. of lamp-black in a ball mill for 1 hour. This composition on testing was found to have very good adhesive properties for rubber-aluminium surfaces, but the drying time was longer than that for the imported sample. A sample was sent to Perambur, but was not approved as quicker drying was desired.

(ii) *Adhesive for plywood*

The resistance to boiling water of plywoods prepared by bonding 3-ply veneers of (i) *Haldu*, (ii) *Toon*, (iii) *Kanju*, (iv) *Sishum* and (v) *Gunjah* with shellac-based and shellac-phenol-formaldehyde resin-based composition was reported earlier. Some of these samples were tested in the composite wood section of the Forest Research Institute (F.R.I.), Dehra Dun. The F.R.I. suggested that since a number of cheap glues were available in the market for the production of inferior grades of plywood such as 'Tea chest plywood' and commercial plywood, our further investigations should be directed to evolve better types of plywood which should resist boiling water for at least 3 hours. It was further suggested that instead of using different species of wood further work should be limited to one type of wood only, viz. *Toon*, and that the use of phenol formaldehyde or such other synthetic resins along with lac should be avoided.

Accordingly a few modified shellac-based compositions were prepared. Three-ply *Toon* veneers were bonded using these compositions and plywoods made by pressing them at 400 lb./sq. in. at a temperature of 140°C. for 20-30 mins. The plywoods were removed after cooling to 90°C. and then subjected to boiling water tests. The following composition was found to be resistant to boiling water for 2½ hours:

Garnet lac	100 parts	Refluxed on water-bath for 2½ hours
Meth. spirit	200 ,,	
Maleic acid	4 ,,	
$AlCl_3$	4 ,,	

11. Miscellaneous Applications of Lac

(i) *Dry-mounting tissue paper*

As reported earlier, the production of dry-mounting tissue paper was included in the proposed ' Production Unit ' of this Institute and the experimental plant was run continuously for this purpose. While the machine was run continuously, some difficulties were experienced, viz. the roller fitted at the top of the baking tower got heated after 3-4 hours with the result that the layers of coated paper used to get stuck to each other on rolling.

This defect could be rectified by replacing the metallic rollers at the top by wooden ones, with arrangements so that these too could be replaced quickly and easily, if needed, without stopping the machine. It has now become possible to run the machine conveniently for 8 hours continuously even during summer months without changing the rollers. Several types of tissue and thin papers available in this country in roll form were examined. It was found that dry-mounting tissues of a very superior grade could be prepared only from a grade of imported tissue paper.

A patent to cover this process has been applied for. Manufacturing rights according to this patent have been granted to two parties on a zonal basis (*vide infra*: Publicity and Propaganda).

(ii) *Use of shellac as sizing material for paper pulp*

At the suggestion of the Chairman, Shellac Export Promotion Council, the possibility of using shellac for sizing paper pulp much in the same way as rosin is used for this purpose was examined. The work was carried out in the laboratories of Cellulose and Paper Pulp Section of the Forest Research Institute, Dehra Dun.

The following types of lac were examined:

(1) Ammonia lac, (2) Bleached lac (dewaxed), (3) Superblonde, (4) *Kusmi* shellac.

It was found that incorporation of up to even 4 per cent of any of these lacs as sizing material did not improve the properties of the paper in any respect. The results obtained by following the standard procedure are given in Table X (Appendix B).

It was next suggested by the Sectional Head of the Paper and Cellulose Section that desirable results might be obtained by dipping soft (1 per cent) rosin-sized paper in dilute aqueous solutions of lac. The work was, therefore, continued in our laboratory (at Namkum). Soft (1 per cent) rosin-sized paper discs prepared from bamboo pulp, and supplied by the Paper Pulp and Cellulose Section of the Forest Research Institute, were coated with (1) aqueous solution of ammonia lac (dewaxed), (2) dewaxed lac (Superblonde) in borax solution and (3) dewaxed lac (Superblonde) in Na_2CO_3 solution. The weight of lac incorporated in the pulp by dipping in the above solutions was up to 4 per cent of the weight of the pulp. The coated papers were air-dried and finally dried at 110°C. under slight clamp pressure between metal sheets. On examination, the lac-treated papers were found not to have developed any further sizing properties. Further work was, therefore, discontinued.

(iii) *Shellac paper pulp compositions for lac bangles*

Lac bangles available in the Indian market are very commonly prepared from a composition made by intimately hot-mixing equal parts (by weight) of lac and inorganic fillers like kaoline or soap-stone. They are very brittle. Attempts were made to improve the strength of the composition by mixing fibrous fillers in place of kaoline or soap-stone. Results of impact strength of compositions prepared by mixing different proportions of paper pulp (prepared from old newspapers) were reported earlier. These compositions

were found to have poor flow. Since bangles are prepared from shellac compositions by heating over fire and then by rolling with hand on stone surfaces, they must have good flow so that they may be easily rolled and shaped. Jute stick dust was, therefore, used in place of paper pulp, the latter being rather bulky and difficult to mix with lac. The impact strength and flow (under working conditions of such compositions) were examined and the results are given in Table XI (Appendix B). Jute stick dust of 30-40 mesh size, mixed in proportions of 30-50 parts with 100 parts of shellac, had good to fair flow and better impact strength.

Samples having good/fair flow were sent to a few bangle manufacturers for their trials and comments.

12. Experimental Testing Laboratory

(i) During the period under report 88 samples for 133 tests were received from 19 parties and tested. Out of these, 73 tests were for hot alcohol-insolubles, 14 for bleach index and bleachability, 7 for cold alcohol-insolubles and the rest for other miscellaneous tests.

Test results of commercial analysis were reported to us only for 6 samples. These were for impurities (hot alcohol-insolubles) and all of them agreed with ours within $\mp 0{\cdot}2$ per cent.

(ii) *Round Robin Test* — In the last annual report it was reported that Round Robin tests were carried out by several laboratories in the U.S.A., U.K., France and India for the determination of bleach index and bleachability of seedlac by the ' Indian ' method and for the determination of non-volatile matter soluble in cold alcohol by the Indian Lac Research Institute and British Standards Institution methods.

The results of analyses from all the laboratories of the participating countries have been received and these are being statistically analysed.

13. Publicity and Propaganda

Lac dye — The cost of the samples of lac dye produced in a fair degree of purity has been calculated to be about Rs. 3.50 to 4.00 per lb. Samples were sent to different parties for the assessment of quality.

The Central Leather Technological Research Institute reported that although the dye has great affinity for both chrome-tanned and vegetable-tanned leather, it shows no penetration and has poor staining power.

The Monsanto Chemicals examined a sample in their U.K. laboratories and reported that the intensity of the colour of the lac dye is only about one-fourth of that of their " Cormine Red 1, 65, 836 " (approved in the Indian Foodstuff list) for use in foodstuff.

The use of the dye as a substitute for tincture cochineal was investigated by the Central Drug Research Laboratory, which reported that " there does not seem to be any objection in using it for colouring Tincture cinchona Co. IPC although it is not suitable for Tr. cardamom Co. due to precipitation ".

Samples of the dye were also sent to some potential consumers and a few reported about its satisfactory performance.

Dry-mounting tissue papers — It has been established that samples prepared at this Institute compare quite favourably with the best imported samples. The manufacture of this dry-mounting tissue was taken up by our Production Unit and the daily average production was about 1,000 feet of 10 inches width. Orders were regularly received since the start of production.

Two parties requested for, and were granted, rights for manufacturing these mounting tissues according to our formulation for which a patent has been applied. One started producing the material during the last quarter of the year. It is understood that the firm made substantial progress and is able to fully meet the demands of its zone. This party was provided minor assistance in the fabrication of their equipment.

The second party belonging to Mirzapur was given all the necessary help to fabricate a machine in the Institute with materials and labour supplied by it. (It has also commenced production from June 1959.)

Bleached lac — There is a reasonable demand for bleached lac and whatever quantity was produced in our 4·5 kg. plant was readily sold. Due to shortage of raw materials, especially bleaching powder, however, production was interrupted.

During the Shellac Exhibition in Bombay in February 1959, it was learnt that 2 to 3 maunds (75 to 112 kg.) of bleached lac could easily be sold daily in that city if adequate publicity is given. Samples of bleached lac were distributed to a very large number of interested enquirers.

A large-scale manufacturer of plaster-of-Paris statues, to whom a sample was given, reported that he found bleached lac varnishes very satisfactory for water-proofing the plaster-of-Paris statues.

Shellac coating for earthenware — Without exception all the parties to whom samples of water-soluble lac had been supplied reported that the material was very satisfactory. Orders for the material have started coming in regularly and it has not been possible to meet the demand with our limited production. The production of the material is being transferred to the Production Unit.

Contact has also been established with the Organizer, Village Pottery, Khadi and Village Industries Commission, Bombay, regarding popularizing the material. They suggested that lectures and demonstrations should be given by the Institute staff to the trainees of the training centres in different parts of the country. (This will be taken up gradually.) It was suggested that the material could be made available to consumers through Khadi Bhandars so that no consumer need carry a large stock. They also agreed that if folders and publicity literature in different languages as well as a few small demonstration models could be prepared and sent to them, they will have these distributed to potters through their different publicity organizations. This is being arranged.

Shellac for gramophone record discs — The All India Radio authorities have set up the necessary plant for the production of gramophone records of programmes recorded in their studios. They are at present reported to be using imported plastic materials. They were contacted and a shellac composition formulated at the Institute was supplied to them for their test. But no report has so far been received regarding the same. Meanwhile the authorities of the Gramophone Co. Ltd. were addressed and they have assured that they will try to supply the A.I.R. the latters' requirements of gramophone stock from shellac composition as far as possible.

Clear baking oil insulating varnishes — One of the defects of the shellac-based clear baking oil insulating varnish formulated in this Institute was that it was not 'through-drying'. Experiments carried out in the laboratory showed that incorporation of a certain small quantity of *tung* oil into the varnish would eliminate this defect.

The India Electric Works, to whom a five-gallon sample of lac-based empire cloth varnish had been supplied, reported that the material was used in their plant, but as their plant could not be raised to the requisite temperature of baking due to some flaw in design, no conclusion could be drawn regarding the performance of the varnish.

Shellac wash primer — The India Electric Works Ltd., Calcutta, and the Indian Naval Chemical & Metallurgical Laboratories, Bombay, reported that they found shellac-based

wash primer supplied from this Institute quite satisfactory. Samples of wash primers were also supplied to the Technical Development Establishment Vehicles, Ahmednagar, the Hindusthan Aircrafts Ltd., Bangalore, the Integral Coach Factory, Perambur (Madras), and the Railway Testing and Research Sub-centre, Chittaranjan, for their tests and reports.

Arrangements have been made to test the primer in actual use in railway coaches in the Eastern and South-Eastern Railways respectively. Contact has also been established with the Production Engineer, Central Railway, Bombay (who visited our Shellac Exhibition at Cawasji Jehangir Hall, Bombay, in February 1959) and attempts are being made to carry out similar tests with Central Railway coaches also.

Meanwhile it has been learnt that two parties in India have started manufacture of zinc tetroxy chromate. Samples procured from them are being tested, and if found satisfactory, attempts will be made to have the two-pack etch primer also similarly tested in railway coaches. (The two-pack primer is considerably superior to the single-pack primer.)

Technical assistance to shellac manufacturers and consumers — As usual, a number of enquiries regarding the manufacture and utilization of lac were received and answered. Improved methods of lac refining evolved at this Institute such as improved washing with the aid of chemicals and the sand separating machine were brought to the notice of manufacturers by means of circulars in English and Hindi. Demonstration of the working of the latter was also arranged at Gondia, Daltonganj and Bundu.

Exhibits and exhibitions — Co-operation was extended to the Extension Wing of the Indian Council of Agricultural Research and Shellac Export Promotion Council for the erection of their respective shellac stalls in the ' India 1958 ' Exhibition held in New Delhi by the supply of exhibits and general assistance regarding lay-outs, technical details, etc., and by deputing technical and exhibition staff to attend their stalls. Also a wholly shellac exhibition was organized at the Cawasji Jehangir Hall in Bombay in February 1959, which was inaugurated by Justice B. N. Gokhale of the Bombay High Court. The Exhibition was largely attended and well appreciated. A separate report about this exhibition was submitted to the President, Indian Lac Cess Committee.

Requests for exhibits of lac and lac products for display at exhibitions, showrooms, etc., were also received from about 50 parties and these were supplied. Exhibits were also sent to 12 foreign exhibitions, showrooms and trade fairs, as detailed below:

1. Pozan International Fair, Poland.
2. Indian Trade Exhibition, Khartoum, Sudan.
3. 36th International Padua Fair, Italy.
4. Trieste Fair, Italy.
5. Levant Fair, Bari, Italy.
6. Milan Sample Fair, Italy.
7. Canadian National Exhibition, Toronto, Canada.
8. St. Eriks Fair, Stockholm, Sweden.
9. Zagreb International Fair, Yugoslavia.
10. Indian Trade Exhibition, Budapest.
11. California International Trade Fair & Industrial Exposition, California.
12. Indian Trade Exhibition, Saigon, S. Vietnam.

Consumption of lac in India — The overall consumption of lac in India is of the order of 1,941 tonnes to 2,053 tonnes, a quarter of which is *kiri* and other refuse lac, an eighth is seedlac and the rest (over 60 per cent) shellac and button lac.

As a result of a study made regarding the pattern of consumption of lac, it was ascertained that the largest consumer of the commodity in this country is the furniture polishing trade. It is believed that if the idea that furniture should be occasionally repolished can be inculcated into the minds of the public by adequate propaganda and demonstration, this will provide one of the best means of increasing the consumption of lac in this country. To start with, a scheme has been prepared for the establishment of a demonstration *cum* publicity centre in one city (New Delhi) involving a net outlay of Rs. 18,500 per year. This was submitted for consideration by the President, Indian Lac Cess Committee, and has since been sanctioned by the Committee. It will be implemented in due course.

Compilation of literature — Compilation of literature on the chemistry of lac: (iv) Revision of the projected book 'Chemistry of Lac' was completed during the year.

METEOROLOGICAL REPORT — 1958-59

Year & months	Mean baro-metric pressure (in.)	Mean max. temp. (°F.)	Mean min. temp. (°F.)	Mean dry bulb (°F.)	Mean humidity (%)	Mean sun-shine (hr./day)	Highest max. temp. during the month (°F.)	Lowest min. temp. during the month (°F.)	Mean wind speed (miles/hr.)	Total rainfall (in.)
1958										
April	—	99·33	71·30	89·03	43·66	8·35	103·0	64·0	2·050	1·30
May	—	103·68	76·52	93·55	47·87	8·71	109·0	71·0	1·950	0·30
June	—	101·53	77·76	91·80	49·40	7·53	110·0	71·0	1·600	2·77
July	27·470	86·52	74·33	79·53	86·29	2·90	95·0	72·0	1·317	18·99
August	27·580	85·75	73·31	79·45	83·94	3·26	92·5	69·9	2·117	9·90
Sept.	27·630	84·80	72·35	79·15	84·33	5·60	91·0	70·0	1·970	11·37
Oct.	27·780	84·28	67·33	78·55	69·42	7·35	88·0	56·0	1·247	3·65
Nov.	27·899	80·70	56·52	73·52	55·40	8·98	85·0	48·0	0·645	nil
Dec.	27·970	76·40	50·01	68·13	53·71	8·63	79·0	41·0	0·294	nil
1959										
Jan.	27·940	76·05	49·95	63·95	64·45	7·58	82·0	39·0	0·200	2·48
Feb.	27·880	78·66	50·93	66·75	49·71	9·18	87·0	42·0	1·480	1·13
March	27·820	90·53	58·87	80·55	26·84	10·43	99·0	51·0	1·520	0·60

The highest maximum temperature (110°F.) during the year was recorded on the 6th of June 1958 and the lowest minimum (39°F.) on the 3rd January of 1959. The total rainfall registered was 52·49 in., of which the rainfall during the monsoon period alone was 43·03 in. It is interesting to note that on 23rd July 1958, we had 7·90 in. of rainfall in the course of 5 hours, which was the highest ever recorded. The highest wind speed recorded was 208 miles/day or 8·66 miles/hour on 20th June 1958. There was no hailstorm during the year.

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APENDIX A

(Tables: Entomology Division)

TABLE I — EFFECT OF PARTIAL DEFOLIATION OF *PALAS* ON BROOD PRESERVATION

Treatment	Inoculation		Yield in terms of lac sticks			Yield in terms of scraped lac			Ratio of brood used to brood yield	Percentage of brood on total yield
50 trees under each treatment	Weight of broodlac	Weight of scraped lac	Weight of broodlac	Weight of scraped lac	Total yield	Weight of broodlac	Weight of rejected lac	Total yield		
	lb. oz.	lb. oz.	lb. oz.	lb. oz.	lb. oz.	lb. oz.	lb. oz.	lb. oz.		
1. Defoliated	44 6	7 6	63 14	207 10	271 8	9 14	35 6	45 4	1 : 1·43	23·5
	=20·1282 kg.	=3·3450 kg.	=28·9738 kg.	=94·1782 kg.	=123·1520 kg.	=4·4794 kg.	=16·0458 kg.	=20·5252 kg.		
2. Control	62 14	10 0	15 0	367 2	382 2	2 2	52 8	54 10	1 : 0·23	3·9
	=28·5202 kg.	=4·5360 kg.	=6·8040 kg.	=166·5278 kg.	=173·3318 kg.	=0·9638 kg.	=23·8136 kg.	=27·7774 kg.		

Analysis of variance (Data on percentage of brood on yield)

Due to	D.F.	S.S.	M.S.S.	F.	If significant
Treatment	1	2286·1635	2286·1635	8·832	Yes
Blocks	9	1770·4714	196·7031	—	—
Error	9	2329·5816	258·8431	—	—
Total	19	6386·2165			
	S.E.	16·088			

Result — The treatments (defoliated and undefoliated trees) differ significantly among themselves.

TABLE II — CROP DATA ON THE ECONOMICS OF UTILIZING *PALAS* FOR *BAISAKHI* CROP AND *BER* FOR *KATKI* CROP

Locality	Host	No. of trees	Lac sticks				Scraped lac			
			Brood used	Brood yield	Total yield	Ratio of brood to brood yield	Brood used	Brood yield	Total yield	Ratio of brood to total yield
			lb. oz.	lb. oz.	lb. oz.		lb. oz.	lb. oz.	lb. oz.	
					***Baisakhi* crop 1957-58**					
Kundri	*Palas*	10	10 6 =4·7058 kg.	0 10 =0·2830 kg.	50 14 =23·0770 kg.	1 : 0·92	1 5 =0·5951 kg.	1 6 =0·6234 kg.	5 4 =2·3812 kg.	1 : 4·20
	Ber	10	32 8 =14·7416 kg.	—	258 14 =117·4250 kg.	—	4 8 =2·0408 kg.	—	20 12 =9·4116 kg.	1 : 4·60
Namkum	*Palas*	10	16 8 =7·4840 kg.	61 8 =27·8960 kg.	116 4 =52·7308 kg.	1 : 3·7	3 12 =1·7012 kg.	12 14 =5·8394 kg.	19 4 =8·7316 kg.	1 : 5·10
	Ber	10	11 4 =5·1028 kg.	—	82 0 =37·1952 kg.	—	3 0 =1·3608 kg.	—	19 0 =8·6184 kg.	1 : 6·30
					***Katki* crop 1958**					
Kundri	*Palas*	10	33 8 =15·1952 kg.	4 12 =2·1540 kg.	22 14 =10·3754 kg.	1 : 0·14	3 10 =1·6438 kg.	0 15 =0·4253 kg.	1 6·5 =0·6234 kg.	1 : 0·39
	Ber	10	30 8 =13·8344 kg.	20 15·5 =9·4973 kg.	37 7 =16·5851 kg.	1 : 0·69	4 3 =1·8993 kg.	4 3½ =1·9134 kg.	5 10 =2·5510 kg.	1 : 1·34
Namkum	*Palas*	10	18 12 =8·5044 kg.	6 6 =2·8914 kg.	89 14 =40·7666 kg.	1 : 0·34	3 14 =1·7570 kg.	1 10 =0·7366 kg.	8 14 =4·0250 kg.	1 : 2·29
	Ber	10	19 8 =8·8448 kg.	6 8 =2·9480 kg.	44 0 =19·9584 kg.	1 : 0·33	5 12 =2·6076 kg.	1 4 =0·5668 kg.	3 14 =1·7570 kg.	1 : 0·60

TABLE III — PRESERVATION OF BROODLAC ON *BER* BY PARTIAL PRUNING BEFORE AND AFTER INFECTION

Particulars	Treatments					
	A		B		C	
	lb.	oz.	lb.	oz.	lb.	oz.
Brood used for infection	10	4	10	12	10	12
	= 4·6492 kg.		= 4·8756 kg.		= 4·8756 kg.	
Scraped lac from brood used	2	10	2	12	2	10
	= 0·9902 kg.		= 1·0468 kg.		= 0·9902 kg.	
Broodlac obtained	—	—	—	—	—	—
Total yield of lac sticks	76	4	89	2	111	2
	= 34·5868 kg.		= 40·4270 kg.		= 50·4062 kg.	
Total yield of scraped lac	9	10	12	8	23	2
Brood to yield ratio:						
Lac Sticks... ... (i)	1 : 7·4		1 : 8·2		1 : 10·3	
Scraped Lac ... (ii)	1 : 3·7		1 : 4·5		1 : 9·0	

TABLE IV — EFFECT OF PARTIAL PRUNING OF *BER* ON BROOD PRESERVATION — STICK EXAMINATION RESULTS

Treatments	Larval settlement per inch	Percentage of larval mortality	Percentage of males	Percentage of mortality due to heat	Percentage of mortality due to parasites and predators
A	234	19·6	50·5	99·1	0·49
B	340	11·1	43·5	99·4	0·16
C	302	14·9	46·7	93·4	1·30

TABLE V — EFFECT OF PARTIAL PRUNING OF *BER* ON BROOD PRESERVATION — MORTALITY RATIO

Treatments	Number of living female cells	Number of dead female cells	Percentage of mortality
A	25	5812	99·5
B	38	6900	99·4
C	251	7932	96·9

TABLE VI — PROPER TIME OF HARVESTING FOR MAXIMIZING YIELDS: CROP DATA

Date of cropping	Treatments (50 trees under each)	Lac sticks			Scraped lac			Percentage of driage on scraped lac
		Brood used	Yield	Brood to yield ratio	Brood used	Yield	Brood to yield ratio	
		lb. oz.	lb. oz.		lb. oz.	lb. oz.		
26-4-58	I	54 7 =24·6925 kg.	533 0 =241·7688 kg.	1 : 9·79	7 4 =3·2884 kg.	106 0 =48·0816 kg. (dry 77-8 =35·1536 kg.)	1 : 14·62	27·8
26-5-58	II	55 3 =25·0321 kg.	410 0 =185·9760 kg.	1 : 7·43	8 9 =3·8835 kg.	70 4 =31·8652 kg. (dry 65-2 =29·5406 kg.)	1 : 8·20	7·9
24-7-59	III	57 6 =26·0250 kg.	155 8 =70·5344 kg.	1 : 2·71	8 3 =3·7137 kg.	35 12 =16·2156 kg. (dry 31-8 =14·2880 kg.)	1 : 4·36	11·7
24-7-59	IV	37 14 =17·1794 kg.	151 8 =68·7200 kg.	1 : 4·00	5 4 =2·3812 kg.	23 0 =10·4328 kg. (dry 19-2 =8·6750 kg.)	1 : 4·36	16·7

TABLE VII — OPTIMUM DENSITY OF LARVAL SETTLEMENT: *PALAS KATKI* (1958)

Experimental details

Treatments		Replication		No. of trees per plot		Total No. of trees
3	×	10	×	1	=	30

Crop Data

Yield particulars	Treatment A			Treatment B			Treatment C		
	Brood used	Yield obtained	Brood to yield ratio	Brood used	Yield obtained	Brood to yield ratio	Brood used	Yield obtained	Brood to yield ratio
	lb. oz.	lb. oz.		lb. oz.	lb. oz.		lb. oz.	lb. oz.	
Lac sticks	5 0 =2·2680 kg.	9 0 =4·0824 kg.	1 : 1·80	10 0 =4·5360 kg.	30 4 =13·7212 kg.	1 : 3·00	20 0 =9·0720 kg.	54 0 =24·4944 kg.	1 : 2·70
Scraped lac	1 2 =0·5102 kg.	0 8 =0·2264 kg.	1 : 0·44	2 0 =0·9072 kg.	2 14 =1·3034 kg.	1 : 1·43	4 4 =1·9276 kg.	6 0 =2·7216 kg.	1 : 1·41

TABLE VII(A) — ANALYSIS OF VARIANCE OF CROP YIELDS (STICKLAC)

Due to	D.F.	S.S.	M.S.S.	F.	Whether significant or not
Treatments	2	1·561981	0·780991	17·108	Yes
Blocks	9	0·671750	0·074639	1·635	
Error	18	0·821708	0·045650		
Total	29	3·055439			

S.E. 0·2137

Result — The treatment C differs significantly from both A and B.

TABLE VIII — *KUSUM JETHWI* (1958) CROP

Experimental details

Treatments		Replication		No. of trees per plot		Total No. of trees
3	×	8	×	1	=	24

Crop Data

Yield particulars	Treatment A			Treatment B			Treatment C		
	Brood used	Yield obtained	Brood to yield ratio	Brood used	Yield obtained	Brood to yield ratio	Brood used	Yield obtained	Brood to yield ratio
	lb. oz.	lb. oz.		lb. oz.	lb. oz.		lb. oz.	lb. oz.	
Lac sticks	35 8	454 2	1 : 12·76	71 0	578 8	1 : 8·43	142 0	898 12	1 : 6·30
	=16·1024 kg.	=205·9910 kg.		=32·2056 kg.	=262·4072 kg.		=64·4112 kg.	=407·6724 kg.	
Scraped lac	20 12	188 2	1 : 9·0	44 14	248 8	1 : 5·50	88 10	386 10	1 : 4·35
	=9·4116 kg.	=85·3334 kg.		=20·3546 kg.	=112·7192 kg.		=40·1998 kg.	=175·3726 kg.	

TABLE VIII(A) — ANALYSIS OF VARIANCE OF CROP YIELDS (STICKLAC)

Due to	D.F.	S.S.	M.S.S.	F.	Whether significant or not
Treatments	2	1952·5894	976·2947	2·978	Not
Blocks	7	4343·0146	620·4307	1·893	
Error	14	4588·9808	327·7843		
Total	23	10884·5848			

S.E. 18·1048

Result — The treatments do not differ significantly among themselves.

TABLE IX — CROP DATA AND EXPERIMENTAL DETAILS FOR *KUSUM AGHANI* (1958-59)

Experimental details

Treatments		Replication		No. of trees per plot		Total No. of trees
3	×	10	×	1	=	30

Crop Data

Yield particulars	Treatment A			Treatment B			Treatment C		
	Brood used	Yield obtained	Brood to yield ratio	Brood used	Yield obtained	Brood to yield ratio	Brood used	Yield obtained	Brood to yield ratio
	lb. oz.	lb. oz.		lb. oz.	lb. oz.		lb. oz.	lb. oz.	
Lac sticks	44 4	92 6	1 : 2·09	88 8	220 10	1 : 2·49	177 0	329 14	1 : 1·86
	=20·0716 kg.	=41·9010 kg.		=40·1432 kg.	=99·7920 kg.		=80·2872 kg.		
Scraped lac	19 6	26 8	1 : 1·37	39 10	87 0	1 : 2·20	76 8	122 4	1 : 1·60
	=8·7890 kg.	=12·0200 kg.		=17·9742 kg.	=39·4632 kg.		=34·7000 kg.		

TABLE IX(A) — ANALYSIS OF VARIANCE OF CROP YIELDS (STICKLAC)

Due to	D.F.	S.S.	M.S.S.	F.	Whether significant or not
Treatments	2	468·3003	234·1501	3·73	Yes
Blocks	9	1428·7434	158·7493	2·53	
Error	17	1065·9954	62·7056		
Total	28	2963·0391			

S.E. 7·91865

Result — Treatments A and C differ significantly between themselves.

TABLE X — RESULTS OF USING VARIED QUANTITIES OF BROODLAC IN INOCULATION

Treatments		Yield Particulars					
		Lac sticks			Scraped lac		
Time of harvest	Brood rate used	Brood used	Yield obtained	Brood to yield ratio	Brood used	Yield obtained	Brood to yield ratio
		lb. oz.	lb. oz.		lb. oz.	lb. oz.	
Ari cutting April	Half normal	3 0 =1·3608 kg.	13 12 =6·2364 kg.	1 : 4·60	0 12 =0·3396 kg.	2 8 =1·1336 kg.	1 : 3·30
do	Normal	6 0 =2·7216 kg.	29 4 =13·2684 kg.	1 : 4·90	1 6 =0·6234 kg.	7 0 =3·1752 kg.	1 : 5·10
do	Double normal	12 0 =5·4432 kg.	27 0 =12·2472 kg.	1 : 2·30	2 14 =1·3042 kg.	5 0 =2·2680 kg.	1 : 1·73
Ari cutting May	Half normal	3 0 =1·3608 kg.	15 0 =6·8040 kg.	1 : 5·00	0 12 =0·3396 kg.	4 0 =1·8144 kg.	1 : 5·30
do	Normal	6 0 =2·7216 kg.	23 0 =10·4328 kg.	1 : 3·80	1 8 =0·6800 kg.	7 2 =3·2318 kg.	1 : 4·80
do	Double normal	12 0 =5·4432 kg.	20 0 =9·0720 kg.	1 : 1·70	2 13 =1·2759 kg.	6 14 =3·1186 kg.	1 : 2·40
Cropping at maturity	Half normal	3 0 =1·3608 kg.	12 2 =5·4998 kg.	1 : 4·05	0 12 =0·3396 kg.	1 8 =0·6800 kg.	1 : 2·00
do	Normal	6 0 =2·7216 kg.	36 0 =16·3296 kg.	1 : 6·00	1 4 =0·5668 kg.	11 0 =4·9896 kg.	1 : 8·80
do	Double normal	12 0 =5·4432 kg.	50 2 =22·7366 kg.	1 : 4·20	2 13 =1·2759 kg.	12 15 =5·8677 kg.	1 : 4·60

Analysis of variance (sticklac in chattaks per tree of plot)

Due to	D.F.	S.S.	M.S.	E.	If significant or not
Treatments	8	1791·00	223·88	2·73	Yes
Brood rate	2	1024·04	512·02	6·24	Yes
Date of reaping	2	332·79	166·40	2·03	Yes
Brood rate & reaping	4	434·17	108·54	1·32	Yes
Blocks	3	476·36	158·79	1·94	—
Error	24	1968·83	82·03	—	
Total	43	6027·19			

S.E. 9·06

TABLE XI — GROWING OF LAC ON *MOGHANIA MARCOPHYLLA* UNDER BUSH CONDITION

Crop	No. of plants	Brood used		Total yield		Ratio of brood to yield	
		Lac sticks	Scraped lac	Lac sticks	Scraped lac	Lac sticks	Scraped lac
		lb. oz.	lb. oz.	lb. oz.	lb. oz.		
Baisakhi (1957-58)	171	21 6 =9·6954 kg.	2 8 =1·1336 kg.	65 8 =29·7104 kg.	6 8	1 : 3	1 : 2·6
Katki (1959)	80	20 0 =9·0720 kg.	6 10 =3·0038 kg.	89 4	9 2	1 : 4·4	1 : 1·4
Jethwi (1958)	65	16 0 =7·2576 kg.	9 10 =4·3662 kg.	46 14	10 8	1 : 2·9	1 : 1·1
Aghani (1958-59)	80	16 14 =7·6538 kg.	5 14 =2·6650 kg.	64 12	12 4	1 : 3·8	1 : 2·1

TABLE XII — COMPARISON OF EMERGENCE OF INSECTS FROM SCRAPED AND UNSCRAPED LAC

Crop	Quantity of lac caged	Emergence of insects			
		Enemy parasites	Enemy predators		Beneficial parasites
			Eublemma	*Holcocera*	
Katki (1958)	50 lb. (22·6800 kg.) of *palas* lac stick	2737	302	169	126
	17·75 lb. (7·7321 kg.) of scraped lac [from 50 lb. (22·6800 kg.) of *palas* lac stick]	986	53	37	35
Baisakhi (1957-58)	30 lb. (13·7212 kg.) of *palas* lac sticks	240	439	1688	83
	11·5 lb. (5·0037 kg.) of scraped lac [from 30 lb. (13·7212 kg.) of *palas* lac stick]	28	58	319	18
Aghani (1958-59)	50 lb. (22·6800 kg.) of *kusum* lac sticks	1561	896	1719	497
	33·75 lb. (14·9899 kg.) of scraped lac [from 50 lb. (22·6800 kg.) of *kusum* lac sticks]	1992	395	777	138

TABLE XIII — LOSS DUE TO ENEMY INFESTATION DURING STORAGE

Crop and treatment	Initial weight lb.	Final weight lb.	Percentage loss in wt.	Difference
***Katki* (1958)**				
Palas lac sticks				
(i) Untreated control	40·00 =18·1440 kg.	20·36 =9·2352 kg.	49·1	10·6
(ii) Fumigated with CS_2	40·00 =18·1440 kg.	24·61 =11·1630 kg.	38·5	
Palas scraped lac				
(i) Untreated control	13·62 =6·2180 kg.	10·00 =4·5360 kg.	26·6	0·2
(ii) Fumigated with CS_2	13·99 =6·3458 kg.	10·30 =4·6720 kg.	26·4	
***Aghani* (1958-59)**				
Kusum lac sticks				
(i) Untreated control	40·00 =18·1440 kg.	26·61 =12·0702 kg.	33·5	2·2
(ii) Fumigated with CS_2	40·00 =18·1440 kg.	27·49 =12·4694 kg.	31·3	
Kusum scraped lac				
(i) Untreated control	27·42 =12·4377 kg.	19·24 =8·7272 kg.	29·8	1·8
(ii) Fumigated with CS_2	25·16 =11·4125 kg.	18·11 =8·2146 kg.	28·0	
***Baisakhi* (1958-59)**				
(i) Untreated control	20·00 =9·0720 kg.	10·71 =4·8580 kg.	41·22	3·4
(ii) Fumigated with CS_2	20·00 =9·0720 kg.	12·05 =5·4658 kg.	37·80	
Palas scraped lac				
(i) Untreated control	7·75 =3·5154 kg.	5·30 =2·4040 kg.	31·67	1·1
(ii) Fumigated with CS_2	7·50 =3·4020 kg.	6·05 =2·7442 kg.	32·70	

TABLE XIV(A) — EMERGENCE OF INSECTS FROM LAC SAMPLES, TREATED WITH INSECTICIDES AND FUMIGANTS AND UNTREATED CONTROL — *PALAS BAISAKHI* (1958-59)

Lac samples and quantity caged	Insecticides and fumigation treatment	Emergence of insects		
		Enemies		Beneficial insects
		Predators	Parasites	
Lac sticks				
10 lb.	Aldrex 2% dust	54	7	—
10 lb.	Aldrex 5% dust	1	2	—
10 lb.	Dieldrex 1·5% dust	78	8	—
10 lb.	Endrex 1% dust	19	—	—
10 lb.	Ekatox 2% dust	5	—	—
10 lb.	Aldrex (W.P.) spray 0·1%	41	—	—
10 lb.	Dieldrex (W.P.) spray 0·1%	164	—	—
10 lb.	Ekatox (W.P.) spray 0·1%	42	—	—
10 lb.	Endrix (E.C.) spray 0·1%	118	—	—
10 lb.	Trichlorethylene	23	1	—
10 lb.	Control	963	125	47
Scraped lac obtained from 10 lb. of lac sticks				
3·50 lb.	Aldrex 2% dust	15	1	—
4·00 lb.	Aldrex 5% dust	2	3	—
3·75 lb.	Dieldrex 1·5% dust	9	4	—
3·75 lb.	Endrex 1% dust	—	—	—
4·00 lb.	Ekatox 2% dust	1	1	—
3·50 lb.	Aldrex (W.P.) spray 0·1%	6	1	—
3·00 lb.	Dieldrex (W.P.) spray 0·1%	1	—	—
3·25 lb.	Ekatox (W.P.) spray 0·1%	1	—	—
3·50 lb.	Endrix (E.C.) spray 0·1%	—	—	—
3·25 lb.	Trichlorethylene	2	2	—
4·00 lb.	Ethylene dibromide	—	—	—
3·75 lb.	Control	126	14	3

TABLE XIV(B) — EMERGENCE OF INSECTS FROM TREATED AND UNTREATED LOTS — *PALAS KATKI* (1958)

Lac samples and quantity caged	Insecticides and fumigation treatment	Emergence of insects		
		Enemies		Beneficial insects
		Predators	Parasites	
Lac sticks				
10 lb.	Aldrex 2% dust	—	238	2
10 lb.	Aldrex 5% dust	—	219	—
10 lb.	Dieldrex 1·5% dust	7	541	8
10 lb.	Endrex 1% dust	—	93	5
10 lb.	Ekatox 2% dust	2	29	3
10 lb.	Aldrex (W.P.) spray 0·1%	—	128	—
10 lb.	Dieldrex (W.P.) spray 0·1%	2	220	1

TABLE XIV(B) — EMERGENCE OF INSECTS FROM TREATED AND UNTREATED LOTS — *PALAS KATKI* (1958) (*Contd.*)

Lac samples and quantity caged	Insecticides and fumigation treatment	Emergence of insects		
		Enemies		Beneficial insects
		Predators	Parasites	
Lac stick				
10 lb.	Ekatox (W.P.) spray 0·1%	2	4	10
10 lb.	Endrix (E.C.) spray 0·1%	0	24	18
10 lb.	Trichlorethylene	86	436	18
10 lb.	Ethylene dibromide	—	1	—
10 lb.	Control	99	985	36
Scraped lac obtained from 10 lb. of lac stick				
3·50 lb.	Aldrex 2% dust	—	206	
3·50 lb.	Aldrex 5% dust	2	228	—
3·50 lb.	Dieldrex 1·5% dust	—	382	—
3·25 lb.	Endrex 1% dust	—	54	2
3·25 lb.	Ekatox 2% dust	—	6	—
4·00 lb.	Aldrex (W.P.) spray 0·1%	—	4	—
3·75 lb.	Dieldrex (W.P.) spray 0·1%	—	6	—
3·75 lb.	Ekatox (W.P.) spray 0·1%	—	—	—
3·50 lb.	Endrix (E.C.) spray 0·1%	—	—	—
3·50 lb.	Trichlorethylene	1	30	—
3·00 lb.	Ethyldibromide	—	—	—
3·25 lb.	Control	23	192	—
				1

TABLE XIV(C) — EMERGENCE OF INSECTS FROM TREATED AND UNTREATED LOTS — *KUSUM AGHANI* (1958-59)

Lac samples and quantity caged	Insecticides and fumigation treatment	Emergence of insects		
		Enemies		Beneficial insects
		Predators	Parasites	
Lac sticks				
10 lb.	Aldrex 2% dust	15	25	—
10 lb.	Aldrex 5% dust	1	9	—
10 lb.	Dieldrex 1·5% dust	129	23	2
10 lb.	Endrex 1% dust	5	13	2
10 lb.	Ekatox 2% dust	12	4	2
10 lb.	Aldrex (W.P.) spray 0·1%	4	18	—
10 lb.	Dieldrex (W.P.) spray 0·1%	229	82	—
10 lb.	Ekatox (W.P.) spray 0·1%	339	40	9
10 lb.	Endrix (E.C.) spray 0·1%	16	21	11
10 lb.	Trichlorethylene	478	197	86
10 lb.	Ethylene dibromide	—	—	—
10 lb.	Control	717	195	94

TABLE XIV(C) — EMERGENCE OF INSECTS FROM TREATED AND UNTREATED LOTS — *KUSUM AGHANI* (1958-59) (*Contd.*)

Lac samples and quantity caged	Insecticides and fumigation treatment	Emergence of insects		
		Enemies		Beneficial insects
		Predators	Parasites	
Scraped lac obtained from 10 lb. of lac sticks				
6·93 lb.	Aldrex 2% dust	11	128	—
7·00 lb.	Aldrex 5% dust	1	44	—
7·12 lb.	Dieldrex 1·5% dust	35	190	5
7·18 lb.	Endrex 1% dust	5	54	2
7·25 lb.	Ekatox 2% dust	—	1	—
7·06 lb.	Aldrex (W.P.) spray 0·1%	4	40	—
7·18 lb.	Dieldrex (W.P.) spray 0·1%	49	95	1
7·18 lb.	Ekatox (W.P.) spray 0·1%	44	38	3
7·25 lb.	Endrix (E.C.) spray 0·1%	6	21	4
6·56 lb.	Trichlorethylene	335	195	19
6·43 lb.	Ethylene dibromide	—	1	—
6·31 lb.	Control	323	407	31

TABLE XV — DATA ON THE MASS BREEDING OF *APANTELES TACHARDIAE*

Months	No. of cages started	No. of hosts offered	Parasites introduced		Parasites bred			Percentage of parasitation
			Males	Females	Males	Females	Total	
March 1958	9	5800	736	368	2472	774	3246	55·96
April 1958	12	9000	1012	506	4139	1077	5216	57·95
May 1958	13	10000	1158	594	3520	837	4357	43·57
June 1958	9	5300	650	325	1622	267	1889	35·64
July 1958	14	12850	1042	821	5918	2858	8776	68·29
August 1958	12	17000	2226	1113	6108	3309	9417	55·39
Sept. 1958	10	8900	507	507	778	181	959	10·77
Oct. 1958	4	2500	230	125	500	190	690	27·60
Feb. 1959	11	3250	41	144	971	—	971	29·87
March 1959	10	5600	476	262	1938	905	2843	50·76

Percentage parasitism: 43·58. Percentage of females: 27·1.

TABLE XVI(A) — CROP DATA OF THE *JETHWI* (1958) CROP OF THE BIOLOGICAL CONTROL EXPERIMENT

Treatments (Release of parasites)	No. of trees	Lac sticks			Scraped lac		
		Brood used	Yield	Ratio of brood to yield	Brood used	Yield	Ratio of brood to yield
		lb. oz.	lb. oz.		lb. oz.	lb. oz.	
A — *A. tachardiae*	24	137 8 =62·3696 kg.	870 8 =394·8584 kg.	1 : 6·3	49 10 =22·5102 kg.	440 8 =199·8104 kg.	1 : 8·7
B* — *B. greeni*	24	116 12 =52·9572 kg.	859 0 =389·6424 kg.	1 : 7·3	46 4 =20·9788 kg.	428 6 =194·3106 kg.	1 : 9·0
C — Both A and B above	24	126 6 =57·3234 kg.	953 8 =432·5072 kg.	1 : 7·5	50 8 =22·9064 kg.	406 2 =154·1616 kg.	1 : 8·0
D — Control (no release)	24	133 0 =60·3288 kg.	1025 12 =465·2796 kg.	1 : 7·6	52 14 =23·9834 kg.	532 0 =241·3152 kg.	1 : 9·8

*Only *A. tachardiae* was released. *B. greeni* not released.

TABLE XVI(B) — CROP DATA OF THE *AGHANI* (1958-59) CROP OF THE BIOLOGICAL CONTROL EXPERIMENTS

Treatments (Release of parasites)	No. of trees	Lac sticks			Scraped lac		
		Brood used	Yield	Ratio of brood to yield	Brood used	Yield	Ratio of brood to yield
		lb. oz.	lb. oz.		lb. oz.	lb. oz.	
A — *A. tachardiae*	30	264 8 =119·9768 kg.	258 10 =117·3118 kg.	1 : 0·98	126 6 =57·3234 kg.	88 0 =39·9168 kg.	1 : 0·70
B* — *B. greeni*	30	226 0 =102·5136 kg.	230 10 =104·6110 kg.	1 : 1·02	114 2 =51·7670 kg.	78 6 =35·5506 kg.	1 : 0·70
C* — Both A and B above	30	201 0 =91·1736 kg.	193 0 =87·5448 kg.	1 : 0·96	97 6 =44·1690 kg.	58 8 =26·5352 kg.	1 : 0·61
D — Control (no release)	30	234 0 =106·1424 kg.	147 6 =66·8490 kg.	1 : 1·04	111 0 =50·3496 kg.	86 8 =39·2368 kg.	1 : 0·75

*Only *A. tachardiae* was released. *B. greeni* not released.

APPENDIX B .

(Tables : Chemistry Division)

TABLE I — CHEMICAL CONSTANTS OF OLD BLEACHED LACS

No.	Date of manufacture	Percentage of cold alcohol insolubles	Acid value	Percentage of chlorine	Sap. value (apparent)	Sap. value (corrected)	Ash percentage	Remarks
BL 7	27.7.54	4·86 on 25.9.54 6·06 on 28.5.58	70·74	1·05	258·3	241·70	0·52	Keeping quality very good
XXII (Regular)	29.6.54	3·1 on 21.9.54 8·84 on 28.5.58	58·78	1·36	246·5	225·60	0·81	Keeping quality very good
593(IV) (Regular)	19.7.57	4·2 on 23.9.57 5·5 on 28.5.58	70·94	0·97	240·2	224·62	0·60	Keeping quality not so good

TABLE II — KEEPING QUALITY OF LACS BLEACHED WITH DIFFERENT AMOUNTS OF BLEACH LIQUOR

Sample No.	Bleach (3% chlorine) added for 30 gm. of lac	Percentage of chlorine present	Percentage of cold alcohol-insolubles
I	Original lac	—	4·60 when taken 4·80 after 6 months 4·80 after 10 months
II	Precipitated from alkaline solution without bleaching	—	4·60 when prepared 4·80 after 6 months 5·00 after 10 months
III	20 cc.	0·23	4·70 when prepared 4·80 after 6 months 5·20 after 10 months
IV	40 cc.	0·60	4·74 when prepared 4·92 after 6 months 5·40 after 10 months
V	60 cc.	0·90	4·80 when prepared 5·00 after 6 months 5·64 after 10 months
VI	80 cc.	1·20	4·72 when prepared 5·10 after 6 months 5·80 after 10 months
VII	100 cc.	1·38	4·78 when prepared 5·18 after 6 months 6·20 after 10 months

TABLE III — BLEACHING AT VARIOUS TEMPERATURES

Sample No.	Temp. of bleaching °C	Amount of bleach liquor (3% chlorine) added for 100 gm. of seedlac cc.	Whether added in lots or at a time	Time required for bleaching hrs.	Colour ratio of 10% solution of bleached lac after completion of bleaching	Colour index of dried bleached lac	Acid value	Per-centage chlorine	Percentage cold alcohol insolubles
BLP 2	35	334	At a time	4½	3·8	0·30	76·33	1·32	3·60 when prepared 3·80 after 4 months 3·99 after 6 months 5·10 after 8 months
BLP 3	35	300	In lots	6½	3·8	0·30	73·08	1·20	3·60 when prepared 3·72 after 4 months 4·04 after 6 months 4·90 after 8 months
BLP 5	25	250	In lots	10	3·8	0·33	73·08	1·02	3·60 when prepared 3·67 after 4 months 3·74 after 6 months 4·76 after 8 months
BLP 7	20	250	In lots	17½	3·7	0·35	72·50	1·04	3·50 when prepared 3·53 after 4 months 3·70 after 6 months 4·63 after 8 months

TABLE IV — PROPERTIES OF BLEACHED LACS PREPARED BY DIFFERENT MODES OF TREATMENT

Sample No.	Mode of treatment	Yield percentage	Acid value	Percentage of chlorine	Colour index of dried bleached lac	Percentage of cold alcohol-insolubles
BLP 8	Bleached in light	88·10	76·83	1·33	0·36	3·09 when prepared 3·22 after 4 months
BLP 9	Bleached in dark	88·30	76·83	1·33	0·36	3·30 when prepared 3·45 after 4 months
BLP 10	Extracted with 7% sodium carbonate	87·80	75·23	1·27	0·33	4·10 when prepared 4·14 after 4 months
BLP 11	Extracted with 8·5% sodium carbonate	87·80	75·78	1·25	0·33	3·50 when prepared 3·52 after 4 months
BLP 12	Extracted with 15% sodium carbonate	87·00	74·65	1·27	0·33	4·20 when prepared 4·20 after 4 months
BLP 13	Extracted with 10% sodium carbonate	88·00	74·65	1·25	0·33	3·60 when prepared 3·62 after 4 months
BLP 15 (a)	Got by adding 3/5ths of requisite acid (H_2SO_4)	34·00	74·15	1·25	0·43	4·16 when prepared 4·17 after 3 months
BLP 15 (b)	Got the rest by 2/5ths of requisite acid (H_2SO_4)	51·00	62·33	1·20	0·40	3·20 when prepared 3·40 after 3 months
BLP 16	Kept bleached lac dipped in 0·1% $NaHCO_3$ solution overnight, washed and dried	85·80	72·00	1·35	0·37	4·18 when prepared 4·39 after 3 months
BLP 17	Kept bleached lac dipped in 0·3% $NaHCO_3$ solution	84·60	69·85	1·36	0·40	3·86 when prepared 4·08 after 3 months
BLP 18	Kept bleached lac dipped in 0·5% $NaHCO_3$ solution	83·30	64·49	1·35	0·40	4·16 when prepared 4·12 after 3 months
BLP 19	Control, subject to no treatment	87·00	76·33	1·35	0·40	3·72 when prepared 4·28 after 3 months
BLP 20	After bleaching was complete, added 5gm. NaOH to the solution, allowed to stand for 1 hr. at room temperature. Precipitated, washed and dried	80·40	90·28	0·44	0·45	4·98 when prepared 5·29 after 3 months
BLP 21	After bleaching was complete, added 2 gm. NaOH and heated gently (70°C.) for ½hr. Cooled, precipitated, washed and dried	83·00	77·43	0·52	0·56	5·07 when prepared 5·29 after 3 months

TABLE IV — PROPERTIES OF BLEACHED LACS PREPARED BY DIFFERENT MODES OF TREATMENT (*Contd.*)

Sample No.	Mode of treatment	Yield percentage	Acid value	Percentage of chlorine	Colour index of dried bleached lac	Percentage of cold alcohol-insolubles
BLP 22	After bleaching was complete, heated gently (70°C.) for ½ hr. Cooled, precipitated, washed and dried	87·30	76·33	0·86	0·50	4·80 when prepared, 5·14 after 3 months
BLP 23	Control, subject to no treatment	87·30	75·23	1·05	0·40	4·87 when prepared, 5·05 after 3 months

TABLE V — CHANGES IN CARBONYL AND SAPONIFICATION VALUES WITH PROGRESSIVE BLEACHING

Sample No.	Bleach liquor (3% chlorine) added for 30 gm. lac	Carbonyl value	Sap. value (3 hrs. refluxing after correcting for chlorine)	Remarks
I	Original shellac	10·66	221·00	—
II	Precipitated without adding bleach from sodium carbonate solution	7·00	218·65	—
III	20 cc. bleach liquor	8·80	222·05	—
IV	40 cc. bleach liquor	11·26	222·10	—
V	60 cc. bleach liquor	14·96	225·80	—
VI	80 cc. bleach liquor	11·86	—	Sample old. Dissolves in alcohol completely but filters slowly, showing start of polymerization.

TABLE VI

Sample No.	Material	Percentage of impurities		Difference between the two values
		By U.S.S.I.A. method	By Double filter paper method	
1	Seedlac	3·360	3·400	+0·040
2	Shellac	1·460	1·470	+0·010
3	Seedlac	4·080	3·990	−0·090
4	Seedlac	2·626	2·644	+0·018
5	Seedlac	4·270	4·310	+0·040
6	Seedlac	4·390	4·410	+0·020
7	Shellac	0·634	0·638	+0·004
8	Shellac	1·590	1·580	−0·010

TABLE VII — SPECIFIC GRAVITY OF VARIOUS SHELLAC SOLUTIONS

Percentage of shellac in solution(%) (Solvent: distilled methylated spirit)	Mean of Sp. Gr.	Remarks
0	0·8225	
1	0·8261	No smooth curve could be obtained from these results
2	0·8322	
5	0·8401	
10	0·8639	
15	0·8795	
20	0·8844	
25	0·8945	
30	0·9061	

TABLE VIII(A) — LAC CONTENT OF SEEDLAC BY ACID VALUE METHOD

Sample No.	Vol. of *N*/10 alcoholic KOH required for 5 cc. solution	Percentage of lac content from graph	Percentage of lac content from H.A. insolubles
30	5·95490	95·15	95·570
33	5·95490	95·15	94·212
44	5·95490	95·15	95·684
45	5·76485	92·14	92·591
50	5·95490	95·15	95·514
51	6·08160	97·21	96·630
54	5·82820	93·12	94·700
65	5·89155	94·12	95·078
66	6·08160	97·21	92·748
67	5·70150	91·12	92·732
69	6·08160	97·21	92·754
70	5·89155	94·12	95·845

TABLE VIII(B) — LAC CONTENT OF STICKLAC BY ACID VALUE METHOD

Sample No.	(A) Percentage of lac from acid value	(B) Percentage of lac from H.A. insolubles
K — *Rangeeni*	83·5	83·280
M — *Rangeeni* 1954	86·5	86·830
N — *Kusmi*	80·2	77·060
O — —	92·8	91·490
P — *Kusmi*	88·2	90·840
R — *Rangeeni*	85·0	88·050
U — —	85·0	85·540
100	88·0	86·610
101	75·0	74·460
102 *Kusmi*	88·0	91·310
103 *Palas, Baisakhi*	83·5	83·700
104 *Ghont*	80·2	82·290
1 — *Katki*	85·0	84·400
2 — *Katki*	83·5	83·500
3 — *Baisakhi*	81·5	81·760

TABLE VIII(C) — LAC CONTENT OF STICKLAC BY ACID VALUE METHOD

Sample No.	*N*/10 alcoholic KOH required for 5 cc. solution (in cc.)	Percentage of lac from graph A	72% of A	Seedlac yield per maund (from *A.V.*) B		Seedlac yield determined by actual washing	
				Srs.	chhk.	Srs.	chhk.
1	6·3710	85·8	61·700	24	11	24	4
2	5·0600	80·9	58·248	23	5	23	0
3	5·0922	81·4	58·608	23	7	23	4
4	5·0340	80·5	57·960	23	3	23	12
5	4·9680	79·5	57·200	22	14	23	4
6	5·2220	83·3	59·976	23	16	24	0
7	5·0922	81·4	58·608	23	7	23	4
8	5·2160	83·2	59·904	23	15	24	8
9	5·3090	84·8	61·056	24	7	24	0
10	5·0340	80·5	57·960	23	3	23	4
11	5·1840	82·9	59·688	22	11	24	0
12	5·0922	81·4	58·608	23	7	23	12

TABLE IX — PROPERTIES OF SHELLAC FROM SEEDLAC MADE BY DIFFERENT PROCESSES

Materials taken	Colour	H.A. insolubles %	Wax %	Life min.	Flow sec.	Remarks
1. Seedlac in autoclave	18·5	0·442	2·25	16	215	The materials charged in autoclave were all mixed with formaline and oxalic acid.
2. Seedlac + *Kiri* in autoclave	18·5	0·448	3·05	16	230	
3. Seedlac by country process	18·5	0·716	3·14	16	230	

TABLE X — LAC AS SIZING MATERIAL FOR PAPER PULP

Sizing material 4%	Freeness in cc.	Drying time in sec.	Basic wt. in gm./m.	Breaking strength (metres)	Stretch per cent	Burst factor	Mean factor	Folding endurance	Sizing
Nil (control)	305	9·0	58·0	4670	3·25	30·3	174·7	260	Nil
Ammon. lac	335	11·0	60·0	3910	3·13	25·7	151·3	70	Nil
Bleached lac	350	9·5	56·5	3940	3·13	25·3	158·5	70	Nil
Superblonde Lac	380	9·0	58·0	3820	3·18	25·0	170·7	80	Nil
Kusmi lac	330	9·0	58·8	3960	2·80	26·7	151·0	110	Nil

TABLE XI — FIBROUS AND OTHER FILLERS FOR LAC BANGLES STOCK

Properties tested	Composition								
	Shellac	Shellac 100 Kaolin 100 (standard composition)	100 parts of shellac mixed with					
			Jute waste (parts)			Jute stick dust (30-40 mesh) parts		
			30	50	70	30	50	70
1. Impact strength in cm. kg. for rods of 1·5 sq. cm. cross-section	1·0	200	2·0	2·0	3·0	2·5	3·0	4·0
2. Flow	—	Good	Good	Fair	Bad	Good	Fair	Bad

APPENDIX C

Method of determining carbonyl value of shellac

For the calculation of the carbonyl value of shellac, Bhatt *et al.* [*J. sci. industr. Res.*, **14B** (1955), 273] suggest the following formula:

$$\text{Carbonyl value} = A - \frac{(V_1N_1 - V_2N_2) \times 56{\cdot}1}{W}$$

where A = Acid value of lac,

W = Weight of shellac taken,

V_1N_1 = Amount of alkali required for the neutralization of residual acidity of shellac and

V_2N_2 = Amount of acid required for the neutralization of the free alkalinity of aqueous alcohol containing sodium sulphite reagent.

During the estimation of carbonyl value of shellac it was detected that this formula is incorrect. The correct formula should be

$$A = \frac{(V_1N_1 + V_2N_2) \times 56{\cdot}1}{W}$$

This correction has been verified by adopting several other procedures: the results obtained for different kinds of shellac and seedlac are given in the following table:

TABLE XII—CARBONYL VALUE OF SEEDLAC AND SHELLAC BY DIFFERENT METHODS

Sample	Carbonyl value by				
	Bhatt's formula	Corrected formula	Modified method as per Siggia's suggestion (a)	Kamath and Mainkar's method (b)	Smith and Mitchell's hydroxylamine method (c)
1. *Kusmi* seedlac (I.L.R.I.)	42·3	24·5	25·2	22·5	—
2. *Kusmi* seedlac (Madras)	42·5	25·2	26·6	25·2	—
3. *Palas* seedlac (I.L.R.I.)	34·8	20·1	21·0	19·8	—
4. *Ber* seedlac (I.L.R.I.)	42·8	24·9	25·2	24·4	—
5. *Palas* seedlac (Umaria)	35·8	20·6	21·5	18·7	—
6. *Ghont* seedlac (I.L.R.I.)	19·1	10·9	11·0	10·3	—
7. *Arhar* seedlac (Assam)	33·5	19·3	20·2	17·7	—
8. *Jalari* seedlac (Mysore)	23·4	13·2	13·6	14·0	—
9. Shellac from 3 (autoclave)	25·0	14·0	14·7	—	—
10. Shellac from 5 (autoclave)	23·9	13·6	13·8	10·4	—
11. Shellac from 6 (autoclave)	13·6	7·7	7·2	6·7	—
12. Shellac from 1 (autoclave)	22·3	12·8	13·3	10·0	—
13. Shellac from 1 (country process)	30·7	17·8	18·5	—	21·0
14. Shellac from 3 (country process)	27·5	16·5	16·6	16·0	—
15. Dewaxed, decolorized shellac (d)	32·5	18·6	19·7	20·1	23·0
16. Dewaxed lemon shellac (d)	19·7	12·0	10·0	—	15·0
17. *Moghania macrophylla* seedlac (I.L.R.I.) through *Kusmi* broodlac	53·9	31·0	31·8	28·2	—
18. Shellac from 17 (country process)	48·1	27·5	28·7	26·4	—

(a) S. SIGGIA, *Quantitative Organic Analysis via Functional Groups* (John Wiley & Co., New York), 1949.
(b) N. R. KAMATH & V. K. MAINKAR, *J. sci. & industr. Res.*, **14B**, (1955), 555.
(c) D. M. SMITH & J. MITCHELL, *Jr. Anal. Chem.*, 22, 750.
(d) Commercial samples.

It will be seen from the table that values obtained by the corrected formula are in good agreement with those obtained by other methods. The value is high in seedlac and decreases in shellac prepared from the same seedlac by the country process; a still further reduction in value is observed in the case of autoclave shellac. A short note on the carbonyl value of lac is ready for communication to the press.

APPENDIX D

Tabulated Statement of Progress of Investigations

ENTOMOLOGY DIVISION

Item	Date commenced	Progress	Remarks/Future work
I. Research and Investigations			
1. Improving crop production on *palas* by partial defoliation			
(i) Large-scale defoliation experiments	1948-49	13,510 *palas* (Coupé I) on pruning *cum ari* cutting gave 4,533 lb. (2056·168 kg.) of scraped lac. 3,795 trees on partial cropping in July 1958 gave 1,689 lb. (766·130 kg.) of brood and 9,877 lb. (4480·207 kg.) of rejected lac sticks: enough lac was left on trees for self-inoculation. In October-November 1958, in all 6,810 trees were cropped giving 19,591 lb. (8886·477 kg.) of brood and 4,448 lb. (2017·612 kg.) of rejected lac. The brood was partially used to inoculate 10,986 *palas* trees including 4,310 partially defoliated trees. Total yield during the year = 101 mds. 19 seers = 3784·045 kg. (8321 lb.) of sticklac and 55 mds. = 24·9480 kg. (4510 lb.) of broodlac. Total gross revenue = *c.* Rs. 6,160 against cultivation and guarding charges of *c.* Rs. 4,342.	To be continued
(ii) Effect of partial defoliation of *palas* on brood preservation	1948-49	Laid out on a randomized block design, there were 10 plots with 25 trees in each. Five central trees in each plot served as experimental trees. An equal number of control trees was also chosen. Ratio of brood yield to brood used for the defoliated group — 1 : 1·43 and that for control — 1 : 0·23. Survival of insects on experimental and control trees was respectively 15·4 and 2·65 per cent.	
2. Economics of utilizing *palas* for *Baisakhi* and *ber* for *Katki* crop	Before 1953	*Ber's* performance in the *Baisakhi* season was poor as compared with *palas's*. In the *Katki* season, data for comparison not available due to severe enemy infestation.	To be continued
3. Comparative preservation of broodlac on *ber* by partial pruning before and after inoculation	1954-55	Experiments designed on correct statistical lines show that neither pre-pruning nor post-pruning helped brood preservation appreciably.	To be continued
4. Finding of, and trials as brood preservers, on lac hosts for *Baisakhi* crop including certain *Ficus*	1945-46	In spite of initial, good larval settlement, larval mortality of 70 to 90 per cent was observed at the time of second moult. Cells left for self-	To be continued

APPENDIX D (*Contd.*)

Item	Date commenced	Progress	Remarks/Future work
and *Albizzia* species, and also trials of hosts similar to those in Thailand		inoculation also hardly yielded any crop.	
5. Proper time of harvesting for maximizing yields	1955-56	Four groups, each comprising 50 *palas* trees, were under observation. Trees were cropped respectively in April, May and at crop maturity; better results were obtained with *ari* cutting in April or May.	To be continued
6. Determination of optimum density of larval settlement on various hosts	1953	Experiments covered *Katki*, *Jethwi* and *Aghani* seasons. Three treatments, i.e. (A) using half the usual (normal) quantity, (B) using the usual normal quantity and (C) using double the normal quantity, were given. (C) proved best in each case. Increased use of broodlac favours better larval survival, albeit with increased male population.	To be continued
7. Optimum density of larval settlement and proper harvesting time for *palas* in the *Baisakhi* season	1957-58	The use of heavier quantity of brood gave the best results either for *ari* cutting or cropping at maturity. Highest ratio of brood used to yield was found to be 1 : 8·8 for the latter. Increased larval settlement resulted in better survival for larvae and increased male population. (*Vide* 6 also.)	To be continued
8. Growing of lac crops under crop and bush conditions	1952-53		
(i) Under crop condition (*Arhar*)		25 six-month-old *arhar* plants were inoculated for *Baisakhi* crop: plants and insects perished in extreme summer. 50 plants inoculated for *Katki* suffered from heavy insect attack giving a brood to yield ratio of 1 : 0·93. Development of *kusmi* strain was poor for both *Jethwi* and *Aghani* crops.	To be continued
(ii) Under bush condition	1952-53	171 *Moghania macrophylla* inoculated for *Baisakhi* (1957-58) gave a brood to yield ratio of 1 : 2·6. 80 plants (with *palas* brood) in the *Katki* season gave the ratio of brood used to yield as 1 : 1·4. Inoculation with *kusum* brood (65 plants) gave a *Jethwi* crop with brood to yield ratio as 1 : 1·1. In the *Aghani* crop (80 plants), the ratio was 1 : 2·1. This plant appears to have a good promise as an alternative host to *kusum*, both as regards yield and quality of lac.	To be continued
9. Influence of various environmental conditions on the lac insect	1952-53	Hosts: *Acacia farnesiana* and *kusum*; potted plants under field conditions and in incubators and refrigerators.	

APPENDIX D (*Contd.*)

Item	Date commenced	Progress	Remarks/Future work
		Temps. 18°, 22°, 27° and 30°C. Growth was very slow at 18° and 22°C., but better at 27° and 30°C. The same observations could be made with the *kusmi* strain also.	
10. Proper storage and quick disposal of lac to avoid enemy infestation	1956-57	(a) Scraped and unscraped sticklac caged and daily examined for emergence of insect enemies. Scraping reduced emergence of enemy insects, except in the case of the *Aghani* crop. (b) One lot of lac (scraped) was fumigated with CS_2 so as to be free from all enemy insects. Another lot of lac sticks was kept as control. Emergence of insects from either lot was counted. When emergence ceased, the lots were weighed. Loss due to enemy insects = 2·2-10·6 per cent for the control and = 0·2-1·8 per cent for the scraped lot.	To be continued
11. Control of enemies of lac during storage by use of insecticides	1954	Lac sticks and scraped lac obtained from similar quantities of lac sticks were treated with insecticides and fumigants. Aldrex 5 per cent among the dusts was the best. Aldrex wettable powder spray at 0·1 per cent strength was also good. Of the fumigants ethylene dibromide was better than trichlorethylene.	
12. Biological control	1942		
(a) Life-history studies and developing breeding techniques		Work on *Apanteles tachardiae* and *Perisierola pulveriae* was completed. Breeding of *B. greeni* continued to be difficult.	
(b) Mass-breeding of *Bracon greeni* and *Apanteles tachardiae*		*E. amabilis*, *E. Zinkenella* and adult *B. greeni* were scarce; this hampered work of breeding. Breeding of *A. tachardiae* on *Corcyra cephalonica* was successful; 38,364 parasites were bred.	
(c) Large-scale liberation in the field and estimation of the effect		Release of *A. tachardiae* alone or together with *B. greeni* in the *kusmi* areas (*Jethwi* and *Aghani*) was done. Periodical examination of sticks as well as of crop yields did not indicate any significant difference between the control and the experimental plots.	
13. Regional Field Research Stations			
Jhalda (*W. Bengal*)			
(a) Spurious emergence of lac larvae	1958	Experiment planned and started. *Kusum* trees inoculated with *kusum* as well as with various *Rangeeni*	

APPENDIX D (*Contd.*)

ITEM	DATE COMMENCED	PROGRESS	REMARKS/FUTURE WORK
		broods were under observation. Small degree of early emergence was noticed on 6 *kusum*, 1 *palas* and 1 *F. infectoria* inoculated with *kusum* brood. Crop matured one month ahead of the crop at Ranchi: obviously climate had significant influence.	
(b) Alternative lac hosts for *kusum*	1958	Among others *Bursera serrata, Dalbergia sissoo, F. infectoria, ber, Cassia fistula* and *Croton oblongifolius* were tried. Only poor crops were obtained from the first two.	
Damoh (M.P.)			
(a) Response of *ghont* to pruning	1958	*Kathki* crop: Trees pruned in February did not respond well, those pruned in May did; those pruned in December put forth buds after one month, but growth of buds was slow. *Baisakhi* crop: April pruning proved better than May pruning.	
(b) Introducing new hosts for brood preservation	1958	New hosts like *A. lucida* and *O. dalbergioides* were planted.	
(c) Investigation on preservation of broodlac		Broodlac at various rates was used for the *Baisakhi* crop. Coverages aimed at were 1: 25, 1: 50, 1: 100. Lighter inoculation ensured better survival of brood. Shaded areas along tank *bunds* also led to better brood survival.	
14. Plantation at Namkum		The plantation maintained as usual. Irrigation provided for *C. saltiana* for supply of *E. zinkenella*.	
15. Training and Advisory Service			
(a) Training		10 trainees on the roll at the beginning of the year. 3 new trainees joined during the year. 11 trainees completed the course. 2 Burma trainees, sponsored under the Colombo Plan received 6 months' training. Lectures were given at several Forest Guards Training Schools.	
(b) Advisory Service		Technical advice was given to Lac Extension Officer and various interested parties.	

CHEMISTRY DIVISION

1. Separation and study of the constitution of the various components of shellac	1947		
(i) Improved method of making shellolic acid	1958	Alcohol-insoluble lead salt separated from mixed acids from shellac	To be continued

APPENDIX D (*Contd.*)

Item	Date commenced	Progress	Remarks/Future work
		hydrolysis was esterified with methyl alcohol and HCl. Dimethyl shellolate, m.p. 150°-151°C. (1·7 per cent on lac), was separated from the esterified mixture. Shellolic acid is to be regenerated from the ester.	
(ii) Separation of the aldehydic acid	1955	Purification of the impure acid was attempted *inter alia* through bisulphites, of which lead bisulphite proved the most convenient. The isolated acid is to be further purified.	
(iii) Fractionation of aleuritic acid	1957	Two fractions of aleuritic acid obtained through methyl alcohol (m.p. 102·5° and 97·5°), as also the parent acid were oxidized with potash permanganate: oxidized dibasic acids are being identified.	
(iv) Fractionation of shellac: shellac-urea complexes	1957	Three fractions separated already (*vide* Report 1957-58). These fractions were examined.	
Properties of the complexes:			
(a) Carbonyl values (C.V.)		The carbonyl values of these complexes are nil: shellac regenerated from the complexes has the same C.V. as the parent shellac. Apparently, urea reacts with the aldehydic group of shellac.	The formula proposed by Bhat *et al.* for the calculation of carbonyl value was noted as inaccurate and corrected (*vide* Appendix C)
(b) Thermosetting properties	1958	The first fraction of shellac-urea complex appears to be thermosetting (moulding at temperature 170°C. at 1½-2 tons/sq. in.).	To be continued
(c) Film-forming properties	1958	Two of the fractions, when used as varnish, had better water-resistance than the parent shellac. Films were resistant to dilute acid and alkali also.	
2. Thermal polymerization of shellac: Carbonyl value	1958	For partially polymerized shellacs sodium sulphite method could not be employed, and so also potentiometric titration.	To be continued
3. Nature and kinetics of thermal polymerization of shellac	1958	Shellac samples heated at 125°, 135°, 150° and 175°C. for definite intervals were prepared and conditioned for study of viscosity of their solutions.	To be continued
4. Bleached lac			
(i) Optimum conditions of bleaching	1953-54	(a) A few samples made *c.* 4 years back have kept well. The keeping quality could not be correlated with any of the chemical constants of the samples.	

APPENDIX D (*Contd.*)

Item	Date commenced	Progress	Remarks/Future work
		The keeping quality, however, was found to improve as the amount of bleach liquor used in bleaching was reduced. Carrying out bleaching at 35°, 25° and 20°C., it was found that bleaching at 25° and 20°C. required 20 per cent less bleach liquor than bleaching at 35°C. (b) To improve the life and flow of bleached lac, bleaching was done under a variety of conditions, e.g. using different amounts of sodium carbonate, modified way of adding mineral acid, use of NaOH to remove Cl from the bleached samples, etc. Samples are being periodically examined.	
(ii) Pilot plant for manufacture of bleached lac	1957	The plant has been designed and ordered.	
(iii) Carbonyl values of bleached lac	1958	Generally carbonyl value (C.V.) decreases when the lac is dissolved in alkali and reprecipitated. The value slowly increases with the amount of bleach liquor added.	
5. Aqueous lac varnishes			
Water-soluble lac	1952	Nitrogen contents of lac exposed to ammonia for 3 and 18 hrs. were respectively 1·213 per cent and 2·63 per cent. Solubility of lac exposed for 3 hrs. is soon lost. 24 hrs.' exposure is necessary to ensure retention of solubility for a long time.	To be continued
Film properties		Baking at 150°-160°C. for ½ hr. improves the gloss and water-resistance of the films. As an alternative to baking, water-soluble accelerators like urea, ammonium tartarate, etc., were tried, but found unsatisfactory. Air-dried (coated) articles kept immersed in 4*N* HCl for 15-20 minutes improved the water-resistance.	
6. Shellac wash primers	1957		
(a) Storage stability	1958	No deterioration was noticed so far (within 12 months of its preparation).	
(b) Weathering tests	1958	Al, Cu, mild steel and galvanized iron panels were brushed with the primer, and dried for 24 hrs. One set was then coated with shellac spirit paint and another set with oil enamel. Coated panels were kept indoors as control, and on roofs for weathering. Primer films (12 months	S.E.Rly. is trying this primer on Al

APPENDIX D (*Contd.*)

ITEM	DATE COMMENCED	PROGRESS	REMARKS/FUTURE WORK
		old) were unaffected under either condition. The spirit paint deteriorated, but the oil paint was quite unaffected except for loss of gloss.	
7. Improvement in analytical methods (grade cum specifications)			
(i) Hot alcohol-insolubles test	1958	Method of USSIA is time-consuming and involves use of costly thimbles. Method based on use of two filter papers in place of thimbles enables the determination to be made in 6 hrs.	To be continued
(ii) Rapid method for assaying resin content of sticklac	1958	Methods based on measurements of vol. and sp. gr. did not succeed. Method based on correlating resin-content with the acid value of lac gave very encouraging results.	To be continued
8. Improvement in the manufacture of seedlac, shellac, etc., and utilization of byproducts			
(i) Sand-separating machine	1955	Demonstrated at Gondia with complete success.	
(ii) Autoclave shellac	1950	Autoclave shellac suffers in comparison with shellac made by country process in respect of colour, flow and wax content. Significant improvements in these respects have been effected, e.g. colour improves by adding 0·1 -0·2 per cent oxalic acid while the lac is dried in steam-heated pan; flow improves by adding formalin (2 cc. in 10 cc. water for 1,000 gm. of seedlac) to seedlac; wax content could be raised by adding in the charge wax-rich (autoclave) *kiri* in certain proportions.	To be continued
(iii) Economic utilization of refuse lac			
(a) French polish from *kiri*		A composition of the required strength (25 per cent of lac by weight) could be made mainly by sedimentation and decantation using the counter-current principle: the residues could be filtered off easily after third extraction. The varnish could be successfully used and easily dewaxed if necessary.	To be continued
(b) Bleached lac from *molamma*		Lac was extracted by dissolution in aqueous soda solution, and then bleached as usual: filtering had to be done in two stages. Yield of	To be continued

APPENDIX D (*Contd.*)

ITEM	DATE COMMENCED	PROGRESS	REMARKS/FUTURE WORK
		bleached lac — 35 per cent on the weight of *molamma*. Alcoholic solution of the bleached lac darkened with time.	
9. Separation of lac dye	1956-57	Crude dye obtained from wash-water was spirit-extracted, and then re-extracted with 1 per cent borax solution, out of which it was precipitated with H_2SO_4: the ppt. with dye content of 65 per cent was quite usable. To improve the yield, the crude dye was treated with white spirit (boiling); wax separated on cooling. Subsequent treatment with borax, etc., gave a yield of 20-30 per cent on the weight of crude dye.	To be continued
10. Adhesives			
(i) Substitute for 'miracle glue'	1958	A lac-based substitute was not accepted, being slower-drying.	
(ii) Adhesive for plywood	1958	A shellac-based composition was formulated and used to bond 3-ply *Toon*-veneers (pressed at 400 lb./sq. inch for 10-30 min. at 140°C.). Plywood so made stood boiling water for 2½ hrs.	
11. Miscellaneous applications of lac			
(i) Dry-mounting tissue paper	1956-57	Difficulties experienced in continuously working the machine were removed by a slight change in the design of the plant.	
(ii) Shellac as sizing material for paper pulp	1958	The use of ammon. lac, bleached lac, superblonde and *kusmi* shellac as a rosin substitute did not succeed.	
(iii) Shellac-paper compositions for lac bangles		Shellac-paper pulp compositions had poor flow. Replacing paper pulp by jute stick dust (30-40 mesh), good to fair flow and improved impact strength were obtained.	Samples sent to parties for test
12. Experimental testing laboratory			
(i) At I.L.R.I.		(i) 88 samples for 135 tests received from 19 parties were tested and reported.	
(ii) Round Robin test		(ii) Results for tests (bleachability, bleach index, cold alcohol insolubles) have been received from U.S.A., U.K. and France and are being statistically analysed.	
(iii) Testing Laboratory at Gondia		263 samples were analysed.	
14. Publicity and propaganda		Work carried on as before. Several exhibitions were organized, of which the one at Bombay was the most important.	

APPENDIX E

List of Papers Published/Communicated to the Press for Publication during 1958-59

1. Descriptive Account of the Host Plants of the Lac Insects, *Laccifer Lacca* (Kerr), and the Allied Plants in the Indian Region. Parts I & II, by M. L. Roonwal, M. B. Raizada, R. N. Chatterjee & Balwant Singh, 1958.
2. A Catalogue of Lac Insects (Lacciferidae, Hemiptera), by A. P. Kapur, 1958.
3. *I.L.R.I. Bulletin No.* 91 — Studies on Non-Insect Enemies of Lac, with special reference to squirrels and birds as serious seasonal predators, by S. Krishnaswami, N. S. Chauhan & P. S. Negi. (Reprinted from *J. Bomb. Nat. Hist. Soc.*, 1958, Vol. **54**, No. 4, pp. 887-907.)
4. *I.L.R.I. Technical Note No.* 14 — Shellac Adhesives: Part I — Electrical, Automobile and Other Industries, by P. K. Ghosh & M. Venugopalan. (Reprinted from *Research & Industry*, 1958, Vol. **3**, No. 6.)
5. Field Observations on a Severe Outbreak of *Tessaratoma Javanica*, Thunberg, a Sporadic Pest of *Kusum* (*Schleichera oleosa*) and Preliminary Trials on its Control, by B. P. Mehra & B. K. Purkayastha. (Reprinted from *Ind. J. of Entomology*, 1957, Vol. **XIX**, Part III, pp. 214-216.)
6. *I.L.R.I. Bulletin No.* 93 — The Use of Shellac in Etch Primers for Metals, by Y. Sankaranarayanan (*Research Memorandum No.* 206 of the Paint Research Station, Teddington, England).
7. *I.L.R.I. Bulletin No.* 94 — Bionomics of *Serinetha Augur* Fabr. and its Association with *Dysdercus Cingulatus* Fabr., The Red Cotton Bug, by C. P. Malhotra. (Reprinted from *Ind. Forester*, 1958, Vol. **84**, No. 11, pp. 669-671.)
8. Assemblage of Ten Species of Coccinellied Beetles on Banyan Trees at Kundri Forest, Bihar, by C. P. Malhotra & S. Krishnaswami. (Reprinted from *Current Science*, 1959, Vol. **27**, pp. 315-352).
9. *I.L.R.I. Technical Note No.* 15 — Lac Dye from Factory Waste Effluents, by T. Bhowmik & A. K. Ghosh. (Reprinted from *Research & Industry*, 1958, Vol. **3**, No. 12.)
10. *I.L.R.I. Bulletin No.* 95 — Tips for Lac cultivation, by S. Krishnaswami.

APPENDIX F

Statement Showing Appointments, Resignations, etc., of Staff during 1958-59

(a) Appointments

(i) *Other than Class IV*

Chemistry Division

1. Sri P. R. Bhattacharya	Grade I Research Assistant as Physical Chemist (Class I)	29th December 1958
2. Sri A. Kumar	Research Assistant	4th November 1958
3. Sri S. V. Kamath	Research Assistant	15th November 1958

4. Sri N. V. Rao	Research Assistant	15th November 1958
5. Sri B. S. Mathur	Junior Research Assistant	10th December 1958
6. Sri M. A. Hassan	Analyst	27th August 1958
7. Sri G. C. Agarwala	Research Assistant	19th November 1958
8. Sri S. S. Chopra	Research Assistant	17th December 1958
9. Sri T. S. Krishnan	Junior Research Assistant	10th December 1958
10. Sri N. Gopal Krishnan	Junior Research Assistant	10th December 1958
11. Sri R. V. Raja	Junior Research Assistant	7th January 1959
12. Sri B. N. Bhattacharya	Junior Research Assistant	9th April 1959
13. Sri Ameresh Gupta	Junior Research Assistant	14th January 1959
14. Sri S. K. Dass	Junior Clerk	21st July 1958
15. Sri D. D. Banerjee	Junior Research Assistant	25th August 1958

Entomology Division

1. Sri G. S. Arora	Research Assistant	15th November 1958
2. Sri M. S. Bhatnagar	Research Assistant	6th December 1958
3. Mrs. P. Dewan	Research Assistant	17th November 1958
4. Sri K. N. Prasad	Research Assistant	6th January 1959
5. Sri Jawala Prasad	Research Assistant	21st February 1959
6. Sri R. C. Maurya	Junior Research Assistant	22nd December 1958
7. Sri Pyre Das	Artist and Photographer	7th October 1958
8. Sri R. S. Gokulpure	Research Assistant	28th October 1958
9. Sri S. S. Prasad	Research Assistant	14th November 1958
10. Sri R. S. Maliya	Laboratory Assistant	16th December 1958

Shri S. N. Gupta reverted to the post of Scientific Officer and Dr. A. Bhattacharya was appointed as Biologist *vice* Sri Gupta with effect from 1st January 1959.

(ii) *The following Class IV Officers were appointed*

Administrative Section

1. Sri Mahadeo Oraon	Chowkidar	16th July 1958
2. Sri Lachman Oraon	Gas Plant Attendant	16th December 1958
3. Sri Balku Lohar	Carpenter	6th February 1959

Chemistry Division

1. Sri Dulka Oraon	Durwan	14th July 1958
2. Sri Premdas Banerjee	Durwan	27th August 1959

Entomology Division

1. Sri Budhwa Oraon	Mali	1st March 1959
2. Sri Mariya Oraon	Mali	1st March 1959
3. Sri Ramkrishan	Chowkidar	17th April 1958
4. Sri Lalpat Bhuian	Chowkidar	1st September 1958
5. Sri Kesar Bhuian	Chowkidar	1st September 1958
6. Sri Malhar Pahan	Durwan	6th May 1958
7. Sri Bertia Chowdhury	Chowkidar	1st August 1958

(b) RESIGNATIONS

(i) *Other than Class IV*

Chemistry Division

1. Sri B. S. Mathur	Junior Research Assistant	23rd February 1959
2. Sri B. K. Ganguly	Analyst	4th July 1958
3. Sri D. D. Banerjee	Junior Research Assistant	3rd December 1958

Entomology Division

1. Sri P. S. B. R. James	Research Assistant	9th July 1958
2. Sri S. B. Agarwal	Research Assistant	26th August 1958
3. Sri S. Roy	Fieldman	31st March 1959
4. Mrs. P. Dewan	Research Assistant	31st March 1959
5. Sri U. P. Chowdhury	Fieldman	17th July 1958
6. Sri C. Tirkey	Laboratory Assistant	10th September 1958
7. Sri Jugraj Behari	Research Assistant	1st November 1958

(ii) *Class IV*

Administrative Section

1. Sri Bacha Mistry	Carpenter	12th December 1958

Entomology Division

1. Sri Dilbhar Pahan	Chowkidar	1st August 1957

(c) DISCHARGED

Administrative Section

1. Sri Sampat Singh	Chowkidar	1st July 1958
2. Sri Budhoo Lal	Driver	1st June 1958

APPENDIX G

Statistics of Sticklac Production (in maunds*) in India during the Years 1956-57 to 1958-59

Year	*Baisakhi*	*Jethwi*	*Katki*	*Aghani*	*Total*
1958-59	6,00,000	30,000	2,52,000	45,500	9,27,500
1957-58	8,40,000	27,000	2,33,000	40,500	11,40,500
1956-57	7,32,000	17,000	5,01,000	65,000	13,15,000

*One maund = 37·32 kg.