INDIAN LAC RESEARCH INSTITUTE

NAMKUM, RANCHI, BIHAR, INDIA

ANNUAL REPORT

FOR THE FINANCIAL YEAR 1961-62

1963

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ADMINISTRATIVE AND GENERAL

General — The Institute pursued its research and other activities as programmed. Certain lac schemes under the Third Five Year Plan were finalized and approved by the Government, but work towards their implementation could not be started, owing to various reasons.

Notable events during the year include the visit of a Russian delegation for exchange of information on the results of Russian experiments to grow lac in Russia in the region round the Black Sea, and the delivery by Dr. Subramaniam, an eminent Cytologist of the Indian Institute of Science, Bangalore, of a course of lectures on cytogenetics with special reference to the coccids: Dr. Subramaniam's review of the subject formed a prelude to the opening of an insect genetics section in the Institute under the Third Five Year Plan.

During the year, the Institute achieved at least two important results in the field of research, namely (i) a rapid method of hypochlorite bleaching of lac and (ii) ' Reconstituted lac '. Under the first, it was found that on addition of common salt, lac is salted out of the soda extract as a fine dispersion, in which form it can be bleached quickly and with much less bleach liquor. ' Reconstituted lac ' has been obtained by hydrolysing lac with caustic soda followed by addition of sulphuric acid to neutralize the alkali: the resulting product, when heated at 150°C. for four hours and then dissolved in alcohol-toluene mixture, gives films having remarkable hardness, elasticity and adhesion.

On the developmental side, the lac-based single-pack wash (etch) primer has proved its usefulness in a series of service tests conducted by different agencies, including the Railways and the State Road Transport authorities: As a result a leading paint factory in Calcutta has agreed to start its commercial production expeditiously.

Visitors — The Institute continued to attract numerous visitors including students and trainees from various Institutions, Government Officials, as also a number of foreign nationals. A few deserving special mention are:

1. Dr. Humayun Kabir, Minister of Scientific Research & Cultural Affairs, Government of India.
2. Dr. L. A. Jordan, ex-Director, Paint Research Station, Teddington, England and Professor Emeritus, Royal Institution, London.
3. Prof. Sharapov
4. Prof. Kachibaia } A Scientific delegation from U.S.S.R.
5. Mr. Zurkhan
6. Dr. Ross of the U.S.A.
7. Mr. T. F. Hoctor, American Consulate, Calcutta.
8. Mr. D. S. Joshi, Additional Secretary, Ministry of Commerce & Industry, Government of India.

Dr. J. S. Patel, President, Indian Lac Cess Committee, visited the Institute in July 1961.

Roads and Buildings — Annual repairs to roads and buildings were, as usual, carried out by the Central Public Works Department.

Construction of four residential quarters was started during the period by the C.P.W.D. and is expected to be completed by July 1962.

An approach road to the new Administrative Block was constructed departmentally: the layout includes a circular island park with flower beds, etc.

A new feature added to the Institute premises during the year is a children's park, complete with a swing, a sea-saw, a merry-go-round, and a slide. The park was opened by Mrs. Jordan (wife of Dr. L. A. Jordan) then on a visit to this Institute in company with her husband.

A straw shed in the premises has been converted into a godown.

Water-supply — The over-head tank, which has developed holes on the sides, is leaking badly. It was to be replaced by a cement-concrete tank, but the idea has been dropped.

Library — The number of bound volumes of periodicals accessioned during the year was 288. In addition, miscellaneous reports and scientific publications numbering about 40 were also received.

The ' Monograph on Lac ', awaiting publication for over four years, was sent to the press after some revisions. Its printing is expected to be over by the end of December 1962.

Training — Forty-eight candidates, deputed by various States, were trained in ' Lac Cultivation ', and two in ' Industrial Uses of Lac '. The duration of the course of training in lac cultivation has been reduced from one year to six months, and the training was undergone by two batches respectively of 11 and 37. The other course, i.e. that on the industrial uses of lac, has been of six months' duration right from the begining.

Exhibitions — The Institute participated in the Bihar State Small-Scale Industries Exhibition, Gaya; National Technical Training Week Celebrations Exhibition, New Delhi; and National Agricultural Fair, Madras.

Staff — Dr. S. Krishnaswami, Entomologist, left the Institute in September 1961 to join the Sericultural Institute at Berhampur, West Bengal, as its Director.

Details regarding staff will be found in Appendix F.

Staff Club — The staff club continued its activities as usual.

ENTOMOLOGY DIVISION

(Dr. S. Krishnaswami, Entomologist)

I—GENERAL

Introduction — Progress was maintained during the year on all the research items under investigation both at the main Laboratory, Namkum and at the Regional Field Research Stations. Work on physiological and genetical studies was intensified.

56 kg. of *Moghania macrophylla* seeds were distributed to various Institutions and State Forest Departments for encouraging lac cultivation on this species.

Staff — Dr. S. Krishnaswami, Entomologist was appointed Director of Research, Central Sericulture Research Station, Berhampur and left I.L.R.I. on 29-9-1961. Sri C. P. Malhotra was promoted to the temporary post of Scientific Officer. Two Research Assistants joined and one Research Assistant resigned from their posts during the period under report.

Season — The weather conditions for all the four crops during the year were favourable. Contrary to expectations (*vide Annual Report*, 1960-61) the *Baisakhi* 1960-61 was a bumper crop which in turn produced a big *Katki* 1961 crop. *Baisakhi* crop 1961-62 is also expected to be a good one. *Jethwi* 1961 crop suffered badly due to a prolonged cold spell. *Aghani* 1961-62 was an average crop.

Chrysopa attack was rather heavy in *Aghani* 1961-62.

IIA—RESEARCH AND INVESTIGATIONS

1. Improving Crop Production on *Palas* (*Butea monosperma*)

Large-scale cultivation experiments

The experiment was continued at Kundri with nearly 21,000 trees. Details of operations and itemwise costs are given in Table I (Appendix A). It will be seen that against a total expenditure of Rs. 4777·88 nP., revenue of Rs. 4391·81 nP. was obtained. This loss despite a total yield of sticklac amounting to 8941·17 kg. is due to a large fall in the prices of lac.

2. Experiments on the Evolution of Suitable Cultivation Practices for *Palas*

(a) The experiment was continued for the third year in succession with four treatments, namely:

A — Heavy inoculation in October-November followed by complete cropping in April (next year).

B — Heavy inoculation in October-November, partial cropping in April (as *ari*) and complete cropping (after one year) in October-November.

C — Medium-light inoculation in October-November, partial cropping in June-July and complete harvesting in October-November (after one year).

D — Light inoculation in October-November and complete cropping in October-November next year.

There were five replications with 100 trees under each treatment, and all told 2000 trees. Per-tree average yield of broodlac was: 2·80 kg. from D, 2·68 kg. from C, and 1·42 kg. from B, the ratio of brood used to brood yield being respectively 1: 12·0 (D), 1: 7·2 (C), and

1: 1·9 (B). As regards yield of scraped lac, the grading in the descending order was B, D, C, A. However, since trees under A could yield another crop if, for instance, inoculation were also done in October-November 1961 and cropping in April 1962, A may theoretically be considered as the best.

Furthermore, 2200 trees under A were heavily inoculated in October-November and completely harvested in April. At the same time 2300 trees were lightly inoculated in October-November and completely cropped in April. Heavy inoculation resulted in per-tree yield of 0·59 kg. and light inoculation in 0·29 kg.; obviously heavy inoculation is to be preferred.

(b) *Evolution of cultivation practice for* kusum (*Schleichera oleosa*)

The experiment was started in June-July 1961 with the following treatments:

A_1 Rest for 1 year — Inoculation in June-July allowed self-inoculation in January-February, complete cropping in June-July (2-coupé system).

A_2 Rest for 1 year — Inoculation in January-February allowed self-inoculation in June-July, complete cropping in January-February (2-coupé system).

B_1 Rest for 2 years — Inoculation in June-July allowed self-inoculation in January-February, complete cropping in June-July (3-coupé system).

B_2 Rest for 2 years — Inoculation in January-February allowed self-inoculation in June-July, complete cropping in January-February (3-coupé system).

C (control) for $1\frac{1}{2}$ years — Complete cropping after six months (4-coupé system).

There are all told 14 coupés, 4A (= 2 × 2, i.e. A_1, A_2), 6B (= 3 × 2, i.e. B_1, B_2), and 4C. Treatments A and B are being tried, since cropping every six months involves heavy expenditure on broodlac, on account of both frequency of inoculation and relatively heavy amount to be used at the time of every inoculation. In A and B, since self-inoculation is allowed after the initial artificial inoculation, broodlac used at the begining is relatively small. Thus brood used was: 1 ft. of brood for $12\frac{1}{2}$ ft. of inoculated length spaces for inoculation under C, and 1 ft. of brood for 30 ft. of inoculated length for A and B.

Each coupé contained 15 trees.

The experiment was started in June-July 1961 and results have been obtained in the case of C (4 coupé) treatment only: Ratio of brood used to brood obtained (in Jan.-Feb. 1962) was 1: 0·40 and that of brood to yield (scraped lac) was 1: 1·96.

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

(a) *Kusum* — The experiment was started in 1958 and was conducted with proper layout on sound statistical lines (*vide* previous reports). Treatments were based on uses of different brood rates: A (Half-normal), B (Normal = N), C (Double-normal), and D (4 N). Data for *Jethwi* 1961 are given in Table II (App. A). Statistical analysis of the yield figures shows that the treatment D differs significantly from all other treatments and treatment C differs significantly from A and B; while A and B do not differ significantly between themselves.

The results of larval mortality and percentage of males are in conformity with previous findings. The experiment was concluded.

(b) *Ber* (*Zizyphus mauritiana*) — The experiment was started in the Namkum Plantation since *Katki* 1961 season, using 3 brood rates, namely $\frac{1}{2}$ N, N (normal) and 2 N. Inoculation was done in June-July 1961, and cropping in October 1961. The data are given in Table III (App. A). Maximum brood was obtained from 2 N, N and $\frac{1}{2}$ N showing little difference in brood yield. Brood to brood ratios were approximately 1: 4·85 for $\frac{1}{2}$ N, 1: 2·58 for N, and 1: 1·77 for 2 N. Increase in brood yield was not, however, proportional to increase in brood used.

4. Proper Time of Harvesting and Determination of Optimum Density of Larval Settlement

(a) *Palas* — The experiment was continued for the fourth year with the following treatments (*Baisakhi*):

A — *Ari*-cutting in April — ½ N brood rate
B — ,, ,, ,, — N ,, ,,
C — ,, ,, ,, — 2 N ,, ,,
D — ,, ,, May — ½ N ,, ,,
E — ,, ,, ,, — N ,, ,,
F — ,, ,, ,, — 2 N ,, ,,
G — Cropping at maturity — ½ N ,, ,,
H — ,, ,, ,, — N ,, ,,
I — ,, ,, ,, — 2 N ,, ,,

N brood rate was fixed arbitrarily as 1 ft. brood for 25 ft. of infectable shoot. Results are given in Table IV (App. A).

Results indicate an increase in yield with an increase in brood used, though not in the same proportion. Maximum crop was obtained from cropping at maturity. Yields obtained from various treatments could be arranged in the descending order as follows:

I, F, H, E, B, D, C, G, A

(b) *Ber* — The same treatments as in the case of *palas*, were adopted for the *Baisakhi* 1961-62 season. Inital larval mortality was the highest for 2 N brood rate, and practically the same for both N and ½ N. Results will be reported after crops are reaped.

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

Baisakhi crop was grown on both (10 trees of each) and cropped in July 1961. No brood was obtained from *ber* while brood to brood (yield) ratio for *palas* was 1 : 2·24. Brood to total yield ratio was 1 : 3·6 for *palas* and 1 : 3·01 for *ber*. Data are given in Table V (App. A). The previous finding, namely superiority of *palas* as a *Baisakhi* host was confirmed. This experiment was concluded.

6. Studies on Pruning Time for *Ber* for *Katki* Crop

Under this experiment, *ber* was pruned respectively in February, May, October and December (A, B, C & D treatments). Data on shoot measurement at the time of inoculation and yields of *Katki* 1961 from the various treatments are given in Table VI and VII (App. A). It will be seen that treatment B (May-pruning) gave the best result.

7. Finding of, and Trials as, Brood Preservers, of Lac Hosts for the *Baisakhi* Crop

Baisakhi 1961 crop was grown on various hosts (14) using brood obtained from *Albizzia stipulata*. There was cent per cent larval mortality on *A. stipulata*, *G. multiflora*, *A. lebbek*, and *Z. xylopyra*, so that crop failed completely. Settlement was poor on *palas*, *ber*, *khair* and *F. glomerata*, resulting in poor crop. Self-inoculation in June-July was allowed on *F. glomerata* and *A. catechu* and cropping was done in October 1961. Data are given in Table VIII (App. A).

F. cunia gave the best crop (brood). Other Ficus species also gave some brood.

8. Growing of Lac Hosts Under Bush Conditions

(i) *Ber* — After regular coppicing for 3-4 years, 40 *ber* plants have grown into good bushes. They were inoculated in October 1961 for the *Baisakhi* crop. The settlement of larvae was satisfactory, initial mortality being 25-30 per cent only. The crop is growing well.

(ii) *A. lucida* — 20 *Albizzia lucida* plants, trained into bushes, were inoculated with *kusum* brood (in Jun.-Jul. 1962) for raising the *Jethwi* 1962 crop. Settlement of larvae has been good, but initial mortality rather high, presumably because of prolonged bad spell of weather.

(iii) *Moghania macrophylla*

(a) *Raising of* Moghania macrophylla

Ten treatments are being tried. These are:

A — Direct sowing in May with 2 seeds per pit
B — „ „ „ „ 3 „ „
C — „ „ June „ 2 „ „
D — „ „ „ „ 3 „ „
E — Transplanting 1 plant (per pit) of March seedlings
F — „ 2 „ „ „ „ „
G — „ 1 „ „ „ April „
H — „ 2 „ „ „ „ „
I — „ 1 „ „ „ May „
J — „ 2 „ „ „ „ „

There was little or no difference in either the rate of germination of seeds or the survival of seedlings for sowings in March, April and May.

All transplantations were carried out in July. Data are recorded in Table IX (App. A). It will be seen that treatment G is the most promising, followed by E and F.

(b) *Spacing trials with* M. macrophylla

Three treatments A, B and C, i.e. respectively with 6′ × 6′, 6′ × 4′ and 4′ × 4′ spacings are being tried since 1960-61. The layout is in randomized block design with 8 replications. There were 24 plots with 3 plants in each under observation.

Results are given in Table X (App. A).

Treatment B is better than either A or C, although taking all the plants into consideration (instead of 3 only in each plot), C appears to be the best.

Inoculation was carried out in July 1961 for *Aghani* 1961-62. Settlement was found with initial larval mortality at 25 per cent. Insect enemies were destroyed by hand-picking. There is no significant difference in per-plant yield between the treatments : Per-acre yield, because of larger number of plants in 4′ × 4′ spacing, was the highest for C, namely 302 kg., as against 133 kg. and 202 kg. for A and B respectively. Crop data are given in Table XI (App. A).

After cropping, the plants gave rise to new buds and from them, fresh infectable shoots.

(iv) *Moghania chappar* — Preliminary experiments with this host have shown promise.

Crop data are given in Table XI (App. A).

9. Biological Control of Insect Enemies

(a) *Mass-rearing of* Apantales tachardiae

Work suffered owing to air-conditioning (a.c.) arrangement having broken down. After the air-conditioning room had been repaired breeding work was started at 27 ± 1 C. and 75-80 per R.H. 105 breeding cages were started with 3,16,700 larvae offered to 2934 gravid

female parasites mated with 5652 males. A total of 10 generations (XX-XXIX) was reared. Average percentage of parasitism was 39·84. Total number of parasites emerged during the year was 1,26,284 (82,398 males and 43,886 females), of which 66,900 parasites (42,600 males and 24,300 females) were released in the field in the same period.

(b) *Life-history studies of* Apanteles fakhrulhajiae

Two sets of cages were run starting from November 1961, one with optimum temperature (27-28°C.) but low humidity (30-40%) and another with low temperature (20°) and optimum humidity (80-90%) respectively designated as A and B treatments.

Viability was higher for B than for A. Average percentage of viability was 57·8. Life cycle was completed in B in 50 days and in A in 30 days: the average was 39 days.

Laboratory-bred male parasites, fed on split raisins, under R.H. 80-90 per cent and temperature 18-20°C., survived for 51 days (maximum) and for 4 days (minimum), the average life being 32·5 days.

(c) *Mass-rearing of* Bracon greeni, Ashmead.

Repeated experiments now show that *Corcyra cephalonica*, chiefly because of its over-activeness, is not a suitable host for *B. greeni*. If paralysed by coddling or chloroforming, *C. cephalonica* is not accepted by the parasite.

Breeding was tried on its natural host (*E. amabilis*) by the usual dome method. The fecundity was low. Parasite density in the cage appears to be the major factor.

The effect of host size on the distribution of progeny was studied. Results are as follows:

Length of host larvae in mm. —	6	7	8	9	10	11
Average number of eggs laid on host —	1·4	2·3	2·6	2·0	2·6	3·0

(d) *Life-history of* Pristomerus sulci

A rearing technique has also been developed. 6000 *Corcyra cephalonica* were offered to *P. sulci* for parasitization. Parasitism in the laboratory was 15·35 per cent (range 4·5-55%); that in the field collected material was 30 per cent.

(e) *Breeding and life-history studies of* Brachymeria tachardiae *Cam. on the alternative host* Corcyra cephalonica *Staint*

The parasite (*B. tachardiae*) was kept in Battery jars (4" × 4") and fed on honey and *kishmish*. Pupae of *C. cephalonica* were put on the floor of the cages for a day, during which time they were parasitized. The parasite laid eggs inside the host body (endo-parasite) and the parasitized *C. cephalonica* pupae were transferred for development under laboratory conditions. Periodical emergence was noted. Data are given in Table XII (App. A). Development is complete in 10-21 days (average 16·0 days for 41 parasites) at 26 ± 1°C. and 11-52 days (average 31·0 days for 70 parasites) at an average laboratory temperature of 19·6°C. (variation 16·1-25·5°C.) during December 1961 to March 1962.

10. Survey of Lac Enemies and Their Parasites

A new internal parasite of *Holcocera pulverea*, namely an insect belonging to genus *Agathis* has been discovered.

11. Pests of Host Trees

(a) *A new pest of* M. macrophylla *was found.* It belongs to *Microlepidoptera*. It was reared in the laboratory where it completed its life cycle in two different periods, namely 20·9 days and 28·8 days. Studies are to continue.

(b) *Holotrichia serrata* (Melolonthidiae) a serious pest of *palas* is being studied for its life-history. Its egg stage was found to last on an average for 12·2 days (range 11-13), first instar for 28·6 days (range 22-39), second instar for 33·5 days (range 27-40), and third instar for 68·4 days (range 64-72).

Eggs measured 3·64 mm. in length and 2·03 mm. in width when freshly laid, and 4·28 mm. in length and 3·40 mm. when about to hatch.

First instar larva measures 17-19 mm. long and 2·49 mm. wide.
Second instar larva measures 22-28 mm. long and 4·15 mm. wide.
Third instar larva measures 38·1 mm. (1½ inches long).
Pupa measures 31 mm. long 17 mm. in breadth.
There is only one generation in a year.

12. Genetical Studies on the Lac Insects

(a) *Cross-breeding of* ranginee *and* kusmi *strains*

F_1 and F_2 generations of the *Baisakhi* 1959-60 crossed with the *Jethwi* 1961 males developed and behaved exactly like the *ranginee* strain in respect of life cycle, quality of resin, etc. The same observation could be made in the case of F_1 and F_2 generations of the *Katki* 1960 females crossed with the *Aghani* 1960-61 males. There is no evidence of segregation in the population into *ranginee* and *kusmi* strains. Negative results of crossing suggest that the two strains are either different species and the *ranginee* females reproduced by parthenogenesis, or the *ranginee* females are hermaphrodites. Cytological studies will be required to clarify the point.

(b) *'Abnormal' lac cells in the* Baisakhi 1960-61

Some abnormal lac tests, appearing to be fungus-attacked, were found to be healthy cells free from any such attack, but with heavy deposition of filamentous wax from the serpentine areas round the lac tests. Further search revealed universal presence of a small percentage of such lac cells in all the *ranginee* crops.

Comparative studies showed certain differences in structure, also that the cells were bigger (6·66 gm. as against 6·031 gm. of normal cells — total number weighed 350 cells), and the average fecundity (879 larvae per mother lac cell) was higher than in the case of normal cells (807).

To see if genetical factors were responsible for this difference, progeny of abnormal lac cells were raised in two successive generations (on *palas*), but these did not differ from the normal cells.

A research note on the results is in course of publication.

(c) *Isolation of pure yellow strain of the lac insect*

235 yellow lac larvae were propagated on *A. farnesiana*. Only 16 per cent remained yellow after the second moult, which were eaten up by cockroaches. Another lot on the same host turned crimson after the first moult. On *A. lucida* plant, 11 females out of 233 yellow lac larvae propagated remained yellow till sexual maturity. Only 4 reached crop maturity in November 1961.

In the second generation, out of 200 yellow larvae (on *A. lucida*) only 10 reached sexual maturity, of which 8 were females; these were destroyed by chalcid attack.

13. Investigations on the Coloration of Lac Resin

Further experiments (*vide Annual Report*, 1960-61) show that neither wax, nor honeydew nor the insect-body fluid had anything to do with the colour. Furthermore, the coloration of the initially colourless resin is due primarily to heat and not to light or any other factor. A paper incorporating the results is ready for publication.

14. Physiological Studies on the Lac Insect

The work on the artificial rearing of the lac insect was continued. 5-20 per cent solution of glucose, dextrose, vitamin B and yeast in distilled water were tried using rubber and cotton

covered by tissue paper in petri dishes as substrates. Former sustained the larvae for about a month, while on the latter the larvae lived for about 2 months: there was even some secretion of resin and wax.

15. Physiological cum Cytological Studies on the Lac Insect

(a) *Physiological studies*

Histology of the glands was studied, using different fixatives and stains. Lac-resin glands were found to have both uni-nuclear and binuclear condition, the nucleus carrying a deeply staining nucleolus; the cytoplasm was quite dense and granular with one or two vacuoles.

Presence of wax in the lac-resin mass of the equatorial region of the insect was quantitatively estimated to be up to 15 per cent, due presumably to presence of giant wax glands in this region.

(b) *Cytological studies*

Chromosome number was determined, for which both ovarioles and adults of *ranginee* as well as *kusmi* strain were fixed in several fixatives for varying periods (10 mins. to 72 hrs.). A diploid chromosome number of 18 consisting of 8 large, 8 medium and 2 small chromosomes was found in all the different types of cells.

Structure of the living spermatozoon under the phase contrast microscope was also investigated. It was found to be slender, thread-like, ranging in size from 0·42-0·45 mm. The anterior end for a distance of 0·016 mm. was like a cork-screw, with 5-6 twists along the (longitudinal) axis. Chromatin material was arranged in helices along the core of the sperm body. Results have been published in the Current Science.

The spermatids are binucleate, 16 in number, and arranged in the form of a rosette. Connective tissues bind the adjoining rosettes by stout cyst walls. A paper on the Spermiogenesis of lac insect has been sent to the Science Congress Association.

X-ray irradiation of lac cells was also carried out to determine its effect on the chromosome: results are to be reported afterwards.

IIB—REGIONAL FIELD RESEARCH STATIONS

1. Jhalda (West Bengal)

(i) *Investigations on the spurious emergence of lac larvae*

The following mixed and cross-inoculations were tried on *kusum* as before with the object of finding out the causes of untimely early emergence of lac larvae and to isolate such early emerging strain of the insects, if possible.

A — Inoculation with *kusum* (pure strain) brood.

B — Inoculation with *ber* brood.

C — Inoculation with *palas* brood.

D — Mixed inoculation with *ber* and *kusum* broods in equal proportions.

E — Mixed inoculation with *palas* and *kusum* broods in equal proportions.

During the *Jethwi* 1961 season two trees of treatment A and one tree of treatment D (inoculated with early emerged brood of their respective treatments in November 1960) were left for self-inoculation for *Aghani* 1961-62 due to poor survival of brood, but ultimately died.

No early emergence was observed in this season anywhere. The crop showed some heat mortality but was satisfactory on the whole and a brood to yield ratio of 1:2·80 was obtained.

During the *Aghani* 1961-62 season out of a total of 40 trees under the experiment 28 trees were inoculated with *kusum* brood (as *ranginee* brood is not available during this season), 5 trees with the progeny of the mixed *ber* and *kusum* broods, and 7 trees with the progeny of the mixed *palas* and *kusum* broods.

Larval mortality was observed to be 30·27-72·49 per cent on trees inoculated with *kusum* brood, 43·52 per cent on D treatment trees inoculated with the harvested brood of the same treatment, and 36·45 per cent on E treatment trees inoculated with harvested brood of the same treatment. An average male to female ratio of 1 : 4·24 was observed.

As reported last year early larval emergence was observed from 5 trees in October 1961 irrespective of the treatment. However, only one tree of A treatment showed vigorous early emergence necessitating its cropping on 23-10-61.

The regular emergence from *Aghani* 1961-62 was observed on 16-1-1962 and a satisfactory crop was obtained.

Inoculation for *Jethwi* 1962 was done partially by harvested broods and partially by purchased *kusum* brood. Thus one tree was inoculated with the progeny of A treatment brood (from spurious emergence), 4 trees with progeny of mixed *ber* and *kusum* broods and 1 tree with the progeny of mixed *palas* and *kusum* broods, and the rest with *kusum* brood.

Development was satisfactory.

(ii) *Alternative lac hosts for* kusumi *strain*

Trials were continued on *Protium serratum* Engl. (syn. *Bursera serrata*), *Dalbergia latifolia*, *Ficus* sp., *palas* and *ber* with *kusum* brood. The resulting broods were either raised continuously on these hosts or alternated with *kusum* trees to see their performance as *kusmi* hosts and the effect of cross-inoculations.

The results are furnished in Table XIII (App. A).

Ficus sp. showed the best results both in *Jethwi* 1961 and *Aghani* 1961-62.

2. Damoh (Madhya Pradesh)

(i) *Experiments on the pruning of* ghont (*Zizyphus xylopyra*)

The experiment for finding a suitable pruning method for raising *Katki* and *Baisakhi* crops on *ghont* were continued. The experimental details are as follows:

Experiment No. I — Katki *crop*

Treatment

A — Pruning in 1st week of December.
B — Pruning in 2nd week of February.
C — Pruning in 2nd week of May.
D — Pruning in 2nd week of May.

Treatments A and B are exploited every year and treatments C and D in alternate years.

Experiment No. II — Baisakhi *crop*

Treatment

A — Pruning in 2nd week of April.
B — Pruning in 3rd week of May.

The shoot measurement studies and the crop data indicate that A treatment under *Baisakhi* experiment and C treatment under *Katki* experiment showed better response than other corresponding treatments.

Table XIV (App. A) records the results of shoot measurements made at the time of crop inoculation under both the experiments.

The crop data from the two experiments are furnished in Table XV (App. A).

Baisakhi 1961-62 crop was progressing satisfactorily.

(ii) *Determination of optimum amount of brood requirement for* ghont

The results of stick examination of samples collected at the time of *phunki* removal, male emergence and crop maturity and crop data are given in Tables XVI and XVII.

In *Baisakhi* crop normal brood rate is showing the least larval and adult mortality, though brood to yield ratio is higher with half-normal than with normal brood rate.

In *Katki* crop half-normal brood rate is showing the least larval mortality and normal brood rate the highest brood to yield ratio.

Baisakhi 1961-62 crop is progressing satisfactorily.

(iii) *Evolution of a suitable cultivation practice to be followed for* ghont

This experiment has been freshly laid with a view to obtain *ari* lac as well as broodlac.

Under this experiment 500 trees have been divided into 5 coupés. There will be 3 treatments, with 10 trees in each treatment and 10 replications.

Treatment

A — Inoculation in October-November with 125 gm. brood per tree, no harvesting in June-July and complete harvesting in October-November next year.

There will be 2 coupés under this treatment for using in alternate years with 100 trees in each coupé.

B — Inoculation in October-November with 250 gm. brood per tree. Dead lac and excess brood will be removed in June-July and complete harvesting will be done in October-November next year. There will be 2 coupés, with 100 trees in each coupé for using in alternate years.

C — Inoculation in October-November with 600 gm. brood per tree and *ari*-cutting in April. There will be one coupé only under this treatment with 100 trees to be used every year, and cropping in April will also serve as pruning.

Baisakhi 1961-62 crop is progressing satisfactorily.

(iv) *Trials of regional hosts to find out their suitability to fortify lac cultivation on* ghont

Palas, ber, airma (*Acacia* sp.), *renja* (*Acacia leucophloea*), *dhoben* (*Dalbergia paniculata*), and *bansa* (*Albizzia* sp.) were tried for lac cultivation to determine their performance both as brood preserver in the *Baisakhi* season and as crop producer in the *Katki* season. The few available trees of these species found in the experimental field area were inoculated in both the seasons after being duly pruned in time. Regular observations on initial larval mortality, sex-ratio, pest attack and heat mortality were made during the progress of the crop.

Ber showed the best results for brood preservation of all the species under trial. No species is indicative of crop producing.

Baisakhi 1961-62 crop is progressing satisfactorily.

(v) *Introduction of exotic hosts*

Seedlings of *Samanea saman, Albizzia lucida, Ougeinia dalbergioides* and *Moghania macrophylla* have been planted and developing satisfactorily.

3. Mirzapur (Uttar Pradesh)

(i) *Experiment on the pruning of* ghont

This experiment is being conducted on the same lines as at Damoh.

B treatment under *Baisakhi* 1960-61 experiment, A treatment under *Baisakhi* 1961-62 experiment, and B treatment under *Katki* 1961 experiment are showing better pruning response than other corresponding treatments.

Table XVIII (App. A) records the results of shoot measurements made at the time of crop inoculation under both the experiments.

A treatment under *Baisakhi* 1960-61 experiment and B & C treatments under *Katki* 1961 experiment have given better crop than other treatments.

The crop data from the two experiments are furnished in Table XIX (App. A).

Since shoot measurement studies and crop data are indicating different results, no conclusions can be drawn yet.

Baisakhi 1961-62 crop is progressing satisfactorily.

(ii) *Determination of the optimum amount of brood requirement for* ghont, palas *and* ber

The results of stick examination of samples collected at the time of *phunki* removal, male emergence and crop maturity and crop data are given in Tables XX, XXI and XXII (App. A).

In *Baisakhi* crop application of half-normal brood rate is showing the best results though the results of stick examination and crop data are showing slightly different results. In *Katki* crop, however, no conclusions could be drawn since the results of stick examination and crop data are indicating widely different results.

Baisakhi 1961-62 crop is progressing satisfactorily.

(iii) *Evolution of a suitable cultivation practice to be followed for* ghont, palas *and* ber *in the region*

A five-coupé modified experiment has been freshly laid on the same lines as at Damoh.

(iv) *Trials of regional hosts to find out their suitability to fortify lac cultivation on* ghont

Palas, ber, khair, rev, kuchai, ail, sidh, siris, kathmauhli, jigna and *katar* are being tried. They are also being identified for their scientific names.

No conclusions can be drawn as yet.

(v) *Introduction of exotic hosts*

Seedlings of *Moghania macrophylla, Samanea saman* and *Albizzia lucida* are developing satisfactorily which were sown during April 1961.

4. UMARIA (MADHYA PRADESH)

(i) *Evolution of a suitable cultivation practice to be followed for* kusum

This experiment was laid out on 210 trees for trial of the 3 treatments as follows:

Treatment

A — One-year rest between pruning and inoculation, i.e. 2-coupé system. There are 4 coupés under this treatment with 15 trees in each coupé. Two coupés will be used in alternate years for inoculation in January-February, leaving for self-inoculation in June-July and harvesting in January-February next year.

The other two coupés will also be used in alternate years for inoculation in June-July, leaving for self-inoculation in January-February and harvesting in June-July next year.

B — Two-year rest between pruning and inoculation, i.e. 3-coupé system.

There are 6 coupés under this treatment with 15 trees in each coupé.

Three coupés will be used in turn each year as in treatment A.

C — One and half-year rest between pruning and inoculation, i.e. the usual 4 coupé system.

Each coupé will be used as usual for one crop every season, without leaving for self-inoculation.

Harvesting in all the above-mentioned treatments will also serve as pruning.

(ii) *Trials on regional hosts to find out their suitability to fortify lac cultivation on* kusum

Being carried out.

(iii) *Introduction of exotic hosts*

Moghania macrophylla seedlings are developing satisfactorily which were sown in April 1961.

III—PLANTATION AT NAMKUM

General upkeep of the plantation was maintained. Hoeing and weeding were carried out to keep down the weeds.

Large-scale raising of *Moghania macrophylla* seedlings was done by sowing seeds in April and May. Direct sowing of seeds and transplanting of seedlings were done in the previously prepared pits in the month of July for extensive cultivation of lac on this bush and for collection of seeds for distribution to outside parties.

Seedlings of various lac hosts were raised for replacing the dead and diseased ones in the plantation, and for potting for experimental studies in the laboratory.

Periodical spraying of insecticides was continued for extermination of insect pests infesting the plantation.

IV—TRAINING AND ADVISORY SERVICE

Two courses of training in improved methods of lac cultivation were conducted during the year, namely from 1st April to 30th September and from 1st October to 31st March with 11 and 37 trainees respectively.

In all 7 candidates from Uttar Pradesh, 13 from Bihar, 10 from Madhya Pradesh, 4 from Andamans and Nicobar Islands, 5 from West Bengal, 2 from Orissa, 1 from Madras, and 6 from Lac Extension Officer's establishment were trained during the year.

Two short courses of training, each of one month's duration, were organized during the year in June-July and October-November. Two Agricultural Officers from Bombay and 11 Statistical Inspectors and 2 Statistical Assistants from Indian Lac Cess Committee's Statistical Section were trained.

Special lectures in lac cultivation were delivered in the Forest Guard Training Schools at Betla, Mahilong, Kathikund, Koderma and Chaibasa.

CHEMISTRY DIVISION

I—GRADING AND ANALYSIS

1. Bleach Index/Bleachability

As reported already (*vide Annual Report* for the year 1960-61), the International Standards Organization Technical Committee on Lac had recommended a fresh set of round robin tests for bleachability by the Indian method, modified by using a photoelectric colorimeter side by side with the method of United States Shellac Importers Association (U.S.S.I.A.). As a preliminary, the Committee also recommended that the photoelectric method might be modified to incorporate a method for calibration of the colorimeter. This was done during the year under report.

The colorimeter (a Klett Sumerson colorimeter, model 900·3, with a green filter Ks-54, approx. spectral range 500-520 μ) was calibrated as follows. The initial null point was adjusted with distilled water. Readings were taken using iodine solutions of concentrations ranging from 0·005*N* to 0·00016*N*. A graph drawn on semilog scale, plotting these readings against the bleach index equivalent of the iodine solutions formed the standard graph for determination of bleach index (*vide* Table I, App. B). The calibration was repeated several times; the results were found to be reproducible.

In order to verify experimentally the reproducibility of the results of bleachability determination by this modified method, ten samples from different regions, two belonging to each grade, were taken and five determinations carried out on each in duplicate (*vide* Table II, App. B). Statistical analysis of the results showed that there was a high degree of reproducibility.

Use of centrifuge for dewaxing — The above method requires removal of the suspended wax from the bleached solution before colour could be determined by visual or photoelectric colorimeter. Filtration is employed for this purpose which sometimes becomes time consuming. Experiments were, therefore, carried out to see if filtration could not be substituted by centrifuging. The results indicated that there was little separation of the wax, even after 30 minutes at 3500 r.p.m.

2. Specifications for Refuse Lac

A number of commercial samples of *molamma, kiri* and *passewa* were obtained and analysed for moisture, water-solubles, cold alcohol-solubles and rosin. On the basis of these results and some data kindly supplied by M/s. R. V. Briggs & Co., a draft specification for refuse lac, together with methods of analysis, were prepared and sent to the Indian Standards Institution. This is now under study by members of the appropriate Technical Committee.

3. Alternative Method for Determination of Moisture

Determination of volatile matter (Moisture) of lac samples was attempted by merely drying the samples in a sulphuric acid desiccator without vacuum. The data obtained from 20 samples (reproduced in Table III, App. B) showed that without vacuum, other details remaining the same, the values of moisture per cent was, on an average, 0·2 lower than when vacuum was used. The results were reproducible.

4. Correlation of Quality of Lac Especially Colour with Climatic Conditions of Area of Cultivation

Lac grown in humid areas were reported to be frequently darker than that grown in drier areas on the same hosts. In view of the importance of this observation, authentic samples of sticklac grown in different areas were procured and converted into seedlac and shellac. The seedlacs were examined for impurities, bleach and colour index and the shellacs

for colour index, life and flow. Yields at different stages as well as the driage in the sticklac were also recorded. Results were given in the *Annual Report*, 1960-61.

During the year, only 7 more samples could be procured and analysed. The results are given in Table IV (App. B). No conclusion can be drawn yet. More data for a few more seasons are necessary.

II — IMPROVEMENTS IN THE MANUFACTURE OF SEEDLAC, SHELLAC, BLEACHED LAC, ETC.

1. Improved Method of Lac Washing (with Potassium permanganate, etc.)

The use of potassium permanganate as a ' washing aid ' for washing of sticklac into seedlac and the optimum quantities and conditions have been already described in the previous *Annual Report*, 1960-61.

Further experiments conducted on the yields of seedlac obtained by the two processes, viz. the permanganate method and the conventional soda method, showed that the yield of seedlac by the former is 5-6 per cent higher.

Storage stability of permanganate washed lac

Three samples each of seedlac produced by permanganate and soda washing, and samples of shellac prepared from these were stored under laboratory conditions of humidity and temperature. Analytical data of these samples after 14 months' storage are brought out in Table V (App. B).

Storage stability of permanganate washed seedlac and shellac produced from it are of the same standard as those of seedlac and shellac obtained by soda wash method.

2. Preparation of Shellac from Seedlac and Refuse Lac by Alkali Extraction

Preliminary experiments on the production of shellac from seedlac by alkali extraction with aqueous sodium carbonate and sodium sulphite have been described in the previous *Annual Report*, 1960-61.

The product obtained by the alkali extraction method had a higher colour index than, and a different hue from, ordinary shellac. This method would obviously be an advantage over the conventional *Bhatta* method, if these two shortcomings were overcome.

Use of a mixture of sodium carbonate and sodium sulphite for the extraction, gave a lac whose hue was very nearly the same as that of ordinary *bhatta* shellac; the colour index however was slightly higher. Boric acid, oxalic acid, tartaric acid, citric acid and sodium hydrosulphite were tried to improve colour index and hue. Use of oxalic and citric acid resulted in a shellac whose colour index was about 5-6 units higher than that of *bhatta* shellac produced from the same seedlac.

With sodium hydrosulphite along with sodium carbonate and sodium sulphite, the shellac obtained had colour index and hue very nearly similar to those of *bhatta* shellac. The optimum amount of sodium hydrosulphite required, depended upon the bleach index of the seedlac, being 1 per cent (on the weight of seedlac) if the bleach index is lower than 100 and 2 per cent, if higher. The process as finally standardized is described below:

Seven parts of sodium carbonate and 3 parts of sodium sulphite were dissolved in 400 parts of water and 100 parts of lac added slowly. The solution is heated to boiling temperature and kept gently boiling for half an hour. The extract is then strained through cloth to free it from insolubles. When the extract cools to 40°C., it is treated with the requisite amount of sodium hydrosulphite and allowed to stand for 15-20 minutes. The solution is then diluted with water to 5 per cent lac content, cooled to below 25°C., and acidified under

vigorous stirring with a spray of 5 per cent sulphuric acid. After complete precipitation, 5 parts of common salt are added to the mother liquor to hasten settling of the precipitate. The precipitate is washed with cold water till free from mineral salts and acid.

It is then suspended in water, and heated to boiling temperature. The molten mass of lac is removed from the hot water, heated in a steam-heated pan to remove moisture and made into sheets by squeezing between cold rollers. 5 kg. batches have been processed in this way and the analytical data of the resulting products are set out in Table VI (App. B).

Shellac produced by this process has a colour index 2-3 units higher than *bhatta* shellac obtained from same seedlac. When the starting material is *molamma* or *kunhi*, the colour of shellacs produced are practically identical. As a process for reclaiming lac from refuse lac such as *molamma, kunhi*, etc., this process is thus very satisfactory.

Storage stability of shellac obtained by alkali extraction process

No change in quality of shellac under storage for 6 months has been observed. The work is being continued.

Film properties of shellac obtained by the new process — alkali method

Shellac made by this process contains sulphur, the quantity varying from 1·05 to 1·25 per cent. As this is likely to have some influence on the film properties, they are being examined.

3. Bleaching of Lac

(a) *Pilot-plant for the manufacture of bleached lac*

The units of the pilot bleaching plant were erected and the plant operated for a few batches. The following observations have been made:

(i) *Dissolution tank* — Rated capacity of the tank is to digest at about 90°C., 45 kg. of seedlac in 180 litres of aqueous soda solution containing 4·5 kg. of soda. The digestion of 45 kg. of seedlac under stirring is completed in 45 minutes.

(ii) *Rotary filter* — The Rotary Filter fabricated in the Institute Workshop takes about 30 minutes to filter the seedlac digest from insolubles.

(iii) *Cooler* — The lac solution coming out of the filter (225 litres) at a temperature of 80°C., was cooled down to about 40°C. before pumping it to the bleaching tank.

(iv) *Bleaching and precipitation tank* — Works satisfactorily.

(v) *Drum-washer* — This is a cylindrical frame lined with drill cloth which serves as the filtering medium, with arrangement for internal spray of water for washing. A 45 kg. batch took about one hour to be washed free from mineral acid. About 1800 litres of water was required for the purpose.

(vi) *Centrifuge* — The centrifuge (with detachable 50 cm. basket) was found to handle the whole of the washed bleached lac in about four batches, each batch taking 30 minutes for the complete operation. The centrifuged product was found to have a moisture content of 60-70 per cent on the weight of dry material.

(vii) *Dryer* — The shelf dryer has 16 trays (60 × 90 cm.) and each tray can hold 2·5 kg. of bleached lac on dry-basis spread in a layer 2 cm. high. The time taken for drying was about 18 hours at 40 ± 2°C. when the humidity in the air was not high, during winter and summer months.

Bleached lac has a slight tendency to form lumps when in the wet state and requires a few periodical rakings during the early stages of drying.

(viii) *Hypochlorite plant* — The present set of experiments in the bleaching plant was carried out with the bleach liquor prepared by chlorination of cold caustic soda solution in glass carboys.

The quality of the bleached lacs produced in the pilot unit *vis-à-vis* that from our small laboratory unit are given below:

	Pilot-plant	*Laboratory unit*
Yield percentage	85-88	85-90
Acid value	74-77	72-75
Colour index	0·3-0·4	0·3-0·4
Keeping quality	Under examination	Keeps well for 9-12 months

(b) *Laboratory studies in bleached lac*

(i) In order to ascertain the relationship, if any, between the keeping quality of bleached lac and the grade of the parent seedlac, seedlacs belonging to the four recognized grades were bleached under the standard conditions using appropriate quantities of bleach liquor. The keeping qualities and other properties of the resultant bleached lacs are set out in Table VII (App. B).

All the bleached lacs have kept well so far (after 8 months' storage).

(ii) *Paler bleached lac* — Bleached lac prepared by using appropriate quantity of bleach liquor, as determined by Institute method, has a colour index of 0·3-0·4. In order to see what further improvement in colour could be brought about without effecting keeping quality, bleaching was done with different excess percentage of bleach. Results are recorded in Table VIII (App. B).

The colour could be brought down to 0·2 (as against 0·33 of bleached lac under standard conditions) by using 50 per cent excess bleach liquor. This is, however, accompanied by lowering in yield and increase in acid value.

There is hardly any change in insoluble as tested after 8 months when bleach was used up to 30 per cent excess. Beyond that, however, the keeping quality is badly affected.

(iii) *Preparation of refined bleached lac* — Mention was made in last year's *Annual Report* of the development of a process for the preparation of dewaxed or refined bleached lac using white spirit. Optimum conditions for the process have now been determined.

These are:

(a) Amount of white spirit ... 10 per cent on wt. of seedlac
(b) Temperature of mixing ... 90 ± 1°C.
(c) Period of mixing ... 20 minutes

The properties of dewaxed bleached lac obtained by the process have been compared with that obtained by conventional cloth-bag filtration method and are brought out in Table IX (App. B).

The results show that the properties of the dewaxed bleached lac obtained by the white-spirit extraction method are in every way comparable to those obtained by conventional cloth-bag filtration method. The yield obtained is somewhat higher, thus offering a distinct advantage. Incidentally the method is quicker and better suited to large-scale production as it requires less floor-space.

(iv) *Stabilizers for bleached lac* — Lead-thiosulphate, when used as a stabilizer, brings about definite improvement in ' life under heat ' of bleached lac without any deteriorating effect in the desirable film properties such as hardness, elasticity and water-resistance of the resultant bleached lac films (*Annual Report*, 1960-61). The optimum quantity of the stabilizer has now been determined and the keeping quality of the stabilized bleached lac investigated under normal and accelerated conditions of storage as laid down in Tables X and XI (App. B).

(v) *Chemistry of bleaching* — The action of bleach liquor (sodium hypochlorite) on lac and the chemical changes brought about during the bleaching process have been studied (*Annual Report*, 1957-58). Aleuritic acid is one of the chief constituent acids of lac and is present to the extent of 43 per cent in it. The study of the action of bleach on this acid, under conditions identical with those of bleaching of lac was carried out.

The findings are recorded in Table XII (App. B). A small percentage of chlorine was found in the acid obtained after treatment with a corresponding drop in the hydroxyl value. To see whether chlorine enters at the vicinal or end OH, percentage of vicinal OH both in the parent and treated products was estimated making use of periodic acid. Vicinal hydroxyl groups remain unaffected. It appears that chlorine has replaced the end OH. The m.p. of the treated product was slightly lower than that of parent acid. A loss of 10 per cent during the reaction was noted. The aqueous mother liquor formed a dinitrophenylhydrazone showing presence of aldehydic group.

Further work is in progress.

(c) *Rapid method of bleaching of lac*

In the usual method of bleaching lac, a soda extract of lac is treated with the requisite amount of bleaching liquor (sodium hypochlorite) in the course of several hours. The resulting bleached lac although satisfactory in respect of colour, has its other desirable properties, such as life and flow, adversely affected. This, as has been found, is due to the fact that during the bleaching operation, a certain amount of chlorine invariably enters the resin molecule. Entry of chlorine in the lac molecule is assisted by the fact that lac is held in solution along with the bleaching agent throughout the bleaching operation, that is, for a considerable period. If, however, the lac is bleached while in fine suspension and not in solution form, the chances of chlorination are likely to be reduced: if further, the time of bleaching is reduced, the chances of chlorination will be correspondingly reduced.

If common salt is added to a soda solution of lac, a fine dispersion of the sodium salt of lac is produced. If bleach liquor is added to this suspension the bleaching is completed with 50-60 per cent of the quantity of bleach liquor required for the conventional bleaching method. If the soda solution of lac is added to a mixture of the bleach liquor and salt solution under efficient stirring, bleaching is complete within 2-3 hours. As usual bleached lac is recovered by decomposing the suspension with dilute sulphuric acid. The yield (85-90%) is of the same order as by the conventional method.

Various seedlacs of different bleach indices have been bleached by this method. The colour indices of the products varied from 0·33 to 0·52. The products are free-flowing fine powders and have a lower acid value and chlorine content than bleached lac produced by the current method. Alcohol solubility of the bleached lac by this method has been found not to have changed over a period of 8 months' storage. The properties of the products are given in Table XIII (App. B).

III — FUNDAMENTAL RESEARCHES

1. Constitution Studies — Separation and Study of the Components of Fraction V

The separation of lac into five fractions by temperature phase separation from acetone solution has already been described in the previous *Annual Report*, 1960-61. Fractions I to IV are being studied at Delhi University, Bose Institute, Calcutta; Department of Chemical Technology, Bombay and National Chemical Laboratory, Poona.

Fraction V has been under detailed study in the Institute since the later half of last year. The study was continued during the year under report.

(a) *Physical and chemical properties*

Some of the physical and chemical properties were recorded in Table XII (App. B) of the previous *Annual Report*, 1960-61. Solubility, molecular weight and iodine value were determnied during this year and are set out in Table XIV (App. B).

(b) *Further fractionation*

(i) *By ether* — Fraction V is not completely soluble in ether, about 88 per cent was extracted when the material (mixed with silver sand) was soxhleted with this solvent. About 33 per cent of the extract gradually separated out of the extract as the soxhleting proceeded indicating that even at that low temperature (boiling temperature of ether) some chemical change was taking place.

The ether-soluble portion was, therefore, separated in an indirect way without any heating by dissolving the fraction (1 part) in acetone (1 part) and precipitating the solutions with ether (10 parts). 80 per cent of the material was retained in the ether solution, the remaining 20 per cent separating as an insoluble mass.

The ether solution was further separated by successive extraction with dilute sodium bicarbonate and dilute caustic soda. The extracted materials were recovered by precipitating with dilute acid. The residue left over in the ether was also recovered by drying the solution and evaporating off the ether. The fractions obtained and their physical and chemical properties are recorded in Table XV (App. B).

This is the first time that the presence of a non-acidic fraction (A.V. 3-4) has been recorded in lac. The work is being continued.

(ii) *By other solvents* — Fraction V (1 part) was mixed with silver sand (25 parts) and soxhleted successively with petroleum ether, benzene, ethyl acetate, acetone and alcohol. The yield of the various fractions obtained and their physical and chemical properties are given in Table XVI (App. B). Paper chromatogram of the products of hydrolysis of these fractions were all found to be alike.

The amount of aleuritic acid and aldehydic acid present in each fraction were estimated by the conventional methods (*vide* Table XVI, App. B). All the fractions contained very nearly the same amount of both these acids.

Further work is in progress.

2. Thermal Polymerization of Shellac

(a) Determinations of hydroxyl, carbonyl, vicinal hydroxyl, periodic value, iodine and acetal values of shellac polymer samples heat-polymerized at various temperatures have been reported already in the previous *Annual Report*, 1960-61. The estimation of acyloin group was attempted during the year under report since the existence of this group had been reported in shellac by earlier workers. For the estimation Rigby's method [Rigby W., *J. Chem. Soc.* (1951), 793], was adopted. The method was first standardized with pure benzoin. Then several samples of lac were examined; none gave any indication of the presence of acyloin group. The estimation of acyloin groups in the polymers of shellac was, therefore, considered not necessary. The work has been completed and from the data, energy of activation, kinetics of reactions have been calculated.

(b) Activation energies of heat-polymerized *kusum* and dewaxed decolorized lacs have been determined by the gel point method [Gough, L. & Smith, L. T., *J. Appl. Polym. Sci.*, **3(9)** (1960), 362]. The values have been found to be 10·85 and 12·01 k.cal/mole respectively. The values for mixtures of urea and hexa-methylenetetramine with shellac have been found to be higher than that for shellac alone, thus providing evidence for a reaction between shellac and these compounds. [Bhattacharya, P. R., *J. sci. industr. Res.*, **20B**, No. 11 (1961), 549].

(c) *Differential thermal studies*

In order to know the structural changes occurring in shellac during thermal treatment, the technique of differential thermal analysis is being adopted. The equipment assembly is in progress.

IV—UTILIZATION OF LAC

1.(a) SHELLAC WASH PRIMER (SINGLE-PACK SYSTEM)

The formulation and testing of shellac-based wash primers suitable for use on light metal surfaces were reported in the *Annual Report*, 1960-61. The study was continued and steps taken to popularize the material among potential consumers.

(i) *Modification of the primer* — It had already been reported that the Primer modified with 3 per cent urea and 10 per cent dibutyl phthalate had proved to be the most satisfactory. Further modifications were carried out to improve the properties still further, particularly in regard to flexibility. Spirit-soluble plasticizers like saponified lac, phenol and cresols were examined. Scratch hardness, elasticity and corrosion resistance of films of compositions containing 25, 50 and 75 per cent saponified lac in replacement of lac, and phenol and cresol up to 30 per cent on lac in place of urea and dibutyl phthalate were studied. The results are given in Table XVII (App. B). These modifications were not superior to the primer containing 3 per cent urea and 10 per cent dibutyl phthalate in regard to scratch hardness or elasticity and were definitely inferior in respect of corrosion resistance.

(ii) *Natural and dynamic weathering* — A few aluminium panels coated with shellac wash primer and finished with oil enamel and nitrocellulose lacquor, was subjected to dynamic weathering by fixing on the body of the Institute's jeep car. After 18 months during which the jeep car was in continuous service, there was no sign of any deterioration of adhesion of the finishing coat tot he primer or of the primer to the metal. A few aluminium panels and a part of a Railway coach was coated with shellac wash primer with and without modification with urea and dibutyl phthalate (*Annual Report*, 1960-61). These were painted over with the same paints and under same conditions as were used in the Railways. The panels were subjected to natural weathering on the roof of our laboratory, and dynamic weathering in the Institute's jeep car. After 15 months' exposure so far, no deterioration of any sort in the panels fixed to the jeep car has been found. In the panels exposed for natural weathering also there is no loss of adhesion between the primer and metal or between the primer and the finishing coats. In that part of the panel, however, where a final varnish coat had been applied there is a flaking off of the enamel along with the varnish coat. But even there the primer and its immediate top coat are in perfect position over the metal substrate.

The Railway coach on parts of which shellac wash primer had been used, was also examined after one year of its service. No deterioration whatsoever was observed. The painted area was in exactly in the same condition as the rest of the surface where a commercial two-pack primer had been used.

(iii) *Pigment settlement* — The only defect mentioned by the Hindusthan Air Craft Factory about an earlier composition was the fact that after storage for one year the pigment settled, could not be redispersed by the usual means. Although later compositions have been stored for several months without this difficulty being experienced, it was considered desirable to examine the effect of incorporation of other anti-settling agents. The use of known amounts of shellac wax for this purpose and the storage of such compositions had been described in the previous *Annual Report*, 1960-61. These primers were examined after one year's storage. It was observed that in primers containing up to 3 per cent of wax (on lac content) there

was settlement of pigment as usual but this could be easily redispersed without any difficulty by merely stirring with a glass rod. In the case of primers containing 4 and 5 per cent wax there was no settlement of pigment at all. However, there was a slight thickening in all the cases and the film properties were not entirely satisfactory. Other anti-settling agents such as aerosil are being investigated.

(iv) *Manufacture* — Laboratory tests and service trials having been found entirely satisfactory steps were taken to popularize the material among potential consumers. Circular letters were issued both from this Institute as well as by the Ministry of Agriculture, about this primer to large-scale potential consumers, offering free samples for service trials. As a result, several requests for small and bulk samples were received from State Road Transport Companies, Public Shipping Organizations, Railways and other Private Organizations. As the total demand exceeded 100 gallons, approach was made to a leading paint manufacturing concern, viz. the Shalimar Paint, Colour & Varnish Co.(P), Ltd., Calcutta for assistance. Their cooperation was readily forthcoming and a 100 gallon batch was successfully manufactured in their factory. The company have taken up commercial production of this shellac-based single-pack etch primer in place of one of their established product.

Our grateful thanks are due to M/s. Shalimar Paint, Colour & Varnish Co.(P), Ltd. for the valuable co-operation extended to us in the form of advice, staff and equipment.

(Details and results of service trials by consumers are described under Section VII, Page 30).

(v) *Test House Report* — Government Test House, Alipore, Calcutta report reads that " the tested characteristics of the sample are considered to be satisfactory for a primer ".

The report is reproduced in Appendix C.

1.(b) Shellac Wash Primer as an Anti-corrosive Primer for Steel

The investigation of shellac wash primer has so far been restricted to its use chiefly on light metals and their alloys. As extension of the use of the primer to steel would considerably extend its consumption potential, this aspect was investigated.

The adhesion of the primer film to mild steel (applied by brush or spray) was found to be quite satisfactory — scratch hardness over a 1 mm. steel ball being over 2·0 kg.

Corrosion resistance requirement was next investigated. Mild steel panels $6'' \times 4''$ were first polished ' mirror bright ' and wiped clean with a solvent mixture of equal parts of solvent naphtha and xylene to remove rust, oil, dust, etc. The panels were then again sprayed over with the above solvent mixture, six times, three times each side for further cleaning, cf. (ASTM D 609-52). These were allowed to dry at room temperature, rubbed with lintless cloth to remove adhering dirt dipped in methyl alcohol and dried at about 75°C. They were cooled to room temperature and the wash primer compositions applied by spraying. The sprayed panels were air-dried for 24 hours and then the edges were sealed to a depth of about 1·5 cm. by dipping in molten paraffin wax. The panels so prepared were exposed in a humidity cabinet (42-48-42°C. one hour cycle). Several compositions were tried such as those modified with urea and dibutyl phthalate, penol, cresol and saponified lac. Side by side, the water-resistance of the resulting films were also investigated by keeping another set of panels immersed in distilled water at 37 ± 1°C. for 15 days (ASTM D 870·54). The results are given in Table XVII (App. B). Rust spots started developing on the third day of exposure in all the panels having the usual compositions and those modified with phenol, cresol, saponified lac, etc. In the case of the composition containing the pigment washed once with boiling water, no rust spots were visible even after fifteen days. Apparently the washing had removed from the pigment the factors responsible for rusting.

Experiments are being continued to standardize the washing operation and to ascertain the nature of the components removed which result in their improved performance.

2. Hydrolysed Lac

Optimum condition for the saponification of lac and the separation of water-insoluble and soluble portions of the resulting product have already been described (*Annual Report*, 1959-60). The former, popularly known as ' hydrolysed lac ' has been recommended for use as plasticizer for lac and has also been modified principally with ethylene glycol to produce materials of high elasticity and flexibility.

Thermal curing of (water-insoluble) hydrolysed lac and behaviour of chemicals as accelerators or retarders for the same had been studied and reported (*Annual Report*, 1960-61). The cured product, without or with small amounts of accelerators, were tacky, elastic and rubbery masses. With larger amount of accelerators, brittle products were obtained.

' Water-soluble ' hydrolysed lac, on the other hand, would not cure at all on continued heating but became thicker and harder. The hardened material was brittle and somewhat hygroscopic but easily and completely soluble in alcohol.

3. Reconstituted Shellac

The effect of heat on a mixture of ' water-soluble ' and insoluble hydrolysed lacs in the appropriate proportions has been investigated. A hard brittle material was obtained which was initially soluble in alcohol but later gradually became insoluble with progressive heating (cf. shellac).

As the product appeared promising and as separation of the water-soluble from the insoluble is unnecessary for this purpose, the procedure for hydrolysis was slightly modified so as to obtain a mixture of the two without losing any portion during the operation.

Shellac (500 parts) was first heated under reflux with caustic soda (125 parts dissolved in 200 parts of water) as usual for 6 hours. The mass was then dissolved in water (200 parts) and precipitated with the calculated amount of 10 per cent sulphuric acid for exact neutralization of the alkali used. The resulting mass was evaporated and finally dried by heating to about 120°C. The product so obtained contained the water-insoluble and soluble portions of hydrolysed lac and also the sodium sulphate formed.

This total hydrolysed lac was heated in an oil-bath at different temperatures and the acid values determined at the interval of half an hour. Results are given in Table XVIII (App. B). It was observed that at all temperatures the acid value (after allowing for sodium sulphate content) dropped from 238 to nearly 108 at which stage the mass showed a tendency to gel. The time taken to reach this stage would depend upon the temperature. At 150°C. it took about 5 hours. The gelled material was brittle and could easily be powdered.

For preparing an aqueous varnish, the powdered material was gradually added to excess of water under stirring and the sodium sulphate thereby dissolved out. After one or two more washings with changes of water, the material was dissolved in aqueous ammonia to produce a 20 per cent solution.

To prepare a spirit varnish, the powdered material was dissolved in (rectified or methylated) spirit in which it dissolved slowly on gently heating.

The solution was clear when hot but became cloudy on cooling. The cloudiness, however, disappeared with the addition of a small amount of toluene. For the spirit varnish, therefore, the resin (1 part) was dissolved in (4 parts of) a mixture of alcohol and toluene in the ratio of 2:1. The sodium sulphate settled down and could be filtered off.

Film properties of reconstituted shellac — Films were prepared from both aqueous and spirit solutions on glass and tin panels by flowing and allowing to drain in an almost vertical position. Some of the films were examined after air-drying for 7 days, and others after

baking at 100°C. for one hour and at 150°C. for 15 minutes respectively (*vide* Table XIX, App. B).

It was observed that although the gloss was only moderate and blush-resistance not of a high order, the films had outstanding hardness, adhesion and unusual flexibility. In view of these very promising results, the process is being patented.

Further work is being continued to reduce the acid value of the product by carrying out the processing at lower temperatures with or without catalysts. Incorporation of limited amounts of phenol formaldehyde and urea or melamine resins are also proposed to be examined for improving gloss, and weather and blush-resistance.

4. Plasticizer for Aqueous Shellac Varnish

Water based finishes, especially of the baking type, are becoming increasingly popular of late in view of their obvious advantages over organic solvent based finishes and especially because of complete safety from fire hazards. The use of shellac varnish in aqueous medium is well known and of the various alkalies used to dissolve lac, ammonia is particularly attractive because of its practically complete removal when the films are baked, leaving the films more heat and water-resistant. Such films, however, made directly from shellac and aqueous ammonia or by dissolving ' water-soluble ' lac in water, are very brittle.

Plasticizers are necessary to improve adhesion and elasticity.

Plasticizer for aqueous shellac have been studied before (*vide London Shellac Res. Bureau. Tech.*, Paper No. 24) and *p*-toluene sulphonamide was found to be generally the best. Shellac-based plasticizers have not been studied.

Ethylene glycol ether of shellac (*London Shellac Res. Bur. Tech.*, Paper No. 17) is a highly flexible balsam like material with sufficient acidity to dissolve in aqueous ammonia forming a clear solution. The plasticizing effect of this for aqueous shellac varnishes *vis-à-vis* *p*-toluene sulphonamide was therefore investigated.

Optimum proportion of lac to lac ethylene glycol ether

20 per cent solution of lac and 2 per cent solution of lac ethylene glycol ether were prepared by dissolving the resin and the ether in water containing 10 per cent liquor ammonia. Varnishes were prepared by mixing these two solutions in ratios of 1:0·5, 1:1 and 1:2. Films were prepared on glass and tin panels and baked at 100°C. for one hour. Hardness, elasticity and blush-resistance (*vide* Table XX, App. B) showed that 1:1 is the optimum proportion. Even in this case gentle blush had developed on continued immersion in water for 24 hours.

In order to see whether even this blush could be eliminated, the affect of limited amount of urea was investigated. It was found (*see* Table XXI, App. B) that 1·5 per cent urea was the most satisfactory, no blush being visible up to 24 hours.

Further work is being continued.

5. Shellac Composition for Hydraulic Models

The Central Water & Power Research Station required, for use as bed materials in hydraulic models, samples of lac in the form of free-flowing particles of uniform specific gravity, unaffected by continuous or periodic immersion in water. For this purpose T. N. Shellac, garnet lac and seedlac, both alone, as well as hot rolled with fillers like barytes and crushed to appropriate particle size, were tried but were found to swell too much under water and to promote fungus growth. Modification with urea reduced swelling to well within limits and paraformaldehyde prevented fungus growth (*vide Annual Report*). Modified samples with coal-dust as the filler were sent, on request, to the Central Water & Power Research Station, for further tests. It has now been reported that these samples are satisfactory and an order has been received for about 1·5 tonnes of the materials for service trials. This is being arranged.

6. Modification of Shellac with Phenols

Phenol has been used with shellac to impart hardness, toughness and better moulding characteristics to the resin to produce improved insulating compound U.S. Patent No. 5730, 1890. Phenol was also reported to impart outstanding toughness, and flexibility to shellac films even when incorporated in the cold into shellac spirit varnish (Shellac Export Promotion Council). Experiments were, therefore, undertaken to determine the optimum quantity and conditions for incorporation of phenol into shellac. Shellac varnishes (25 per cent non-volatiles) were prepared incorporating 12·5, 25, 37·5 and 50 per cent (on the weight of lac) of phenol, *m*-cresol, *p*-cresol and cresylic acid. Three sets of films were made on glass slids and tin panels. One set was left to air-dry for seven days. Second and third sets were baked at 100°C. for 1 hour and 160°C. for 7½ minutes respectively. Scratch hardness, flexibility, blush-resistance and heat-resistance of these were then determined. The results are given in Tables XXII, XXIII, XXIV and XXV (App. B).

Scratch hardness (*vide* Table XXII) — While there is not any improvement in scratch hardness of air-dried films (except in the case of *p*-cresol), baking does improve this property considerably of the films on tin panels. On glass, however, the improvement is not appreciable.

Blush-resistance (vide Table XXIII, App. B) — Blush-resistance on immersion in water, is not improved by addition of phenols. It has an adverse effect as far as air-dried films are concerned. In regard to baked films, there is apparently no noticeable change (except for a slight decrease in adhesion on glass).

Flexibility and adhesion (*vide* Table XXIV, App. B) — The flexibility and adhesion of shellac films improve with increasing amounts of the phenols. In this respect also, baked films are superior.

Heat-resistance (*vide* Table XXV, App. B)—The heat-resistance of the films on wooden panels were determined by placing a beaker containing hot water at 60°, 62°, 64°, 66°, 68°, and 70°C. on the panels for 5 minutes and seeing the extent of sticking.

There was only a slight improvement in heat-resistance with increasing amounts of the phenols.

Thermal properties — The life under heat of lac with various amounts of the phenols (Graph I) as well as the softening and melting points (Graph II) of lac containing different amounts of these phenols incorporated by melting together were investigated. 'Life' increased and melting and softening points decreased with progressive increase in the amount of the phenols. Lac and phenol blends were held together in the molten condition at 150°C. for 80 per cent of the life for the respective proportions.

Melting and softening points of the resulting resins were then determined (Graph III). The melting and softening points again decreased with increasing amount of the phenols.

All the above results (except perhaps the slight improvement in heat-resistance) indicate that phenols incorporated into shellac, either by mixing in the cold or by heating together, behave more or less like solvents/plasticizers added to the lac. The absence of any sharp bend in the graphs II and III provides additional support to the above view.

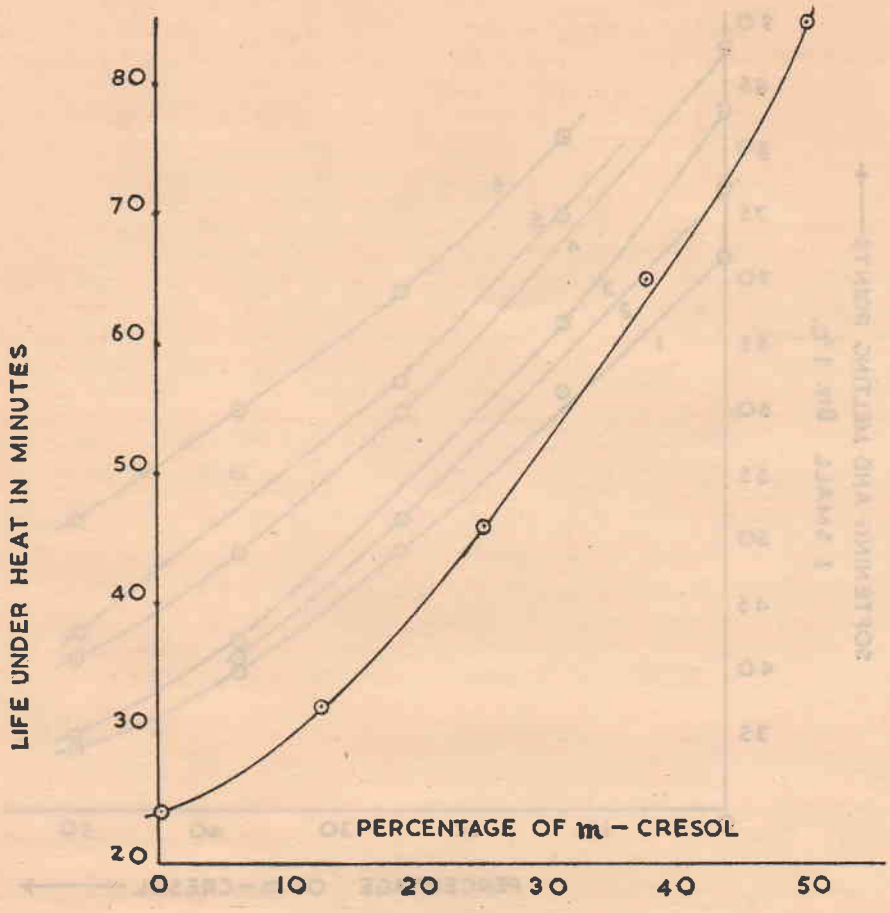
(*See* graps on pages 25, 26 and 27)

The possibility of imparting substantial improvement in respect of blush- and heat-resistance by treating shellac and phenols with formaldehyde *in situ* by adding phenol formaldehyde, urea formaldehyde or other resins to shellac varnishes is being investigated.

7. Shellac Spirit Varnish

Improving heat- and blush-resistance

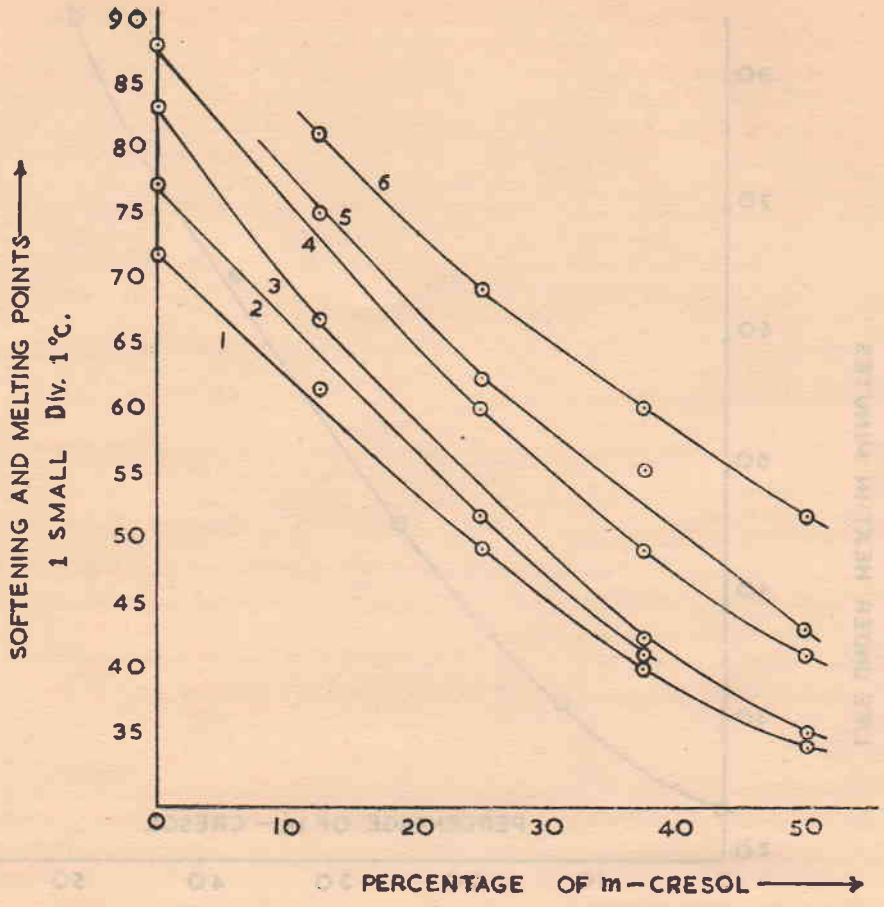
The formulation of a shellac varnish with improved heat- and blush-resistance by incorporation of 3 per cent urea and 10-30 per cent plasticizers and film properties of such composition *vis-à-vis* those of a shellac urea sulphite varnish developed by the Shellac



GRAPH I — LIFE UNDER HEAT

Export Promotion Council (S.E.P.C.) were described in detail in the previous *I.L.R.I. Annual Report*, 1960-61.

The incorporation of 3 per cent urea and 10 per cent dibutyl phthalate (on the weight of lac) produced shellac varnishes which had the same heat- and blush-resistance as shellac urea sulphite varnishes but had better elasticity. The effect of plasticizers on shellac urea sulphite varnishes was therefore investigated. For this purpose one sample of shellac urea sulphite resin was procured from the S.E.P.C. and another sample prepared in the laboratory. Different proportions of the various plasticizers like dibutyl phthalate, tricresyl phosphate, etc., were dissolved in shellac urea and shellac urea sulphite varnishes. Films were made on tin and glass panels and tested after seven days air-drying for scratch hardness, flexibility and blush-resistance. The results are given in Table XXVI (App. B). Shellac urea sulphite varnishes of both I.L.R.I. and S.E.P.C. manufacture and shellac urea dibutyl phthalate varnish all have almost the same scratch hardness. With plasticizers such as dibutyl phthalate and, sextol phthalate this property is only slightly better (0·50-0·55 kg.). Other plasticizers are not good. Regarding blush-resistance shellac urea sulphite varnish with tricresyl phosphate and shellac varnish with urea dibutyl phthalate, and sextol phthalate showed no blush after 24 hours' immersion. Regarding flexibility, it is seen that urea sulphite varnish does not improve much with various plasticizers unless substantial quantities are used in which case blush-resistance is adversely affected.

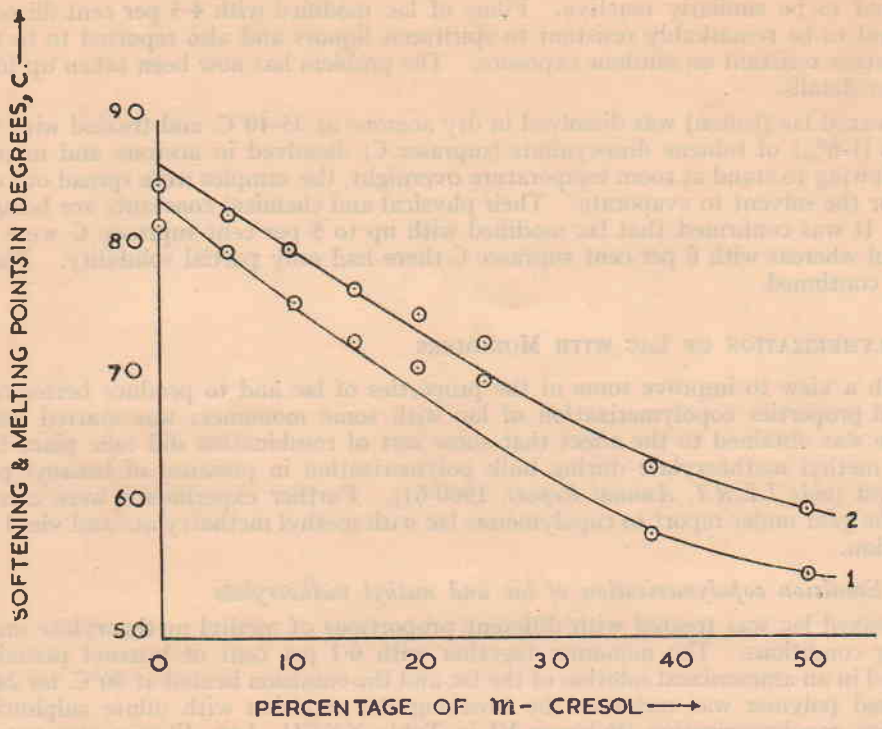


GRAPH II — SOFTENING AND MELTING POINTS

(1. Softening point after 10 mins. heating. 2. Melting point after 10 mins. heating. 3. Softening point after 20 mins. heating. 4. Melting point after 20 mins. heating. 5. Softening point after 30 mins. heating. 6. Melting point after 30 mins. heating)

8. LAC-OIL INSULATING VARNISHES

Lac-oil varnishes have been the subject of considerable research. The products generally do not have the expected combination of desirable properties of shellac and the drying oil. Films produced are soft, dull and somewhat tacky. One of the uses in which appearance is not of prime consequence is as baking type of clear oil insulating varnishes or impregnating varnishes for manufacture of varnished cloth, etc. Shellac-based clear baking oil insulating varnishes have been attempted before and one composition, based on lac-resin-glycerine ester and linseed stand oil was reported as meeting the specifications of the B.S.I., for the product. In actual use, however, the product was found to have one defect, it was not 'through' drying. Incorporation of China wood oil eliminates this defect, but the material becomes expensive. Alternative compositions were therefore investigated. The most promising compositions described in patent literature for the purpose is based on shellac, drying oils, glycerine and phthalic anhydride.



GRAPH III — SOFTENING AND MELTING POINTS (AFTER HEATING AT 150°C. FOR 80% OF TIME OF POLYMERIZATION)

(1. Softening points. 2. Melting points)

This was, therefore, reinvestigated. As a first step linseed oil monoglycerides were prepared by reacting linseed oil with 20 per cent of its weight of glycerol at temperatures of 225-250°C. and using lead peroxide, trisodium phosphate and potassium carbonate, as catalysts, in an atmosphere of carbon dioxide. The monoglycerides were then brought to temperatures of 225-260°C. and shellac (60% of the weight of monoglyceride) was added and cooked. Thinner was then added and the properties of the varnish studied by the addition of phthalic anhydride. The resulting products are under study.

V—MODIFICATION OF LAC

1. MODIFICATION WITH DIISOCYANATES

Diisocyanates react in the cold with compounds containing carboxyl groups with the evolution of Co_2, giving rise to foam products and with those containing hydroxyl to yield urethane type of products. Shellac being a resin with both carboxyl and hydroxyl, the action of diisocyanates on this resin was taken up for study.

Toluene diisocyanate (suprasec C) reacts with lac in the cold. Lac (100 parts) dissolved in dry acetone or methyl ethyl ketone (100 parts) was treated with varying amounts of suprasec C (1-6 parts). Allowing the reactants to stand at room temperature overnight and evaporating off the solvent at room temperature, the resins obtained had progressively higher melting and softening points. The lac treated with 6 per cent of the diisocyanate would not dissolve in alcohol whereas those containing less would. Ethyl ester of lac was

also found to be similarly reactive. Films of lac modified with 4-5 per cent diisocyanate was found to be remarkably resistant to spirituous liquors and also reported to be remarkably weather resistant on outdoor exposure. The problem has now been taken up for study in greater details.

Dewaxed lac (lemon) was dissolved in dry acetone at 35-40°C. and treated with varying amounts (1-6%) of toluene diisocyanate (suprasec C) dissolved in acetone and mixed well. After allowing to stand at room temperature overnight, the samples were spread out on glass plates for the solvent to evaporate. Their physical and chemical constants are being determined. It was confirmed that lac modified with up to 5 per cent suprasec C were soluble in alcohol whereas with 6 per cent suprasec C there had only partial solubility. The study is being continued.

2. Copolymerization of Lac with Monomers

With a view to improve some of the properties of lac and to produce better resins of improved properties copolymerization of lac with some monomers was started last year. Evidence was obtained to the effect that some sort of combination did take place between lac and methyl methacrylate during bulk polymerization in presence of benzoyl peroxide as catalyst (*vide I.L.R.I. Annual Report*, 1960-61). Further experiments were carried out during the year under report to copolymerize lac with methyl methacrylate and vinyl acetate in emulsion.

(a) *Emulsion copolymerization of lac and methyl methacrylate*

Dewaxed lac was treated with different proportions of methyl methacrylate under the following conditions. The monomer together with 0·1 per cent of benzoyl peroxide was emulsified in an ammoniacal solution of the lac and the emulsion heated at 80°C. for 24 hours. The mixed polymer was reclaimed by breaking the emulsion with dilute sulphuric acid. Suspension copolymerization (Polymer VI in Table XXVII, App. B) was also carried out at room temperature with redox catalyst (potassium persulphate and potassium metabisulphite). Solubility behaviour of the products are given in Table XXVIII (App. B). The copolymers dissolve in alcohol in the cold giving solutions with a slight opacity which disappears on gentle warming but reappears on cooling. Addition of toluene or benzene removes the opacity permanently, giving a clear solution.

Viscosities of the copolymers as well as physical mixtures (in appropriate proportions) of lac and methyl methacrylate solution were determined in dioxane at 30°C. In all cases $\eta sp/C$ curves were linear but not parallel to the C-axis. Intrinsic viscosities (η), were found to rise gradually from 0·067 for lac to 2·40 for polymethyl methacrylate (*vide* Table XXVII, App. B).

The solubility behaviour of lac and the polymers and the differences in intrinsic viscosities of the polymers and the physical mixtures, though small, suggest that some copolymerization between lac and methyl methacrylate has taken place. Further work is being continued.

(b) *Emulsion copolymerization of lac and vinyl acetate*

In a similar manner attempts were made to copolymerize vinyl acetate and lac by the emulsion method but without success. In all cases, the lac separated out of the solution during the course of polymerization.

VI—HYGIENIC DISPOSAL OF LAC FACTORY WASTES

A simple method for the hygienic disposal of the wash water from lac factories by treatment with sulphuric acid thereby preventing putrefaction and at the same time recovering the lac dye, had already been worked out and reported [*vide I.L.R.I. Tech. Note*, No. 15, *J. sci. indutr. Res.*, Vol. 3, No. 12 (1958), pp. 320-21].

As a preliminary to the examination of the process on a pilot scale in a regular factory, a continuous process was worked out in the laboratory. The lac wash water was allowed to flow in a steady stream where it was treated with concentrated sulphuric acid to give about 0·1 per cent solution. Baffles built into the drain ensured thorough mixing. The treated water flowed through a series of settling tanks. The precipitate settled almost completely within three tanks and the clear overflow water did not show any tendency to putrefaction even after 20 days standing. Pilot plant work is in progress.

VII — UTILIZATION OF LAC IN INDIA — PUBLICITY AND PROPAGANDA

1. Lac Dye

Lac dye sample technical grade was sent to Silk & Art Silk Mills Research Association, Bombay for testing and report. The salient points of the report are summarized below:

(a) The commercial feasibility of lac dye is limited only to few shades to wool and silk and very limited to nylon and viscose material.

(b) The shades obtained are comparatively dull than equivalent shades obtained by the use of synthetic dyes on wool, silk, nylon and viscose material.

(c) The important range of blue, green and yellow colours through this process of dyeing with lac dye is not possible and thus research work will be needed to obtain such shades.

(d) Cost of dye is comparatively low but cost of application is much more than with synthetic dyes for equivalent shades. In case of wool and silk, it will be one-and-half times and in case of nylon it will be two times costlier than with synthetic dyes.

(e) The fastness properties of lac dye are encouraging factor on wool and silk and if further research work can be done in purifying and concentrating the dye, the shades obtained will be definitely encouraging for wool and silk.

(f) On dyeing trials on wool, the dye did give comparatively bright shades and it was observed that purified dye on wool and silk may prove useful in not too distant a future, of course, work in obtaining blue, green and yellow shades on wool must be done for making it a commercial success.

For their further research for improving the performance and scope of the lac dye — the Association was supplied with more of the dye. Their reports are awaited.

A firm in Bombay was supplied with a sample of the dyes for trial as colouring matter for food, meat and wine.

An improved method of preparing Lac Dye Technical (70/75% purity) without prior dewaxing was developed and communicated, on request, to Superintendent, Industrial Centre for Lac, Government of West Bengal, Balarampur.

2. Varnish and Lacquer

An anti-mold varnish using insecticide was developed for varnishing the cover of books for protecting them against damage by mold, mildew, insects, etc. Five litres of the varnish was supplied to a book-binder for trial. Seven gallons of the varnish were supplied to the Library of the Indian Institute of Technology, Kharagpur, where 11,000 books were coated.

Heat- and water-resistant shellac varnish using urea and dibutyl phthalate was prepared and samples were sent to four parties for trial.

Samples of paper varnish for coating paper boards along with samples of coated paper boards were supplied to a firm in Bombay for trial.

Shellac-Picture Varnish was supplied to Curator, Rabindra Sadan, Santi Niketan for coating photographs for display in Tagore Centenary Celebration Exhibition, and to Kanke Agricultural College for coating mural paintings.

Central Handicraft Development Centre, Bangalore, was supplied with the method of preparation and application of a varnish for coating penholders replacing nitrocellulose lacquer. A few coated penholders were sent to them for comments.

A party was supplied with samples of Shellac-Rosin Glycerine Ester, and details about its preparation and properties and also about clear baking Insulating Varnish and Empire cloth.

Varnishes with water-soluble lac and bleached lac which may be resistant to trichloroethylene were suggested to M/s. Indian Telephone Industries Ltd., Bangalore on request.

Method of preparation of air-drying Insulating Varnish and clear Banking Insulating Varnish were supplied to two parties.

3. Water-soluble Lac

An aqueous solution of water-soluble lac has been found suitable as binding material for green sand mould in iron foundry industry. But as the cost of material is uneconomic in comparison to that of the material at present in use, cheaper varieties of water-soluble lac were prepared from sticklac, seedlac, *molamma* and *kiri* and 1 kg. samples of each were sent to a firm for trial and report.

Water-soluble lac sample was sent to M/s. Telco, Jamshedpur for trials as binding material for green sand mould.

Sample of water-soluble lac was supplied to a firm for preparing a varnish to coat iron sheet to protect against rusting, and to Arecanut Technologist, Mysore for trial in coating earthenware for storing mild acid solution.

Samples of water-soluble lac 'AL' and 'DL' grade were supplied to (1) a firm for preparing printing ink; (2) Pottery cum training centre, Mysore; and (3) Indian Telephone Industries (P) Ltd., Bangalore for trial. 1 kg. of water-soluble lac was supplied as sample to Director, Indian Institute of Sugarcane Research, Lucknow, who wanted to coat the cut ends of sugarcane cuttings in water-soluble lac solution, to prevent evaporation of moisture from the cut ends, to preserve them for germination.

4. Adhesive and Cement

In response to a circular to all the bulb manufacturing firms of the country, for using shellac-based bulb capping cement three parties requested for sample, formula, method of preparation and application of the cement, which were supplied.

One party was supplied with a note on the method of preparation of shellac-based micanite and another with a note on the method of preparation of laminated hessian board, as requested.

5. Shellac Etch Primer

Single-pack shellac etch primer has been developed and thoroughly tested in the laboratory and in service. Circular letters were issued introducing the shellac etch primer to potential consumers and industries using etch primer, including the Defence Department Ordnance Factories, Air Force, Railways, State Transport, Development Directorate Ministry of Commerce & Industry, Ship Building Organizations, etc., for trial on aluminium and light

metal alloys. Ministry of Food & Agriculture, Government of India issued a circular letter to all Ministries intimating the development of the single-pack etch primer and requesting them to take up service trials of the primer in all organizations under them prior to adopting it for regular use. M/s. Shalimar Paint, Colour & Varnish Co. Ltd., Calcutta produced satisfactorily in their factory on our behalf 100 gallons of the primer in one charge. Four lots of 10-15 gallons each of the etch primer were also prepared in the Institute Laboratory.

About 110 gallons of the primer have been sent to some 60 parties including the Railways, State Road Transport Organizations, Ship Building Organizations, etc., for service trial and report. Assistance was given to these organizations by members of staff of the Institute in the correct method of application of the primer.

Several satisfactory reports about the performance of the primer have been received.

6. Technical Assistance to Lac Manufactures and Consumers

Scheme was supplied as requested to:

(a) Block Development Officer, Rajim, Fingeshwar for a shellac co-operative factory.

(b) Small Industries Service Institute, Indore, for starting shellac factories for processing 10 mds. and 40 mds. of sticklac per day; for manufacturing Sealing wax, Gasket shellac compound, French polish of different grades, Insulating varnish, Picture varnish, etc.

(c) Forest Utilization Officer, Madras, to improve their Lac Factory at Cumbum.

(d) Director of Industries, Government of Orissa for starting a factory for processing sticklac to seedlac, shellac and button lac and also to utilize the lac manufactured in small-scale industries. Formerly, Orissa used to produce a good quantity of lac, specially of the *kusmi* variety but of late the production has gone down. (The scheme for processing factories has been sponsored to give proper initiative to revive the production in the State.)

Industrial Centre for Lac, Government of West Bengal, was supplied with detailed specifications and drawings of Bleached Lac Washing Barrel and Sand Separating Machine for use in their Centre.

A Sand Separating Machine was fabricated in the Institute and supplied to Director of Industries, West Bengal for use in Lac Service Co-operative Centre, Tulin.

Several maunds of shellac was prepared from old and partially polymerized seedlac supplied by a party by Autoclave Process and sent to them.

Shellac Utilization Officer met some lac manufacturers at Gondia and supplied them schemes for manufacturing bleached lac and for lac-based small-scale industries.

A party was supplied with all grades of special shellac of our Production Unit and a note on the method of preparing different compositions for use as leather finishes.

7. French Polishing Publicity Centre, New Delhi

The work of the Centre continued smoothly. It continued its house-to-house demonstration work of polishing old furniture with Shellac French Polish.

8. Regional Testing Laboratory

Two new laboratories were started — One at Balarampur, Dt. Purulia, West Bengal on 16th April 1961 and the other at Daltonganj, Dt. Palamau, Bihar on 25th September 1961.

The laboratory at Jhalda has been temporarily closed from 15th July 1961 since the work load for the Centre was inadequate.

During the period number of samples analysed at laboratories were as under :

(a) Gondia (Maharastra)	...	791
(b) Balarampur (W. Bengal)	...	645
(c) Jhalda (W. Bengal)	...	54
(d) Daltonganj (Bihar)	...	14

Besides the analytical work in the laboratory, the Officer-in-charge of Gondia Laboratory, demonstrated the manufacture of (i) Bleached lac to four factories, (ii) Improved quality of French polish to one factory, (iii) Improved method of Seedlac manufacture to three factories, and (iv) Sealing wax to one factory.

9. Exhibitions and Other Activities

During the year, the Institute participated in the following exhibitions :

(1) Bihar State Small-Scale Industries Exhibition, Gaya.

(2) Commonwealth Technical Training Week Celebrations Exhibition, New Delhi.

(3) Second National Agriculture Fair, Madras.

Samples of lac and lac products were sent on request to 9 Vijnan Mandirs, for display in their museums.

The Indian Museum, Calcutta, was advised to renovate lac-exhibits on display in the Industrial Section. Necessary assistance towards the layout and replenishing of lac-exhibits, was rendered to the museum.

(a) During a survey tour to Jaipur and Udaipur to study the various aspects of lac-bangles and wooden lacquer-ware industries, a number of manufacturing centres including Vidya Bhawan-Handicrafts Institute at Udaipur were visited and advice was given to the craftsmen, to use shellac-picture varnish on handicrafts they are manufacturing.

(b) The Institute of Industrial Designs, Patna, was also visited and the use of shellac-picture varnish, on papier mache and bamboo articles, was discussed with the Officer-in-charge of the Institute. A sample of the varnish was also supplied subsequently.

(c) At Rabindra Sadan, Santiniketan, 561 photographs of different sizes were coated by spraying with shellac-picture varnish supplied from this Institute as a protective coating, in response to a request from Visva Bharati authorities. The Exhibition Assistant was deputed to undertake this work there.

(d) During the Second National Agriculture Fair at Madras, Exhibition Assistant visited a number of handicrafts centre manufacturing papier mache dolls, wooden articles, bamboo crafts and wooden lacquerware, etc., etc., in Madras, Bangalore, Channapatna, Mysore, Hyderabad (Nirmal Industry), Pondichery and advised the craftsmen, on the improved uses of shellac in Handicrafts Industry. Demonstration of shellac-picture varnish was arranged at these centres and the use of this varnish was very much commended by the craftsmen.

VIII—PRODUCTION UNIT

The Production Unit manufactured five grades of special shellacs and sold to customers.

Technical help and advice as well as practical demonstrations were given to interested parties as a result of which three parties have taken up the manufacture of bleached lac. Autoclave shellac is also finding wider market.

Working of the Bleached Lac Pilot Plant (1 md. capacity) have also been standardized and bleached lac of good-keeping quality have been prepared.

873 kg. of special shellacs at a total price of Rs. 5,937·60 nP. were sold with a gross profit of over Rs. 2000.

METEOROLOGICAL REPORT FOR THE YEAR 1961-62

The average meteorological data for each month during the year 1961-62 *are given*:

Month & Year	Mean Barometric pressure (in.)	Mean wind speed (miles/hr.)	Mean max. temp. (°F.)	Mean min. temp. (°F.)	Mean dry bulb temp. (°F.)	Mean humidity	Mean sunshine (hr./day)	Total rainfall (in.)	Highest max. temp. (°F.)	Lowest min. temp. (°F.)
April 1961	27·72	1·900	98·28	70·13	66·66	31·23	9·40	0·10	106·0	63·0
May 1961	27·60	1·906	101·77	76·48	91·84	33·51	8·00	1·55	108·0	66·0
June 1961	27·53	2·320	90·15	74·77	82·80	73·83	4·23	13·68	109·0	69·0
July 1961	27·47	1·870	87·00	73·21	78·70	88·77	3·19	12·30	91·5	71·0
August 1961	27·51	1·250	86·01	73·60	80·26	85·51	4·11	18·30	90·0	72·0
September 1961	27·57	1·180	85·18	72·00	78·33	86·40	4·74	14·44	89·0	69·0
October 1961	27·77	1·230	81·87	65·90	74·82	77·37	6·50	11·95	88·0	56·0
November 1961	27·94	0·394	75·70	53·10	67·88	59·40	8·78	0·10	80·0	46·5
December 1961	27·93	0·570	64·82	44·32	62·74	50·55	8·60	0·05	72·0	39·0
January 1962	27·91	0·650	64·19	45·70	62·92	47·22	9·18	0·71	73·0	38·0
February 1962	27·92	0·640	70·38	53·53	69·84	63·43	8·82	1·39	83·0	48·0
March 1962	27·82	1·333	80·05	60·20	79·90	47·40	8·66	0·88	91·0	50·0

The highest maximum temperature recorded was 109·0°F. on the 3rd June 1961, whereas the lowest recorded was 38·0°F. on the 17th January 1962. The total rainfall during the year amounted to 75·45 inches of which the monsoon rainfall (June-Sept.) was 58·72 inches. The rainfall during the year was above normal as compared to 1960-61 the total rainfall being 59·96 of which the monsoon rainfall was 53·31. The highest wind speed recorded was 242·01 miles on 3rd October 1961 whereas the lowest recorded wind speed was 0·4 miles on 1st February 1962.

20th July 1962

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APPENDIX A

(Tables: Entomology Division)

TABLE I — DETAILS OF LARGE-SCALE LAC CULTIVATION WITH REVENUE AND EXPENDITURE STATEMENT AT *KUNDRI* (APRIL 1961 TO MARCH 1962)

Season of operation	Particulars of operation	No. of trees	Yield of lac (if any)			Quantity of broodlac used for inoculation	Cost of the operation (Rs. nP.)	Revenue						Total revenue	Remarks
			Lac sticks (kg.)	Scraped lac (kg.)	Brood-lac (kg.)			By sale of surplus broodlac			By sale of yield of sticklac				
								Wt. of brood lac (kg.)	Rate	Amount (Rs. nP.)	Wt. of scraped lac (kg.)	Rate (Rs. nP.)	Amount (Rs. nP.)	(Rs. nP.)	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
pril 1961	Pruning	20979	35699·425	—	—	—	612·94	—	—	—	—	—	3398·06	3398·06	5482·50 kg. (147 mds.
	Ari collection	—	—	—	—	—	823·62	—	—	—	—	—	—	—	4 ch.) sold by public au
	Scraping	—	—	6023·94	—	—	809·09	—	—	—	—	22·50	—	—	on 15th June 1961 a
								—	—	—	—	—	—	—	rate of Rs. 22·50 per
ly 1961	Partial cropping and selection of brood-lac	2233	647 (rejected)	—	430	—	50·24	—	—	—	—	—	—	—	(this includes 4 mds. bro to Institute)
	Scraping	—	—	183·8	—	—	23·34	—	—	—	—	—	—	—	
ugust 1961	Inoculation	459	—	—	—	—	13·78	—	—	—	—				
	Phunki removal	459	—	—	—	—	9·37	—	—	—	—	—	—	—	169·81 kg. (4 mds. 22
	,, scraping	—	—	—	—	—	3·88	—	—	—	—	25·00	113·75	113·75	lac sold at the rat Rs. 25 per md.
ct.-Nov. 1961	Complete cropping	10886	—	—	—	—	298·37	—	—	—	—	—	—	—	—
	Collection and selection of brood	—	4292	—	18473·4	—	762·87	—	—	—	—	—	—	—	—
	Inoculation including chope	18647	—	—	—	6581·72	621·80	—	—	—	—	—	—	—	—
	Scraping	—	14343	3016·85	—	—	439·31	—	—	—	—	—	880	880·00	3464·69 kg. (92 mds. 33
	Miscellaneous	—	—	—	—	—	48·25	—	—	—	—	—	—	—	lac lying in godown bu
								—	—	—	—	—	—	—	sold although price of
ec. 1961	*Phunki* removal	18647	—	724·46	—	—	164·75	—	—	—	—	—	—	—	was Rs. 14 per md.
	,, scraping	—	—	724·46	—	—	96·57	—	—	—	—	—	—	—	weighed on 10-7-62 a
	Miscellaneous	—	—	—	—	—	nil	—	—	—	—	—	—	—	88 mds. (3284·16 kg.) by auction at Rs. 10 pe
eb. 1962	Pruning	—	—	—	—	—	—	—	—	—	—	—	—	—	
			54981·425	9949·05	18903·4		4777·88						4391·81	4391·81	8941·17 kg. of total lac

TABLE II — OPTIMUM DENSITY OF LARVAL SETTLEMENT ON *KUSUM*

Experimental details

Treatment		Replication		No. of trees per plot		Total No. of trees
4	×	10	×	1	=	40

Crop data (*Jethwi* 1961)

Yield Particulars	Treatment A			Treatment B			Treatment C			Treatment D		
	Brood used kg.	Yield obtained kg.	Brood to yield ratio	Brood used kg.	Yield obtained kg.	Brood to yield ratio	Brood used kg.	Yield obtained kg.	Brood to yield ratio	Brood used kg.	Yield obtained kg.	Brood to yield ratio
Lac sticks	22·91	50·80	1 : 2·21	45·82	70·20	1 : 1·53	91·64	145·90	1 : 1·59	183·28	217·00	1 : 1·18
Scraped lac	7·83	10·65	1 : 1·36	19·16	13·67	1 : 0·71	38·76	28·86	1 : 0·74	73·96	47·03	1 : 0·64

TABLE III — OPTIMUM DENSITY OF LARVAL SETTLEMENT ON *BER*

Experimental details

Treatment		Replication		No. of trees per plot		Total No. of trees
3	×	12	×	1	=	36

Crop data (*Katki* 1961)

Yield Particulars	Treatment A			Treatment B			Treatment C		
	Brood used kg.	Yield obtained kg.	Brood to yield ratio	Brood used kg.	Yield obtained kg.	Brood to yield ratio	Brood used kg.	Yield obtained kg.	Brood to yield ratio
Lac sticks	4·537	47·11	1 : 10·38	9·068	23·40	1 : 5·48	18·133	64·79	1 : 3·57
Scraped lac	0·837	7·83	1 : 9·35	1·453	9·15	1 : 6·30	2·742	11·64	1 : 4·21

TABLE IV — PROPER TIME OF HARVESTING AND DETERMINATION OF OPTIMUM DENSITY OF LARVAL SETTLEMENT

Experimental details

Treatment		Replication		No. of trees per plot		Total No. of trees
9	×	4	×	1	=	36

Crop data (*Baisakhi* 1960-61)

Date of cropping	Treatment	Lac sticks			Scraped lac					
		Brood used kg.	Yield obtained kg.	Brood to yield ratio	Brood used kg.	Yield obtained		Brood to yield ratio		
						Fresh kg.	Dry kg.	Fresh	Dry	Percentage of driage
25-4-61	A	0·68	6·40	1 : 9·42	0·11	0·90	0·74	1 : 8·0	1 : 6·53	
,,	B	1·36	8·67	1 : 1·63	0·22	1·27	1·04	1 : 5·6	1 : 4·60	16·0
,,	C	2·72	7·71	1 : 2·83	0·48	1·19	0·97	1 : 2·5	1 : 2·02	
25-5-61	D	0·68	7·26	1 : 10·68	0·11	1·10	1·00	1 : 9·6	1 : 8·85	
,,	E	1·36	5·98	1 : 4·40	0·22	1·22	1·11	1 : 5·4	1 : 4·92	10·7
,,	F	2·72	8·78	1 : 3·23	0·45	2·38	2·17	1 : 5·2	1 : 4·80	
8-7-61	G	0·68	5·81	1 : 8·55	0·14	1·04	0·87	1 : 7·4	1 : 6·15	
,,	H	1·36	6·92	1 : 5·09	0·22	2·00	1·67	1 : 8·8	1 : 7·36	18·0
,,	I	2·72	13·49	1 : 4·96	0·45	5·14	4·30	1 : 11·3	1 : 9·48	

TABLE V — UTILIZING *PALAS* FOR *BAISAKHI* AND *BER* FOR *KATKI* CROPS

Crop data (*Baisakhi* 1960-61)

Host	No. of trees	Lac sticks				Scraped lac			
		Brood used kg.	Brood yield kg.	Total yield kg.	Ratio of brood to yield	Brood used kg.	Brood yield kg.	Total yield kg.	Ratio of brood to yield
Palas	10	8·06	17·95	43·85	1 : 5·44	1·89	3·81	6·81	1 : 3·60
Ber	10	16·78	—	71·85	1 : 4·28	4·76	—	14·35	1 : 3·01

TABLE VI — PRUNING TIME OF *BER* FOR *KATKI* CROP

Data on shoot measurements (*Katki* 1961)

Treatment	Primaries			Secondaries	
	Percentage of buds developed into shoots	Average No. of shoots per tree	Average length per shoot cm.	Average No. of shoots per tree	Average length per shoot cm.
A	80·1	44·4	70·9	224·6	27·6
B	82·0	52·4	108·3	235·8	41·9
C	77·2	103·6	43·9	303·0	19·5
D	77·9	46·0	65·8	239·4	23·5

TABLE VII — PRUNING TIME OF *BER* FOR *KATKI* CROP

Experimental details

Treatment		Replication		No. of trees per plot		Total No. of trees
4	×	10	×	1	=	40

Crop data (*Katki* 1961)

Treatment	Lac sticks			Scraped lac		
	Brood used kg.	Total yield kg.	Brood to yield ratio	Brood used kg.	Total yield kg.	Brood to yield ratio
A	3·45	22·60	1 : 6·52	0·86	2·55	1 : 2·96
B	8·86	47·54	1 : 5·36	2·10	8·30	1 : 3·95
C	3·67	15·66	1 : 4·27	0·86	2·49	1 : 2·90
D	3·72	22·75	1 : 6·11	0·87	4·01	1 : 4·61

TABLE VIII — TRIALS ON BROOD PRESERVATION (*Baisakhi* 1960-61)

Crop data

Host	Lac sticks						Scraped lac		
	No. of trees	Brood used kg.	Brood yield kg.	Total yield	Ratio of brood to yield	Ratio of brood to brood	Brood used kg.	Yield obtained kg.	Ratio of brood to yield
Albizzia stipulata	3	32·77	—	—	—	—	9·36	—	—
Butea monosperma	2	0·79	—	5·89	1 : 7·42	—	0·21	0·59	1 : 2·81
Acacia catechu	2	1·36	—	4·62	1 : 3·40	—	0·35	0·93	1 : 2·6
Albizzia lucida	3	0·79	3·35	7·16	1 : 9·02	1 : 4·22	0·198	0·47	1 : 2·4
Grewia multiflora	2	0·45	—	—	—	—	0·12	—	—
Zizyphus mauritiana	2	0·90	0·85	8·45	1 : 9·32	1 : 0·94	0·28	0·85	1 : 2·9
Ficus infectoria	1	1·58	9·65	15·05	1 : 9·48	1 : 6·08	0·48	1·42	1 : 2·9
Ficus glomerata	2	1·13	—	3·65	1 : 3·22	—	0·24	0·56	1 : 2·3
Ficus glabella	2	2·04	5·42	12·62	1 : 6·18	1 : 2·66	0·65	1·17	1 : 1·8
Albizzia lebbek	1	1·02	—	—	—	—	0·31	—	—
Zizyphus xylopyra	1	0·90	—	—	—	—	0·22	—	—
Moghania macrophylla	40	2·26	—	3·50	1 : 1·54	—	0·69	1·36	1 : 2·0
Ficus cunia	2	2·94	30·90	46·30	1 : 15·71	1 : 10·48	0·90	7·16	1 : 7·9

TABLE IX — RAISING OF *MOGHANIA MACROPHYLLA*

Treatment	No. of plants	No. of plants dried or damaged	Average height per plant cm.	Average No. of shoots per tree	Average total length of shoots per tree cm.
A	24	5	115·7	14·8	771·7
B	36	1	78·3	8·1	345·3
C	24	7	60·1	6·5	220·5
D	36	11	65·9	8·0	280·7
E	12	—	145·9	27·5	1310·5
F	24	—	163·7	21·4	1016·3
G	12	—	159·0	33·8	1694·9
H	24	—	153·7	20·4	963·6
I	12	—	97·0	13·5	602·7
J	24	—	90·5	14·3	465·5

TABLE X — SPACING TRIALS WITH *MOGHANIA MACROPHYLLA*

Treatment	No. of plants	Average height per plant cm.	Average No. of shoots per tree	Average total length		
				Shoots cm.	Larval settlement cm.	Lac encrustation cm.
A	288	148·8	30·2	1462·0	976·5	449·2
B	432	153·7	29·7	1448·9	1067·9	545·8
C	648	159·7	27·6	1329·3	924·9	481·2

TABLE XI — SPACING TRIALS WITH *MOGHANIA MACROPHYLLA*

Crop data (*Aghani* 1961-62)

Treatment	No. of plants in 36′×36′ plot	Lac sticks				Scraped lac				
		Brood used kg.	Brood obtained kg.	Total yield obtained kg.	Brood to yield ratio	Brood used kg.	Brood obtained kg.	Total yield obtained kg.	Brood to yield ratio	Yield per acre kg.
A	288	21·950	20·150	164·550	1 : 7·49	9·150	—	32·000	1 : 3·49	133
B	432	32·170	50·480	239·860	1 : 7·45	12·150	—	48·580	1 : 4·00	202
C	648	49·150	62·460	316·810	1 : 6·05	18·920	—	72·670	1 : 3·84	302

TABLE XII — BREEDING AND LIFE-HISTORY STUDIES OF *BRACHYMERIA TACHARDIAE* CAM.

Period pupae were parasitized	At room temperature					At 26°C.±1°C.		
	Range of developmental period. Days	Average length of developmental period. Days	No. of parasites emerged	Temperature °C.	Humidity %	Range of developmental period. Days	Average length of developmental period. Days	Total parasites emerged
June 1961	11-20	14·4	25	28·8	69	—	—	—
July 1961	11-22	14·6	32	26·6	68	—	—	—
August 1961	11-18	14·1	22	27·2	89	—	—	—
September 1961	13-21	17·4	18	26·6	87	—	—	—
October 1961	12-19	16·3	10	25·0	76	—	—	—
November 1961	48-62	55·0	2	21·1	61	—	—	—
December 1961	45-52	47·7	4	18·3	63	14-17	15·5	4
January 1962	29-33	31·0	4	16·1	51	12-18	15·0	18
February 1962	No emergence			18·8	53	18-21	19·5	7
March 1962	11-20	14·4	62	25·5	38	10-17	14·0	12

TABLE XIII — CROP DATA OF ALTERNATIVE *KUSUM* HOSTS (JHALDA)

Host	No. of trees	Brood used kg.	Yield obtained kg.	Brood to yield ratio
	***Jethwi* 1961**			
Protium serratum Engl. (Syn. *Bursera serrata*) and *kusum*	18	39·65	78·91	1 : 1·98
Dalbergia latifolia	6	23·29	10·54	1 : 0·45
Ficus sp.	5	10·49	2·90	1 : 2·8
Palas	10	8·31	1·30	1 : 0·15
Ber and *kusum*	11	18·81	1·82	1 : 0·09
	***Aghani* 1961-62**			
Protium serratum	16	53·61	69·41	1 : 1·3
Dalbergia latifolia	8	27·19	41·10	1 : 1·5
Ficus sp.	4	5·24	21·80	1 : 4·0
Palas	9	18·31	42·42	1 : 2·30
Ber	10	10·20	19·25	1 : 1·88
Mallotus philippinensis	Group of bushes	7·53	1·72	1 : 0·23

TABLE XIV — DATA ON SHOOT MEASUREMENT AT THE TIME OF INOCULATION (DAMOH)

Treatment	Date of pruning	Primaries				Secondaries				No. of tertiary shoots given out
		Date of first appearance of buds	No. of shoots given out per tree	No. of living shoots per tree	Average length cm.	Date of first appearance of buds	No. of shoots given out per tree	No. of living shoots per tree	Average length cm.	
					***Baisakhi* 1960-61**					
A	13-4-60	2-5-60	81·5	60·0	67·0	21-5-60	508·0	429·8	41·9	561·0
B	19-5-60	1-6-60	47·6	37·6	73·1	17-6-60	340·8	300·6	37·8	329·0
					***Katki* 1961**					
A	26-12-60	2-2-61	51·6	37·6	76·1	16-2-61	346·8	304·1	34·5	324·0
B	13-2-61	16-3-61	54·6	35·0	53·7	16-3-61	316·5	255·0	35·1	297·3
C	19-5-60	17-6-60	84·8	33·0	130·2	17-6-61	535·8	308·0	55·2	370·0
					***Baisakhi* 1961-62**					
A	13-4-61	20-5-61	52·0	34·5	57·6	20-5-61	330·0	277·8	36·3	406·1
B	19-5-61	17-6-61	37·6	28·6	48·6	17-6-61	210·0	185·0	38·1	304·3

TABLE XV — RESPONSE OF *GHONT* TO PRUNING (DAMOH)

Exprimental details

	Treatment		No. of trees per plot		Replication		Total
Katki	4	×	5	×	10	=	200
Baisakhi	2	×	5	×	10	=	100

Yield particulars	Treatment A			Treatment B			Treatment C		
	Brood used kg.	Yield obtained kg.	Brood to yield ratio	Brood used kg.	Yield obtained kg.	Brood to yield ratio	Brood used kg.	Yield obtained kg.	Brood to yield ratio
				***Baisakhi* 1960-61**					
Lac sticks	8·2	21·7	1 : 2·6	6·4	8·7	1 : 1·3	—	—	—
				***Katki* 1961**					
Lac sticks	26·0	22·5	1 : 0·86	26·0	21·7	1 : 0·83	26·0	33·7	1 : 1·29

TABLE XVI — OPTIMUM AMOUNT OF BROOD REQUIREMENT FOR *GHONT* (DAMOH)

Results of stick examination

Treatment	After 4 weeks		At male emergence		At crop maturity	
	Density of settlement per inch	Percentage of larval mortality	No. of living insects per inch	Percentage of males	No. of living cells per inch	Percentage of adult mortality
			***Baisakhi* 1960-61**			
A (Half-normal)	60	88·3	13	585	9	98·3
B (Normal)	199	81·5	10	7·6	8	98·0
C (Double-normal)	177	82·6	38	16·6	14	99·8
			***Katki* 1961**			
A	67	57·8	27	8·7	16	44·9
B	85	59·7	32	13·3	21	40·5
C	135	55·7	71	14·6	11	35·5

TABLE XVII — OPTIMUM AMOUNT OF BROOD REQUIREMENT FOR *GHONT* (DAMOH)

Experimental details

Treatment		Replication		No. of trees per plot		Total
3	×	10	×	5	=	150

Crop data

Yield Particulars	Treatment A			Treatment B			Treatment C		
	Brood used kg.	Yield obtained kg.	Brood to yield ratio	Brood used kg.	Yield obtained kg.	Brood to yield ratio	Brood used kg.	Yield obtained kg.	Brood to yield ratio
				***Baisakhi* 1960-61**					
Lac sticks	9·0	48·2	1 : 5·3	11·9	43·5	1 : 3·6	19·3	54·9	1 : 2·8
				***Katki* 1961**					
Lac sticks	10·4	5·3	1 : 0·5	20·8	11·3	1 : 0·54	41·6	17·6	1 : 0·4

TABLE XVIII — DATA ON SHOOT MEASUREMENT AT THE TIME OF INOCULATION (MIRZAPUR)

Treatment	Date of pruning	Primaries				Secondaries				No. of tertiary shoots given out
		Date of first appearance of buds	No. of shoots given out per tree	No. of living shoots per tree	Average length cm.	Date of first appearance of buds	No. of shoots given out per tree	No. of living shoots per tree	Average length cm.	
				***Baisakhi* 1960-61**						
A	14-4-60	20-4-60	14·5	14·5	55·0	4-5-60	102·3	102·3	45·8	569·8
B	18/19-5-60	25-5-60	10·6	10·6	74·0	13-6-60	115·0	115·0	47·3	505·1
				***Katki* 1961**						
A	17-12-60	28-1-61	26·3	25·5	21·2	18-2-61	112·0	112·0	13·9	277·6
B	14-2-61	9-3-61	35·1	35·1	48·9	16-3-61	206·0	205·0	27·2	641·1
C	20/21-5-60	25-5-60	6·5	6·5	110·1	13-6-60	84·5	84·5	41·1	551·0
				***Baisakhi* 1961-62**						
A	12-4-61	21-4-61	48·0	48·6	69·8	26-4-61	425·0	423·3	33·9	1093·3
B	21-5-61	31-5-61	46·3	46·3	49·9	9-6-61	353·0	346·3	32·4	1179·5

TABLE XIX — RESPONSE OF *GHONT* TO PRUNING (MIRZAPUR)

Experimental details

Treatment			No. of trees per plot		Replication		Total No. of trees
Katki	4	×	5	×	10	=	200
Baisakhi	2	×	5	×	10	=	100

Yield Particulars	Treatment A			Treatment B			Treatment C (*Katki* 1961)		
	Brood used kg.	Yield obtained kg.	Brood to yield ratio	Brood used kg.	Yield obtained kg.	Brood to yield ratio	Brood used kg.	Yield obtained kg.	Brood to yield ratio
				***Baisakhi* 1960-61**					
Lac sticks	14·5	62·6	1 : 4·4	13·6	44·7	1 : 3·2	—	—	—
				***Katki* 1961**					
Lac sticks	6·2	0·3	1 : 0·5	5·1	2·3	1 : 0·9	25·4	7·1	1 : 0·9

TABLE XX — OPTIMUM AMOUNT OF BROOD REQUIREMENT (MIRZAPUR)

Treatment	Results of stick examination: After 4 weeks Percentage of larval mortality	At male emergence Percentage of males	At crop maturity Percentage of adult mortality
	***Baisakhi* 1960-61**		
Ghont			
A (Half-normal)	14·2	—	100
B (Normal)	13·3	—	100
C (Double-normal)	26·0	—	100
Palas			
A	8·0	35·6	80
B	14·0	40·8	77
C	16·0	38·3	94
Ber			
A	16·0	49·2	100
B	12·0	43·1	100
C	15·0	54·9	100

TABLE XXI — OPTIMUM AMOUNT OF BROOD REQUIREMENT (MIRZAPUR)

Treatment	Results of stick examination: After 4 weeks Percentage of larval mortality	At male emergence Percentage of males	At crop maturity Percentage of adult mortality
	***Katki* 1961**		
Ghont			
A (Half-normal)	60·3	nil	100
B (Normal)	62·1	84·6	100
C (Double-normal)	70·1	75·7	100
Palas			
A	78·9	21·7	—
B	51·9	26·0	—
C	56·4	29·4	—
Ber			
A	16·0	49·2	100
B	12·0	43·1	100
C	15·0	54·9	100

TABLE XXII — OPTIMUM AMOUNT OF BROOD REQUIREMENT (MIRZAPUR)

Experimental details

Treatment		Replication		No. of trees per plot		Total No. of trees
3	×	10	×	5	=	150

Crop data

Yield particulars	Treatment A			Treatment B			Treatment C		
	Brood used kg.	Yield obtained kg.	Brood to yield ratio	Brood used kg.	Yield obtained kg.	Brood to yield ratio	Brood used kg.	Yield obtained kg.	Brood to yield ratio
				***Baisakhi* 1960-61**					
Ghont Lac sticks	7·3	36·5	1 : 5·0	13·2	40·3	1 : 3·1	22·2	47·1	1 : 2·1
Palas Lac sticks	12·0	71·5	1 : 5·9	19·8	46·5	1 : 2·4	42·8	48·8	1 : 2·0
Ber Lac sticks	7·6	43·8	1 : 5·2	13·1	49·5	1 : 3·7	20·2	54·61	1 : 2·7
				***Katki* 1961**					
Ghont Lac sticks	1·4	nil	1 : 0	3·0	0·4	1 : 0·05	5·3	0·01	1 : 0
Palas Lac sticks	9·0	8·3	1 : 0·9	18·8	11·5	1 : 0·6	22·4	12·2	1 : 0·5
Ber Lac sticks	0·7	0·3	1 : 0·4	1·3	0·1	1 : 0·1	2·6	0·4	1 : 0·1

APPENDIX B

(Tables : Chemistry Division)

TABLE I — EQUIVALENT BLEACH INDEX OF STANDARD IODINE SOLUTIONS

Sl. No.	Strength of Iodine solution (N)	Equivalent bleach index
1	1/200	170
2	1/400	152
3	1/500	144
4	1/750	133
5	1/1000	122
6	1/2000	98
7	1/3000	81
8	1/4000	70
9	1/5000	62
10	1/6000	58

TABLE II — RESULTS OF BLEACH INDEX DETERMINATION WITH PHOTOELECTRIC COLORIMETER

Sl. No.	Description of sample	Grade	Deflection	Bleach index from graph	Average	Remarks
1	Seedlac, *kusmi* (I.L.R.I. factory)	IA	1. (a) 17	59		
			(b) 18	60		
			2. (a) 18	60		
			(b) 18	60		
			3. (a) 19	61		
			(b) 18	60	59·7	
			4. (a) 17	69		
			(b) 17	59		
			5. (a) 17	59		
			(b) 18	60		
2	Seedlac, *kusmi*, washed with water (I.L.R.I. factory)	IA	1. (a) 24	68		
			(b) 25	69		
			2. (a) 24	68		
			(b) 24	68		
			3. (a) 22	66		
			(b) 23	67	67·5	
			4. (a) 23	67		
			(b) 23	67		
			5. (a) 24	68		
			(b) 23	67		
3	Seedlac, *kusmi* (I.L.R.I. factory)	IB	1. (a) 30	76		
			(b) 29	75		
			2. (a) 29	75		
			(b) 28	75		
			3. (a) 30	76		
			(b) 30	76	75·6	
			4. (a) 30	76		
			(b) 30	76		
			5. (a) 30	76		
			(b) 29	75		
4	Seedlac, *kusmi* from Orissa	IB	1. (a) 34	79		
			(b) 35	80		
			2. (a) 34	79		
			(b) 34	79		
			3. (a) 33	79		
			(b) 34	79	79·2	
			4. (a) 34	79		
			(b) 34	79		
			5. (a) 35	80		
			(b) 33	79		
5	Seedlac, *palas* from Maharashtra	IIA	1. (a) 72	109		
			(b) 73	109		
			2. (a) 71	108		
			(b) 71	108		
			3. (a) 72	109		
			(b) 72	109	109·7	
			4. (a) 76	112		
			(b) 74	110		
			5. (a) 72	109		
			(b) 74	110		

TABLE II — RESULTS OF BLEACH INDEX DETERMINATION WITH PHOTOELECTRIC COLORIMETER — *Contd.*

Sl. No.	Description of sample	Grade	Deflection	Bleach index from graph	Average	Remarks
6	Seedlac, *palas* from M.P.	IIA	1. (a) 58	101		
			(b) 58	101		
			2. (a) 58	101		
			(b) 60	102		
			3. (a) 60	102		
			(b) 60	102	101·5	
			4. (a) 59	101		
			(b) 60	102		
			5. (a) 58	101		
			(b) 59	102		
7	Seedlac, *palas* from M.P.	IIB	1. (a) 87	117		
			(b) 89	118		
			2. (a) 91	118		
			(b) 90	118		
			3. (a) 87	117		
			(b) 86	117	117·3	
			4. (a) 87	117		
			(b) 91	118		
			5. (a) 83	116		
			(b) 87	117		
8	Seedlac, *palas* from Bihar	IIB	1. (a) 87	117		
			(b) 88	118		
			2. (a) 91	119		
			(b) 93	119		
			3. (a) 87	117		
			(b) 88	118	118	
			4. (a) 89	118		
			(b) 90	118		
			5. (a) 90	118		
			(b) 89	118		
9	Seedlac, *arhar* from Assam	Fails IIB	1. (a) 260	159		
			(b) 260	159		
			2. (a) 270	160		
			(b) 275	161		
			3. (a) 278	161		
			(b) 274	160	160	
			4. (a) 260	159		
			(b) 260	159		
			5. (a) 250	158		
			(b) 250	158		
10	Seedlac, *ghont* from M.P.	Fails IIB	1. (a) 425	177		
			(b) 420	177		
			2. (a) 410	176		
			(b) 400	175		
			3. (a) 400	175		
			(b) 405	175	175·7	
			4. (a) 400	175		
			(b) 410	178		
			5. (a) 405	175		
			(b) 410	176		

TABLE III — COMPARISON OF RESULTS, WITH AND WITHOUT VACUUM FOR VOLATILE MATTER (MOISTURE)

Sample No.	Percentage moisture standard method	Percentage moisture using no vacuum	Difference
1	1·82	1·73	—0·09
2	1·77	1·77	nil
3	1·72	1·64	—0·08
4	2·46	2·42	—0·04
5	1·57	1·50	—0·07
6	0·47	0·47	nil
7	2·74	2·64	—0·10
8	1·29	1·30	—0·01
9	1·51	1·49	—0·02
10	1·62	1·42	—0·20
11	1·22	1·22	nil
12	2·68	2·54	—0·14
13	1·36	1·31	—0·05
14	1·50	1·40	—0·10
15	1·92	1·73	—0·19
16	1·67	1·56	—0·11
17	1·75	1·66	—0·09
18	2·21	2·09	—0·12
19	1·71	1·56	—0·15

TABLE IV — CORRELATIONSHIP OF QUALITY (ESPECIALLY COLOUR) WITH CLIMATE OF REGION

Analytical data

Sl. No.	Region of production	Host	Crop	Loss of weight on drying sticklac per cent on wet weight	Yield of seedlac per cent	Seedlac			Shellac		
						Impurities per cent	Bleach index	Colour index	Colour index	Flow (sec.) 5 inches	Life at 150°C. min.
1	Dhamtiri (M.P.)	*Palas*	*Katki phunki*	—	71·0	5·69	120	15	12	98	37
2	Damoh (M.P.)	*Ghont*	*Katki Phunki*	—	61·0	6·52	144	14	10	95	34
3	Janipore (Orissa)	*Kusum*	*Phunki*	—	82·0	3·11	82	9	5	27	53
4	Cuddalore (Madras)	*Kusum*	*Phunki*	2·5	82·0	4·27	132	19	7	50	47
5	Duar Amla (Assam)	*Ficus*	*Katki Ari*	7·5	59·8	4·1	160	19	15	70	28
6	Latehar (Bihar)	*Palas*	*Baisakhi*	3·75	61·1	7·26	115	12	16	155	35
7	Daltonganj (Bihar)	*Palas*	*Baisakhi*	—	57·0	—	114	13	11	240	37

TABLE V — ANALYTICAL DATA OF PERMANGANATE AND SODA WASHED LAC SAMPLES AFTER 14 MONTHS' STORAGE

Sample	Washing aid	Yield of seedlac per cent	Bleach index of the seedlac			Properties of the shellacs produced											
			When fresh	After three months	After fourteen months	Life at 150°C. minutes			Flow seconds Westing house			Colour index			Hot alcohol-insoluble per cent		
			I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
1	Soda	55	97	98	98	48	44	40	69	105	112	14	14	14	4·05	4·08	4·08
	Permanganate	60·2	98	99	99	47	43	40	70	105	112	13·5	14	14	4·06	4·06	4·08
2	Soda	52·2	92	91	92	46	45	41	68	78	90	13	14	13·5	3·88	3·86	3·86
	Permanganate	57·5	90	91	92	46	45	41	67	78	91	13	13·5	13·5	3·86	3·85	3·87
3	Soda	45·5	93	92	92	47	45	41	162	190	200	12	12	12	2·50	2·51	2·56
	Permanganate	50·1	88	90	89	47	45	41	164	190	200	12	12	12	2·52	2·56	2·54

TABLE VI — ANALYTICAL DATA OF SHELLAC

Expt. No.	Starting material	*Bhatta* shellac				New process shellac			
		Colour index	H.A.I. per cent	Life at 150°C. min.	Flow sec.	Colour index	H.A.I. per cent	Life at 150°C. min.	Flow sec.
1	Seedlac	16	0·96	46	125	18	1·06	28	540
2	,,	—	—	—	—	17·5	1·02	30	545
3	,,	—	—	—	—	17·5	1·02	29	545
4	*Molamma*	30	2·1	34	185 secs. to flow to 3″	32	1·96	22	650 secs. to flow to 2″
5	,,	—	—	—	—	33·5	2·01	20	do
6	,,	—	—	—	—	32·5	2·01	22	do

TABLE VII — PROPERTIES OF BLEACHED LAC FROM DIFFERENT GRADES OF SEEDLAC

Grade No.	Type seedlac	Source	Bleach index	Yield per cent	Acid value	Colour index	Cold alcohol-insolubles, per cent	
							When fresh	After 8 months
IA	*Kusmi*	Institute Plantation	80	90·5	72·5	0·31	3·9	4·25
,,	,,	,,	80	90·0	74·3	0·33	3·7	—
IB	*Baisakhi*	Jhalda	90	88·0	70·7	0·33	4·94	4·86
,,	,,	,,	90	88·4	73·2	0·33	4·64	4·30
IIA	*Baisakhi*	Jhalda	102	88·5	74·9	0·33	4·20	4·44
,,	,,	,,	102	88·0	76·1	0·33	4·00	4·48
IIB	*Baisakhi*	Institute Plantation	135	86·0	71·3	0·31	4·50	5·34
,,	,,	,,	135	85·0	71·9	0·31	4·70	5·42

TABLE VIII — PROPERTIES OF BLEACHED LAC OBTAINED BY USING EXCESS BLEACH LIQUOR (BLEACH INDEX OF SEEDLAC 102)

Excess bleach used per cent	Yield per cent	Acid value	Colour index	Cold alcohol-insolubles per cent	
				When fresh	After 8 months
nil	88·5	74·9	0·33	4·2	4·44
10	87·4	75·5	0·31	4·45	5·3
20	86·0	82·9	0·29	5·5	5·68
30	85·0	82·0	0·25	5·2	5·94
50	82·2	85·9	0·2	5·3	49·42

TABLE IX — COMPARISON OF PROPERTIES OF DIFFERENT TYPES OF REFINED BLEACHED LAC

	Obtained by cloth-bag filtration method	Obtained by white-spirit extraction method
Yield percentage	83·2	86·0
Acid value	73·8	74·2
Wax percentage	0·08	0·07
Hot alcohol-insoluble percentage	0·2	0·2
Matter soluble in water percentage	0·32	0·33
Ash percentage	0·4	0·42
Keeping quality	No increase in insolubles noticed so far (after six months)	No increase in insoluble noticed so far (after six months)
Scratch hardness in gm. (25% solution W/W) applied over glass surface	1400	1350

TABLE X — PROPERTIES OF LEAD-THIOSULPHATE STABILIZED BLEACHED LAC

Amount of lead-thiosulphate in dried bleached lac per cent	Life at 150°C. min.	Cold alcohol-insolubles		
		Per cent		Increase
		When fresh	After a year	
0·00	10	3·1	5·5	2·4
0·25	11	—	—	—
0·50	15	—	—	—
0·75	18	—	—	—
1·00	21	4·0	5·25	1·25

TABLE XI — ACCELERATED AGING TEST AT 45±1°C.

Storage time hrs.	Cold alcohol-insolubles per cent	
	Untreated bleached lac	Lead-thiosulphate stabilized bleached lac (1% Lead thiosulphate)
0	4·2	5·2*
48	6·56	5·88
96	25·1	11·06
144	60·18	14·76
240	70·98	27·56

*The 1 per cent excess insolubles over the control is due to the lead-thiosulphate.

TABLE XII — ACTION OF BLEACH LIQUOR ON ALEURITIC ACID

Treatment	Loss percentage	Acid value	Chlorine content per cent	Hydroxyl value	M.P. °C.
Aleuritic acid	—	183·9	—	560·0	100-101
Precipitated from sodium-carbonate solution without addition of bleach	1·0	179·9	—	—	—
Sodium-carbonate solution of acid treated with bleach (3 gm. chlorine for 100 gm. of acid added)	10·0	183·9	0·264	554·8	—
Solution prepared as above (6 gm. chlorine for 100 gm. of acid added)	11·0	180·8	0·5135	550·4	97-98·5

TABLE XIII — PROPERTIES OF BLEACHED LAC OBTAINED BY RAPID METHOD OF BLEACHING

Bleach index of seedlac	Bleach liquor added	*Properties of the resulting bleached lacs* Acid value	Chlorine content per cent	Colour index
80	100	71·2	1·3	0·33
80	90	—	—	0·35
80	80	—	1·1	0·34
80	70	—	1·0	0·34
80	60	—	0·9	0·34
80	60	69·92	0·82	0·41
80	60	69·11	0·82	0·40
80	55	70·36	0·69	0·35
80	55	68·16	0·65	0·35
80	55	71·00	0·76	0·41
80	50	—	0·60	0·40
80	50	71·30	0·67	0·45
100	55	69·30	0·84	0·52
100	60	68·00	0·81	0·50
116	55	61·3	0·69	0·50
116	60	62·09	0·84	0·48
120	55	78·00	0·77	0·50
130	55	60·20	0·69	0·41
130	60	—	0·77	0·40
132	55	69·7	0·96	0·36
160	55	75·0	0·98	0·52
*80	100	78-80	1·2-1·4	0·33-0·4

*By standard conventional method.

TABLE XIV — PROPERTIES OF FRACTION V

Solubility:	(i) Alcohols (CH_3OH, C_2H_5OH, glycol, etc.)	Soluble
	(ii) Fatty acids (CH_3COOH; C_2H_5COOH, etc.)	Soluble
	(iii) Esters: (a) Ethyl lactate, dibutyl phthalate, etc.)	Soluble
	(b) Ethyl acetate	Partly soluble
	(iv) Ketones and Aldehyde (acetone, M.E.K., etc.)	Soluble
	(v) Aniline	Soluble
	(vi) Dioxane	Soluble
	(vii) Fusel oil	Soluble
	(viii) Hydrocarbon and Chlorohydrocarbons (like Benzene, Chloroform, Petroleum, etc., etc.)	Partly soluble
	Iodine value	8
	Molecular weight	500
	Percentage of constituent acids (i) Aleuritic acid 10 per cent (ii) Aldehydic acid 21 per cent (iii) Shellolic acid	

TABLE XV — EXTRACTION OF THE ETHER SOLUTION OF FRACTION V WITH $NaHCO_3$ SOLN. AND NaOH SOLN. PROPERTIES OF VARIOUS FRACTIONS

Name of fraction	Yield	Solubility	Acid value	Sap. value	Hydroxyl number	Iodine value	Molecular weight
(i) *Neutral Mass* (residue left over in ether)	6% (2% on the weight lac)	Soluble in ether, alcohol, acetone, etc.	3·5	162	16.0	3·3	338
(ii) $NaHCO_3$ extracted fraction	31%	Soluble in acid alcohol, ketone ether, etc.	Yet to be studied				
(iii) Caustic soda extracted fraction	52%	do					

TABLE XVI — SOLVENT EXTRACTION OF FRACTION V

Solvent used for fraction	Yield of fraction per cent	Properties of various fractions					
		Acid value	Sap. value	Hydroxyl value	Percentage of the constituent acid		Molecular weight
					Aleuritic acid per cent	Aldehydic acid per cent	
Petroleum ether	14	180	230	128	—	—	328
Benzene	30	98	191	179	16	22	412
Ethyl acetate	50	128	205	—	12	24	512
Acetone	3	—	—	—	—	—	—
Alcohol	1	—	—	—	—	—	—

TABLE XVII — FILM PROPERTIES OF WASH PRIMERS

Sl. No.	Modifiers	Percentage of modifier on the wt. of lac	Scratch hardness over 1 mm. steel ball kg.	Flexibility over (3 mm.) ⅛″ mandrel	Evaluating degrees of rusting in humidity cabinet at 42°-48°-42°C. 1 hr. cycle				Water immersion test at 37±1°C.			
					First rust spot developed (days)	Nature of rusting	Condition after 7 days	Condition after 15 days	First rust spot developed (days)	Nature of rusting	Condition after 7 days	Condition after 15 days
1	Urea and dibutyl phthalate	3 & 10	2000	Good	2	Fine rust spots without blistering	Rust spots increased	Same as on 7th day				
2	Saponified lac	25	1800	—	No rust spot	No rust spot	No rust spot	No rust spot	—	—	—	—
3	do	50	2000	—	4	Fine rust spots with med. dense blistering	Blisters increased	Same as on 7th day		—	—	—
4	do	75	1600	—	4	Fine rust spots with dense blistering	do	do	—	—	—	—
5	do	100	1300 (Tacky film)	—	—	—	—	—	—	—	—	—
6	Phenol	10	1700	Good	2	Fine rust spots without blistering	Rust spots increased	do	—	—	—	—
7	do	20	1850	do	2	do	do	do	—	—	—	—
8	do	30	1900	do	2	do	do	do	—	—	—	—
9	Cresol	2·5	1700	do	2	do	do	do	3	Fine rust spots without blistering	No further change	No further change
10	do	5·0	1700	do	2	do	do	do	3	do	do	do
11	do	7·5	1750	do	2	do	do	do	No rust spot	No rust spot	No rust spot	No rust spot
12	do	10	2000	do	2	do	do	do	do	do	do	do
13	do	20	2000	do	2	do	do	do	9	Fine rust spots without blistering	No further change	No further change
14	do	30	1900	do	2	do	do	do	3	do	do	Rust spots increased
15	Urea and dibutyl phthalate (washde pigment)	3 & 10	2000	do	No rust spots	No rust spots	No rust spots	—	—	—	—	—

TABLE XVIII — EFFECT OF HEAT ON 'TOTAL' HYDROLYSED LAC

Duration of heating hours	Temperature of oil-bath °C.	Acid value of reaction mixture
0	100°	237·8
1	—	232·0
2	—	228·8
3	—	226·3
4	—	215·9
5	—	209·3
6	—	201·4
7	—	195·3
8	—	189·3
9	—	181·5
10	—	176·4
12	—	168·3
14	—	159·4
16	—	148·3
18	—	138·7
20	—	129·4
22	—	119·9
24	—	112·4
26	—	109·8
28	—	99·4
30	—	97·4
0	150°	236·4
½	150°	226·2
1	150°	212·3
1½	150°	198·6
2	150°	196·5
2½	150°	187·3
3	150°	169·2
3½	150°	142·8
4	150°	128·3
4½	150°	109·9
5	150°	106·1
½	160°	220·9
1	160°	190·8
1½	160°	171·8
2	160°	148·9
2½	160°	143·3
3	160°	134·5
3½	160°	126·9
4	160°	116·6
4½	160°	111·9
½	180°	222·3
1	180°	175·2
1½	180°	140·1
2	180°	115·2
2½	180°	103·0

TABLE XIX — FILM PROPERTIES OF RE-CONSTITUTED SHELLAC

Expt. No.	Solvent used	Baking temp. °C.	Baking time	Hardness in kg.	Flexibility	Blush test
1	Aqueous ammonia	Air-dried	for 7 days	>2	Flexible	Blushed in 2½ hours
2	do	100	60 mins.	do	do	do
3	do	150	15 mins.	do	do	do
4	do	do	7½ mins.	do	do	do
5	Spirit: Toluene 2:1	Air-dried	for 7 days	do	do	do
6	do	100	60 mins.	do	do	Blushed in 3 hours
7	do	150	15 mins.	do	do	do
8	do	do	7½ mins.	do	do	do

TABLE XX — FILM PROPERTIES OF LAC-ETHYLENE GLYCOL ETHER SHELLAC COMPOSITIONS. FILMS BAKED AT 100°C. FOR 1 HOUR

Soln. No.	Composition lac: lac-ethylene glycol ether	Flexibility	Hardness on tin plates load on 1 mm. ball kg.	Blush test in glass plates
1	1: 0·5	Flexible	2·5	Blushed in 24 hours
2	1: 1	do	2·5	Slight blush in 24 hours
3	1: 2	do	1·0	Blushed in 40 hours 40 min.

TABLE XXI — FILM PROPERTIES OF SHELLAC-ETHYLENE GLYCOL ETHER OF LAC (1:1) COMPOSITION CONTAINING UREA — FILMS BAKED AT 100°C. FOR 1 HOUR

Expt. No.	Urea used % on the wt. of lac	Hardness on tin panels kg.	Blushing on 24 hours immersion	Flexibility
1	0	>2	Faint blush	Flexible
2	0·5	>2	do	do
3	1·0	>2	do	do
4	1·5	>2	No blush	do
5	2	>2	do	do
6	2	>2	Slight blush	do
7	6	>2	Blushed in 4 hours	do
8	9	>2	Blushed in 3 hours	do

TABLE XXII — FILM PROPERTIES OF LAC — PHENOL COMBINATION SCRATCH HARDNESS — LOAD IN KG. ON 1 MM. STEEL BALL

Solutions containing 25 gm. of dewaxed decolourized lac in 75 gm. of spirit were used for all these experiments

Phenol used — Conditioning of film

tity enol ent ight c	Phenol						*meta*-cresol						*para*-cresol						Cresylic acid					
	Air-dried at lab. temp. for 7 days		Baked at 100°C. for 1 hour		Baked at 160°C. for 7½ mins.		Air-dried at lab. temp. for 7 days		Baked at 100°C. for 1 hour		Baked at 160°C. for 7½ mins.		Air-dried at lab. temp. for 7 days		Baked at 100°C. for 1 hour		Baked at 100°C. for 7½ mins.		Air-dried at lab. temp. for 7 days		Baked at 100°C. for 1 hour		Baked at 160°C. for 7½ mins.	
	Tin	Glass	Tin	Glass	Tin	Glass	Tin	Glass	Tin	Glass	Tin	Glass	Tin	Glass	Tin	Glass	Tin	Glass	Tin	Glass	Tin	Glass	Tin	Glass
0	0·40	0·75	1·80	—	1·10	0·90	0·35	0·70	1·80	1·20	2·00 scratch	—	0·40	0·50	1·80	0·90	1·40	0·90	0·40	0·70	1·80	0·70	1·70	—
5	0·30	0·90	more than 2·00	—	2·00	0·70	0·30	0·65	1·10	1·05	do	—	0·50	0·60	1·90	0·90	1·90	0·80	0·40	0·80	2·00	0·80	1·90	—
0	0·30	0·75	do	—	more than 2·00	0·90	0·45	0·65	1·00	1·25	2·00	—	0·80	1·20	2·00	0·90	2·00	0·80	0·30	0·65	2·00	0·65	more than 2·00	—
5	0·30	0·80	do	—	do	1·00	0·30	1·20	1·90	1·35	2·00	—	1·20	1·20	2·00	0·90	2·00	0·80	0·30	0·60	2·00	0·60	do	—
·0	0·20	1·15	do	—	do	2·00	0·40	1·50	more than 2·00	2·00	2·00	—	1·00	2·00	2·00 better than above	2·00	1·90	0·80	0·40	0·30	2·00	0·30	do	—

TABLE XXIII — FILM PROPERTIES OF LAC — PHENOL COMBINATION

Blush-resistance test — Panels immersed in water for 24 hours

Solution containing 25 gm. of dewaxed decolourized lac in 75 gm. of spirit were used for all these experiments

Phenol used — conditioning of film

ntity henol cent veight ac	Phenol (carbolic acid)						*meta*-cresol						*para*-cresol						Cresylic acid					
	Air-dried at lab. temp. for 7 days		Baked at 100°C. for 1 hour		Baked at 160°C. for 7½ mins.		Air-dried at lab. temp. for 7 days		Baked at 100°C. for 1 hour		Baked at 160°C. for 7½ mins.		Air-dried at lab. temp. for 7 days		Baked at 100°C. for 1 hour		Baked at 160°C. for 7½ mins.		Air-dried at lab. temp. for 7 days		Baked at 100°C. for 1 hour		Baked at 100°C. for 7½ mins.	
	Tin	Glass	Tin	Glass	Tin	Glass	Tin	Glass	Tin	Glass	Tin	Glass	Tin	Glass	Tin	Glass	Tin	Glass	Tin	Glass	Tin	Glass	Tin	Glass
0·0	F	F	—	N	N	N	F	F	N	N	N	N	F	F	N	N	N	N	F	F	N	—	N	—
2·5	D	D	—	Y.D.	N	D	D	D	N	D	N	D	D	D	N	N.c.	N	N	D	D	N	—	N	—
5·0	D	D	—	D	N	D	D	D	N	N	N	D	D	D	N	N.c.	N	N	D	D	N	—	N	—
7·5	F	F	—	F	N	D	D	D	N	N	N	F	D	D	N	N.c.	N	N	D	D	N	—	N	—
0·0	F	F	—	F	N	D	D	D	N	D	N	D	D	F	N	N.c.	N	D	D	D	N	—	N	—

N=No blush. D=Distinct blush. N.c.=No blush—Film came out. F=Faint blush. Y.D.=Deep blush.

TABLE XXIV — FILM PROPERTIES OF LAC — PHENOL COMBINATION

Flexibility — Bent on ⅛″ rod

Solutions containing 25 gm. of dewaxed decolourized lac in 75 gm. of spirit were used for all these experiments. All film were on tin panels only

Phenol used — conditioning of film

Quantity of phenol per cent on weight of lac	Phenol (carbolic acid)			*meta*-cresol			*para*-cresol			Cresylic acid		
	Air-dried at lab. temp. 7 days	Baked at 100°C. for 1 hour	Baked at 160°C. for 7½ mins.	Air-dried at lab. temp. 7 days	Baked at 100°C. for 1 hour	Baked at 160°C. for 7½ mins.	Air-dried at lab. temp. 7 days	Baked at 160°C. for 1 hour	Baked at 160°C. for 7½ mins.	Air-dried at lab. temp. 7 days	Baked at 100°C. for 1 hour	Baked at 160°C. for 7½ mins.
0·0	M.c.	M.c.	N.c.	M.c.	M.c.	N.c.	N.c.	M.c.	N.c.	M.c.	M.c.	M.c.
12·5	M.c.	M.c.	S	S	M.c.	S	M.c.	N.c.	S	M.c.	N.c.	N.c.
25·0	M.c.	S	U	M.c.	U	U	N.c.	N.c.	U	S	N.c.	U
37·5	S	U	U	M.c.	U	U	N.c.	U	U	S	U	U
50·0	U	U	U	U	U	U	U	U	U	S	U	U

C=Film crack. N.c.=No crack. S=Not scratchable at bend but removable by nail. M.c.=Micro crack.

TABLE XXV — HEAT-RESISTANCE TEST

The solutions containing 25 gm. of lac and 75 gm. of spirit

Sl. No.	Composition	Temperature °C.					
		60	62	64	66	68	70
1	0·0% of phenol	S.	—	—	—	—	—
2	12·5% ,,	—	—	S.S.	S.	—	—
3	25·0% ,,	D.S.	S.S.	S.S.	S.	—	—
4	37·5% ,,	—	D.S.	D.S.	S.S.	S.S.	S.
5	50·0% ,,	D.S.	D.S.	D.S.	S.S.	S.	—
6	0·0% *m*-cresol	S.	—	—	—	—	—
7	12·5% ,,	D.S.	D.S.	S.S.	S.	—	—
8	25·0% ,,	D.S.	D.S.	S.S.	S.	—	—
9	37·5% ,,	D.S.	D.S.	D.S.	S.S.	S.S.	S.
10	50% ,,	D.S.	D.S.	D.S.	S.S.	S.S.	S.
11	0·0% *p*-cresol	S.	—	—	—	—	—
12	12·5% ,,	D.S.	D.S.	S.S.	S.	—	—
13	25% ,,	D.S.	D.S.	S.S.	S.S.	S.	—
14	37·5% ,,	D.S.	D.S.	D.S.	D.S.	S.S.	S.
15	50% ,,	D.S.	D.S.	D.S.	S.S.	S.S.	S.
16	0·0% cresylic acid	S.	—	—	—	—	—
17	12·5% ,,	D.S.	S.S.	S.S.	S.	—	S.
18	25·0% ,,	D.S.	D.S.	D.S.	D.S.	D.S.	S.S.
19	37·5% ,,	D.S.	D.S.	D.S.	D.S.	S.S.	S.S.
20	50% ,,	D.S.	D.S.	D.S.	S.S.	S.S.	S.

D.S.=Does not stick. S.S.=Sticks slightly. S.=Sticks fully.

TABLE XXVI

(i) *All varnishes contained 25 gm. of lac for 75 gm. of spirit.*

(ii) *Percentage of urea and plasticizers indicated are on the weight of lac.*

(iii) *All panels were tested after seven days of air-drying.*

Lac	Additives curing agent and plasticizers	Scratch hardness of film on tin panels, load on 1 mm. steel ball kg.	Heat-resistance 1 litre beaker containing water at boiling temp. placed on film on wooden surface for five minutes and then removed	Water immersion test			Flexibility bent on ½" rod
				Film on tin plates after 24 hrs. immersion	Film glass plates After 3 hrs. immersion	Film glass plates After 24 hrs. immersion	
W.R. Lac* (I.L.R.I.)	—	0·40	—	No blush	No blush. Film came out	No blush. Film came out	Fine hair cracks
,,	10% D.B.P.	0·30	—	D. blush†	No blush	F. blush§	No crack
,,	20% D.B.P.	0·30	—	D. blush	F. blush	D. blush	Fine hair cracks
,,	10% T.C.P.	0·25	It stands the heat. Beaker does not stick	No blush	No blush	No blush	Cracks and peals off
,,	10% Sextol pthalate	0·20	It stands the heat. Beaker does not stick	F. blush	No blush	No blush	Fine hair cracks
W.R. Lac* (S.E.P.C.)	—	0·35	—	F. blush	Film came out	Film came out	Fine hair cracks
,,	10% D.B.P.	0·45	—	F. blush	F. blush	D. blush	Cracks and peals off
,,	20% D.B.P.	0·35	—	D. blush	D. blush	D. blush	No crack
,,	10% T.C.P.	0·35	It stands the heat. Beaker does not stick	F. blush	No blush	D. blush	Fine hair cracks
,,	10% Sextol pthalate	0·25	—	F. blush	Film came out	Film came out	Fine hair cracks
D.D. Shellac‡	—	0·40	—	No blush	No blush	No blush	Fine hair cracks
,,	3% urea† 10% D.B.P.	0·40	It stands the heat. Beaker does not stick	No blush	No blush	No blush	Fine hair cracks
,,	10% D.B.P.	0·50	—	D. blush	F. blush	D. blush	No crack
,,	20% D.B.P.	0·30	—	D. blush	F. blush	D. blush	No crack
,,	10% T.C.P.	0·40	—	F. blush	F. blush	D. blush	Fine hair cracks
,,	10% Sextol pthalate	0·55	—	F. blush	No blush	F. blush	Fine hair cracks
,,	3% urea† 10% sextol pthalate	0·30	It does not stand the heat. Beaker sticks	No blush	Film came out	Film came out	Fine hair cracks

*Water-resistant Lac (Urea-sulphur dioxide treated lac).
†Deep blush. ‡Dewaxed decolorized shellac. §Faint blush.

TABLE XXVII — LAC-METHYL METHACRYLATE (EMULSION)

Polymer No.	Copolymer		Intrinsic viscosity of the	
	Composition — polymers prepared from dewaxed lac (parts by weight)	Methyl methacrylate (parts by weight)	Physical mixture	Copolymers
I	100	0	0·067	0·067
II	80	20	0·36	0·52
III	70	30	0·78	0·73
IV	60	40	0·94	0·99
V	50	50	1·09	1·20
VI	50	50	1·33	1·19
VII	0	100	2·40	2·40

TABLE XXVIII

Solvent	Solubility of polymers						
	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)
Alcohol	S	S	S	S	S	S	I
Diacetone alcohol	,,	,,	,,	,,	,,	,,	S
Dioxane	,,	,,	,,	,,	,,	,,	,,
Dimethyl formamide	,,	,,	,,	,,	,,	,,	,,
Cyclohexanol	,,	,,	,,	,,	,,	,,	,,
Propyl alcohol	,,	PI	PI	PS	PS	PS	—
Butyl alcohol	,,	,,	,,	,,	,,	,,	—
Ethyl acetate	PS	PS	PS	I	I	I	—
Benzene	I	SS	SS	SS	SS	SS	—
Toluene	PS	,,	,,	,,	,,	,,	—
Acetone	,,	,,	,,	,,	,,	,,	—
Methyl alcohol	S	,,	,,	,,	I	I	—
Methyl ethyl ketone	PS	I	I	I	I	I	S
Ether	,,	,,	,,	,,	,,	,,	—
Petroleum ether (60-80°C.)	I	,,	,,	,,	,,	,,	—
Chloroform	PS	,,(Sw)	,,(Sw)	,,(Sw)	,,(Sw)	,,(Sw)	S

S=Soluble; PS=Partly soluble; SS=Slightly soluble; I=Insoluble; PI=Partly insoluble; Sw=Swelling.

APPENDIX C

GOVERNMENT OF INDIA
MINISTRY OF WORKS, HOUSING & SUPPLY
GOVERNMENT TEST HOUSE, ALIPORE, CALCUTTA

TEST CERTIFICATE

No. CP/SP/61/60, dated the 20 Jan. '62

Issued to the Director, Indian Lac Research Institute, P.O. Namkum, Ranchi (Bihar) correspondence resting with his
letter No. LR-IU/34A/61/6828, dated the 16-12-1961.

Register No. 60/SP — Dated the 14-11-61

Sample received on the 8-11-61 in a tin container.

One sample of Readymixed Paint of the following particulars:

Description — Shellac Wash Primer.
Identification mark — 107-IV.
Forwarding letter No. LR-IU/34A/61/6040 dt. 20-11-61.
Tested for the usual physical characteristics of a primer.

Results of tests:

1. Consistency	...	Suitable for application by brushing
1. (a) Time of hard drying	...	Less than 1 hour
2. Finish	...	Hard, brittle, smooth and matt
3. Colour	...	Yellow with a greenish tint; similar to that of zinc chrome primer
4. Protection against corrosion	...	Satisfactory
5. Resistance to salt spray (96 hours)	...	Satisfactory
6. Scratch hardness test	...	Passes
7. Flexibility and adhesion test (after 48 hrs. drying)	...	Passes
8. Closed flash point (Abel)	...	70°F.
9. Weight per Imperial gallon	...	10·6 lb.

Remarks:

The tested characteristics of the sample are considered to be satisfactory for a primer.

Sd/-
(N. B. SEN GUPTA)
Asstt. Director (Chemical), for Director,
Government Test House

APPENDIX D

Tabulated Statement of Progress of Investigation

ENTOMOLOGY DIVISION

ITEM	DATE COMMENCED	PROGRESS	REMARKS
IIA — RESEARCH AND INVESTIGATIONS			
1. Improving crop production on *palas*			
Large-scale cultivation	1948-49	(i) Over 21,000 trees under lac. Expenditure Rs. 4777·88 nP. Revenue Rs. 4391·81 nP. Loss due to fall in price.	To be continued
2. Evolution of cultivation practices			
(i) *Palas*	1959	(a) Four treatments under trial. Of them, D (Light inoculation in Oct.-Nov. followed by complete cropping in Oct.-Nov. next) gave maximum broodlac per tree, namely 2·80 kg. and also maximum brood to brood yield ratio, namely 1: 12·0.	
		B [Heavy inoculation in Oct.-Nov., partial cropping (as *ari*) in April and complete cropping in Oct.-Nov. next] gave the maximum scraped lac.	To be continued
		(b) 2200 trees were heavily inoculated and 2300 trees were lightly inoculated in October-November and completely harvested. Heavy inoculation gave better results with 0·59 kg. yield per tree.	To be continued
(ii) *Kusum*	1961	(ii) Three treatments, namely: A — 1-year rest; inoculation in January-February and June-July in separate coupés leaving for self-inoculation in next season and cropping 1 year after inoculation; B — 2-year rest; inoculation and cropping as in A;	
		C — 1½-year rest; 4 coupés to be used as usual.	To be continued
3. Determination of optimum density of larval settlement on various hosts			
(i) *Kusum*	1958	(i) D treatment (using 4 times the normal brood) showed the best results and confirmed the previous finding, i.e. increased yields go with increased brood rates.	Concluded
(ii) *Palas*	1961	(ii) Three treatments in the form of 3 brood rates being tried, namely A — Half-normal brood rate, B — Normal brood rate, and C — Double-normal brood rate.	
		Increase in brood yield was not proportional to increase in brood rate.	To be continued

APPENDIX D (*Contd.*)

ITEM	DATE COMMENCED	PROGRESS	REMARKS
4. Determination of optimum density of larval settlement and proper time of harvesting			
(i) *Palas*	1957-58	Increase in brood used gave increased yield. Maximum crop obtained by harvesting at maturity.	To be continued
(ii) *Ber*	1961	Same treatments as in *palas* adopted. Inoculated for *Baisakhi* 1961-62.	To be continued
5. Economics of utilizing *palas* for *Baisakhi* crop and *ber* for *Kátki* crop only	1953	Results confirm previous findings, i.e. *palas* is better than *ber* as brood preserver in the *Baisakhi* crop.	Concluded
6. Studies on pruning time for *ber* for *Katki* crop	1960-61	Four treatments, namely pruning in February, May, October and December are being tried. Results of *Katki* 1961 indicate B (May pruning) to be the best.	To be continued
7. Finding of brood preservers for *Baisakhi* crop	1945-46	*Albizzia stipulata* brood was used to inoculate 14 hosts. *Albizzia lucida, Ficus infectoria, Ficus glabella* and *Ficus cunia* have shown promising results.	To be continued
8. Growing of lac hosts under bush conditions	1957-58		
(i) *Ber*		(i) After coppicing for 3-4 years, *ber* plants grew into good bushes and *Baisakhi* 1961-62 crop is progressing satisfactorily.	To be continued
(ii) *A. lucida*		(ii) *A. lucida* trained into bushes and inoculated for *Jethwi* 1962 showed heavy larval mortality.	To be continued
(iii) *Moghania macrophylla*		(iii) Transplanting of 1 April-raised *Moghania macrophylla* seedling in July is the most satisfactory treatment.	
		C treatment (4′×4′ spacing) of *Moghania macrophylla* has given the maximum yield in a fixed size of plot.	To be continued
(iv) *Moghania chappar*		(iv) Preliminary experiments on lac cultivation on *Moghania chappar* has shown promising results.	To be continued
9. Biological control of insect enemies			
(i) Mass-rearing of *Apanteles tachardiae*	1957	(i) Ten generations with a total of 1,26,284 were reared. On an average 39·84 per cent *Corcyra cephalonica* were parasitized.	To be continued
(ii) Life-history studies of *Apanteles fakhrulhajiae*	1959	(ii) Two treatments are being tried, namely: A — Optimum temperature 27-28°C. with 30-40 per cent humidity and B — 20°C. temperature with optimum humidity 80-90 per cent.	
		B treatment gave better results as regards viability, life period and longevity.	To be continued

APPENDIX D (*Contd.*)

Item	Date commenced	Progress	Remarks
(iii) Mass-rearing of *Bracon greeni*	1959	*Corcyra cephalonica* has been found to be an unsuitable alternative host due to its over-activities. Parasite did not accept coddled or chloroformed hosts. Reverted to trials with its natural host — *Eublemma amabilis* by the usual dome method. Number of eggs laid were directly proportional to the host-size.	To be continued
(iv) Life-history studies of *Pristomerus sulci*	1961	A rearing technique has been evolved. 15·35 per cent *Corcyra cephalonica* were parasitized in the laboratory against 30 per cent field-parasitization.	
(v) Rearing and life-history studies of *Brachymeria tachardiae* Cam.	1961	Development was found to be quicker at 26±1°C. than at laboratory temperature ranging from 16·1°C. to 25·5°C.	To be continued
10. Survey of lac enemies and their parasites	1961	A new endo-parasite of *Holcocera pulverea*, namely *Agathis* sp. was discovered.	To be continued
11. Pests of host trees			
(i) Pest of *Moghania macrophylla*	1961	A microlepidopteron pest was collected. In the laboratory it completed its life cycle in 20·9 and 28·8 days.	To be continued
(ii) Pest of *palas*	1961	*Holotrichia serrata* (Melolonthidiae) is being studied. Egg stage lasted on an average for 12·2 days, 1st instar for 28·6 days, 2nd instar for 33·5 days and 3rd instar for 68·4 days.	
12. Genetical studies on lac insect			
(i) Cross-breeding of *ranginee* and *kusmi* strains	1959	*Ranginee* females crossed with *kusmi* males behaved like *ranginee* insects which indicates that either they are different species and they reproduce parthenogenetically or they are hermaphrodites.	To be continued
(ii) Abnormal lac cells	1960-61	Apparently such cells appeared to be fungus-attacked but found to be healthy but with heavy deposition of wax filaments from surpentine areas. These cells are bigger in size and with higher fecundity than the normal cells, and produced normal cells.	Concluded
(iii) Isolation of pure yellow strain		Only about 5 per cent of the yellow larvae reached crop maturity in two generations. They were destroyed by chalcid attack in the second generation.	To be continued
13. Investigations on the coloration of lac resin	1960	Coloration of the initially colourless resin is primarily due to heat and not due to light, wax, honey-dew or insect body fluid.	Concluded
14. Physiological studies on the lac insect	1960	5-20 per cent solutions of glucose, dextrose, vitamin B and yeast with rubber and cotton covered by tissue paper as substrates were tried for rearing of lac insects through artificial feeding.	
		Larvae lived longer (2 months) with cotton as substratum and secreted some resin.	To be continued

APPENDIX D (*Contd.*)

Item	Date commenced	Progress	Remarks
15. Physiological cum Cytological studies on the lac insect			
(a) Physiological studies	1960	Lac-resin glands were found to have both uni-nuclear and binuclear condition; the nucleus carries a deeply staining nucleolus; Cytoplasm is dense and granular with one or two vacuoles.	
		Wax in the lac-resin mass of the equatorial region of the insect was quantitatively estimated to be up to 15 per cent, presumably due to presence of giant wax glands in the region.	
(b) *Cytological studies*		A diploied chromosome number of 18 was found in all the different types of cells	
		A living sperm is slender thread-like with anterior end spirally twisted.	
IIB — Regional Field Research Stations			
1. Jhalda (West Bengal)			
(i) Spurious emergence of larvae in *kusum* lac	1959	*Kusum* trees inoculated with pure *palas, ber* and *kusum* and mixed broods.	
		Aghani 1961-62 from spuriously emerged progeny died completely.	
		Early emergence was observed in October 1961 from *Aghani* 1961-62, but only one tree of A treatment was harvested and used for inoculation.	To be continued
(ii) Alternative *kusmi* hosts	1959	*Ficus* sp. showed the best results both in *Jethwi* 1961 and *Aghani* 1961-62. Brood to yield ratio being 1 : 2·8 and 1 : 4·0 respectively.	To be continued
2. Damoh (M.P.)			
(i) Pruning response of *ghont*	1959	Pruning in second week of April (A treatment) for the *Baisakhi* and in second week of May of the previous year (C treatment) for the *Katki* showed the best results in shoot-growth as well as yields.	To be continued
(ii) Optimum brood requirement for *ghont*	1959	In *Baisakhi* 1960-61 half-normal brood rate showed the highest brood to yield ratio.	
		In *Katki* 1961 normal brood rate showed the highest brood to yield ratio.	To be continued
(iii) Evolution of a cultivation practice for *ghont*	1961	Freshly laid out for three treatments:	
		A — Light inoculation in October-November and complete harvesting in October-November next without any operation in June-July.	
		B — Heavier inoculation (twice the rate of A) in October-November, removal of dead lac and excess brood in June-July and complete harvesting in October-November next.	
		C — Very heavy inoculation (4 times the rate of A) and complete *ari*-cutting in April.	To be continued

APPENDIX D (*Contd.*)

Item	Date commenced	Progress	Remarks
(iv) Trials with regional hosts	1959	*Ber* proved better brood preserver than *ghont*.	To be continued
(v) Introduction of exotic hosts	1959	*Samanea saman, Albizzia lucida, Ougeinia dalbergioides* and *Moghania macrophylla* have been planted.	To be continued
3. Mirzapur (U.P.)			
(i) Pruning response of *ghont*	1960	Pruning in third week of May (B treatment) for *Baisakhi* 1960-61 showed the best results in shoot-growth and yield.	
		Pruning in second week of February (B treatment) for *Katki* 1961 showed the best results in shoot-growth as well as yields.	To be continued
(ii) Optimum brood requirement for *ghont, palas* and *ber*	1960	In *Baisakhi* 1960-61 half-normal brood rate in all the three hosts gave the best crop.	To be continued
		No conclusion could, however, be drawn for *Katki* 1961.	
(iii) Evolution of a cultivation practice to be followed for *ghont, palas* and *ber*	1960	Freshly laid out as at Damoh.	To be continued
(iv) Trials with regional hosts	1960	No conclusions can be drawn.	To be continued
(v) Introduction of exotic hosts	1960	*Samanea saman, Albizzia lucida* and *Moghania macrophylla* have been planted.	To be continued
4. Umaria (M.P.)			
(i) Evolution of a suitable cultivation practice for *kusum*	1961	Three treatments are being tried.	
		1-year rest between pruning and inoculation (A treatment), 2-year rest (B treatment), and 1½-year rest (C treatment) are being tried. Harvesting in all the treatments will also serve as pruning.	To be continued
(ii) Trials with regional hosts	1961	Being carried out.	To be continued
(iii) Introduction of exotic hosts	1961	*Moghania macrophylla* has been planted.	To be continued
III. Plantation at Namkum		General upkeep maintained. *M. macrophylla* and other hosts raised.	
IV. Training and Advisory Service			
(i) Training		Forty-eight trainees completed 6-month course in two sessions. Fifteen trainees completed 1-month course in two sessions.	
(ii) Extension and advisory service		Technical advice given to various parties and extension work done in neighbouring villages.	

APPENDIX D (*Contd.*)

CHEMISTRY DIVISION

Item	Date commenced	Progress	Remarks
I. Grading and Analysis			
(1) Bleach index/ bleachability	1957	Use of photoelectric colorimeter has been standardized for determination of bleach index as recommended by the Technical Committee of I.S.O.	Work completed
(2) Specification of refuse lac	1960	A draft specification has been prepared after analysing a number of samples of refuse lac collected from different factories.	do
(3) Alternative method for determination of moisture	1961	The determination of moisture in lac samples by the simple method of drying in a H_2SO_4 desiccator has been investigated, in place of using vacuum for drying in the desiccator.	do
(4) Correlation of quality of lac especially colour with climatic conditions of area of cultivation	1960	More samples were tested and the work is in progress.	Work to be continued
II. Improvement in the manufacture of seedlac, shellac, bleached lac, etc.			
(1) Improved method of lac washing with potassium permanganate	1957	Some more experiments have been done. The result shows that yield by this process is 5-6 per cent higher than by the conventional soda process.	
		Bleach index and keeping qualities are similar.	Work completed
(2) Preparation of shellac from seedlac and refuse lac by alkali extraction	1956-57	Extraction of lac from seedlac and refuse lac by a solution of a mixture of sodium carbonate and sodium sulphite produced a shellac which is very near to the shellac made by *bhatta* process as regards hue and colour. The method of extraction has been standardized. Further work is in progress.	To be continued
(3) Bleaching of lac			
(a) Bleached lac plant	1957	Pilot plant has been installed and a number of batches of bleached lac has been prepared. The plant is complete to produce regular (with wax) quality bleached lac.	
(b) Bleached lac, Laboratory studies		(i) Dependence of keeping quality on the quality of seedlac has been studied. So far no difference could be observed.	
		(ii) Paler colour bleached lac could be prepared by using 50 per cent excess bleach liquor. But the keeping quality in comparison with normal bleached lac is poor.	Work completed

APPENDIX D (*Contd.*)

ITEM	DATE COMMENCED	PROGRESS	REMARKS
		(iii) Lead-thiosulphate has been found to act as a good stabilizer to bleached lac and does not affect the useful properties of bleached lac. Optimum quantity required has been determined.	Work completed
		(iv) The reaction of sodium hypochlorite solution on aleuritic acid which is a chief constituent of lac has been studied. The vicinal hydroxyl groups remain unaffected where as the end —OH group is replaced by chlorine. Further work is in progress.	
(c) Rapid method of bleaching lac		Prolonged contact of sodium-hypochlorite bleaching solution with lac during bleaching adversely affect the flow and life of the bleached lac. A method has been developed where lac is kept in suspension as sodium salt and bleached by 50-60 per cent of the quantity of bleach liquor required by conventional method. By this method bleaching is complete within 2-3 hours. The product compares very well with the bleached lac obtained by the conventional method.	
III. Fundamental Researches			
(1) Constitution studies: Separation and study of the components of fraction V	1961	Fraction V is soluble in organic solvents and has molecular weight 500 and iodine value 8. Percentage of constituent acids: Aleuritic acid 10 per cent, aldehydic acid 21 per cent. A non-acidic fraction has been obtained. The original fraction V has been further separated by extracting with different organic solvents. Paper chromatogram of the products of hydrolysis of these fractions were found to be alike.	
(2) Thermal polymerization of shellac	1959	(i) Activation energies of heat polymerized shellac and mixtures of urea and hexa with shellac have been determined.	
		(ii) The equipment for study of differential thermal study is being assembled.	
IV. Utilization of lac			
(1)(a) Shellac wash primer	1957	The formulation and testing of the primer was continued. Steps have been taken to popularize the primer among the potential consumers. Natural and dynamic weathering tests of primer films have been found satisfactory. Railway coaches painted with the primer were examined after one year of run. No deterioration was noticed.	

APPENDIX D (*Contd.*)

ITEM	DATE COMMENCED	PROGRESS	REMARKS
		To meet the demand for samples, totalling about 100 gal., from different consuming industries a batch of 100 gal. was manufactured by M/s. Shalimar Paint, Colour & Varnish Co., Calcutta. Now the party is manufacturing the shellac primer on a commercial basis. Over two thousand litres of the primer have been sold to various industries.	
(b) Shellac wash primer as an anti-corrosive primer for steel	1961	Shellac-based etch primer for mild steel has been developed, serving as an anti-corrosive primer.	
(2) Hydrolysed Lac			
(3) Reconstituted shellac	1961	Reconstituted shellac in alkali-hydrolysed whole lac (water-soluble and insoluble) partially recombined by heating to have the acid value of 108. The solution of the shellac in water with ammonia or in spirit produces films hard and flexible but not blush-resistant.	Work is in progress
(4) Plasticizer for aqueous shellac varnish		Performance of ethylene glycol ether of shellac as plasticizer for aqueous shellac varnish has been studied. 20 per cent solution of lac and 2 per cent solution of ether in ammoniated water in 1:1 proportion has been found to be best so far.	Work is in progress
(5) Shellac composition as bed material for hydraulic models	1959	The modified composition with urea, paraformaldehyde and coal-dust has been approved by Central Water & Power Research Station, and order for 1·5 tons (approximately) has been placed.	
(6) Modification of shellac with phenols		Shellac varnish in spirit has been modified by adding phenol, *m*-cresol, *p*-cresol and cresylic acid in different proportions. Scratch hardness and flexibility increases with increasing proportion of phenols whereas blush- and heat-resistances are not improved. Melting and softening points of shellac modified by mixing phenols either in cold or by heating are lowered. Other properties are being studied.	
(7) Shellac spirit varnish—improving heat- and blush-resistance		The incorporation of 3 per cent urea and 10 per cent dibutyl phthalate on the wt. of lac has improved the heat- and blush-resistance. Similar properties were noticed with shellac urea sulphite varnish with tricresyl phosphate.	
(8) Lac oil insulating varnish		A 'through' drying insulating varnish based on shellac, drying oil, glycerine and phthalic anhydride as described in patent literature has been prepared. The properties are being studied.	

APPENDIX D (*Contd.*)

Item	Date Commenced	Progress	Remarks
V. Modification of lac			
(1) Modification with diisocyanate		Toluene diisocyanate (Suprasec C) and lac was reacted in acetone solution in different proportion (1 to 6 parts). Product with up to 5 parts suprasec was soluble in spirit while with 6 parts only partially soluble. Films of product of 5 parts suprasec and lac has been found to be remarkably resistant to spirituous liquor.	Study is being continued
(2) Copolymerization of lac with monomers	1960	Experiments on emulsion copolymerization of methyl methacrylate and vinyl acetate with lac were continued in presence of benzoyl peroxide as catalyst. Suspension copolymerization also was carried out in presence of redox (Pot-persulphate and pot *meta*-bisulphite) catalyst. Evidence of copolymerization of lac with methyl methacrylate has been observed from the difference of viscosities of copolymerization product and mechanical mixture of the components. Copolymerization with vinyl acetate could not be accomplished.	Work is in progress
VI. Hygienic disposal of lac factory waste		As a preliminary of the pilot plant experiment, an experiment of continuous process was conducted in the laboratory by adding sulphuric acid to a steady flow of lac-wash. The dye precipitation in the settling tanks and the effluent water did not putrify even after 20 days.	Pilot plant work is in progress
VII. Utilization of lac in India — Publicity and Propaganda			
(1) Lac dye		To determine the possibility of reintroducing lac dye in trade sample was sent to Silk and Art Silk Research Association, Bombay. Their report suggests some research problem on dye to improve its qualities.	
(2) Varnish and lacquer		Book varnish with anti-mould compound has been tried with success in I.I.T., Kharagpur. Picture varnish is a new introduction. Samples and methods of preparation of different varieties of varnish have been supplied to different firms.	
(3) Water-soluble lac		Use of water-soluble lac as a binding resin in metallurgical green sand mould is a new one. To prevent evaporation of water, water-soluble lac has been used as sealer at the cut ends of sugarcane cuttings meant for germination. Pottery training centres have taken the material regularly.	
(4) Adhesive and cement		Some of the electric bulb manufacturers have taken caping cement made of shellac.	

APPENDIX D (*Contd.*)

ITEM	DATE COMMENCED	PROGRESS	REMARKS
(5) Shellac wash primer		110 gallons samples have been supplied to 60 prospective consumers and most of them have given satisfactory report. Now the primer is marketed by M/s. Shalimar Paint, Colour & Varnish Co. Ltd., Calcutta.	
(6) Technical aid to manufacturers		As technical aid to manufacturers schemes, suggestions, drawings and details of processes have been supplied. Three parties have installed sand separator in their factories.	
(7) French Polishing Publicity Centre		French Polishing Publicity Centre at New Delhi. Work continued very smoothly.	
(8) Regional Testing Laboratories		Two Regional Testing Laboratories were started. One at Balarampur, Dt. Purulia, West Bengal and other at Daltonganj, Dt. Palamau, Bihar. Laboratory at Jhalda was temporarily closed as no work was being received. Samples tested during this year: Gondia 791, Balarampur 645, Jhalda 54, and Daltonganj 14. Besides analytical work the analyst incharges gave demonstration of the processes of making some articles from lac.	
(9) Exhibition and other activities		The Institute participated in three Industrial exhibitions. Various lac products and exhibits were shown. A survey of the lacquer industry of the country has been made.	
		All pictures and photographs of Rabindra-sadan, Santiniketan have been varnished with shellac lacquer.	
VIII. Production Unit		Five grades of special shellac were manufactured and sold. Three parties have started making bleached lac and selling in the market. 873 kg. of special shellac at a total price of Rs. 5,937.60 nP. has been sold with a gross profit of Rs. 2,000.	

APPENDIX E

List of Publications from the Institute during 1961-62

1. Towards More and Better Lac, by S. Krishnaswami (*Indian Farming*, Vol. **XI**, No. 1, April 1961, pp. 14-17, 39).
2. Rat Menace to Lac Crops, by S. Krishnaswami, B. K. Purkayastha & M. K. Chowdhury (*Indian J. Ent.*, Vol. **XXI**, Part 3, Sept. 1959, pp. 222-25).
3. The Value of Shellac in Arts, by O.P. Ratra (*Indian Nation*, dated 19th October 1960).
4. Notes on Some Recorded and Unrecorded Plants with *Kusmi* Strain of the Lac Insect, by B. K. Purkayastha & S. Krishnaswami (*Current Science*, April 1961).

5. The Living Sperm of *Laccifer lacca*, by S. Dikshit (*Current Science*, Vol. **31**, No. 2, February 1962, pp. 73-74)
6. *Coptosoma ostensum* Dist. — A Pentatomid Pest of *Palas* (*Butea monosperma*) with Notes on Its Coccinellid predator *Synia melanaria* Var. *Rougeti muls* and Egg parasite *Telenomus* species, by C. P. Malhotra & S. Krishnaswami (*Indian Forester*, Vol. **88**, No. 3, March 1962, pp. 231-37).

APPENDIX F

Statement Showing Appointments, Promotions, Transfers, Resignations, Retirements, Deaths, etc., during 1961-62

Appointment

Administrative Section

1. Shri V. N. Gopal Krishnan, Store-keeper	20th October 1961
2. Shri S. P. Sahu, Junior Clerk (re-appointed)	15th November 1961

Chemical Section

1. Shri R. C. Arora, Research Assistant	14th December 1961
2. Shri B. B. Banerjee, Junior Research Assistant	5th January 1962
3. Shri Habibur Rahman, Junior Research Assistant	8th January 1962
4. Shri K. M. Das, Junior Research Assistant	18th January 1962
5. Shri B. P. Banerjee, Junior Research Assistant	1st November 1961
6. Shri Noas Minz, Laboratory Assistant	1st August 1961
7. Shri Dukha Oraon, Durwan (redesignated as Lab. Attendant)	14th August 1961
8. Shri Ram Charitra Tiwary, Durwan	20th July 1961

Entomological Section

1. Shri L. M. Pramanik, Research Assistant	6th May 1961
2. Shri R. L. Singh, Artist	8th May 1961
3. Shri S. M. Kulkarni, Research Assistant	1st June 1961
4. Shri L. Linda, Fieldman	12th May 1961
5. Shrimati N. Nandy, Laboratory Assistant-cum-Insect Setter	20th July 1961

Transfer

Chemical Section

1. Shri S. K. M. Tripathi, Research Assistant, from Jhalda to Gondia	15th April 1961
2. Shri V. S. Saxena, Research Assistant, from H.Q. to Jhalda	28th April 1961
3. Shri V. S. Saxena, Research Assistant, from Jhalda to Daltonganj	15th July 1961
4. Shri S. Prasad, Junior Research Assistant, from H.Q. to Gondia	10th June 1961
5. Shri N. G. Rudra, Junior Research Assistant, from H.Q. to Jhalda	1st July 1961
6. Shri S. Prasad, Junior Research Assistant, from Gondia to H.Q.	15th July 1961
7. Shri S. N. Prasad, Senior Clerk, from Administrative Section to Production Unit and Shri P. K. Chowdhury, from Production Unit to Administrative Section	5th April 1961
8. Miss Shivani Hazra, Jr. Clerk, from Production Unit to Administrative Section	1st April 1961

9. Shri S. K. Das, Junior Clerk, from Gondia to H.Q.	29th May 1961
10. Shri N. K. Naik, Laboratory Assistant, from Jhalda to Daltonganj	25th July 1961
11. Shri S. K. Deogharia, Durwan, from Jhalda to Balrampur	17th July 1961

Entomological Section

1. Shri N. Mazumdar, Research Assistant, from H.Q. to Umaria	18th May 1961
2. Shri P. Sen, Research Assistant, from H.Q. to Umaria	2nd December 1961
3. Shri N. Mazumdar, Research Assistant, from Umaria to H.Q.	11th December 1961
4. Shri A. K. Das, Junior Research Asistant, from H.Q. to Umaria	18th May 1961

Administrative Section

1. Shri Deolal Singh Yadav, Chowkidar to ILCC *vice* Shri Chamu Uraon, transferred to Adminstrative Sec.	1st June 1961

PROMOTION/APPOINTMENT

Chemical Section

1. Shri A. Rahman, Junior Research Assistant, promoted as R.A.	17th November 1961
2. Shri G. M. Borkar, Peon, promoted as Laboratory Assistant	23rd October 1961

Entomological Section

1. Shri P. Sen, Junior Research Assistant, promoted as R.A.	11th September 1961

RETIREMENT

Administrative Section

1. Shri Md. Sharfuddin, Store-keeper	6th December 1961

APPOINTMENT IN LEAVE VACANCY

1. Shri Surya Sharma, Carpentar (Admn. Section)	24th May 1961
2. Shri Budhua Ram, Sweeper	3rd December 1961

RESIGNATION

Administrative Section

1. Shri S. P. Sahu, Junior Clerk	27th December 1961

Chemical Section

1. Shri Satya Murti, Research Assistant	10th July 1961
2. Shri J. S. Pathak, Junior Research Assistant	11th July 1961
3. Shri N. S. Ghosh, Junior Research Assistant	1st June 1961
4. Shri Habibur Rahman, Junior Research Assistant	5th March 1962
5. Shri D. K. Sirkar, Laboratory Assistant	15th July 1961
6. Shrimati C. Dev (Hazra), Laboratory Assistant	14th August 1961

Entomological Section

1. Dr. S. Krishnaswami, Entomologist	29th September 1961
2. Shri H. D. Sharma, Research Assistant	1st June 1961
3. Shri A. K. Dev, Junior Research Assistant	4th April 1961
4. Shrimati R. Mathew, Junior Research Assistant	8th June 1961
5. Shri B. Chakravorty, Junior Research Assistant	23rd August 1961
6. Shri N. Biswas, Junior Clerk	22nd May 1961
7. Shri Lateya Linda, Fieldman	16th September 1961

CONFIRMATION

1. Shri P. C. Ghosh, Research Assistant 2. Shri A. K. Ghosh, Research Assistant 3. Shri V. S. Rao, Research Assistant	15th June 1961
4. Shri A. Kumar, Research Assistant 5. Shri R. S. Gokulpure, Research Assistant	14th August 1961

TERMINATION

1. Shri S. Sharma, Carpenter on leave vacancy	2nd August 1961
2. Shri N. G. Rudra, Junior Clerk	1st July 1961

DISCHARGE

1. Shri Kripal Ram, Laboratory Attendant	14th August 1961
2. Shri Jatru Munda, Chowkidar	11th September 1961

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