INDIAN LAC RESEARCH INSTITUTE

NAMKUM, RANCHI, BIHAR, INDIA

ANNUAL REPORT

FOR THE FINANCIAL YEAR 1957-58

1959

CONTENTS

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ADMINISTRATIVE AND GENERAL

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

An important new activity, started during the year, was the holding of weekly colloquia separately in the chemistry and entomology divisions of the Institute. The object was to enable the senior research staff to discuss various topics freely among themselves and, through such discussions, provide the freshly recruited staff with the necessary detailed background of various aspects of lac research. A few joint sittings were also held in which the workers of the chemistry, entomology and the lac extension divisions participated to discuss matters of common interest.

A very interesting sequel to the colloquium of the entomology division was the inauguration of a local entomological society, which, though necessarily a very modest affair now, is expected eventually to develop into an active centre for entomological research for the whole country.

As usual, the Institute continued to attract a large number of visitors from all over India, and also a few from abroad: Some of the distinguished visitors are named below:

1. Dr. Zakir Hussain, Rajyapal, Bihar
2. Profs. J. B. S. Haldane, F.R.S. and Mrs. Haldane
3. Mr. A. Kopelovitch, an industrialist from Israel
4. Shri A. P. Ghosh, Deputy Accountant General, Bihar
5. Shri Chowdhury, Conservator of Forests, West Bengal

Only one member of the Indian Lac Cess Committee, Shri Gandharpanath Sahadeo (member, G.B.) visited the Institute during the year.

Roads and Buildings — Annual repairs to roads and buildings were carried out by the C.P.W.D.

Tar-felting of roofs as an alternative to re-roofing was carried out in the case of a number of old residential quarters.

Construction of the Administrative Block had not commenced yet. Meanwhile, since quarters No. A-4 was proving too small for the purpose, Director's office was shifted from A-4 to A-1, a large A-type quarters, vacated by Shri M. Venugopalan on retirement.

Construction of the projected solvent godown was started towards the end of the period under report.

The buildings in the Lac Products area, taken on lease since 1-1-57, were electrified and given water connections. Three of the buildings in the area are being utilized as C-type residential quarters; the trainees' hostel and the Lac Extension Officer's Office have not yet shifted to this new premises on account of the absence of a ceiling which yet remains to be provided. Trainees' classes, however, are being held there already.

Water-supply — The water-works has been provided with two centrifugal pumps, one in the river-bed pump shed and the other near the settling tank in the Institute premises. The two replaced pumps have been retained as stand-by pumps.

Gas supply — As an alternative to the hitherto existing coal-gas plant, an old Mansfield gas plant lying idle so far was repaired and put into operation during the period. This extra gas-generator has proved of great advantage to the laboratories.

Library — The proposed annexe to the library is yet to be built. Meanwhile, extreme congestion continues.

Books and bound volumes of journals accessioned during the period numbered 320. Miscellaneous scientific pamphlets, numbering 65, were also received.

The Institute sold some 80, distributed 2,500, and transferred to Lac Extension Officer, 65 publications of its own during the year.

Training — There were 17 trainees in lac cultivation at the commencement of the year. During the period 10 trainees joined and 17 completed the course and were released so that at the end there were left 10 trainees on the roll.

Only one candidate sponsored by the West Bengal Government took the 6 months' course of training in the industrial uses of lac.

An officer from Thailand joined the Institute on about a 6 months' miscellaneous course of training in lac, having been sponsored by the Food and Agricultural Organization (F.A.O.) of UNESCO.

Staff — Shri Y. Sankaranarayanan, Shellac Utilization Officer, who had been out to the U.K. under the Colombo Plan for 6 months' training in the Teddington Paint Research Station, returned to the Institute early in September 1957.

Shri J. K. Guha Roy, Assistant-in-Charge, who had been in the continuous employ of the Institute for well over 30 years, passed away on 1-6-57: his death was deeply mourned by all the staff.

Other details regarding appointment, discharge, etc., of staff will be found in Appendix G.

Staff Club — For the first time since April 1951, the staff club received towards the end of 1957-58 a sum of Rs. 600 from the Committee as the latter's consolidated grant for 3 successive years. By an important change of its constitution, the club has now been thrown open to Class IV servants of the Committee.

ENTOMOLOGY DIVISION

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

I — GENERAL

Introduction — During the year under report attempts were made to switch over to the revised research programme as recommended by the Second Reviewing Committee and finally adopted by the Indian Lac Cess Committee with slight changes and some additions. Most of the field experiments have been redesigned on sound statistical lines on the advice of the Statistical Advisor to the I.C.A.R. and are under implementation from the last June-July season onwards.

Staff — While some of the junior posts vacant in the Division could be filled up, many senior posts such as the Scientific Officers and Research Assistants continued to remain vacant. Further, due to the expansion of the activity of the Division (the Entomology Section's status having been raised to that of a division recently) some of the existing senior staff members had to be diverted to the new items of work that are being taken up, such as the establishing of Regional Field Stations, etc. Thus the overall shortage of the staff was very much felt.

Season — The season was quite favourable initially to the *Baisakhi* (1956-57) crop, but the extreme summer heat from April to June accompanied by long spells of drought conditions very much affected the survival of brood and consequently the carry-over to the *Katki* crop. The *Jethwi* crop which had a good start following infection in January-February was very badly affected towards the end of March and complete crop failure was reported from practically every *kusum* area in Bihar. At Hesal-Berwari and Mahespur-Sirka, there had been a severe attack of parasites towards the later half of March just before the crop failed. As to the causes of failure, it appears that certain complex conditions resulting from the influence of climatic factors on both the host tree and the lac insect, as also the parasite enemies, were responsible.

The seasons for *Katki* (1957) and *Aghani* (1957) have been favourable but the crop production was limited due to restricted crop infections resulting from brood shortages.

II — RESEARCH AND INVESTIGATIONS

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

(i) *Large-scale defoliation experiments*

In April 1957, 23,633 *palas* trees and 66 *ber* trees were pruned which yielded 88 mds. 23 seers (7,286 lb.) and 1 md. 30 seers (143 lb.) of sticklac respectively. In July 1957, dead lac and surplus broodlac from 8,824 trees were cropped from Coupé I, after leaving sufficient quantity of broodlac on the trees themselves for self-infection of the *Katki* crop. From this operation, 55 mds. 17 seers (4,567 lb.) of surplus broodlac and 208 mds. 29 seers (17,116 lb.) of rejected lac on scraping yielded a total of 37 mds. 12 seers (3,065 lb.) of sticklac. From *phunki* lac of Coupé II an additional quantity of 4 mds. 5 seers (338 lb.) of sticklac was obtained.

In October-November 1957, a total of 13,168 trees from both Coupés I and II were harvested, which yielded 249 mds. 7 seers (20,423 lb.) of broodlac and 276 mds. 2 seers (22,638 lb.) of rejected lac. With 239 mds. 17 seers (19,519 lb.) of broodlac 16,845 trees in Coupé II were infected, of which 11,169 trees were partially defoliated ones. In addition, 13 *ber* and 203 *khair* trees were also infected. After infection, a total quantity of 70 mds.

37 seers of *phunki* lac sticks were recovered, which on scraping yielded 14 mds. 19 seers (1,184 lb.) of sticklac.

During the month of February 1958, 1,578 *palas* (in Coupé II), 12 *ber* and 118 *khair* trees were also pruned.

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

At Kundri and Namkum, experiments on the effect of partial artificial defoliation on brood preservation were continued. At Kundri, there were three treatments, namely (i) trees partially defoliated, (ii) trees not defoliated, and (iii) trees cultivated according to villagers' method (i.e. continuous cropping with heavy infection), whereas at Namkum there were only two treatments, namely (i) trees defoliated and (ii) trees not defoliated. Under each of the treatments, there were 200 trees at Kundri and 16 trees at Namkum. The crops infected in October-November 1956 were partially cropped in June-July (1957) season and fully harvested in October-November 1957. In the case of villagers' method treatment, the lac was cut *ari* in April leaving sufficient lac for self-infection of the *Katki* crop. In the Namkum experiments, however, the trees were fully cropped in July 1957.

The crop data are furnished in Table I (App. A).

The results of the Kundri experiments show that the ratio of brood used to yield obtained (both lac sticks and scraped lac) was better for the defoliation treatment than for "no defoliation" treatment, while in the Namkum experiments, the undefoliated trees gave better yields than the defoliated trees. In both the experiments the percentage of selected brood was higher in the case of defoliated than in the case of undefoliated trees, thus indicating that the defoliation treatment has been helpful in the preservation of brood-lac. In the villagers' method treatment, practically no brood was obtained.

Since 1957-58 *Baisakhi* crop, the experiment has been relaid on sound statistical lines with two treatments, namely (i) trees defoliated and (ii) trees undefoliated (control) on ordinary randomized block design, replicated 10 times. The crop is progressing satisfactorily and will be harvested completely in June-July 1958 and the data analysed.

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

The experiment was conducted in both *Baisakhi* (1956-57) and *Katki* (1957) seasons with 16 trees of each species for the *Baisakhi* crop and 10 trees of each species (*palas* and *ber*) for the *Katki* crop. The crops were completely reaped on maturity and the yield data were compared. Data are presented in Table II (App. A).

The results of the *Baisakhi* crop show that *ber* did not produce any broodlac and that even the brood to yield ratio in terms of both lac sticks and scraped lac is poorer in the case of *ber* than in the case of *palas*. In the *Katki* season, the predator incidence and damage were severe towards crop maturity with the result that poor yields were obtained. The results, however, indicated that *ber* had performed better than *palas* in the *Katki* season.

3. Comparative Preservation of Broodlac on *Ber* by Partial Pruning before and after Infection

The experiment being conducted since 1954-55 was carried out for the third year in 1956-57 *Baisakhi* season. There were the three usual treatments, namely (A) partial pruning in October-November before infection, (B) partial pruning in December-January after infection, and (C) control; and under each there were 10 trees under observation. The crops were completely harvested in July so that the brood yields could be compared. The crop data are presented in Table III (App. A).

The crop suffered very much from heavy parasite attack in March-April 1957. This was followed by very severe summer and drought which resulted in the complete mortality

of the broodlac for all the treatments. This indicates that partial pruning (treatments A & B) has not been helpful in saving the broodlac from the extreme summer heat.

The data of lac yields (dead lac), however, indicate that better crop was obtained from treatment A.

In the 1957-58 *Baisakhi* season, the experiment has been laid out afresh on statistical basis and the crop is progressing satisfactorily. Results of stick examination indicated that initial mortality after 4 weeks was slightly more in the case of treatment A. Even the percentage of males tended to be more under this treatment. Stick examination data are given in Table IV (App. A).

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

During 1956-57 *Baisakhi* season, *A. lucida*, *O. dalbergioides* and *F. cunia* were infected with both *palas* and *ber* broodlac. The crop on all the species of trees was generally poor due to heavy enemy insect attack. The crop on *A. lucida* was more attacked than that on the other two species.

The results furnished in Table V (App. A) indicate that the crop yields have been so poor due to the attack of the enemies that no reliance can be placed on them.

The experiments being carried out since 1951-52 have been concluded and a paper on *A. lucida* and *O. dalbergioides* has been already published this year. These two species have proved to be good hosts as brood preservers in the *Baisakhi* season over a period of 5 years. During 1957-58 *Baisakhi* season, three species, namely *Albizzia lebbek*, *Ficus glabella* and *Ficus glomerata* were taken up for trial and infected in the month of October 1957. In the case of the first two species, the larval mortality was heavy and the development of cells was poor. In the case of *Ficus glomerata*, the mortality although initially light, increased with the progress of the crop. The crop on all the three hosts is not satisfactory now.

5(a). Proper Time of Harvesting for Maximizing Yields

The experiment was carried out for the first time on a preliminary scale in 1956-57 *Baisakhi* season both at Kundri and Namkum. There were four treatments as follows:

I. Initial heavy infection and *ari* cutting in April.
II. ,, ,, ,, ,, *ari* cutting in May.
III. ,, ,, ,, ,, cropping at maturity.
IV. Initial light infection and cropping at maturity.

Under each of the treatments, there were 50 *palas* trees at Kundri and 10 at Namkum.

The experiments at Namkum suffered to some extent due to heavy enemy attack of the lac crops and hence the results may not be quite reliable. However, in the case of Kundri (Table VI, App. A) better ratios of brood to crop yield were obtained when the crop had been reaped as *ari* in April or May and not at maturity.

The experiment is being repeated in 1957-58 *Baisakhi* also to confirm the results.

5(b). Determination of Optimum Density of Larval Settlement on Various Hosts

The experiment was conducted with *palas* and *ber* during 1956-57 *Baisakhi* season. There were the usual three treatments, namely (A) one-third the normal requirement of brood, (B) half the normal requirement, and (C) the full normal requirement. There were five blocks and three treatments with one tree in each.

An analysis of yield figures (Table VII, App. A) indicates that for both *palas* and *ber*, treatment A was better than either B and C, judging by the ratio of brood used to

yield obtained; as regards the treatments B and C, judging by the scraped lac figures, the former was better than the latter in the case of *ber* but not in the case of *palas*.

In *Katki* (1957) and *Aghani* (1957-58) seasons, the experiments were laid out on proper statistical basis with 10 blocks and the three treatments. The treatments have been slightly modified as follows:

Treatment A — Half the normal requirement of brood.
Treatment B — Normal requirement of brood.
Treatment C — Double the normal requirement of brood.

The crops were badly attacked by parasites and predators and a species of cockroach. As a result the yields were not normal and fluctuated much from tree to tree. The *Aghani* (1957-58) crop was very poor and the data could not therefore be analysed. In the case of *Katki* (1957) crop, the statistical analysis of the ratios of brood to yield (crop data in Table VIII, App. A) showed that there was no significant difference between the treatments. However, the scraped lac ratio for B treatment appeared to be slightly better than treatments A and C.

Observations made on the initial larval mortality indicated that it was generally more on twigs with sparser settlement of larvae.

Jethwi 1958 — The experiment according to the new layout is being conducted on *kusum* trees at Hesal in the *Jethwi* (1958) season, and the progress of the crop and experiment is quite satisfactory.

Baisakhi 1957-58 — The experiments under 5(a) and 5(b) above have been combined for this crop in order to ascertain the proper time of harvesting, as well as the optimum density of larval settlement. The experiment is being conducted on *palas* with 9 treatments, i.e. 3 harvesting periods (namely in April, in May and at crop maturity) × 3 densities of larval settlement (half normal, normal and double normal requirements of brood).

The crop is progressing satisfactorily and the results of stick examination indicate that larval mortality is more on sticks with sparser settlement as also that the percentage of males in the crop tends to increase with the density of larval settlement.

6. Determination of the Most Suitable Pruning Methods and Seasons for *Kusum*

The experiment is being carried out since 1948-49, infection for the *Jethwi* (1957) crop was done under the four usual treatments, namely

A — Apical pruning with $1\frac{1}{2}$ years' rest.
B — ,, ,, ,, 1 year's rest.
C — Surface pruning with 1 year's rest.
D — ,, ,, ,, 6 months' rest.

Shoot measurements and observations on the progress of crop under the various treatments were made.

In this season there was almost total failure of lac crop throughout Ranchi and the experimental crop at Hesal was also seriously affected. In addition to heavy larval mortality following infection, there was an unusually severe infestation by parasites during March-April, and by the end of April there was complete failure of lac.

The experiment has been concluded in this year. The data of the past 8 years have been analysed and the following conclusions have been arrived at:

(i) The results of shoot study indicate that there are two main seasons of active growth, namely February-April and July-September. Comparatively greater number of shoots appeared on the trees pruned in June-July than on those pruned in January-February, irrespective of the type of pruning and the period of rest. Again, between the two types of pruning, namely 'Apical' and 'Surface', a larger number of shoots were produced in the former case than in the latter. Primary and secondary shoots up to 6 months and to

some extent one year old, showed linear growth while older primaries and secondaries showed hardly any linear growth. Secondaries and tertiaries usually appeared from primary or secondary shoots, 6 to 12 months old, respectively.

(ii) As regards larval settlement and development of lac cells, shoots 6 to 12 months old appeared to be more suitable than either older or younger shoots.

(iii) In respect of crop yields, the general conclusions were as follows. In the *Jethwi* season, best results, in terms of ratio of brood used to yield, were obtained from apical pruning with 18 months' rest. For the *Aghani* crop, on the other hand, the difference among the four treatments (A, B, C & D) was not quite marked. However, quantitatively larger crops were obtained in either season, from trees rested for longer periods, since on those trees, a large number of shoots had appeared and were available for infection, although the ratio of brood used to yield obtained remained comparable.

(iv) Hence it is advantageous to rest trees long enough for a period of one year to one and a half years so that larger crops can be had with minimum of expenditure.

(v) Between the two types of pruning, 'apical' pruning should be preferred to 'surface' pruning, as the former causes a greater number of shoots to appear, as also tends to build a compact and convenient crown.

7. Growing of Lac Crops Under Crop and Bush Conditions

(a) *Under crop condition* — 150 *Arhar* (*Cajanus cajan*) plants were infected in 1956-57 *Baisakhi* season. The settlement of the larvae was very good and the crop progressed well till March-April when a severe attack of parasites and predators destroyed the lac crop. The plants also started drying up in large numbers due to the excessive summer heat and drought, with the result that the crop totally failed.

In the *Katki* (1957) season, 60 plants were infected but these again suffered heavily after August due to a severe *Eublemma* predator attack.

For the *Baisakhi* (1957-58) crop, 25 healthy *Arhar* (six-month old) plants were infected. The larval settlement was patchy and sparse following light infection. The larval mortality amounted to about 40 per cent. Later on, after male emergence, the crop considerably pulled up and the cells are showing good development.

(b) *Under bush condition* — Attention is being concentrated on three host species that show considerably fast growth and can stand repeated cutting for being trained into bushes. They are (i) *Albizzia lucida*, (ii) *ber*, and (iii) *Flemingia congesta*. 60 *A. lucida* and 30 *ber* trees have been coppiced with a view to train them into bushes. The response so far has been satisfactory. Within about 2 years' time they will be fit for taking lac infection.

Flemingia congesta — In 1956-57 *Baisakhi* season, *F. congesta* which is a natural bush, was infected with 3 seers and 2 chattaks (*c.* 6 lb. 4 oz.) of broodlac on 25 plants. The crop, which showed good development initially suffered from March onwards due to heavy parasite attack resulting in almost total failure of the crop.

In the *Katki* (1957) season, 100 two-year old *F. congesta* bushes were infected. Subsequent to initial larval mortality of about 30-40 per cent, the crop pulled up and showed good progress. Yield data (Table IX, App. A) showed that the ratio of brood used to yield obtained was 1: 4·3 (lac sticks) and 1: 2·5 (scraped lac).

In the year 1957-58 *Baisakhi* season, 160 plants raised at a close spacing of 3×1 ft. were infected lightly with broodlac from the preceding *Katki Flemingia* crop. The crop is showing satisfactory progress. With the advent of summer, thinner twigs were observed to dry resulting in the mortality of lac. A few plants also wilted due to the summer heat.

For the *Jethwi* crop, 64 *Flemingia* plants were infected and the crop developed satisfactorily till the hot weather set in, when the development of the cells considerably slowed down. To prevent heat mortality, the plants are being irrigated but the cell development

is still only gradual. A few plants and some thin twigs on the plants are drying up due to the summer heat. The irrigation of plants has considerably reduced the heat mortality, which otherwise could have been very serious.

8. Influence of Various Environmental Conditions on the Lac Insect

The effect of climatic factors, in particular the temperature, on the growth and development of the lac insect is being studied. The temperatures under study are 18°C., 22°C., 27°C. and 30°C. Potted plants of *Acacia farnesiana* and *kusum*, infected with the *Rangeeni* and *kusum* strains respectively, were placed under the various environments of constant temperature and fortnightly observations on the moulting, growth and development, etc. were taken. Infected potted plants kept under natural atmospheric fluctuating temperature conditions were also under observation to serve as control for comparison.

The following observations were made during the year:

Rangeeni *strain — Katki* crop: At 27°C., the first moulting started within 17 days of infection. Both males and females attained maturity much earlier at this temperature than at the field atmospheric temperature. Males emerged in 41 days and larval emergence from females was in evidence after 96 days.

At 30°C., the first moulting was observed 14 days after infection. The male and female insects reached adult stage in 40-43 days and the development of cells was faster and the cells looked much larger in size. The plants, however, did not survive long at this temperature, with the result that the insects could not complete their life-cycle.

Under field conditions, the first moulting was observed after 30 days, male emergence in 76 days and larval emergence from female insects in 112 days.

Baisakhi (1957-58) *crop* — At 18°C., the first moulting was observed after 49 days from the date of infection. The males emerged after 92 days and the females reached their adult stage after about 94 days. The life-cycle is still continuing.

At 22°C., first moulting was in evidence 24 days after infection. Males emerged in about 44 days and the females moulted finally, 44-49 days after infection.

At 30°C., the first moulting was noticed after 17 days. Male emergence took place in 43 days and the female attained maturity in 41-47 days. The life-cycle, however, could not be completed owing to the plant wilting after continued exposure at this temperature.

In the case of pots under observation under field conditions first moult was in evidence in 63 days and male emergence took place after 129 days. The pots are still continuing to be under observation.

Kusmi *strain — Aghani* (1957-58) crop: At 27°C., first moulting was observed in 13 days after infection. Male emergence occured after 35 days while the female insects took 35-40 days to reach adult stage. The females, however, could not complete the cycle owing to plants wilting away by the end of September 1957.

Aghani crop infected on 30-8-57 from brood obtained from a pot kept under 18°C. and cultured at the same temperature is showing slow progress and is yet to complete the life-cycle. First moult was observed in 12 days and male emergence in 58 days.

Jethwi 1958 — The *Jethwi* crops infected at 22°C., 27°C. and 30°C. have all failed owing to the plants prematurely drying after the first moult. The field crop is still continuing.

9. Survey of Lac Enemies and Their Parasites

Caging of lac samples — During the year only a few samples were caged and no new enemy insects or beneficial parasites were encountered.

Non-insect enemies — Observations, continued on the role of squirrels in damaging lac at Kundri orchard, indicated that unlike in previous years, squirrel damage to maturing *Baisakhi* (1956-57) crop was negligible in June-July but it was in evidence on broodlac used for infection. Subsequent to *phunki* removal, a large number of squirrel nests were also observed in the field. These observations go to show that the squirrels take to maturing lac female insects just prior to breeding as they need heavy and nutritive food at this time.

In order to assess the damage to broodlac, *phunki* lac from 25 trees was examined and it was seen that up to 65·7 per cent of the lac sticks were damaged by squirrels. 37 per cent of the sticks showed damage over 25 per cent of the cells present.

Monkey menace as a serious handicap to lac cultivation has been reported from the field stations at Damoh and Jhalda. These animals do considerable damage to new as also infected shoots of lac host trees (*ghont* and *kusum* respectively), purely out of their mischievous habits.

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

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

In order to ascertain the extent to which emergences are checked by the scraping of the harvested lac soon after reaping, known quantities of lac in two lots were caged, of which one was as lac on sticks without scraping and another after scraping. The daily emergences of insects from these two lots were recorded till there was no further emergence. The experiments were conducted with the lac obtained from *Katki* (1957) and *Aghani* (1957-58) crops. The emergence figures are given in Table X (App. A).

It is seen that as a result of the scraping there is considerable reduction in the population of predators and parasites in the case of *palas* lac, while in the case of *kusum* lac the reduction is observed only in respect of predators. Further the reduction is more in the case of *palas* lac than in the case of *kusum* lac. This can be easily explained since scraping of *palas* lac which has a comparatively thinner encrustation leads to crushing of most of the cells if not practically all the individual cells.

(b) *Loss due to enemy infestation in storage*

The experiment for assessing the loss due to damage by enemy insects during storage was carried out as follows: Two lots were compared of which one was fumigated with CS_2 and the other kept as it was without any treatment. The daily emergences as well as the weekly weight of the quantity of lac stored were recorded regularly till the emergence ceased and the weight became constant. In the case of the fumigated lot, the loss in weight was due only to driage since the enemy insects had been killed by fumigation prior to storage. In the control lot, however, the total loss includes the loss due to damage by insects as well as loss due to driage. Hence the difference in the loss of weight between the two lots indicates the loss due to enemy insect damage.

The experiment was carried out with lac harvested from *Katki* (1957) and *Aghani* (1957-58) crops. The results of the experiment are given in Table XI (App. A).

The results indicate that the driage loss from lot to lot has been very widely varying and this has not helped to bring out clearly the loss due to enemy insects alone. Only the average of a large number of replicated lots can give some idea of the real loss due to the enemies. The experiment in the coming seasons will be taken up on these lines.

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

Under this experiment known quantities of lac sticks and scraped lac obtained from similar known quantities of lac sticks were treated with the following insecticides immediately after the harvest of the *Katki* (1957) and *Aghani* (1957-58) crops and such treated

lac was caged for noting emergence of enemy and friendly insects. There were also parallel untreated lots (control) for comparison.

The insecticides used were the following:

(i) Aldrex 2 per cent dust
(ii) Aldrex 5 per cent dust
(iii) Dieldrex 1·5 per cent dust
(iv) Endrex 1 per cent dust
(v) Ekatox 2 per cent dust
} Mixed in the proportion 1: 100 with lac.

(vi) Aldrex 40 per cent wettable powder
(vii) B.H.C. 50 per cent ,, ,,
(viii) Dieldrex 40 per cent ,, ,,
(ix) Ekatox 20 per cent ,, ,,
(x) Endrex 20 per cent emulsifiable concentrate
} Sprayed at 0·1 per cent strength on the lac.

Record of emergence of insects from treated and control lots is furnished in Tables XII and XIII (App. A) for *Katki* (1957) and *Aghani* (1957-58) crops respectively.

A scrutiny of the results indicates that in the case of *palas* lac sticks, all the treatments have helped to reduce the emergence to a considerable extent and among them both Aldrex 5 per cent dust and Endrex 1 per cent dust have given best results. Generally sprays were less effective than dusts. In the case of *kusum* lac, however, both Ekatox 2 per cent and Endrex 1 per cent dusts have given better results than other treatments. Here again the performance of sprays in general is poorer than that of dusts.

12. Biological Control

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

A. Tachardiae — Life-history of the parasite (*Braconidae*) on its laboratory host (*Corcyra cephalonica*) was studied under laboratory temperature and humidity conditions, and since July 1957, 9 continuous generations were bred. It was observed that the development period was the shortest during August when the male and the female parasites took on an average 17·7 and 19·8 days respectively to complete their life-cycle and it was maximum for eggs laid in the month of November, which took 72·95 and 89·2 days respectively for the male and female parasites to complete their life-cycles.

Studies made on the life-history of the parasite on its natural host (*Holcocera pulverae*) under laboratory conditions during the month of September showed that the life-cycle periods of the male and female parasites were 17·4 and 19 respectively.

Work on the developmental stages of the parasite during its endoparasitic life indicated that the egg period varied from 22 to 30 hours, the first instar period from 5 to 8 days and the second instar period from 5 to 10 days. The total endoparasitic life varied from 11 to 19 days. After emergence from the host larva, the parasite spends 1 to 2 days in the pre-pupal stage and takes 3 to 5 days for emergence as adult from the pupa.

Perisierola pulveriae (*Bethylidae*) — Studies on the life-history and breeding technique having been completed, attention was paid to the ecological studies on the parasite for determining the best conditions for rearing it on a mass scale efficiently. During the period under report, the longevity and the life-history of the parasite were studied (i) at 18°C. and 30, 60 and 90 per cent relative humidity (R.H.) and (ii) at 30°C. and 30 and 60 per cent R.H.

It was generally observed that the female parasites lived the longest and laid the largest number of eggs at 18°C. and 30 per cent R.H., the longevity being generally higher at the lower temperature of 18°C. At 30°C., the higher R.H. of 60 per cent was more

favourable for both longevity and oviposition than 30 per cent R.H. As regards the life-history, the development was faster at the higher than at the lower temperature. The R.H. did not have any marked influence on the development.

Elasmus claripennis (*Elasmidae*) — Attempts to breed the parasite in the laboratory did not meet with success and no oviposition was noticed in a large number of cages under observation between August and November 1957.

Mass-breeding of Bracon greeni *and* Apantales tachardiae — *B. greeni* was bred under laboratory condition and at controlled temperature of 27°C. and R.H. 70 per cent. Both *Etiella zinckenella* and *Eublemma amabilis* were used as hosts and a total number of 2,335 parasites bred. Breeding rate fell considerably during the year due to the non-availability in large numbers of the natural host and the parasites in the plantation. The parasites lived for short periods of 24 to 48 hours only in the laboratory and the oviposition was very poor. All attempts to improve the laboratory breeding of the parasites through change of food and environment failed. Attempts are being continued to improve the breeding technique and increase the rate of breeding.

Apanteles tachardiae was bred on a mass scale under both laboratory conditions and constant temperature (27°C.) and humidity (70 per cent R.H.) conditions on *Corcyra cephalonica* as the laboratory host. In all 16,495 parasites were bred during the year. The parasites could be bred easily even under laboratory conditions, after inducing oviposition at 90 per cent R.H. During summer months, however, the breeding suffered somewhat due to excessive heat.

(b) *Large-scale liberations in the field and estimation of the effect of these liberations*

Under this experiment it has been proposed to liberate both *B. greeni* and *A. tachardiae* for the control of *Eublemma amabilis* and *Holcocera pulveriae* respectively. The experiment was laid out on proper statistical lines in June 1957. The first infections were carried out in one of the four coupés, while two other coupés were pruned. Owing to a great shortage of *kusum* brood, all the plots could not be infected nor the parasite releases started in the *Aghani* (1957-58) season. The crop on the trees infected, however, progressed well but for a severe attack of *Chrysopa* for a short period.

The *Jethwi* (1957) crop infected in the area on 233 trees with 9 mds. and 8½ seers of broodlac prior to the new layout of the experiment, showed good progress initially but failed totally as it did throughout in Ranchi and Purulia Districts following a very severe attack by parasites in March-April due to a very unfavourable season.

In *Jethwi* (1958) season, the experiment according to the new layout could be started and the release of *Apanteles* parasites was commenced towards the end of March 1958. The experiment comprises four treatments, namely (i) release of *Apanteles* parasites alone, (ii) release of *B. greeni* parasites alone, (iii) release of both *Apanteles* and *B. greeni* parasites, and (iv) no release or control. The layout is in ordinary randomized blocks replicated five times. In each plot there are 24 trees which are subdivided further into four coupés with 6 trees in each for systematic working of the trees on a four-coupé basis in a two-year cycle. At a time, only one of the four coupés in the plot will be under infection, the remaining three being under rest after due pruning. Each plot for the treatments is situated at least 2 furlongs away from the rest so that interference due to flight of parasites may be avoided.

During the *Jethwi* (1958) season, only 4 blocks could be infected with the limited supply of broodlac. The crop is progressing satisfactorily. Following infection, an initial average sample of the lac sticks 3 in. in length from all the experimental trees, was collected and examined for larval settlement and mortality and initial population of the predatory enemies. The percentage of larval mortality ranged from 12 to 60·2 per cent. The enemy insect incidence was negligible. Only *Eublemma* incidence was noticed as stray attack here and there while the samples did not reveal the presence of *Holcocera*.

The crop is progressing and will be harvested in June-July 1958.

13. Regional Field Research Stations

Under this scheme it has been proposed to set up four regional research stations for investigations of local problems. During the year under report two field Research Stations at Damoh and Jhalda for studies on *ghont* and *kusum* were started as per schedule. The scientific Officer-in-Charge of the scheme and the Research Assistants for Jhalda and the central Laboratory are yet to be appointed and this has been a handicap to the progress of work under the scheme.

Damoh — Two areas of the M.P. forest Department have been selected for this station with 500 and 1,200 *ghont* trees, situated respectively 2 and 7 miles away from the Damoh town. After the areas had been selected in March, the survey and plotting of the trees were completed in April. The first *Katki* infection was carried out in July 1957 on 177 unpruned trees with 1 md. 33 seers of *palas* brood. Due to rather advanced stage of larval emergence in the brood used and the heavy downpour of rains at the time of infection, the larval settlement was not quite satisfactory and even the few larvae that had settled died subsequently in large numbers, leading to complete failure of the crop.

In the *Baisakhi* (1957-58) season, 153 trees (in forest compartment No. 105) and 300 trees (in compartment No. 109) were infected with 1 md. 30 seers, and 2 mds. 12 seers of *ghont* brood respectively. The infection was carried out with a view to gathering preliminary data on the performance of the crop in this season, and unpruned trees were infected. After initial larval mortality, the development of the cells was somewhat slow in the beginning, but later following male emergence in March, the crop showed satisfactory development. The progress of crop till the time of reporting was satisfactory.

In February 1958, the pruning experiment has been laid out for the two crops, *Katki* and *Baisakhi* on ordinary randomized replicated block design. The experimental details are as follows:

Katki Crop

Treatments: A — Pruning in last week of December.
B — Pruning in 2nd week of February.
C — (i) & (ii) 2nd week of May.
No. of trees under each treatment: Five comparable trees.
No. of replications: Ten.

Baisakhi Crop

Treatments: A — Pruning in 2nd week of April.
B — Pruning in 3rd week of May.
No. of trees under each treatment: Five comparable trees.
No. of replications: Ten.

The prunings at the different times have been started from February, and the infection will be undertaken in due course.

Other preliminary work connected with the establishment of the station, such as equipping the laboratory, fencing of the field areas, layout of experiments and coupéing and numbering of trees, etc., are in progress.

Jhalda — An area with 300 *kusum* trees on the South western slope of the Sirka-Bundia Hills at Jhalda was taken up for working in July 1957, from the W.B. Forest Department. The area was divided into four sub-equal coupés with 75 trees each and coupé Nos. III and IV were pruned for the first time in July 1957. In January 1958, Coupé No. I was pruned. Preliminary data on the size, crown, height, girth and location of the trees have been recorded. It was generally noted that a larger number of shoots appeared from trees pruned

in July than from those pruned in January, but the growth was more vigorous in the latter. Further the new flush appeared earlier on trees located at the foot of the hill than on those located higher up along the slope or on rocky beds. Work relating to equipment of the laboratory, fencing of the area by live hedges, etc., is under progress.

14. Plantation at Namkum

The general upkeep of the plantation was looked after. Hoeing and weeding operations were carried out systematically throughout the plantation to keep down the weeds and maintain proper soil mulch. Seedlings of a variety of lac hosts were raised in nurseries both for filling up gaps in the plots and for potted plants required for experimental studies in the laboratory. *Crotolaria saltiana* was continuously raised with a view to maintain a constant supply of the pod-borer (*Etiella zinkenella*) for use as an alternative host in the laboratory for breeding *B. greeni* and the bethylid parasites.

During the year, in all 280 trees were infected in the plantation to grow the various crops under different experiments.

With a view to intensify studies on the crop and bush type lac hosts, 2 in. irrigation pipe-line has been drawn from the main estate water-supply line, for trials on the irrigation of such hosts during the summer months.

Part of the plantation not required for experimental purposes was handed over to the Lac Extension Officer as per the decision of the Indian Lac Cess Committee on the recommendation of the Second Reviewing Committee.

15. Training and Advisory Service

(a) *Training* — On the first of April 1957, there were 17 trainees on roll for the course in the lac cultivation (8 from Assam, 8 from U.P. Forest Department and 1 from West Bengal). During the year 10 more trainees joined the course (8 from Assam and 2 from Madras) while 17 were relieved after the successful completion of their training. At present 10 trainees are continuing to receive their training. Between December 1957 and March 1958, a trainee from Thailand deputed under the F.A.O. fellowship scheme received his training in lac cultivation for a period of about 2½ months.

A series of 8 lectures to the village level workers and another of 4 lectures to the group level workers of the Ranchi Extension Training Centre were delivered on lac cultivation. They were also shown practical demonstration of the various operations connected with lac cultivation. Similarly, lectures and practical demonstrations were given to two batches of forest guards of the forest school in the Palamau Division and to batches of students from Basic Agricultural Schools in Bihar. Short lectures were delivered to batches of officer trainees from the Block Development Officers Training Centre at Ranchi and the Forest Research Institute, Dehra Dun.

(b) *Advisory Service* — As usual a large number of enquiries relating to lac cultivation were received and technical advice was rendered to private individuals and Government Institutions interested in lac cultivation. A large number of lac samples from Forest Departments, the Lac Extension Officer and the Lac Development Officer, Bihar, etc. were examined and reports on the same were sent. Brood farms of the Assam Forest Department, Lac Extension Officer and the Bihar State were visited and technical advice given.

To many parties including C.P. and National Extension Service administrations, literature and publications on lac and lac cultivation were sent.

Many parties including student parties visited the Institute and they were shown round the various activities of the Institute.

Part was taken in a large number of exhibitions including the Delhi Farmers' Forum Exhibition to popularize scientific methods of lac cultivation.

A STATEMENT OF LAC PRODUCED AND ITS DISPOSALS FROM THE INSTITUTE PLANTATION DURING THE PERIOD 1ST APRIL 1957 TO 31ST MARCH 1958

Crop and locality	Scraped or broodlac and its disposals														
	Produced			Under use in department			Driage			Supplied to Chemical Section			Sold		
	Md.	sr.	ch.	Md.	sr.	ch.	Md.	sr.	ch.	Md.	sr.	ch.	Md.	sr.	ch.
Baisakhi 1956-57 crop															
Namkum plantation	1	0	14*	—	—	—	—	4	15½*	—	32	3*	—	3	11½*
Jethwi 1957 crop															
Namkum plantation	No crop														
Hesal plantation	,,														
Berwari plantation	,,														
Maheshpur-Sirka plantation	,,														
Katki 1957 crop															
Namkum plantation	0	20	14½*	—	—	—	—	3	11½*	—	17	3*	—	—	—
	0	15	0†	—	15	—†	—	—	—	—	—	—	—	—	—
Aghani 1957-58 crop lac															
Namkum plantation	No crop														
Hesal plantation	,,														
Berwari plantation	,,														
Maheshpur-Sirka plantation	2	27	0*	2	27	0*	—	—	—	—	—	—	—	—	—

RECEIPTS

	Quantity					Value	
	Md.	sr.	ch.	lb.	oz.	Rs.	nP.
*Scraped lac**							
*By supply of scraped lac to Chemical Section from Namkum plantation (*Baisakhi* 1956-57) crop ...	0	32	3	65	8	30	59
*Scraped lac sold, from Namkum plantation (*Baisakhi* 1956-57) crop	0	3	11	7	6	3	55
*By supply of scraped lac to Chemical Section from Namkum plantation (*Katki* 1957) crop lac ...	0	17	3	35	2	16	34
*By supply of scraped lac for use in the Deptt. from Mahespur-Sirka (*Aghani* 1957-58) crop lac ...	2	27	0	219	4	147	12
*TOTAL	4	0	1	327	4	197	60
Lac sticks†							
†By supply of lac sticks for use in the Deptt. from Namkum plantation (*Katki* 1957) crop lac ...	0	15	0	30	12	17	62

*Indicates scraped. †Indicates lac sticks.

CHEMISTRY DIVISION

General — The division continued to be very much understrength throughout the year. As a result, only about a dozen out of the forty items of the approved research programme could be tackled.

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

A few of the several acid constituents of which shellac is made have been already isolated, but complete resolution of the complex is yet to be achieved. Various techniques, e.g. hydrolysis, fractionation through formation of complexes, paper-chromatography, etc., are being employed for the purpose and results are reported below:

(i) *Separation of aldehydic acid* — One of the constituents of lac appears to be an aldehydic acid: Attempts to regenerate it from its 2:4 dinitrophenylhydrazone did not succeed. Its separation in a pure form through its barium and lead bisulphite compounds is being tried.

(ii) Dewaxed decolorized shellac was hydrolysed with 5*N* alkali in presence of sodium sulphite, and sodium, barium, zinc and copper salts were successively prepared. No hot-water-insoluble zinc salt was obtained.

(iii) Aleuritic acid, M.P. 100°-101°C., was fractionated from methyl alcohol into two fractions melting at 102°-102·5°C. and 97°-97·5°C. respectively. Aleuritic acid and its fractions have been oxidized with periodic acid and the 2:4-dinitrophenylhydrazones of the cleavaged products prepared, which are being identified.

(iv) Shellac has been fractionated by means of urea from hot acetone, methyl ethyl ketone, ethyl acetate, dioxane, and methyl alcohol solutions. In all cases, three products, two, solid and one, a soft mass, were obtained. The relative proportions of these products varied with the solvents in which they had been formed. The soft portion became ultimately a powder on rubbing with water. The properties of the fractions obtained from acetone are given in Table I (App. B).

The first two products were almost insoluble in all common organic solvents at room temperature, but soluble at water-bath temperature in all alcohols, acetic acid, lactic acid and dioxane, while the third one was soluble at room temperature in all alcohols, acetone, methyl ethyl ketone and insoluble in ether. A film from one of the two solid products, in butyl alcohol, was far superior to that from original shellac in respect of blushing and water-resistance.

The product obtained by thermal polymerization of a mixture of shellac and urea also gave three fractions on extraction with acetone.

Similarly the reactions of melamine and hexamine with shellac in hot acetone solution have been studied; with melamine and hexamine, respectively 2 and 3 solid fractions were obtained.

(v) *Paper chromatography* — In the previous work, the presence of sodium ion caused interference, retarding the R_f values during paper chromatography of shellac acids; the removal of sodium by ion-exchange resin was only partly successful. In a further experiment, practically the whole of sodium could be removed as chloride following hydrolysis of seedlac in absolute alcohol. The sodium-free clear solution containing shellac acids gave a chromatogram in which there were seven spots due to lac constituents, plus one faint spot due to sodium.

2. Bleached Lac

(i) *Chemical changes during the bleaching of lac* — It has been reported previously (*I.L.R.I. Bull. No.* 29) that bleached lac had acid values (A.V.) of 80 and above. But recent observations show that if the precipitated lac is washed well, the acid value comes down to near about 70 which is approximately equal to that of the original lac. Further it has been noted that well-washed samples with A.V. 70 have good-keeping qualities, while those having A.V. more than 70-72 have a poor keeping quality.

A systematic study has been undertaken to ascertain the nature and mechanism of the action of the bleach. *Kusmi* and *Rangeeni* seedlac were bleached with progressively increasing quantities of bleach liquor. It was noted that with an increase in the quantity of bleach liquor, the products isolated suffered in respect of life under heat and fludity and that the acid value and the sap. value also first decreased, but increased subsequently. It was also observed that the iodine value decreased and chlorine content increased with an increase in the quantity of bleach liquor added. Results are given in Tables IIA & IIB (App. B).

(ii) *Optimum conditions for bleaching lac* — The Institute, as reported already, has developed an improved method of bleaching lac: The yield of bleached lac, by this as by other methods, is, however only 80-85 per cent of the seedlac, which is rather low. Investigations were continued to determine the nature and cause of this apparently high loss. Facts emerging as a result of these studies are as follows: (i) The fact that the bleach liquor is alkaline causes some loss. To be efficient and stable, however, the bleach liquor must have a certain degree of alkalinity, which is between 0·02*N* and 0·04*N* (*p*H 10·5), (ii) Since shellac is made up of two principal constituents, the so-called hard lac and soft lac, their individual responses to bleach liquor were studied. The bleach indices of hard and soft resin were 52 and 82 respectively, whereas that of the parent lac was 60. On separate bleaching by hypochlorite, the loss in yield in the case of the hard resin was found to be 7·2 per cent and that for soft resin to be 4 per cent: the loss for the parent shellac amounted to 5·6 per cent. Further work will be done.

(iii) *Pilot plant for the manufacture of bleached lac* — A pilot plant to produce 80 lb. of bleached lac per day has been designed. Quotations have been invited from different firms for the above plant.

3. Kinetics of Polymerization and Depolymerization of Lac and its Constituents

During the year under report, the differential number distribution curves dn/dD.P. of the same three polyesters were studied showing the growth of number of molecules against their D.P. The details of the method were the same as in the previous two studies of integral and weight distribution of the self-esters. The same three self-esters were dissolved in acetone and precipitated each of their fractions successively by non-solvent water, separating them and finally determining their D.P. To find dn/dD.P., i.e. number distribution curve we divide graphically, each function of the weight distribution curves by the corresponding molecular weight or any value equivalent to the length of the polymer, e.g. D.P. in the present case. The resulting curves indicated that for polymers of low (A) or medium (B) D.P., they were not so sharp and each had its own prominent peaks while C, (High) in somewhat smooth and narrow in nature. The maxima and minima represented by these peaks signify less homogeneity near about the region.

This part of the investigation has been completed and a paper incorporating the results reported in a paper to the Indian Science Congress, Madras — 1958.

4. Aqueous Lac Varnishes

Water-soluble Lac — It was reported earlier (*I.L.R.I. Annual Report,* 1952-53) that shellac becomes soluble in water if it is exposed to moist ammonia vapour, but the films of varnish prepared from it had no gloss and cracked after drying for a few days. So the

present work was undertaken with a view improving the quality of the product and also to study the nature of reaction between lac and ammonia.

In preliminary experiments, it has been found that the nitrogen content of the ammonia-exposed shellac progressively increases with the increase of time of exposure, but that the acid value remains practically unchanged. Films formed from an aqueous solution on a glass surface cracked on drying while those on a porous surface such as an earthen pot were glossy and did not crack.

5. Lac-oil Combinations

(i) *Incorporation of lac into linseed oil* — Although a number of methods are known for the incorporation of lac in linseed oil, none of the compositions is entirely satisfactory. The present investigation was started in 1956 with the object of incorporating lac into linseed oil without the use of catalysts with the idea of producing a lac-oil varnish that would be free from such defects as persistent tackiness, slow drying and comparatively low hardness of the film. It was found that lac dissolved in linseed oil at a rather high temperature, namely 360°C. Results of adding various chemicals were also studied, in particular the reactions involved were investigated. At first the reaction between shellac and triacetin when heated for two hours was studied. This was followed by a detailed study in which the periods of heating were ½, 1 and 1½ hours at 250°±5°C.; the products obtained were steam-distilled till the distillates were free from acid as tested by litmus.

The sample of shellac used had A.V. (Acid Value) and H.N. (Hydroxyl Number) respectively as 72 and 255, while these values for the triacetin employed were respectively 7·73 and 124·48. By taking the materials in equal quantities, the calculated A.V. and H.N. of the mixture should be 39·87, and 189·74. By heating the mixture for 2 hours at 250°C., the values came down to 5·93 and 59·59 (*I.L.R.I. Annual Report*, 1956-57) while the product after being subjected to steam distillation had A.V. and H.N. of 18·03 and 128·23 respectively, which are higher than the values, recorded prior to steam distillation.

This may be due to the decomposition of the acetyl compound of shellac formed by the reaction between shellac and triacetin. The distillate of steam distillation consists of triacetin, water solution of acetic acid and wax. To prepare stable products, triacetin was substituted by tricresyl phosphate and dibutyl pthalate, but the shellac polymerized within ½ hour of heating. The reaction of shellac with triacetin is being studied further.

(ii) *Insulating varnish* — In the *Annual Report* 1956-57, it was reported that the shellac-rosin-glycerine compound when incorporated into linseed oil, failed to produce a satisfactory insulating varnish as the composition did not dry "through" and had poor oil-resistance. In continuing the work, attempts were made to improve upon this composition by modifying it with (i) thickened cashew nut shell liquid, (ii) phenol, (iii) formaldehyde, (iv) phenolformaldehyde resin, and (v) hexamethylene tetramine; in addition, the base linseed oil, also was partly substituted in some experiments with varying proportions of *tung* oil. It was found that a varnish made up of 100 parts shellac-rosin-glycerine ester, 41·65 parts *tung* oil, and 83·35 parts linseed stand oil together with sufficient quantities of thinners and driers was quite up to the mark in respect of scratch hardness, flexibility, water-resistance, "through" drying and oil-resistance. A sample of the varnish was tested by the India Electric Works Ltd., Calcutta, and reported to be satisfactory. Work has been undertaken to substitute *tung* oil by dehydrated castor oil.

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

(i) *Preparation of shellac from seedlac by alkali extraction and acid precipitation* — It was reported earlier that shellac made by the above method differs from ordinary shellac

in having a darker colour. Attempts to improve the colour of the lac by reacting the lac solution (alkaline solution) with potassium permanganate proved futile. Even so, this method was applied in extracting lac from some of the lac factory wastes. Results have been given in Table III (App. B).

It is found that practically cent per cent extraction is possible by this process, but the life and flow of the product are rather poor, and the colour is very dark. The possible uses of this type of shellac are being investigated.

(ii) *Disposal of lac factory-wastes* — As reported already (*I.L.R.I. Annual Report*, 1956-57) the addition of 0·1 per cent concentration of sulphuric acid to the lac wash-water precipitates the albuminous as also the colouring matters present in the wash-water. It was pointed out that while this acidification stops putrefaction, the colouring matter, on separation, may prove useful as a natural dye. During the period, the time the precipitate takes to settle down was determined and found to be 11-12 minutes for one ft. of height. This information is required in designing an efficient form of settling tank.

From several experiments with different qualities of sticklac, it has been found that yields of precipitated dye vary from 4 to 5 lb. per maund of sticklac.

It was reported before that 1 lb. of concentrated sulphuric acid is required to treat the wash-water from 1 maund of sticklac. Experiments have been done to find a substitute for the chemical. The results are given in Table IV (App. B).

Among the chemicals giving satisfactory results, oxalic acid was studied in detail, in view of its low cost. 0·5 gm. of oxalic acid per 1000 cc. of wash-water was found sufficient to precipitate the dye and stop putrefaction. This corresponds to ½ lb. of the acid for wash-water from 1 maund of sticklac against 1 lb. of sulphuric acid.

It has been further found that if the dye is removed immediately after precipitation, putrefaction does not take place even after 10 days, whereas if the precipitate is left in the solution putrefaction occurs after 4 or 5 days.

Vegetable leaves having acidic character were also found to be effective in combating putrefaction but the quantity required is prohibitive.

The above experiments, therefore, indicate that either 1 lb. sulphuric acid or ½ lb. oxalic acid is required to treat the wash-water from 1 maund of sticklac. Considering the comparative cheapness of sulphuric acid, all subsequent experiments were done with this chemical.

Regarding the materials for construction of the vat or cistern in which precipitation is to be done, it has been found that ordinary cement lining is not affected by the sulphuric acid at the concentration finally attained by the wash-water.

Then the precipitate was analysed and the results are given below:

1. Water-soluble matter (by hot water extraction)	25-30%
2. Hot alcohol-soluble matter (after water extraction)	20-22%
3. Total hot alcohol-solubles	45-52%
4. Petroleum ether-soluble	8-9%
5. Nitrogen	4·5-5·0%
6. Ash	7·0-7·5%
7. Acid value	79-80

(iii) *Lac dye recovered from lac wash-water*

(a) *Assaying of the crude dye for actual dye content* (vide Appendix D).

(b) *Lac dye in a usable form* — The precipitated dye as such is not sufficiently soluble in water for use in dyeing. So, to make it more soluble, the dye was converted to a sodium

salt by adding equivalent weight of sodium carbonate or caustic soda. Though obtained in a soluble form, the product contained proteinous matters. Experiments are being done to purify the crude dye.

However, with the sodium salt, wool yarns have been dyed into different colours with the help of different inorganic mordants.

Shelf-stability of the dye was tested by examining samples of dye at intervals of seven days for two months, and found satisfactory. Further work is being done.

7. Adhesives

(i) *Accelerators for heat curing of saponified lac* — The importance of hydrolysed or saponified lac as a constituent of adhesives is well recognized. The life under heat (150°C.) of hydrolysed lac, however, is about 2 hours, which makes it slow curing. To overcome this drawback, attempts were made to find out suitable accelerators. To start with, a few chemicals in amounts up to 10 per cent on the weight of saponified lac were tried, of which the most promising ones were further studied. It is interesting to note that the known accelerators for shellac, e.g. urea, ' hexa ', calcium oxide have no accelerating action on the curing of saponified lac. The results are shown in Table V (App. B).

(ii) *Hydrolysed bleached lac for making transparent, flexible micanites* — Micanites prepared by using saponified lac have been found to be better in electrical insulation than those prepared by using resin and castor oil. But the colour of the micanite with saponified lac was dark-brown. It was found that this defect could be overcome if hydrolysed bleached lac were used instead of ordinary saponified lac. Hydrolysed bleached lac can be prepared either by hydrolysing bleached lac or by bleaching hydrolysed lac. Micanites prepared with this bleached saponified lac, besides being of light colour, were otherwise satisfactory too.

(iii) *Adhesive for " thermocole " sheets* — Alcoholic solutions of dewaxed lac modified by refluxing at 90°-95°C. for 2 to 2½ hours with 2 per cent tartaric or maleic acid have been found to act as good adhesives for fixing " thermocole " to metallic or wooden surfaces. The adhesive could be used either as a thick or a thin solution. If the application is done at room temperature, setting takes place in 3 to 4 days, while if carried out at 70°C., the process is completed overnight.

(iv) *Adhesive for plywood* — Work on the subject was done in this Institute during the last war and the product was made according to some military specifications. It was found subsequently, however, that the product does not comply with some of the recent I.S.I. specifications and hence fresh investigations were undertaken.

The previous composition of the adhesive was modified and tested for moisture resistance for different types of veneers. Results are given in Table VI (App. B). It would appear that none of these were good enough to satisfy the I.S.I. specifications for " moisture-proof plywood ". However, *toon* veneers bonded with compositions Nos. 2 and 3 just met the I.S.I. specifications with regard to " resistance to moisture " for " commercial plywood ". Further work on the modifications of the adhesive composition is being continued.

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

(i) *Round robin test* — Round robin test for the determination of bleach index and bleachability of seedlac by a method developed by the I.L.R.I. and sponsored by the Indian Standards Institution, as also the round robin test for the determination of non-volatile matter soluble in cold alcohol in seedlac, shellac and bleached lac sponsored by the British Standards Institution (U.K.) was undertaken in accordance with a scheme formulated by the I.L.R.I. and the Indian Standards Institution. Two laboratories in France, 5 in U.K., 5 in U.S.A. and 4, including this Institute, in India participated in the tests. The samples

for the tests were prepared by the Indian Lac Research Institute and analysed before sending to the participating laboratories. Seven samples were selected for bleach index and bleachability tests and 6 for non-volatile matter determination tests. Results of tests from some of the laboratories have been received. Others are awaited. The method for the determination of bleach index and bleachability of seedlac is according to Doc: 150/TC-50 (Secr — 49) 82, and the determination of non-volatile matter soluble in cold alcohol is according to I.S.I., Doc No. I.S.O./TC-50 (U.K.— 12)/109 as also by Indian method (I.S.I., Doc No. I.S.O./TC-50 (Secr — 51) 84.

(ii) *Determination of wax in shellac by photo-electric colorimeter* — Experiments were carried out for exploring the possibility of determining wax in shellac by measuring the turbidity with the help of a photo-electric colorimeter. For this, samples of shellac containing varying quantities of wax were prepared by dissolving dewaxed shellac as well as ordinary shellac in different proportions in alkali solution and precipitating with acid. Shellac thus prepared was dissolved in 96 per cent alcohol to make a 0·5 per cent solution by refluxing. The deflections of the colorimeter needle were recorded for solutions as such and after filtering.

(iii) *An alternative method for rapid determination of insoluble matter in various grades of lac* — The usual method of determining insoluble matter in lac is slow and cannot be applied as an on-the-spot method in the market-place.

Preliminary work has shown that if in the current methods sodium sulphite is used instead of sodium carbonate, dissolution of lac is much quicker. It has been further observed that the resin from a sulphite solution can be precipitated out by the addition of a dilute sodium chloride solution or acetone. The possibility of utilizing this observation for the determination of the percentage of soluble resin in raw lac is being further examined.

9. Shellac Wash Primers

The effects of a shellac wash primer on different metals have been studied. The performance of the following composition has been recorded in Table VII (App. B).

(A)	Dewaxed lac	40 gm.	(B)	Phosphoric acid	12 gm.
	Ethyl acetate	32 ,,		Sp. gravity 1·75	
	n-Butyl alcohol	8 ,,		Ethyl alcohol	15 ,,
	Talc	2 ,,		*n*-Butyl alcohol	33 ,,
	Zine chrome	38 ,,			
		120 gm.			60 gm.

(A) was prepared by grinding the pigment (Zinc chromate and talc) in a solution of dewaxed lac in a ball mill, then (B) was added to (A) and thoroughly mixed by further grinding in the ball mill.

The effects of varying the proportion of phosphoric acid and pigment have been studied and results given in Table VIII (App. B). It is found that for the most efficient composition, phosphoric acid and pigment contents should be respectively 30-40 per cent and 75-100 per cent on the basis of lac. Its performance appears to be quite satisfactory, except for brass surfaces.

10. *Ad hoc* Work

(i) *Shellac coating on shuttlecocks* — By coating the edges and tips of feather shuttlecocks with a dilute solution of shellac (e.g. 10 per cent solution of " Superblonde " lac) their life could be increased from 1½ to 2½ games, and sometimes even to 5 games. The increase in weight due to this treatment is very negligible being actually 0·03 gm. to 0·09 gm., and does not affect the flying efficiency of the shuttlecocks.

(ii) *Shellac paper-pulp composition for lac bangles* — As a possible means of overcoming the brittleness of lac bangles, unsized paper-pulp (e.g. from old newspapers) was incorporated with shellac in various proportions by hot rolling. The impact strengths of compositions with different proportions of shellac and paper-pulp were tested; the results (Table IX, App. B) indicate that incorporation of 70 per cent of paper-pulp on the weight of shellac gives products of maximum impact resistance.

(iii) *Shellac water-proof inks* — A number of water-proof inks were made using either dewaxed bleached lac or dewaxed decolourized lac or simple dewaxed shellac and the samples were sent to a firm in Ambala, which was interested in making water-proof inks. The firm's report is awaited.

(iv) *Marking-inks for aluminium sheets and foils* — A firm in Jayakayanagar was interested in preparing lac-based marking-inks for aluminium sheets and foils. A number of compositions were made using dewaxed lac and samples were sent to it for testing. As reported by the firm, the composition containing 15 gm. of dewaxed lac in 35 gm. of methylated spirit with 0·15 gm. of maleic anhydride, 0·75 gm. of pine oil and 0·075 gm. of Rhodamine B, worked satisfactorily.

(v) *Shellac varnishes for gold thread* (Jari *thread*) — A firm in Delhi was making spirit varnishes for coating gold thread, using 1 per cent pale shellac solution in spirit with 1 per cent dibutyl phthalate. This was found to be particularly very poor in gas resistance (H_2S). So a number of spirit varnishes were made, which proved satisfactory. Three typical compositions were as follows: (i) 5 per cent dewaxed bleached lac in rectified spirit with 1 per cent dibutyl phthalate, (ii) dewaxed bleached lac 10 gm. rectified spirit 80 gm., butyl alcohol 10 gm., tricresyl phosphate 0·5 gm., maleic acid 0·05 gm., (iii) the (ii) diluted with rectified spirit.

(vi) *Paper varnishes* — A number of paper varnishes prepared according to the formula given in Angelo Brothers' publication "Angelo's Shellac" were tried; of these, the composition containing 125 parts of dewaxed lac, 65 parts of gum mastic and 65 parts of gum sandarac in 500 parts of methylated spirit was found to work best.

(vii) *Dry photo-mounting tissue paper* — It was reported (*I.L.R.I. Annual Report*, 1956-57) that by dipping tissue paper in a 20 per cent alcoholic solution of a mixture of shellac and rosin (3:1) dry mounting tissue paper of satisfactory quality can be made. A further study of the process has given the following results: The minimum thickness of coated paper to have satisfactory adhesion should be 4·5 mils., the thickness of the original paper being 3·0 mils. If the coating is done by dipping the paper in a varnish tank and drawing it out by hand, then the thickness of coating is not uniform. It has also been found that to obtain good results, the maximum speed of the passage of the paper through the varnish tank should not exceed 6 ft./min. and that drying should be done in an oven having a temperature of 80°±3°C. The best results are obtained by passing the coated paper at a speed of 4 ft./min. through an oven 6 ft. high maintained at 80°±3°C. Under these conditions, paper dries properly and can be collected in a roll form. Keeping all these in view, a machine has been designed which has worked satisfactorily.

Regarding the varnish composition, the following one has proved quite satisfactory and may be adopted in general:

Shellac ...	...	710 gm.
Rosin WW ...	...	236 ,,
Methylated spirit	...	1,500 cc.

The presence of shellac wax is not desirable as it makes the surface of the finished 'paper' uneven; hence dewaxed shellac is to be preferred. Indeed, if ordinary shellac is used, the varnish should subsequently be dewaxed, say, by extracting the varnish (shellac solution in spirit) with white spirit at a temperature 30°-35°C.: the rosin in this case should be added after dewaxing.

To have the desired thickness of coating, the varnish should have a specific gravity 0·930 to 0·940 at the room temperature, when coating is done.

A composition prepared as above has been certified by prominent photographic material dealers as a very good one. Economics of the process is also very favourable; its manufacture is to be undertaken in the proposed production unit at the Institute.

11. Experimental Testing Laboratory

During the year 1957-58, 84 samples were received from 22 parties for 122 tests. Of these, 67 tests were for hot alcohol insolubles and 10 for bleachability and bleach index; the rest covered other miscellaneous tests.

Reports of analysis for 11 samples only by commercial analysts were communicated to us, and all of them were for hot alcohol insolubles. The reported percentage of impurities in these samples agreed with ours within $\pm 0{\cdot}2$ in 6 cases and in the rest the difference was more than $\pm 0{\cdot}4$.

12. Miscellaneous

(i) More abstracts have been collected and complied in connection with the " Monograph on Lac ".

(ii) Several chapters on the book " Chemistry of Lac " have been rewritten.

13. Propaganda and Publicity

Utilization of lac — Manufacturers of seedlac and shellac were personally contacted and recent developments at the Institute in the refining processes of lac such as the new sand separating machine, autoclave process and improved methods of washing, explained to them. Demonstration of the operation of the sand separating machine was carried out in two factories. The Umaria Shellac Factory was visited and a final plan for improving the quality of seedlac prepared there, submitted. As desired by the Chief Conservator of Forest, Madras, the Madras Government Lac Factory at Cumbum was inspected and a report together with recommendations for improving the factory sent to him.

Technical enquiries in regard to manufacture of bleached lac, seedlac, shellac, insulating cloth, varnishes, lac dye, etc., received from several manufacturers and consumers of lac, present or potential, were answered and samples of lac and modified lac compositions supplied for experimental purposes. Requests for literature were also complied with.

Consumption of lac in India — Attempts to obtain reliable figures of the consumption of lac in India were continued. The statistical section of the Indian Lac Cess Committee was approached to compile the data about the various forms of lac despatched by rail from the principal manufacturing centres to destinations other than Calcutta. According to figures (for 1956-57) supplied by them the total quantities thus despatched are:

Shellac and button lac	...	16,807 mds.
Seedlac ...	...	7,070 ,,
Sticklac ...	...	1,103 ,,
Kirilac ...	...	12,810 ,,
	Total	37,790 mds. say, 38,000 mds.

Attempts are being made to obtain the export figures out of this quantity by land to Pakistan from Amritsar, the quantity exported from Bombay Port, the production figures in various other centres and the quantity consumed in Calcutta and despatched from that city to other consuming centres in the country in order to obtain an accurate figure about the quantity consumed in the whole country.

Regarding the pattern of consumption: furniture polishing appears to be easily the largest consumer with lac bangles and gramophone records following. Refuse lac is the material largely used for bangle-making. Other consumers in order of importance are wood lacquering, grinding wheels, sealing wax and leather finishing. There are a number of minor uses also.

Survey of potential consumers of lac — Several places in the Northern and South India were visited. It was ascertained that there is a good potential market for bleached lac in the sports goods industry at Jullundar and Meerut, and for metal lacquering at Moradabad. Parties have been contacted and samples sent. With a view to impress upon the officers concerned, the need for greater utilization of lac for the requirements of the Defence Services, the officers of the Technical Development Establishments at Kanpur were met at a conference and various points discussed. Samples of modified lac compositions for some of their applications are being sent to them for their experiments.

Difficulty and problem of manufacturers and consumers of lac: *Industry-wide conference* — As a preliminary to the convening of an industry-wide conference on lac, manufactures of seedlac and shellac were contacted at the meetings of their respective associations at Bundu, Tulin, Jhalda, Gondia, Mirzapur and Daltonganj and their problems and difficulties discussed. The authorities of the two large-scale mechanized lac factories in Calcutta were also contacted and their views ascertained. A report is being submitted shortly.

Adhesives and Cements

(a) *Dry mounting tissue paper* — Samples of dry mounting tissue prepared at this Institute were sent to a number of photographers of Calcutta and Bombay and these have evoked considerable interest amongst them as these were found to be highly satisfactory. The unanimous opinion was that these samples are not in any way inferior to the best imported products.

(b) *Jointing compound hermetite* — A shellac-based formula evolved at this Institute was reported as satisfactory by tests at the Technical Developments Establishments at Kanpur and Ahmednagar. They have been intimated the composition as well as possible sources of supply of this material. Samples sent by a party at Ranchi at our request have also been approved by them. The annual consumption of this material, however, was reported to be about 450 lb. only.

Bleached lac — Demand for bleached lac has increased appreciably. One party at Damascus has shown keen interest in the bleaching of lac. Samples of large quantities of bleached lac have been supplied to various consumers. But due to shortage of staff and the smallness of our plant (10 lb.) it has not been possible to meet all demands.

A design for a larger unit with an output capacity of about 80 lb. of bleached lac per day has been finalized in consultation with the National Research Development Corporation. Quotations are being invited for the installation of the plant.

On the basis of technical informations supplied from this Institute, one party in Calcutta has started manufacturing bleached lac, their production capacity being about 30-40 lb. per charge. A representative of this firm who paid a visit to the Institute was given all the technical assistance asked for.

Shellac coating for earthenware — The use of shellac in this field did not develop as rapidly as was expected. Renewed attempts are being made to popularize the process. The All-India Khadi and Village Industries Board, Pottery Section has been contacted several times in this respect.

A list of pottery co-operative societies is also being collected from the various State Governments with a view to contacting these societies direct with the necessary literature and information.

Simultaneously, a new process is being worked out to make the operation even simpler. A water-soluble form of lac has been produced which can be applied to the earthenware without the use of any chemicals or processing. Preliminary experiments have given promising results. Experiments are also in progress to produce these finishes in different colours as was desired by many potters.

Gramophone records — The All-India Radio authorities have set-up the necessary plant for production of gramophone records of programmes recorded in their studios. They are, at present, reported to be using imported plastic material for their tests. About 20 lb. of shellac composition formulated at the Institute is being prepared and sent. Their annual requirement of gramophone stock at present is about 5 tons, which is expected to increase in the coming years.

Moulded articles — It has been reported by a party in Calcutta that they have obtained satisfactory results in the final test of a sample plate sent to them for the manufacture of battery boxes. They have been given details about the actual composition of the moulding powder. Their progress is being watched.

"Empire cloth" — In a factory manufacturing fans in West Bengal, an empire cloth baking tower is nearing completion as also a calendering plant. The firm is likely to commence production of empire cloth very shortly. Our shellac composition will be tried. Several other parties were also supplied information regarding empire cloth manufacture.

Insulating varnish — Samples and processes of insulating varnish were supplied to several parties in Bombay and Karnal.

Use of lac in wash primers — Steps are being taken to popularize in this country the use of lac in wash primers or etch primers. This use for lac was developed by our Shellac Utilization Officer during his recent stay at the Paint Research Station Teddington, England. Shellac-based wash primers were found to compare very favourably with commercial wash primers on the market which contained no lac. The findings were published as a Research Memorandum of the Paint Research Station during the period under report.

Exhibits and exhibitions — Requests for exhibits of lac and lac products for display at exhibitions, show-rooms, etc., were received from about 40 parties and complied with. The Institute also took part in several exhibitions in this country, the most important of which were:

1. Exhibitions of Lac and Lac Products at Gondia in connection with the Silver Jubilee of I.L.C.C.

2. Art and Industrial Exhibition at Bilaspur.

3. The All-India Khadi and Village Industries Exhibition at Pragjyotishpur in Assam during the 63rd session of Indian National Congress.

4. Farmers Forum Exhibition in New Delhi.

In addition, exhibits were sent to the following foreign exhibitions, Trade Fairs and Show-rooms:

1. Washington State International Trade Fair, Seattle.

2. Poznan International Fair, Poland.

3. Wholly Indian Exhibition in China.

4. St. Eriks Fair, Sweden.

5. 33rd International Marsailla Fair, France.

6. Indian Trade Exhibition, Sudan.

7. Indian Government Show-room — Jaddah.

Months & years	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.	Lowest min.
April 1957	2·30	96·30	71·50	87·70	23·10	9·04	nil	104·0	57·0
May 1957	3·22	105·40	76·50	95·30	22·30	10·70	0·50	112·0	70·0
June 1957	2·20	97·80	76·20	91·40	48·70	6·60	6·60	106·0	70·0
July 1957	1·61	84·50	73·50	80·00	83·20	3·70	14·25	91·0	70·0
Aug. 1957	1·04	86·60	73·40	80·80	80·00	5·30	12·20	91·0	71·0
Sept. 1957	0·95	86·30	71·30	81·20	71·00	5·95	12·17	92·0	67·0
Oct. 1957	0·48	87·40	64·58	81·48	58·09	7·45	1·91	93·0	53·0
Nov. 1957	0·63	81·40	50·96	74·80	61·26	8·74	nil	84·0	46·0
Dec. 1957	0·56	78·29	46·50	69·60	52·90	—	nil	84·0	39·0
Jan. 1958	0·51	79·95	48·60	68·90	47·10	8·00	1·26	85·0	40·0
Feb. 1958	1·25	80·00	53·30	69·35	48·60	8·88	2·38	87·0	41·0
Mar. 1958	1·42	88·40	61·93	81·80	68·80	7·70	nil	98·0	52·0

REMARKS — The highest maximum temperature recorded was 112°F. on two days in May 1957, viz. on 30th and 31st. The lowest recorded temperature was 39°F. on 23-12-57. The total and the monsoon rainfall during the year were respectively 51·27″ and 45·22″ as against 53·03″ and 39·31″ in the last year. The highest wind speed as recorded on 7-5-57 was 175 miles/day and there was no hailstorm during the year.

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APPENDIX A

(Tables : Entomology Division)

TABLE I — CROP DATA OF EXPERIMENT ON THE EFFECT OF PARTIAL DEFOLIATION ON BROOD PRESERVATION

Locality and treatments	Brood used	Yield				Total quantity of brood-lac	Brood to yield ratio	Brood to brood ratio	Per cent of selected brood
		Cut as *ari* in Apr.	Cropped in July	Cropped in Oct.	Total yield				
	lb. oz.	lb. oz.	lb. oz.	lb. oz.	lb. oz.	lb. oz.			
Kundri									
Defoliated	161 14	—	523 12	401 5	925 1	419 14	1 : 5·71	1 : 2·59	45·4
(200 trees)	(16-13)	—	(52-0)	(29-1)	(81-1)	(32-7)	1 : 4·82	1 : 1·93	—
Undefoliated	449 0	—	1204 8	356 12	1561 4	318 6	1 : 3·47	1 : 0·70	20·1
(200 trees)	(29-6)	—	(141-11)	(26-0)	(167-11)	(25-6)	1 : 5·70	1 : 0·86	—
Villagers' type	Conti-	788 9	—	—	788 9	—	—	—	—
(200 trees)	nuous crop	(133 lb. 1203)	—	—	133 12	—	—	—	—
Namkum									
Defoliated	11 0	—	24 8	—	24 8	17 8	1 : 2·2	1 : 1·59	71·4
(16 trees)	(2-8)	—	(4-4)	—	(4-4)	(3-10)	1 : 1·7	1 : 1·45	—
Undefoliated	15 0	—	51 4	—	51 4	27 12	1 : 3·4	1 : 1·85	54·1
(16 trees)	(3-7)	—	(6-14)	—	(6-14)	(4-15)	1 : 2·0	1 : 1·44	—

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

Host	No. of trees.	Lac sticks					Scraped lac				
		Brood used	Brood yield	Ratio of brood			Brood used	Brood yield	Total yield	Ratio of brood	
				Total yield	Brood	Yield				Brood	Yield
		lb. oz.	lb. oz.	lb. oz.			lb. oz.	lb. oz.	lb. oz.		
				***Baisakhi* crop — 1956-57**							
Palas	16	16 0	35 8	61 8	1 : 2·2	1 : 3·8	3 2	6 5	9 1	1 : 2·02	1 : 2·9
Ber	16	18 12	—	60 0	—	1 : 3·2	4 13	—	6 12	—	1 : 1·4
				***Katki* — 1957**							
Palas	10	20 8	1 12	28 4	1 : 0·09	1 : 1·4	3 14	0 9	5 5	1 : 0·15	1 : 1·3
Ber	10	19 8	10 4	56 12	1 : 0·53	1 : 2·9	3 9	2 2	5 8	1 : 0·6	1 : 1·5

TABLE III

Particulars	Treatments lb. oz.	Treatments lb. oz.	Treatments lb. oz.
Brood used for infection	13 8	19 0	20 4
Scraped lac from brood used	3 10	4 0	4 2
Broodlac obtained	nil	nil	nil
Total yield of lac sticks	30 12	33 0	36 0
Total yield of scraped lac	3 10	3 4	3 14
Brood to yield ratio			
(i) Lac sticks	1: 2·23	1: 1·74	1: 1·78
(ii) Scraped lac	1: 1·00	1: 0·81	0: 0·94

TABLE IV — RESULTS OF STICK EXAMINATION OF 30 SAMPLES CARRIED OUT AFTER 4 WEEKS AND 14 WEEKS OF INFECTION

Treatments	After 4 weeks		After 14 weeks		
	Settlement of larvae per inch	% Larval mortality	No. of females per inch	No. of males per inch	% males
A — Partial pruning before infection (Oct.-Nov.)	234	19·6	61	62	50·2
B — Partial pruning after infection (Dec.-Jan.)	340	11·1	96	74	43·5
C — Control	302	14·9	106	93	46·7

TABLE V — CROP DATA ON THE PERFORMANCE OF *A. LUCIDA, O. DALBERGIOIDES* AND *F. CUNIA* AS BROOD PRESERVES IN *BAISAKHI* SEASON

Crop particulars/Host species	***Palas*** brood				***Ber*** brood	
	A. lucida	*O. dalbergioides*	*F. cunia*		*A. lucida*	*O. dalbergioides*
	lb. oz.	lb. oz.	lb. oz.		lb. oz.	lb. oz.
Brood used	10 8	16 4	4 8		6 0	5 0
Scraped lac from brood used	1 12	3 9	0 13		1 8	1 2
Yield of broodlac (lac sticks)	— —	9 12	7 4		— —	— —
Scraped lac	— —	1 12	0 12		— —	— —
Total yield (lac sticks)	— —	17 12	13 4		— —	2 0
Scraped lac	— —	2 4	1 2		— —	— 4
Brood yield ratio (lac sticks)	— —	1: 1·09	1: 2·9		— —	1: 0·40
Scraped lac	— —	1: 0·63	1: 1·4		— —	1: 0·22
Percentage of selected broodlac	— —	54·9	54·9		— —	— —

TABLE VI — CROP DATA FOR THE EXPERIMENT ON PROPER TIME OF HARVESTING FOR MAXIMIZING YIELD

Date of cropping	Treatments	Lac sticks					Scraped lac					
		Brood used		Yield		Brood to yield ratio	Brood used		Yield		Brood to yield ratio	% of driage on scraped
		lb.	oz.	lb.	oz.		lb.	oz.	lb.	oz.		
Namkum Experiments (10 trees)												
15-4-57	I	25	8	10	4	1 : 0·40	6	7	1	1	1 : 0·17	15·1
15-4-57	II	23	12	31	12	1 : 1·34	6	0	5	10	1 : 0·93	13·3
5-7-57	III	24	8	72	8	1 : 2·96	5	8	9	0	1 : 1·63	20·0
5-7-57	IV	12	12	39	4	1 : 3·07	2	14	5	3	1 : 1·80	25·2
Kundri Experiments (50 trees)												
16-4-57	I	104	9	369	0	1 : 3·53	5	10	85	6	1 : 11·6	14·9
16-5-57	II	106	9	368	4	1 : 3·45	5	10	66	14	1 : 11·9	18·8
23-7-57	III	139	6	290	2	1 : 2·08	5	14	44	1	1 : 7·5	42·7
	IV	57	6	295	4	1 : 5·14	3	5	44	1	1 : 13·3	33·5

TABLE VII — CROP DATA ON THE DETERMINATION OF OPTIMUM DENSITY OF LARVAL SETTLEMENT (*BAISAKHI* 1956-57 CROP)

Host	Crop and yield particulars	Treatment A			Treatment B			Treatment C		
		Yield		Ratio of brood to yield	Yield		Ratio of brood to yield	Yield		Ratio of brood to yield
		lb.	oz.		lb.	oz.		lb.	oz.	
Palas (trees)	Lac sticks	22	12	1 : 6·06	27	14	1 : 4·93	45	0	1 : 4·00
	Scraped lac	2	15	1 : 3·13	3	0	1 : 2·09	6	5	1 : 2·40
Ber (trees)	Lac sticks	20	8	1 : 5·47	25	0	1 : 4·44	29	0	1 : 2·46
	Scraped lac	2	4	1 : 2·40	2	11	1 : 2·15	2	7	1 : 1·00

TABLE VIII — CROP DATA ON THE DETERMINATION OF OPTIMUM DENSITY OF LARVAL SETTLEMENT (*KATKI* 1957 CROP)

Host and number of trees	Crop and yield particulars	Treatment A			Treatment B			Treatment C		
		Yield		Ratio of brood to yield	Yield		Ratio of brood to yield	Yield		Ratio of brood to yield
		lb.	oz.		lb.	oz.		lb.	oz.	
Palas 10 trees in each treatment	Lac sticks	19	2	1 : 3·8	38	4	1 : 3·8	42	2	1 : 2·1
	Scraped lac	2	12	1 : 2·4	5	10	1 : 2·8	9	6	1 : 2·3

TABLE IX — CROP DATA FOR *FLEIMENGIA CONGESTA* BUSH GROWN IN *KATKI* 1957 SEASON

Number of plants infected	100 (two-year old)
Date of infection	7-7-57
Date of male emergence	20-8-57
Date of harvesting	24-10-57
Quantity brood used	13 lb. 8 oz.
Broodlac yield	28 lb. 12 oz.
Total yield of lac sticks	58 lb.
Brood to yield ratio	
(i) Lac sticks	1 : 4·3
(ii) Scraped lac	1 : 2·5

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

Crop	Quantity of lac caged	Emergence of insects			Beneficial parasites
		Enemy parasites	Enemy predators		
			Eublemma	*Holcocera*	
***Katki* 1957**	10 lb. *palas* lac sticks	441	1389	194	85
	4 lb. 6 oz. scraped lac (from 10 lb. *palas* lac sticks)	157	140	12	3
***Aghani* 1957-58**	10 lb. *kusum* lac sticks	161	354	146	56
	8 lb. 4 oz. scraped lac (from 10 lb. *kusum* lac sticks)	302	156	36	26

TABLE XI — LOSS DUE TO ENEMY INFESTATION DURING STORAGE

Crop and treatment	Initial weight lb.	Final weight lb.	Loss in weight %
***Katki* 1957**			
Palas lac sticks			
(i) Untreated control	10·0	7·324	26·76
(ii) Fumigated with CS_2	10·0	7·26	27·40
Palas scraped lac			
(i) Untreated control	4·375	3·212	26·58
(ii) Fumigated with CS_2	3·50	2·874	17·89
***Aghani* 1957-58**			
Kusum lac sticks			
(i) Untreated control	10·0	8·224	17·76
(ii) Fumigated with CS_2	10·0	7·645	23·55
Kusum scraped lac			
(i) Untreated control	8·25	7·196	12·78
(ii) Fumigated with CS_2	8·125	7·26	10·65

TABLE XII — DATA ON COMPARATIVE EMERGENCE OF INSECTS FROM LAC SAMPLES TREATED WITH INSECTICIDES — *PALAS* LAC (*KATKI* 1957)

Lac samples and quantity caged	Insecticidal treatment	Emergence of insects		
		Enemies		Friendly parasites
		Predators	Parasites	
Lac sticks 10 lb.	Aldrex 2% dust	55	823	—
,,	Aldrex 5% dust	52	88	—
,,	Dieldrex 1·5% dust	230	743	5
,,	Endrex 1% dust	91	334	5
,,	Aldrex (W.P.) spray 0·1%	122	581	1
,,	B.H.C. (W.P.) spray 0·1%	314	99	2
,,	Dieldrex (W.P.) spray 0·1%	63	704	1
,,	Endrex (E.C.) spray 0·1%	130	419	21
,,	Control	676	1796	58
Scraped lac obtained from 10 lb. of lac sticks 3·5 lb.	Aldrex 2% dust	3	180	1
4·5 ,,	Aldrex 5% dust	6	36	—
4·0 ,,	Dieldrex 1·5% dust	10	2151	—
4·0 ,,	Endrex 1% dust	2	191	—
4·0 ,,	Aldrex (W.P.) spray 0·1%	17	193	—
4·25 ,,	B.H.C. (W.P.) spray 0·1%	49	58	6
3·75 ,,	Dieldrex (W.P.) spray 0·1%	18	172	—
4·0 ,,	Endrex (E.C.) spray 0·1%	—	64	3
4·25 ,,	Control	24	476	13

TABLE XIII — DATA ON COMPARATIVE EMERGENCE OF INSECTS FROM LAC SAMPLES TREATED WITH INSECTICIDES — *KUSUM* LAC (*AGHANI* 1957-58)

Lac samples and quantity caged	Insecticidal treatment	Emergence of insects		
		Enemies		Friendly parasites
		Predators	Parasites	
Lac sticks 10 lb.	Aldrex 2% dust	169	262	—
,,	Aldrex 5% dust	80	40	—
,,	Dieldrex 1·5% dust	169	42	1
,,	Ekatox 2% dust	34	1	—
,,	Endrex 1% dust	—	35	—
,,	Aldrex (W.P.) spray 0·1%	200	83	1
,,	Dieldrex (W.P.) spray 0·1%	153	213	1
,,	Ekatox (W.P.) spray 0·1%	283	27	1
,,	Endrex (E.C.) spray 0·1%	97	39	—
,,	Control	381	132	59

TABLE XIII—DATA ON COMPARATIVE EMERGENCE OF INSECTS FROM LAC SAMPLES TREATED WITH INSECTICIDES—*KUSUM* LAC (*AGHANI* 1957-58) *(Contd.)*

Lac Samples and quantity caged	Insecticidal treatment	Emergence of insects		
		Enemies		Friendly parasites
		Predators	Parasites	
Scraped lac 8·125 lb.	Aldrex 2% dust	111	214	—
8·125 ,,	Aldrex 5% dust	33	110	—
8·25 ,,	Dieldrex 1·5% dust	87	67	1
8·25 ,,	Ekatox 2% dust	28	7	—
8·37 ,,	Endrex 1% dust	68	52	1
8·43 ,,	Aldrex (W.P.) spray 0·1%	110	117	3
8·00 ,,	Dieldrex (W.P.) spray 0·1%	91	94	2
8·25 ,,	Ekatox (W.P.) spray 0·1%	125	27	2
8·25 ,,	Endrex (E.C.) spray 0·1%	59	52	2
8·125 ,,	Control	149	174	23

APPENDIX B

(Tables: Chemistry Division)

TABLE I — PROPERTIES OF FRACTIONS OBTAINED FROM 100 GM. SHELLAC BY UREA FROM HOT ACETONE SOLUTION

Products	Yield in gm.	Melting point	% of nitrogen	% of urea	Acid value
I	63·5	Does not melt up to 200°C.	1·7-2·0	3·6-4·2	60·0
II	14·8	185°C. with decomp.	3·0-3·5	6·4-7·4	65·5
III	28·6	85°C.	3·3	7·0	101·2
Original shellac	—	78-79°C.	0·08	—	74·2

TABLE IIA — PROPERTIES OF BLEACHED LAC OBTAINED BY USING DIFFERENT QUANTITIES OF BLEACH LIQUOR

Bleach (3% available chlorine) added in cc. for 30 gm. of lac	Life at 150°C.	Flow time for 5″	Acid value	Sap. value (appx.)	Sap. value (conc.)	Iodine value	% of chlorine	Iodine value, Iodine equivalent of chlorine
Original shellac	64 min.	40 sec.	70·65	221·8	221·8	12·6	—	12·6
Precipitated without bleaching	32 ,,	66 ,,	69·18	218·5	218·5	11·9	—	11·9
20 cc.	15 ,,	115 ,,	69·36	224·6	218·3	8·6	0·36%	9·89
40 cc.	13 ,,	160 ,,	69·97	233·4	222·44	7·7	0·68%	10·13
60 cc.	14 ,,	140 ,,	70·94	240·2	224·62	6·8	0·97%	10·27
70 cc.	13 ,,	228 ,,	70·36	—	—	6·4	—	—
80 cc.	12 ,,	360 ,,	71·52	248·5	227·73	6·2	1·29%	10·82
100 cc.	12 ,,	480 ,,	73·86	255·8	233·57	6·2	1·38%	11·14

TABLE IIB — PROPERTIES OF BLEACHED LAC PRODUCED BY USING DIFFERENT QUANTITIES OF BLEACH LIQUOR

Bleach (3% Cl) added in cc. for 30 gm. shellac	Life at 150°C.	Flow time for 5″	Acid value	Sap. value (apparent)	Sap. value *(corrected)	Iodine value	% of chlorine	Iodine value, Iodine equivalent chlorine
Original shellac	45 min.	140 sec.	73·28	221·0	221·0	14·1	—	14·1
Precipitated without bleaching	33 ,,	265 ,,	70·94	218·65	218·65	13·2	—	13·2
20 cc.	12 ,,	Does not flow 5″	70·36	225·8	222·05	10·5	0·23%	11·32
40 cc.	11 ,,	do	70·94	231·7	221·1	9·5	0·6%	11·6
60 cc.	10 ,,	do	71·52	240·2	225·8	8·5	0·902%	11·74
80 cc.	10 ,,	do	73·28	249·0	229·4	7·8	1·2%	12·2
100 cc.	10 ,,	do	75·03	254·7	232·2	7·3	1·3%	12·24

*Sap. value corrected was found after subtracting KOH equivalent which reacts with the chlorine present in bleached lac, from the " apparent saponification value ".

TABLE III — RECOVERY OF LAC FROM LAC FACTORY WASTES (ALKALI-EXTRACTION)

Type of waste lac used	Lac cont. hot alc. solution	Yield of pptd. lac	Weight of insol. residue	Life of shellac	Flow of shellac	Colour
1. *Kunni*	81·86%	80%	50%	46 min.	12 min.	V E R Y D A R K C O L O U R
2. *Molama* (*Kusmi*)	70·34%	68%	26%	42 ,,	No flow	
3. *Molamas* (obtained from Lac factory at Gondia)						
Grade — A	83·63%	82%	14%	42 ,,	5″ in 4 min.	
Grade — B	83·66%	82%	12%	53 ,,	¾″ in 5 min.	
Grade — C	83·26%	82%	13%	43 ,,	3″ in 12 min.	

TABLE IV — TREATMENT OF LAC WASH-WATER WITH CHEMICALS TO STOP PUTREFACTION

Chemicals used	Remarks
Acid HCl 0·1%	Does not putrefy for 10 days
Acid HNO_3 0·1%	do
Acid Oxalic 0·1%	do
Acid Tartaric 0·1%	do
Pot. chloride 1%	do
Calcium chloride 1%	Putrefy after 24 hours
Aluminium chloride 1%	,, ,, 48 ,,
Aluminium sulphate 1%	,, ,, 48 ,,

TABLE V — ACCELERATORS FOR HEAT-CURING OF SAPONIFIED LAC

Chemicals	Life under heat with (in mins.)					
	1%	3%	5%	7%	10%	Control
1. Phthalic acid	108	98	94	94	94	121
2. Salicylic acid	96	74	69	63	54	121
3. Oxalic acid	71	41	31	20	15	116
4. Tartaric acid	80	56	48	41	39	116
5. Aluminium chloride	—	—	—	—	49	114
6. Paraform	—	—	—	—	107	
7. Benzoic acid	—	—	—	—	101	
8. Phthalic anhydride	—	—	—	—	89	
9. Sulphuric acid	—	—	—	—	4	110
10. Hydrochloric acid	—	—	—	—	9	
11. Phosphoric acid	—	—	—	—	8	
12. Malonic acid	—	—	—	—	86	
13. Lactic acid	—	—	—	—	111	

TABLE V — ACCELERATORS FOR HEAT-CURING OF SAPONIFIED LAC (*Contd.*)

Chemicals	Life under heat with (in. mins.)					
	1%	3%	5%	7%	10%	Control
14. Stannous chloride	—	—	—	—	15	110
15. Succinamide	—	—	—	—	111	
16. Benzamide	—	—	—	—	156	
17. Ferric sulphate	—	—	—	—	105	
18. Ferric chloride	—	—	—	—	6	
19. Hexamethylene tetramine (Hexa)	—	—	—	—	More than 10 hours	112
20. Urea	—	—	—	—	More than 10 hours	
21. Calcium oxide	—	—	—	—	More than 10 hours	

TABLE VI — MOISTURE-RESISTANCE OF ADHESIVES FOR PLYWOOD

Composition	Modifier	Fillers	Other resin	Time of failure under boiling water				
				Haldu	*Toon*	*Kanju*	*Sishum*	*Gunjam*
1. Shellac 100 gm. Spirit 200 ml. Formalin 25 ml. Urea 8 gm.	$AlCl_3$-2 gm.	$CaCO_3$-20 saw dust 30	—	5 min.	30 min.	15 min.	5 min.	5 min.
2. ,,	,,	—	Phenolformaldehyde 60 pts.	—	60	7	10	7
3. ,,	,,	$CaCO_3$-20 saw dust 30	,,	15	60	45	15	12
4. Shellac 60 gm. Spirit 200 ml.	Lime 0·6 gm. $AlCl_3$-2·0	Saw dust 30	Phenolformaldehyde 40 gm.	—	5	—	—	—

TABLE VII — EFFECT OF SHELLAC WASH PRIMER ON METAL FILMS

Sl. No.	Type of panel	Dry weight of the primer in gm.	Time for air drying	Scratch hardness in gm.
1	Aluminium	0·3864	24 hrs.	2000
2	Copper	0·3576	,,	2000
3	Brass	0·4710	,,	350
4	G.I. sheet	0·3590	,,	1200
5	Mild steel	0·4090	,,	1800

TABLE VIII — EFFECT OF VARYING PROPORTIONS OF PIGMENT AND PHOSPHORIC ACID ON LAC WASH PRIMER

Sl. No.	Experiment	% phosphoric acid on lac	% pigments on lac	Dry weight of the film in gm.	Time for air drying	Scratch hardness in gm.	Remarks
1	S.W.P.-1	30	100	0·4234	24	1900	Shellac was used
2	S.W.P.-1(a)	30	100	0·4459	24	800	
3	S.W.P.-2	0	100	0·3654	24	700	
4	S.W.P.-3	10	100	0·2222	24	600	
5	S.W.P.-4	20	100	0·2585	24	1300	
6	S.W.P.-5	40	100	0·4785	24	1700	
7	S.W.P.-6	50	100	0·4744	24	1600	
8	S.W.P.-7	60	100	0·5857	24	1700	
9	S.W.P.-8	30	5	0·3545	24	800	
10	S.W.P.-9	30	15	0·3314	24	1000	
11	S.W.P.-10	30	25	0·4274	24	1600	
12	S.W.P.-11	30	50	0·3610	24	1600	
13	S.W.P.-12	30	75	0·3620	24	1800	

TABLE IX — STRENGTH OF PAPER-PULP *GUM* SHELLAC COMPOSITIONS

Shellac / Paper-pulp	100/0	100/10	100/20	100/30	100/50	100/70	100/100	100/150
I.S. Scale div. in curkg.	1	2·5	2·5	2·9	3·0	4·87	4·66	4·1

APPENDIX C

Tabulated Statement of Progress of Investigations

ENTOMOLOGY DIVISION

ITEM	YEAR OF COMMENCEMENT	PROGRESS	REMARKS AND FUTURE WORK PROPOSED
II. RESEARCH & INVESTIGATIONS ...		8824 (Coupé II) cropped in July 1957 yielded 4,567 lb. of surplus brood plus 17,115 lb. of rejected lac. The total scraped lac amounted to over 3,400 lb.	To be continued
1. Improving crop production on *palas* by partial defoliation			
(i) Large-scale defoliation experiments	1948-49	In October-November 1957, 13,168 trees from coupés I & II gave 20,423 lb. of brood plus 22,638 lb. of rejected lac.	
(ii) Effect of partial defoliation on brood preservation (from the summer crop)	...	200 trees in *Kundri* and 16 trees in Namkum tried for summer crop. Ratio of *overall yield* to brood used was higher for *Kundri* for defoliated trees, but lower for defoliated trees at Namkum. Percentage of *brood* yield, however, was higher for defoliated trees at either place: Obviously defoliation helps brood preservation. No broodlac from the summer crop could be obtained from trees by the villagers' method.	Experiments have been re-laid on sound statistical lines, from *Baisakhi* 1957-58 crop.
2. Economics of utilizing *palas* for the *Baisakhi* and *ber* for the *Katki* crop only	Before 1953	16 *ber* and 16 *palas* for *Baisakhi*, and 10 *ber* and 10 *palas* for *Katki* tried. *Ber* did not yield any brood (summer crop). Overall (summer) yield also lower for *ber*. Results of *Katki*, though vitiated by predator attack, suggest better performance by *ber*.	To be continued
3. Comparative preservation of broodlac on *ber* by partial pruning before and after infection	1954-55	A heavy parasite attack in March-April 1957, followed by a severe summer plus drought completely killed out the broodlac. Apparently, partial pruning does not help brood preservation. The overall crop, however, was best with partial pruning in October-November before infection.	Experiment re-laid on better statistical lines To be continued
4. Finding of, and trials as brood preservers on lac hosts for *Baisakhi* crop, including certain *Ficus* and *Albizzia* species and hosts similar to those in Thailand	1945-46	Work on *A. lucida* and *O. dalbergioides* concluded, and a paper published. These have proved to be good hosts. Experiments started with *F. glabella*, *F. glomerata* and *A. lebbek*.	To be continued with new hosts
5. (i) Proper time of harvesting for maximizing yields	1955-56	50 trees at *Kundri* and 10 at Namkum under 4 treatments, e.g.	To be continued

APPENDIX C (*Contd.*)

ITEM	YEAR OF COMMENCEMENT	PROGRESS	REMARKS AND FUTURE WORK PROPOSED
		I. Initial heavy infection plus *ari* cutting in April. II. Ditto plus *ari* cutting in May. III. Ditto plus cropping at maturity. IV. Initial light infection plus cropping at maturity. Best results obtained with *ari* cutting in April or May.	
(ii) Determination of optimum density of larval settlement	1953	Broodlac in 3 quantities used, namely (A) 1/3 the normal (customary), (B) ½ the normal, and (C) the full normal quantities. For *Baisakhi*, for *ber* A > B > C; for *palas* A best; position regarding B and C uncertain. Experiment with better statistical layout (10 blocks) and modified treatments of half, normal and double brood rate do not indicate any significant difference. Higher mortality recorded for sparser settlement in general.	To be continued with better statistical layout
6. Determination of the most suitable pruning methods and seasons for *Kusum*	1948-49	Four treatments were given: A — Apical pruning with 1½ years' rest. B — Apical pruning with 1 year's rest. C — Surface pruning with 1 year's rest. D — Surface pruning with 6 months' rest. Experiments concluded: Results are: (i) Two main seasons for growth of shoots: Feb.-April and July-September. (ii) Shoots 6 to 12 months old are most suitable for sustaining lac insects. (iii) Apical pruning is to be preferred. (iv) Resting for a longer period (1½ years) is to be recommended.	Concluded
7. Growing of lac crops under crop and bush conditions	1952-53	150 *Arhar* plants infected in 1956-57 *Baisakhi* season. Initial larval settlement good. Crop destroyed by parasites and predators.	To be continued
(i) Under crop condition	...	Plants also dried up in summer. 60 plants infected for *Katki* 1957. Severe *Eublemma* attack was witnessed. Twenty-five 6-month-old *arhar* plants infected for 1957-58 *Baisakhi* crop.	
(ii) Under bush condition	...	*A. lucida*, *ber* and *F. congesta* being tried. Although growing satisfactorily, the crop on *F. congesta* (*Baisakhi* 1956-57) almost completely destroyed by a parasite attack. The *Katki* crop (1957) gave the	To be continued

APPENDIX C (*Contd.*)

ITEM	YEAR OF COMMENCEMENT	PROGRESS	REMARKS AND FUTURE WORK PROPOSED
		ratio of brood used to brood yield as 1: 4·3, but that in terms of scraped lac as 1: 2·5. In 1957-58 *Baisakhi* season, summer is adversely affecting the infected *congesta* plants. *F. congesta*, infected for *Jethwi* crop, is also affected by summer; irrigation has been resorted to with favourable results.	
8. Influence of various environmental conditions on lac insect	1952-53	Hosts chosen: *Acacia farnesiana* and *kusum* (potted plants). For *Rangeeni*, (*Katki*) growth at 27°C. faster than that under field conditions. Growth still faster at 30°C., at which temp., however, insects failed to complete the life-cycle owing to plants wilting at that temp. For *Baisakhi*, growth very slow at 18°C. [male emergence (m.e.) after 92 days], almost equally fast at 22°C. (m.e. after 44 days), and 30°C.; at 30°C., plants wilted and hence insects died out. In the case of *Kusmi* (*Aghani*), growth very slow at 18°C.; at 27°C., host plants wilted. For *Jethwi*, infected plants died at 22°C., 27°C. or 30°C.	To be continued
9. Survey of lac enemies and their parasites	1950	Caging lac samples did not reveal new enemy or parasite insects. Squirrels did not damage appreciably the maturing *Baisakhi* crop, but the broodlac used for infection. They eat lac insects when about to breed. Monkey menace has been reported from Jhalda and Damoh.	
10. Proper storage and quick disposal of lac to avoid enemy infestation			
(i) Comparison of emergence from scraped and unscraped lac	1956-57	*Katki* and *Aghani* lac were experimented upon. Scraped *palas* lac showed far more reduction in predators and parasites than *kusum* scraped lac for which a reduction in predators only was observed.	To be continued
(ii) Loss due to enemy infestation in storage	...	Observations taken with *Katki* and *Aghani* crops. Driage varied so greatly from one lot to another that no valid conclusion is permissible.	
11. Control of enemies of lac during storage by use of insecticides	1954	*Katki* and *Aghani* crop yields were dusted and sprayed with insecticides, and stored for emergence of insects. Dusting found more effective than spraying. Effect more	To be continued

APPENDIX C (*Contd.*)

Item	Year of commencement	Progress	Remarks and future work proposed
		marked in the case of *palas* than in that of *kusum* lac.	
12. Biological control:			
(a) Life-history studies and developing breeding techniques			
(i) *A. tachardiae*	1942	Life-history of *A. tachardiae* on its laboratory host (*Corcyra cephalonica*) as also its natural host (*H. pulverae*) studied: 9 continuous generations could be bred on the laboratory host.	
(ii) *Perisierola pulveriae*	...	Ecological studies on *Perisierola pulveriae* (Bethylidae) started and are under progress. (Breeding technique perfected and life-history studies completed already.)	
(iii) *Elasmus claripennis*	...	*Elasmus claripennis* could not be bred successfully.	
(iv) Mass-breeding of *B. greeni* and *A. tachardiae*	...	For *B. greeni* both *E. zinkenella* and *E. amabilis* were used as hosts. Laboratory breeding rate was poor and attempts to improve the rate are under progress. *A. tachardiae* could be easily bred on *C. cephalonica*.	To be continued
(b) Large-scale liberation in the field and the effect thereof	1956	Experiment laid out on proper statistical lines in June 1957. Scarcity of broodlac and bad season interfered with the starting of the experiment. Release of parasites (*apanteles* and *greeni*) commenced towards the end of March 1958 (*Jethwi* 1958 season). Examination of samples after infections revealed negligible incidence of enemy insects.	To be continued
13. Regional Field Stations	1956-57	Two field stations, one at Damoh (*ghont*) and one at Jhalda (*kusum*) started. Pruning and infection of hosts have been carried out. Laboratories being equipped.	
14. Plantation at Namkum	...	General upkeep looked after. Lac hosts were raised in nurseries and *C. saltiana* raised to obtain *E. zinkenella*.	
15. Training and Advisory Service	...	17 trainees on the roll at the commencement of the year. 10 joined during the period, and 17 released on completion of the course, so that 10 are still on the roll. A F.A.O. candidate from Thailand trained for 2½ months. Lectures were given to	

APPENDIX C (*Contd.*)

ITEM	YEAR OF COMMENCEMENT	PROGRESS	REMARKS AND FUTURE WORK PROPOSED
		Village Level Workers, etc., outside Namkum. Technical advice was given to Lac Extension Officer and also to various Governments, etc.	
CHEMISTRY DIVISION			
1. Separation and study of the constitution of the various components of shellac	1947		
(i) Aldehydic acid component	1955	Regeneration of the aldehydic acid component from its 2:4-dinitrophenyl hydrazone was not fully successful, and is being attempted through bisulphite derivatives.	To be continued
(ii) Acid fractions from hydrolysed shellac	1953	Hydrolysis of dewaxed decolourized shellac in presence of sodium sulphite gave several salt fractions.	
(iii) Fractionation of aleuritic acid	1957	Aleuritic acid separated into two fractions which were oxidized and their respective 2:4-dinitrophenyl hydrozones prepared.	
(iv) Fractionation of shellac as urea and other complexes	1957	Three fractions have been obtained as urea complexes. Several fractions were obtained similarly with melamine and hexamine.	
(v) Paper chromatography	1954	In paper chromatography, seven spots corresponding to 7 components were obtained.	
2. Bleached lac			
(i) Chemical changes in the bleaching of lac	1957	Observations with both *Rangeeni* and *Kusmi* seedlac show that as the quantity of bleach liquor in bleaching is increased, products deteriorate in life under heat as well as fluidity, and that A.V. and S.V. after an initial decrease go on increasing afterwards.	To be continued
(ii) Optimum conditions for bleaching lac (alkalinity of bleach liquor)	1953/57	Part of the loss (15 to 20 per cent on the weight of seedlac) is due to alkalinity of bleach liquor, of which the optimum value is found to be 0·02*N*-0·04*N*. Separate bleaching of hard and soft resin components of lac shows the loss to be 7·2 per cent for hard and 4 per cent for soft resin.	To be continued
(iii) Pilot plant for bleached lac	1957	A plant (capacity 80 lb./day) has been designed, and is to be ordered early.	
3. Kinetics of polymerisation and depolymeriza-	1954	Polymers (Polyesters) of 9:10 dihydroxy hexadecane 1:16 dicar-	To be continued

APPENDIX C (*Contd.*)

ITEM	YEAR OF COMMENCEMENT	PROGRESS	REMARKS AND FUTURE WORK PROPOSED
tion of lac (and its constituents). Polemolecularity of 9:10 dihydroxy hexadecane 1:16 dicarboxylic acid		boxylic acid were prepared, and both integral and differential weight distributions of the various polymers determined.	
4. Aqueous lac varnishes: (Water-soluble lac)	1952	As previously found, lac exposed to ammonia becomes water-soluble. Films of this on glass crack, but not those on porous (e.g. earthenware) surfaces.	To be continued
5. Lac-oil combinations			
(i) Incorporation of lac into linseed oil	1956	Shellac dissolves in linseed oil at 360°C. Addition of triacetin lowers this temp. to 250°C. or so. Effects of heating shellac plus triacetin for ½, 1, 1½ and 2 hrs. studied. Products not yet satisfactory. Substitution of triacetin by tricresyl phosphate and dibutyl pthalate resulted in too quick polymerization (½ an hour).	To be continued
(ii) Insulating varnish: Shellac-rosin-glycerine compound	1953-54	Shellac-rosin-glycerine (s-r-g) compound incorporated into linseed oil was not satisfactory. After many trials, the composition: 100 parts s-r-g ester, 41·65 parts *tung* oil, plus 83·35 parts linseed stand oil, mixed with thinners and driers, proved quite up to the mark.	To be continued with a view to replacing, *tung* oil by dehydrated castor oil
6. Improvement in the manufacture of seedlac, shellac, etc., and utilization of by-products			
(i) Shellac from seedlac by alkali extraction and acid precipitation	1953	Colour of the product was dark, and could not be improved by reacting with $KMnO_4$. Method applied to recovery of resin from lac factory wastes. Possible utilization of the recovered resin being investigated.	To be continued
(ii) Disposal of lac factory wastes (wash-water)	1956-57	As stated previously, addition of 0·1 per cent H_2SO_4 to wash-water stops putrefaction, precipitates dye (4 to 5 lb. per md. of sticklac). A settling tank is being designed. Other chemicals for same purpose tried.	
(iii) Lac dye from lac wash-water	1957	The precipitated dye [vide (ii) above] partially purified and converted into sodium salt (water-soluble) suitable for dyeing wool and silk. The quality of the dye is satisfactory.	To be continued. The dye is to be further purified.

APPENDIX C (*Contd.*)

Item	Year of commencement	Progress	Remarks and future work proposed
7. Adhesives			
(i) Accelerators for heat curing of saponified lac	1957	Hydrolysed lac, a very good adhesive, is slow-curing. Various chemicals to accelerate curing were tried: oxalic acid was found to be the most efficacious.	To be continued
(ii) Hydrolysed bleached lac for making transparent flexible micanite	1955	Hydrolysed bleached lac prepared either by bleaching hydrolysed lac or by hydrolysing bleached lac proved satisfactory, and better than rosin-castor oil as bonding agent.	
(iii) Adhesive for "Thermocole" sheets	1957	A satisfactory composition has been worked out.	
(iv) Adhesive for plywood	Before 1945	Previously developed composition is being modified to satisfy the more stringent I.S.I. specifications; (boiling water test) recently introduced.	To be continued
8. Improvement in Analytical methods (grade *cum* specification)			
(i) Round robin test	1957	Round robin tests for bleachability and bleach index as also non-volatile matter insoluble in seedlac were carried out. Samples collected and despatched to participating countries, viz. in U.K., France, U.S.A., etc.	To be continued
(ii) Determination of wax in shellac by photo-electric colorimeter	1957	Deflections due to solutions of wax-free as well as wax-containing shellacs were noted. Correlation of data to be attempted.	To be continued
(iii) Rapid determination of insoluble matter in various grades of lac: an alternative method	1957	The current method is slow. Dissolution in aqueous sodium sulphite (instead of into washing soda) is much quicker: the possibility of utilizing the observation for an on-the-spot determination (in the market-place) is being investigated.	To be continued
9. Shellac wash primers	1957	A lac-based wash primer for metals was evolved, and tried. The optimum phosphoric acid and pigment (zinc chrome) contents were found to be respectively 30-40 per cent and 75-100 per cent on the basis of lac. Its performance appears to be satisfactory except on brass surfaces.	To be continued
10. *Ad hoc* work			
(i) Shellac coating on shuttlecocks	1957-58	Coating of edges and tips of feather cocks increases the playing life 2½ to 5 times.	

APPENDIX C (*Contd.*)

Item	Year of commencement	Progress	Remarks and future work proposed
(ii) Shellac paper-pulp composition for lac bangles	1957-58	Incorporation of paper-pulp (about 70 per cent) on the weight of shellac increases the impact strength to nearly 5 times, and thus reduces brittleness greatly.	
(iii) Shellac water-proof inks	1957-58	A number of compositions using either dewaxed bleached lac, dewaxed decolorized lac or simple dewaxed lac were formulated.	Firm's report not yet received
(iv) Marking inks for aluminium sheets and foils	1957-58	A composition made up of 15 gm. dewaxed lac, in 35 gm. methylated spirit with 0·15 gm., maleic anhydride, 0·75 gm. pine oil and 0·075 gm. of "Rhodamine" B proved satisfactory.	
(v) Shellac varnishes for gold thread (*Jari*)	1957-58	A number of satisfactory compositions were formulated.	
(vi) Paper varnishes	1957-58	A few trade recipes (Angelo's) were tried, and at least one found satisfactory.	
(vii) Dry photo-mounting tissue paper	1956-57	Formulated last year, details of the process such as speed of paper through varnish tank have been worked out, and a machine designed. This has proved very satisfactory and its manufacture is to be undertaken in the proposed production unit of the Institute.	
11. Experimental Testing Laboratory (Scheme)	1955	84 samples received from 22 parties for 122 tests were analysed. Reports for 11 samples received from commercial analysts showed agreement to within $\pm 0{\cdot}2$ in 6 cases. For the rest difference was more than $\pm 0{\cdot}4$.	
12. Miscellaneous	...	Some progress made towards writing "Monograph on Lac" and Chemistry of lac.	
13. Propaganda and Publicity	...	Work towards increased utilization of lac was carried out by Shellac Utilization Officer with the co-operation of other staff as in previous years.	

APPENDIX D

Assaying of the crude dye for actual dye content

A simple method developed for the purpose is described: 1 gm. of crude dye dried over calcium chloride is mixed with 2 gm. of acid-washed sand and extracted in soxhlet meant for hot extraction with 150 cc. of distilled water for six hours. The extract is acidified with 20 cc. This is compared with a standard solution of lac dye. It has been found that 0·05 per cent fresh solution of methyl orange compares exactly with 0·1 per cent solution of lac dye and in subsequent experiments, the methyl orange solution has been used as standard. Comparison is done in an immersion type colour comparator. The following formula has been used for calculation of the dye content in the precipitate.

Percentage of pure dye in the precipitate (crude dye) = (Height of the standard solution in cc. × strength of the standard × total Vol. of the extract) / (Height of the extract in cc. × lb. weight of the sample).

Reproducibility of the results has been proved by a series of experiments.

APPENDIX E

List of papers published during the year 1957-58

1. A machine for separating sand from seedlac, by A. K. GHOSE & T. BHOWMIK (*Research & Industry*, Vol. **2**, No. 4, April 1957, pp. 87-89).
2. Methods of Manufacturing seedlac of Improved quality. Part I — Use of Alkaline reagents, by A. K. GHOSE & T. BHOWMIK.
3. The Lac Industry and the Forests, by S. KRISHNASWAMI (*The Southern Forest Rangers College Magazine*, Vol. **33**, No. 3, July 1957, pp. 89-93).
4. Annual Report of Indian Lac Research Institute 1955-56.
5. Variation of Specific Heat of Lac with Temperature, by S. N. SRIVASTAVA (*Zeitsch. für Physikalische Chemie*, 206, 1957).
6. I.L.R.I. Bulletin 90: Method of Manufacturing seedlac of Improved quality. Part II — Use of Oxidizing reagents, by A. K. GHOSE & T. BHOWMIK.
7. Autoclave Method of Shellac Manufacture, by T. BHOWMIK (*Research & Industry*, Vol. **2**, No. 12, December 1957, pp. 309-314).
8. Report of the Proceedings of the Symposium on Lac & Lac Products held at Indian Lac Research Institute, Namkum, Ranchi.
9. Field observation on a severe outbreak of *Tessaratoma javanica* Thunberg, a sporadic pest of *kusum* (*Schleichera oleosa*) and preliminary trials on its control, by B. P. MEHRA & B. K. PURKAYASTHA (*Indian J. Ent.*, Vol. **XIX**, Part III, September 1957, pp. 214-216).
10. Trials of *Albizzia lucida*, Benth and *Ougeinia dalbergioides* Benth, as new Lac Hosts for *Baisakhi* Crop in Chotanagpur, by B. K. PURKAYASTHA & S. KRISHNASWAMI. (*Indian Forester*, March 1958, Vol. **84**, No. 3, pp. 137-145).

11. Studies on Non-Insect Enemies of Lac, with special reference to birds and serious seasonal predators, by S. KRISHNASWAMI & N. S. CHOUHAN (*Jr. Bombay Nat. Hist. Soc.*, Vol. **54**, No. 4, pp. 887-907, December 1957).
12. A note on insects consumed as food by squirrels and birds at Kundri Forest, Palamau Dist., Bihar, by S. KRISHNASWAMI & N. S. CHOUHAN (*Jr. Bomb. Nat. Hist. Soc.*, April 1957, pp. 457-59).

APPENDIX F

Statistics of annual sticklac production in India (in maunds)

Year	*Baisakhi*	*Jethwi*	*Katki*	*Aghani*	Total
1957-58	8,40,000	27,000	2,33,000	40,500	11,40,500
1956-57	7,32,000	17,000	5,01,000	65,000	13,15,000*
1955-56	8,13,000	41,000	3,33,000	61,000	12,48,000*

*Revised.

APPENDIX G

Details of new appointments/resignations, etc., during the year 1957-1958

(a) APPOINTMENTS

Admin. Section

1. Shri Tarashankar Debnath as Sr. Clerk,	with effect from	1st June 1957
2. Shri A. Mukherjee as Jr. Clerk	do	1st November 1957
3. Shri D. P. Sen Gupta as Jr. Clerk	do	21st October 1957
4. Shri Shivajee Sahu as Jr. Clerk	do	24th October 1957
5. Mst. Mundri as Sweepress	do	23rd October 1957
6. Shri Budhoo Lal as Chaukidar	do	1st June 1957
7. Bharu Munda as Khalasi	do	17th February 1958 (on leave vacancy)

Chemical Section

1. Shri A. V. Subba Rao as R.A.	do	29th November 1957
2. Shri B. K. Ganguli as Jr. R.A.	do	27th May 1957
3. Shri Karunamoy Chatterjee as Jr. R.A.	do	8th June 1957
4. Shri P. K. Sanyal as Jr. R.A.	do	4th June 1957
5. Shri S. K. M. Tripathi as Jr. R.A.	do	30th July 1957
6. Shri Anwaral Haque as Lab. Asstt.	do	20th February 1957
7. Shri S. K. Mukherjee as Jr. R.A.	do	4th March 1958

Entomological Section

1. Shri K. John as R.A.	with effect from	23rd December 1957
2. Shri Jugraj Bihari as R.A.	do	2nd November 1957
3. Shri B. P. Misra as Jr. R.A.	do	17th June 1957
4. Shri J. M. Das Gupta as Jr. R.A.	do	20th June 1957
5. Shri B. N. Sah as Jr. R.A.	do	1st July 1957
6. Shri Samresh Roy as Fieldman	do	2nd July 1957
7. Shri Bartua Chawdhury as Chaukidar	do	1st July 1957
8. Shri Dilbar Pahan as Chaukidar	do	1st July 1957
9. Shri Kunji Patar as Chaukidar	do	13th July 1957
10. Shri Gandur Bowari as Durwan	do	13th July 1957
11. Shri Kamla Pd. as Chaukidar	do	1st December 1957
12. Shri Badri Prasad as Chaukidar	do	1st December 1957

(b) RESIGNATIONS

Admin. Section

1. Shri Tara Shankar Debnath, Sr. Clerk	with effect from	31st July 1957
2. Shri H. K. Sokey, Jr. Clerk	do	21st October 1957

Chemical Section

1. Shri Karunamoy Chatterjee, Jr. R.A.	do	27th November 1957

Entomological Section

1. Shri M. Sen, Jr. R.A.	do	30th April 1957
2. Shri D. M. Joshi, Asstt. Artist	do	1st November 1957
3. Shri B. P. Misra, Jr. R.A.	do	31st July 1957
4. Shri K. John, R.A.	do	3rd February 1958