INDIAN LAC RESEARCH INSTITUTE

NAMKUM, RANCHI, BIHAR, INDIA

ANNUAL REPORT

FOR THE FINANCIAL YEAR 1963-64

1965

CONTENTS

INDIAN LAC RESEARCH INSTITUTE

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ANNUAL REPORT FOR THE FINANCIAL YEAR 1963-64

A SUMMARY

A. ENTOMOLOGY DIVISION

During the year, studies were continued on the basis of the research programme as revised by the *Ad hoc* Entomology Research Sub-committee and according to the priorities indicated by them.

1. Studies for the evolution of suitable cultivation practices for *palas* at Kundri were concluded during the year and it was found that heavy inoculation in October/November and complete harvesting of the crop in the following April, and light inoculation in October/November, self-inoculation in June/July and complete harvesting in October/November, produced the best results in regard to yield of sticklac and broodlac respectively. Based on the above findings, new experiments have been taken up to determine the advantages of the above findings over the villagers' method of cultivation of lac on *palas*.

2. Experiments were continued for the determination of the proper time of harvesting-cum-pruning for the two crops on *palas* as well as the optimum density of larval settlement on this host.

3. Experiments were continued aimed at reducing the cost of cultivation of lac on *kusum*. Instead of the currently recommended four-coupé system, two-coupé and three-coupé systems with different periods of rest as also self-inoculation facilities are under study at Hesal.

4. Work has been taken up on detailed studies for the evolution of cultivation schedule and determination of optimum density of larval settlement on *Moghania macrophylla*. The plants have been raised on a two-acre plot and are to be coppiced in July 1964, for first inoculation in January 1965 (on 6 months' old shoots) and subsequent inoculations thereafter on shoots of different ages.

5. Simultaneously, a permanent field experiment has also been laid out at Namkum for working out the economics of cultivation of *Kusmi* lac on *M. macrophylla* under different conditions of manuring, irrigation, etc.

6. Similar experiments have also been initiated at the Regional Field Stations at Mirzapur in U.P. and Damoh and Umaria in M.P.

7. Studies have been completed on (a) the mode of reproduction in lac insect, (b) chromosome numbers of both the sexes of the *Kusmi* and *Rangeeni* strains, and of the 'yellow' lac insect, and (c) spermatogenesis in these insects.

8. Life-history studies on *Brachymeria tachardiae* and *Holotrichia serrata* have also been completed, as also of certain other pests of the host plants.

9. Studies have been taken up of the incidence of the two important predators, viz. *Eublemma amabilis* and *Holcocera pulverea*, on lac developing on *M. macrophylla*.

10. Ecological studies including the influence of various temperatures and humidity conditions on the fecundity, oviposition and longevity of the predators have also been taken up and are in progress.

11. Genetical studies have progressed during the year and a pure breeding yellow strain of lac insect has been developed which is awaiting a field trial in a small way. Studies on the crossing of *Rangeeni* and *Kusmi* varieties showed that in the F_2 generation, the segregated and emergences critical of *Rangeeni* and *Kusmi* strains took place from the same progeny. It was also observed that for the yellow lac insect obtained from Jodhpur, the colour does not depend upon the host.

12. Physiological studies on the lac insect were taken up only very recently and chromatograms have been prepared of free amino acids and sugars from the total body extracts of the insects. Eight spots of amino acids and three spots of sugars were obtained.

13. Experiments at the Field Stations were continued as usual.

14. Two sponsored research schemes were in progress in universities since 1961; one at the Aligarh University and the other at Ranchi College, Ranchi.

14. " Morphology and biological studies of parasites associated with the lac insect " and " histological studies and seasonal variation in the gonad of the lac insects " were the problems for study at the above-mentioned institutions. The scheme at Ranchi College was terminated in October 1963 and the one at Aligarh University is to terminate in May 1964. Detailed reports are yet to be received.

15. During the year under report two batches of trainees, 5 and 15 respectively, received training on " Improved Methods of Lac Cultivation ".

B. CHEMISTRY DIVISION

During the year under report, almost all items of research as programmed were continued.

1. Determination of bleach index/bleachability according to the ILRI method were carried out using different types of photo-electric colorimeters and it was found that any type could be used. It was also ascertained that the most suitable filter was 480 mμ.

2. Several samples of sticklac from different regions of cultivation have been tested. Nevertheless, no correlation has yet been found between the quality of lac specially colour and the climatic conditions of the area in which it was cultivated. More samples are being examined.

3. Specific heats of seedlac and bleached lac at various temperatures were determined in a modified calorimeter with a view to correlate these data with the ' age ' of the lac, if possible.

4. Repeated melting experiments have shown that replacement of wood charcoal by soft coke reduces the cost of processing seedlac into shellac by Rs. 3.15 per quintal of seedlac processed.

5. Semi-pilot experiments for the recovery of wax from the acid precipitated sludge from lac factory effluent have been carried out. Ninety per cent of the wax present could be recovered using commercial hexane as the solvent.

6. The use of oxalic acid during the processing of seedlac into shellac has been found to affect the flow and life of shellac.

7. Conditions have been determined for the mechanical drying of seedlac in a continuous rotary drier at the Delhi Polytechnic. Based on these data, a design for a full-scale rotary drier capable of drying 1·9 quintals (5 mds.) per hour for commercial operation has been worked out.

8. Details for a continuous solvent extraction plant for reclamation of lac from lac wastes have also been worked out.

9. The neutral constituent of lac resin has been obtained as a colourless solid (m.p. 49°C.) and was found to be a mixture. Chromatographic fractionation of shellac has given a few fractions which appear to be mixtures of free fatty acids.

10. The brittleness of films from lac diisocyanate varnish has been overcome by the addition of plasticizer.

11. Incorporation of polyvinyl butyral into shellac etch primer has been found to improve the adhesion and weather resistance of the primer film, but storage life of the primer itself was found to be poor. The weathering test of the panels already exposed for over three years so far continues to be satisfactory.

12. Properties of baked and air-dried films of shellac varnishes modified with butylated melamine, urea and epoxy resins, and *tung* and linseed oils respectively on metal and wooden surfaces, have been studied. Baked films have been found to be very good in respect of adhesion, flexibility, resistance to various solvents, alkalies, acids and accelerated weathering. The storage stability of the varnishes is also good.

13. The preparation of insulating varnishes from lac and drying oil was continued and their modifications with *iso*-phthalic acid, rosin and cashewnut shell liquid-formaldehyde studied. *Iso*-phthalic acid has been found to improve the drying properties.

14. A graft polymer of lac and methyl methacrylate has been prepared and its properties are under study.

15. Studies on the hydrolysis of lac were continued and some conditions for easier technical preparation of aleuritic acid worked out.

16. Technical service was extended, as usual, to all interested parties and samples of various varnishes, including the recently developed heat- and water-proof varnish for which several parties have shown special interest, were supplied.

17. The performance of shellac etch primer on aluminium bodies has been found satisfactory by several large-scale users. Efforts are being made to popularize use of the etch primer more widely.

18. Demand of water-soluble lac for photo-engraving and of bleached lac is increasing gradually. A few parties have started manufacturing bleached lac.

19. The Sticklac Processing Unit is ready. It can process over 5,000 quintals of sticklac per year.

20. As usual the Regional Testing Laboratories have tested a large number of samples for the trade.

21. The Pilot Production Unit sold, during the year, lac materials worth Rs. 18,064.10 making a gross profit of Rs. 7,411.29.

Sponsored Research

At Delhi University — Hard resin from lac has been converted into the chloro derivative from which, after hydrolysis, *erythro*-aleuritic acid to the extent of 30-35 per cent has been obtained.

At the National Chemical Laboratory, Poona — A tentative composition of hard resin from *palas* lac in terms of constituent acids and their percentages has been put forward. The hard resin has also been fractionated into several fractions. The structure of butolic acid has been confirmed as 6-hydroxymyristic acid.

Studies on laccaic and xantholaccaic acids have suggested that a group of the type $-CH_2\,CH_2O-$ is present on the purpurin part of the molecule and that the dye, as isolated, is a mixture of closely related compounds.

At the Central Leather Research Institute, Madras — A few formulations have been made for top gloss composition, finishing chrome retan uppers and impregnation of chrome tanned leathers. Work on other lines is in progress.

ADMINISTRATIVE AND GENERAL

General — The Institute pursued its research and other activities as programmed. The research activities, particularly of the Chemistry Division, were on a restricted scale due to acute shortage of staff.

During the year, the setting up of the sticklac processing unit, suggested by Dr. Ram Subhag Singh, Union Minister of Agriculture, and approved by the Government of India, was completed. It is now ready for operation.

Among the results of research in the Institute worthy of special mention is the production of a heat- and water-proof shellac varnish based on the combination of butylated melamine resin and dewaxed shellac. Another shellac varnish obtained by the modification of lac with epoxy resin has also shown outstanding performance. In addition to processing all the desirable properties of lac, the combination shows improved heat, solvent and alkali resistance and is comparable to epoxy resins in general performance, and is much cheaper. Another noteworthy results is the preparation of graft-polymers of lac with vinyl monomers, which promises to provide newer outlets for lac.

In the entomological field, an important advance was the isolation of a pure breeding yellow strain of the lac insect. Previously, the yellow strain occurred sporadically and attempts to raise a pure strain had failed; the yellow colour, during the latter stages of development of the insect, always changed to crimson.

Larger numbers of this pure breeding yellow strain are proposed to be raised in the next season so that the resin produced by them can be exhaustively studied.

Visitors — As usual, the Institute continued to attract a large number of visitors including a few from overseas. It is gratifying that among the visitors, a substantial number comprised students and trainees from colleges and government institutions, indicating the general appreciation of the importance and educative value of getting acquainted with lac. A few visitors deserving special mention are:

1. Dr. R. N. Mathur, Additional Agricultural Commissoner, Government of India.
2. Shri A. C. Guha, M.P., Member, Estimates Committee.
3. Mr. William O. Baxter, American Consul-General.
4. Mr. Alfred L. Atherton Jr., American Consul.
5. Prof. E. V. Brochsenius (*A delegation of Russian Zoologists*), Specialist on Coccoidea and other Parasitic Insects, Zoological Institute, Academy of Science, U.S.S.R.
6. Dr. K. A. Breav (*A delegation of Russian Zoologists*), Specialist on Parasitic Insects and Insect Parasites on Agricultural Animals.
7. Sri K. S. Pradhan, Superintending Zoologist, Zoological Survey of India.
8. Mr. Neal M. Bowers, U.S. Educational Foundation in India.
9. Mr. Aryant Manjukul, Entomologist to the Government of Thailand.
10. Dr. Friedrich Stang, University of Frieburg, West Germany.
11. Dr. Chippalkutti, Director, Shri Ram Institute of Industrial Research, New Delhi.
12. Mr. Hugh Humphrey, Senior Department of Technical Cooperation, London.
13. Trade Representative of U.S.S.R.
14. Rumanian Trade Commissioner.
15. Dr. Marion Wesley Parker, Director, Crops Research Division, Agricultural Research Service, U.S.D.A.
16. Dr. Roy Lee Lovvorn, Director of Research, North Carolina Agricultural Experiment Station, University of North Carolina.
17. Dr. Oscar Burr Ross, Professor and Head of the Department of Animal Science, University of Illinois.

18. Dr. E. E. Cheesman, Scientific Assistant to the Secretary, Agricultural Research Council, London.

19. Prof. P. Maheshwari, Head of the Department of Botany, University of Delhi, Delhi.

Roads and Buildings — No annual repairs to roads and buildings of the Institute were carried out during the period. However, for the new Sticklac Processing Unit, some essential constructions, additions and alterations in the Factory Block were carried out under departmental supervision. A cemented courtyard with a floor area of about 2,000 sq. ft. with surrounding walls for drying seedlac and a room with asbestos ceiling to house the Combi-roller mill newly imported from West Germany were constructed.

Water Supply — The construction of a new R.C.C. overhead tank of 15,000 gallons capacity, to replace the existing mild steel tank, was taken up by the C.P.W.D. The construction is expected to be completed by the end of June 1964.

Library — The number of books and bound volumes of journals accessioned during the year was 1,158. In addition, some 45 miscellaneous publications and reports were also received. A large number of microfilm copies of research publications were also obtained from INSDOC, New Delhi.

The following new books were brought out during the year: (i) The 'Monograph on Lac', and (ii) 'Chemistry of Lac'.

Training — A total of twenty candidates in two batches (of five and fifteen), deputed by various State Governments, were imparted training in 'Improved Methods of Lac Cultivation'.

Exhibitions — The Institute did not participate in any exhibition during the year as a measure of economy due to the National Emergency.

Staff: (a) APPOINTMENTS

Dr. G. S. Misra, M.Sc., Ph.D. (London), joined the Institute as Director on 21st November 1963.

Dr. T. Bhowmik, M.Sc., Ph.D., Scientific Officer (Utilization), was promoted as Senior Scientific Officer (Utilization) on 24th December 1963.

Dr. P. N. Srivastava, M.Sc., Ph.D. (Luck.), joined as Scientific Officer (Insect Genetics) in July 1963.

(b) DEPUTATIONS

Dr. T. P. S. Teotia, Entomologist, visited Thailand for a week in July 1963 as a member of an Indian Lac Delegation sponsored by Government of India.

Shri S. C. Sen Gupta, M.Sc., Scientific Officer (Applied), completed one year's training under the Colombo Plan at St. Andrew's University, Scotland, and returned and resumed his duties in October 1963.

Shri B. B. Khanna, M.Sc. (Tech.), Senior Research Assistant, Chemistry Division, left for London in September 1963, for training in Rubber Technology at the National College of Rubber Technology, London, under the Colombo Plan.

Shri N. S. Chauhan, M.Sc. (Agri.), Senior Research Assistant, Entomology Division, left for Edinburgh in September 1963 for higher training in Insect Genetics at the Institute of Animal Genetics, Edinburgh, under the Colombo Plan.

(c) RESIGNATIONS

Dr. T. P. S. Teotia, Entomologist, resigned the post with effect from 27.10.63 to return to his parent department. The post of Entomologist has not yet been filled up.

Shri R. Viswanathan, Scientific Officer (Insect Physiology), resigned the post on 10th December 1963.

Further details regarding the staff will be found in Appendix F.

Staff Club: The Staff Club continued its activities as usual.

ENTOMOLOGY DIVISION

(Dr. A. Bhattacharya)

I—GENERAL

Introduction — During a meeting of the Advisory Board of the Indian Lac Cess Committee, it was observed that greater emphasis should be laid on more intensive cultivation of lac and towards this end an *Ad hoc* Entomological Research Sub-committee was constituted to review the programme of work of the Entomology Division and make recommendations. This Sub-committee met at Namkum on the 26th and 27th March 1963 and reviewed the progress of work so far and prepared a revised programme of work with priorities indicated.

Work during the year under report was therefore based on this revised programme and according to the priorities indicated.

Season — The weather conditions in the lac-growing areas during all the four seasons of the year were favourable. Nevertheless, the lac crops were only moderate, mainly because the prices obtained by the cultivators were very low and there was no enthusiasm to cultivate as much lac as possible. The *Baisakhi* crop was 20·4 per cent below average, the *Katki* 55·0 per cent. In the case of *Kusmi* lac, the *Aghani* crop was 52·1 per cent below average although the *Jethwi* was just about average.

The progress of work on the various problems of research in the order recommended by the *Ad hoc* Entomological Research Sub-committee is detailed below.

IIA—RESEARCH AND INVESTIGATIONS

1. Potentiality Trials on *Ber*

(i) *Determination of optimum density of larval settlement for* ber *in* Katki *season*

The experiment was started in the Namkum plantation from *Katki* 1961 season, using 3 brood rates, namely ½N (Treatment A), N normal (Treatment B), and 2N (Treatment C) replicated 12 times with 1 tree per treatment, i.e. on a total of 36 trees.

The normal brood rate (N) was arbitrarily fixed as 1 ft. of healthy brood for 25 ft. of inoculable shoots.

The experiment was continued during the year for which inoculations were carried out in June 1963 and the crop harvested in October 1963. The crop data are given in Table I (App. A). The maximum yield of broodlac was obtained from the resulting crop when normal (N) quantity of brood was inoculated and followed by 2N and ½N brood rates where difference was not much. In regard to the ratio of brood used to brood obtained B treatment is superior whereas in regard to the ratio of brood used and total yield obtained (scraped lac) there is hardly any difference between the treatments C and B. This observation also confirms previous conclusions that treatment C is superior to all other treatments in respect of total yield. Thus the density of larval settlement is to be taken into consideration depending on whether broodlac or yield of lac is required.

(ii) *Determination of proper time of harvesting and optimum density of larval settlement for* ber *in* Baisakhi *season*

The study which was initiated in 1960-61 was continued for the fourth season with the following 9 treatments:

Treatments

A — *Ari*-cutting in April with $\frac{1}{2}$N brood rate.
B — ,, ,, ,, N ,,
C — ,, ,, ,, 2N ,,
D — ,, May ,, $\frac{1}{2}$N ,,
E — ,, ,, ,, N ,,
F — ,, ,, ,, 2N ,,
G — Harvesting at maturity with $\frac{1}{2}$N brood rate
H — ,, ,, ,, N ,,
I — ,, ,, ,, 2N ,,

where the brood (rate) applied was the same as at 1(i) above.

There were 4 replications with 1 tree under each treatment, and a total of 36 trees.

Inoculations for *Baisakhi* 1962-63 were effected in October 1962 and crop reaped as per schedule given above during April 1963, May 1963 and October 1963. Results of *Baisakhi* 1962-63 crop are presented in Table II (App. A).

From the yields of the crop obtained at different times of harvesting, it was found that the rate of yield of sticklac in terms of broodlac used was the highest with $\frac{1}{2}$ normal brood rate (Treatment A) for *ari* lac harvested in May. This observation is not in conformity with that reported earlier (*Annual Report*, 1962-63). This is being looked into. However, with normal (N) brood rate (Treatment H) maximum quantity of broodlac as well as total yield was obtained when harvested at crop maturity, and conforms to previous observation.

Inoculations for the next *Baisakhi* 1963-64 were carried out in October 1963 and the crop in all treatments is progressing well.

(iii) *Studies on the response of* ber *to pruning for growing* Katki *crops*

The experiment was initiated in 1960 and since then two crops have been obtained in 1961 and 1962. The *ber* tree was pruned in February 1964, May 1963, October 1963 and December 1963 (A, B, C and D treatments respectively) with 1 tree under each treatment replicated 10 times.

Since no inoculation for *Katki* 1963 was carried out in July 1963 as identical results were obtained in the two previous seasons; it was later decided to base our conclusions on the results of 3 crops. Therefore, the trees under different treatments were pruned for the third time for *Katki* 1964 crop. Data on shoot measurement are given in Table III (App. A).

2. Potentiality Trials on *Palas*

(i) *Determination of optimum density of larval settlement on* palas *in hot areas (at Kundri)*

This study is new and is to be carried out on the same lines as on *kusum* and *ber*. However, the brood rate has been arbitrarily fixed as heavy and light instead of $\frac{1}{2}$N, N and 2N rates since *palas* never produces as many branches as the other two hosts and thus the area of infectable shoots available is too low.

The experiment was started at Kundri in October 1963 with 14 groups (treatments) of 10 trees each. Each group of 10 trees had been inoculated heavily with broodlac ranging from 1·5 kg. to 5 kg. with an increase of 0·5 kg. of brood from treatment to treatment (Treatments A to H). Likewise, in the remaining 6 groups 0·25 kg. to 1·5 kg. of brood were

used with 0·25 kg. increase per treatment (Treatments I to N). The treatments A to H are to be harvested in April 1964 whereas the rest (I to N) are to be allowed self-inoculation in June/July and completely harvested in October 1964. The crop is developing satisfactorily on all the treatments.

(ii) *Studies on the proper time of harvesting-cum-pruning on* palas *within April-May*

So far, in lac cultivation, it is the general practice to carry out pruning and harvesting operations separately. It has been observed from experiments already concluded that the maximum yield of scraped lac is obtained if the harvesting is carried out (as *ari*) during April and May. Hence an attempt is being made to see whether pruning and harvesting cannot be carried out at the same time, i.e. utilize harvesting as the pruning operation itself, so that the cost of cultivation could be brought down.

This experiment was initiated in April 1963 and the following five treatments with different times of pruning and harvesting have been set up with 4 replications with 10 trees under each treatment, and laid out in randomized block design in a fixed plot.

Treatments

A — Complete pruning-cum-harvesting in the first week of April.

B — Complete pruning-cum-harvesting between 15th and 20th April.

C — Partial (i.e. new shoots were left uncut) pruning-cum-harvesting between 15th and 20th April.

D — Complete pruning-cum-harvesting between 15th and 20th May.

E — Partial (as in C above) pruning-cum-harvesting between 15th and 20th May.

All the trees have been inoculated at the rate of 4 kg. of broodlac per 10 trees. These will be pruned/harvested during April and May 1964.

(iii) *Studies on the proper time of harvesting-cum-pruning on* palas *within October/November*

The study was initiated in October/November 1962 at Kundri with the same purpose as at 2(ii), i.e. to find out if harvesting cannot serve the purpose of pruning which always is carried out in April at present. The following three treatments with different brood rates have been set up with 5 replications and 30 trees under each treatment.

Treatments

A — Heavy inoculation in October/November and complete harvesting in April.

B — Medium inoculation in October/November, allowing self-inoculation in June/July and complete harvesting in October/November next year.

C — Light inoculation in October/November, allowing self-inoculation in June/July and complete harvesting in October/November next year.

All the trees were pruned initially in October/November 1962 and have been inoculated in October/November 1963. Harvesting would be undertaken during 1964, as per schedule.

(iv) (a) *Evolution of cultivation practice for* palas *at Kundri for maximum crop production at minimum cost and working out economics*

This study was continued for the fifth year in succession with 4 treatments. The fifth treatment which was introduced last year and reported (cf. *Ann. Rep.*, 1962-63) was dropped as per advice of the reviewing committee. The treatments which are continued are:

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

B — Heavy inoculation in October/November, partial harvesting (as *ari*) in April next year and complete harvesting in the following October/November.

C — Medium inoculation in October/November, partial harvesting in June/July next year and complete harvesting in the following October/November.

D — Light inoculation in October/November and complete harvesting in October/November next year.

There were five replications with 100 trees under each treatment and all told 2,000 trees. The average yield of broodlac per tree was: 1·46 kg. in the case of treatment C, 0·9 kg. in D, and 0·46 kg. in B, the ratio of brood used to brood yield being respectively 1: 5·23 (C), 1; 9·0 (D), and 1:1·16 (B). As regards the yield of scraped lac, the grading in the descending order was B, C, D, A. However, since trees under treatment A could yield another crop during October-November to April — A treatment could theoretically be taken as the best. The crop data are presented in Table IV (App. A).

(b) *Large-scale trials*

One thousand trees under each of the treatments A and D as described above were inoculated in October/November 1962. An yield of 0·579 kg. and 0·596 kg. per tree for treatments A and D respectively was obtained. The ratio of brood used to yield of treatment D was found to be 1: 9·2. Crop data are recorded in Table IV (App. A).

(v) *Large-scale cultivation experiments on* palas

These experiments have been going on in Kundri Lac Orchard (Palamau District) for the past three years. The lac orchard at Kundri with nearly 20,000 *palas* trees is being run under the administrative control of the Bihar Forest Department for our experiments and under our technical supervision. This has now been placed as an item under Training and Demonstration as recommended by the Entomological Sub-committee.

Details of operations and itemwise costs are given in Table V (App. A). It will be observed that against a total expenditure on lac operations of Rs. 4,632.96 a revenue of Rs. 3,777.99 was obtained. The loss despite a total yield of 10,414 kg. of sticklac is due to a big fall in the price of sticklac. Further, out of a total quantity of 2,350·50 kg. of broodlac obtained from the area (the major quantity being produced during *Katki* season), 1,200 kg. were used in experimental work and only 697 kg. were sold. The remaining 453·50 kg. could not be sold due to lack of demand.

3. Potentiality Trials on *Moghania macrophylla*

(i) *Evolution of cultivation schedule and determination of optimum density of larval settlement on* M. macrophylla *for growing* Aghani *and* Jethwi *crops*

This is a new item on the programme. The necessary plants (nearly 3,240 in number) have been raised in a two-acre plot in the Institute plantation for this experiment.

(ii) *Spacings trials on* Moghania macrophylla

The experiments are going on since 1960-61. Three spacings, namely 6′×6′, 6′×4′ and 4′×4′ (A, B and C treatments respectively) are being tried. The layout is in randomized block design with 8 replications. There are $3 \times 8 = 24$ plots with 5 bushes in each under observation. Each plot measures 36′×36′ with 288, 432 and 648 bushes respectively in each of the treatments A, B and C.

Observations on the height growth, shoots put forth and total length of shoots attained up to the time of inoculation have been reported already (cf. *Ann. Rep.*, 1962-63). The inoculations for *Jethwi* 1963 were carried out in February 1963. Settlement was not uniform and 75 per cent of the shoots had only sparse settlement due to poor emergence on account of unfavourable climatic condition immediately after inoculation. Initial larval mortality was approximately 40 per cent. Some plants got damaged due to excessive heat during May and June.

The results are given in Table VI (App. A). It will be seen that the performance as regards crop yield per plant shows no significant difference between the treatments. But, if the yield of lac per acre is to be considered, then treatment C is the most satisfactory. These results are in conformity with the findings for the previous season also.

(iii) *Working out plantation technique of raising* Moghania macrophylla

These experiments are going on since 1961. The treatments tried are as follows:

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

After the plants were ready to receive lac inoculation, the first inoculation was carried out in July 1962 (cf. *Ann. Rep.*, 1962-63), and the crop harvested in January 1963. The observations on the plants were continued and the results of shoot measurement immediately before the subsequent inoculation (for *Jethwi* 1964 crop) are presented in Table VII (App. A). Unfortunately due to non-availability of brood, the intended inoculation in January 1964 for *Jethwi* 1964 crop could not be carried out. The bushes were therefore pruned again for new growth. Shoot growth till March 1964 shows that treatment H is the most promising, followed by treatments F and G, in respect of the number and the average total length of the shoots.

(iv) *Effect of NPK on the yield of lac on* Moghania macrophylla (*both with organic and inorganic manures*)

This experiment was laid out in 1962 on 640 bushes with a view to increase the yield of lac by applying different fertilizers individually and in combination.

The following 8 treatments, with 20 bushes in each treatment, are being replicated 4 times in randomized block design layout.

A — No fertilizer (control)
B — Nitrogen (N) alone
C — Phosphorus (P) alone
D — Potassium (K) alone
E — N + P
F — N + K
G — P + K
H — N + P + K

The fertilizers alone and in various combinations were applied to the bushes after a fortnight of the inoculation, the dosage of ammonium sulphate and muriate of potash being 20 kg. each per acre (for 1,800 bushes) and of superphosphate 40 kg. per acre.

Inoculations were carried out in January 1963 on bushes having one-year-old shoots. Larval settlement on all the bushes was satisfactory and continuous though there was an initial mortality of 30-40 per cent. The crop data for *Jethwi* 1963 are given in Table VIII (App. A).

It will be seen that treatment F (N + K) has given the best results followed by treatment H (N + P + K) in respect of yield of lac per plant as well as brood to yield ratio.

In the previous (*Aghani* 1962-63) crop, treatment H gave better results than F.

(v) *Effect of different levels of nitrogen on the growth of* Moghania macrophylla *bushes*

The experiment was laid out in randomized block design in 1962 on 640 bushes with the following 5 treatments replicated 8 times, and with 16 bushes in each treatment.

A — No ammonium sulphate (control)
B — 10 kg. ,, ,, per acre
C — 20 kg. ,, ,, ,,
D — 30 kg. ,, ,, ,,
E — 40 kg. ,, ,, ,,

Seedlings raised in the nursery in March were transplanted in July 1962 and ammonium sulphate applied once after transplantation.

The data of shoot measurements at the time of inoculation (in July 1963) are given in Table IX (App. A).

It may be seen that treatment E is superior to all other treatments in respect of height growth and the total length of the shoots.

The bushes were inoculated in July 1963 with *Kusmi* broodlac for raising the *Aghani* 1963-64 crop. Approximately 75 per cent of the shoots had fairly good settlement and there was comparatively low larval mortality and good development. However, there was later a severe attack of ants of different types which caused damage to the lac cells which were again heavily infested by predators with the result that the yield of the lac crop was poor. The data are given in Table X (App. A).

There is, however, no significant difference between the treatments as far as the crop yield is concerned.

A similar set has again been started in July 1963 for receiving inoculations in July 1964.

4. Permanent Field Experiments for Working out the Economics of Cultivation for *Kusmi* Lac on *Moghania macrophylla* under Different Conditions of Manuring and Irrigation

This is another new item in the revised programme. The experiment is to be conducted on 3-coupé system. Plants were raised in July 1963 in a selected plot by transplanting nursery-raised seedlings. The spacing followed is 4′ × 4′ (1·25 × 1·25 metres); therefore, the number of plants per acre is 2,700.

The experiment is being conducted on split plot design. There are two main plot treatments termed as 1st factor and 4 sub-plot treatments termed as 2nd factor. The number of replications are four; thus there will be $2 \times 4 \times 4 = 32$ sub-plots, each containing 60 bushes. The treatments are as follows:

(a) *Main plot treatments*

a_1 — Irrigation
a_2 — No irrigation

(b) *Sub-plot treatments*

b_1 — Control
b_2 — Organic manure (Farm-yard manure)
b_3 — Inorganic manure (NPK)
b_4 — Combination of organic and inorganic manures

For the *Aghani* crop only one post-monsoon irrigation will be given and for *Jethwi* crop fortnightly irrigation from March-June (8 irrigations) will be given.

Other details of the dosage of manure to be applied and other economical factors for raising a plantation involving raising nursery, digging pits, filling pits and transplanting expenditures have been worked out and will be adopted as per schedule.

5. Evolution of Cultivation Practices for *Kusum* at Hesal for Maximum Crop Production at Minimum Cost and Working out Economics

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

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

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

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

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

C — (*control*) Rest for

$1\frac{1}{2}$ years — Complete cropping after six months (4-coupé system) as in vogue at present.

There are altogether 14 coupés, 4 A's (i.e. $2A_1 + 2A_2$), 6 B's (i.e. $3B_1 + 3B_2$) and 4 C's. Treatments A and B are being tried, since cropping every six months involves heavy expenditure on broodlac on account of both frequency of inoculation and relatively heavy amount to be used at the time of every inoculation. In A and B, since self-inoculation is allowed after the initial artificial inoculation, broodlac used at the beginning is relatively small. Thus brood used was: 1 ft. of brood for $12\frac{1}{2}$ ft. of inoculated length space for trees under C treatment and 1 ft. of brood for 30 ft. of inoculated length for trees under A and B treatments. Each coupé has 15 trees.

Fifteen trees each in coupés A_1 II, B_1 II, which had primary inoculations in July 1962, were left for self-inoculation during January/February 1963, and C IV inoculated in January/ February 1963 were harvested in June/July 1963 for *Jethwi* crop 1963.

Likewise, same number of trees in coupé A_2 II which had primary inoculations in February 1963 were left for self-inoculation during June/July 1963 and CI inoculated in June/July 1963 were harvested in January/February 1964 for *Aghani* 1963-64 crop. The crop data for both the crops are presented in Tables XI and XII (App. A).

It will be seen that in the *Jethwi* crop treatment A gave a better yield than either B or C. On the other hand in the *Aghani* crop treatment B gave better result than either A or C. Further trials are still required for a definite conclusion. Due to unavailability of broodlac further scheduled inoculations could not be carried out.

6. Finding out Alternate Hosts for the *Kusmi* Strain of Lac Insect and Conducting Cultivation Experiments on them (e.g. *Albizzia lucida, Ougeinia oojeinensis, Ficus* sp., *Moghania chappar, Samanea saman,* etc.)

These experiments were started in 1962-63. Trials are being conducted on *Albizzia lucida* and *Ougeinia oojeinensis* by inoculating them with *Kusum* broodlac for *Jethwi* crop and alternating with the original host *kusum* for *Aghani* crop.

The crop data are presented in Table XIII (App. A).

The *Jethwi* lac crops on the alternate hosts were extremely poor. However, the surviving insects matured and indicated the possibility of using these alternate hosts for *Kusmi* strain.

7. Physiological Studies

(i) *Studies on the rate of secretion and composition of honeydew of the lac insect*

Standard technique for the collection of fresh honeydew secreted by the lac insects is being evolved. Preliminary experiments in this regard have not given encouraging results.

With a view to compare the amino acids and sugar contents of the honeydew with that of the insect body fluid, analysis of the total extract of the insect body has been initiated. This study is being made with the aid of paper chromatography. At least 8 spots of free amino acids and 3 of sugars have been detected in the total body extract of the mature female lac insect.

(ii) *Studies on the requirements of major, minor and trace elements and their influence on resin secretion, sex ratio and fecundity, etc., of the lac insect. (By growing host plants in culture solutions under completely controlled conditions and also by foilar spray of the nutrients)*

This is a new item on the programme. Trial experiments were initiated in July 1963 with the start of *Katki* crop.

Fifteen seedlings (eleven *Acacia farnesiana* and four *Butea monosperma*), all 3½ months' old, were removed from the nursery and transferred to culture bottles after their root systems had been washed with distilled water. The culture bottles contained only tap water which was changed every week. These bottles were also covered with black paper to cut off light from the root system.

Five *A. farnesiana* and one *B. monosperma* plants in these bottles were inoculated in July 1963 and the rest kept as control. In August, all the three control *B. monosperma* plants unfortunately died due to root injury, and the one carrying lac insects survived.

All the inoculated culture plants were weak and the development of the lac insects on these was found to be slow. Male emergence occurred in September and the females matured and subsequent larval emergence took place in December, thus taking a much longer time than under normal conditions. The emerged larvae were left on the plants for self-inoculation. Two of the *A. farnesiana* and one *B. monosperma*, carrying the lac insects, died within the next 3 months. The resulting progeny survived and attained sexual maturity, but emergence of larvae took place from only a few surviving mother cells from only one *A. farnesiana*. Meanwhile, two of the six control *A. farnesiana* died and the rest are surviving.

8. Genetical and Breeding Studies

(i) *Collection of various species, races and strains of lac insects from different geographical areas in the country and from neighbouring countries, and studies on their isolation, taxonomic characters and performance*

This is another new item of work in the programme. Forest Departments of different States and our Regional Field Stations were requested for regular supply of living lac material of exotic origin occurring in their localities. However, most of the samples received were found to be of cultivated type which originated from progenies received from other areas. Attempts are being continued to procure pure strains of naturally occurring lac from other sources if possible.

Several slides of *female* body parts have been made from available old collection of lac samples of Siam, Mysore, Assam and Rajasthan. Besides, such slides were also made from lac occurring on various host plants from Namkum plantation. These are under study.

Certain taxonomic characters such as anal tubercle, antennae, chitinization of brachia and dimples on brachial craters are not so stable, indicating that *Laccifer lacca* (Kerr) is a very polymorphic species and there are certain other species mixed with it. The study is being continued.

(ii) *Studies on crosses between* Rangeeni *and* Kusmi *strains of lac insect and also between the two colour forms of* Rangeeni *strain*

In this experiment *Kusmi* and *Rangeeni* strains were crossed along with reciprocal crossings. The lac insects were reared in family lines on potted *Moghania macrophylla* plants which were covered with 80 mesh wire net sleeve cages.

(a) *Crosses between* Rangeeni *females* × Kusmi *males*

Baisakhi females belonging to F_1 generation reared on 10 potted plants available from a previous crossing of R ♀♀ × K ♂♂ behaved in all respects like *Rangeeni* strain and produced the F_2 generation in June-July 1963.

The F_2 larvae settled satisfactorily and further development was quite normal till September 1963, and there were 99 females altogether. During the month of October 1963, however, 23 of the females started behaving like *Kusmi* females. The remaining 76 females behaved as normal *Rangeeni* and produced a progeny, i.e. larval emergence occurred during the month of October/November 1963 as in nature. Whereas those 23 females produced the progeny as *Kusmi* during December 1963/January 1964.

The genealogical history is as follows:

1962 *Katki* ♀ × 1962-63 *Aghani* ♂ ... P
↓
Baisakhi 1962-63 ... F_1
↓
Katki 1963 (?) ... F_2

Total number of females in F_2 99

Out of the above females

the number of females behaving like *Kusmi* was ... 23
and the number of females behaving like *Rangeeni* was ... 76

(b) *Crosses between* Kusmi *females* × Rangeeni *males*

The same technique of rearing as above was followed here also.

The *Jethwi* females belonging to F_1 generation available from a previous crossing of *Kusmi* ♀♀ × *Rangeeni* ♂♂ behaved in all respects like *Kusmi* strain and produced the F_2 generation in June-July 1963.

The larval settlement and development was fair and satisfactory. Till September 1963 normal growth took place for the 49 females in the F_2 generation. During October, 10 out of these started behaving like *Rangeeni* strain and larval emergence occurred in the second fortnight of October 1963. The remaining 39 females went on developing like normal *Kusmi* strain and produced the progeny in January 1964 as in nature.

The genealogical history is as follows:

1962-63 *Aghani* ♀ × 1962 *Katki* ♂ ... P
↓
Jethwi 1963 ... F_1
↓
Aghani 1963-64 (?) ... F_2

Total number of females in F_2 ... 49

Out of the above females

the number of females behaving like *Rangeeni* was ... 10
and the number of females behaving like *Kusmi* was ... 39

Segregation has taken place in the F_2 generation in both types of crosses and it has been established that the two strains can interbreed. However, no differentiation could be noticed in the shape or nature of the males in either case, though the *Kusmi* males were smaller in size.

It would appear from the evidence obtained from the above experiment that the cause of spurious emergence, reported from time to time from various places, is possibly inter-breeding of the two strains, and not ecological factors as was presumed.

(c) *Crosses between crimson and yellow forms of lac insects*

In the hybrid produced by crossing *Kusmi* ♀ (crimson) × *Rangeeni* ♂ (yellow) the dominant colour was crimson. The F_1 females matured and in the F_2 generation (initially crimson) development is continuing and showing evidence of segregation into crimson and yellow forms. The study is in progress.

(iii) *Evolution of a better yielding strain of the lac insect through selection*

This study was initiated from *Baisakhi* 1961-62 crop by segregating bold and healthy mature cells. Progenies from these were raised in family lines on *Moghania macrophylla* plants in pots under cover of 80 mesh wire net cages. In every progeny, the boldest 5 cells were selected and reared along with equal number of normal cells. The females were always mated with boldest males, the weaker ones being eliminated. After breeding up to 4th generation, it was found that there was practically no difference in size in the progenies that developed from these two kinds of cells. There was also no indication that a more vigorous and better resin yielding strain could be obtained by such selective breeding.

The genealogical history is as follows:

Baisakhi 1961-62 ... P
↓
Katki 1962 ... F_1
↓
Baisakhi 1962-63 ... F_2
↓
Katki 1963 ... F_3
↓
Baisakhi 1963-64 ... F_4

(iv) *Isolation of pure yellow strain of lac insect*

It was reported earlier (cf. *Ann. Rep.*, 1961-62) that 233 yellow lac larvae were propagated on potted plants of *Albizzia lucida*, out of which only 11 females remained yellow till sexual maturity, the rest by that time having changed to crimson. It was also reported that in the second generation, out of 200 yellow larvae only 10 reached maturity of which 8 were females and these females ultimately were destroyed by chalcid attack.

Again a fresh start was made during *Katki* 1962 and a third generation is in progress. Isolation of the crimson-coloured insects was carried out during development of the parent and the first filial generations, and yellow ones allowed to develop. No colour change to crimson was observed in the 2nd and 3rd generations. It is presumed that a pure breeding yellow strain has now been developed. It is hoped to raise a bigger colony of this pure breeding yellow strain when 4th generation becomes available in June-July 1964.

The genealogical history is as follows:

Katki 1962 ... P
↓
Baisakhi 1962-63 ... F_1
↓
Katki 1963 ... F_2
↓
Baisakhi 1963-64 ... F_3

(v) *Studies on the chromosomal cytology of the different strains of the lac insect*

The chromosome number of females of both *Kusmi* and *Rangeeni* strains and the males of *Rangeeni* strains were reported earlier (*Ann. Rep.*, 1962-63). During the year under

report chromosomal cytological studies in regard to male and female yellow strain and *Kusmi* male have been completed.

It has been observed that females of all the three strains have a diploid complement of 18 chromosomes, and so far no morphological variations either in their size and form or structure could be made out. The chromosome complements thus do not throw any light on the exact taxonomic position of these three kinds of insects.

Like the females, male lac insects also carry 18 chromosomes as the $2n$ number. Certain peculiar behaviours and heterochromatization of one set of nuclei of these 18 chromosomes were also noted.

(vi) *Studies on the mode of oogenesis and spermatogenesis of the different strains of lac insects*

The study of spermatogenesis has been completed. The pattern of sperm formation, i.e. spermiogenesis, in *Laccifer lacca* presents nuclear specialization in that the nucleus transfers its contents into the nuclear papilla which finally transforms into a sperm.

The binucleate sister spermatids fuse to form the quadrinucleate spermatid. Of the four nuclei, two are diffuse and the remaining two are pycnotic. In the course of development, each diffuse nucleus develops a nuclear papilla which in later stages becomes conspicuous, while the rest of the cell together with the pycnotic nuclei passes into the nuclear papillae and this brings about the spiralization of the spermatid cysts and bundles. With the formation of a sheath layer the coiled sperm bundles start unwinding themselves.

The culmination stage in the sperm formation reaches when the cell bodies and the cytoplasmic sheath are also sloughed off and the sperms appear as slender filamentous structures.

The work on oogenesis is going on.

(vii) *Breeding studies on the yellow variety of lac insect in relation to host specificity*

On maturity of *Baisakhi* 1962-63 crop of yellow lac of progeny of *Ficus* sp. from Delhi, the individual cells were inoculated on potted plants of *Acacia farnesiana* and *ber* (*Zizyphus mauritiana*). All the larvae were yellow on emergence. Percentage mortality at the larval stage was 38·2 in case of the former and 44·1 in case of the latter. However, the surviving insects retained their yellow colour till maturity.

In addition to the above experiments, inoculations were also made on the potted plant of *M. macrophylla*, *A. lucida*, *A. farnesiana* and *Z. mauritiana* with yellow variety of lac obtained from Jodhpur. The yellow colour was retained by all the insects inoculated. Proper fertilization was ensured in all at the time of male emergence. The experiment is being continued as no conclusions could be drawn.

9. Biological and Ecological Studies

(i) *Collecting the pests of lac host trees, and studies on the life-history and control operations against important pests*

(a) *On* Moghania *and* ghont *only*

(1) *Thiacidas postica* Walker is a pest of *ber* which was under study last year. Activity of the pest was noted to be from June to September with July and August as the peak period of infestation. From a collection of 107 larvae of the pest from the field, 26 were found to be parasitized. The parasite is being identified.

(2) *Hypena iconicalis* Walker (Lepidoptera), a pest of *Moghania macrophylla*, was found to be active from May to October 1963 and the peak period of infestation was July and August. This pest seems to be a serious defoliator of fresh leaves. Eggs are laid on leaf buds, new shoots and stems. Eggs collected from the field

were kept for hatching and rearing. The adults obtained from the reared material, however, failed to lay eggs in the laboratory. The larval period lasted 6-7 days when it passed through 5 instars and the pupal period was 7-8 days. Longevity was 2-4 days for males and 4-7 days for females.

(3) *Hemithea tritonaria* Walker, another pest of *M. macrophylla* reported last year as *Hemithea* sp., has been identified as *H. tritonaria* Walker. Further progress was made in the study of its life-history. It was found to pass through nine generations from October 1963 to September 1964. Activity in the field continued from first week of June to the end of February. From samples collected from the field, three types of larval parasites were encountered, one belonging to Braconidae and the other two to Ichneumonidae. The percentage of parasitism was 10·5 (out of 114).

(4) *Nephopteryx leucophaella* Zell. (Lepidoptera), a leaf skeletonizer as well as binder, was under study in the previous year. The 3rd generation was completed in April 1963, but further progress was hampered as the 3rd generation adults failed to oviposit in the laboratory. However, again some larval material was collected in June 1963 and by the end of March 1964, 6 generations had been reared continuously and the 7th generation is on. The details of life-cycle are given in Table XIV (App. A).

(5) Another unidentified lepidopterous leaf binder-cum-defoliator was found to attack *M. macrophylla* bushes. This pest generally feeds on the apical tender leaves of growing shoots and was found to be active from June to January next year. In the laboratory, the pest could not be bred, but four generations were raised by rearing the larval material (July 1963) in the field in potted plants covered with wire net sleeve cages. After the 4th generation, no further egg laying took place in these sleeve cages. Data on developing stages have been recorded.

(6) Tussock moth caterpillar was encountered on *M. macrophylla* defoliating the leaves. These larvae ate up entire leaves and were active from July to October. Life-history studies have been undertaken and till October, four generations have been raised.

(7) Hairy caterpillar reported on *ghont* last year was recorded on *ber* and *Moghania macrophylla* this year. The presence of larvae was noted on *ghont* from July to October, on *M. macrophylla* in November and December, and on *ber* in January. Two generations were reared from material obtained from *ghont* and another generation from material from *ber*.

(b) *On lac hosts other than* Moghania macrophylla *and* ghont

(1) *Holotrichia serrata* Fab. (Coleptera) is a serious pest of *palas*. Its life-history studies have been completed. The insect passes through a single generation in a year; the adults disappear completely after first week of August, and remain inactive throughout the winter reappearing in April and causing the entire denudation of trees during May and June. The duration of development, on an average, was 170·6 days, but the pre-oviposition period varied from 53·4 days where winter did not intervene to 195·2 days where winter intervened between the emergence of the adult and egg laying. The complete work is being reported separately.

(2) *Leaf binder of rain tree* — This is a highly destructive pest of rain tree as observed here. Some progress has been made in the study of its biology. The identification of the insect is awaited.

The pest was found to be extremely active from July to September, the incidence was reduced during October and negligible damage was recorded from November to June. After hatching out, the larvae take shelter in unopen

leaflets and start scraping the epidermis of the leaflets from inside. As the larvae grow they draw together other pinnae and form nests and feed on the leaflets. Eggs are laid singly on tender leaves and hatch within 2-3 days. The larval period varies from 15 to 18 days and they pupate very quickly after the final moult within the leaf folds, the pupal period being 5-8 days.

(3) *A notodontid pest of* Grewia multiflora — *Grewia multiflora* is a naturally occurring host tree in Assam. In Namkum, we have a few of these. This pest was noted to be quite active from June to September and feeds on the leaf, either tender or old, leaving only the midrib and strong veins.

Eggs are laid individually indiscriminately on either side of the leaves, leaf buds or stems, and are green when freshly laid. Newly hatched larvae are black in colour with two white bands on the thorax. They moult five times. The mature larvae do not differ morphologically very much from those in the 1st instar.

The larval period varies from 12 to 15 days. The full fed larvae form a tough smooth black semi-lunar cocoon prior to pupation. The pupal period extends from 8 to 10 days.

10. Biological Control of Lac Enemies

(i) *Life-history studies and developing breeding technique for important indigenous parasites*

(a) *Brachymeria tachardiae* (Cam.)

The life-history and biology of this pupal parasite of *Eublemma amabilis* Moore and *Holcocera pulverea* Meyr. have been reported earlier (cf. *Ann. Rep.*, 1962-63). Attention was paid to develop a mass-breeding technique. With the facilities available small-scale breeding was taken up and seven generations have been raised continuously and the eighth generation has been started.

(b) *Elasmus claripennis* (Cam.)

Progress of the study of the life-history and biology of this insect was hampered when the strain developed in the laboratory, as a result of continuous breeding up to the eighth generation, was destroyed by severe mite attack. Fresh attempts were also made, but a new strain could not be started as the material collected during September to November was again attacked by mites and another progeny of 41 consisted entirely of males.

However, the following observations were noted. During September to November, 80 host larvae (*E. amabilis*) were collected of which 19 were found parasitized. Under the field conditions a single host may harbour 2-20 parasites. In all 97 adult parasites were available from these 19 parasitized hosts where the percentage of females was 81·44 and the percentage of parasitization was 23·7.

(ii) *Mass-breeding and large-scale liberation of* Apanteles tachardiae *and* Bracon greeni *in the field and estimation of the effect of these liberations*

Due to certain unavoidable reasons, the experiment was proposed to be shifted from its existing site at Maheshpur-Sirka to a new site. Earlier, a preliminary survey was conducted at Pancha near Taimara. Since the area did not have the necessary number of trees for the proper layout of the experiment, a further new site was searched. Another site was located on Ranchi-Purulia Road where the final survey could not be carried out due to various difficulties among which was shortage of staff. Hence no further progress could be made in this particular experiment.

However, breeding of *Apanteles tachardiae* was continued on a comparatively small scale in the laboratory under room conditions due to lack of air-conditioning facilities which completely broke down. A total of 57,123 adults (19,653 females and 37,470 males) were bred.

(iii) *Ecological studies including the influence of various temperature and humidity conditions on the growth and development of the lac insect predators,* Eublemma amabilis *and* Holcocera pulverea

This item is also a new addition in the programme and was initiated in March 1963. Preliminary experiments were started by collecting pupal material of the predators and rearing them to adults. As soon as the adults were available, these were mated and caged in small vials plugged with cotton inside desiccators maintained at 15°C., 25°C., 30°C., and 35°C. $\pm 1°$ and RH 85% ± 1 for collecting the data on ovipositional activities, fecundity and longevity.

During the period May 1963 to February 1964 a total of 10,323 pupae of *Eublemma amabilis* were collected of which 3,921 emerged as adults which included 2,195 females. 61·8 per cent and 61·1 per cent female emergence occurred during July and September from a population of 1,049 and 546 respectively which were the maximum.

At 15°C., the average number of eggs laid per female was 100·46 and the pre-oviposition and oviposition periods were 6·3 and 8·8 days respectively. Longevity of females and males was, on an average, 25·3 and 23·3 days respectively.

At 25°C., the eggs laid were 219·2 per female with pre-oviposition and oviposition periods of 1-3 days and 1-11 days respectively. The longevity was 10·96 and 10·46 days for the females and males respectively.

At 30°C., the eggs laid were 289·5 per female with pre-oviposition and oviposition periods of 1-3 days and 3-7 days with a longevity of 8·7 days for females and 8·1 days for males.

At 35°C., longevity was reduced very much with practically no egg laying.

All observations were based on 15 sets of paired adults at these temperatures and fed with 5 per cent glucose solution. The eggs were counted daily and removed.

11. Chemical Control of Parasites and Predators of Lac Insect

Effect of different insecticidal sprays on the incidence of parasites and predators attacking Kusmi *lac crop grown on* M. macrophylla

As recommended by the Entomological Sub-committee, only stomach poisons were to be tried for this experiment. Since, however, no other stomach poison except 'cryolite' could be procured in spite of all efforts, Dieldrex (a contact poison) was also used as a second insecticide.

The schedule laid out was as follows:

Treatments

A — Insecticidal treatment (1st factor)

B — Number of sprays (2nd factor)

Main Plot treatments (a) and dosage applied were:

(i) Cryolite — 0·1% (a_1)
0·25% (a_2)

(ii) Dieldrex — 0·25% (a_3)
0·1% (a_4)

Sub-plot treatments and spraying schedule:

(i) 2 sprays at 3 weeks' interval	(b_1)	July to mid-August.
(ii) 3 ,, 2 ,, ,,	(b_2)	
(iii) 4 ,, 3 ,, ,,	(b_3)	End of September onwards.
(iv) 6 ,, 2 ,, ,,	(b_4)	
(v) No spray ,, ,,	(b_5)	

At 4 levels of 1st factor and 5 levels of 2nd factor there were in all 20 treatments with 3 replications.

The initial experiment was carried out during the *Aghani* crop 1963-64 and the yield thus obtained is given in Table XV (App. A). However, it may be said that since the bushes were young and single-stemmed, a thorough sample examination for larval mortality, settlement and predator damage could not be carried out. Some mature lac was caged for observation. From this initial experiment no inference can be drawn at present.

IIB — REGIONAL FIELD RESEARCH STATIONS

1. JHALDA (WEST BENGAL)

(i) *Studies on the causes of spurious emergence of lac larvae at times other than normal and finding out methods to prevent such occurrences and/or its utilization to the best advantage of lac cultivation*

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

Treatments

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

B — Inoculation with *ber* brood.

C — Inoculation with *palas* brood.

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

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

For *Jethwi* 1963 crop, 2 trees of C treatment, 3 trees of D treatment and 2 trees of E treatment were inoculated with the harvested brood of their respective treatments and the rest were inoculated with *kusum* brood only, as *Rangeeni* broods were not available at that time. The crop did not show spurious emergence.

Maximum brood to yield ratio (i.e. 1: 2·24 scraped to scraped) was obtained from treatment C and is given in Table XVI (App. A).

Inoculation was done for *Aghani* 1963-64 partially by harvested broods and partially by purchased *Kusmi* and *Rangeeni* broods. A feeble spurious emergence was observed on trees inoculated with harvested brood.

Jethwi 1964 could not be continued due to non-availability of brood.

(ii) *Investigation of the likely* Kusmi *hosts occurring in the region and their proper use to supplement production of* Kusmi *lac*

Trials were continued on *Protium serratum, Dalbergia latifolia, Ficus arnottiana, Butea monosperma* and *Zizyphus mauritiana* with *kusum* brood. The resulting broods were either raised continuously on these hosts or alternated with *kusum* trees, to see their performance as *Kusmi* host, and the effect of cross-inoculation. A fair *Jethwi* 1963 crop was obtained from *M. macrophylla* while it was poor on *P. serratum* and failed on *D. latifolia, F. arnottiana* and *B. monosperma*. A good *Aghani* 1963-64 crop was obtained from *M. macrophylla* while it was poor on other hosts. The results of stick examination and crop data are recorded in Tables XVII and XVIII, respectively (App. A).

Since *Jethwi* 1963 and *Aghani* 1963-64 crops were very poor on Z. *mauritiana*, harvesting of *Aghani* crop was not done and trees were left for self-inoculation.

(iii) *Selection and introduction of suitable regional or exotic hosts to fortify cultivation of lac on* kusum (*emphasis on introduction of* M. macrophylla)

Of 50 *Moghania* bushes very few are surviving.

(iv) *Relative importance of enemy and friendly insects*

More parasites than predators were collected from lac obtained from *Jethwi* 1963 and *Aghani* 1963-64 crops samples of which were caged during the period under report.

The parasites collected were: *Tetrastichus purpureus, Eupelmus tachardiae, Parechthrodryinus clavicornis, Erencyrtus dewitzi, Tachardiaephagus tachardiae* and *Tachardiaephagus somervilli.*

Both the major predators, viz. *E. amabilis* and *H. pulverea,* were collected during June and July from *Jethwi* 1963 crop. In *Aghani* 1963-64 lac *E. amabilis* was more prevalent during October to December and *H. pulverea* during October, November 1963 and March 1964.

Among friendly insects, *Apanteles fakhrulhajiae* was collected from *Jethwi* 1963 lac and *B. greeni, Pristomerus sulci, A. fakhrulhajiae, A. tachardiae, B. tachardiae, Chelonella* sp. and *E. claripennis* from *Aghani* 1963-64 lac.

2. DAMOH (MADHYA PRADESH)

(i) *Studies on the response of* ghont *to pruning to grow lac crops and systematic cultivation of lac on this host*

The experiment was continued and the experimental details are as follows:

Treatments for Katki *crop*

A — Pruning at the time of harvesting in November
B — Pruning in the second week of February } Operated every year.

C — Pruning in the second week of May — 2 C treatments operated in alternate years.

Treatments for Baisakhi *crop*

A — Pruning in the second week of April.

B — Pruning in the third week of May.

C — Pruning in November.

Shoot measurement study and crop data indicate that treatment A under *Baisakhi* crop and treatment C under *Katki* crop showed better results than the other treatments. Table XIX (App. A) records the results of shoot measurements at the time of inoculation. Table XX (App. A) records the crop data, and Table XXI (App. A) records the results of stick examination for larval settlement.

(ii) *Determination of optimum requirement of broodlac for crop inoculation on* ghont

The experiment was continued with the object of finding out the effect of different densities of larval settlement on ultimate crop as well as on brood preservation in both *Baisakhi* and *Katki* crops.

Half-normal (A) (average 125 gm. brood per tree), normal (B) (250 gm. brood per tree) and double-normal (C) (500 gm. brood per tree) treatments were tried.

No significant conclusions could be drawn from *Baisakhi* 1962-63 and *Katki* 1963 crops. The results of stick examination and crop data are recorded in Tables XXII and XXIII (App. A).

On the basis of the past results the treatments have been revised as follows:

Treatments

A — Normal brood rate. Average 400 gm. brood per tree.

B — Double-normal brood rate. Average 800 gm. brood per tree.

C — Triple-normal brood rate. Average 1·200 kg. brood per tree.

Baisakhi 1963-64 crop is progressing satisfactorily.

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

The experiment was continued with the object of obtaining *ari* lac and broodlac and reducing the cost of operations.

On the basis of the crop data of *Baisakhi* 1962-63, B treatment (i.e. inoculation in October/November with 250 gm. of brood per tree; dead lac and excess broodlac removal in June/July and complete harvesting in October/November next year) gave the best results in terms of brood used to yield ratio.

The experiment has now been modified as follows:

Treatments

A — Pruning in April, light inoculation (average 200 gm. brood per tree) in October/November, no partial harvesting during June/July, complete harvesting in October/November next year).

B — Pruning in April, normal inoculation (average 400 gm. brood per tree) in October/November, partial harvesting in June/July and complete harvesting in October/November next year.

C — Pruning in April, heavy inoculation (average 800 gm. brood per tree) in October/November, *ari*-cutting in April and May.

D — Pruning in October/November, light inoculation in October/November next year, no partial harvesting in June/July, complete harvesting in October/November next year. Thereafter harvesting will also serve for pruning.

E — Pruning in October/November, light inoculation in October/November next year, partial harvesting in June/July, complete harvesting in October/November next year. Thereafter harvesting will also serve for pruning.

Each treatment will be tried on 5 trees and in 10 replications. Each treatment will have two coupés for use in alternate years. There will thus be 500 trees under this experiment.

Crop on 50 trees under each treatment of *Baisakhi* 1963-64 is progressing satisfactorily.

(iv) *Permanent field experiment for working out economics of cultivation of* Kusmi *and* Rangeeni *lacs on* Moghania macrophylla *under different conditions of manuring and irrigation*

The experiment has already been laid out on split plot design on two acres for *Rangeeni* lac and two acres more will be covered for *Kusmi* lac. The following treatments will be tried:

(a) *Main plot treatments*:

(1) *Irrigation — Katki* crop — No irrigation.

Baisakhi crop — One irrigation in the post-monsoon season plus fortnightly irrigations from March to June (i.e. a total of 9 irrigations).

Aghani crop — One irrigation in the post-monsoon season, when found necessary.

Jethwi crop — Fortnightly irrigation from March to June (i.e. a total of 8 irrigations).

No irrigation will be carried out in any treatment during the one-year rest period after the crop has been harvested.

(2) *No irrigation* — All bushes receiving inorganic fertilizers only will be given light irrigation (if there is no rain just after the application of the fertilizers) irrespective of the two main-plot treatments. No irrigation will be given otherwise.

(b) *Sub-plot treatments*:

(1) *Organic manure*, i.e. Farmyard manure, will be applied approximately two months before inoculation in pits @ 500 gm. per bush (i.e. approx. 1,500 kg. per acre).

(2) *Inorganic fertilizers* — A combination of 14 gm. ammonium sulphate (for nitrogen), 7 gm. superphosphate (for phosphorus) and 7 gm. potassium sulphate or muriate of potash (for potassium) per bush will be used, followed immediately by light irrigation.

(3) *Combination of organic manure and inorganic fertilizers* — They will be used in equal quantities, i.e. 250 gm. organic manure per bush and 7 gm. ammonium sulphate, 3·5 gm. superphosphate and 3·5 gm. potassium sulphate or muriate of potash per bush. Organic manure will be applied approximately two months before inoculation and the inorganic fertilizers a fortnight after inoculation.

(4) *No manure or fertilizers, i.e. control* — Each treatment will be tried on 50 bushes in four replications. There will thus be $8 \times 50 \times 4 = 1,600$ bushes in each coupé. There will be three such coupés for the two *Rangeeni* and *Kusmi* experiments.

(v) (a) *Investigation of likely* Rangeeni *hosts occurring in the region and their proper use to supplement production of* ghont *lac*

Baisakhi 1962-63 and *Katki* 1963 crops succeeded only on *palas* trees, whereas they failed on *airma, renja, dhoben, bansa* and *khair*.

Baisakhi 1963-64 crops on *ghont, palas, airma, renja* and *khair* are progressing well, but failed on *bansa* and *dhoben*.

(b) *Selection and introduction of suitable regional or exotic hosts to fortify cultivation of lac on* ghont

Regional and exotic hosts are being raised since 1962 for lac cultivation. Seven *Samanea saman* (rain tree) and one *A. lucida* are developing satisfactorily. All *M. macrophylla* and *O. oojeinensis* plants died.

Four hundred seeds each of *A. lucida* and *S. saman* sown during mid-March 1964 already germinated.

Fresh sowing of *M. macrophylla* seeds in 22 beds was done during mid-March 1964.

(vi) *Relative importance of enemy and friendly insects*

More predators than parasites were collected from lacs caged from the three crops, viz. *Katki* 1962, *Baisakhi* 1962-63 and *Katki* 1963.

The parasites — *T. purpureus, E. tachardiae, T. tachardiae* were collected from the *Katki* lac and only the latter two from *Baisakhi* lac.

Amongst predators more *H. pulverea* than *E. amabilis* were collected from the three crops. *Coccidiphaga scitula* (Ramb.) (= *Eublemma scitula*) was also collected from the *Baisakhi* lac.

Friendly insects such as *B. greeni, Eurytoma palidiscapus, P. sulci* and *A. tachardiae* were collected from the *Katki* lac and only *P. sulci* from the *Baisakhi* lac.

3. Mirzapur (Uttar Pradesh)

(i) *Studies on the response of* ghont *to pruning to grow lac crops and systematic cultivation of lac on this host*

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

Both the crops *Baisakhi* 1962-63, which suffered from heat mortality and *Katki* 1963, which faced heavy rains at the time of inoculation, were total failures. Fresh inoculation of *Baisakhi* 1963-64 crop was carried out during October 1963 and the crop is progressing satisfactorily.

Data on shoot measurement, crop and stick examination are recorded in Tables XXIV and XXV (App. A).

(ii) *Determination of the optimum requirement of broodlac for crop inoculation on* ghont *and* palas

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

Baisakhi 1962-63 crop was a failure on *ghont* whereas on *palas* half-normal brood rate (A treatment, i.e. 100 gm. brood per tree) was better than normal and double-normal (B & C treatments respectively).

Katki 1963 crop although very poor on *ghont* was better in C treatment (double-normal brood); and on *palas* the crop was better in B treatment (normal brood rate).

Crop data are recorded in Table XXVI (App. A).

The experiment has been modified by deleting half-normal brood rate in *ghont* only and by adding a triple-normal brood rate on both the hosts. The normal brood rates have also been revised to average 500 gm. per tree for *ghont* and 800 gm. per tree for *palas*. Other rates have been calculated accordingly.

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

Baisakhi 1962-63 crop completely failed on *ghont* immediately after *phunki* removal, whereas on *palas* A treatment gave better results than B and C treatments respectively.

For *Baisakhi* 1963-64 the experiment has been modified by revising the light, normal and heavy brood rates to 250 gm., 500 gm. and 1·0 kg. for *ghont* and 400 gm., 800 gm. and 1·6 kg. for *palas* respectively, and is similar to the one conducted at Damoh in other details. Fifty trees under each treatment both *ghont* and *palas* are progressing well. The crop data are given in Table XXVII (App. A).

(iv) *Permanent field experiment for working out economics of cultivation of* Kusmi *and* Rangeeni *lacs on* Moghania macrophylla *under different conditions of manuring and irrigation*

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

It has been laid out on a two-acre plot and another two-acre plot will be covered this year. Though the two plots have been selected near a canal of the Canals Division, U.P., the plants transplanted last year suffered setback due to irregular supply of water and grazing by wild animals.

(v) (a) *Investigation of likely* Rangeeni *hosts occurring in the region and their proper use to supplement production of* ghont *lac*

Only *Cassia fistula* (*amaltas*) carried some *Baisakhi* 1962-63 lac and *kuchai* the *Katki* 1963 crop.

C. fistula is again carrying *Baisakhi* 1963-64 crop, though poor. No other hosts were found successful.

(b) *Selection and introduction of suitable regional or exotic hosts to fortify lac cultivation on* ghont

Hosts are being raised for the purpose as at v(b) under Damoh.

Samanea saman (rain tree) and *A. lucida* grown previously died. They will be introduced afresh.

(vi) *Relative importance of enemy and friendly insects*

More predators than parasites emerged from *Baisakhi* 1962-63 and *Katki* 1963 lacs and *vice versa* from *Baisakhi* 1963-64 lac. More friendly insects emerged from *Katki* 1963 lac than the two *Baisakhi* lacs.

The parasites were *T. purpureus, E. tachardiae, P. clavicornis, T. tachardiae, E. dewitzi* and *Coccophagus tschirchii* which emerged from both the *Baisakhi* and *Katki* lacs and *T. somervilli* also from *Katki* lac.

More *H. pulverea* than *E. amabilis* were collected from all the three crops. Friendly insects such as *E. palidiscapus, B. tachardiae, B. greeni, A. tachardiae, Chelonella* sp. *P. sulci* and *Perisierola pulveriae* were collected from all the three crops. Besides these *E. claripennis* was also collected from *Katki* crop and *Agathis coryphe* Nixon (Braconidae) and *Monodontomerus* sp. near *aereus* Wlk. (Hymenoptera: Torymidae) from *Baisakhi* lac.

4. Umaria (Madhya Pradesh)

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

The experiment was laid out with the under-mentioned treatments on the lines as at Hesal (at 5 above).

Treatments

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

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

B — Two-year rest between pruning and inoculation, i.e. three-coupé system. There are six coupés under this treatment with 15 trees in each coupé. Three coupés will be used in turn each year, as in treatment A.

C — One and a half-year rest between pruning and inoculation, i.e. the usual four-coupé system. There are 15 trees in each coupé. Each coupé will be used as usual for one crop every season, without leaving for self-inoculation.

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

No crop was obtained from B_2I coupé (inoculated during July 1962) and very poor crop from coupé A_2I (inoculated in July 1962). The brood used to yield ratio in A_2I coupé was 1: 0·12 in terms of sticklac.

In February 1963 A_1II, B_1II and CIII coupés were inoculated. The crop was poor in all but coupé B_1II. The brood used to yield ratio in terms of sticklac being 1: 0·34; with maximum brood yield of 0·643 kg.

Due to scarcity of brood, coupés CIV and B_2II could not be inoculated in July 1963; whereas only 2 trees each in coupés B_1III, CI and A_1I were inoculated in February 1964. Remaining 13 trees under each of the above-mentioned coupés and 15 trees in B_2III were not inoculated at all.

(ii) *Investigation of likely* Kusmi *hosts occurring in the region and their proper use to supplement production of* Kusmi *lac*

Only *khair* gave a little crop in *Aghani* 1963-64 crop. The ratio of brood used to yield obtained was 1: 2·29 in lac sticks and 1: 0·61 as scraped lac. Other hosts (viz. *dhawa, sidh, bhirra, barsaja, mahua, char, kakai, karonda, tendu, makoi, phulchuria* and *imlaua*) failed to carry any lac.

(iii) *Relative importance of enemy and friendly insects*

More predators than parasites were collected from both the crops, viz. *Jethwi* 1963 and *Aghani* 1963-64.

Among the parasites only *T. somervilli* was collected from *Jethwi* 1963 and *T. purpureus* and *T. somervilli* from *Aghani* 1963-64.

More *H. pulverea* than *E. amabilis* were collected from both the crops.

Among the friendly insects only *P. sulci* was collected from both the crops and *A. fakhrulhajiae* only from *Aghani* 1963-64 lac.

Five new insects collected from *Aghani* 1962-63 lac were identified as *Apanteles* sp. (2 specimens) (Braconidae) and *Scambus* sp. (3 specimens) (Ichneumonidae) at the Commonwealth Institute of Entomology, London. The relation of these insects with lac insect or its associated insects is yet to be investigated.

A. coryphe was collected from *Katki* 1962 and *Baisakhi* 1962-63 lac on *palas*.

IIC—SPONSORED RESEARCH

1. Award of Research Fellowships (Entomology) at Ranchi College, Ranchi and Aligarh University, Aligarh

The Entomology Fellowship Sub-committee of the Indian Lac Cess Committee, in its meeting held on 7th January 1961, recommended the award of two Junior Fellowships @ Rs. 250 per month to two candidates for carrying out research work on entomological problems at Ranchi College, Ranchi and Aligarh University, Aligarh, for a period of two years. The results of the investigations at the two centres are summarized below.

(a) *Aligarh* — The problem for the fellowship at Aligarh was " The Morphology and Biology of some parasites associated with lac insects ". The candidate joined the fellowship with effect from 1st June 1961.

A new parasite, *Parageniaspis indica* Alam, belonging to Encyrtidae-Hymenoptera was collected as a result of extensive survey of plants infested with lac in and around Aligarh during the previous year. Besides, two others belonging to Braconidae and Eulophidae were identified up to family stage.

For the year under report, a report of this work only for the period April to September 1963 has been received. An exhaustive and comparative study of the morphology of the different body parts such as (i) Forecoxa, (ii) Trochanter, (iii) Femur, (iv) Tibia, (v) Tarsus, (vi) Pretarsus of the forelegs, middle legs and hind legs were made, and its homologies discussed with related species.

The fellowship which was to terminate by 31st May 1963, was extended for another year, i.e. up to 31st May 1964. A complete report about the work is expected shortly.

(b) *Ranchi* — The problem for the fellowship at Ranchi was " Histological studies on the seasonal variation in the gonads of the lac insect ". The candidate joined the fellowship with effect from 12th May 1961.

Prior to the period under report the following studies had been made:

(i) Structure of the gonads and associated ducts in adults of both sexes.

(ii) Development stages of the reproductive system in both sexes.

(iii) Origin and homologies of the different parts of the reproductive organs in both sexes.

(iv) Differences in the time of maturity and structural differences of the reproductive system in various crops.

(v) Histology of the different parts of the reproductive system in both the sexes.

(vi) Growth rate of the female insect in the pregestational period.

(vii) Chromosomal complement of the somatic cells, spermatogonia and oogonia.

(viii) Chromosomal behaviour during somatic divisions, spermatogenesis and oogenesis (partly).

(ix) Fate of cytoplasmic inclusions during oogenesis (partly).

During the year under report, the work was aimed mainly to complete certain unfinished work and to confirm earlier observations as outlined below:

(i) Growth rate during gestational period.

(ii) Confirmation of certain results in the next *Katki* and *Aghani* crops.

(iii) Growth rate, fecundity and structural modification if any in the parthenogenetic forms.

(iv) Oogonial divisions — chromosomal behaviour.

(v) Fate of cytoplasmic inclusions during oogenesis.

The fellowship which was to terminate by 30th April 63, was granted extension for six months, i.e. up to October 1963. Full report about the completed work at this centre is expected shortly.

III—PLANTATION AT NAMKUM

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

Nearly 15,000 pits were dug in different areas of the plantation and *Moghania macrophylla* seedlings were transplanted in those pits. Seedlings of various other lac hosts, e.g. *palas*, *ber*, *kusum*, etc., were also raised in the nursery, for general planting and for experimental use in pots.

About 1,100 dead, diseased and malformed trees of *palas*, *ber* and *kusum* were cut and removed. Fresh pits have been dug and arrangements made for planting healthy seedlings of *palas*, *ber* and *kusum* during the ensuing monsoon in their place. Periodical spraying of insecticides was continued for extermination of insect pests infesting the plantation.

About 50 kg. of *M. macrophylla* seeds were collected from our plantation and distributed to interested parties and organizations for raising *Moghania* plantations for lac cultivation.

IV—TRAINING AND ADVISORY SERVICE

Two regular courses of six months' duration in improved methods of lac cultivation were conducted during the year, namely from 1st April 1963 to 30th September 1963 and 1st October 1963 to 31st March 1964 with 5 and 15 trainees respectively.

In all 20 candidates (8 from Bihar, 5 from Madras, 3 from Gujarat and 4 from Uttar Pradesh) were trained during the year.

During July one short course of a month's duration was also conducted for an Entomological Research Assistant from the Rajasthan Department of Agriculture. Lectures on improved methods of lac cultivation were delivered at Forest Guards Training Schools at Mahilong and Betla.

During August a radio talk was given on the old and improved methods of lac cultivation in the villager's programme. Specimens, exhibits and literatures on lac cultivation and lac insects were sent to large number of interested parties and Vigyan Mandirs.

CHEMISTRY DIVISION

I—GRADING AND ANALYSIS

1. Bleach Index/Bleachability

The merit of the method for determination of bleach index/bleachability of seedlac by use of Klett Summerson calorimeter was discussed in the Lac and Lac Products Sectional Committee of the Indian Standards Institution after receiving the comments from other members of ISO/TC-50 on lac. The Committee agreed with the opinions expressed by U.K. and U.S.A., that an equipment under proprietory name should not be specified. It was felt, that this could only be avoided, if the principles involved in the use of photoelectric colorimeter with which this test was carried out at the Institute were mentioned and the filter, which is essential for carrying out this test were properly defined.

To find out the suitability of different types of photoelectric colorimeters and spectrophotometers for the bleach index determination, their calibration with different strengths of iodine solutions was done in a similar way as done previously on Klett Summerson model. The calibrations were confirmed by testing a few samples of seedlac. Comparative figures of optical density and per cent transmittance for iodine solutions is given in Table 1 (App. B). Experiments to define the suitable filter for all instruments showed that 480 mμ is the most suitable wavelength covering the range of bleach indicii from 50 to 170.

2. Correlation of Quality of Lac, Especially Colour, with Climatic Conditions of the Area of Cultivation

Experiments were continued during the year under report to determine the correlation, if any, between the quality, especially colour of lac and the climatic conditions of the area in which it was cultivated. An examination of 42 samples had already been reported earlier and twelve more samples of sticklac obtained from the same areas are under examination. No correlation could be detected so far.

3. Study of Variation of Specific Heat of Seedlac and Bleached Lac with Temperature and Age

In continuation of the work to correlate the age of various samples of seedlac with their specific heats already reported last year [*vide ILRI, Annual Report* (1962-63), 20], specific heats of seedlacs were determined at different temperatures in the range 10-100°C. The determinations were carried out at intervals of 10°C. by the same method as reported by Srivastava earlier [*Indian J. of Physics*, **32** (1958), 443-46]. The values obtained ranged from 0·25 at 10°C. to a maximum of 0·66 at 70°C. and then fell to 0·5 at 100°C. The results were reproducible.

The variation of specific heat of bleached lac with temperature is also under investigation.

For this purpose a new calorimeter has been designed taking into consideration the inherent physical condition of bleached lac while heating. Some limitations found in the design of calorimeter used by Srivastava were removed by redesigning it.

The improved calorimeter was designed taking the following into consideration:

(1) For uniform heat conduction of bleached lac, a rather bad conductor, it was designed in a circular shape instead of rectangular to ensure uniform radial flow of heat.

(2) The position of heating elements inside the calorimeter was fixed in such a way that the masses of substance taken inside and outside of it (heating element) were equal.

(3) The calorimeter was completely enclosed to prevent flying of bleached lac powder packed inside, under high vacuum.

The work is continuing.

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

1. Making of Shellac Using Soft Coke in Place of Charcoal

Experiments on the production of shellac, by the *bhatta* process using soft coke in place of wood charcoal, were continued. Repeated experiments with various types of seedlac have confirmed that there was a saving of Rs. 3.15 per quintal of seedlac melted by using soft coke instead of wood charcoal. The yield and quality of shellac were found to be always the same in all respects. Shellac prepared by both the method had been stored under ordinary laboratory conditions for one year. The deterioration in life and flow has been found to be similar in both the samples.

2. Economic Utilization of By-products

(a) *Recovery of lac from refuse lac*

A few commercial samples of lac factory refuse named as *Bhole Kunhi* were processed to shellac by alkali extraction method. The lac content of the *Kunhi* was 65-70 per cent. The samples of shellac have been sent to different parties for their examination and comments.

(b) *Recovery of wax lost during the processing of sticklac into seedlac*

In continuation of last year's work, experiments were carried out on pilot plant scale at the Indian Institute of Technology, Kharagpur to extract wax from the dry sludge, which has been obtained by precipitating lac factory effluent with acid. The wax could be extracted smoothly up to over 90 per cent with commercial hexane. A similar plant was fabricated at the Institute in which more experiments were carried out.

It has also been found that the plant should be made of aluminium to obtain lac wax of natural light colour. Other metals like copper, zinc, brass, galvanized iron, mild steel and stainless steel affect the colour of the wax adversely.

The wax obtained from the plant was analysed and the results are given below:

	M.P. in °C.	*Acid value*	*Sap. value*
1. Wax extracted with hexane	79-81	31·27	115·7
2. Same wax treated with sodium carbonate	82-83	17·74	96·87

As the acid value (sample No. 1) was found to be somewhat higher than that of the lac wax usually available in the market (acid value, 16-18) attempts were made to reduce it as far as possible. Finally, it could be brought down to the desired range of 16-18, simply by boiling the wax in water containing 2 per cent sodium carbonate on the weight of wax for thirty minutes. The melting point of the wax also rose by this treatment to 82-83°C.

3. Use of Oxalic Acid in the Processing of Seedlac to Shellac and the Effect thereof

Shellac manufacturers sometimes mix a small quantity of oxalic acid during the processing of seedlac to shellac. The object of this addition of acid, which must have some

effect on the properties of lac, is not clearly known. So a thorough study has been felt necessary. Seedlac was mixed thoroughly with different proportions of oxalic acid, dissolved in water and dried. It was melted by normal *bhatta* process. The samples produced were then analysed and the results are given in Table II (*vide* App. B).

It will be seen from the results that with the increase in percentage of oxalic acid, the life and flow of shellac are progressively impaired with a little improvement in colour. These samples will be stored and tested at intervals of 4 months during one year.

4. Rotary Drier for Seedlac

Based on the conclusion of previous workers (Private communication from Mr. N. H. Wagh), about the suitability of a Rotary Drier for drying of seedlac, it was decided to design a full-scale Rotary Drier for commercial operation. For making the design, it was first necessary to perform some pilot plant experiments to gather data on the operational aspects so that improvements and modifications might be effected for the satisfactory handling of the particular material, and, to develop suitable relations between the operating variables in the form of equations for scaling up and designing the large-scale drier. A laboratory-scale continuous Rotary Drier was available at the Delhi Polytechnic Institute and the pilot experiments were performed with this drier. The experiments were divided under two broad classifications, viz. (i) Flow characteristics and (ii) Drying characteristics. Under flow characteristics, hold-up determinations were made by varying the feed rates, speeds, slopes and air velocities. Under drying characteristics, overall volumetric heat transfer coefficient determinations were made with the same variations. The results of these experiments (*vide* Tables III & IV, App. B) conclusively proved that, the various relations proposed by Friedman and Marshall (*Am. Inst. Chem. Engrs. meeting*, New York, Nov. 10, 1948) could be suitably applied in the present design. The operation envisaged in the design starts from feeding the wet seedlac into a feed hopper which discharges on a vibrating screen.

Detailed descriptions of the screen and the drier are as follows:

A. screen — (i) The bed thickness on the screen is maintained at 1″ by a baffle, (ii) the screen mesh size is 40 mesh, and (iii) the screen size is 10′ long × 4′ wide inclined at an angle of 10°, stroke of the shaker is 4″ and speed 40 strokes/min. The screen serves the dual purpose of providing a uniform feed to the drier feed chute and draining off excess moisture while performing some preliminary drying to reduce drier load.

B. Drier — The salient features of the drier are: (i) The minimum design capacity of the drier is 5 maunds of dry seedlac/hour, (ii) Overall dimensions — 3′ dia. × 30′ long, (iii) Slope 1 in 40, (iv) Speed-variable from 5 to 15 r.p.m. (stepless reduction being provided by a set of cone-pulley drive), (v) Drier driving motor 10 h.p., 960 r.p.m., 400/440V., 3 phase 50 cycles A.C. totally enclosed fan cooled, squirrel cage type, (vi) Drier shell made of 3/8″ thick M. steel, discharge chutes and breechings made of 3/16″ thick M. steel, (vii) Drier shell supported on two sets of idlers in rolling contact with two girth rollers. There are two sets of thrust rolls to prevent axial displacement, (viii) The drier is provided with longitudinal flights starting 1′-6″ from the feed and extending right up to the discharge end. Number of flights — 12, radial depth — 4″, length of folded edge — 4″, angle between two edges of flight — 120°, and (ix) The drier is provided with 2 sets of knockers at the wet end.

The air flows countercurrent to the material for better heat transfer and less dusting. It is worthwhile to mention that no dehumidification of the air is necessary due to the higher allowable temperature of air in spite of the limiting temperature of material (40°C.). Inlet temperature of air can be as high as 57°C., the exit material temperature remaining still below 40°C. This results in high gradients for both heat and mass transfer for drying and consequential saving in cost. An axial flow fan driven by 3 h.p. motor with normal capacity — 1800 to 2000 cfm. and maximum capacity — 3600 cfm. with developed head of 1·5 in water is to be used.

The air is to be heated by steam in a finned tube heater. The heater employs 3/4″ O.D. × 14 G. Mild steel heat exchanger tubes with 3/8″ high × 20 G annular transverse mild steel fins at a spacing of 1/8″. There are 58 tubes arranged in 5 banks, a staggered spacing being used for better heat transfer. Tube pitch is 2″. The overall duct size for the heater is about 2′ × 2′ rectangular. Pressure drop through the heater is about 1·1″ water.

5. Solvent Extraction Plant for Reclamation of Lac from Waste Products

The process employed follows the pattern of lac extractor as described by Mr. Bazle Karim [*vide* Mukhopadhaya, B. & Muthana, M. S., *Monograph on Lac*, Indian Lac Research Institute (1962), 171]. The complete design of the unit is to be undertaken after the preliminary design of the major equipment has been completed. The operation is as follows:

Waste lac is first charged into an extractor in which alcohol of strength 45 O.P. is added as solvent. There are steam coils in the extractor and a water-cooled shell and tube condenser is provided to condense and reflux back into the extractor. The refluxing continues for 2 hours to complete the solution of lac in the solvent. The proportion of lac containing material to alcohol added is about 1 : 4. The extractor takes 20 kg. of waste lac per charge and there are two such extractors with a common condenser to make the process continuous. While in one reflux extraction is going on, in the other it is being discharged and contents taken out for subsequent processing like straining, evaporation, cooking and stretching. The capacity of the unit thus is 10 kg./hour. This is a pilot-cum-demonstration unit and can be conveniently erected indoors or in a small shed. The main features of the equipment are: Extractor vessel — 2′ dia. × 2′ high with welded on dished bottom and bolted on dished top. The steam inlet and condensate outlet, vapour outlet and alcohol inset connections are provided on the straight side of the vessel. The dished top has got a sight glass and has a connection for charging the lac, which can be plugged off. There are 5 turns of helical coil of dia. 1′-6″ and coil pitch — 2″. The reflux condenser is horizontal shell (I.D. = $4\frac{3}{16}$″) and tube type with cooling water in the tubes. There are 24 nos. $\frac{1}{2}$″ O.D. × 16 G × 2′ long tubes with 2 tube passes. There are two 25 per cent cut segmental baffles. The evaporator is identical in dimension to the extractors but is provided with 6 pan cake type steam coils at $1\frac{1}{2}$″ pitch with common steam inlet and condensate outlet heaters because a much higher heat transfer area is required in the evaporator. 2″ thick asbestos magnesia insulation is used on the evaporator body to reduce steam consumption.

III — FUNDAMENTAL RESEARCH

1. Constitutional Studies

(a) *Separation and study of the neutral fraction*

Work on the neutral fraction was continued. The neutral substance was prepared from fraction V, viz. the fraction of *palas* seedlac retained in acetone at —11°C. [*vide ILRI, Annual Report* (1960-61), 19] according to the procedure as described below:

The ether soluble portion of fraction V was extracted repeatedly with sodium carbonate solution (10%) and then with 0·5 N sodium hydroxide to make it free from acid. The solution was finally washed with water till free from alkali and then dried over anhydrous sodium sulphate. After removal of the ether a light yellow, sweet smelling, soft and sticky mass was left over. Wax was removed from this substance by keeping its alcoholic solution in ice. After removal of wax the soft mass was decolourized by animal charcoal. The white product softened at 43°C. and melted at 49°C. and the sap. and hydroxyl values were 162 and 158 respectively. The elementary analyses were, C = 68·61%; H = 9·10%.

Paper chromatography of the neutral substance with liquid paraffin as stationery phase and *n*-butyl alcohol: chloroform (5 : 5) as mobile phase showed that it is a mixture of at least two compounds. The acids obtained after saponification also gave three spots with acetone-

acetic acid-water (5 : 3 : 2) as mobile phase and liquid paraffin as stationary phase. Further work is in progress.

(b) *Isolation and identification of free fatty acids present in shellac*

Weinberger and Gardner [*Ind. Eng. Chem.*, **30** (1938), 454] reported for the first time the presence of free aleuritic acid (1·7%) in shellac. Later on the presence of jalaric acid (1%) and butolic acid (1·5%) in the free state has been reported [*vide ILRI, Annual Report* (1955-56), 45; (1959-60), 23]. It is not unlikely that some other acids also might be present in shellac to a smaller extent in the free state.

To ascertain and identify the free acids present in shellac a systematic investigation has been started. Dewaxed shellac was chromatographed over cellulose powder with several lots of *n*-hexane and seven fractions were collected giving a total yield of 5·6 per cent. The second fraction (2% was the highest and was rechromatographed over silicic acid with increasing proportion of ether in hexane. The column was ultimately stripped off with methyl alcohol. Thus eleven fractions were collected and attempts are being made for further purification and identification of the fractions by Thin Layer Chromatography and other methods.

IV—MODIFICATIONS AND USES

1. Modification of Lac with Di-isocyanate

It has already been reported [*vide ILRI, Annual Report* (1962-63), 26] that dewaxed lemon shellac when reacted with varying amounts (1-6%) of toluene di-isocyanate (Suprasec C), undergoes modification producing films of improved properties. Some of the chemical constants, physical and film properties were also reported. All the polished wooden panels kept for natural weathering lost their gloss completely after six months exposure. Further these treated varnish films showed fine cracks indicating brittleness, even though they showed better adhesion, hardness and weather resistance as compared with the untreated shellac varnish films.

To improve upon the brittleness characterized by cracking of films, 5, 10 and 15 per cent of dibutyl phthalate, on the weight of 4 per cent di-isocyanate treated lac, were used, and varnishes made as usual. The adhesion and hardness of these varnish films were found to be quite satisfactory and comparable to the non-plasticized isocyanate treated lac. Weather resistance of these were studied as usual by polishing a set of wooden panels and exposing on a stand on the roof of the laboratory. The plasticized films showed no cracks though there was a slight decrease in gloss. By using 15 per cent dibutyl phthalate more satisfactory results were, however, obtained. The film also gave better gloss than that without the plasticizer. Further work is in progress.

2. Shellac (Single pack) Etch Primer

Shellac-based etch primer had been tested exhaustively both in the laboratory as well as in field trials on aluminium surface and the results were reported in the previous *Annual Report*. The study was further continued as follows:

(a) *Modification of the primer*

Modification of the primer with different proportions of phenolic resins had been tried before and reported. Further to improve its adhesion and weather resistance and also to make it suitable for steel surfaces, experiments were continued with polyvinyl butyral resin as a modifier. Though all these modifications brought certain improvements in respect of their film properties, their shelf life was hardly satisfactory. All the modified etch primers slowly thickened in course of three months and finally gelled on storage.

(b) *Natural and dynamic weathering*

The panels prepared in November 1960, using shellac etch primer with and without urea and dibutyl phthalate were exposed to natural weathering since then on the roof of the laboratory and to dynamic weathering in the Institute's jeep car. The panels have been exposed for more than 3 years so far. The adhesion between the primer and metal, and also between the primer and the immediate top coat is still found to be quite satisfactory. The test is being continued.

3. Modification of Shellac with Synthetic Resins

(a) *Heat- and water-proof shellac varnish*

It was reported previously [*vide ILRI, Annual Report* (1962-63), 33] that the incorporation of butylated melamine resin to shellac varnish produces air-dried films with excellent resistance to heat, water and liquor and serves very satisfactorily as a finish for wooden furniture. It has been found that the composition has to be allowed to stand at room temperature for at least three days to obtain films of improved performance. A chemical reaction is obviously taking place between the two resins, the nature of which is being investigated.

Further experiments were also carried out to determine its weathering properties. A varnished wooden panel was exposed to sun and rains up to 2 months. It was found that the varnish film did not show any deterioration in gloss, adhesion and smoothness. No whitening, peeling or scrubbing of the film could be noticed during the period.

This composition also served very satisfactorily for giving a protective coating to metals like brass and copper, etc. Coated panels did not show any sign of tarnishing up to one year.

Storage stability experiments showed that this varnish composition can safely be stored in glass and polythene containers up to one year. Further experiments on storage stability are in progress. During this period no thickening or gelling of the varnish could be seen, nor any deterioration in the film properties took place. Data are summarized in Table V (App. B).

(b) *Modified shellac varnish for use as tin plate lacquer*

It was reported earlier [*vide ILRI, Annual Report* (1962-63), 33] that the incorporation of 20 per cent spirit soluble urea resin to shellac varnish results in baked films of outstanding adhesion and flexibility.

With a view to further evaluate its use as tin-plate lacquer, baked films were studied for their resistance to alcohol, aromatic solvents, soap solution, etc. These films resisted the action of alcohol and aromatic solvents up to six months without being affected in any way. In 2 per cent soap solution lifting of the film took place after 6 days.

Baked films on tin and mild steel panels when exposed in a humidity cabinet for 20 days showed no sign of rusting, peeling, or whitening of the film.

Storage stability experiments showed that this composition (25% solids) could be safely stored in glass and polythene containers up to one and a half year without thickening of the varnish or any deterioration in the film properties. Data are summarized in Table VI (App. B).

Pigmented coating compositions were found to possess good adhesion and flexibility on a variety of surfaces.

A sufficiently viscous solution for roller coating process could be prepared without gelling or precipitation.

(c) *Modification of lac with epoxy resins*

Epoxy resins even when baked have very little value. The properties of adhesion, flexibility, toughness and chemical resistance are obtained by chemical reaction with a polyfunctional substance known as a curing agent.

Shellac is also a polyfunctional material containing several hydroxyl and carboxyl groups and as such it may combine with epoxy resins. The resulting material could then be made to thermoset under the influence of heat due to cross-linking.

In the present investigation modification of lac with epoxies has been tried with a view to applying by brush, spray or roller coating process.

Varnishes prepared from lac and epoxy resin in dioxane, dimethyl formamide, etc., gave hard, smooth, flexible and glossy films on air-drying or on baking. Air-dried films showed poor resistance to dilute acids, aromatic solvents, acetone, alcohol, soap solution and boiling water, etc., but baked films showed excellent resistance to these solvents and chemicals.

In addition to possessing all the desirable properties of lac such as good gloss and adhesion, the lac-epoxy combination shows improved properties in regard to flexibility, resistance to alkali, boiling water and acetone. Further it is found that it is comparable to epoxy resins in all respects except impaired alkali resistance. In resistance to acetone and boiling water this composition shows some slight improvement over the epoxies. These films were found to possess very good corrosion resistance. Film properties are given in Table VII (App. B).

This varnish because of its excellent adhesion and flexibility and good resistance to solvents and chemicals, can be used as a metal plating lacquer. Further experiments are in progress.

4. Aqueous Lac-drying Oil Varnishes

(a) *Aqueous lac-tung oil varnishes*

In the previous *Annual Report* (1962-63, 33) it was mentioned that aqueous lac-tung oil varnish produces films which on baking show excellent resistance to heat, water and dilute acids and possess good adhesion and flexibility.

Baked films were further studied for their resistance to alcohol and aromatic hydrocarbons. These films did not show any deterioration in the film properties when immersed in these solvents up to 3 months. In 2 per cent soap solution lifting of the film took place on the fourth day.

Accelerated weathering test performed in a humidity cabinet showed very satisfactory results. Tin and mild steel panels coated with the varnish did not show any sign of rusting, blistering, peeling or whitening up to twenty days.

Experiments were also carried out to determine the optimum conditions for maleinization of tung oil and it was observed that a minimum of 30 gm. of maleic anhydride when reacted with 100 gm. of tung oil at 200°C. for 2 hours, gives a product which dissolves in ammonia and can be diluted with water.

It was further observed as a result of a series of experiments that among different acids and anhydrides, maleic acid gave the best results.

(b) *Aqueous lac-linseed oil varnishes*

It had been observed earlier that aqueous lac-tung oil varnish produces baked films with outstanding adhesion and flexibility and excellent resistance to chemicals and solvents.

As tung oil is more expensive and not available in our country so easily, efforts were made to find a substitute for this oil. Linseed oil was found to give almost a similar performance.

Aqueous lac-linseed oil varnishes prepared from maleinized linseed oil and dewaxed shellac produced hard, smooth and glossy films on baking. These films showed excellent resistance to water, dilute acids, aromatic solvents, alcohol, etc. They did not show any sign of blushing, peeling or softening when immersed in the respective solvents up to 15 days. These film properties are summarized in Table VIII (App. B).

These varnishes can be diluted with water to any desired extent and can be applied by dipping, flowing, brushing or roller coating process.

Coated tin and mild steel panels did not show any sign of rusting, blushing and peeling of the film, etc., on exposure in a humidity cabinet for 20 days.

In view of its excellent adhesion and flexibility and outstanding resistance to heat, water, dilute acids and alkalies, organic solvents, oil, etc., this varnish can very satisfactorily be used as a metal plating lacquer. Because of its additional property of good corrosion resistance its suitability in inhibitive primers is being investigated.

Air-drying properties of these compositions are also under study.

5. Lac-drying Oil Insulating Varnishes

(a) Mention was made in the previous *Annual Report* (1962-63, 34) about the method and optimum proportions of shellac, linseed oil, glycerine and phthalic anhydride to manufacture a baking type of clear, oil insulating varnish for the impregnation of electrical components and also of yellow varnished insulating cloth, tape, etc. The characteristics of a typical composition were also described in detail. Test report according to the I.S. Specification No. 350-1952 on the varnish sample made as above, was received from Government Test House, Alipore. The varnish conformed to the requirements of the said specification except for higher viscosity and volatiles. Accordingly, experiments were undertaken to reduce viscosity and also modify the composition further to meet the specification in all respects. In the new composition the amount of phthalic anhydride was reduced to half, the proportion of other ingredients remaining the same. Cooking schedule was also adjusted to ensure desired viscosity. The two steps of preparation of monoglycerides and incorporation of shellac and phthalic anhydride in it were combined, so that the whole process was accomplished in the same reaction vessel in approximately 3 hours. The varnishes produced are under examination.

(b) Effect of using other isomers of phthalic acid, i.e. terephthalic and *iso*-phthalic acids in the above-mentioned formulation was also studied, as they have the advantage of being non-volatile. It was found that with *iso*-phthalic acid, harder films could be obtained and also having lower acidity as compared to phthalic anhydride.

(c) *Acidolysis* — Preliminary experiments were carried out to see if lac can be made to combine with ' acid oil ' made from the reaction of linseed oil with *iso*-phthalic acid in an inert atmosphere, as ' acidolysis ' method of making alkyds has come into prominence of late, besides the more well-known ' alcoholysis ' technique. It was found that lac was soluble in the ' acid oil ' so made.

6. Shellac-rosin Combination and Its Use in Oil Varnishes

For the preparation of insulating varnishes, etc., generally two parts of rosin and one part of shellac are used to make the composition compatible with drying oils. Attempts were made to reduce the quantity of rosin and make it compatible with drying oils and also soluble in hydrocarbon solvents to make the air-drying composition cheap.

Preliminary experiments were made by heating rosin and shellac at 150°C. in the ratios of 1:1, 1:1·5; 1:2, 1:3, 1:4 and samples were drawn at suitable intervals depending on polymerization times which were previously determined. Further work in this line is in progress.

7. Lac-cashewnut Shell Liquid Combinations

(a) *Hot melt composition for coating hessian*

When lac is added to cashewnut shell liquid, previously heated to 120°C. for one hour and the heating continued for 2-3 hours at this temperature, a resinous product is obtained, which in molten condition can be applied on hessian. From the experiments carried out at the laboratory of Shellac Export Promotion Council, it was found that the shellac/CNSL coated gunny bag was fairly resistant to moderate concentration of acids, alkalies and salts and might be suitable for the packing of commodities containing some free acid or alkali. The coated gunny bags, however, on trial, were found to have the drawback of tackiness. Some experiments were conducted to study the reaction of lac and CNSL at temperatures varying from 150-200°C., using fully treated CNSL and polymerized CNSL. It was possible to get hard films thereby, but mechanical strength of hessian suffered, as the coating did not have sufficient elasticity. To make the coating both hard and elastic, many experiments to incorporate linseed-stand oil in the composition were made, but the coating obtained did not dry thoroughly.

Another composition based on emulsion method [*vide ILRI, Annual Report* (1945-46), 4] was also tried, but as this composition was thermoplastic, it did not pass 'bleed test' at 80°C.

(b) *Insulating varnishes from shellac-CNSL combination*

Shellac and CNSL are two versatile indigenous raw materials suitable for many types of surface coatings, particularly in formulation of clear baking type of oil-based insulating varnishes. Most of the earlier work in this direction at the Institute used alcohols and fusel oil, etc., as solvents. On the basis of some experiments a formulation based on linseed oil, CNSL and shellac was also suggested [*ILRI, Annual Report* (1948-49), 15], though its performance was not mentioned. This composition was, therefore, re-examined. To start with, this method was followed in making varnishes and suitability of raw CNSL, pre-treated CNSL and fully treated CNSL was studied. Only the last mentioned oil was fully compatible with linseed oil and shellac to give clear varnish. Effect of replacing raw linseed oil by boiled oil and stand oils as well as partial replacement by dehydrated castor oil was also studied as also use of polymerized CNSL, polymerized *in situ* or with catalysts, in place of treated CNSL. The effect of these changes was not satisfactory, and improved varnishes could not be obtained thereby.

To enhance inertness and water-resistance of the varnish film, trials were made with formaldehyde CNSL condensates and also with shellac 'formals' but a useful way of combining these ingredients has not yet been found. Reacting the finished product with formaldehyde seems to be a better way. Further, experiments to get a suitable composition conforming to IS-350 (1952) are continuing.

8. Modification of Lac by Grafting

When oxygen is passed through an aqueous ammoniated shellac solution, it gets peroxidized most likely at the tertiary carbon atom, placed in α-position to the double bond of jalaric acid (which is a constituent acid of the lac molecule). The hydroperoxide thus formed can then break up into two free radicals. The two reactions can be pictured to take place as follows:

$$\text{Shellac} + O_2 \rightarrow \text{Shellac} - \text{OOH} \quad \ldots(1)$$

$$\text{Shellac} - \text{OOH} - \text{Shellac} - O\cdot + OH^- \quad \ldots(2)$$

The reaction is usually carried out in presence of a reducing agent like sodium formaldehyde sulphoxylate, which decomposes the shellac hydroperoxide at 20°C. If a suitable vinyl monomer such as methyl-methacrylate, ethyl acrylate or methyl acrylate is present in the

system, a chain of the vinyl monomer will be built up as a graft on shellac by a free-radical process.

The hydroxyl radical formed as in (2) may also lead to the homopolymerization of the vinyl monomer yielding mixtures of grafted shellac and homopolymers. This is prevented by using a redox system consisting of shellac hydroperoxide and ferrous ammonium sulphate, using a complexing reagent, thus:

$$\text{Shellac} - \text{OOH} + \text{Fe}^{+2} \longrightarrow \text{Shellac} - \text{O}\cdot + \text{OH}^{(-)} + \text{Fe}^{+3} \qquad \ldots(3)$$

Using the above technique, a graft polymer of shellac and methyl methacrylate has been prepared and its properties are under study. More work with shellac and other monomers is under way.

9. Hydrolysed Lac

It has been reported [*vide ILRI, Annual Report* (1962-63), 30] that when shellac is hydrolysed by 1·0 N aqueous caustic alkali, the maximum saponification of lac was obtained by using 40 per cent excess alkali. Further attempts were made to verify this observation with 2·0 N caustic soda solution. The saponification of lac was carried out with different excess volumes of alkali solution at 97°C. for 5 hours. The maximum saponification value was obtained by using 30-40 per cent excess of alkali which is in good agreement with the previously observed value.

10. Technical Preparation of Aleuritic Acid

The work on the technical preparation of aleuritic acid was continued. A modified method for such a preparation is described in Appendix C.

11. *Ad hoc* Work

(a) *Composition for filling crevices of plywood*

An enquiry was received to formulate a composition based on lac which could be used for filling the crevices of plywood. The composition should dry quickly and be very hard. Many compositions were tried using talc powder, sawdust, and barytes in 25 per cent shellac solution. Of these the composition with barytes proved to meet the requirement and a sample has been sent out for trial.

(b) *Wax engravers*

A request was received from the Defence Research Laboratory, Kanpur to formulate a composition based on lac for use as wax engravers. The requirements were that the composition should have specific gravity of 1·53 at 18°C., softening point of 77°C. (approx.) and penetration number of 1·4 units at 25°C.

Different proportions of saponified lac were mixed with shellac and melted at 110°±5°C. and tested for the penetration number. A composition of 65 per cent shellac and 35 per cent saponified lac, melted together for about 30 minutes at 110°±5°C., have a product which met the specification. This composition mixed with a red dye (Rhodamine B) and made into stick form has been sent for user's trial.

V — UTILIZATION OF LAC IN INDIA — PUBLICITY AND PROPAGANDA

1. Varnish and Paints

Samples of special varnishes, e.g. book varnish, picture varnish, hair lacquer, etc., were sent for trial to several parties intending to manufacture them.

Some new compositions of heat- and water-proof varnish were developed and samples were sent to several renowned furniture makers for trial. As a result, a few parties became interested. They enquired regarding details of the preparation of the varnish with the intention to manufacture it.

Due to shortage of spirit throughout the country many enquiries have been received for formulation of aqueous-based varnishes. Experiments to formulate such compositions are being carried out at the Institute.

2. Shellac Lacquer for Brass Metal-ware

From the All-India Handicrafts Board an enquiry was received to formulate a lacquer composition based on lac to protect tarnishing of brass-wares. Two satisfactory compositions based on lac and urea-formaldehyde resin were tried. After initial air-drying followed by baking they developed very hard and glossy films. Brass panels coated with lac varnish as mentioned above were sent to the Handicraft Board for their examination.

3. Shellac Etch Primer

The paint on primer coating on the aluminium body of the motor van belonging to Prof. Ross of U.S.A. stood very satisfactorily the entire journey of 50,000 km. to U.S.A. through several eastern countries. Satisfactory reports on the performance of the primer on aluminium bodies of Railway Coaches have been received from Western and S.E.Rly. State Transport Corporations also have sent satisfactory reports after proper trials on bus bodies made of aluminium.

After receiving satisfactory reports of field trials, the Ministry of Agriculture was approached to issue a circular letter to all other Ministries and Departments concerned requesting them to use Shellac Etch Primers, wherever suitable. The Ministry has kindly authorized the Secretary, ILCC to issue letter on this subject.

4. Adhesive and Cements

Samples of Shellac Gasket Compound were received in the Regional Laboratory, Namkum for tests according to the specification No. DTD-777. At the request from the Indian Standard Institution a tentative draft specification for shellac jointing compound has been prepared and sent to them for comments.

5. Water-soluble Lac

Enquiries were received mostly from South India regarding the method of preparation and use of water-soluble lac for coating earthenware. A new field of consumption of water-soluble lac as an ingredient for photo-engraving has been developed by Sri B. Mazumdar of the School of Printing Technology, Calcutta in collaboration with ILRI. Demand of this material in this field is gradually increasing.

6. Bleached Lac

Demand for bleached lac particularly for the dewaxed variety was noticed to increase gradually. Several parties were interested to know the process of manufacture of the material and sent their representatives to this Institute for training. Over a dozen parties have already started manufacturing bleached lac in a small way and one prominent manufacturer of shellac in Calcutta has started manufacturing bleached lac for export. The setting up of a State owned Bleached Lac Factory is also under active consideration of the Bihar Government.

7. Shellac Impregnated Tissue Paper

Investigations, in collaboration with Central Tobacco Committee, were started to develop a paper-coating composition which may stand sharp bending or folding without forming any cracks or crinkles, for use as a wrapper for chewing tobacco. So far the results obtained have not been satisfactory and more experiments are being carried out to achieve this object.

8. Technical Service to Manufacturers and Consumers

At the instance of M.P. Government efforts have been made to revive the activity of the State owned Government Shellac Factory, Umaria, M.P. which remained idle for some time past. The State Trading Corporation agreed to lift the entire produce of the factory from Umaria. Technical assistance was offered from ILRI to restart the factory but uptil now no action has been taken by M.P. Government.

The Government Shellac Factory, Chaparmukh, Assam was also closed down as it was found uneconomical to run. A committee was formed by the Assam Government to consider the question of the reopening of the factory. A meeting was held in August 1963 at Shillong where the reasons for the loss were discussed. The next meeting would be held sometimes in 1964 to decide the issue finally.

To increase the activity of Lac Utilization Centre, Pendra, M.P. the Supervisor of the Centre has prepared a scheme after discussion with ILRI.

Interested parties have been supplied with literature on: (i) improved method of manufacturing seedlac, (ii) substituting coke for charcoal for making of shellac, and (iii) methods of preparing various varnishes.

9. Sticklac Processing Unit

It was suggested by Dr. Ram Subhag Singh, Union Minister of Agriculture that a Sticklac Processing Unit be installed at ILRI. Accordingly equipment and machinery to process 5,000 quintals of sticklac annually has been installed. Preliminary trials have been carried out. It has since been decided by the Governing Body of ILCC that this unit may process lac supplied through the Bihar State Co-operative Lac Federation.

10. Regional Testing Laboratories

Five Laboratories, one each at Gondia (Maharashtra), Bilaspur (M.P.), Balarampur (W.B.), Daltonganj (Bihar) and Namkum (Bihar), continued their normal activity and a large number of samples of seedlac and shellac were analysed. Several other products of lac received occasionally from the manufacturers and the seedlac purchasing centres of the State Trading Corporation were also tested.

VI—PILOT PRODUCTION UNIT

The Pilot Production Unit continued to function throughout the year and five grades of special shellacs, viz. two grades of bleached lac — refined and regular, two grades of water-soluble lac — (DL and AL), and one grade (ASK) of autoclave shellac were manufactured and sold to the public. Besides these, picture varnish, french polish, hydrolysed lac etc., were also manufactured and sold.

Sales

During the period under review, the unit has sold 2,923·39 kg. of special shellacs for Rs. 17,650.80. Other miscellaneous lac-based products like varnishes, hydrolysed lacs,

etc., valued at Rs. 413.30 were also sold. This totals to Rs. 18,064.10. The gross profit made during this year amounted to Rs. 7411.29 only.

The sale figures of bleached lacs maintained steady progress, the total quantity sold during 1963-64 being 1,809·69 kg. as against about 900 kg. during 1962-63 and about 400 kg. during 1961-62. Thus the sale figures for bleached lac by this unit are double those of the previous year in spite of the fact that several firms have started production, meeting the demands, at least partially, of their respective zones. There was, however, a sudden drop of sale figures of ASK grade (autoclave) shellac during 1963-64. The statement of sale figures of the unit for the last three years has been brought out in Table IX (App. B).

Advertisement and publicity

The usual publicity of the products made by the Production Unit of ILRI by periodical insertions of advertisements in dailies and periodicals through the Directorate of Advertisement and Visual Publicity was discontinued during the year under review. Letters in the form of circulars and other informations were, however, sent to intending purchasers. Free samples together with price list, methods of use of different products of lac and business terms were also sent to about 60 parties on request. Free samples exceeding the normal quantity were also sent to a few firms of repute to meet their specific requirements for large-scale experiments.

VII—SPONSORED RESEARCH SCHEMES

1. Constitution of Lac

(a) *Delhi University*

Lac resin was fractionated by the fractional precipitation method. A concentrated alcoholic solution of the resin was poured into a large volume of ether when an amorphous poweder (hard resin I) separated out. This was filtered and the solvent was removed from the solution and the residual gum on repeated maceration with ether gave another powdery mass (hard resin II). After filtration and removal of ether from the filtrate a gummy mass (soft resin) was obtained.

The hard resin fraction was treated with hydrogen chloride gas in acetic acid solution with the formation of chloro resin. Alkaline hydrolysis of this chloro resin gave a gummy mass from which the sparingly soluble *erythro*-aleuritic acid could be separated out by treatment with ether. The ether solution yielded the terpene acids along with other minor components. *Erythro*-aleuritic acid is obtained straightway by the modified method as against the *threo*-aleuritic acid by the direct alkaline hydrolysis of the resin. The yields of crude *erythro*-aleuritic acid from different samples of lac are given below. In all cases, the product was fairly pure and yielded readily on recrystallization more than 75 per cent as the pure acid.

Sample	*Percentage yield of crude erythro-aleuritic acid.*
Hard resin I (from *palas* seedlac) ...	30-35
Hard resin II (from *palas* seedlac) ...	25
Platina shellac	30-35
Lemon shellac	40
Super blond shellac	40

(b) *National chemical laboratory*

After standardizing the procedure for the separation of uniform harder fraction of the resin from *palas* seedlac, further work on the analysis of the hard resin was continued.

The water-soluble acids formed after the hydrolysis of the hard resin using 20 per cent alkali for five hours were separated and the remaining portion was continued to react with 20 per cent alkali for a further period of five hours. Water-soluble acids were removed this time also. The water-soluble portion was mainly composed of jalaric acid. The period for third stage hydrolysis was twenty-four hours and within this period the hydrolysis was expected to be complete as had been observed from the curve of the rate of hydrolysis. After the hydrolysis was over aleuritic acid was separated as its sodium salt.

A portion of the remaining acids was extracted with pet. ether for the isolation of butolic acid. Another portion was methylated and chromatographed over alumina to yield various fractions, the composition of which was determined by observing the intensities of spots of the esters resolved by thin layer chromatography technique.

For the detection and fairly accurate estimation of the resin acids in various fractions, paper chromatography was very useful and a solvent system containing buffer, butanol and ethanol could be standardized after many trials. For most of the acids the above results were confirmed by thin layer chromatography of the esters on silicic acid plates. A satisfactory resolution of the esters was obtained using a solvent system containing toluene, ethyl acetate and acetone.

The estimation of the resin acids by VPC technique using specially prepared columns is being continued.

For the hard resin from *palas* seedlac, the following composition was arrived at by the above-mentioned procedure. Search for the isolation and identification of minor components is in progress.

Composition of the products of hydrolysis
(100 gm. of hard resin)

1. Aleuritic acid	41·50
2. Jalaric acid containing smaller quantities of shellolic and epishellolic acids as impurities	22·00
3. Butolic acid (together with other long chain aliphatic acid)	4·80
4. Shellolic, epishellolic and trihydroxy acids (Artefacts)	18·60
5. (a) Neutral fraction (b) Lactonic material }	0·60
(c) Unidentified products	11·40

Butolic acid

From the products of perbenzoic acid oxidation of butolic acid followed by hydrolysis *n*-octanol and adipic acid have been isolated. The identity of these two compounds was confirmed by comparing their VPC and IR curves with those for the corresponding authentic samples. The structure for butolic acid as 6-hydroxymyristic acid has thus been confirmed.

Constituents of lac resin

Hard resin from *palas* seedlac was fractionated using column chromatography to yield fractions having lesser number of component molecules. The results seem to be encouraging as some of the fractions show only two to three spots on thin layer chromatographic analysis.

A further purification is possible which would help in arriving at some conclusions regarding the structure of lac molecule.

2. Lac Dye Scheme at National Chemical Laboratory, Poona.

Laccaic and xantholaccaic acids have been methylated and separated by chromatography into different components such as MLA-I, II, III, IV and V and MXLA-I, II and III respectively. MLA-III and MXLA-III only contained nitrogen 2·5 and 2·4 per cent respectively. The mass spectra of MLA-I and II, IR and NMR Spectra of all but MLA-IV and MXLA-II, the acid from MXLA-I and a few methoxy anthraquinones were studied.

The IR Spectra of MLA-I, II and III were found to be almost superimposable over each other suggesting very minor structural variations. The NMR spectra suggested that (a) the structure proposed by Mayer and Cook [*Chemistry of Natural Colouring Matters*, ACS Monograph Series (1943), 144] for laccaic acid is not correct, (b) a group of the type $-CH_2CH_2O-$ is present in the molecule, and (c) some aromatic system is attached to the anthraquinone nucleii as indicated by the high content of aromatic protons in the compounds.

It has been suggested that the substituent containing the probable $-CH\,2\,CH_2O-$ group lies on the purpurin part of the molecule and that the dye as isolated is probably a mixture of very closely related compounds.

3. Shellac-based Leather Finishes at Central Leather Research Institute, Madras

Shellac has been used as one of the auxiliary materials in the finishing of leather and leather goods. But its consumption was considerably reduced and has now dropped down to negligible proportions with the introduction of synthetic resins. The object of the Scheme is to revive the market abroad and also find ways to increase the consumption at home.

The following is a brief outline of the programme:

Using shellac (i) in finishing composition to produce good leather finishes, (ii) as such or in modified form in impregnation or retanning, etc., (iii) as a modifier for the synthetic resins in finishing, (iv) as an ingredient for alkyd finishes for leather, and (v) in miscellaneous uses, e.g. reducing agent for chrome liquor, for the development of a filling fat liquor or as phenol modified syntan, etc.

Results so far obtained are as follows:

(a) *Development of a top gloss composition from shellac*

Shellac (wax-free) was modified with various polyhydric alcohols like polyethylene glycol, glycine, sorbitol, etc., producing tacky, soft and non-drying type of resins which did not give satisfactory results either as a top-gloss composition or for finished leathers. The behaviour of these resins as a top spray was also studied. A tack-free and satisfactory composition was, however, formulated by compounding 2 parts of the modified resin with 3 parts of shellac.

(b) *Shellac as principal binder for leather finishing*

A few common leather finishing plasticizers were tried and the finish performance evaluated. Although the adhesion of the pigmented lac film on leather was commendable, the flexural endurance was poor. Studies are in progress with sulphated fish oil as plasticizer.

(c) *Shellac-synthetic resin combination finishes*

Experiments have shown that acrylic resins used in leather finishing can be replaced by an aqueous dispersion of shellac. A method has been evolved in finishing chrome retan uppers.

(d) *Impregnation studies*

A new type of retanning material has been developed from shellac for impregnating chrome tanned leathers and its advantages and disadvantages observed.

(e) *Sulphation/Sulphonation of shellac*

Preliminary studies have been made for sulphation/sulphonation of shellac in analogy of fatty acids and oils to prepare fat liquors.

(f) *Oxidation of shellac and reduction of dichromate to produce chrome liquors for tanning*

Refuse lac, sticklac and seedlac available at cheaper rates are being investigated as possible reducing agents for dichromate to make chrome tanning liquors. Experiments have been conducted in this regard and fixation studies with hide-powder and a few tanning trials have also been done.

(g) *Oxidation of shellac by chromium trioxide*

By this oxidation, the amount of shellac oxidized to water-soluble acids is 35·0 to 43·0 per cent and that oxidized to carbon dioxide is 10-17 per cent. By paper chromatography the acids identified so far are tartaric acid, oxalic acid and phthalic acid. Work on the oxidative degradation of lac resin is being continued.

METEOROLOGICAL REPORT FOR THE YEAR 1963-64

The average meteorological data for each month during the year 1963-64 *are given*:

Month & Year	Mean Baro-metric pressure (mm.)	Mean wind speed (km./hr.)	Mean max. temp. (°C.)	Mean min. temp. (°C.)	Mean dry bulb temp. (°C.)	Mean humi-dity (%)	Mean sun-shine (hr./day)	Total rain-fall (mm.)	Highest max. temp. (°C.)	Lowest min. temp. (°C.)
April 1963	704·09	2·931	34·98	19·63	30·32	33·0	7·33	34·54	38·00	16·50
May 1963	701·04	2·768	36·19	21·70	31·35	43·0	8·89	69·85	41·25	17·50
June 1963	698·83	2·774	33·15	23·37	29·65	65·0	6·06	163·07	36·50	21·10
July 1963	697·79	2·517	30·74	22·96	27·37	79·0	3·48	323·09	35·50	21·10
August 1963	698·70	1·330	30·56	23·06	27·51	79·0	4·27	363·22	32·50	21·10
September 1963	701·19	1·854	29·76	21·89	26·95	74·0	5·43	282·96	32·00	19·40
October 1963	705·64	0·800	28·39	19·32	25·58	69·0	6·52	310·13	32·50	16·67
November 1963	708·76	0·773	27·38	14·61	23·94	57·0	8·63	15·24	30·50	11·11
December 1963	711·66	0·592	24·06	9·23	18·72	53·0	8·47	Traces	28·25	5·56
January 1964	709·45	0·968	24·91	9·64	19·10	54·0	8·57	Traces	29·00	5·00
February 1964	707·82	0·730	27·70	12·13	21·66	42·0	8·10	26·42	33·00	6·11
March 1964	706·27	1·738	33·44	16·40	28·40	27·5	8·78	17·53	36·00	13·33

The highest maximum temperature recorded was 41·25°C. (106·25°F.) on the 26th May 1963, and the lowest 5·0°C. (41·0°F.) on the 30th January 1964. The total rainfall during the year amounted to 1606·042 mm. (63·23 inches) of which the monsoon rainfall (June-September) was 1132·332 mm. (44·58 inches). The rainfall during the year was more than that of 1962-63; the total rainfall being 1170·178 mm. (46·07 inches) of which the monsoon rainfall for the year was 1010·158 mm. (39·77 inches). The highest wind speed recorded was 199·04 km. (124·4 miles) on 20th June 1963 whereas the lowest recorded wind speed was 1·12 km. (0·70 miles) on 4th January 1964. A mild tremor was felt on 9th April 1963 at about 5·35 a.m. There was a mild hailstorm accompanied with rain on 20th March 1964 at 3-00 p.m. which lasted for about fifteen minutes.

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APPENDIX A

(Tables: Entomology Division)

TABLE I — DETERMINATION OF OPTIMUM REQUIREMENT OF BROOD FOR *BER* IN *KATKI* CROP

Crop data (*Katki* 1963)

Treatment	No. of trees	Brood used		Yield obtained						Ratio of brood used to yield		Remarks
				Total		Brood		Rejected				
		Sticks kg.	Scraped kg.	Sticks kg.	Scraped kg.	Sticks kg.	Scraped kg.	Sticks kg.	Scraped kg.	Sticks	Scraped	
A (½ Normal)	12	4·200	1·030	26·100	3·680	6·100	2·080	20·000	1·600	1 : 6·21	1 : 3·57	Brood to brood ratio 1 : 1·45
B (Normal)	12	8·400	2·120	36·300	8·000	21·150	5·340	14·150	2·660	1 : 4·30	1 : 3·77	1 : 2·51
C (2-Normal)	12	16·800	3·290	18·850	6·460	6·450	4·790	12·400	1·670	1 : 1·12	1 : 1·96	1 : 0·38

TABLE II — DETERMINATION OF PROPER TIME OF HARVESTING FOR *BER* IN *BAISAKHI* CROP

Crop data (*Baisakhi* 1962-63)

Treatment	No. of trees	Brood used		Yield obtained (lac sticks)			Yield obtained (sticklac)					Remarks
		Sticks kg.	Scraped kg.	Total kg.	Brood kg.	Rejected kg.	Total kg.	Brood kg.	Rejected kg.	Ratio of brood used to yield		
										Sticks to sticks	Scraped to scraped	
A (½N) April cutting	4	1·55	0·28	14·200	—	—	3·270	—	—	1 : 9·16	1 : 11·67	Ari
B (N) ,, ,,	4	3·10	0·69	15·300	—	—	4·170	—	—	1 : 5·00	1 : 6·04	,,
C (2N) ,, ,,	4	6·20	1·23	15·250	—	—	3·800	—	—	1 : 2·46	1 : 3·08	,,
D (½N) May ,,	4	1·55	0·29	17·000	—	—	4·450	—	—	1 : 10·96	1 : 15·34	,,
E (N) ,, ,,	4	3·10	0·66	23·500	—	—	8·600	—	—	1 : 7·58	1 : 13·03	,,
F (2N) ,, ,,	4	6·20	1·30	21·700	—	—	6·080	—	—	1 : 3·50	1 : 4·67	—
G (½N) Mature ,,	4	1·55	0·31	14·600	2·100	12·500	2·583	—	—	1 : 9·42	1 : 8·33	—
H (N) ,, ,,	4	3·10	0·65	20·300	7·300	13·000	6·372	—	—	1 : 6·54	1 : 9·80	—
I (2N) ,, ,,	4	6·20	1·09	24·790	5·090	19·700	5·905	—	—	1 : 3·99	1 : 5·42	—

TABLE III — STUDIES ON THE RESPONSE OF *BER* TO PRUNING FOR GROWING *KATKI* CROP

Data on shoot measurement

Treatment	Average No. of buds appeared	Average No. of buds developed into shoots	Average total length of primaries cm.	Average length of primaries cm.	Average No. of secondaries	Average total length of secondaries cm.
A	—	—	—	—	—	—
B	69·6	58·2	5432·0	100·1	246·4	9862·4
C	89·4	55·2	2434·4	43·2	99·4	1758·8
D	68·4	37·8	1148·2	31·3	24·2	474·6

TABLE IV — EVOLUTION OF A CULTIVATION PRACTICE FOR *PALAS* AT KUNDRI (1962-63)

Treatment	No. of trees	Broodlac used		Yield in all seasons			Ratios		Yield of scraped lac per tree kg.
		Lac sticks kg.	Scraped lac kg.	Brood-lac kg.	Total lac sticks kg.	Total scraped lac kg.	Brood used to brood obtained	Brood scraped to yield scraped	
A	500	200	19·00	—	860·50	199·50	—	1 : 10·5	0·399
B	500	200	22·00	232·50 (0·4640 per tree)	1307·25	321·75	1 : 1·16	1 : 14·6	0·6435
C	500	100	11·75	523·75 (1·460 per tree)	1450·75	300·30	1 : 5·23	1 : 25·5	0·6060
D	500	50	4·80	450·00 (0·900)	1044·25	228·50	1 : 9·00	1 : 48·00	0·4570
Large Scale Trials									
A	1000	400	42·50	—	2128·00	579·00	—	1 : 13·6	0·5790
D	1000	100	11·00	924·50	1232·00	596·00	1 : 9·20	1 : 54·00	0·5960

TABLE V — DETAILS OF LARGE-SCALE TRIALS OF LAC CULTIVATION AT KUNDRI WITH REVENUE AND EXPENDIT

(April 1963 to March 1964)

Season of operation	Particulars of operation	No. of trees	Quantity of broodlac used for inoculation kg.	Yield of lac if any			Cost of the operation	Revenue				
				Lac sticks kg.	Scraped lac kg.	Brood-lac kg.		By sale of surplus broodlac			By sale of yield of	
							Rs. P.	Wt. of broodlac kg.	Rate Rs. P.	Amount Rs. P.	Wt. of scraped lac kg.	Rate Rs. P.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
April 1963	Pruning and *Ari* collection	23187	—	49868·00	9701·50	—	2298·58	—	—	—	240 mds. (8958 kg. approx.)	11.00 per md.
	Scraping	—	—	—	—	—	1243·23	—	—	—	5 mds. (86 kg. approx.)	do
June 1963	(i) Inoculation	225	1455·00	—	—	—	—	—	—	—	—	—
	(ii) Partial cropping and selection of broodlac	3513	—	1954·20	—	145·00	—	—	—	—	—	—
	(iii) Scraping	—	—	—	62·00	—	—	—	—	—	—	—
Aug. 1963	*Phunki* removal	225	—	47·00	—	—	3·25	—	—	—	—	—
	Scraping	—	—	—	11·00	—	1·37	—	—	—	—	—
Oct. & Nov. 1963	(i) Complete cropping collection and selection of brood	4500	—	5988·75	—	2205·00	657·46	18 mds. (672 kg. approx.)	69·00 per md. (minus Rs. 190 as conveyance charges)	693·22	34 mds. (1270 kg. approx.)	10·50 per md.
	(ii) Inoculation including chop	—	1508	—	—	—	225·56	—	—	—	—	—
	(iii) Scraping	—	—	—	1488·00	—	149·34	25 kg.	69·00 per md.	32·77	—	—
Dec. 1963	*Phunki* removal	4500	—	712·00	—	—	42·92	—	—	—	—	—
	Scraping	—	—	—	89·00	—	11·25	—	—	—	—	—
	TOTAL	—	—	58569·95	11351·50	2350·00	4632·96	697	—	725·99	279 mds. (10,414 kg. approx.)	—

'URE STATEMENT

sticklac Amount	Total revenue	Remarks
Rs. P.	Rs. P.	
(14)	(15)	(16)
2640·00	—	—
55·00	2695·00	—
—	—	—
—	—	Lac brought to Institute
—	—	—
—	—	—
—	—	—
357·00	1082·99	This quantity of lac includes scraped lac collected in July, Aug. and Dec. 1963
—	—	—
—	—	—
—	—	—
—	—	—
—	—	—
3052·00	3777·99	

TABLE VI — SPACING TRIALS FOR *MOGHANIA MACROPHYLLA*
Crop Data (*Jethwi* 1963)

Treatment	Total No. of plants	Lac sticks				Scraped lac			
		Brood-lac used kg.	Brood-lac yield kg.	Total yield kg.	Brood to yield ratio	Brood-lac used kg.	Total yield kg.	Brood to yield ratio	Yield of lac per acre kg.
A	40	2·330	1·480	7·720	1 : 3·3	1·350	1·220	1 : 0·90	36·600
B	40	4·050	2·130	13·290	1 : 3·4	2·180	1·940	1 : 0·91	87·300
C	40	3·460	2·170	12·930	1 : 3·7	2·010	1·930	1 : 0·89	129·300

TABLE VII — PLANTATION TECHNIQUE OF RAISING *MOGHANIA MACROPHYLLA*

Shoot Measurements

Treatment	Average main height cm.	Average number of shoots per bush	Average total length of shoots per bush cm.
A	184·2	27·0	2027·8
B	200·9	28·5	2332·0
C	187·9	25·1	1865·6
D	199·3	29·1	2102·0
E	176·6	17·3	1298·4
F	214·6	32·0	2430·7
G	231·2	30·8	2394·2
H	222·2	33·5	2662·1
I	198·5	21·4	1648·3
J	215·4	33·2	2665·4

TABLE VIII — EFFECT OF NPK ON THE YIELD OF LAC ON *MOGHANIA MACROPHYLLA*

Crop Data (*Jethwi* 1963)

Treatment	No. of plants	Lac sticks				Scraped lac			
		Brood-lac used kg.	Brood-lac yield kg.	Total yield kg.	Brood to yield ratio	Brood-lac used kg.	Total yield kg.	Brood to yield ratio	Yield of lac per plant gm.
A	120	10·600	5·800	28·300	1 : 2·7	2·900	4·970	1 : 1·7	49·7
B	120	11·700	9·500	34·300	1 : 2·9	2·900	5·690	1 : 1·9	56·9
C	120	10·600	5·200	32·900	1 : 3·1	3·300	4·540	1 : 1·4	45·4
D	120	10·600	7·400	31·200	1 : 2·7	3·350	5·080	1 : 1·5	50·8
E	120	10·500	5·300	27·800	1 : 2·6	3·000	4·740	1 : 1·6	47·4
F	120	13·700	14·000	44·800	1 : 3·3	3·450	8·430	1 : 2·4	84·3
G	120	13·700	6·000	33·700	1 : 2·4	3·850	5·270	1 : 1·4	52·7
H	120	11·700	5·600	36·400	1 : 2·3	3·300	5·720	1 : 1·8	57·2

TABLE IX — EFFECT OF DIFFERENT LEVELS OF NITROGEN ON THE GROWTH OF *MOGHANIA MACROPHYLLA*

Data on shoot measurement

Treatment	Initial height cm.	Final height cm.	No. of shoots per plant	Total length of shoots per plant cm.
A	50·2	99·1	7·9	383·8
B	46·5	104·0	10·6	475·1
C	45·2	111·3	10·0	539·1
D	44·8	114·8	10·8	485·4
E	50·4	123·3	12·3	661·3

TABLE X — EFFECT OF DIFFERENT LEVELS OF NITROGEN ON THE GROWTH OF *MOGHANIA MACROPHYLLA*

Crop data (*Aghani* 1963-64)

Treatment	Lac sticks				Scraped lac		
	Broodlac used kg.	Broodlac yield kg.	Total yield kg.	Brood to yield ratio	Broodlac used kg.	Total yield kg.	Brood to yield ratio
A	3·650	0·600	11·050	1 : 3·0	1·640	1·370	1 : 0·83
B	4·230	1·350	12·650	1 : 3·0	2·030	1·790	1 : 0·88
C	4·840	2·000	15·450	1 : 3·2	2·290	1·900	1 : 0·83
D	4·520	1·600	13·350	1 : 2·0	2·100	1·710	1 : 0·81
E	5·180	2·650	16·100	1 : 3·1	2·500	2·250	1 : 0·90

TABLE XI — EVOLUTION OF A CULTIVATION PRACTICE FOR *KUSUM* (HESAL)

Crop data (*Jethwi* 1963)

Coupé	Lac sticks					Scraped lac		
	Brood used kg.	Brood yield kg.	Total yield kg.	Brood to brood ratio	Brood to yield ratio	Brood used kg.	Total yield kg.	Brood to yield ratio
A_1 II	61·55	170·46	746·78	1 : 2·76	1 : 12·13	23·09	131·28	1 : 5·68
B_1 II	57·20	36·60	421·58	1 : 0·63	1 : 7·37	22·98	82·52	1 : 3·58
C IV	110·74	46·64	227·83	1 : 0·42	1 : 2·05	42·34	35·75	1 : 0·85

TABLE XII — EVOLUTION OF A CULTIVATION PRACTICE FOR *KUSUM* (HESAL)

Crop data (*Aghani* 1963-64)

Coupé	Lac sticks					Scraped lac		
	Brood used kg.	Brood yield kg.	Total yield kg.	Brood to brood ratio	Brood to yield ratio	Brood used kg.	Total yield kg.	Brood to yield ratio
A_2 II	63·66	nil	46·30	1 : 0·00	1 : 0·72	23·87	4·100	1 : 1·71
B_2 II	75·11	nil	116·60	1 : 0·00	1 : 1·55	28·60	9·70	1 : 0·33
C I	93·70	nil	28·45	1 : 0·00	1 : 0·30	25·91	4·22	1 : 0·16

TABLE XIII — FINDING OUT ALTERNATE HOSTS FOR THE *KUSMI* STRAIN OF LAC INSECT

Crop data (*Jethwi* 1963)

Brood history	Lac sticks				Scraped lac		
	Brood used kg.	Brood yield kg.	Total yield kg.	Brood to yield ratio	Brood yield kg.	Total yield kg.	Brood to yield ratio
K(Prog. K × A.l × K × A.l) × A.l	9·000	7·300	12·900	1 : 1·43	4·000	3·700	1 : 0·92
K (Prog. K × S) × S	2·000	1·300	3·000	1 : 1·50	0·700	0·950	1 : 1·36

TABLE XIV — DURATION OF VARIOUS STAGES IN THE LIFE-HISTORY OF *NEPHOPTERYX LEUCOPHAELLA* ZELL.

Generation	Date of egg laying	Egg stage days	1st larval instar days	2nd larval instar days	3rd larval instar days	4th larval instar days	5th larval instar days	6th larval instar days	Pre-pupal stage days	Pupal stage days	Date of adult emergence	No. under observation	Total duration egg to adult days
First	24-6-63	4	3·1 (3-4)	2·3 (2-3)	2·1 (2-3)	3·0 (3-4)	5 (4-6)	—	2·0	8·2 (8-9)	28-29. 7.63	10	29·6 (29-31)
Second	30-7-63	4	3·0 (3-4)	2·0 (2-2)	2·0 (2-3)	3·0 (3-4)	4·8 (4-6)	—	1·2 (1-2)	9·5 (8-11)	27-31. 8.63	11	30·0 (28-32)
Third	29-8-63	4	3·0 (3-3)	2·2 (2-3)	2·8 (2-6)	4·1 (2-7)	3·8 (3-6)	—	2·0 (2-2)	8·0 (6-11)	28.9-5.10.63	9	32·1 (30-37)
Fourth	30-9-63	4	3·5 (3-4)	3·6 (3-4)	3·8 (3-5)	4·5 (4-5)	7·0 (6-8)	—	2·3 (2-3)	10·6 (10-13)	8-12. 11.63	12	40·5 (39-43)
Fifth	13-11-63	7	4·7 (4-5)	5·2 (4-7)	8·7 (6-11)	7·0 (6-8)	13·0 (7-22)	13	4·5 (4-5)	27·4 (24-32)	27.1-6.2.64	10	80·1 (75-85)
Sixth	10-2-64	10	4·5 (3-7)	4·6 (3-7)	4·8 (3-7)	4·1 (2-6)	4·5 (3-6)	5 (5-5)	2·0 (2-2)	9·7 (9-11)	23-31. 3.64	11	34·8 (32-37)

TABLE XV — CHEMICAL CONTROL OF PARASITES AND PREDATORS OF LAC INSECT

Crop data (*Aghani* 1963-64)

(Average of three replications)

Treatment	Brood used			Wt. of broodlac		Yield obtained		
	Wt. of broodlac used kg.	Wt. of *phunki* lac stick kg.	Wt. of *phunki* sticklac kg.	Lac stick kg.	Sticklac kg.	Wt. of rejected lac: Lac stick kg.	Wt. of rejected lac: Sticklac kg.	Total yield kg.
a_3b_3	0·117	0·081	0·055	1·400	0·380	5·400	0·510	0·890
a_3b_5	0·117	0·084	0·056	0·500	0·180	4·800	0·500	0·680
a_1b_4	0·117	0·081	0·053	1·400	0·549	3·900	0·420	0·969
a_1b_3	0·117	0·079	0·048	1·200	0·468	5·500	0·500	0·968
a_2b_5	0·117	0·086	0·049	0·650	0·219	3·100	0·350	0·569
a_3b_4	0·117	0·089	0·049	0·800	0·330	2·500	0·300	0·630
a_2b_3	0·117	0·083	0·051	—	—	2·500	0·200	0·200
a_4b_1	0·117	0·084	0·059	0·225	0·080	2·200	0·330	0·410
a_4b_3	0·117	0·081	0·085	0·550	0·150	2·200	0·270	0·420
a_3b_2	0·117	0·033	0·057	0·100	0·050	1·200	0·120	0·170
a_1b_5	0·117	0·036	0·056	—	—	1·100	0·120	0·120
a_2b_2	0·117	0·087	0·058	0·400	0·100	1·850	0·185	0·285
a_4b_4	0·117	0·081	0·061	1·000	0·289	2·500	0·270	0·559
a_2b_1	0·117	0·078	0·059	0·250	0·082	2·400	0·248	0·330
a_1b_1	0·117	0·073	0·056	—	—	1·600	0·150	0·150
a_4b_2	0·117	0·091	0·057	0·800	0·280	2·250	0·200	0·480
a_4b_5	0·117	0·089	0·056	0·500	0·150	1·900	0·250	0·400
a_2b_4	0·117	0·086	0·058	0·700	0·228	3·900	0·350	0·578
a_3b_1	0·117	0·082	0·056	1·100	0·358	3·950	0·280	0·630
a_1b_1	0·117	0·085	0·057	1·100	0·420	3·850	0·470	0·890

TABLE XVI — CAUSES OF SPURIOUS EMERGENCE IN *KUSUM* (JHALDA)

Crop data

Yield particulars	Treatment A			Treatment B			Treatment C			Treatment D			Treatment E		
	Brood used kg.	Yield obtained kg.	Brood used to yield ratio	Brood used kg.	Yield obtained kg.	Brood used to yield ratio	Brood used kg.	Yield obtained kg.	Brood used to yield ratio	Brood used kg.	Yield obtained kg.	Brood used to yield ratio	Brood used kg.	Yield obtained kg.	Brood used to yield ratio
							***Jethwi* 1963**								
Lac sticks	34·92	22·6	1 : 0·64	43·42	63·4	1 : 1·45	35·28	53·0	1 : 1·5	26·64	29·00	1 : 1·1	35·40	33·93	1 : 0·95
Sticklac	10·87	3·8	1 : 0·32	10·9	9·1	1 : 0·87	8·6	10·7	1 : 1·24	9·25	5·8	1 : 0·77	10·2	7·40	1 : 0·83
							***Aghani* 1963-64**								
Lac sticks	50·16	12·20	1 : 0·24	58·2	No crop		52·92	No crop		40·2	4·55	1 : 0·11	53·64	14·35	1 : 0·26
Sticklac	16·27	3·72	1 : 0·22	15·12	—	—	8·67	—	—	13·3	0·67	1 : 0·05	15·225	2·36	1 : 0·15

TABLE XVII — INVESTIGATION OF LIKELY *KUSM*

Results of stick examination

Hosts	At *phunki* removal		At male emergence		A
	No. of larvae per 2·54 cm.	Larval mortality %	No. of insects per 2·54 cm.	Male %	ce 2
					Jethwi 1963
P. serratum	333·85	51·1	28·34	22·3	
B. monosperma	234·44	46·99	21·59	33·82	
D. latifolia	142·55	59·92	58·26	18·26	
F. arnottiana	121·28	59·86	12·38	35·89	
M. macrophylla	109·12	50·67	17·04	31·14	
					Aghani 1963-64
P. serratum	237·33	67·89	19·08	35·44	
B. monosperma	174·60	64·47	31·78	36·14	
D. latifolia	144·52	69·98	16·42	33·43	
F. arnottiana	224·09	56·21	25·55	18·72	
M. macrophylla	—	—	—	—	

TABLE XVIII — INVESTIGATION OF LIKELY *KUSMI* HOSTS OCCU

Crop data

Yield Particulars	*P. serratum*			*B. monosperma*			*D. latifolia*			
	Brood used kg.	Yield obtained kg.	Ratio of brood to yield	Brood used kg.	Yield obtained kg.	Ratio of brood to yield	Brood used kg.	Yield obtained kg.	Ratio of brood to yield	Brood used kg.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
										Jethwi 1963
Lac sticks	11·28	12·30	1 : 1·08	4·08	No crop	1 : 0·0	12·8	0·10	1 : 0·008	6·52
Sticklac	3·65	1·70	1 : 0·46	0·78	No crop	1 : 0·00	2·95	Negligible	1 : 0·00	1·2
										Aghani 1963-64
Lac sticks	34·8	12·30	1 : 0·35	8·28	2·00	1 : 0·24	15·6	2·00	1 : 0·13	9·6
Sticklac	10·92	2·17	1 : 0·19	2·73	0·45	1 : 0·16	3·94	0·40	1 : 0·1	3·07

II HOSTS (JHALDA)

At crop maturity		Remarks
verage No. of lls per ·54 cm.	Adult mortality %	
12·66	89·64	Male emergence on 26.3.1963
88·9	65·00	
5·08	87·5	
—	—	
9·40	81·34	
12·47	88·19	
6·1	82·00	
3·7	80·00	
16·15	92·73	
12·87	96·38	

RRING IN THE REGION (JHALDA)

. arnottiana		*M. macrophylla*			*Kusum* general		
Yield obtained kg.	Ratio of brood to yield	Brood used kg.	Yield obtained kg.	Ratio of brood to yield	Brood used kg.	Yield obtained kg.	Ratio of brood to yield
(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)
No crop	1 : 0·0	2·76	6·68	1 : 2·42	68·88	157·51	1 : 2·28
No crop	1 : 0·0	0·83	0·80	1 : 0·96	24·86	62·96	1 : 2·53
7·80	1 : 0·81	3·48	2·35	1 : 0·67	55·04	48·35	1 : 0·87
1·85	1 : 0·06	0·16	0·55	1 : 3·43	24·69	8·53	1 : 0·34

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

Treatment	Date of pruning	Primaries				Secondaries				No. of tertiary shoots given out
		Date of first appearance of buds	No. of shoots given out per tree	No. of living shoots per tree	Average length cm.	Date of first appearance of buds	No. of shoots given out per tree	No. of living shoots per tree	Average length cm.	
					***Baisakhi* 1962-63**					
A	10-4-62	18-4-62	88·8	69·6	92·2	4-5-62	611·7	605·3	46·5	504·3
B	19-5-62	23-5-62	35·0	29·8	78·2	9-6-62	501·0	257·3	42·3	214·8
					***Katki* 1963**					
A	20-11-62	14-12-62	—	21·5	37·1	—	—	91·5	14·6	35·5
B	12-2-63	25-2-63	—	44·0	30·3	—	—	147·1	19·0	54·6
C	19-5-62	2-6-63	—	25·1	137·3	—	—	254·8	60·1	551·3
					***Baisakhi* 1963-64**					
A	15-4-63	4-5-63	—	19·6	81·9	—	—	157·1	47·1	371·5
B	18-5-63	27-5-63	—	23·8	74·2	—	—	155·0	38·0	299·0
C	20-11-63	28-12-63	—	39·6	77·0	—	—	317·0	38·2	376·1

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

Experimental details

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

Yield particulars	Treatment A			Treatment B			Treatment C		
	Brood used kg.	Yield obtained kg.	Brood to yield ratio	Brood used kg.	Yield obtained kg.	Brood to yield ratio	Brood used kg.	Yield obtained kg.	Brood to yield ratio
				***Baisakhi* 1962-63**					
Lac sticks	21·6	108·2	1 : 5·0	21·6	72·1	1 : 3·3	—	—	—
Sticklac	4·3	9·84	1 : 2·2	4·6	7·03	1 : 1·5	—	—	—
				***Katki* 1963**					
Lac sticks	26·4	29·9	1 : 1·1	26·4	37·2	1 : 1·4	26·4	64·2	1 : 2·4
Sticklac	3·68	3·93	1 : 1·0	4·06	6·56	1 : 1·6	4·15	7·36	1 : 1·7

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

Results of stick examination

Treatment	After 4 weeks		At male emergence		At crop maturity	
	Density of settlement per 2·54 cm.	Percentage of larval mortality	No. of living insects per 2·54 cm.	Percentage of males	No. of living cells per 2·54 cm.	Percentage of adult mortality
			***Baisakhi* 1962-63**			
A	69·62	88·04	69	22·17	19	28·37
B	78·49	80·50	69	20·81	8	26·29
			***Katki* 1963**			
A	64	26·84	47	26·91	26	17·41
B	86	26·30	54	22·21	29	16·75
C	153	29·42	89	22·89	42	16·45

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

Stick examination

Treatment	After 4 weeks		At male emergence		At crop maturity	
	Density of larval settlement per 2·54 cm.	Percentage of larval mortality	No. of living insects per 2·54 cm.	Percentage of males	No. of living cells per 2·54 cm.	Percentage of adult mortality
			***Baisakhi* 1962-63**			
A	73·12	91·47	40	28·51	10	35·54
B	44·56	93·39	56	37·83	14	33·48
C	76·96	91·63	102	44·41	27	32·00
			***Katki* 1963**			
A	41·52	27·82	32·57	23·30	10	20·14
B	75·70	26·94	59·27	20·50	11·92	26·06
C	122·52	29·08	105·70	24·52	29·62	23·72

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

Crop data

Yield particulars	Treatment A			Treatment B			Treatment C		
	Brood used kg.	Yield obtained kg.	Brood to yield ratio	Brood used kg.	Yield obtained kg.	Brood to yield ratio	Brood used kg.	Yield obtained kg.	Brood to yield ratio
				***Baisakhi* 1962-63**					
Lac sticks	12·4	37·5	1 : 3·0	24·8	53·7	1 : 2·1	49·6	70·1	1 : 1·4
Scraped lac	1·7	2·19	1 : 1·2	3·6	4·56	1 : 1·2	6·9	5·46	1 : 0·7
				***Katki* 1963**					
Lac sticks	6·9	3·6	1 : 0·5	13·8	6·8	1 : 0·4	27·6	11·64	1 : 0·4
Scraped lac	1·00	0·34	1 : 0·3	1·97	1·00	1 : 0·5	3·37	1·88	1 : 0·5

TABLE XXIV — DATA ON SHOOT MEASUREMENT OF *GHONT* AT THE TIME OF INOCULATION (MIRZAPUR)

Treatment	Date of pruning	Primaries				Secondaries				No. of tertiary shoots given out
		Date of first appearance of buds	No. of shoots given out per tree	No. of living shoots per tree	Average length cm.	Date of first appearance of buds	No. of shoots given out per tree	No. of living shoots per tree	Average length cm.	
					***Katki* 1963**					
A	10-11-62	4-1-63	25	25	63·32	4-1-63	187	180	30·92	488
B	16-2-63	6-3-63	51	51	46·93	17-2-63	338	338	22·85	706
C	19-5-62	1-6-62	71	65	67·21	23-6-62	657	624	36·53	1765
					***Baisakhi* 1963-64**					
A	14-4-63	—	17	17	74·36	—	172	172	41·18	705
B	18-5-63	—	13	13	75·36	—	118	118	41·83	613

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

Experimental details

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

Yield particulars	Treatment A			Treatment B			Treatment C		
	Brood used kg.	Yield obtained kg.	Brood to yield ratio	Brood used kg.	Yield obtained kg.	Brood to yield ratio	Brood used kg.	Yield obtained kg.	Brood to yield ratio
				***Baisakhi* 1962-63**					
Lack sticks	22·900	nil	1 : 0	22·900	nil	1 : 0	—	—	—
Sticklac	3·466	nil	1 : 0	3·639	nil	1 : 0	—	—	—
				***Katki* 1963**					
Lac sticks	25·00	11·400	1 : 0·456	29·00	14·00	1 : 0·471	40·700	26·300	1 : 0·64
Sticklac	5·850	0·177	1 : 0·030	6·240	0·270	1 : 0·043	8·650	0·410	1 : 0·04

TABLE XXVI — OPTIMUM REQUIREMENT OF BROOD (MIRZAPUR)

Yield particulars	Treatment A			Treatment B			Treatment C		
	Brood used kg.	Yield obtained kg.	Brood to yield ratio	Brood used kg.	Yield obtained kg.	Brood to yield ratio	Brood used kg.	Yield obtained kg.	Brood to yield ratio
				***Baisakhi* 1962-63**					
Ghont									
Lac sticks	12·500	No crop		25·00	No crop		50·00	No crop	
Sticklac	1·623	No crop		3·898	No crop		7·864	No crop	
Palas									
Lac sticks	16·300	64·600	1 : 3·96	32·6	73·9	1 : 2·26	65·2	133·7	1 : 2·05
Sticklac	3·056	11·450	1 : 3·74	5·186	16·060	1 : 3·09	12·334	26·050	1 : 2·11
				***Katki* 1963**					
Ghont									
Lac sticks	16·500	17·100	1 : 1·030	24·100	14·900	1 : 0·618	30·00	22·00	1 : 0·733
Sticklac	3·715	0·280	1 : 0·075	4·730	0·250	1 : 0·052	5·745	0·670	1 : 0·116
Palas									
Lac sticks	36·00	29·100	1 : 0·808	42·800	41·100	1 : 0·960	62·400	54·8	1 : 0·187
Sticklac	7·950	2·240	1 : 0·281	8·850	3·00	1 : 0·338	13·160	4·060	1 : 0·310

TABLE XXVII — EVOLUTION OF A SUITABLE CULTIVATION PRACTICE FOR *GHONT* AND *PALAS* (MIRZAPUR)

Crop data

Yield particulars	Treatment A			Treatment B			Treatment C		
	Brood used kg.	Yield obtained kg.	Brood to yield ratio	Brood used kg.	Yield obtained kg.	Brood to yield ratio	Brood used kg.	Yield obtained kg.	Brood to yield ratio
				***Baisakhi* 1962-63**					
Ghont									
Lac sticks	21·375	nil	1 : 0	42·75	nil	1 : 0	85·50	nil	1 : 0
Sticklac	4·594	nil	1 : 0	7·508	nil	1 : 0	16·312	nil	1 : 0
Palas									
Lac sticks	17·350	154·300	1 : 8·89	34·700	190·00	1 : 5·47	69·400	71·30	1 : 1·02
Sticklac	4·004	34·300	1 : 3·86	7·097	22·00	1 : 3·09	11·989	19·185	1 : 1·60

APPENDIX B

(Tables: Chemistry Division)

TABLE I — COMPARATIVE DATA (OPTICAL DENSITY AND PER CENT TRANSMITTANCE) OF IODINE SOLUTIONS

Sl. No.	Name of apparatus		Klett-Summerson photo-electric colorimeter (model 900·3) (20 mm. cell)		Helliger 'SPEKKER' photo-electric colorimeter (10 mm. cell)				Bush	Lomb*	Beckman DU spectrophotometer (10 mm. cell)			
	Wave length used		520-580 μμ.		480 μμ		540 μμ		540 μμ		478 μμ		535 μμ	
	Strength of iodine solution	Corresponding bleach index	Optical density	% trans.	Optical density	% trans.	Optical density	% trans.	Optical density	% trans.	Optical density	% trans.	Optical density	% trans.
1	N/200	170	0·824	15	0·555	27·58	0·265	54·1	1·222	6·0	1·4	4·0	—	—
2	N/400	152	0·432	37	0·318	48·0	0·123	75·0	0·77	17·0	0·432	37·0	0·212	61·2
3	N/500	144	0·372	42·5	0·267	54·0	0·108	78·0	0·615	23·5	0·328	47·0	0·175	67·0
4	N/750	133	0·272	53·5	0·19	64·0	0·065	87·0	0·425	37·5	—	—	—	—
5	N/1000	122	0·208	62·0	0·157	69·8	0·067	87·5	0·33	46·5	0·195	64·0	0·087	82·0
6	N/2000	98	0·110	77·67	0·086	82·0	0·027	93·0	0·162	69·0	—	—	—	—
7	N/3000	81	0·076	84·0	0·057	87·8	0·020	95·5	0·112	77·5	—	—	—	—
8	N/4000	70	0·058	87·5	0·038	91·9	0·017	96·0	0·07	85·0	—	—	—	—
9	N/5000	62	0·042	90·78	0·030	93·1	0·005	98·8	0·051	89·0	—	—	—	—
10	N/6000	58	0·034	92·5	0·026	94·0	0·004	98·9	0·042	91·0	—	—	—	—

*Unicam instrument also gave similar readings.

TABLE II — EFFECT OF OXALIC ACID ON SEEDLAC PROCESSING TO SHELLAC

Sl. No.	Amount of oxalic acid %	Date of manufacture and test	Colour index	Life in minutes	Flow in seconds	Rate of filtration in c.c.	Acid value
1	0·0	Feb. 1964	12	54	65	48	71·1
2	0·1	do	11	49	72	50	71·5
3	0·25	do	11	44	95	48	71·8
4	0·5	do	10·5	18	125	46	72·1

TABLE III — HOLD-UP EXPERIMENTS

Length of drier = 8′-0″
Diameter of drier = 1′-0″

No. of observation	Slope ft./ft. length of drier	Speed r.p.m.	Feed rate lb./hr.	Actual hold-up with no air lb.	Actual hold-up with air lb.	Theoretical hold-up with no air, according to Friedman and Marshall's eqn. lb.
1	0·03125	10	28·86	4·221	4·86	4·37
2	0·03125	10	165·1	24·5	26·25	24·93
3	0·03125	8	43·278	7·221	7·852	8·2386
4	0·03125	8	185·0	32·0	—	35·203
5	0·03125	8	213·0	69·5	—	40·55
6	0·03125	8	308·7	114·0	—	58·76
7	0·03125	6	114·76	25·5	26·75	28·32
8	0·05078	10	28·6	2·5	3·264	2·73
9	0·05078	8	22·8	2·105	2·62	2·688
10	0·05078	8	193·92	23·25	25·5	22·72
11	0·05078	6	40·0	6·543	7·35	6·072
12	0·05078	6	215·34	49·5	—	32·69
13	0·06250	10	23·2	1·852	1·73	1·807
14	0·06250	10	126·66	10·50	12·0	9·849
15	0·06250	8	39·03	3·5	4·12	3·7145
16	0·06250	6	46·296	4·833	5·323	5·712
17	0·06250	6	133·2	17·5	18·5	16·405

Friedman & Marshall's relation: $T = \frac{0{\cdot}23 \times L}{S \times NO{\cdot}9 \times D}$, where T = Time of passage, mins. L = Effective length of drier, ft. S = Slope of drier, ft./ft. length of drier. N = Rotative speed of drier, r.p.m. D = Diameter of drier, ft.

$H = F \times \frac{T}{60}$, where H = Hold-up in drier, lb. F = Feed rate to the drier, lb./hr.

TABLE IV — DRYING EXPERIMENTS

Length of drier = 8′-0″ **Speed = 10 r.p.m.**
Diameter of drier = 1′-0″ **Slope = 0·06250 ft./ft. length of drier**

No. of obs.	Atmospheric air				Drier inlet air				Drier exit air	Air mass velocity	Feed			Product		Water removed	Heat transferred	Temp.	Ua (actu (hr.) (ft B.T.U drier vo (°F.)
	D.B. temp. °F.	W.B. temp. °F.	Relative humidity %	Absolute humidity lb. moisture lb. dry air	D.B. temp. °F.	W.B. temp. °F.	Relative humidity %	Absolute humidity lb. moisture lb. dry air	D.B. temp. °F.	lb. hr./ft.	Rate lb./hr.	Moisture content lb. moisture lb. dry solid	Temp. °F.	Moisture content lb. moisture lb. dry solid	Temp. °F.	lb./hr.	B.T.U./hr.	°F.	
1	68	62·5	70	0·0107	120	77·5	15	0·0107	94	1484	25·62	0·149	67	0·02086	91	3·282	3742·2	28	21·28
2	69	63	70	0·011	115	77	17	0·011	87	1484	19·3	0·138	66	0·019	85	2·297	2587·35	25·23	16·46
3	64·5	59·5	75	0·00979	125	78	12	0·00979	96·5	1484	24·03	0·1609	63	0·02176	95	3·343	3880·5	26·63	23·2
4	65·5	60·5	77	0·01021	130	79·5	11	0·01021	88	1484	31·22	0·1599	65	0·02095	105	4·336	5091·9	27·15	29·27
5	65·5	60·5	77	0·01021	135	81	9	0·01021	89	1484	25·02	0·1323	64	0·016503	111	2·898	3514	26·88	20·82
6	64·75	60	77	0·01	140	82	8	0·01	90	1484	33·73	0·1293	64	0·02072	111	3·58	4521·2	27·46	26·22
7	65·5	60·5	77	0·0102	145	83	7	0·0102	94	1484	23·81	0·1397	65	0·01848	118	2·862	3601	27·98	20·48
8	66	60·75	75	0·01	135	81	9	0·01	88	1484	23·81	0·1513	68	0·01719	107	3·193	3789·1	23·78	25·38
9	64·5	59	72	0·0096	135	80	8	0·0096	88	1484	29·5	0·1729	65	0·01954	105	4·5245	6308	26·34	38·13
10	65	59·5	72	0·0097	130	79	10	0·0097	79	1484	76·06	0·14747	63·5	0·02434	95	9·364	10974	27·1	64·46
11	64·75	59	71	0·0094	125	78·5	11	0·0094	83	1484	52·91	0·1229	64	0·02267	92	5·302	6282	25·95	38·53
12	63·5	59	75	0·0096	120	76·5	13	0·0096	80	1484	61·32	0·1534	63	0·02465	82	7·893	8855·7	26·1	54·02
13	63	59	80	0·0099	135	80	9	0·0099	84	1484	68·46	0·14875	63	0·01765	94	8·975	10443	29·88	55·60
14	63·5	58·5	76	0·0095	140	81	7	0·0095	87	1484	72·31	0·14582	63	0·01635	104	9·362	11223	29·59	60·39
15	69	63	70	0·011	120	78	15	0·011	91	636·2	30·23	0·1415	69	0·05171	88	2·714	3142·91	26·69	18·75
16	65	59	70	0·0093	135	79·5	8	0·0093	87	636·2	31·48	0·14725	67	0·024265	92	3·872	4439	31·33	22·56
17	65	58·75	70	0·0091	135	79·5	8	0·0091	86	636·2	42·86	0·1189	67	0·03068	86	3·781	4363	31·66	21·94

TABLE V — PROPERTIES OF HEAT- AND WATER-PROOF VARNISH AFTER DIFFERENT MATURITY PERIOD (25 PER CENT SOLUTION WAS TESTED)

Sl. No.	Maturity period in days	Viscosity, time in seconds at 30°C.	Acid value	Colour index, B.D.H.	Heat-resistance (boiling water beaker put for 2 mins.)	Water-resistance (immersed in water for 7 days)	Scratch hardness (load on 1 mm. ball in gm.)	Flexibility (bent round 3 mm. mandrel)	Gloss
1	Fresh sample	26·0	16·9	2·5	SM	FB	800	MC	70
2	One	26·0	16·9	2·5	ST	NB	900	NC	68
3	Two	28·0	14·8	2·5	ST	NB	900	NC	72
3	Three	29·5	14·6	2·5	NS	NB	1000	NC	76
5	Seven	29·5	14·5	2·5	NS	NB	900	NC	70
6	Thirty	30·0	14·5	2·5	NS	NB	1100	NC	71

SM, Sticking and faint mark; ST, Slight sticking; NS, No sticking and no mark; NB, No blushing; FB, Faint blushing; NC, No cracks; MC, Micro cracks.

TABLE VI — FILM PROPERTIES OF TIN PLATE LACQUER AFTER DIFFERENT MATURITY PERIOD

	Fresh sample	6 months old	12 months old	18 months old
1. Appearance of the varnish	Clear homogeneous solutions			
2. Colour of the varnish	Pale yellow	Pale yellow	Pale yellow	Pale yellow
3. Viscosity at 30°C. (time in seconds)	28·5	30·2	31·0	31·2
4. Baking time in minutes	15	15	15	15
5. Baking temperature in °C.	150	150	150	150
PROPERTIES OF BAKED FILMS				
6. Appearance of the film	HSG	HSG	HSG	HSG
7. Flexibility (film bent round a 3 mm. mandrel)	NC	NC	NC	NC
8. Scratch hardness (load on 1 mm. steel ball in gm.)	1200	1100	1200	1300
9. Water-resistance of the film on glass slides (immersed in water for one month)	NB	NB	NB	NB
10. Heat-resistance (Beaker containing boiling water put over the film for 5 mins.)	NS	NS	NS	NS
11. Resistance to dilute acids (immersed in 5% solution of various acids)	No effect	No effect	No effect	No effect
12. Resistance to spirit (film immersed in spirit and allowed to stand for one month)	Good	Good	Good	Good
13. Resistance to aromatic solvents such as Benzene toluene, etc.	Good	Good	Good	Good

NS — No sticking and no mark
NC — No cracks
HSG — Hard, smooth and glossy

TABLE VII — FILM PROPERTIES OF LAC-EPOXY RESIN VARNISH

(Shellac varnish containing 20% Epikote resin 1004 in Dioxane)

A. PROPERTIES OF THE VARNISH

1.	Appearance of the varnish	Clear homogeneous lacquer
2.	Solid content %	25
3.	Air-drying time, minutes	5
4.	Baking temperature, °C.	150
5.	Baking time in minutes	20-30

B. FILM PROPERTIES

		Air-drying	*Baked*
6.	Appearance of the film	Smooth, hard and glossy	Smooth, hard and glossy
7.	Flexibility (film bent round 3 mm. mandrel)	No cracks	No cracks
8.	Scratch hardness (load on 1 mm. steel ball in gram.)	1000-1100	1800-2000
9.	Water-resistance (film immersed in water)	Blushes within one hour	No blushing up to 20 days
10.	Heat-resistance (beaker containing boiling water put over the film for 2 mins.)	Sticking takes place	No sticking and no mark
11.	Resistance to dilute acids (5% solution) films immersed in various acids	Blushing takes place within an hour	No blushing and no lifting off of the film up to 7 days
12.	Resistance to boiling water (immersed in boiling water)	Blushes within 20 seconds	No blushing or lifting up to 5 mins.
13.	Resistance to aromatic solvents (immersed in respective solvents for 7 days)		
	(a) Toluene	Film becomes soft	No loss of gloss or sticking or softening of the film
	(b) White spirit	Stickiness of the film	do
	(c) Benzene	do	do
14.	Resistance to lubricating oil	do	do
15.	Resistance to alcohol—film hard rubbed with cotton wad dipped in alcohol	5th rub washed out the film	50 rubs no effect
16.	Resistance to acetone—film hard rubbed with cotton wad dipped in acetone	One rub removes the film	10th rub washes out the film
17.	Resistance to 2% NaoH solution—film immersed in the solution	Film dissolves in 10 min.	No effect up to 5 hours
18.	Resistance to concentrated acids:		
	(a) 50% V/V hydrochloric acid	Blushing within 30 min.	No effect up to 48 hours
	(b) 50% V/V nitric acid	do	do
	(c) 50% V/V acetic acid	do	do

TABLE VIII — FILM PROPERTIES OF AQUEOUS LAC-LINSEED-OIL VARNISHES

		De-waxed lac	*Linseed oil*
		ratio	
		1:1	2:1
1.	Appearance of the varnish	Clear homogeneous solution	Clear homogeneous solution
2.	Solid content	20%	20%
3.	Baking time (optimum)	30 minutes	30 minutes
4.	Baking temperature	150°C.	150°C.
	PROPERTIES OF THE BAKED FILMS		
5.	Film appearance	Golden, smooth, hard and glossy	Golden, smooth, hard and glossy
6.	Flexibility (film bent round 3 mm. mandrel)	No cracks	No cracks
7.	Water-resistance of the films on glass slides (immersed in water for 7 days)	No blush or lifting	No blush or lifting
8.	Scratch hardness, load on 1 mm. steel ball in gm.	1400	1600
9.	Resistance to spirit-films immersed in spirit for 3 months	No softening, lifting or loss of gloss	No softening, lifting or loss of gloss
10.	Resistance to lubricating oil (samples on glass slide immersed for 7 days)	No effect	No effect
11.	Resistance to aromatic solvents (films immersed in the respective solvents for 7 days)		
	(a) Benzene	No effect	No effect
	(b) Toluene	do	do
	(c) White spirit	do	do
	(d) Solvent naphtha	do	do
12.	Resistance to acetone, film hard rubbed with cotton wad soaked with acetone	30 rubs removes the film	50 rubs no effect

TABLE IX — STATEMENT OF SALE FIGURES OF PRODUCTION UNIT FOR CONSECUTIVE 3 YEARS

Materials	1961-62		1962-63		1963-64	
	Quantity kg.	Price Rs. P.	Quantity kg.	Price Rs. P.	Quantity kg.	Price Rs. P.
1. BRF grade bleached lac	302·27	2,763.83	645·50	4,617.58	1,160·55	8,090.91
2. BR grade bleached lac	98·65	806·21	278·60	1,717.45	649·14	3,897.33
3. DL grade water-soluble lac	101·75	701.84	298·80	1,876.86	681·30	4,099.87
4. AL grade water-soluble lac	143·98	818.44	138·75	730.98	121·20	661.09
5. ASK grade autoclave shellac	225·60	847.28	1,307·70	3,591.67	311·20	897.60
6. Lac wax	—	—	5·00	40.00	0·50	4.00
7. Miscellaneous products	—	—	—	—	—	413.80
TOTAL	873·25	5,937.60	2,694·35	12,574·54	2,923·39	18,064·10

APPENDIX C

Technical Preparation of Aleuritic Acid

Dissolve 100 parts of lac in 100 parts of water containing 17·5 parts of caustic soda at water bath temperature and the heating is continued for an hour more. This solution is then allowed to stand at room temperature for 8-10 days while crystals of sodium aleuritate separate out. The solution is diluted with 1 litre of saturated common salt solution with efficient stirring. A sufficient amount of a mixture of asbestos powder and fibre (50: 50) is mixed up and the solution filtered through a similar bed of asbestos and finally washed with 500 ml. of saturated common salt solution. The sodium aleuritate is then dissolved out of the asbestos with hot water. To the cold solution dilute sulphuric acid is added and the precipitated aleuritic acid is washed repeatedly with water to make it free from sulphuric acid. The crudi aleuritic acid is then decolourized and recrystallized from hot 30 per cent aqueous ethyl alcohol containing 1·0 N hydrochloric acid. The yield of pure aleuritic acid, m.p. 101°C., is 15-16 per cent.

APPENDIX D

List of Publications from the Institute during 1963-64

1. Bleached Lac, by B. B. Khanna [*Paint India*, Vol. **13**, No. 4 (1963), pp. 28].
2. Insulating Varnishes, by S. S. Chopra [*Engineering Times & Foundry News*, Vol. **6**, No. 10 (1963), pp. 25-27].
3. Emergence of Lac larvae from parasitized female lac insect '*Laccifer lacca* Kerr.', by B. P. Mehra and N. Mazumdar [*Science & Culture*, Vol. **29**, No. 4 (1963), pp. 203-6].
4. Occurrance of winged males of *Laccifer Lacca* (Kerr.) in *Aghani* 1962-63 Crop, by B. P. Mehra and N. S. Chouhan [*Indian Forester*, Vol. **89**, No. 11 (1963), pp. 757-8].
5. Damage to Lac Crops by Monkeys, by R. S. Gokulpure, B. P. Mehra and S. Krishnaswamy [*Indian Forester*, Vol. **89**, No. 4 (1963), pp. 291-2].
6. Determination of optimum quantity of broodlac for crop inoculation: Part I — *Kusmi* Lac Crop, by S. Krishnaswami, B. K. Purkayastha and N. Mazumdar [*Indian Forester*, Vol. **89**, No. 8 (1963), pp. 540-49].
7. Abnormal incidence of *Holotrichia, serrata* F. (Melolonthidae: Coleoptera), by S. Krishnaswami, M. R. Ghosh, N. Mazumdar and Y. S. Krishnan [*Indian Journal of Entomology*, Vol. **25**, Part IV (1963), pp. 381-2].
8. Driage in *Ari* Sticklac from *Palas* (Butea monosperma), by C. P. Malhotra and S. N. Sharma [*Indian Forester*, Vol. **89**, No. 11 (1963), pp. 736].
9. A new plan of lac cultivation on *Palas* (Butea monosperma) in hot areas by C. P. Malhotra [*Proc.* 50th *Ind. Sci. Cong.* (1963) Part II, pp. 598].

APPENDIX E

List of Patents Accepted

(1) No. 81054 — Manufacture and use of shellac-based sprayable picture varnish for the preservation of works of arts, by O. P. Ratra.

(2) No. 82257 — A process for the manufacture of a reconstituted or modified shellac and varnish composition containing the same, by Y. Sankaranarayanan, A. K. Sengupta and S. S. Chopra.

List of Patents Applied for

(1) No. 88758 — A process for the preparation of heat- and water-proof shellac varnish, by Shravan Kumar and Y. Sankaranarayanan.

(2) No. 88878 — A process for the preparation of aqueous Shellac-drying oil varnishes, by Shravan Kumar and Y. Sankaranarayanan.

APPENDIX F

Statement, Showing Appointments, Promotions, Resignations, Retirement, etc., during 1963-64

APPOINTMENT

Administrative Section

1.	Dr. G. S. Misra, Director	21 November 1963
2.	Sri Ram Baran Singh, Junior Clerk	2 November 1963
3.	Sri Harihar Prasad Sah, Junior Clerk	4 November 1963
4.	Sri Kuldip Pandey, Junior Clerk	31 March 1964
5.	Sri Tumna Munda, Assistant Mechanic	1 June 1963
6.	Sri Govind Prasad Sinha, Instrument Maker	6 November 1963
7.	Sri Dharam Nath Mahto, Labour Supervisor	1 August 1963
8.	Sri Budhu Ram, Sweeper	22 July 1963

Chemistry Division

1.	Sri Ujjal Banerjee, Chemical Engineer	5 September 1963
2.	Sri Premchandra Gupta, Research Assistant	12 February 1964
3.	Sri Tribeni Sahu, Research Assistant	22 February 1964
4.	Sri Ram Nagina Singh, Junior Analyst	1 May 1963

Entomology Division

1.	Dr. P. N. Srivastava, Scientific Officer (Insect Geneticist)	29 July 1963
2.	Sri Sashi Sekhar Sinha, Research Assistant	28 January 1964
3.	Sri Shaligram Chowdhury, Research Assistant	19 February 1964
4.	Sri Bhudeb Ch. Ghosh, Research Assistant	16 March 1964
5.	Sri Ram Deo Pathak, Laboratory Assistant	2 November 1963

PROMOTION

Administrative Section

1.	Sri P. C. Ghosh, Technical Assistant to Director	30 November 1963
2.	Sri S. K. Sarkar, Assistant	9 August 1963
3.	Sri L. M. Nandy, Assistant	9 August 1963

4.	Sri Surendra Prasad, Assistant	2 December 1963
5.	Miss Thresiamma, Stenographer, Gr. I. (*Transferred from C.L.D.O's Office*)	11 November 1963
6.	Sri D. P. Sengupta, Store-keeper	25 April 1963
7.	Sri A. K. Saha, Stenographer, Gr. II (*Transferred to C.L.D.O's Office*)	11 November 1963
8.	Sri S. K. Das, Senior Clerk (*Transferred to Secy. I.L.C.C's Office*)	9 October 1963
9.	Sri A. Haque, Junior Clerk	1 June 1963
10.	Sri K. P. Keshri, Junior Clerk	1 June 1963
11.	Sri S. C. Mehtha, Junior Clerk	30 October 1963

Chemistry Division

1.	Dr. T. Bhowmik, Sr. Scientific Officer (Utilization)	24 December 1963
2.	Sri A. Kumar, Sr. Research Assistant	30 November 1963
3.	Sri A. Rahman, Research Assistant, Transferred from Analyst	25 January 1964 (A/N)
4.	Sri Minhajul Islam, Analyst	25 January 1964
5.	Sri P. K. Ghosh, Jr. Scientific Officer (Production)	10 March 1964

Entomology Division

1.	Sri B. P. Mehra, Scientific Officer (Cultivation)	10 March 1964
2.	Sri C. P. Malhotra, Scientific Officer (Field Station)	10 March 1964
3.	Sri Netai Mazumdar, Senior Research Assistant	19 March 1964

Resignation

Administrative Section

1.	Sri T. T. Sammuel, Junior Clerk	31 May 1963 (F/N)
2.	Sri Chandra Mani Dubey, Chowkidar	12 June 1963 (F/N)
3.	Sri Sitaram Jha, Labour Supervisor	31 July 1963
4.	Sri S. C. Mahtha, Junior Clerk	19 March 1964 (A/N)
5.	Sri P. S. S. Kumar, Assistant Mechanic	7 April 1963 (A/N)

Chemistry Division

1.	Sri Subodh Ch. Sinha, Senior Research Assistant	15 July 1963
2.	Sri V. S. Saxena, Research Assistant	26 August 1963 (F/N)
3.	Sri Surendra Pd. Srivastava, Junior Research Assistant	3 February 1964 (F/N)
4.	Sri Ram Nagina Singh, Junior Research Assistant	1 March 1964 (F/N)
5.	Sri V. S. Iyer, Senior Research Assistant	13 March 1964

Entomology Division

1.	Dr. T. P. S. Teotia, Entomologist	27 October 1963 (A/N)
2.	Sri K. R. Nomani, Research Assistant	13 September 1963 (A/N)
3.	Sri D. N. Prasad, Junior Research Assistant	13 September 1963 (A/N)
4.	Sri Y. S. Krishnan, Senior Research Assistant	23 September 1963
5.	Sri Manoranjan Verma, Research Assistant	17 July 1963 (A/N)
6.	Sri V. K. Sehgal, Senior Research Assistant	23 September 1963
7.	Sri R. Viswanathan, Scientific Officer (Physiology)	10 December 1963

RETIRED

Administrative Section

1. Sri Ledwa Oraon, Bullock Keeper — Leave preparatory to retirement 1 March 1963
2. Mt. Lachmania Hari, Sweepress — Leave preparatory to retirement 22 July 1963

The Designations of the following posts have been changed with effect from 8.4.1963

1.	Organic Chemist	to Senior Scientific Officer (Organic)
2.	Physical Chemist	to Scientific Officer (Physical)
3.	Shellac Utilization Officer	to Scientific Officer (Utilization)
4.	Senior Scientific Officer (Utilization of by-products)	to Scientific Officer (Applied)
5.	Senior Scientific Officer (Protective & Decorative Coatings)	to Scientific Officer (Decorative Coatings)
6.	Senior Scientific Officer (Leather Finishes)	to Scientific Officer (Leather Finishes)
7.	Biologist	to Scientific Officer (Biology)
8.	Insect Geneticist	to Scientific Officer (Insect Genetics)
9.	Insect Physiologist	to Scientific Officer (Insect Physiology)

The following posts have been upgraded with effect from 8.4.1963

1.	Factory Officer (350-900)	to Scientific Officer (Factory) (400-950)
2.	Production Manager (Rs. 325-575)	to Junior Scientific Officer (Production) (Rs. 350-900)
3.	Scientific Officer (Field Research) (350-900)	to Scientific Officer (Field Research) (Rs. 400-950)
4.	Scientific Officer (Cultivation & Training) (Rs. 350-900)	to Scientific Officer (Cultivation & Training) (Rs. 400-950)
5.	Scientific Officer (Arboriculture) (Rs. 350-900)	to Scientific Officer (Arboriculture) (Rs. 400-950)

A new post of Senior Scientific Officer (Utilization) has been created with effect from 8.4.1963 *in the scale of pay Rs.* 700-1250.

APPENDIX G

Statistics of Production in Quintals of Sticklac during the Years 1961-62 to 1963-64

Year	*Baisakhi*	*Jethwi*	*Katki*	*Aghani*	*Total*
1963-64	2,13,866	11,944	47,215	14,183	2,87,208
1962-63	3,06,058	11,196	65,317	34,151	4,16,722
1961-62	2,09,020	11,580	1,46,320	18,660	3,85,580

Note: Figures for the year 1963-64 are provisional.

APPENDIX H

Tabulated Statement of Progress of Investigation

ENTOMOLOGY DIVISION

Item	Date commenced	Progress	Remarks
IIA — Research and investigations			
1. Potentiality trials on *ber*			
(i) Determination of optimum density of larval settlement for *ber* in *Katki* season	1962	The usual three brood rates are being used. Normal brood rate (treatment B) gave the maximum brood.	To be continued
(ii) Determination of proper time of harvesting and optimum density of larval settlement for *ber* in *Baisakhi* season	1961	Nine treatments are being tried. $\frac{1}{2}$N brood rate and harvesting in May (Treatment D) gave the maximum brood to yield ratio for harvesting as *Ari* lac, and normal brood rate (Treatment H) gave maximum brood to yield ratio at crop maturity	To be continued
(iii) Studies on the response of *ber* to pruning for growing *Katki* crops	1960-61	No crop was taken this year. A crop will be taken in 1964.	To be continued
2. Potentiality trials on *palas*			
(i) Determination of optimum density of larval settlement on *palas* in hot areas (at Kundri)	1963	Fourteen treatments under trial. Trees in treatments A to H to be inoculated heavily and harvested in April 1964. Trees in Treatments I to N to be lightly inoculated, left for self-inoculation in June/July 1964 and completely harvested in October 1964.	To be continued
(ii) Studies on the proper time of harvesting-cum-pruning on *palas* within April-May	1963	Attempts are being made to combine pruning and harvesting in one operation so as to cut down the cost of cultivation. Five treatments are being tried.	To be continued
(iii) Studies on the proper time of harvesting-cum-pruning on *palas* within October/November	1962	Object of the experiment is same as at 2(ii). Three treatments are being tried. Standing crop inoculated in October/November 1963 will be harvested in October/November 1964.	To be continued
(iv) Evolution of a cultivation practice for *palas* at Kundri for maximum crop production at minimum cost and working out economics	1959	(a) Four treatments under trial. Light inoculation in October/November followed by complete harvesting in October/November next (Treatment D) showed the maximum brood used to brood yield ratio, namely 1 : 9·0.	To be continued
		(b) 1000 trees were heavily inoculated and an equal number lightly inoculated as under treatments A and D above respectively. The latter showed slightly better result with 0·596 kg. yield per tree and the ratio of brood used to yield obtained was 1 : 9·2.	To be continued

APPENDIX H (*Contd.*)

Item	Date commenced	Progress	Remarks
(v) Large-scale cultivation experiments on *palas*	1948-49	Nearly 20,000 trees were under lac. Expenditure Rs. 4,612.96 and Revenue Rs. 3,777.99. Loss due to fall in price.	To be continued
3. Potentiality trials on *Moghania macrophylla*			
(i) Evolution of a cultivation schedule and determination of optimum density of larval settlement on *M. macrophylla* for growing *Aghani* and *Jethwi* crops	1963	The experiment is being laid out on a two-acre plot in the Institute Plantation.	To be continued
(ii) Spacing trials on *Moghania macrophylla*	1960-61	Three spacings are being tried. Spacing 4′×4′ (Treatment C) gave the highest yield per acre.	To be continued
(iii) Working out plantation technique of raising *M. macrophylla*	1961	Ten treatments are being tried. Transplanting of 2 April raised seedlings per pit (Treatment H) showed the highest average total length of shoots and their number.	To be continued
(iv) Effect of NPK on the yield of lac on *M. macrophylla* (both with organic and inorganic manures)	1962	Eight treatments by supplying nitrogen, phosphorus and potassium alone and in combinations are being tried, supply of nitrogen and potassium (Treatment F) gave better results in terms of yield of lac per tree as well as brood to yield ratio.	To be continued
(v) Effect of different levels of nitrogen on the growth of *M. macrophylla* bushes	1962	Five levels of nitrogen are being tried in the form of ammonium sulphate. 40 kg. ammonium sulphate per acre (Treatment E) showed the best results in respect of height growth and total length of shoots. There was, however, no significant difference in respect of crop yield.	To be continued
4. Permanent field experiment for working out economics of cultivation for *Kusmi* lac on *M. macrophylla* under different conditions of manuring and irrigation	1963	Two treatments, i.e. with and without irrigation along with 4 sub-treatment, e.g. (i) no manuring (control), (ii) organic manure (farm-yard manure), (iii) inorganic manure (nitrogen, phosphorus and potassium), and (iv) mixture of organic fertilizers will be tried. All other economical factors have also been taken care of.	To be continued
5. Evolution of a cultivation practice for *kusum* at Hesal for maximum crop production at minimum cost and working out economics	1961	Three treatments are being tried, 1-year rest (Treatment A) gave the highest yield in *Jethwi* 1963 and 2-year rest gave the highest yield in *Aghani* 1963-64.	To be continued
6. Finding out alternate hosts for the *Kusmi* strain of lac insect and conducting experiments on them	1962	Only *Albizzia lucida* and *Ougeinia oojeinensis* are being tried as alternate hosts at present. *Jethwi* 1963 crop was a failure.	To be continued

APPENDIX H (*Contd.*)

Item	Date commenced	Progress	Remarks
7. Physiological studies			
(i) Studies on the rate of secretion and composition of honeydew of the lac insect	1963	Free amino-acids and sugars of the total extract of the mature female lac insects being determined chromatographically. At least 8 spots of free amino-acids and 3 of sugars were detected. Similar studies with honeydew are under study.	To be continued
(ii) Studies on the requirements of major, minor and trace elements and their influence on resin secretion, sex ratio and fecundity, etc., of the lac insect	1963	*Katki* 1963 crop raised on seedlings in culture bottles matured in December, thus taking much longer than in nature.	To be continued
8. Genetical and breeding studies			
(i) Collection of various species, races and strains of lac insects from different geographical areas in the country and from neighbouring countries, and studies on their isolation taxonomic characters and performance	1963	Samples are being collected. Slides of female bodies made from older specimens of the collection, indicate that *Laccifer lacca* (Kerr) is a very polymorphic species and other species are mixed with it.	To be continued
(ii) Studies on crosses between (a) *Rangeeni* and *Kusmi* strains of lac insect and also (b) between the two colour forms of *Rangeeni* strain	1962	(a) *Baisakhi* females of F_1 generation from a previous crossing of *Rangeeni* females and *Kusmi* males behaved like *Rangeeni* insects and produced F_2 generation in June-July 1963, of which about 76 per cent behaved like *Rangeeni* strain and produced a progeny in October/November 1963 and the rest behaved like *Kusmi* strain and produced a progeny in December/January. Similar results were obtained from the crossing of *Kusmi* females with *Rangeeni* males. (b) Crossing of *Kusmi* crimson female and *Rangeeni* yellow male showed crimson as dominant colour. Segregation of colours was observed in F_2 generation.	To be continued
(iii) Evolution of a better yielding strain of lac insect through selection	1962	Bold females crossed with bold males showed practically no difference in size in comparison to normal individuals after four generations of continuous breeding.	To be continued
(iv) Isolation of a pure yellow strain of lac insect	1962	A pure yellow strain could be segregated in the F_2 generation. A bigger colony is expected next season for chemical analysis of the resin.	To be continued

APPENDIX H (*Contd.*)

Item	Date commenced	Progress	Remarks
(v) Studies on the chromosomal cytology of different strains of lac insect	1961	Females of *Rangeeni, Kusmi* and yellow strains have a diploid complement of 18 chromosomes. Exact taxonomic position of these strains could not be ascertained. Their males also carry 18 chromosomes as the 2n number. Peculiar behaviour and heterochromatization of one set of nuclei of these 18 chromosomes were recorded.	To be continued
(vi) Studies on the mode of oogenesis and spermatogenesis of the different strains of lac insect	1962	Study on spermatogenesis has been completed and work on oogenesis is progressing.	To be continued
(vii) Breeding studies on the yellow variety of lac insect in relation to host specificity	1962	Yellow females of *Baisakhi* 1962-63 (Progeny of lac on *Ficus* sp. from Delhi) inoculated on *Accacia farnesiana* and *ber* and progeny of lac from Jodhpur inoculated on *M. macrophylla, A. lucida, A. farnesiana* and *ber* showed no effect of host plant on the colour of lac insect.	To be continued
9. Biological and ecological studies			
(i) Collecting the pests of host trees and studies on the life-history and control operations against important pests			
(1) *Thiacidas postica* Walker	1962	Pest of *ber*. Active from June to September, peak period July and August, 24·3 per cent field parasitization.	Concluded
(2) *Hypena iconicalis* Walker	1962	Pest of *M. macrophylla*. Active from May to October, peak period July and August. Defoliates fresh leaves. Field collected eggs studied — larval period 6-7 days for 5 larval instars, pupal 7-8 days, longevity of males 2-4 days and of females 4-7 days.	To be continued
(3) *Hemithea tritonaria* Walker	1962	Pest of *M. macrophylla*. Passed through 9 generations between October 1962 and September 1963. Active from June to February. 10·5 per cent (out of 114) larvae were found parasitized. One Braconid and two Ichneumonid parasites collected.	Concluded
(4) *Nephopteryx leucophaella* Zell	1962	Binder-cum-skeletonizer of *M. macrophylla*. 7th generation continuing.	To be continued
(5) Unidentified	1963	Leaf binder-cum-defoliator on *M. macrophylla*. Tender apical leaves affected. Active from June to January, 4 generations reared in field cages.	To be continued
(6) Tussock-moth	1963	Defoliator of *M. macrophylla*. Active from July to October. 4 generations reared till October.	To be continued

APPENDIX H (*Contd.*)

Item	Date commenced	Progress	Remarks
(7) Unidentified	1962	Defoliator of *ghont* active from July to October. Also collected from *M. macrophylla* during November and December and from *ber* in January, two generations reared from material from *ghont* and one from that on *ber*.	To be continued
(b) On other lac hosts			
(1) *Holotrichia serrata* Feb.	1961	Pest of *palas*. One generation a year. Adults found only between April to July, with a peak period in June. Development in 170·6 days on an average. Pre-oviposition period 53·6 days where winter did not intervene and 195·2 days where winter intervened between emergence of adult and egg laying.	Concluded
(2) Leaf-binder of rain tree	1963	Active from July to September. Larvae hide in unopened leaflets and scrape epidermis from inside. More leaflets are gradually drawn together to form nests. Eggs hatch within 2-3 days. Larval period 15-18 days and pupal period 5-8 days.	Concluded
(3) Defoliator of *Grewia multiflora*	1963	Active from June to September feeding on young or old leaves, leaving only thick veins. Eggs green. Newly hatched larvae black with 2 white bands on thorax. Moult five times, larval period 12-15 days. Pupal period 8-10 days.	To be continued
10. Biological control of lac enemies			
(i) Life-history studies and developing breeding techniques for important indigenous parasites			
(a) *Brachymeria tachardiae* (Cam.)		Pupal parasite of *Eublemma amabilis* Moore and *Holcocera pulverea* Meyr. Breeding being attempted. 8th generation being continued.	To be continued
(b) *Elasmus claripennis* (Cam.)	1962	Continuous breeding affected by mites. 23·7 per cent field parasitization in 80 field collected larvae. Single host may harbour 2-20 parasites. 97 parasites collected from 19 hosts.	To be continued
(ii) Mass breeding and large-scale liberation of *Apanteles tachardiae* and *Bracon greeni* in the field and estimation of the effect of these liberations	1957	A new site is to be selected for releases. 57,123 adult *A. tachardiae* (19,653 females and 37,470 males) bred in the laboratory at room temperature.	To be continued
(iii) Ecological studies including the influence of various temperature and humidity conditions on the	1963	Observations on ovi-positional activities, fecundity and longevity taken at controlled temperatures. Fecundity increased and pre-ovipositional and ovipositional periods and longe-	To be continued

APPENDIX H (*Contd.*)

Item	Date commenced	Progress	Remarks
growth and development of lac insect predators *E. amabilis* and *H. pulverea*		vity decreased with the increase in temperature from 15°C. to 30°C. Practically no egg laying and further decrease in longevity took place at 35°C.	
11. Chemical control of parasites and predators of lac insect	1963	Only cryolite and dieldrex were used. 20 treatments with 4 levels of insecticidal treatment and 5 levels of number of sprays are being tried in replications. No inference drawn from *Aghani* 1963-64 crop.	To be continued
IIB — Regional Field Researgh Stations			
1. Jhalda (W. Bengal)			
(i) Studies on spurious emergence of larvae in *Kusum* lac	1959	*Kusum* trees being inoculated with pure *kusum, ber* and *palas* and mixed broods. Mild spurious emergence was observed in *Aghani* 1963-64 crop.	To be continued
(ii) Alternative *Kusmi* hosts	1959	*Protium serratum, Ficus arnottiana* and *M. macrophylla* have shown encouraging results.	To be continued
(iii) Relative importance of enemy and friendly insects	1959	No new insects were encountered.	To be continued
2. Damoh (M.P.)			
(i) Pruning response of *ghoni*	1959	April-pruning for *Baisakhi* crop (Treatment A) and pruning in May of previous year (Treatment D) for *Katki* crop showed better results.	To be continued
(ii) Optimum brood requirement for *ghoni*	1959	No conclusions could be drawn from *Baisakhi* 1962-63 and *Katki* 1963 crops. Treatments have been revised.	To be continued
(iii) Evolution of a cultivation practice for *ghoni*	1961	In *Baisakhi* 1962-63 crop pruning in April, normal inoculation in October/November, partial harvesting in June-July and complete harvesting in October/November (Treatment B) showed the best result in terms of brood used to yield ratio. Normal brood rate revised and two treatments added.	To be continued
(iv) Permanent field experiment on *M. macrophylla* for *Rangeeni* and *Kusmi* lacs	1963	8 treatments in combination of irrigation, no irrigation, use of farmyard manure, inorganic fertilizer, mixture of the two and no manure or fertilizer, being tried. Two sepafate experiments for *Rangeeni* and *Kusmi* strains will be tried. *Rangeeni* experiment laid out.	To be continued
(v) Trials with regional hosts	1959	*Baisakhi* 1962-63 and *Katki* 1963 succeeded on *palas* only.	To be continued
(vi) Introduction of regional or exotic hosts	1959	*S. saman* and *A. lucida* are growing satisfactorily.	To be continued
(vii) Relative importance of enemy and friendly insects	1959	*Coccidiphaga scitula* (Ramb.) collected from *Baisakhi* 1962-63 crop.	To be continued

APPENDIX H (*Contd.*)

Item	Date commenced	Progress	Remarks
3. Mirzapur (U.P.)			
(i) Pruning response of *ghont*	1960	*Baisakhi* 1962-63 and *Katki* 1963 crops completely failed.	To be continued
(ii) Optimum brood requirement for *ghont* and *palas*	1960	*Baisakhi* 1962-63 crop failed on ghont. Half-normal brood rate (Treatment A) showed better results on *palas*. Double-normal brood rate (Treatment C) on *ghont* and normal brood rate (Treatment B) on *palas* showed better results in *Katki* 1963 crop.	To be continued
(iii) Evolution of a cultivation practice for *ghont* and *palas*	1960	*Baisakhi* 1962-63 failed on *ghont*. Pruning in April, light inoculation in October/November, partial harvesting in June/July and complete harvesting in October/November (Treatment A) showed the best result on *palas*. Normal brood rate revised.	To be continued
(iv) Permanent field experiment on *M. macrophylla* for *Rangeeni* and *Kusmi* lacs	1963	Being conducted on the same lines as at Damoh. Experiment for *Rangeeni* lac laid out.	To be continued
(v) Trials with regional hosts	1960	*Cassia fistula* carried *Baisakhi* 1962-63 and 1963-64 and *Katki* 1963 was on *Kuchai*.	To be continued
(vi) Introduction of regional or exotic hosts	1960	Only a few *S. saman* and *A. lucida* trees are surviving.	To be continued
(vii) Relative importance of enemy and friendly insects	1960	New parasites have been identified as *Agathis coryphe* Nixon (Braconidae), a parasite of *H. pulverea* from caged lac and *Monodontomerus Sp. nr. aereus* (Wlk.) (Hymenoptera: Torymidae) from caged *Baisakhi* 1962-63 lac.	To be continued
4. Umaria (M.P.)			
(i) Evolution of a cultivation practice for *kusum*	1961	Three treatments as under item 5 being tried. Experiment hampered due to unavailability of brood in July 1963 and February 1964.	To be continued
(ii) Trials with regional hosts	1961	Only *Acacia catechu* (*khair*) gave a little *Aghani* 1963-64 crop. Performance of the hosts is under study.	To be continued
(iii) Introduction of regional or exotic hosts	1961	Some *M. macrophylla* plants are developing in spite of termite attack and setback due to no irrigation facilities.	To be continued
(iv) Relative importance of enemy and friendly insects	1961	New parasites emerged from caged *Aghani* 1962-63 crop have been identified as *Agathis coryphe* Nixon (Braconidae), *Apanteles* Sp. (Braconidae) and *Scambus* sp. (Ichneumonidae).	To be continued
IIC — Sponsored Research	1961	Two Junior Fellowships @ Rs. 250 per month each for two years awarded to one candidate each at Aligarh Muslim University and Ranchi College, Ranchi.	

APPENDIX H (*Contd.*)

Item	Date commenced	Progress	Remarks
(a) Aligarh (U.P.)			
The morphology and biology of some parasites associated with lac insects	1961	A new parasite *Parageniaspis indica* Alam (Hymenoptera: Encyrtidae) was discovered and described in detail. Only the morphology has been dealt with. No work done on the biology of the insect. Two more parasites belonging to Braconidae: Eulophidae were identified up to the family.	
(b) Ranchi (Bihar)			
Histological studies on the seasonal variation in the gonads of the lac insect	1961	Developmental stages, the structure, origin and homologies of the different parts of the reproductive systems of both sexes, differences in time of maturity of reproductive systems in various crops were studied. Histology of different parts of reproductive system of both sexes and growth rate of female insect in pregestational period, chromosomal complement of somatic cells and their behaviour during somatic divisions, spermatogenesis, oogenesis, etc., were studied.	
III — Plantation at Namkum		General upkeep maintained. *M. macrophylla* and other lac hosts raised. Dead and diseased hosts removed for replacement.	
IV — Training and Advisory Service			
(i) Training		Twenty trainees completed 6-months course in two sessions. One trainee completed 1-month course.	
(ii) Extension and Advisory Service		Technical advise given and specimens, exhibits and literature sent to various parties including Vigyan Mandirs. Extension lectures delivered at Forest Institutions.	

APPENDIX H (*Contd.*)

CHEMISTRY DIVISION

Item	Date Commenced	Progress	Remarks
I. Grading and Analysis			
1. Bleach index/bleachability	1957	As suggested by some members of ISO/TC-50, experiments have been conducted with different types of photoelectric colorimeter and suitable filter (480 mμ) has been recommended.	To be continued
2. Correlation of quality especially colour of sticklac with areas of cultivation	1960	Twelve more samples of sticklac have been received and are being examined.	To be continued
3. Determination of age of lac	1962	The variation in the values of specific heat of seedlac with temperature has been studied and found reproducible. The results are being analysed to correlate with the age of seedlac. Calorimeter has been modified for studying the specific heat of bleached lac.	To be continued
II — Improvement in the manufacture of seedlac, shellac, bleached lac, etc.			
1. Making of shellac using soft coke in place of charcoal		Further work has shown that replacement of charcoal by soft coke reduces the cost by Rs. 3.15 per quintal of seedlac processed.	Concluded
2. Economic utilization of the by-products			
(a) Recovery of lac from refuse lac	1962	Shellac has been prepared by alkali extraction method from refuse lac of commerce known as *Bholé Kunhi*.	To be continued
(b) Recovery of wax lost during the processing of sticklac into seedlac	1962	Pilot plant scale trials have been carried out for the recovery of wax from the acid precipitated sludge of the factory effluent. The wax could be extracted up to over 90 per cent with commercial hexane. Aluminium body for the plant is recommended to obtain a colourless variety.	Completed
3. Use of oxalic acid in the processing of seedlac to shellac and the effect thereof	1963	Effect of oxalic acid on the processing of seedlac to shellac has been studied. Preliminary experiments have shown that it affects the flow and life of the shellac with slight improvement in colour.	To be continued
4. Rotary drier for seedlac	1963	Successful pilot plant scale experiments have been carried out for drying seedlac in a continuous rotary drier at the Delhi Polytechnic Institute. Based on these drying trials the details of a full-scale rotary drier for commercial operation have been worked out.	To be continued

APPENDIX H (*Contd.*)

Item	Date commenced	Progress	Remarks
5. Solvent extraction plant for reclamation of lac from waste products	1963	The details for a continuous solvent extraction plant for reclamation of lac from waste products have been worked out.	To be continued
III — Fundamental Research			
1. Constitutional studies			
(a) Separation and study of the neutral fraction	1961	The neutral fraction after dewaxing and decolourization has been obtained as a solid, m.p. 49°C. Paper chromatographic studies showed it to be a mixture of components and not a single entity as was believed earlier.	To be continued
(b) Isolation and identification of free fatty acids present in shellac	1963	Dewaxed shellac has been chromatographed on cellulose column with hexane and a number of fractions collected. The fractions are being rechromatographed and the individual acidic fractions isolated and identified by thin layer chromatography and other methods.	To be continued
IV — Modification and uses			
1. Modification of lac with di-isocyanate	1961	The brittleness of films from lac-di-isocyanate varnish has been overcome by the addition of dibutyl phthalate (15 per cent).	To be continued
2. Shellac Etch Primer (Single pack)			
(a) Modification of the primer	1957	Incorporation of polyvinyl butyral to shellac etch primer has improved its adhesion and weather resistance on steel surfaces but the storage life of the primer is not satisfactory.	To be continued
(b) Natural and dynamic weathering		The weathering test continues to be satisfactory after the expiry of the third year.	To be continued
3. Modification of shellac with synthetic resins			
(a) Heat- and water-proof shellac varnish	1962	Shellac varnish modified with butylated melamine resin has been found to stand the natural weathering test well and to give a satisfactory protective coating to brass and copper. It has got a good storage life. The exact nature of chemical combination of the two resins is in progress.	To be continued
(b) Modified shellac varnish for use as tin plate lacquer	1962	Shellac varnish modified with urea resin has been found to possess, after baking, excellent resistance to alcohol, aromatic solvents, boiling water and dilute acids, etc. It has got a storage life and stood the accelerated weathering test.	To be continued

APPENDIX H (*Contd.*)

Item	Date commenced	Progress	Remarks
(c) Modification of lac with epoxy resins	1964	Shellac varnish modified with epoxy resins has been found to give baked films having outstanding adhesion, flexibility and excellent resistance to solvents, chemicals, boiling water, etc., and to accelerated weathering test.	To be continued
4. Aqueous shellac-drying oil varnishes			
(a) Lac-*tung* oil varnish	1962	The baked films have been tested further and found to be resistant to alcohol, aromatic hydrocarbons and to accelerated weathering test. The optimum conditions of maleinization of *tung* oil has been determined.	
(b) Lac-linseed oil varnishes		The varnish has been found to produce hard, smooth, glossy and flexible films on baking. Due to its elasticity, it is suitable for tin plate lacquering. In performance it compares with lac-*tung* oil varnish.	To be continued
5. Lac-drying oil insulating varnishes	1961	Test report of the varnish sample sent last year has been received. The varnish conformed to requirements of I.S.I. Specification No. 350-1952 except for higher viscosity and volatiles. Experiments have been conducted to modify these and successful results obtained. *Iso*-phthalic acid has been found to give better drying properties to the varnish.	Large-scale trials are being planned
6. Shellac-rosin combination and its use in oil varnishes	1963	Shellac and rosin in different propertions have been heated at 150°C. to find out the minimum quantity of rosin required to make shellac compatible with drying oils and soluble in hydrocarbon solvents.	To be continued
7. Lac-cashewnut shell liquid compositions			
(a) Hot melt composition for coating hessian	1963	Shellac has been reacted with cashewnut shell liquid at temperatures varying from 150°-200°C. to formulate a suitable hot melt composition for coating hessian. Hard but non-elastic films have been obtained so far.	To be continued
(b) Insulating varnish from shellac-cashewnut shell liquid combination	1963	Experiments to formulate insulating varnish using shellac, cashewnut shell liquid, drying oils and formaldehyde are in progress. Effect of bodied oils in the combination has also been studied	To be continued
8. Modification of lac by grafting	1964	Graft polymer of dewaxed lac and methyl methacrylate has been prepared and its properties are under study.	To be continued

APPENDIX H (*Contd.*)

Item	Date commenced	Progress	Remarks
9. Hydrolysed lac	1962	Hydrolysis of lac has been found to be complete in 5 hrs. at 97°C. with 30-40 per cent excess (2*N*) alkali.	
10. Technical preparation of aleuritic acid	1962	A satisfactory method for the preparation of technical aleuritic acid has been worked out.	
11. *Ad hoc* work			
(a) Composition for filling crevices of plywood	1963	A satisfactory composition has been formulated by mixing barytes in 25 per cent shellac solution.	Completed
(b) Wax engravers	1963	A suitable compound has been prepared from shellac and saponified lac (6·5 : 3·5) for wax engravers.	Completed
V — Utilization of lac in India — Publicity and Propaganda			
1. Varnish and paints		Attempts have been continued to popularize book, paper and hair varnishes and also the newly developed heat- and water-proof varnish for which a few parties have shown keen interest.	
2. Shellac lacquer for brass metal-ware		Two satisfactory formulations have been tried and the samples sent to Handicraft Board for examination.	
3. Shellac etch primer		The performance of the etch primer on aluminium bodies has been found satisfactory by the Western and South Eastern Railways and State Transport Corporations. The Agricultural Ministry has kindly authorized the Secretary, Indian Lac Cess Committee to issue circular letters on this subject to all other Ministries and Departments concerned requesting the use of the primer where suitable.	
4. Adhesive and cements		At the request of Indian Standard Institution a tentative draft specification for shellac jointing compound has been prepared and sent to the Institution for comments, etc.	
5. Water-soluble lac		Use of water-soluble lac for photo-engraving has been developed in collaboration with Shri B. Mazumdar of School of Printing Technology, Calcutta and its consumption in this field is gradually increasing.	
6. Bleached lac		Demand for refined bleached lac has increased. Representatives of several firms have been trained in the manufacture of bleached lac. They and some other firms have started its manufacture.	

APPENDIX H (*Contd.*)

ITEM	DATE COMMENCED	PROGRESS	REMARKS
7. Shellac coated tissue		Development of satisfactory paper-coating composition for wrapping chewing tobacco is under progress in collaboration with Central Tobacco Committee.	
8. Technical service to manufacturers and consumers		Fullest cooperation and technical service have been provided to manufacturers of seedlac, shellac and varnishes. Technical assistance has also been offered to restart the Government Shellac Factory at Umaria, M.P. and at Chaparmukh, Assam.	
9. Sticklac Processing Unit		Equipment and machinery to process 5,000 quintals of sticklac annually has been installed and preliminary trials carried out.	
10. Regional Testing Laboratory		As usual a large number of samples of of seedlac and shellac have been analysed.	
VI — PILOT PRODUCTION UNIT		The unit has sold 2,923·39 kg. of special shellacs valued at Rs. 17,650.80 and other miscellaneous products for Rs. 413.30 with a gross profit of Rs. 7,411.29 only.	
VII — SPONSORED RESEARCH SCHEMES			
1. Constitution of lac (a) At Delhi University		The hard resin has been converted to the chlororesin by passing hydrogen chloride gas in acetic acid solution; the alkaline hydrolysis of which yielded erythro-aleuritic acid to the extent of 30-35 per cent.	To be continued
(b) At National Chemical Laboratory, Poona		Perbenzoic acid oxidation of butolic acid has confirmed its structure as 6-hydroxymyristic acid. Hard resin has been hydrolysed and attempts made to detect and estimate the various acids by means of paper, thin layer and vapour phase chromatographic methods. Based on these findings a tentative composition has been put forward. The resin as such has been fractionated on column and a few constituent fractions obtained showing only two to three spots on thin layer chromatography.	To be continued
2. Lac dye scheme at National Chemical Laboratory, Poona		Laccaic and xantholaccaic acids have been fractionated into different components. The Mass, IR and NMR spectra of some of the components have been studied. The studies suggest that a group of the type — CH_2CH_2O — is present on the pur-	To be continued

APPENDIX H (*Contd.*)

ITEM	DATE COMMENCED	PROGRESS	REMARKS
		purin part of the molecule and that the dye as isolated is probably a mixture of very closely related compounds.	
3. Shellac-based leather finishes at Central Leather Research Institute, Madras		Shellac has been modified and a tack-free composition formulated for top gloss composition for leather. A method has been evolved in finishing chrome retan upper by an aqueous dispersion of shellac. A new type of retanning material has also been developed for impregnation of chrome tanned leathers. Studies for making shellac as a principal binder for leather finishing are in progress. Some preliminary studies have been made with shellac to prepare fat and chrome tanning liquors.	To be continued

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