INDIAN LAC RESEARCH INSTITUTE

NAMKUM, RANCHI, BIHAR, INDIA

ANNUAL REPORT

FOR THE FINANCIAL YEAR 1947-48

1949

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ADMINISTRATIVE SECTION

General — The unsatisfactory position of supply of chemicals and apparatus referred to in the previous reports continued throughout the year, apparently without hope of substantial improvement in the near future. Non-availability of machinery and apparatus for which enquiries have been pending for years has been felt to be a serious handicap.

As usual, the Institute continued to attract a large number of visitors. Some of these deserving special mention are named below :

(i) His Excellency Sir Hugh Dow, K.C.S., C.I.E., I.C.S., Governor of Bihar, and Lady Dow.
(ii) Dr. K. R. Krishnaswamy, D.Sc. (London), F.I.C., Director of Industries, Bihar.
(iii) Dr. J. S. Wilcock, B.A., O.B.E., I.C.S., Secretary, Development Department, Bihar.
(iv) Mr. K. B. Bhatia, B.Sc., O.B.E., I.C.S., Development Commissioner, U.P.

Roads & Buildings — No new construction was undertaken. Urgent petty repairs and white-washing were done. The part of road running from the central office to the plantation was thoroughly metalled.

Library — Foreign journals are being regularly received.

The Library registered a total accession of 131 volumes, including bound volumes of journals, during the per od under report.

Medical Aid — Free medical aid continued to be given to the staff as usual. This was the first year of the extension of free medical aid to the families of the members of staff.

Scheme for the Intensification of Demonstration of the Methods of Cultivation of Lac in Bengal, Bihar & U.P.— Details will be found in the appendices and also under appropriate headings in the report of the Entomological Section.

Training in the Industrial Uses of Lac — Three regular students received six months' training and they are to be awarded certificates of the Indian Lac Cess Committee. Two officers on deputation from the U.P. Government, and several casual students were also trained in selected items.

Training in the Improved Methods of Lac Cultivation — Altogether fifteen persons including two newly appointed Institute Demonstrators were trained in the improved methods of lac cultivation. Details will be found in the report of the Entomological Section.

Staff — The following appointments were made during the year :

1. Mr. A. Bhattacharya, M.Sc., as Class II Research Asstt. in the Entomological Section, on 6 December, 1947.
2. Mr. Edward Ekka, Demonstrator, on 1 May, 1947.
3. Mr. S. N. Sahay, Demonstrator, on 16 June, 1947.
4. Martin Beck, Office Peon, on 21 August, 1947.

Mr. C. Tirkey, a Laboratory Assistant, who had gone out on war-service, reverted to the Institute on 9 August, 1947.

The following members of staff resigned from the services of the Institute :

1. Mr. T. K. Roy, M.Sc., Class II Research Assistant, Chemical Section, on 2 July, 1947.
2. Mr. T. Venkatraman, M.Sc., Class II Research Assistant, Entomological Section, on 11 August, 1947.
3. Mr. D. N. Rai, Demonstrator, on 21 May, 1947.
4. Mr. Edward Ekka, Demonstrator, on 9 December, 1947.

Mr. B. Kullu, Laboratory Assistant, Entomological Section was discharged on 8 June, 1947 on Mr. C. Tirkey's reversion from military service.

Bonifus Runda, Lac Factory Boy, was discharged on 20 June, 1947.

Md. A. Khan, Demonstrator, was dismissed on 1 March, 1948.

The Staff Club — The Club gradually returned to its pre-war level of activities, except that all annual programmes of sports, amusements, competition and outings had been cancelled for the year out of respect to the sacred memory of Mahatma Gandhi.

ENTOMOLOGICAL SECTION

General — MR. P. M. GLOVER, Entomologist, proceeded on leave preparatory to retirement on 15 January, 1948 and MR. P. S. NEGI was appointed as officiating Entomologist.

The Assistant Entomologist was on leave for about four months and a half. Of the other three Research Assistants, one post was vacant throughout the year and another for about five months. The Department was short of one Fieldman throughout the year.

HOST TREES

1. IMPROVING CROP PRODUCTION ON *palas* (*Butea monosperma* SYN. *B. frondosa*) BY ARTIFICIAL PARTIAL DEFOLIATION IN KUNDRI FOREST AREA

In view of the satisfactory results obtained by investigations on artificial partial defoliation, a scheme was prepared in 1945, under which the Kundri Forest area of 421 acres was divided into three coupés (one to grow the *Katki* crop every year and the other two to grow *Baisakhi* in alternate years so that each of these two coupés gets in turn more than one year's rest). Partial defoliation was to be practised in *Baisakhi* coupés only immediately before infection for the crop in October. Following the Institute methods and in collaboration with the Institute, the Bihar Forest Department worked the scheme from October 1945 and good results were obtained as mentioned in the Report for 1946-47.

During the year under review all the lac-growing areas of Chotanagpur particularly Palamau District, where Kundri Forest is situated, experienced one of the worst summers that have occurred for many years. The intensity of the hot weather can be imagined from the fact that for the first time in its history, the Piparniha *bandh* (pond) of Kundri forest completely dried up. Added to this, in Palamau the monsoon did not break out till late July. Hence the *Baisakhi* 1946-47 crop grown on 12,400 defoliated trees developed under most adverse conditions possible. As a result, less than 40 per cent of normal crop was obtained in Palamau, and in July little brood lac was available in this as well as in most other districts of Chotanagpur. Conditions, however, were definitely better in the Government Forest, Kundri, where owing to artificial partial defoliation over 26 Bengal maunds of brood lac were obtained in July in addition to considerable quantity of brood left over on the trees in the *Baisakhi* coupé for natural infection for the succeeding *Katki* crop.

In October the yield of brood lac from *Katki* crop from 13,956 trees in Kundri Forest amounted to some 120 Bengal maunds. This seems to be very satisfactory considering that brood lac suppliers to the Institute, from practically the whole of Chotanagpur (comprising 5 districts), could supply only 38 Bengal maunds against an order for supply of 64 maunds.

Further, it may be pointed out by way of contrast that while owing to adoption of the Institute methods over 9,000 trees in Kundri Government Forest are carrying lac, Kundri village which still follows the old system of cultivation has practically no lac on their trees and the villagers are patiently waiting to buy brood lac in October 1948, to re-introduce lac cultivation on their trees.

Unfortunately, however, for some reasons, there has been a disturbance of the coupé system in Kundri, and a great wastage of *Baisakhi* brood lac on the trees themselves in 1946-47, resulting in infection of fewer trees. As a consequence, progress in Kundri has received a setback, and as conditions obtain now it will take at least another two years to rearrange the coupés and bring cultivation to the desired level and that too if only the Forest Department, which is highly pressed with the increased responsibilities of Zamindari Forests, can devote as much time and staff to Kundri as it was doing till the year 1946.

Kundri has continued to serve as an excellent training centre for the trainees. However, owing to an increase in the staff and work of the Forest Department, it is becoming

a problem to find sufficient housing accommodation for the trainees in Kundri during the crop seasons (July-August and October-November). This difficulty greatly tells upon their training as well as upon the quality of the work entrusted to them.

2. Determination of most suitable Pruning Methods & Seasons for *Kusum* & *Palas*

Kusum — There are two types of pruning under investigation at Hesal : (1) the normal ' Apical (Tip) ' pruning and (2) a new type of pruning named the ' Surface ' pruning (in which the tips of the main branches and shoots are not cut, but shoots arising from them are cut flush at the point of their origin). The latter type of pruning has been specially evolved to see if *kusum* may be made to yield lac crop every 6 or 12 months instead of once every 18 months as hithertofore. As a result of ' surface ' pruning conducted in January, 1947 excellent shoots were produced in 6 months but these could not be brought under cultivation in July, 1947 as brood lac was scarce ; for the same reason a second set of trees was not ' surface ' pruned for use in January or July, 1948. This has resulted in breaking the continuity of experiments for production of two crops on six-month-old shoots and one crop on twelve-month-old ' surface ' pruned shoots.

Hence in February, 1948, to study the growth of shoots and their capacity to bear lac crops, Hesal area has been divided into 12 coupés as shown below :

Table I

No. of coupés	Type of pruning to be practised	Age of shoots to be infected (in months)
4	Apical	18
3	Apical	12
3	Surface	12
2	Surface	6

One of the last-named coupés designed for infection of six-month-old shoots is the poorest of the lot both as regards the size and growth of trees as well as topography.

This study should be conducted undisturbed for at least three years to get conclusive results.

Lac Crops on Kusum — Climatic conditions in the whole of Chotanagpur during the hot weather months of 1947 were the worst for many years. As a result, throughout the lac-growing area *Jethwi* crop was extremely poor and *kusum* brood was unobtainable in July. The scarcity of good quality brood lac was responsible for the succeeding *Aghani* crop being also poor.

The brood to yield ratios of crops grown in Hesal, on shoots put forth respectively six months, twelve months and eighteen months after pruning are given in Table II. The reasons for low yield from six-month-old shoots are two : (1) formerly, for over eight years the trees had been used to grow crops on eighteen-month-old shoots by apical pruning, and they will, therefore, take some time to adapt themselves to the newly introduced ' surface ' pruning ; (2) the coupé containing these trees is the poorest as regards both topography and tree growth. The best results in both the crops were given by trees having eighteen-month-old shoots. The adverse climatic conditions had also something to do with the unsatisfactory crop yield here as in other parts of Chotanagpur ; the yields, however, were better than those obtained by cultivators elsewhere in Chotanagpur.

TABLE II

Brood to Yield Ratio from Kusum Shoots of Varying Age

Age of shoots (months)	Ratio of brood to yield of scraped lac	
	Jethwi 1947	*Aghani* 1947-48
18	1 : 1·05	1 : 1·19
12	1 : 0·8	1 : 1·08
6	1 : 0·4	Not infected

Growth of Shoots on Kusum — Results show that shoots resulting from crop cutting and pruning in January-February continue to come forth and grow linearly until April-May, when linear growth ceases for the year. From then onwards, the shoots mature and thicken only. Further linear growth or production of more than one shoot from points where growth may have normally stopped, or from other parts of the shoots occurs again the following spring only. However, during April, the growing points of a large percentage of shoots are damaged by insect pests and the result is the production of secondaries, which in their turn continue to grow till September unless they themselves are damaged in the meantime.

Shoots arising from pruning or crop cutting in June-July continue to grow linearly till September-October ; thereafter, growth is retarded and new growths do not appear till next spring. In September also, the growing points of most of the shoots are damaged by insect pests, as a result of which buds of secondary shoots begin to appear in October, but these do not grow vigorously till the following spring.

Normal growth of new shoots in *kusum* begins close on leaf-fall. The time of leaf-fall varies widely in different localities.

Palas — In all areas trees pruned in February and April produced good shoots to grow the *Katki* and *Baisakhi* crops respectively.

3. INVESTIGATIONS INTO THE ECONOMICS OF UTILIZING *Palas* FOR THE *Baisakhi* CROP ONLY & *Ber* FOR THE *Katki* CROP ONLY

This year, even in Ranchi plateau, there was practically no survival of brood lac for *Baisakhi* crop on *ber*, whereas *palas* was able to carry lac to brood stage in July. This fully confirms the findings of the previous years that *palas* carries *Baisakhi* crop better than *ber*.

The system of cultivation of lac on *ber* for the *Katki* crop and on *palas* for the *Baisakhi* crop is being recommended through the demonstration scheme to all cultivators who own both kinds of trees.

4. INVESTIGATION OF THE POSSIBILITIES OF *Albizzia lucida, Ficus bengalensis* & *Ougenia dalbergoides* AS *Baisakhi* BROOD-PRODUCING HOSTS

Best results were obtained from *A. lucida*, the ratio of brood used to brood yield being 1 : 4·6. *Ougenia dalbergoides* (*pandan*) gave good results on defoliated *palas*. Out of three *F. bengalensis* (*barh*) brood lac survived on one tree only.

For the next year (1948-49) no *A. lucida* or *F. bengalensis* tree has been infected. However, in Mako one *F. bengalensis* not cropped in October 1947 is carrying a good *Baisakhi* 1948-49 crop.

INSECT ENEMIES OF LAC

5. (a) Proper Harvesting, Storage & Disposal of Lac

Ari (immature) cutting of crops has been definitely shown to be detrimental to the cultivators. Henceforth attempts will be made to evaluate damage to lac by insect enemies during storage.

(b) *Use of Wire-gauge Baskets as Brood Containers during Infection as a Control against Enemies of Lac*

In July as well as in February *kusumi* brood lac placed in wire-gauze baskets was used to infect a few *kusum* trees. This enabled the lac larvae to emerge freely in spite of rains in July and unfavourable climatic conditions in February. No fungus attack due to humid conditions was noticed. Practically the whole range of enemy insects was trapped within the baskets. Results of experiments are given in Table III. Experiments conducted from 1945 to 1948 confirm that wire-gauze baskets of 60 mesh, while eliminating the whole range of non-lac insects, permit free exit to lac larvae.

This is the only control method by which practically (insect) enemy-free lac cultivation can be started in a new area.

It also prevents wastage of stick lac, as any lac that may fall from brood sticks is caught in the baskets.

Table III

Catch of Enemy Insects in Wire-gauge Baskets

Wt. of lac used in infection		No. of baskets used	Catch of	
Sr.	Ch.		Eublemma & Holcocera	Chalcid
2	8	12	291	210
				Decomposed ones could not be counted

6. Control of Insect Enemies of Lac

(a) *By the Use of Gammexane & D.D.T.*

Experiments were conducted in three ways : (1) lac sticks were kept under a solution for 12 hours ; (2) lac sticks were sprayed ; (3) stick lac (scraped lac) was sprayed. Results of experiments, though yet inconclusive, indicate that Gammexane gives better results than D.D.T. In both cases spraying of lac sticks or scraped lac is more effective than immersion in solutions for about 12 hours.

(b) *By Fumigation*

Fumigation is not a practical method of control for small cultivators, but is handy and possible for big cultivators who use thousands of trees for cultivation each season. So far carbon bisulphide has been found to be the most convenient and effective fumigant, but it has the disadvantage of being inflammable. Therefore, attempts were made to find out a

non-inflammable fumigant. Ethylene dichloride, carbon tetrachloride and ethylene trichloride singly or in combinations were tried. Results obtained so far indicate that a non-inflammable mixture of ethylene dichloride 75 per cent and carbon tetrachloride 25 per cent, at the rate of 5 oz. per 10 cubic feet of space, may prove as good a fumigant as carbon disulphide.

Results of analysis of seed lac obtained from the treated samples indicate that the quality of seed lac is not adversely affected by either spraying, immersion or fumigation.

7. Biological Control

(1) To Discover Suitable Alternative Hosts for Bracon (Microbracon) greeni *in the Laboratory*

Some larvae of pink boll-worm were obtained from cotton seeds received from U.P. and the Punjab in 1946 ; due to disturbances in the country fresh supply of seeds could not be arranged for. Locally, larvae of *Trychylepidia fructicassiella*, a borer of *amaltus* (*C. fistula*) pods, *Etiella zinkenella*, pea borer, and *L. orbonalis*, brinjal borer, were collected. Lately a shoot borer of *Karanj* (*Pongamia glabra*) and a pod borer of beans were also tried.

(2) Breeding of B. greeni *on a Mass Scale on Unnatural Hosts*

The chief host tried during the year was *T. fructicassiella*. It gave a parasitization of 47·1 per cent. The results of breeding are given in Table IV. In the same table results obtained with *E. amabilis* are also given for comparison.

Table IV

Mass Breeding of B. greeni *on Unnatural Hosts and* E. amabilis *on the Natural Host*

Host and number introduced	Percentage parasitism	Number of *B. greeni* bred	Percentage of females	Number of adults bred per host parasitized
E. amabilis 13,270	43·8	5,800	77·90	0·99
T. fructicassiella (*amaltas* pod borer) 12,260	47·1	6,995	63·30	1·20
P. gossypiella (cotton borer) 2,319	8·8	227	60·79	1·10
E. zinkenella (pea borer) 680	21·3	95	65·26	0·65
Pongamia glabra (*Karanj* shoot borer) 106	1·4	19	55·90	3·10

8. Demonstration

(a) Advice & Training

Advice on lac cultivation was given to cultivators all over India both by correspondence and by personal contacts. Mr. Glover, the Entomologist, toured the Rewa State and advised on the reorganization of the lac industry in the State. Mr. Negi, the Assistant

Entomologist, toured the Saranda Forest Division of Bihar and advised the Bihar Forest Department on lac cultivation on *kusum* in that division.

Two Institute Demonstrators and seven Bihar Government Demonstrators were under training during the year. Of the two Institute Demonstrators under training one resigned the post to join the Bihar Forest Department. In addition, one Forest Ranger from Jeypore Estate, one Forest Ranger from Rewa State, two Forest Officers from Palanpur State and two candidates of the Government of U.P. underwent training in lac cultivation.

Supply of Pruning Instruments & Brood Lac

Supply of pruning instruments was chiefly restricted to replacement of broken or worn-out instruments in charge of the Demonstration staff of the Provincial Governments. Details of supply of brood lac are given in Table V. Under demonstration, the brood was supplied free.

TABLE V

Details of Brood Lac Supply

Type of brood	Demonstration scheme		Intensive demonstration scheme		Sold
	Weight Md. sr. ch.	Cost Rs. as. p.	Weight Md. sr. ch.	Cost Rs. as. p.	Md. sr. ch.
Rangini ..	2 10 0	130 4 0	33 13 4 Bihar	2,182 5 3	nil
			338 Turries	1,301 8 0	
			Bengal 11 20 0 U.P.	765 0 0	
Kusum ..	..	..	4 7 8 Bihar	604 7 0	
			0 30 0 U.P.	136 8 0	0 20 0

Due to scarcity of brood lac in all the three seasons full requirements of brood lac in demonstration areas could not be met.

(b) Demonstration

Practical demonstration of improved methods of lac cultivation using villagers' own trees was given through the Demonstration Staff. Demonstration also included taking part in exhibitions and sending exhibits to educational institutes and museums.

Institute Demonstration Scheme

Of the three Institute Demonstrators one resigned his post to join the Bihar Forest Department, one was dismissed from the service and the third is working in Silli-Jhalda area of Ranchi District and a fourth man has just been posted to Murhu near Khunti (Ranchi) on completion of his training in May 1948.

Intensive Demonstration Scheme (vide Appendix also)

In Bihar — There were eight Supervisors and seventeen Demonstrators working in eight centres. Two of the seventeen Demonstrators worked only up to September, 1947. In Singhbhum the centre of activity has been changed from Hat Gamaria to Saranda.

In Bengal — Due to division of the country into India and Pakistan, a portion of Malda District has gone to Pakistan and most of the Muslim staff have opted for Pakistan.

Now there is one centre in Malda District and one in Murshidabad District. The former is being worked by a Supervisor only and the latter by a Supervisor and three Demonstrators. Vacancies of three Demonstrators for Malda have to be filled in.

In U.P.— One Supervisor and three Demonstrators are working in Mirzapur District. The Supervisor carried out a cursory survey of lac-growing areas of the district.

More detailed reports of the working of the scheme in respective provinces will be found in the appendices.

The main objects of the demonstration scheme are as follows :

(1) Systematic cultivation using regular coupés in rotation, thereby allowing rest to trees and facilitating supervision and guarding against theft.

(2) Means of ensuring the production of *Baisakhi* brood, by partial pruning of *ber* and artificial partial defoliation of *palas*.

(3) The exclusive use of *palas* as *Baisakhi* host and of *ber* as *Katki* host in areas where both are in sufficient numbers.

(4) Adoption of the four-coupé system for *kusum* utilizing complete cropping and correct methods of pruning.

(5) Adoption of the three-coupé system for *ber* and *palas*. Of these three, one coupé is to be for *Katki* crop and the other two for alternate *Baisakhi* crops. The *Katki* coupé is to be cropped fully in October. From the *Baisakhi* coupé shoots bearing only thick encrustation of dead and living lac are to be cut in June and the rest left for self-infection; the coupé should be harvested fully in October.

(6) To avoid self-infection in growing the *Baisakhi* crop.

Baisakhi 1946-47 Crop — Mention has already been made of the exceptionally severe nature of this year's summer, resulting in widespread and very high mortality of brood lac. Even so, Institute methods of partial pruning of *ber* and artificial partial defoliation of *palas* proved very successful in Bihar, inasmuch as while destruction of lac insects on untreated (control) trees was almost complete, good amounts of brood lac survived wherever the cultivators adopted the methods of partial pruning of *ber* and partial defoliation of *palas*. In one area cultivators even succeeded in producing surplus brood lac.

In U.P. lac survived on the partially defoliated *palas* trees but the brood lac had been stolen before it could be collected.

In Bengal too, lac thrived on partially pruned *ber* trees and died on the control trees.

The average brood to yield (of scraped lac) ratio in Bihar was 1 : 2·6 and in Bengal 1 : 4.

Katki Crop — Because of the extreme heat in the summer months the quality of brood lac used to grow this crop was anything but good. However, some cultivators of Bihar were able to obtain from their *Katki* crop brood lac in excess of their own requirement, which they sold out. Hence brood to yield ratio was not available to evaluate the crops correctly. However, the maximum brood to yield (of scraped lac) ratio was 1 : 3.

In Bengal, the maximum brood to yield (of scraped lac) ratio was 1 : 4.

Jethwi 1947 Crop — Though *kusum* is almost an evergreen tree the draught affected it also and in Bihar only one demonstration area gave satisfactory results. The ratio of brood to yield (scraped lac) was 1 : 2·2. There was no *kusum* cultivation in Bengal and U.P.

Aghani 1947-48 Crop — Due to unavailability of brood lac in July, crops were grown in two centres only. One of these had to be abandoned before the crop matured and the other produced a poor *Aghani* crop, the brood to yield (scraped lac) ratio being 1 : 0·9.

(c) Improved Cultivation in Forest Areas

This is the last year of the second three-year extension of the Mako-Oreya lac cultivation scheme jointly worked by the Bihar Forest Department and the Indian Lac Research Institute.

In Mako *O. dalbergoides* (*pandan*) and *palas* carried the *Baisakhi* brood lac equally well. *F. bengalensis* did not prove as satisfactory as in previous years. Cultivation of crop in the orchard was stopped in July.

Jethwi and *Aghani* crops were grown in Oreya. The *Jethwi* crop was affected by extreme heat and draught. Compared to other neighbouring areas the crop was good. The succeeding *Aghani* crop mostly was grown by self-infection. In the whole of Latehar subdivision this was the only area which had anything like an *Aghani* crop ; but about 3 maunds of brood lac were stolen a little before the harvesting time.

Theft of lac from Oreya has greatly handicapped the scheme and every effort is being made to prevent it.

9. Namkum Plantation

The general upkeep of the plantation was maintained according to the funds available.

Over 300 yards of roadway were paved with cinders and 530 yards of the perimeter fenced with *concertina* barbed wire.

The following hosts were extended or intersown in various plots :

Kusum	..	379	
Palas	..	900	sown in new areas
		2,406	intersown between existing hosts with poor growth
Pandan	..	306	

Attempts to grow *kusum* by root suckers failed hundred per cent. Thirty-six cuttings of banyan were put in, of which only four seem to have survived.

Sugarcane, cotton, pea, brinjal, hibiscus and maize were grown in a small area to obtain larvae of the lepidopterous pests from these plants for use as alternative hosts for laboratory breeding of *B. greeni*. Borers could not be got from sugarcane and maize. Results of breeding on other borers are given under item 7 (page 7). A small area was also planted with groundnut to cover the part cost of the cultivation as recommended by the Bihar Horticulturist.

Sales of grass and miscellaneous produce from the plantation brought cash revenue of Rs. 300-6-0, and firewood worth about Rs. 114/- was supplied to the Mechanical Section.

A statement of lac produced in the Institute plantation and showing its disposal is given in Appendix A. The proceeds of sale of lac from Namkum and Hesal amounted to Rs. 797-1-0.

CHEMICAL SECTION

1. Moulding Powders

(a) Standardization of L-U-F Moulding Powders

The work on this particular problem has been completed with regard to (a) the optimum particle size of the moulding powders; (b) optimum moisture content to produce blister-free samples; and (c) optimum temperature, pressure and time of curing. During the period under review the effect of heat cure on the physical properties of the moulded samples was studied. A large number of standard bar specimens were moulded from the standard lac-urea-formaldehyde moulding powders as also from compositions containing cashew nut shell liquid and these were subjected to ageing at 80°C. for different periods of time. The samples were then allowed to cool overnight in a desiccator and then tested for impact strength and heat resistance.

The following table gives the results obtained:

Table I

Temp. (°C.)	Duration (hour)	Samples	Impact strength (cm. kg./cm.²)	Heat resistance (Marten) (°C.)
80	1	Sample I	4·00	80
		Sample II	4·50	75
80	2	Sample I	3·70	85
		Sample II	4·40	76
80	3	Sample I	4·63	83
		Sample II	4·50	78

(b) Lac-CNSL-S Combinations

A few experiments were made on the combination of lac with CNSL in presence of varying proportions of sulphur mainly with a view to examining whether the resultant products would be suitable for utilization in the plastic and/or varnish field. It has been found that when CNSL is heated with 10-20 % of sulphur at 200°-205°C. a thick viscous resin is obtained with evolution of hydrogen sulphide, thereby showing that combination of the two constituents has taken place. When this viscous resin is further combined with equal proportion of lac a soft rubbery material is obtained, which, when mixed on hot rollers with fillers like asbestos and suitable proportions of zinc oxide, hexa, stearic acid, etc., gave a plastic composition which could be moulded hot or cold depending upon the proportions of the different ingredients used, temperature and duration of the reaction. In a typical experiment, using fine asbestos as filler, the composition could be moulded at 140°-145°C. and removed at the same temperature with good gloss and finish. The water absorption of the finished articles was found to be as low as 0·38 % (24 hours' immersion), the impact strength was, however, found to be low being of the order of 2·3-2·66 cm.kg./cm². Further experiments to improve the properties are in progress.

(c) Lac-dimethylol Urea Compositions

The reaction time of dimethylol urea and shellac was increased in both the wet and the dry processes in order to get an improved product. In the wet process there was observed no appreciable improvement while in the dry process the product deteriorated as it was found to be softer during ejection from the mould and had a tendency to stick to it.

A large sample of moulding powder was prepared using 15 gm. of dimethylol urea for 100 gm. of shellac, by the wet process to study the optimum time, temperature and pressure necessary for moulding.

From production point of view it is desirable that the time required for moulding should be as little as possible. A better product is one which becomes less soluble after moulding due to chemical transformation. Hence it became necessary to ascertain the degree of polymerization of lac-dimethylol urea compositions after moulding. This was done by determining the percentages of hot and cold alcohol insolubles in the original powder and moulded products. The results are given below :

TABLE II

Moulding pressure (ton/sq. in.)	Moulding		Hot alcohol insolubles (%)	Cold alcohol insolubles (%)
	time (min.)	temp. (°C.)		
Original powder	..	..	42·41	75·47
1·5	1	140	43·12	74·35
1·0	2	140	44·36	75·46
1·0	3	140	53·17	76·80

Attempts were also made to find the optimum pressure and temperature. The moulding time was 3 min. in each case and the finish was observed to be good in all cases. The results are given in Table III.

TABLE III

Moulding temp. (°C.)	Moulding press. (ton/sq. in.)	Hot alcohol insolubles (%)	Cold alcohol insolubles (%)
130	1·0	44·68	77·49
140	1·0	53·17	76·17
150	1·0	60·62	81·26
130	1·5	44·44	77·60
140	1·5	53·87	81·19
150	1·5	57·21	81·59
130	2·0	48·24	79·63
140	2·0	57·99	81·50
150	2·0	57·61	80·50

It will be seen from the above that a temperature of 150°C. and a pressure of 1 ton/sq. in. raise the hot alcohol insolubility of the stock from 42·41 to 60·62%.

The influence of the percentage of dimethylol urea on the progress of polymerization under moulding conditions has also been determined. Results are given below :

TABLE IV

Dimethylol urea used per 100 gm. of shellac	Original powder		Moulded product		Conditions of moulding
	Hot alcohol insolubles	Cold alcohol insolubles	Hot alcohol insolubles (%)	Cold alcohol insolubles (%)	
10 gm.	45·02	75·00	42·60	73·15	3 min. at 140°C. and 1 ton/sq. in.
15 gm.	42·41	75·47	53·17	76·80	do
20 gm.	43·66	82·22	59·58	81·42	3 min. at 140°C. and 1·5 ton/sq. in.
30 gm.	47·51	86·82	70·30	84·10	do
35 gm.	42·76	86·40	71·86	85·40	3 min. at 145°C. and 2 tons/sq. in.

It will be seen that on moulding, compositions having shellac and dimethylol urea in the ratio of 100 : 30-35 became more insoluble in hot alcohol than other compositions.

2. FILLERS

Experiments were continued to increase the yield of 100 mesh fraction of jute stick dust which was found to be a fairly suitable filler for lac moulding powder. Normally, the yield by simply hammering and grinding the sticks in the small disintegrator was found to be only 15-20% on the total weight of the sticks taken. The yield could not be improved by either flattening the sticks in the lac crushing machine or passing through rollers. The yield, however, could be increased to 30-35% by baking the flattened sticks before grinding. It was found after baking the sticks for different times at 90°-95°C. in the steam oven that the minimum time required for the best result is about 1 hour. But as the process of baking before grinding will add to the cost of production, it was considered desirable that some other simpler method should be devised. It was found that by simply drying the sticks in the sun for about 3 hours followed by disintegration with greater impact (i.e. passing twice through a big disintegrator of 17" blades) the yield could be raised to 50-52% of the total weight. A further yield of 15-20% on the weight of the coarse residue could be recovered by repeating the process once again.

3. VARNISHES & LACQUERS

(a) Lac-cashew-nut Shell Liquid Varnishes

In the methods hitherto adopted for the preparation of lac-CNSL varnishes and their modifications with formalin, urea, etc., the principal media used were alcohols like ethyl, butyl and fusel oil fractions. The properties of such varnishes together with details of their preparation have been described in previous annual and six-monthly reports. During the period under review, experiments on the combination of lac and CNSL in presence of linseed oil were undertaken. As a first step, the effect of small quantities of lac was studied. The preparation of some typical varnishes with different quantities of lac is described below :

CNSL (100 gm.) is at first heated to 130°-140°C. for 15-20 minutes to remove moisture. Then dewaxed lac (30 gm.) is gradually added under efficient mechanical stirring. The temperature is quickly raised to 250°-260°C. and maintained at this value for 30 minutes. To this is immediately added double-boiled linseed oil previously heated to 250°C. and heating is continued for a further period of 10-15 minutes. The product is finally cooled to 100°-120°C. and thinned with 300 cc. of solvent naphtha. 2 gm. of cobalt naphthenate dissolved in a small quantity of the thinner is now added and the varnish allowed to cool and settle overnight and then filtered through cotton wool.

A control varnish was also prepared at the same time using CNSL and linseed oil only for comparing the film properties.

The following are some of the film properties obtained with the varnishes :

Composition	Drying time (hrs.)	Nature of the film	Effect of water (7 days') immersion	Scratch hardness after 1 wk. air-drying
(1) CNSL 100 Dewaxed Lac 30 Linseed oil 100	18	Smooth, glossy and non-tacky	No effect	600 gm.
(2) CNSL 100 Dewaxed Lac 40 Linseed oil 100	18	do	do	700 gm.
(3) *Control* CNSL 100 Linseed oil 100	24	Smooth, less glossy and slightly tacky	do	500 gm.

It was also noticed that tackiness in control film persisted even after 4 days' air-drying. All the films had good flexibility and adhesion, and showed no signs of failure when subjected to the usual bending tests. Further tests are in progress.

In a further set of experiments, attempts are being made to incorporate larger quantities of lac in linseed oil in presence of CNSL. With a view to finding the maximum period of time for which lac and CNSL could be heated at 250°-260°C. without polymerization setting in, the time of gelation or polymerization for the different quantities of lac was at first determined. The results are given below :

Temperature 250°-260°C.

		Time of polymerization
CNSL Kusmi shellac	100 30	75 minutes
CNSL K. shellac	100 40	50 minutes
CNSL K. shellac	100 50	30-35 minutes
CNSL K. shellac	100 60	30-32 minutes
CNSL K. shellac	100 70	25-28 minutes

(b) Waterproof Varnishes

In response to an enquiry from the Inspectorate of Military Explosives, Kirkee, for waterproof varnishes for use in coating paper and wooden bullets for dummy cartridges, several samples of varnishes were sent. Of these, two samples have been approved by them. Bulk samples of the approved quality of each type were also sent on request for large-scale trials. Reports received from the Inspectorate show that both the varnishes withstood all the rigorous tests of humidity and temperature and several repeat trials.

The Inspectorate are now seriously considering drawing up specifications for the two varnishes for use by them and have requested for the particulars with regard to their manufacture and suggestions for the specific names of the two varnishes. These details have been supplied and further contact is being maintained. The appreciative remarks made by the Chief Inspector of Military Explosives concerning these varnishes are quoted below for information :

" I am very glad to inform you that your Varnish No. 144(a) has been found very successful in waterproofing wooden bullets for dummy cartridges and has been finally approved after repeat trials. It is now desired to draw up and seal a detailed specification including proportion and quality of ingredients, method of manufacture and inspection tests."

(c) Lac-linseed Oil-glycerine Air-drying Varnish

The preparation of an air-drying varnish by combining lac with linseed oil, pre-treated with glycerine, has been described in the previous Annual Report (p. 19, Annual Report, 1946-47). It has been shown that though the composition possessed most of the desirable properties of an air-drying varnish, it suffered from one particularly serious drawback, viz. tackiness of the air-dried film. Experiments were continued to eliminate this.

Four possible modifications were studied, viz. modifications as a result of : (i) treatment with phthalic anhydride or linseed oil fatty acids to eliminate the residual hydroxyl ; (ii) incorporating the requisite amount of lime into the hot melt before thinning to eliminate residual acidity ; (iii) using less lac and continuing cooking for longer periods ; and (iv) using more lac and extra oil to maintain the oil-lac ratio. None of these proved successful in reducing the tackiness appreciably.

(d) Lac-linseed Oil-lime Varnishes

The possibility of using lime in place of litharge as an incorporating agent in the preparation of lac oil varnishes has been already examined, and the properties of the resulting compositions have been described. Further modifications of the compositions were continued.

Varnishes were prepared having the same lac : lime ratio but different lac-oil proportions, by cooking into the same weight (100 parts) of oil 2·5, 3·75 and 5 parts of lime and 50, 75 and 100 parts of lac, the temperatures of incorporation being 290°C., 270°C. and 250°C. respectively. Again, another batch of varnishes having the same lime : oil ratio but different lac : lime contents was made by cooking 2·5 parts of lime into 100 parts of oil and then incorporating 50, 60, 70 and 80 parts of lac into the mixture, the temperature of incorporation in this series being the same in all cases, viz. 290°C. The " life " or jellying time in this second series, however, was found to fall rapidly with increasing proportions of lac. In fact, when about 75-80% lac on the weight of oil was used, the life was generally so short that by the time the melt cooled down sufficiently for thinning, it often gelled and so became useless. The air-dried films from none of these compositions showed any substantial improvement over the original proportion described in the previous report, viz. lac : oil : lime in the ratio of 50 : 100 : 2·5.

(e) Lac-oil Insulating Varnishes

The method of preparing clear baking lac-oil insulating varnishes and the possibility of making varnished insulating cloth (empire cloth) therefrom have been demonstrated to interested parties and several samples supplied to enquirers.

(f) Chemical Reactions involved in the Formation of Lac-linseed Oil Compositions

Conditions for the preparation of lac-linseed oil combinations using " incorporating " agents like litharge and lime have been fully described in previous reports. The compatibility of linseed oil and shellac in the presence of these compounds has been known for a long time but no systematic investigation of the reactions involved appears to have been attempted. As a result of a series of experiments the following information has now been obtained.

As is well known, when litharge is cooked into linseed oil, two new products are formed, viz. (i) lead linoleate and (ii) glycerine or the glyceride of the oil. In order to ascertain which of these two materials is principally responsible for inducing the compatibility, pure precipitated lead linoleate was used in place of litharge thereby eliminating glycerine from the reaction mixture. This did not affect the compatibility, and the products obtained were substantially the same as when litharge was used, showing that the lead soap is mainly responsible for inducing the compatibility. Again in order to ascertain whether lead is the only metallic radical or whether any other linoleate will serve the purpose, experiments were repeated with manganese, calcium and potassium linoleates and the same compatibility was still observed. Having proved that any metallic linoleate induces compatibility, soaps with other acidic radicals like the stearates of calcium, aluminium, zinc and potassium were tried. All these soaps behaved in much the same way as lead or other linoleates, showing thereby that any metallic soap will serve the purpose.

The acid value, saponification value and hydroxyl number of the reaction products were next determined. As lead compounds do not give a sharp end point for these determinations, potassium hydroxide, potassium linoleate and potassium stearate were used for the incorporation and the constants for the reaction mixtures using different proportions of lac and oil were determined. It was observed that there was practically no change in the acid or saponification values but there was usually a lowering of the hydroxyl number by 30 to 40.

The possibility of double decomposition between the metallic soap used and the lac resulting in the formation of the metal soap of lac and the free fatty acids was then examined. For this purpose, sodium or potassium soap of lac was prepared by dissolving lac in aqueous alkali containing the requisite amount of the respective hydroxide (as determined by the acid value). The various metal soaps were then precipitated from these by the addition of aqueous solutions of their soluble salts. It was observed that the lead soap of lac dissolves in linseed oil quite smoothly at temperatures above 260°C. but the calcium and zinc soaps do not. Further work is in progress.

In the course of these studies some interesting observations have been made. The products obtained by incorporating lac in linseed oil using potassium hydroxide or potassium linoleate as incorporating agents are completely soluble in water as well as in the usual varnish solvents like white spirit. The suitability of these and similar products for use as emulsion paints or emulsifying agents is being studied.

(g) Oil-cloth

Samples of oil-cloth prepared as described in the previous report have retained their original suppleness and have not shown any tendency to stiffen or crack (these were made about 16 months back). Samples of improved finish have been obtained by starching and calendering the cloth prior to the application of the " dobe ". A smooth and glossy finish

is obtained on air-drying. The gloss may be further enhanced if the coated fabric is baked at 90°-95°C. for about half an hour before air-drying. By suitable formulations with pigments and driers, a fine wrinkle finish may also be obtained.

The preparation of these as well as our earlier compositions has been demonstrated to parties interested in its manufacture and samples of the coating compositions supplied to many on request.

(h) Lac-oil Paints

A new lac-linseed oil vehicle for paints and enamels was prepared using the composition linseed oil 100 parts, lac 20 parts and litharge 3 parts. Preliminary experiments with this have shown that quick-drying satisfactory paints may be formulated from these. The ageing properties of these are being studied.

About half a ton of such a lac-linseed oil paint in different shades has been prepared and used to paint the Institute laboratories and buildings as a " service " trial and its performance is being watched.

4. Fundamental Researches

(a) Chemical Composition of Hard Lac Resins

The acid values of the acids (*vide* Annual Report, 1946-47, pp. 24-25) obtained from the salts of the lac acids were determined by the micro method, and the results are given below :

Acid obtained from fraction	M.P. (°C.)	Acid value
B_2	78-79	206·7
Z_2	93·5	190·8
L_1	110-115	309·0

The method of separation of the various salts of lac acids was modified. 300 gm. of hard lac resin, prepared from dewaxed shellac in the usual manner, were hydrolysed in the cold with 300 cc. of 20% caustic soda solution during 10 days. The solution was then diluted to 600 cc. with 20% caustic soda solution and kept for 48 hours at 10°C. The precipitated crude sodium aleuritate was filtered off through sintered glass funnels and the filtrate evaporated to dryness. Excess caustic soda was removed as carbonate by passing CO_2 through the alcoholic solution of the residue. The filtrate was worked up as before (*vide* Annual Report, 1946-47). The amounts of various salts obtained were as follows :

Crude sodium aleuritate	110 gm.
Yellow barium salt	14 gm.
Dark-brown barium salt	6 gm.
Dark-brown zinc salt	95 gm.
Light-yellow zinc salt	20 gm.
Hot water insoluble zinc salt	26 gm.
Alcohol insoluble lead salt	27 gm.
Alcohol soluble lead salt with inorganic matter	32 gm.

The crude sodium aleuritate, on decomposition with a slight excess of 10% sulphuric acid, yielded only 56 gm. of white crystalline aleuritic acid melting at 96°-97°C. Attempts to recover further amounts from the dark-brown mother-liquor were not successful.

Attempts to reprecipitate the dark-brown zinc salt (cold water insoluble) failed. On decomposition with dilute sulphuric acid, it gave a dark-brown gummy mass. No crystalline product has yet been isolated from this fraction.

The hot water-insoluble zinc salt was found to be sparingly soluble in cold water. On decomposition with H_2S, this salt (0·85 gm.) gave no crystalline product, contrary to the observation made elsewhere, but instead gave a resinous mass (0·5672 gm.). Several attempts were made to induce crystallization from hot water, but every time the resinous mass was obtained.

The product was hygroscopic, softened at 70°C. with evolution of gas and partially melted at 85°-90°C. The evolution of gas continued up to 150°C. and the substance completely melted at 210°-215°C.

The alcohol-insoluble lead salt (5 gm.) was decomposed by H_2S in water suspension. The PbO-residue was extracted with hot absolute alcohol which on evaporation gave an amorphous brown mass (0·76 gm.). If softened at 70°C. and decomposed at 110°C. with evolution of gas.

The filtrate was evaporated to a syrup and the syrup was taken in solution with (40 cc.) absolute alcohol to which (40 cc.) ether was added. Immediately some white flocculent substance separated out. The alcohol-ether mixture was decanted off and the residue was washed with fresh alcohol-ether mixture. The residue gradually turned to a brown syrupy resin, which on drying became a white amorphous mass (1·2 gm.). It decomposed between 90°-95°C. with evolution of gas.

The alcohol-ether solution from above was slowly evaporated to a thin syrup and water added. There was slight turbidity but nothing precipitated even on cooling for a long time. It was then evaporated to dryness and a colourless brittle film-like substance was obtained (1·1 gm.). It softened at 125°C. and decomposed at 150°C. with evolution of gas.

Attempts are being made to get crystalline acids from the above fractions.

Esterification of the lead salt with 3% HCl in absolute methyl alcohol gave a syrupy mass and attempts to get crystalline product were unsuccessful.

It has been mentioned earlier (*vide supra*) that no crystalline acid was obtained from the hot water-insoluble zinc salt. It was thought, however, that the absence of this crystalline acid might be due to over-heating or to other treatments during the preparation of the respective salt fractions. As there was no hard resin at hand, Angelo's dewaxed shellac was used for the preparation of the salt fractions with minimum of heating.

A run was carried out with 250 gm. of the shellac following the method given in the Annual Report, 1946-47, in every detail except that after saponification, the excess alkali was almost completely neutralized with 4N HCl solution. After the separation of some hot water-insoluble zinc salt, the container accidentally broke and the experiment could not be pursued for the time being. The amounts of salts obtained were as follows :

Dark barium salt	..	3·7 gm.
Violet barium salt	..	25·3 gm.
Dark zinc salt	..	88·0 gm.
Cream zinc salt	..	42·0 gm.
Hot water-insoluble zinc salt	..	7·8 gm.

Another run was made employing 2 kgm. of the shellac. In this case the crude sodium aleuritate was separated after saponification, the next processes followed being the same as above. The amounts of different salts so far obtained are as follows :

Crude sodium aleuritate	..	575 gm.
Brown barium salt	..	80 gm.
Violet barium salt	..	565 gm.
Dark zinc salt	..	686 gm.

Cream zinc salt	..	.. 62 gm.
Hot water insoluble	..	.. 24·7 gm.

The work is being continued to get further quantities of hot water-insoluble zinc salt and lead salts.

A crystalline acid and a resinous residue were obtained by decomposing the hot water insoluble zinc salt as usual. The crystalline acid was recrystallized twice from hot water and lastly from an alcohol-water mixture. It melted sharply at 93°-94°C. Mixed melting point with pure aleuritic acid (m.p. 100°C.) was 96°-97°C. Melting point of the methyl ester of the acid was 72°-73°C., the mixed melting point with pure methyl aleuritate (m.p. 70°-71°C.) being also the same (72°-73°C.). The acid value, as determined by the micro method, was 185·0.

The acid was insoluble in ether, chloroform, benzene, petroleum ether and cold water and soluble in methyl alcohol, ethyl alcohol, acetone and hot water. It crystallized well from a mixture of alcohol and water.

From the acid value, m.ps. and mixed m.ps. of the acid and the ester, it seems that it is an insomer of aleuritic acid. Further work is in progress.

An apparatus has been set up for the preparation of hard lac resin on a large scale and so far about 400 gm. have been prepared from *kusmi* shellac.

(b) Constitution of Soft Lac Resin

(i) When the lead salts of hydrolysed soft lac resin were decomposed, only about 50% of the total hydrolysates could be accounted for. No appreciable quantities of other substances could be isolated from the mother liquor after the separation of lead salts. The method was modified to see if the total yield of hydrolysate could be improved either in the form of Pb salt or from the mother liquor. In this modified method, hydrolysis and precipitation were carried out in absolute alcohol. Two fractions were eventually obtained: (1) A dark-brown acidic resin which forms a lead salt insoluble in alcohol medium (yield 0·92 gm.). The alcohol-insoluble lead salt thus formed was much less than that obtained by the previous method using aqueous medium. (2) A dark brown semi-solid, the lead salt of which is soluble in alcohol. This is acidic (A.V., 48·39 ; S.V., 131·7). Yield is 8·8 gm. These fractions are being further studied.

The ether-insoluble solid acid (m.p. 94°) mentioned in the previous Annual Report could not be obtained in a crystalline form though it was found to be freely soluble in cold alcohol, chloroform and hot water. Micro-acid and micro-saponification values are 157-160·4 and 160·2 respectively. The amount of acid at our disposal being very small, further work could not be carried out. Isolation of a fresh quantity of this acid is in progress.

(ii) *Oxidation of the Ether-soluble Fraction of Hydrolysed Soft Lac Resin* — Oleic acid or any hydroxy oleic acid when oxidized by alkaline permanganates gives, usually, dihydroxy-stearic acid or trihydroxy stearic acid respectively (HAPWORTH and MOTTRAN, *J.C.S.*, 1925, **127,** ii, 1629). This observation was utilized to examine if the ether-soluble acid, isolated from hydrolysed soft lac resin called Fraction I which also has one double bond, contains any oleic acid, hydroxy derivative of oleic acid or any other unsaturated fatty acid.

Oxidation of Ether-soluble Acid Fraction I — The sodium salt of ether-soluble Fraction I was prepared by heating 1·0 gm. of Fraction I acid with 1·0 gm. of NaOH dissolved in 100 cc. of water, on water bath and then cooled. To this 80 cc. of ice-cold water were added and the whole thing kept at 10°C. in a refrigerator with intermittent shaking. Then at this temperature 80 cc. of 1% $KMnO_4$ solution were added quickly. After about 15 minutes, SO_2 was passed into the solution till it was decolourized when con. HCl (30 cc.) was added. No precipitate appeared indicating non-formation of any dihydroxy stearic acid.

A modified method of oxidation (K. HAZMA and A. GRÜSSNOR, MONATSCH, 1888, **9,** 948 and HAZURA and FREDERICK, ibid., 1887, **13,** 798) was also tried, but did not give any oxidation product. 1·0 gm. of ether-soluble acid Fraction I was treated with 1·6 cc. of KOH

(sp. gr. 1·27) and to this were added 100 cc. of water ; 100 cc.1·0% of $KMnO_4$ sol. were then added and the whole heated over a water bath for 4 hours. Decolourization of this by SO_2, followed by addition of con. HCl (25 cc.), did not give any precipitate, showing that on oxidation product had been formed.

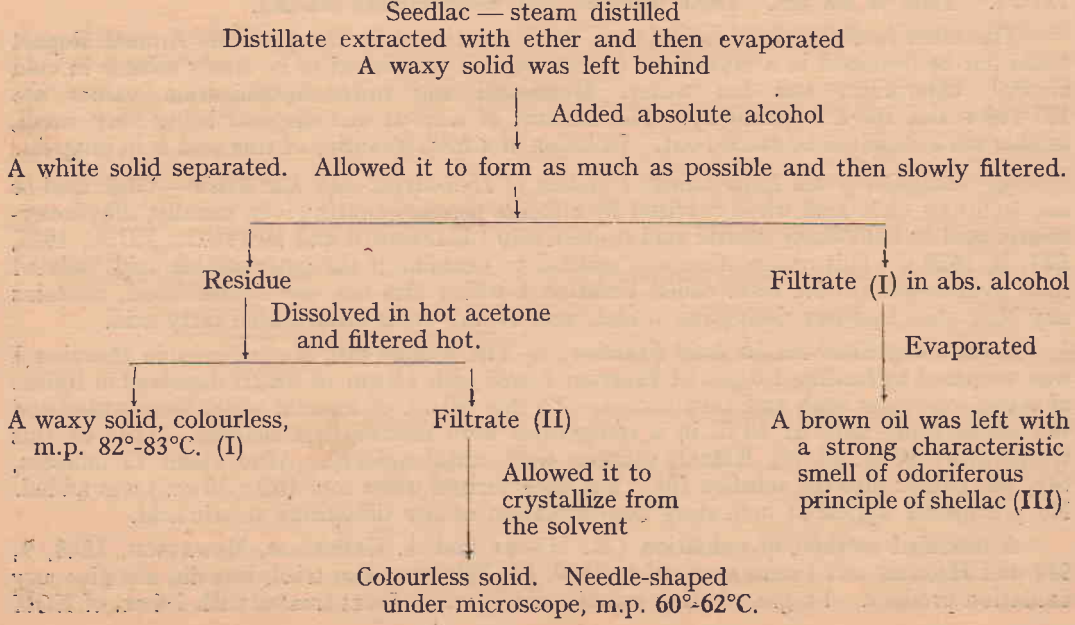
Odoriferous Principle of Shellac — TSCHIRCH and STOCK (" Die Harze " Band II 2 Halfte, 2 Teil, p. 11) reported the isolation of a crystalline substance from the steam distillate of seed lac. The product was believed by them to be the odoriferous principle but does not seem to have been further investigated. In view of the possible genetic relationship between this compound and shellac components a detailed investigation of this substance has been taken up.

1,000 gr. of seed lac were steam-distilled to yield about 30 litres of distillate which was then extracted with ether. On removing the ether a waxy solid was left behind. To this 95% alcohol was added when a white solid separated. It was kept for 2 days for the separation to be complete. The separated solid was then slowly filtered and washed with ice-cold alcohol and the filtrate (I) collected. The residue was dissolved in hot acetone and filtered hot when waxy colourless solid, m.p. 82°-83°C. (Fraction I), was obtained. The filtrate (II) was allowed to crystallize in cold when colourless needle-shaped crystals (Fraction II) viewed under microscope were obtained. The m.p. was determined to be 62°-63°C.

Alcohol from the collected filtrate (I) consisting of washings of 95% alcohol was removed mostly by distillation, complete removal of alcohol being then secured by slow evaporation when a brown oil (Fraction III) was left behind with the strong characteristic smell of the odoriferous principle of shellac. The whole process is illustrated in the following schematic diagram.

It is interesting to note that solid Fractions I and II, when kept for some time in a desiccator, lost all their characteristic odour but the oil Fraction III retained it permanently. Hence it may be concluded that the characteristic odour of shellac is due to the presence in it of this oil (Fraction III).

DIAGRAM



The fraction III was examined in various ways. The oil was treated with solutions of sodium bicarbonate but there was no effervescence indicating absence of any acidic or phenolic group. This was confirmed by observing that the oil was not soluble in a solution of NaOH. The oil was also indifferent to a solution of ferric chloride. When treated with 2 : 4 dinitrophenyl hydrazine or semi-carbazide hydrochloride, there was no formation of any compound, indicating absence of aldehyde or ketonic group. Further work on the nature of the oil is in progress.

The yield of oil by the steam-distillation method was very low, hence another method was tried to improve the yield. About 250 gm. of stick lac were dissolved in Na_2CO_3 solution with a little warming. The solution was then filtered through a wire-gauze of fine mesh. The whole thing was then extracted with ether. After removing the ether, the residue was washed with ice-cold alcohol and the alcoholic solution kept for several days in a refrigerator to get rid of the dissolved wax by precipitation. It was finally filtered and the alcohol removed when the oil was obtained.

Though the yield was larger (1·04%) on the weight of seed lac, the oil obtained by this method differed from that obtained by steam distillation. The substance is more highly coloured and its odour is much fainter as compared with the substance obtained by the other method. It also contains a larger amount of wax, which is difficult to separate.

Further work is in progress.

(c) Hydrogenation of Shellac & Shellac Components

Catalytic hydrogenation of a few samples of shellac and soft resin has been done in alcohol and acetic acid medium using palladinized charcoal as catalyst. A very small quantity of hydrogen is absorbed by the substances which does not correspond to the adsorption due to the unsaturation in shellac. The products on hydrogenation are paler in colour than the parent substance and unlike this do not give intense violet colouration with alkali when just prepared. But on keeping this property revives. The work is in progress.

(d) Effect of Infra-red Heat on Lac & Lac Fibres

Mention was made in the last Annual Report (*vide* Report for 1946-47) of the improvement noted with regard to water resistance of lac films after exposure for short periods to infra-red heat. These investigations have been further extended to include the study of such specific properties as hardness and abrasion resistance of lac films. Films of uniform thickness were made on glass panels either by dipping or spinning, and after air drying for 12 days under laboratory temperature and humidity were exposed to infra-red rays for 15 minutes. The films were then conditioned for 24 hours by keeping them in a desiccator, and then subjected to hardness and abrasion tests. Tests on air-dried films were also made for comparison. Some of the results are quoted below :

	Scratch hardness	Emery required to abrade the film
Films air dried for 12 days ..	1,000 gm.	935 gm.
Films oven dried at 95°-100°C. for 2 hours	1,200 gm.	1,490 gm.
Films baked under infra-red rays for 15 minutes	800-900 gm.	1,460 gm.

It will be seen that scratch hardness diminished on exposure to infra-red heat but abrasion resistance did not appreciably change.

(e) Accelerators in the Heat-curing of Shellac

The action of the following chemicals on shellac has also been determined by the same process as described in the last Annual Report.

TABLE V

Chemicals	Efficiency of hardening with		
	1%	2%	5%
*Benzoic acid ..	0·91	0·88	0·80
Benzamide ..	1·11	1·23	1·69
Citric acid ..	1·57 (2·3)	2·04 (2·7)	3·61 (3·6)
Hexamine ..	1·25 (1·3)	2·78 (1·5)	5·00 (5·4)
Paraformaldehyde..	1·04	1·14	1·23

Figures in parenthesis are those recorded by ALDIS and RANGANATHAN (*Bull. No. 14*, Indian Lac Research Inst.).

(f) Physico-chemical Studies

(*a*) *Ultra-violet Absorption Spectra of Shellac Solutions* — Measurements of the ultra-violet absorption spectra of shellac in dilute solutions in various alcohols and acids have been done using Adam-Hilgers E3 type of quartz prism spectrograph. For want of a sector photometer, quantitative measurements at relatively higher concentrations of the solute were not possible. Semi-quantitative absorption curves in different solvents in dilute solutions of shellac were obtained by Hartley's graphical method.

The absorption maxima in lower alcohols and acids were markedly different from that in dioxan, the only known non-polar solvent for shellac. This may be explained on the assumption that shellac molecules are not solvated in these solvents, i.e. no marked damping of the electronic vibration of shellac molecules takes place by interaction with solvent dipole. In the case of lactic acid and benzyl alcohol, however, the shift in the absorption maxima was somewhat greater than in the case of lower alcohols. This may be due to greater damping of the electronic vibration of shellac molecules by substances of higher polarity in one case and of greater molecular weight in the other. In no case, however, the shift was so marked as to prove the existence of definite solvated complexes in solution, at least in the dilute region.

(*b*) *Flowing Birefringence of Shellac Solutions* — Measurements of birefringence of streaming shellac solutions have been done with a view to getting a clearer idea of the anisotropy of shellac molecules. Measurements have been done with shellac and hard resin solutions in 10 to 30% concentrations in solvents of different refractive index. At concentrations still higher, measurements were not possible as the transmitted light was absorbed mostly by the dye present in shellac and was, therefore, very much reduced in intensity. At low concentrations the birefringence was so small as to render accurate measurements impossible. The apparatus used was similar to that of Singer with the alteration that a quarter-wave mica plate was used in place of Babinet compensator in Singer's apparatus.

Measurements of birefringence were done in different solvents and under different velocity gradients. The birefringence was negative and was found to increase linearly with the velocity gradient and to be approximately proportional to it in all solvents and at all concentrations. The angle of extinction was found to be 135° in all solvents, concentrations and velocity gradients, which indicates that the orientation by flow was greatly

* Benzoic acid acts as a retarder.

counteracted by the dis-orientation due to Brownian movement of the particles. This may be expected, for the molecules of shellac being small, the rotary diffusing constant, due to Brownian movement, will be very high. The existence of measurable birefringence even in solvents with refractive indices nearly equal to that of shellac, shows that shellac molecules are inherently anisotropic.

(c) *X-ray Structure of Shellac* — The measurements of X-ray defraction patterns have been done with hard resin in various forms. " Powder photographs " were taken, using a Hadding-Siegbahn tube and K radiation from a copper cathode.

The diffraction photographs were found to correspond to the generally accepted amorphous nature of the resinous substance and consisted of two diffuse rings at 4·21Å and 10Å respectively. The 10Å ring may be attributed to miceller aggregation while 4·21Å to a side chain exceeding 4 carbon atoms in length. The diffraction study also enabled a distinction to be made between heat-polymerized and acid-polymerized substances. The extended specimen of hard resin gave an indication of the orientation effect in a stretched film by a concentration of intensity in certain parts of the diffraction ring.

(g) Dielectric Properties

(a) *The Dielectric Properties of Acetic Ester of Lac* — The dielectric properties of acetic ester of lac were studied during the period under report to get an idea of the effect of esterification of lac with simple organic acids on its dielectric behaviour. The esterification was carried out by refluxing lac with acetic anhydride with pyridine as catalyst. It was observed that the dielectric constant of this ester was rather low in comparison with that of lac and remained within the limits 3·5 to 5·8 for the temperature range 30° to 110°C. at any frequency between 1 to 500 Kc./s. The dielectric constant at any frequency within this range attained its maximum within the range of temperature investigated and, therefore, measurement at still higher temperatures was considered unnecessary. Its d.c. conductance was found to be very much less than that of lac and hence the amount of correction required for the calculation of dielectric loss was also less. The maximum value of dielectric loss was, however, only slightly less than the corresponding figure for lac. Owing to lower internal viscosity of this ester in comparison with lac, the maximum of dielectric loss at any frequency always took place at a lower temperature. Low values of dielectric constant as well as loss were expected for this ester since the hydroxyl groups of lac were no longer free on esterification. A detailed discussion regarding the theoretical aspects will be incorporated in a research note from the Institute.

(b) *The Dielectric Properties of Lac-glycol Ether* — GIDVANI (*L.S.R.B. Tech. Paper 17*) observed in course of his studies on the electrical properties of lac-glycol compounds that the insulating properties of lac-glycol ether improve with progressive polymerization, the electric strength of the fully polymerized compound being quite high. GIDVANI, however, limited his experiments only to a few measurements at room temperature of the dielectric constant and power factor of the semi-polymerized and fully polymerized resin. It seemed desirable to get a complete idea of the dielectric properties of this resin, and for this, the unpolymerized lac-glycol ether was first prepared and measurements of dielectric constant and loss factor were made within the temperature range 30° to 70°C. at all frequencies between 1 and 500 Kc./s. The acid value of the ether was 30 and its d.c. conductance fairly high. Its dielectric constant is also fairly high, the value varying between 5·4 and 9·0 within the limits stated above. The power factor as well as loss are not small also ; the unpolymerized resin, therefore, is not a good insulating material and may safely be included in the category of bad dielectrics. The properties of the polymerized resin are being studied and the work is not yet complete.

(c) *Insulating Properties of Lac-linseed Oil-lime Varnish* — In the previous Annual Report, a reference was made to the good insulating properties of this simple varnish. In order to

arrive at the most successful formula, a large number of compositions were prepared varying the proportions of the ingredients. Most of these compositions, however, failed to satisfy the British Standard Specifications for baking insulating varnish requiring a B.D.V. of 900 volts/mil. at 90°C. The following table shows how the B.D.V. varies with different proportions of the same ingredients. It may be seen that only in one case the high temperature dielectric strength test just touched the mark set by the B.S. Specification.

TABLE VI

Varnish No.	Average B.D.V. values for	
	High temp. test (90°C.)	High humidity test
Ca 14	420 volts/mil.	340 volts/mil.
Ca 21	900 ,, ,,	377 ,, ,,
Ca 52	560 ,, ,,	400 ,, ,,
Ca 53	400 ,, ,,	400 ,, ,,
Ca 58	550 ,, ,,	300 ,, ,,

(h) Determination of Moisture in Lac by Infra-red Heating

It is known that the usual method of drying a substance to constant weight at 100°C. or above is not applicable to lac since it easily gives off its combined water at such high temperatures resulting in a partially polymerized product. Various methods are, therefore, in use employing lower temperatures and vacuum for the purpose of determining moisture in lac. These methods are, however, more or less time-consuming, while a rapid method would be definitely helpful to the trade.

Hence an investigation was undertaken sometime ago to see if the dielectric constant method could be successfully applied to lac powder for determining its moisture content. It was found, however, that there is no direct correlation between the increase in moisture content and the consequent variation in dielectric constant, the increase in capacitance due to gradual absorption of moisture being even anomalous at a certain stage (BHATTACHARYA, G. N., *Cur. Sci.*, Vol. 16, p. 117, 1947), which made this particular method clearly inapplicable to lac.

It appeared, therefore, that heating of the sample followed by desiccation was indispensable. It was thought, however, that the various special features embodied in infra-red heating and its successful application to fields wherever quick, uniform drying is essential, might render this method suitable for our purpose also. To see if it is really so, a large number of experiments were done with a Modinstal dull-emitting infra-red heater and different samples of lac containing various percentages of moisture ; the results obtained so far have proved very encouraging in that the total time required for the determination of moisture in lac could be reduced from about 24 hours to less than 4 hours only. This period includes infra-red heating of the sample at about 45°C. for only 30-45 minutes and subsequent desiccation for 3 hours. The actual values obtained correspond in all cases to the values obtained by the Institute method of moisture determination. Further experiments to shorten the period of heating by raising the temperature appreciably above 45°C. were unsuccessful since lac showed a tendency to softening and consequent blocking. Also, experiments carried out so far to dispense with desiccation after infra-red heating have proved inconclusive. Investigations towards this end as well as simplification of the apparatus employed are in progress.

5. Seedlac Washing

Some experiments have been performed to improve upon the existing process of seedlac washing, using a number of wetting agents received from *I.C.I.*, viz. Lissopol, Gilapol-P, Calcinol oil H.S. and Icipol. The effects of these chemicals were compared with those of soda. The results so far obtained do not show any advantage over the existing soda process. The work is being continued with an apparatus similar to the washing barrel commonly employed in lac factories.

6. Making of Shellac by the Autoclave Method

The work was continued throughout the year. The results of the experiments show that the maximum height of the layer of seed lac in the autoclave which can be melted economically is two inches. The molten lac cannot be allowed to pass a number of sieves put one upon the other, as the yield of shellac is thereby adversely affected. So each filtering sieve must have a separate receiver from which it can flow down by a side channel. About the " life " of the product it was stated in the previous report that it is less than that of ordinary shellac. It has been found, however, that if shellac is taken out immediately after it melts, by a bottom passage, its life is not so badly affected. The autoclave was modified accordingly and the following data will show how the product from this modified autoclave compares with ordinary shellac.

Table VII

	Life under heat at 150°C.
1. Ordinary shellac	43 min.
2. Shellac made by heating in autoclave at 3 atm. pressure for 3 hr. and taking after the period of heating	25 min.
3. Shellac prepared as (2) but taken out after ½ hr. ..	32 min.
4. Shellac prepared as (2) but taken out after 1 hr. ..	26 min.
5. Shellac prepared as (2) but taken out after 2 hr. ..	25 min.
6. Shellac prepared as (2) but taken out after 3 hr. ..	24 min.

In the above experiments the wire-netting used was of 50 mesh. Experiments are being carried on to find out the proper mesh number to give the most economical yield.

7. Making of *Kiri* Lac

(1) *Kiri* lac was prepared by dissolving *kiri* in soda solution, followed by precipitation with dilute sulphuric acid. Before precipitation the lac solution had to be filtered. Details have been given in *Practical Applications of Recent Lac Research*, 2nd edition.

(2) *Kiri* lac prepared as above was boiled with water for 2 hours and the process was repeated with fresh water, after which the lac was filtered and dried.

(3) *Kiri* lac prepared as (1) was kept immersed in water for 24 hours, then filtered and dried.

Results of analyses of the treated and untreated *kiri* lac prepared as above are given below :

TABLE VIII

Sample	(1)	(2)	(3)
S.P. °C.	81-84	78-81	78-81
M.P. °C.	100-102	91-93	90-92
Hot alcohol insoluble	12·18	10·15	11·42
Cold alcohol insoluble	14·9	12·4	13·34
Acid value	67·0	68·5	69·0
Saponification value	245·2	219·6	214·3
Nitrogen	0·48	0·47	0·47
Life under heat at 150°C. (min.) ..	23	33	26
Flow (sec.)	nil	nil	nil
Moisture	2·13	2·14	2·00
Colour No.	37	30	34
Wax	3·25	3·31	3·1

It is evident that *kiri* lac as made above has all the properties of a somewhat good shellac excepting flow, which, however, is the most important characteristic of shellac. Some experiments have been done to increase the flow by adopting the process of partial hydrolysis advocated in *London Shellac Research Bureau Tech. Paper No. 25.* It was found, however, that with the increase in the degree of hydrolysis, the products became semi-solid without any improvement in " flow ". The work is being continued.

8. MAKING OF SHELLAC-WAX FROM VARNISH RESIDUE

Samples of varnish residues received from *Mysore Government Lac & Paint Works* were found to contain 46·71% wax on an average. A method for the isolation of wax out of this waste product has been worked out and recommended to the firm.

9. INSTANTANEOUS SOUND-RECORDING DISCS

It has not been found possible to overcome completely the tendency of the plasticized lac films to become brittle in dry weather. The idea of conditioning the discs immediately before use has also not been entirely successful.

10. *Ad hoc* INVESTIGATIONS

As the result of an enquiry from a firm in Calcutta, experiments were undertaken with a view to utilizing photographic film scrap in combination with shellac for producing suitable spraying or brushing lacquers. Several combinations of solvents, both low and high boiling ones, were at first tried so that the resulting solutions of the film scrap would have low viscosity. Among the combinations of solvents tried, it was found that a mixture of low boiling solvents like methylated spirits, acetone and benzene in suitable proportions gave solutions of low viscosity compared to several other combinations of solvents investigated. Experiments were, therefore, at first made with the film scrap solution containing 15% solids in the above mixture of solvents. Wax-free solutions of lac in methylated spirit containing 28% lac were mixed with various proportions of the film scrap solution and the resultant lacquers examined for the various film properties. It was found that a lacquer containing about 20% of the film scrap on the weight of lac gave films of good clarity, gloss and hardness but the water resistance of the film was low. The water resistance of the films could, however, be improved by increasing the proportion of the film scrap present in the lacquer to 50% or more on the weight of lac. But the disadvantage of this is that

the solutions were highly viscous which could not be brushed or sprayed. Attempts are being made to reduce the viscosity of such a varnish by various means.

Meteorological Report

The average meteorological data for each month during the period under report are given in the following table :

Table IX

Month	Wind-speed (miles per hr.)	Dry bulb °F.	Max. temp. °F.	Min. temp. °F.	Relative humidity %	Sun-shine, hr. per day	Rainfall (inches)	Remarks
April 1947	3·5	88·5	100·9	71·7	27·5	10·4	..	
May 1947	3·8	88·3	104·0	75·8	44·2	9·4	1·75	
June 1947	3·2	86·6	98·1	76·7	63·3	7·4	10·60	
July 1947	4·1	79·1	86·5	74·4	87·0	4·5	10·98	
Aug. 1947	2·3	79·5	87·6	73·5	85·0	4·7	11·93	
Sept. 1947	1·8	80·2	88·4	72·9	81·0	5·6	8·66	
Oct. 1947	1·0	77·0	85·4	64·6	67·0	7·8	7·39	
Nov. 1947	0·8	72·1	81·5	54·4	54·1	10·2	2·25	
Dec. 1947	1·1	64·2	75·4	50·3	62·5	7·9	1·50	
Jan. 1948	1·0	64·5	76·1	51·9	66·3	8·3	1·17	
Feb. 1948	1·8	66·6	79·4	53·1	55·2	8·9	0·92	
March 1948	4·2	76·2	89·3	58·6	36·0	10·7	1·08	

The total rainfall during the period as well as the monsoon rain as compared with those of the previous three years was as follows :

	1944-45	1945-46	1946-47	1947-48
Total rainfall (March-April) ..	66·47	52·23	56·00	58·23
Monsoon rainfall (June-Sept.) ..	54·01	40·91	36·13	42·17

The rainfall during 1947-48 was normal. The highest maximum temperature during the period was 109°F. and was recorded on 24-5-47, 30-5-47, 1-6-47, 2-6-47 and 3-6-47, the lowest minimum temperature during the same period was 38°F. and was recorded on 8th February, 1948.

DEMONSTRATION & PUBLICITY

The Lac Information Officer maintained contact with shellac manufacturers and prospective consuming industries through correspondence, interviews and personal visits.

Uses of Lac in India

Enquiries for bleached lac were received from wood-working establishments, manufacturers of scientific equipment and pencils, chocolate works, colleges and research institutes. A company in Bombay is making bleached lac.

The demand for lac-wax still continues for making boot-polishes.

A factory in Bangalore for making oil-cloth is still not ready for operation awaiting arrival of certain items of machinery from abroad. A prospective producer of oil-cloth from Delhi was trained at the Institute. Contact is maintained with a few more likely entrants to this field. There was also an enquiry for insulating cloth, the production of which is expected to begin shortly.

About 20 enquiries were answered regarding French polish, packing of varnishes, flexible coatings, coloured lacquers, hot spraying and lacquering of wood.

The use of air-drying insulating varnishes by electrical goods manufacturers is on the increase but baking insulating varnishes have not yet been adopted regularly.

Shellac plastics have not been widely developed, but a firm in South India is still marketing goods made of dry-mixed compositions. There are several firms interested in starting plastic moulding and these were supplied with literature and data.

The manufacture of waterproof abrasive papers continued with some improvements.

Six firms have come into the line of sealing-wax manufacture.

A large number of enquiries about literature, sources of supply of lac and lac products and methods of manufacture was answered.

A scheme for reorganizing seed lac and shellac manufacture on a large scale was drawn up for a party.

Foreign Markets

Although exports to foreign countries did not reveal any serious decline, the replacement by synthetics is very much on the increase ; this shows that the off-take of Indian lac is not increasing proportionately with the world demand for resins in general. It has to be recorded, however, that Siam is supplying more shellac to other countries than ever before. Contact was maintained with the India Government Trade Commissioner in New York, importers in U.S.A., the Indian Legation in Bangkok and consumers of lac in foreign countries through correspondence.

Publicity

Publicity notes and articles were published in the general and scientific press under the following titles :

Gramophone Records of Synthetic Resins
Lac or Synthetic Resins ?
Valite 7796-D, New Thermoplastic Extender for Shellac

There were editorial references to the lac industry in the *Statesman*, the *Indian Finance*, the *Hindusthan Standard*, the *Searchlight* and several other newspapers.

Samples of lac products were sent as exhibits to the science sections of the Indian Museum and various colleges, All-India Exhibition at Calcutta and Patna, several district exhibitions and those held abroad in Singapore, Toronto and Milan.

General

A close touch was maintained with development in lac research and lac markets in India and abroad. Data, notes and statements were compiled and supplied to Government departments, Indian Standards Institution and other bodies.

M. Venugopalan
Acting Director
Indian Lac Research Institute

6th June 1948

APPENDIX A-I

A statement of lac produced and its disposal

Crop and locality	Scraped or brood lac produced and its disposal					
	Produced	Under use in department	Driage	Supplied to lac factory	Sold	Distributed free
	Md. sr. ch.	Md. sr. ch.	Md. sr. ch.	Md. sr. ch.	Md. sr. ch.	Md. sr. ch.
Baisakhi 1946-47						
Namkum ..	3 29 4*	..	0 5 0	..	..	3 24 4
	1 38 1†	0 1 0	..	1 37 1	..	..
Jethwi 1947						
Hesal ..	2 14 4	0 4 0	0 4 0	2 6 8	..	..
Katki 1947						
Namkum ..	0 5 0*	..	..	..	..	0 5 0
	0 23 9†	0 9 13	..	0 13 12	..	..
Aghani 1947-48						
Namkum ..	1 2 8*	..	0 0 8	1 2 0	..	..
Hesal ..	1 36 12†	0 2 8	0 18 0	0 36 4	..	0 20 0

	Md. sr. ch.	Rs. as. p.
(1) Receipts by supply to lac factory of scraped lac from Institute Plantation	1 37 1	91 1 6
do do ..	2 6 8	172 14 0
do do ..	0 13 12	22 5 6
do do ..	1 2 0	88 3 0
do do ..	0 36 4	76 1 9
TOTAL ..	6 15 9	450 9 9
(2) Receipts by supply to free distribution of brood lac from Institute Plantation	3 24 4	295 11 3
do do ..	0 5 0	8 12 0
TOTAL ..	3 29 4	304 7 3
(3) Receipts by supply to free distribution of scraped lac from Institute Plantation	0 20 0	42 0 0
(4) Receipts by supply of scraped lac to lac factory from Institute Plantation	1 34 0	83 4 0
do do ..	0 30 10	34 7 3
do do ..	1 28 0	102 0 0
do do ..	0 3 0	6 12 0
do do ..	0 18 8	39 2 0
do do ..	0 10 0	17 8 0
do do ..	0 5 0	8 2 0
do do ..	0 27 0	43 14 0
do do ..	0 1 8	3 2 3
TOTAL ..	5 37 10	338 3 6

*Brood lac
†Scraped lac

APPENDIX A-II

Report on the Intensive Demonstration Scheme, Bihar for the year 1947-48, by the Entomologist, Bihar

General

The demonstration staff contacted lac cultivators in 195 villages in the districts of Ranchi, Manbhum, Palamau and Singhbhum.

Broodlac Supply

The Lac Cess Committee supplied a limited quantity of free brood lac.

There was, however, a great scarcity of *kusum* brood both in the *Jethwi* 1947 and *Aghani* 1947-48 seasons and consequently no *kusum* brood could be sent out to demonstration areas in July, 1947. In February, 1948, however, a small quantity could be supplied with great difficulty. Scarcity was also felt with respect to *Rangini* brood especially in July, 1947. However, a small amount could be supplied to demonstration areas as detailed below :

District	Name of centre	June-July '47 season		Oct.-Nov. '47 season	Jan.-Feb. '48 season
		Rangini	*Kusum*	*Rangini*	*Kusum*
		Md. sr. ch.	Md. sr. ch.	Md. sr. ch.	Md. sr. ch.
Ranchi	1. Palkot	1 20 0	nil	1 20 0	nil
	2. Bundu	2 18 4	..	1 2 0	..
Manbhum	3. Garhjaipur	4 6 0	..	1 22 0	0 15 0
	4. Chandil	1 0 0	..	2 0 0	..
Singhbhum	5. Hatgamaria	1 29 0	1 11 0	..	Given up in Dec. '47
	Saranda division at Jeraikella opened in January, 1948				1 1 4
Palamau	6. Satberwa	1 25 0	..	5 0 0	..
	7. Panki	..	..	6 35 0	1 20 0
	8. Balumath	2 0 0	..	0 36 0	..
	TOTAL	14 18 4	1 11 0	18 35 0	2 36 4

Detailed Crop Reports in Various Demonstration Areas

Baisakhi 1946-47 — The crop passed through one of the severest summers experienced in the province.

133 *ber* and 551 *palas* were infected at 7 centres with 22 mds. 16 srs. of brood lac partly supplied from the Institute and partly produced in the area. Of these host trees, 11 *ber* were partially pruned and 130 *palas* defoliated. The data available from Bundu, Balumath and Panki showed that brood lac was produced at these places only from the defoliated and partially pruned trees and not from others. The brood/yield ratios for the total crop were 1 : 1·4 on lac sticks and 1 : 2·6 on scraped lac.

Katki Crop 1947 — During this crop 444 *palas*, 60 *ber* and 4 *khair*, altogether 548 hosts were infected in 7 localities with 15 mds. 1 sr. 6 ch. of brood lac partly supplied from the Institute and partly produced from the area. Brood/yield ratio on sticks varied from 1 : 0·37 at Chandil to 1 : 3·1 at Satberwa, and on the whole it was 1 : 2·2. On scraped lac

it varied from 1 : 0·7 at Balumath to 1 : 3 at Hatgameria. On the whole, it was 1 : 1·5. The cultivators of Garhjaipur and Bundu were able to produce surplus brood lac which was sold by them.

Baisakhi 1947-48 — 153 *ber* and 577 *palas* trees had been infected in 10 areas, of which 11 *ber* were partially pruned and 328 *palas* defoliated. It is reported from Bundu and other areas also that the cultivators are not very willing to partially prune a further number of trees and efforts are being made to induce them to do so. A total of 35 mds. 35 srs. of brood lac has been used for infection and the condition of crop is reported to be satisfactory so far. People seem to have no objection to defoliation of *palas*.

Kusmi Crops

Jethwi 1947 — Infection was carried out in 7 localities on 47 *kusum* trees with 3 mds. 21 srs. of brood lac supplied from Oreya. The crop passed through one of the extreme summers. Excepting at Balumath the crop failed in all areas. The brood to yield ratios in Balumath were 1 : 2·3 on sticks and 1 : 2·2 on scraped lac. Brood lac was also obtained to infect trees for the following *Aghani* 1947-48 crop.

Aghani 1947-48 Crop — Infection was carried out at Balumath on 7 trees with 1 md. 5 srs. of brood obtained from the area, while at Hatgameria on 8 trees with 1 md. 11 srs. of brood locally purchased at the cost of the Institute. Results from the latter area arenot available while at Balumath the brood/yield ratios were 1 : 1·4 on stick and 1 : 0·97 on scraped lac.

Jethwi 1948 — Infection was done in 4 localities on 22 *kusum* trees with brood lac supplied from the Institute and at Balumath with that produced in the area. Condition of crop is reported satisfactory so far.

Propaganda has been carried out in a large number of areas and people are slowly adopting the Institute methods, especially those of pruning. There was a very great demand for brood lac and the owners of the areas where intensive demonstrations were carried out insisted on getting free brood every season. However, there were some who co-operated, and in spite of some areas being given up, in each centre work of demonstration was still carried out in a large number of areas. People everywhere seem to be getting gradually interested and casual demonstrations of pruning of hosts and defoliation of *palas* have been given in a fairly good number of localities in each centre.

Number of Intensive Demonstration Areas under Various Lac Supervisors in Bihar

Sl. No.	On 1 April 1947		Taken up during the year		Given up during the year		Casual areas being worked in addition	Position on 1 April 1948	
	Rangini	*Kusum*	*R.*	*K.*	*R.*	*K.*		*Rangini*	*Kusum*
1. Bundu	30	11	×	5	11	11	...	19	5=24*
2. Balumath	18	11	5	×	6	2	...	17	9=26*
3. Garhjaipur	9	1	5	2	5	×	...	9	3=12
4. Chandil	7	2	4	4	5	×	5 (casual)	6	6=12
5. Satberwa	10	1	×	×	2	1	...	8	×= 8
6. Panki	24	2	×	×	16	×	3 (casual)	8	2=10
7. Hatgamaria	12	9	×	×	12	9	Work discontinued in December, 1947		
Jeraikella 8. Palkot	Started in Jan. 1948 No reports available.		×	4	×	4	...	×	4= 4
TOTAL	110	37	14	15	57	23	8	67	29=96

*Amongst those given up there are 2 at Bundu and 4 at Balumath which have become self-sufficient with regard to their brood requirement.

Training

During the year a revised course of practical and theoretical training was drawn up by the Lac Research Institute and altogether 7 newly recruited Demonstrators were admitted to this course of training. They were also taken to field areas at Hesal, Kundri and Oreya for practical training in field operations and in addition they worked in the plantation attached to the Institute.

In the month of August-September, 1947 a refresher course of training was also held for the Bihar Government Lac Supervisors. During this course they were instructed in the proper laying out of their areas of demonstrations, the working plan to be followed and the method of reporting the results of lac operations. Forms were drawn up for submission of their diaries, monthly reports and crop-data sheets and the same were fully explained to them.

APPENDIX A-III

Report on the Lac Demonstration Scheme, West Bengal for the year 1947-48 by the Entomologist, West Bengal

Introduction

The working of the scheme was confined to two districts only of this province, viz. Malda and Murshidabad. During the period under review, the scheme had to be worked with reduced staff at Malda, some members of the staff having opted for East Bengal.

Staff

Before the partition of Bengal, there were one Supervisor and three Demonstrators at Murshidabad and two Supervisors and four Demonstrators at Malda. After partition the strength of staff at Murshidabad was the same but at Malda, part of which had gone to East Bengal, the staff consisted of one Supervisor only, the rest having opted for East Bengal.

Demonstration of Improved Methods of Cultivation & Advice to Cultivators on Request

Cultivators were told to observe the following, and actual demonstrations were given on their trees :

(1) Advantages of cultivation by coupé system.
(2) Preservation of *Baisakhi* crop on *ber* by partial pruning.
(3) Cropping by improved methods and in proper time.
(4) Proper selection of brood lac.

Intensive Demonstration — The following centres were selected in the two districts for making intensive demonstration of the coupé system. A plantation was divided into three coupés, one coupé being infected with *Baisakhi* brood, second one with *Katki* and the third being allowed rest in rotation. Names of centres with crops are given below :

Centres	Brood lac infected in June, 1947 Md. sr.	Brood lac obt. in Oct., 1947 Md. sr.	Brood lac infected in Oct., 1947 Md. sr.	Remarks
District Murshidabad				
Ankura ..	1 20	4 20	..	*Katki*, 1947
Bewa	1 0	3 10	..	
Bhabanipur ..	..	..	3 38	*Baisakhi*
Chhabghati ..	..	..	2 5	1947-48
Durgapur	..	..	2 0	Standing crop
District Malda				
Jodhpatta	0 30	0 4	..	
Panchanandpur ..	1 30	2 15	..	*Katki*, 1947
Kahala	1 35	1 10	..	
Panchanandanpur ..	..	..	2 15	*Baisakhi*
Kahala	..	..	1 10	1947-48

Scarcity of Brood Lac — During the year under review there was a general complaint from the lac cultivators about scarcity of brood lac for infection for the *Katki* crop. Owing to high temperature prevailing in these parts of West Bengal as usual, there was a high mortality of lac insects resulting in death of brood lac.

Programme of Work for 1948-49 — The scheme was started some years back, but still it is difficult to assess minutely the actual progress made for want of comparable data. This would have been possible if at the time of starting the scheme a close survey had been made of the two lac-growing districts of Malda and Murshidabad, keeping a record of the names of owners of lac hosts, the number of lac hosts possessed by individuals, and the number of infected and uninfected hosts. A regular yearly record should have been kept of the number of additional trees infected, additional yield obtained and also trees infected previously but abandoned. By comparing these records it would have been possible to estimate the increase in the number of cultivated lac hosts, as well as the increase in the annual yield of lac, and thus assess the results of the demonstration work.

In consideration of the above, the following programme for 1948-49 has been drawn up :

(1) General demonstration of improved methods of cultivation.

(2) Intensive demonstration.

(3) Collection of information union by union on the following points :

(i) Names of lac host owners.
(ii) Number and names of lac hosts in the possession of different owners.
(iii) Number of infected and uninfected lac hosts.
(iv) Brood lac requirement of the owner.

During 1948-49 an attempt will also be made to propagate cultivation of lac in different districts of this province other than Malda and Murshidabad.

Concluding Remarks—The scheme was started in 1942 and demonstrations of methods of improved cultivation have been made to lac growers of Murshidabad and Malda. These two districts are the major and perhaps the only lac-growing districts of Bengal. Lac being grown here since long, the growers inheriting the host trees from previous generations, also inherited the methods practised by the previous generations. Naturally, being mostly illiterate, they were not very much inclined to take up the new methods demonstrated by the lac staff. It is quite true that the lac staff explained and demonstrated to them the improved methods in the various demonstration centres, but it is difficult to find out how

far the demonstration work of the lac staff has been fruitful in inducing them to take up these improved methods. Further, the increase in the number of cultivated lac hosts (*ber*) and the consequent increase in lac production may be due to an impetus received by the shooting up of the prices of lac during the war period and cannot be definitely attributed to the propaganda under the Demonstration Scheme.

At the time of inception of the scheme, it was proposed by the President, Lac Cess Committee, in his letter No. D. 2828/42/D, New Delhi, dated 7th May, 1942, addressed to the Secretary, Government of India, Education, Health and Lands Department that " In order that demonstration may be effective in a province it will be divided judiciously into centres and those centres where lac cultivation is popular will be taken up first ". It is high time, however, that the line of work under the scheme be changed now and the demonstration work be not confined to the same two districts only where the work had been carried out for the last few years.

The two important lac hosts, viz. *palas* and *ber* are found in some parts of Midnapore and Birbhum. It will be of great benefit to this province if the uncultivated hosts of these two districts are brought under cultivation by demonstrating the improved methods as practically no lac is produced in these two districts. As the cultivators know nothing about lac cultivation, they may be expected to take up the improved methods advocated by the Lac Research Institute unhesitatingly.

APPENDIX A-IV

Report on the Lac Demonstration Scheme in the U.P. for the year 1947-48 by the Entomologist, U.P.

Staff

The Lac Supervisor and three Lac Demonstrators held their posts throughout the year.

Areas under Intensive Demonstration

The work under the scheme was confined to Mirzapur District only. The major portion of the lac-growing area of this district is divided into three circles, viz. Mirzapur Sub-division with headquarters at Mirzapur, Robertsganj Sub-division with headquarters at Muirpur and Dudhi Sub-division with headquarters at Windhamganj. Each circle is in charge of a Lac Demonstrator who has to work within a radius of about 15 miles from his headquarters except in the case of Mirzapur circle where some places of work are more than 30 miles away. The details of work done in each circle are given below.

I. Mirzapur Circle

Intensive demonstration of the various operations of lac cultivation on improved lines as recommended by the Indian Lac Research Institute, Namkum, Ranchi was carried out at five centres, viz. Jhelempur, Malwa, Kakrod, Dibhore and Khoradih on *palas* trees and at three centres, viz. Mirzapur proper, Bariaghat and Dibhore on *kusum* trees. Working plans were drawn up for each area and the owners of the trees carried out all operations under the direction of lac staff. Each of the *Rangini* areas contains over 2,000 *palas* trees but there are only few *kusum* trees at each of the three *kusum* lac centres.

II. Windhamganj Circle

The main *Rangini* lac areas under improved methods of lac cultivation in the circle are Nahuli, Hernakacher, Kolindubhe, Bairkher, Mandisemar and Dudhi. *Kusum* lac has been grown on a small scale at Berkher Bome and Jaugal Jharia. At all these places *palas* trees were left for self-infection for the last two seasons due partly to the unavailability

of brood lac and partly because the cultivators neglected lac cultivation on trees leased out to them by the Gladstone Wylie Company as a result of an agitation going on in the locality regarding the ownership of the trees. Towards the end of the year under report, nine villages, viz. Kachnerwa, Bairkher, Dumor, Dudhi, Mahali, Kewal, Hernakacher, Mandisemar and Jaugal Jharia were selected for intensive demonstration in consultation with the manager of the Gladstone Wylie Company and the local growers.

III. Robertsganj Circle

Demonstrations and propaganda were carried out in a number of villages. No intensive demonstration of lac operations and coupé division of trees could be done for reasons mentioned above. The liaison officer of the Indian Lac Research Institute visited this area in March, 1948 and fixed nine centres, viz. Bajiya, Chainpur, Gohanda, Kirwil, Nadira, Babhni, Kundri, Jhers and Bhawar for intensive demonstration of the various lac operations in consultation with the zamindars and cultivators.

General Propaganda Work

Besides intensive demonstration of lac operation in the selected areas, the staff toured about extensively in other lac-growing areas and visited over 100 villages all over the district. At these places the object of the scheme was explained to the cultivators and lectures were delivered on improved methods of pruning, infection, the coupé system, collection of lac, etc. Many of the cultivators of these places were persuaded through the headmen of villages, Presidents of the local Congress Committees and members of *Gram Panchayats* to adopt improved methods of lac cultivation. Casual demonstration of pruning and other operations was also given at several of the villages. As a result, the condition of lac in these villages was, on the whole, better than in other areas where people were still following the old methods.

Distribution of Free Brood Lac & Implements

7 mds. and 33 srs. of *Rangini* brood lac, received from Ranchi in October, 1947, were supplied free to cultivators of Jhelempur, Kakrod and Dibhore and 1 md. and 7 srs. of *kusum* brood to cultivators of Rakharghat, Bishambharpur, Bariaghat and Dibhore in the Mirzapur circle. Pruning instruments were given on loan to deserving cultivators for the time of pruning operation only.

Crop Yields

Katki crop of the demonstration areas was left over for self-infection. The condition of the *Baisakhi* crop was quite good and development of lac cells was normal.

GENERAL APPENDIX I

Comparative Figures of Stick Lac Production in India (in maunds)

Year	*Baisakhi*	*Jethwi*	*Katki*	*Kusumi*	*Total*
1947-48	6,16,000	30,250	2,31,500	94,000	9,71,750
1946-47	10,97,500	1,19,750	3,75,000	1,75,000	17,67,250
1945-46	6,35,250	28,750	2,60,125	2,02,500	11,26,625

GENERAL APPENDIX II

List of Publications during April 1947 to March 1948

Bulletin No. 65. Lac-linseed oil varnishes, Part I: Lac-linseed oil red-lead, by Y. SANKARANARAYANAN

Bulletin No. 66. Melt viscosity, Part I: Shellac and its constituents, by S. BASU

Bulletin No. 67. Molecular state of dissolved shellac, by S. BASU

Bulletin No. 68. Viscosity and axial ratio of shellac, by S. BASU

Bulletin No. 69. Melt viscosity Part II: Esters and acetyl derivatives of shellac and its constituents, by S. BASU

Bulletin No. 70. Diffusion of axial ratio of shellac and its constituents, by S. BASU

Bulletin No. 73. Lac-linseed oil varnishes, Part II: Lac-linseed oil glycerine, by Y. SANKARANARAYANAN

Research Note No. 37. On the function of the "feeding tubes" of Bracon (Microbrocon) greeni, Ashmed, by P. M. GLOVER, T. VENKATRAMAN & S. N. GUPTA

IN THE PRESS

Bulletin No. 71. Melt Viscosity Part III, Plasticised Shellac, by S. BASU

Bulletin No. 72. Elasto-viscous effect in Shellac, by SADHAN BASU

Bulletin No. 74. Preliminary trails in the propagation of bracon (*Microbrocon*) *greeni, Ashmed*, on unnatural hosts, by T. VENKATRAMAM, S. N. GUPTA & P. S. NEGI

Research Note No. 36. On the suitability of dielectric constant method for the determination of moisture in lac, by G. N. BHATTACHARYA

Bulletin No. 75. Osmotic pressure and molecular weight of shellac, by S. BASU

Bulletin No. 76. Improved methods of lac cultivation, by P. S. NEGI

*These figures are for Indian Union and the acceding States only.

GENERAL APPENDIX III

Tabulated Statement of the progress of investigations

ITEM	COMD. IN	PROGRESS	FUTURE WORK PROPOSED
1	2	3	4
		ENTOMOLOGICAL SECTION	
1. Improving crop production on *palas* by artificial defoliation.	1940	In spite of extreme hot weather 26 mds. of *Baisakhi* and 120 mds. of *Katki* brood lac were obtained. At present lac is on over 9,000 trees whereas in the adjoining village Kundri there is practically no lac.	Commercial cultivation at Kundri to be continued.
2. Determination of most suitable pruning methods and seasons for *kusum* and *palas*.	*Kusum* 1941	Both *Jethwi* and *Aghani* crops were better in our area at Hesal than in other localities. "Surface" pruning seems to be satisfactory.	Work to be continued for 3 years on "surface" pruned shoots 6 and 12 months after surface pruning and "apical" pruned shoots, 12 and 18 months after apical pruning.
	Palas 1942	Both February and April pruning produced satisfactory shoots. Thick pruning not conducive to growth of infectable shoots.	To be continued for another season.
3. Investigating the economics of utilizing *palas* for the *Baisakhi* crop only and *ber* for the *Katki* crop only.	1942	Results have clearly established that this method is sound. It should be encouraged by propaganda and demonstration.	Completed.
4. Investigating the possibilities of *F. bengalensis* (*barh*), *O. dalbergoides* (*pandan*) and *A. lucida* as *Baisakhi* hosts.	1945-46	*Pandan* and *A. lucida* gave good results, *barh* was less satisfactory.	To be continued.
5. Proper harvesting, storage and disposal of stick lac to avoid enemies.	1945-46	*Ari* crop cutting proved detrimental to the interest of cultivator.	Completed.
		Storage and effect of enemies to be studied.	To be continued for one year only.
6. Using brood lac in wire-gauze baskets with a view to control of enemy insects.	1945	Results obtained proved it to be an ideal method for propagation of lac in new areas. It might be useful also for areas already under lac cultivation.	A large-scale trial should be given.
7. Control of insect enemies by :			
(a) heat treatment	1941	Was suspended in July, 1947.	To be taken up if staff is available.
(b) Gammexane	1946	Spraying gave better results than immersion for 12 hours.	To be continued.
(c) D.D.T.	1947	do	do
(d) Fumigation	1947	A mixture of ethylene dichloride and carbon tetrachloride, and ethylene trichloride was tried.	To be continued.
8. *Biological Control*			
(a) To discover suitable unnatural hosts to breed *B. greeni* in the laboratory.	1942	*T. fructicassiella* (*amaltas* borer) gave the best results. Borer of *Karanj* (*P. glabra*) and bean pod borer were introduced for the first time. Due to disturbances cotton seeds could not be procured.	To be continued.

GENERAL APPENDIX III (*cont.*)

Item	Comd. in	Progress	Future work proposed
1	2	3	4
(b) Breeding of *B. greeni* on a mass scale on natural and unnatural hosts.	...	5,800 *B. greeni* were bred on *Eublemma* and 6,995 on *T. fructicassiella*. Total *greeni* bred was 13,136.	To be continued and other possible hosts explored.
9. *Demonstration*			
(a) Demonstration of improved methods of cultivation and advice to cultivators.	1940	Brood lac was distributed. Provincial and Indian States' staff were trained. Practical demonstration in Bihar, Bengal and U.P. continued and proved superiority of Institute methods.	To be continued.
(b) Improved cultivation in forest areas.	1943	Second 3-year term completed. The scheme was extended for another 3 years. Mako omitted from the scheme.	To be continued.
10. Namkum Plantation.	...	*Khair* produced good *Aghani* brood crop. A scheme for improvement of the plantation sanctioned.	To be continued.
		CHEMICAL SECTION	
11. *Moulding Powders*			
(a) Lac - urea - formaldehyde powders	1938-39	Standardization of lac moulding powders : effect of ageing, infra-red heating, etc., was studied.	To be continued.
(b) Lac-CNSL-S compositions.	...	Mouldable compositions with good gloss and high water resistance, but somewhat low impact strength.	To be continued.
(c) Lac-dimethylol-urea compositions.	1947	Direct combination of dimethylol-urea and lac further studied.	To be continued.
12. *Varnishes & Lacquers*			
(a) Lac-CNSL varnishes.	1943-44	Lac-CNSL varnishes further studied.	Electrical insulating properties to be further studied.
(b) Waterproof shellac varnishes.	1947	Work completed.	
(c) Lac-linseed oil-glycerine air-drying varnishes.	1944-45	Modifications tried to eliminate tackiness but so far without success.	To be continued.
(d) Lac-linseed oil-lime varnishes.	1946-47	Chemical reactions involved are being studied.	To be continued.
(e) Lac-linseed oil insulating varnish.	1945-46	" Empire cloth " samples were prepared and these are reported to be satisfactory.	To be further standardized.
(f) Oil-cloth	...	An apparently satisfactory air-drying composition has been evolved.	The ageing properties are being studied.
(g) Lac-castor oil combination.	1948	Drying and other properties are being studied.	To be continued.
13. *Fundamental Researches*			
(1) Constitution of hard lac resin.	1947	Degradation products are being studied.	To be continued.
(2) Constitution of soft resin.	1943		

GENERAL APPENDIX III (*cont.*)

Item	Comd. in	Progress	Future work proposed
1	2	3	4
(3) Odoriferous principle of shellac.	1947	Isolated and constitution being studied.	To be continued.
(4) Effect of infra-red and direct heat on lac and lac films.	1947	Hardness and abrasion tests done.	To be continued.
(5) Accelerators in the heat curing of shellac.	1946	The influence of some new chemicals observed.	To be continued.
(6) Nature of shellac in solution.	1946	Ultra-violet absorption spectra and flowing birefringence studied.	
(7) X-ray structure of shellac.	1947	Powder pattern suggests liquid (amorphous) structure.	
(8) Dielectric properties.	1940-41	Dielectric properties of acetic ester of lac, lac-glycol ether studied. Insulating properties of lac-linseed oil-lime varnishes investigated.	To be continued.
(8a) Hydrogenation of lac.	1947	Study started.	To be continued.
(9) Moisture content of shellac: use of infra-red heating for determining.	1947	Method appears to be promising.	To be continued.
14. *Improvements in the Manufacture of Seed Lac, Shellac, etc.*			
(a) Making of shellac by autoclave method.	1947	Laboratory experiments are being conducted.	To be continued.
(b) Making of kiri lac.	...	Improvement of the soda-process product is being tried.	To be continued.
(c) Seed lac washing	...	New melting agents are being tried.	To be continued.
15. Shellac-wax	1944	Details of process for isolating lac-wax from varnish residue worked out.	Completed.
16. Home-recording Disc.	1941	Simple plasticized lac varnishes in aqueous ammoniacal solution suitable for single coat application have been studied. Results not encouraging.	Synthetic plasticizers to be tried.