INDIAN LAC RESEARCH INSTITUTE
NAMKUM, RANCHI, BIHAR

Annual Report
1967

INDIAN COUNCIL OF AGRICULTURAL RESEARCH
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Contents

I. Introduction

The Indian Lac Research Institute came into existence as a result of the recommendation of a two-man enquiry committee (comprising Shri H.A.F. Lindsay and Shri C.M. Harlow) appointed early in 1920 by the then Government of India to enquire into the conditions of the Indian Lac Trade and suggest measures for its all-round improvement. The report of this committee was published in 1921 in which they observed *inter alia* that the two major ills from which the lac trade was then suffering, namely, liability to violent price fluctuations and adulteration in times of short supply, could be cured only by improved outturn. For this, they suggested that recourse should be taken to intensive cultivation by scientifically tested methods, rather than to extensive cultivation. In order to implement this suggestion, members engaged in the lac trade at that time constituted themselves into a private registered body under the name of Indian Lac Association for Research. This Association set up the Indian Lac Research Institute in 1925.

In 1930, on the recommendation of the Royal Commission for Agriculture (1927), the Indian Lac Cess Act was passed by the Central Legislature. Under this Act, the Government of India constituted the Indian Lac Cess Committee which took over the Institute from the Lac Association in 1931. The Committee maintained the Institute till 31st March 1966. With the abolition of the Committee on this day, the Institute was taken over by the Indian Council of Agricultural Research with effect from 1st April 1966. The Institute is now functioning under this Council.

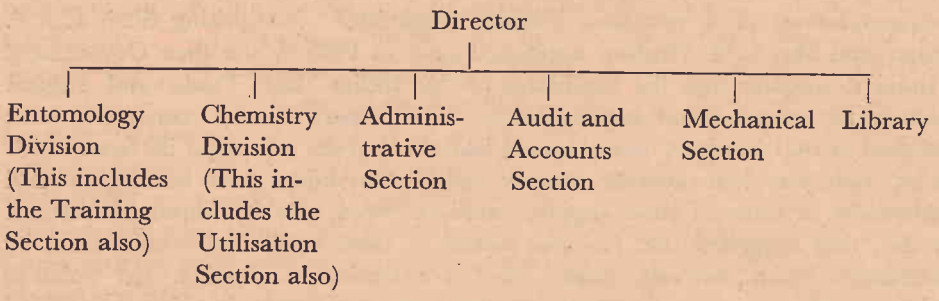
The Institute is situated at Namkum, about nine km east of Ranchi. The laboratories of the Institute consist of three fair-sized separate buildings, housing the Chemistry Laboratory, the Entomology Laboratory and the Experimental Factory. The Institute Library adjoins the Entomology building and the Administrative Section and Museum are housed in another block. The water-works, workshop, gas plant, etc., are located in small constructions between the main Chemistry and Entomology Laboratories. Due to paucity of accommodation, the Audit and Accounts Section and one unit of the Administrative Section are temporarily accommodated in two small rooms adjoining the workshop.

Apart from these, the Institute also has an adjoining plot of over 35 ha for use as an experimental plantation. The total estate of the Institute at Namkum including the plantation covers an area of about 49 ha. For outstation experiments, areas/trees have been taken on long-term lease.

The Institute is headed by the Director who also functions as Head of the Chemistry Division. The Head of the Division of Entomology is the Entomologist.

Objective and structure. The main objective of the Institute is to carry on research towards effecting improvements in the cultivation, processing, standardisation and modification of lac through scientific research so as to intensify cultivation and extend utilisation. In addition, the Institute is also to carry on publicity and maintain liaison with and provide technical service to the indigenous industries towards improving the quality of their products and increased utilisation of lac.

Present structure of the Institute is indicated in the following plan:



Visitors. This Institute has always been a regular attraction to most visitors to Ranchi particularly scientists and technologists. During the period under report also, it received the usual complement of visitors including students and trainees from different colleges and institutions, officials and others VIPs which included Shri R.N. Banerjee, I.C.S., Special Secretary, Ministry of Commerce, Government of India.

In addition, a Russian scientists' study team comprising Dr. N.A. Kachibaya and Dr. I.D. Mamedov and an interpretor, Mm. Albina Datsenko, paid a visit to the Institute in March and spent about three weeks visiting the Laboratories, outstations as well as a few important lac markets and processing factories.

Collaboration with other institutions. Apart from work within its own premises, the Institute has always sought to take advantage of technical know-how and facilities available in other institutions also for the furtherance of its objectives. A Research Project is being implemented since 1960 under which the constitution of lac is being studied simultaneously (i) at the Chemistry Laboratory of the Delhi University under the guidance of Prof. T.R. Seshadri, F.R.S. and (ii) at the National Chemical Laboratory, Poona, under the guidance of Dr. Sukh Dev. In addition, the constitution of lac dye is also being investigated at the National Chemical Laboratory, Poona, under the guidance of Prof. K. Venkataraman and development of shellac based leather finishes at the Central Leather Research Institute, Madras, both under separate schemes. Shri C.P. Malhotra, Scientific Officer (Field Station), was permitted to avail study leave and to join Indian Agricultural Research Institute, New Delhi for post-graduate research leading to Doctorate degree.

The Institute is continuing to get co-operation from the Indian Institute of Technology, Kharagpur in its work on shellac-rubber combinations as during the last two years.

The Institute also takes advantage of International Technical Co-operation Schemes to provide specialized knowledge to its employees. During the year under report, Shri B.P. Mehra, Scientific Officer (Cultivation), who was deputed to Canada for training in the field of Insect Ecology at the Canada Department of Agricultural Research Station, St. Jean, for one year under the Colombo Plan, returned in the month of October 1967, after successful completion of training.

The Institute continued to collaborate, as usual, with the Indian Standards Institution in the formulation of Indian standards for lac and lac products and allied materials. The scheme of co-operative research with the Jute Technological Research Laboratories, Calcutta, taken up during last year with a view to developing newer uses of lac in conjunction with jute, was continued.

Advisory services. The Institute provides technical assistance to all those interested in the cultivation, processing, grading and utilisation of lac. During the year, among others, technical assistance was also provided to the Bihar State Lac Co-operative Marketing Federation Limited for their purchase and processing operations and to the Bihar State Forest Department in the setting up and maintenance of their *Kusmi* brood-cum-demonstration Farm at Maheshpur (Ranchi District).

In addition, the Institute provides two courses of training of six months duration: (i) on the improved methods of lac cultivation, and (ii) on industrial uses of lac. The training is given to deputees of Central and State Governments and industrial undertakings.

For the benefit of the trade and industry, the Institute also maintains Regional Analytical Laboratories in the major lac processing centres of the country. During the period under report, three laboratories were functioning, one each at Namkum (Ranchi District, Bihar), Balarampur (Purulia District, West Bengal), and Gondia (Bhandara District, Maharashtra).

Library. The number of books and bound volumes of journals accessioned during the year was 789. This brought the total number of books and bound volumes of journals in the library as on 31st December 1967 to 12,376. In addition, 143 periodicals were subscribed for and a few received in exchange or as free gift. Some miscellaneous publications and reports were also received.

Staff club. The Staff Club continued its activities as usual towards which the Institute made a recurring contribution of Rs. 459 for 1967–68.

Finances. Since its inception, lac research was financed through a cess levied on all exports of lac. Since 1962–63, however, some grants were also received from the Government of India, as the income from the cess was found inadequate. Since the Institute has been taken over by the ICAR with effect from 1st April 1966, it is now being wholly financed by the ICAR.

The revised budget estimates of the Institute for 1967–68* amounted to Rs. 13,10,000. The actual expenditure during the same period was, however, only Rs. 10,53,524.

*The budget estimates and actual expenditure are included as of the financial year because it is impracticable to work out the same for the calendar year.

II. Progress of Research

A. ENTOMOLOGY DIVISION

Work on the various problems was continued as per Project Proposals of the Entomology Division submitted for 1967.

The staff position remained difficult as before. One Senior Research Assistant, Shri S.M. Kulkarni, resigned and left in the early part of the year. As mentioned earlier, Shri Malhotra, Scientific Officer, who was looking after the work of the Field Research Stations proceeded, in October, for higher studies at the Indian Agricultural Research Institute. However, Shri B.P. Mehra, Scientific Officer, returned in late October after his training in Canada and took over the Field Station work. The posts of three Scientific Officers (that of Biology, Insect Physiology and Arboriculture) remained vacant throughout the period and so was the post of Instructor and a few Research Assistants.

For the third successive year, the unprecedented drought again prevailed, in its worst possible form, in most of the more important lac-growing areas in the country. However, in spite of these adverse conditions, progress of experiments at Namkum was not disturbed and fairly good crops were obtained. Broodlac was also produced in adequate quantities to meet our requirements.

Among the more important findings during the year, particular mention may be made of the following conclusions arrived at on completion of the appropriate studies.

1. It has been confirmed that harvesting of the crop on *palas* (*Butea monosperma*) can profitably be utilised to serve as pruning of the tree also and that the maximum yield of sticklac from this host is obtained by harvesting the crop as *ari* between 15th and 20th April.

2. Highest yield of broodlac as well as sticklac is obtained from *palas* inoculated in July at the rate of 200 g of broodlac per tree and harvested in October. Also a lighter inoculation (100 g per tree) is preferable for broodlac production only, as the ratio of broodlac used to broodlac obtained is higher at this rate.

3. For large-scale cultivation, the prevalent villagers' method is disadvantageous since sufficient broodlac is not produced thereby.

4. *Kusmi* lac, which is the most valuable of all lacs, can be successfully produced on the alternate host *galwang* (*Albizzia lucida*) during *Jethwi* season and on *bhalia* (*Moghania macrophylla*) during *Aghani*.

Other notable findings are (i) for intensive lac cultivation on a plantation basis on *bhalia*, the optimum spacing of the host is 1.22 m × 1.22 m as reported earlier, (ii) the yield of lac from *bhalia* increases nearly two-fold with manuring, particularly with farmyard manure at the rate of 36 quintals per acre, (iii) advance harvesting of broodlac is best carried out a week before maturity in the case of *ber* (*Zizyphus mauritiana*) and two weeks in the case of *palas*, and (iv) for lac cultivation on *kusum* (*Schleichera oleosa*) it is better to harvest the crop once in two seasons and not in every season as is the present practice. Among other interesting results are (i) the successful training of *galwang* and *ber* into bushes, (ii) the survival of *Kusmi* strain of lac insects on *palas* up to the third generation (so far) maintaining the *Kusmi* life-cycle and producing thick and continuous encrustation similar to *Kusmi* lac, and (iii) the successful use of *Bacillus thuringiensis* Berl. in the field to control lac insect predators which resulted in increasing the crop 2 to 3.5 times.

RESEARCHES COMPLETED

1. Studies on the proper time of harvesting-cum-pruning *palas* within April–May

Experiments had been initiated in 1963 at Kundri to determine if harvesting of the crop on *palas* can also be utilised to serve as pruning of the host in order to cut down the cost of cultivation. This experiment was laid out on the basis of the result of systematic studies which had shown that the maximum yield of lac from *palas* is obtained by harvesting the crop as *ari* in April or May, which are also the months for pruning this host for *Baisakhi* inoculations. The experiment was continued for the fifth year. Due to extreme drought, the crop suffered adversely and the results were somewhat contradictory to those obtained so far.

However, based on the results obtained during the four crops studied and reported earlier, it can safely be concluded that harvesting of this host in April-May can profitably be utilised to serve as pruning also.

2. Studies on the proper time of harvesting-cum-pruning *palas* within October–November

October–November is the second period in the year during which *palas* trees come into operation for lac cultivation. Therefore, the above studies were extended to this period also.

The experiment was carried out for the fourth year in succession. In this case also, it was found that the harvesting can be combined with pruning. It was also found that the highest yield of broodlac as well as sticklac is obtained from the trees inoculated with medium brood rate (200 g per tree). However, from the results of the four crops studied so far it was observed that a lighter rate of inoculation (100 g per tree) behaves almost similarly. Therefore, it is advisable to inoculate trees lightly, that is, at the rate of 100 g per tree.

3. **Evolution of cultivation practices for *palas* at Kundri (direct comparison of the newly evolved plan with villagers' method)**

The study was continued for the fourth year in succession for comparing the newly formulated cultivation practices against the prevalent villagers' method. The following three treatments were studied with 500 trees under each :

Treatment	Inoculation		Harvesting of crop (month)
	Month	Broodlac used per tree (g)	
Newly formulated	A–Oct./Nov.	400	Following April
	B–Oct./Nov.	100	Subsequent Oct./Nov.
Villagers' method	C–Oct./Nov.	300	Partial harvesting successively in April and Oct./Nov. for a number of years with no fresh inoculation

It was found that in respect of the ratio of broodlac used to broodlac yield, B (1 : 4) was the best, whereas in respect of total yield of sticklac, there was hardly any difference between A and C which produced 204.8 g and 185.4 g sticklac per plant respectively. B (108.8 g per plant) was the poorest. Therefore, if broodlac multiplication is the aim, light inoculation at the rate of 100 g per tree is to be preferred. Otherwise either of the other two practices is adoptable.

4. **Finding out alternate hosts for *Kusmi* strain of lac insect and conducting cultivation experiments on them (e.g., on *Albizzia lucida*, *Ougeinia oogeinensis*, *Ficus* sp., *Moghania chappar*, *Samania saman*, etc.)**

Use of galwang *for raising* Jethwi *and* bhalia *for* Aghani *crop in alternation: Bhalia*, a natural shrub, which has been found to be a successful alternate host for the *Kusmi* strain for *Aghani* crop is not so successful for *Jethwi* and also shows poor shoot growth following *Jethwi* harvest. Recently, *galwang*, a recognised summer broodlac preserver of *Rangeeni* strain, has been found to be a potential alternate *Kusmi* host for the *Jethwi* crop also. *Bhalia* is a bush whereas *galwang* is a tree. The latter had been suitably trained into a bush for growing lac on a plantation basis so that cost of cultivation could be reduced. It was, therefore, hoped that *bhalia* and *galwang* would be a successful pair for use for the *Aghani* and *Jethwi* crops respectively as alternate hosts to *kusum*.

The first inoculation was carried out on *bhalia* with fresh *kusum* broodlac for *Aghani* 1963–64 and the resulting brood was utilised on *galwang* for *Jethwi* 1964 crop. This alteration was continued till the eighth generation in *Jethwi* 1967. The progenies have continued to breed satisfactorily and continuously all these eight generations maintaining their vigour and also showing no deviations in the crop durations.

The crops have also been quite satisfactory on both the species. The average ratio of broodlac applied to total yield of sticklac was 1 : 2.4 for *bhalia* and 1 : 2.9 for *galwang* which compares quite well with the production on *kusum* itself. The average percentages of selected broodlac were 39.5 and 53.8 for *bhalia* and *galwang* respectively.

Other studies in respect of finding alternate hosts for *kusum* which are still in progress are described on page 11.

RESEARCHES IN HAND

1. Studies to ascertain the most appropriate time for harvesting *ber* broodlac for crop inoculations

The object of this study, which is in progress since April 1966, is to determine how early, prior to the actual date of larval emergence, broodlac from *ber* can be cut and it will still be satisfactory for inoculation. This is of importance where broodlac has to be cut in advance for despatch to distant destinations for use there. A similar study on *palas* was also being carried out and is reported later (see page 8).

For the present study, 5 kg lots of broodlac were harvested 3, 2 and 1 week before, and on the actual date of larval emergence. Each of these lots (A, B, C and D) were used for inoculating 5 trees.

Crops developed only in the case of C and D which, however, were somewhat adversely affected later due to drought. Nevertheless, on harvesting in October–November, the ratio of broodlac used to total yield of sticklac was 1 : 1.90 and 1 : 2.63, respectively.

Fresh inoculations have been carried out during the year with broodlacs similarly harvested. Crops are developing in the case of broodlacs harvested up to a fortnight before the actual larval emergence.

2. Studies on the relative merits of *ber* and *palas* broodlac on *ber* and *palas*

As reported last year under the heading 'Researches Contemplated', this experiment was initiated during October–November 1967.

A set of 5 trees each of *palas* and *ber*, appropriately pruned, were inoculated with 800 g of *ber* broodlac per tree and another similar set with an equal weight of *palas* broodlac. Settlement of larvae was observed to be uniformly good on all the trees and development of the insects has been normal.

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

There was no crop in the previous year due to excessive drought. The study was resumed in October this year with the start of the *Baisakhi* season. The crop is progressing.

4. **Studies to ascertain the most appropriate time for harvesting of *palas* broodlac for crop inoculation at Kundri**

The object of this study is the same as described for *ber* earlier, i.e., to find out how early broodlac can safely be harvested before emergence of larvae from this host for purposes of despatch to distant places.

Last year, normal emergence of larvae was noted from broodlac harvested up to a fortnight before crop maturity (*Annu. Rep.* 1966, p. 7), although the crops resulting therefrom suffered later because of the drought. Broodlacs harvested earlier than two weeks prior to larval emergence were not satisfactory.

For a fresh study, broodlac samples were again harvested, as before, on the 15th, 22nd and 29th September, 7th, 14th, 21st and 28th October and 6th November, the last being at the time of larval emergence to serve as control.

This year also, emergence of larvae was observed from broodlac harvested up to 2 weeks before crop maturity and not earlier. The crops developing from these samples are under observation.

5. **Evolution of cultivation schedule and determination of optimum density of larval settlement on *bhalia* for growing *Aghani* and *Jethwi* crops**

This study is very important as this bush has already been shown to be a very good host for the *Kusmi* strain of lac insects and is also promising for cultivation on a plantation basis.

The study was initiated in 1966 when the ground was prepared and seeds sown for raising the plantation.

Only 1,100 bushes survived from the previous year. During the current year, an additional 3,200 plants were transplanted in July when manure was available. The study will be taken up when the bushes establish themselves and attain the age of 2–2½ years.

6. **Spacing trial on *bhalia***

Three spacings, namely, 1.83×1.83 m (6 ft × 6 ft), 1.83×1.22 m (6 ft × 4 ft) and 1.22×1.22 m (4 ft×4 ft) (A, B and C) in each of three coupes were under study.

The plants under coupe I were inoculated in February, for the *Jethwi* crop. The shoots were fairly covered by larvae and development was very satisfactory till May. Thereafter, the plants started drying up. Similarly, under coupe II, the *Aghani* crop that was inoculated last year and harvested in February this year was also far from satisfactory. Both these failures were apparently due to the fact that the plants could not sustain the high density of insect population during the period of unusual drought.

The shoots of the plants coppiced/harvested in February this year showed continuous linear growth till the end of October, the growth being vigorous from June to August.

In coupe III, the plants raised from transplanting in July 1966 resumed the

second phase of growth from March this year and continued till July when the plants were inoculated for raising the *Aghani* 1967–68 crop.

All the shoots showed fair coverage by larvae and progress of the lac crop was also satisfactory.

In all the coupes, spacing B was the best in respect of plant height and number and length of shoots developed. Lac production (66.2 g) per plant, however, was the best in C. As under this spacing the number of plants per acre is also more, this spacing (1.22×1.22 m) is obviously the optimum. With this spacing, the yield of sticklac per acre was 156 kg as against 72 kg and 84 kg in the case of spacings A and B respectively.

7. Effect of NPK on the yield of lac on *bhalia* (trials with organic and inorganic manures)

The experiment, laid out on a randomized block design, is being carried out since 1965 for evaluating the manurial requirements of the bush.

The following treatments, each with 10 bushes and four replications, were under trial for both the *Aghani* 1966–67 and *Jethwi* 1967 crops.

Treatment	Manure	Dose
A	NPK	Normal
B	NPK	Double normal
C	Organic	Normal
D	Organic	Double normal
E	No manure	(Control)

NPK was supplied as ammonium sulphate, superphosphate and muriate of potash and the 'normal' dozes were 16 kg N, 20 kg P and 20 kg K per acre (of 1,800 bushes). For organic manure, farmyard manure was used, the 'normal' being 18 quintals per acre.

Both *Aghani* and *Jethwi* crops were raised during the period under report. Like the previous season, the *Jethwi* crop again suffered considerably due to the wilting of the plants during summer. On the other hand, the yield of the *Aghani* was quite satisfactory.

The crop results showed that in B and D, i.e., with manuring at double normal rates, sticklac yields increased by about 50 per cent with NPK and by about 100 per cent with farmyard manure in the *Aghani* crop and 80 and 142 per cent respectively in the *Jethwi*. These findings are in conformity with previous year's observations.

8. Evolution of a suitable cultivation practice for *kusum* at Hesal for maximum crop production at minimum cost and working out economics

The study, initiated in 1961, was continued during the year with the following cultivation practices as hitherto.

Treatments	Period of rest for the host (years)	No. of coupes	No. of trees in each coupe	Brood rate used	Cultivation practice			
					Inoculation	Self inoculation allowed	Harvesting	Period between initial inoculation and harvesting (month)
A_1	1	2	15	0.5 N*	June–July	Jan.–Feb.	June–July	12
A_2	1	2	15	0.5 N	Jan.–Feb.	June–July	Jan.–Feb.	12
B_1	2	3	15	0.67N	June–July	Jan.–Feb.	June–July	12
B_2	2	3	15	0.67N	Jan.–Feb.	June–July	Jan.–Feb.	12
C	1.5	4	15	N	Jan.–Feb.	—	June–July	6
(Control)					June–July	—	Jan.–Feb.	6

*N=Normal is 1 cm length of broodlac per 12.5 cm of inoculable shoots.

Thus, along with a comparison of the performance of shoots of different ages, the present study is to compare the practice of light inoculations in January–February and June–July and harvesting once after two seasons with the current practice of inoculating and harvesting in each season. The comparison was of the actual lac crop obtained *per annum*, that is, of one crop in A and B and two crops in C each of which is of six months' duration. The crop data obtained during the year were as follows:

	Yield of sticklac (kg)		Crop ratio†	
	1*	2**	1*	2**
A	104.2	270.2	3.50	11.50
B	110.7	202.2	3.93	7.30
C††	286.3	445.6	2.46	4.05

*Crop inoculated in June–July and harvested 12 months later.
**Crop inoculation in January–February and harvested 12 months later.
†The number of times the weight of sticklac of the crop increased over that in broodlac used for inoculation.
††The data given are for the two crops harvested during the corresponding period.

Data for a few more seasons are necessary before any inferences can be drawn. Fresh inoculations have been carried out to continue the study.

9. **Studies on training of major lac hosts, e.g., *palas*, *ber*, *kusum*, *galwang* and rain tree into bushes**

Studies were continued to examine the possibility of training the above host trees into bushes for reducing the cost of lac cultivation and providing agronomical treatments for maximizing yield of lac. In addition, the possibility of cultivating lac on such trained bushes on plantation basis was also studied.

(a) **Training into bushes.** *Galwang* and *ber* had already been successfully trained and brought under lac cultivation during the previous year. *Palas* and *kusum* were still in the process. The study was continued.

It was seen that *palas* bushes coppiced both in February and April showed satisfactory growth till the end of July recording a total length of shoots of 660.3 cm and 682.0 cm, respectively.

As regards *kusum*, the plants coppiced in July 1966 showed the second phase of shoot growth from March 1967 and recorded 773.8 cm in total length of shoots at the end of December. Shoots developed from plants coppiced in January 1967 continued to grow till August and recorded a total length of 660.7 cm. Plants coppiced in July developed primaries by August and recorded a total shoot length of 155.9 cm during the first phase of growth which extended up to November 1967.

The development of these bushes appear, so far, quite satisfactory.

(b) **Lac cultivation on the trained bushes.** *Galwang* and *ber* bushes and a few of the *palas* trees which have since been trained into bushes were inoculated for lac cultivation. All the crops developed satisfactorily. The crop data (Table 1) revealed that the yield of lac per bush on *palas* (156 g) was higher in the *Baisakhi* season than (70.7 g) in the *Katki*. The data of two successive *Katki* crops indicate that *palas* bushes are not satisfactory for growing this crop.

Unlike the previous season, *ber* bushes gave a satisfactory crop during the *Katki* season in alternation with *galwang* on which the *Baisakhi* crop was raised.

The study is continuing.

10. **Finding out alternate host for *kusmi* strain of lac insects and conducting cultivation experiments on them**

The two hosts tried were *galwang* and *sandan* both to alternate with *kusum* as well as an alternate for *kusum*.

(i) **In alternation with** *kusum*. *Galwang* and *sandan* were studied for raising the *Jethwi* crop in alternation with *kusum* on which the *Aghani* crop was raised.

The crop data (Table 2) revealed that the performances of these hosts in alternation with *kusum* are very satisfactory and progress of lac crops on *kusum* inoculated with broodlac from these is very good.

TABLE 1. LAC CULTIVATION ON HOST TREES TRAINED INTO BUSHES

Host	No. of bushes	Coppicing Harvesting	Shoot measurement data per bush					Crop data			
			Time of shoot measurement as on	Primaries		Secondaries		Crop	Broodlac yield in lacsticks (kg)	Total yield of sticklac (kg)	Yield of sticklac per bush (g)
				Av. No. of shoots	Total length (cm)	Av. No. of shoots	Total length (cm)				
Galwang	60	July 1965	October 1966	14.5	2,303.6	58.3	5,085.0	*Baisakhi* 1966–67	24.0	9.2	153.3
	60	July 1966	October 1967	12.7	1,543.6	31.3	2,067.8	—	—	—	—
Ber	40	May 1966	June 1967	8.0	1,127.4	89.4	2,495.0	*Katki* 1967	19.2	7.9	197.5
	50	May 1967	December 1967	17.3	1,360.0	48.3	1,774.6	—	—	—	—
Palas	50	April 1966	October 1966	14.8	622.8	—	—	*Baisakhi* 1966–67	20.0	7.8	156.0
	75	Feb. 1967	June 1967	8.9	669.2	—	—	*Katki* 1967	7.4	5.3	70.6

TABLE 2. FINDING OUT ALTERNATE HOSTS FOR THE *Kusmi* STRAIN OF LAC INSECTS
(Crop data on alternate hosts)

Crop and year	Crop history*	Lac sticks			Scraped lac		
		Broodlac used	Brood for yield	Total yield	From Brood lac used	Total yield	Broodlac to yield ratio
Aghani 1966–67	G (K) ×K	3.6	4.3	9.8	1.1	2.4	1 :2.2
Jethwi 1967	K (K×G) ×G	4.3	9.2	13.2	1.9	3.5	1 :1.8
Aghani 1966–67	S (K) ×K	2.0	2.3	4.5	0.9	1.7	1 :1.9
Jethwi 1967	K (K×S) ×S	2.3	3.9	8.7	1.1	2.9	1 :2.6
Aghani 1966–67	G (K) ×A.L.	5.3	2.8	5.8	1.6	1.5	1 :0.9
Jethwi 1967	G (K×A.L.) ×A.L.	2.8	5.0	6.5	0.8	1.7	1 :2.1
Aghani 1966–67	S (K) ×S	2.6	1.6	4.1	1.2	1.3	1 :1.1
Jethwi 1967	S (K×S) ×S		Crop failed				
Aghani 1966–67	G (K×M.m.×G×M.m.×A.L.×M.m.) M.m.	9.8	14.5	27.5	2.0	5.7	1 :2.8

*Crop histories have been denoted in the following order.

The first letter stands for the host from which the brood used have been obtained. The second letters within bracket indicate the host from which the first brood was originally obtained. The last letter indicates the host on which the crop (indicated in Col. 2) is being raised.

(ii) **As alternates for** *kusum*. The performance of *galwang* was found to be satisfactory in both the *Aghani* and *Jethwi* seasons. The *Aghani* on *sandan* was even better but the progeny thereon failed to produce the subsequent *Jethwi* crop.

Broodlac obtained from *galwang* in the *Jethwi* season was again inoculated on the same species for raising the subsequent *Aghani*. There was only poor emergence of lac larvae and complete mortality of the insects occurred before male emergence.

PHYSIOLOGICAL STUDIES

11. Amino acid and sugar contents of lac insect body at different developmental stages

These studies were again taken up in October with the transfer of a Research Assistant to the Section of Insect Physiology.

The *Rangeeni* crop (*Baisakhi* 1967–68) was initiated in October. Two sets of samples– one of larvae immediately after emergence and before they settled, and the second after the first moulting—were collected and paper chromatograms of their body fluids were prepared. At least 5 to 6 spots were detected. Further samples are to be taken at intervals with the progress of the crop.

12. Studies on the relation of host to the fecundity and resin secretion efficiency of the *Rangeeni* and *Kusmi* strains of lac insects

Cultures of the *Rangeeni* strain of the insects have been raised on *bhalia*, *galwang*, *sandan*, *ber* and *palas* for further study.

GENETICAL AND BREEDING STUDIES

13. Evolution of a high-quality strain of lac insects for lac cultivation on *palas*

To boost production of superior lac, attempts to adapt *Kusmi* strain of lac insects to breed on the abundantly available *Rangeeni* host, *palas*, were continued by inoculating *palas* with *kusum* broodlac and using the rare survivors to continue their progeny on *palas*.

During the year, the second and the third generations matured in late March and early August, respectively. In the fourth generation, an estimated 300 females have survived till the end of December. These females are expected to mature in February 1968.

It has been interesting to note that the *Kusmi* strain, even when grown successively on an exclusively *Rangeeni* host, viz., *palas*, has retained its own schedule of crop maturity. Still more interesting has been the improvement the insect has shown in its survival rate from generation to generation. If this trend is maintained, it should be possible to have a sizable colony of the insect in the next few generations for specific genetic tests and also for analysis of the resin properties of the lac produced.

14. **Study of the pleiotropic effects of the yellow gene**

In order to determine the effects of yellow gene on economic performance of lac insects, yellow females were mated to crimson males and, as was to be expected, the resulting yellow progeny (F_1) turned crimson in their immature stages. These insects are to be used to raise a large F_2 from which the segregating yellow and crimson females will be collected for a comparative study of their size, fecundity and resin yield.

15. **Study of hybrids in lac insects**

Kusmi females have been mated to *Rangeeni* males to study the resulting hybrid in relation to the parental stocks.

BIOLOGICAL AND ECOLOGICAL STUDIES ON PESTS OF LAC HOSTS, LAC ENEMIES AND THEIR PARASITES

16. **Collection of pests of lac host trees and studies on the life-history and control operations against important pests**

(a) **Pests of** *palas*. The two pests of *palas* collected were a limacodid moth and a coreid bug. Their life-history studies were completed.

The limacodid was most active in the field during July–August and October–November. The early instar larvae feed on the upper surface of leaves while older larvae devour the entire leaves.

The incubation, larval and pupal periods were 7–9, 53–55 and 32–35 days respectively in the 7th generation studied. On an average the pest thus took 93–96 days from egg to adult stage.

The coreid bug was present in the field throughout the year and was most active during the rainy season. The nymphs and the adults feed by sucking the juice of succulent leaves and shoots and remain hidden on the underside of the leaves. The durations of egg, nymphal and total life-cycle in various generations of this pest were 6–8, 30–35 and 35–42 days, respectively.

(b) **Pests of** *Grewia multiflora*. Life-history study of a Lepidopteron leaf defoliater, a pest of this host, was completed.

The pest was found most active from July to October and to hibernate in December and reappear with the start of rainy season. The pest was not found attacking any other plant species.

This pest was successfully reared for 5 generations till the end of December under laboratory conditions with temperature ranging between 15.5°C and 28.6°C. The egg, larval, pre-pupal and pupal stages were 2–4, 14–22, 1–2 and 6–11 days, respectively. The egg to adult stage was thus 23–39 days and adult longevity in the case of males 7–12 and in the case of females 4–13 days.

SURVEY OF LAC ENEMIES AND THEIR PARASITES

17. General survey: Qualitative

The survey of inimical insects associated with lac and lac-insects in all the crops on different hosts was continued.

Kusmi lac was grown on *kusum* and *bhalia* and *Rangeeni* on *palas* and *galwang*. Lacstick samples (500 g) were collected at fortnightly intervals starting from a fortnight after *phunki* removal till maturity of crop and were caged separately for noting the emergence of various parasitic, predatory and beneficial insects.

Aghani **1966-67.** Emergence of the various insects from samples collected during January and onwards was not much. Amongst these, the parasites were in the largest number as was observed in the previous *Aghani* crops also. The predators, *E. amabilis* and *H. pulverea*, emerged more or less in equal numbers. Beneficial insects were rare. No marked difference was in evidence between the hosts used.

Jethwi **1967.** Emergence of the two predators was more from *bhalia* than from *kusum* lac and *E. amabilis* emerged in larger numbers than *H. pulverea*. Host differences were, however, not so marked in the case of the parasites and friendly insects. Emergence of the parasitic and predatory insects increased with the age of the crop.

Aghani **1967-68.** Emergence till December showed that the maximum number of parasites emerged from this crop. *Tetrastichus purpureus* Cam. constituted more than 90 per cent of the total parasites. Host differences were insignificant. Among the predators, *E. amabilis* emerged in larger numbers than *H. pulverea* as has been the case in all the crops.

Emergence of all the insects was the maximum from samples collected from September to November.

Baisakhi **1966-67.** Host plant differences appeared to be insignificant. Emergence of the predator was steady from the 8th fortnight onwards and was maximum from samples collected towards the maturity of the crop. Here also, the emergence of *E. amabilis* was more than of *H. pulverea*.

The parasites emerged more from samples collected during October and from those collected towards the end of the crop.

Katki **1967.** The number of the predators which emerged from samples collected during the second fortnight and onwards was the maximum in this crop, which continued till the end of November. Here also, host plant differences were hardly noticeable.

Emergence of the parasites was fairly high and was the maximum from the samples collected in the last two fortnights preceding crop maturity.

18. **Seasonal incidence and extent of damage by predators** *E. amabilis* **and** *H. pulverea* **on** *Kusmi* **lac grown on** *bhalia*

Jethwi and *Aghani* crops were again grown on *bhalia* to determine incidence of these two most destructive lac predators. Random samples were collected at fortnightly intervals from the time of male emergence till maturity of the crops. They were microscopically examined for (i) population of lac insects living, dead and damaged, (ii) population of predators including their immature stages, (iii) number of cells damaged or eaten up by the predators, and (iv) area of encrustation damaged by the predators. The results are presented in Table 3.

The results show that (a) incidence of the predators is much less in the *Jethwi* crop than in the *Aghani*, (b) natural mortality of lac insects is higher in the former, (c) both in *Jethwi* and *Aghani* crops, incidence of the predators increases from about the third fortnight after male emergence, (d) attack of *E. ambilis* is much less than that of *H. pulverea*, and (e) the peak period of incidence of both the predators is in September–October and remains thereafter.

BIOLOGICAL CONTROL OF LAC ENEMIES

19. **Control of lac predators by the use of** *Bacillus thuringiensis* **Berl.**

Experiments to test the efficacy of *B. thuringiensis* in the control of *E. amabilis* and *H. pulverea* were continued.

(a) *Aghani* **1966-67.** The experiment was carried out on the crops on *ber* and *kusum*. The thuricide was sprayed at a concentration of 0.03 per cent at intervals of 10 and 30 days from the time of *phunki* removal till the maturity of the crop. A set of 3 trees was used for each treatment and spray with water was used for control.

Lacstick sample (500 g) was collected at the time of harvest from each treatment and caged separately for noting the emergence of the various insects.

(i) **On** *ber*. It was observed that the treated crop was practically free of *E. amabilis* and *H. pulverea*, although the usual emergence of these predators was recorded from the control. In the case of hymenopterous insects, no marked difference was in evidence.

Yields of sticklac from the thuricide sprayed crops were 3.5 and 2.2 times that of control for the 10 and 30 days spray intervals, respectively.

(ii) **On** *kusum*. Here also, the treated crop was practically free of the two predators while the usual emergence of these was recorded from the control. As in the case of *ber*, incidence of hymenopterous insects remained more or less unaffected.

Yields of sticklac from the treated lots were 3.0 and 2.5 times that of control for 10 and 30 days spray intervals, respectively.

(b) *Baisakhi* **1966-67.** The experiment was carried out on *palas* in *Baisakhi* 1966–67 on the same lines as for *Aghani* 1966–67 except that the total number of sprayings was reduced to 3 (2 in the beginning starting from the time of *phunki* removal

TABLE 3. EXPERIMENTS: INCIDENCE OF PREDATORS *E. ama*

Location : Namkum Plantation
Host : *Bhalia* (*Moghania macrophylla*)

Jethwi : Inoculation : February 1967
Crop : Harvesting : July 1967

Sl. No.	Crop	Date of collection of samples	Average circumference (cm)	Total area of the samples examined (sq. cm)	Population of lac insects		
					Total No. in living insects	Total No. of dead insects	Total No. of lac insects damaged by predators
1.	*Jethwi*	15.4.1967	2.57	642.50	4,032	3,064	—
2.	,,	1.5.1967	1.98	475.00	3,452	3,564	5
3.	,,	16.5.1967	2.51	627.50	3,867	3,510	18
4.	,,	1.6.1967	2.03	507.50	2,076	3,069	160
5.	,,	17.6.1967	2.32	580.00	1,981	3,037	200
6.	,,	2.7.1967	1.62	405.00	2,006	2,929	97
7.	,,	16.7.1967	2.02	505.00	1,967	2,814	60
1.	*Aghani*	18.9.1967	1.82	455.00	3,735	1,773	454
2.	,,	3.10.1967	2.10	525.00	2,491	1,332	952
3.	,,	16.10.1967	—	—	—	—	—
4.	,,	3.11.1967	2.39	597.50	2,361	957	849
5.	,,	16.11.1967	—	—	—	—	—
6.	,,	1.12.1967	2.35	587.50	1,659	397	592
7.	,,	15.12.1967	2.29	572.50	1,219	340	329
8.	,,	1.1.1968	2.34	585.00	1,308	349	495
9.	,,	15.1.1968	2.21	552.50	748	257	266
10.	,,	1.2.1968	2.33	582.50	594	75	286

Remarks: Heavy mortality was observed during *Jethwi* season besides the damages by the predators. The natural mortality which occurred was probably due to (i) excessive heat and dry weather during the first four fortnights and (ii) poor quality of the hosts employed and dense settlements.

bilis AND *H. pulverea* ON *Kusmi* LAC GROWN ON *bhalia*

Aghani : Inoculation : July 1967
crop : Harvesting : Feb. 1967

Total length of samples examined : 250 cm

Population of predators							
	E. amabilis		*H. pulverea*				
Total population of lac-insects present	Eggs hatched and unhatched	Larvae all stages including pupae	Eggs hatched and unhatched	Larvae all stages including pupae	No. of damaged cells per unit area	Percentage of damage	No. of naturally dead and damaged cells per unit area
7,096	21	—	10	1	—	—	4.76
7,021	28	—	30	5	0.01	0.07	7.51
7,395	18	7	—	9	0.02	0.24	5.62
5,305	16	15	—	20	0.31	3.01	6.36
5,218	—	20	—	23	0.34	3.83	5.58
5,032	6	19	3	21	0.24	1.92	7.47
4,841	5	12	2	16	0.12	1.24	5.69
5,962	112	116	13	49	0.99	7.61	4.89
4,775	179	167	42	97	1.81	19.51	4.35
—	—	—	—	—	—	—	—
4,167	83	160	50	88	1.42	20.36	3.02
—	—	—	—	—	—	—	—
2,648	39	150	48	87	1.00	22.35	1.68
1,888	43	103	13	38	0.57	17.43	1.16
2,152	44	94	89	103	0.84	23.00	1.44
1,271	73	94	75	106	0.48	20.92	0.94
955	66	48	42	55	0.49	29.94	0.62

and one at the end of about a fortnight before crop maturity).

It was interesting to note that even with only three sprayings, incidence of the two predators was as low as was achieved with 10–12 sprayings in the *Aghani* crop. Hymenopterous insects, however, remained unaffected.

Yield of sticklac from sprayed lots were 2.6 and 2.0 times that of control for the 10 and 30 days spray intervals, respectively.

(c) *Jethwi* **1967.** The experiment was carried out on *kusum* in the *Jethwi* crop on the same lines as on *palas* in the *Baisakhi* crop with more or less similar results establishing the high degree of effectiveness of the pathogen in the control of the two most destructive predators of lac with 10 days spray intervals giving the best control.

The experiments are being carried out on *bhalia* in the *Aghani* and *Jethwi* seasons and on *palas* in the *Baisakhi* crop in order to determine the optimum conditions for these crops and hosts.

Laboratory studies have shown that the degree of effectiveness of the thuricide decreases with the age of predator larvae and also with the thickening of lac encrustation.

The bacillus treatment was also found to reduce considerably the longevity of the males and fecundity of the females of the two predators.

20. **Survey of pathogenic organisms in the lac insect predators** *E. amabilis* and *H. pulverea*

The survey of the pathogenic organisms of the larvae of *E. amabilis* and *H. pulverea* was continued.

It was observed that of the two, *E. amabilis* is more susceptible to attack of polyhydrosis and cocci infection and that the latter disease is more frequent.

CHEMICAL CONTROL OF LAC INSECT PARASITES AND PREDATORS

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

The study of the effect of the stomach poisons, cryolite and sodium fluosilicate, at 0.4 per cent concentration and of Dieldrex at 0.25 per cent concentration were continued with sprayings at 10 and 15 days interval on *Aghani* 1966–67 and *Jethwi* 1967 crops.

Emergence of parasites and predators of lac insect from samples caged (i) after two sprayings, (ii) after male emergence, (iii) 15 days before crop maturity, and (iv) after harvesting indicated that cryolite and sodium fluosilicate were effective only on the predators. These were reduced by 50–60 per cent with the use of cryolite and 40–46 per cent with sodium fluosilicate. The lac crops also increased by 40 and 26 per cent, respectively.

Dieldrex was somewhat effective both on parasites and predators. These findings are in close conformity with those of 1966.

22. Microbiological studies on lac insects

For studying the specific roles played by micro-organisms harboured by lac insects in its physiology of nutrition and other metabolic activities, the study was taken up from July, 1967.

Micro-organisms were isolated from free moving lac larvae, settled larvae and females just after fertilization and at crop maturity by aseptic methods. From these, pure cultures were obtained. Six different organisms have been collected and are being maintained on nutrient agar. It is proposed that these organisms, after identification, will be subjected to various biochemical tests for establishing the roles played, if any.

REGIONAL FIELD RESEARCH STATIONS

Three Stations were functioning during the year under report—two for *Rangeeni* lac at Damoh (M.P.) and Mirzapur (U.P.) and one for *Kusmi* lac at Dharamjaigarh (M.P.), to where the station at Umaria was shifted. *Ghont* is the chief host under study at Damoh, *ghont* and *palas* at Mirzapur and *kusum* at Dharamjaigarh. The experiments on *ghont* were identical both at Damoh and Mirzapur.

DAMOH AND MIRZAPUR

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

The pruning periods studied were as follows:

Treatment	Pruning time	
	Baisakhi 1966–67	*Katki* 1967
A	2nd week of April	At the time of harvesting in November
B	3rd week of May	2nd week of February
C	November	2nd week of May (There were two coupes in this for use in alternate years)

Damoh. Under *Baisakhi* crop, B gave the best crop ratio*. No broodlac was obtained from any treatment. This result is at variance with previous years' findings, where A showed the best crop ratio.

Under *Katki* crop, C provided the maximum area for larval settlement which is in conformity with the previous years' findings. However, no crop could be raised for want of broodlac.

Mirzapur. Under *Baisakhi* crop, A provided the maximum area for larval settlement. No crop was, however, obtained on any treatment.

*Crop ratio is the ratio of sticklac (scraped lac) obtained from the broodlac used for inoculation to the total sticklac ultimately obtained in the resulting crop.

No *Katki* crop was tried as this experiment was discontinued after *Baisakhi* 1966–67 crop due to continued crop failures.

(ii) **Determination of optimum requirement of broodlac for crop inoculations on *ghont* (at Damoh) and *ghont* and *palas* (at Mirzapur)**

(a) *Ghont.* Three brood rates, namely, normal (A), double normal (B) and treble normal (C) were under study at both the stations for both *Baisakhi* and *Katki* seasons, the normal for Damoh being an average of 400 g per tree and that for Mirzapur 500 g because of the larger size of the trees there.

DAMOH: Under *Baisakhi* crop, A gave the highest crop ratio though all the three treatments gave poor performance and no broodlac was obtained in any.

No *Katki* crop could also be raised for want of broodlac.

MIRZAPUR: No crop was obtained from any treatment of the *Baisakhi* crop. This experiment was discontinued thereafter due to continued crop failures.

(b) *Palas.* The study was continued with four rates of broodlac, namely, 0.4(A), 0.8(B), 1.6(C) and 2.4(D) kg per tree for both the *Baisakhi* and the *Katki* seasons.

In *Baisakhi* 1966–67, the maximum crop ratio was found in D, although here no broodlac was obtained. The highest quantity of broodlac was obtained from C.

In *Katki* 1967, the maximum crop ratio as also the highest quantity of broodlac, were obtained from C.

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

The following treatments were continued:

Treatment	Time of pruning	Inoculation		Time of crop harvesting		Period from inoculation to harvesting (Months)
		Month	Broodlac used per tree	Partial	Complete	
A	April	Oct.–Nov.	0.5 N*	—	Oct.–Nov.	12
B	,,	,,	N	June–July	Oct.–Nov.	8 and 4
C	,,	,,	2 N	—	April–May	6
D	Oct.–Nov.	,,	0.5 N	—	Oct.–Nov.	12
E	,,	June–July	N	—	Oct.–Nov.	4

*Normal brood rate which was arbitrarily fixed as 400 g at Damoh and 500 g at Mirzapur per *ghont* tree and 800 g at Mirzapur per *palas* tree.

Each treatment was tried on 5 trees with 10 replications and in two coupes for use in alternate years. There are 500 trees under each host at each Station.

Damoh. Ari cutting in May gave a higher crop ratio than in April. Among the rest, B gave the highest ratio though the crop was rather poor in all the treatments and no broodlac was obtained from any.

Mirzapur. On *ghont*, the crop failed under all the treatments. On *palas*, *ari* cutting in April showed higher crop ratio than in May. The crop failed in the rest of the treatments.

(iv) **Permanent field experiment for working out economics of cultivation of *Kusmi* and *Rangeeni* lacs on *bhalia* under different conditions of manuring and irrigation at Damoh and Mirzapur**

A successful plantation of *bhalia* could not be raised at either station due to lack of irrigation facilities and additional handicaps of frost and termite at Damoh. This experiment was therefore discontinued.

(v) (a) **Investigation of likely *Rangeeni* hosts occurring in the region and their proper use to supplement production of *ghont* and *palas* lacs at Damoh and Mirzapur**

At Damoh, *palas*, *khair* (*Acacia catechu*), *airma* (*A. donaldi*), *dhobein* (*Dalbergia paniculata*) and *renja* (*A. leucophloea*) trees were pruned and are awaiting inoculation.

At Mirzapur, *gular* (*Ficus racemosa*) gave an encouraging result with a broodlac multiplication ratio (ratio of broodlac used to selected broodlac obtained) of 1 : 5.79.

(b) **Selection and introduction of suitable regional and exotic hosts to fortify cultivation of lac on *ghont* and *palas* at Damoh and Mirzapur**

Attempts to raise *galwang*, rain tree and *sandan* failed due to lack of irrigation facilities. This experiment was, therefore, discontinued.

(vi) **Qualitative and quantitative survey of the friends and enemies of the lac insect**

The following insects emerged from the various caged lacs (page 24).

DHARAMJAIGARH

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

This experiment is being conducted on the same lines as was previously done at Umaria.

Since the experiment was started only during the year under report, the trees did not come under pruning cycles. Hence, initial inoculation was done on unpruned trees. Hereafter, harvesting is also to serve as pruning. Complete regularization of pruning will be achieved in 1970.

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

Khair, *Ficus* spp. and several other local plant species were inoculated but the larvae died soon after settlement on all the species.

Month	Damoh		Mirzapur		Dharamjaigarh	
	Baisakhi 1966–67	*Katki* 1967	*Baisakhi* 1966–67	*Katki* 1967	*Jethwi* 1967	*Aghani* 1967–68
1	2	3	4	5	6	7
January 1967	1. *Tetrastichus purpureus*		1. *T. purpureus*			
	2. *Tachardiaephagus tachardiae*		2. *Parechthrodryinus clavicornis*			
	3. *Apanteles tachardiae*		3. *Marietta javensis*			
	4. *Pristomerus sulci*					
	5. *Eublemma amabilis*					
	6. *Holcocera pulverea*					
February	1. *T. purpureus*		1. *T. purpureus*		Nil	
	2. *T. tachardiae*		2. *P. clavicornis*			
	3. *E. amabilis*		3. *Erencyrtus dewitzi*			
	4. *H. pulverea*		4. *T. tachardiae*			
			5. *Coccophagus taschirchii*			
			6. *H. pulverea*			
March	1. *T. purpureus*		1. *T. purpureus*			
	2. *T. tachardiae*		2. *P. clavicorni*			
	3. *E. amabilis*		3. *E. dewitzi*			
	4. *H. pulverea*		5. *C. taschirchi*			
April	1. *E. amabilis*		Nil			
	2. *H. pulverea*					

Month	Damoh		Mirzapur		Dharamjaigarh	
	Baisakhi 1966-67	*Katki* 1967	*Baisakhi* 1966-67	*Katki* 1967	*Jethwi* 1967	*Aghani* 1967-68
1	2	3	4	5	6	7
May	Nil		Nil			
June	1. *A. tachardiae* 2. *P. sulci* 3. *E. amabilis* 4. *H. pulverea*		Nil			
July	Lac cleared	Nil	1. *T. purpureus* 2. *C. taschirchii*	Nil	*H. pulverea*	
August		Nil	1. *T. purpureus* 2. *H. pulverea*	Nil	1. *Bracon greeni* 2. *Apanteles fakhrulhajiae* 3. *A. tachardiae* 4. *P. sulci* 5. *E. amabilis* 6. *H. pulverea*	Nil
September		Nil	Lac cleared	1. *T. purpureus* 2. *H. pulverea*	1. *E. amabilis* 2. *H. pulverea*	1. *T. tachardiae* 2. *A. fakhrulhajiae* 3. *H. pulverea*
October		Nil		1. *T. purpureus* 2. *Eupelms tachardiae*	1. *A. tachardiae* 2. *H. pulverea*	1. *T. tachardiae* 2. *Brachymeria tachardiae*

Month	Damoh		Mirzapur		Dharamjaigarh	
	Baisakhi 1966–67	*Katki* 1967	*Baisakh* 1966–67	*Katki* 1967	*Jethwi* 1967	*Aghani* 1967–68
1	2	3	4	5	6	7
				3. *P. clavicornis*		3. *B. greeni*
				4. *E. dewitzi*		4. *A. fakhurlhajiae*
				5. *T. tachardiae*		5. *A. tachardiae*
				6. *C. taschirchii*		6. *E. amabilis*
				7. *Tachardiaephagus somervilli*		7. *H. pulverea*
				8. *Elasmus claripennis*		
				9. *Euryoma padiliscapus*		
				10. *B. tachardiae*		
				11. *B. greeni*		
				12. *A. fakhrulhajiae*		
				13. *Perisierola pulvereae*		
				14. *E. amabilis*		
				15. *H. pulverea*		
November		1. *T. purpureus*		1—15. Same as against October	Nil	1. *E. tachardiae*
		2. *E. dewitzi*		16. *Chelonella* sp.		2. *T. tachardiae*
		3. *T. tachardiae*				3. *A. fakhrulhajiae*
		4. *C. taschirchii*				4. *E. amabilis*

	Damoh		Mirzapur			Dharamjaigarh
Month	*Baisakhi* 1966–67	*Katki* 1967	*Baisakhi* 1966–67	*Katki* 1967	*Jethwi* 1967	*Aghani* 1967–68
1	2	3	4	5	6	7
		5. *T. somervilli*				5. *H. pulverea*
		6. *H. pulverea*				
December		1. *T. purpureus*		1. *T. purpureus*	*H. pulverea*	1. *T. purpureus*
		2. *E. tachardiae*		2. *E. dewitzi*		2. *E. tachardiae*
		3. *T. tachardiae*		3. *A. tachardiae*		3. *T. tachardiae*
		4. *P. sulci*		4. *Chelonella* sp.		4. *A. fakhrulhajiae*
		5. *E. amabilis*		5. *P. pulverea*		5. *A. tachardiae*
		6. *H. pulverea*		6. *E. amabilis*		6. *E. amabilis*
				7. *H. pulverea*		7. *H. pulverea*

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

Galwang is being raised.

(iii) **Permanent field experiment for working out economics of cultivation of** *Kusmi* **lac on** *bhalia* **under different conditions of manuring and irrigation**

A site has been selected for raising a plantation and negotiations are underway with the Forest Department, Madhya Pradesh, for taking over the same.

Plantation at Namkum. General upkeep of the plantation was maintained. Hoeing and mulching operations were carried out to improve the condition of the plantation.

Seedlings of various lac host plants, viz. *palas*, *ber*, *kusum*, *galwang* and *bhalia*, etc., were raised in nursery beds for general planting in the field and for experimental use in pots. Approximately 2,000 coppiced bushes of *palas*, *ber* and *kusum* were treated with inorganic fertilizers for inducing the plants to develop satisfactory shoots.

As in the previous years, another set of dead and diseased *palas*, *kusum* and *khair* trees were removed. Further, suitable dressing and pruning operations were carried out on a large number of host plants of different species to make them suitable for experimental use.

Periodical spraying of insecticides was carried out in termite affected regions for its extermination.

Bhalia seeds were distributed to a limited extent to parties interested.

AD-HOC STUDIES

Studies on the effect of herbicides on the weeds

Like the previous seasons, with the onset of monsoon, the herbicides, namely, Stam F. 34, TOK-25, Atrazine, Varitox and Spontox were tried again to see the effect of these on the weeds. Spontox and Varitox were found effective against herbs and undershrubs and Stam F. 34 against grasses.

B. CHEMISTRY DIVISION

Research activities of the Chemistry Division, like those of the Entomology Division, were as per Project Proposals submitted to the ICAR for the year 1967. These were mainly based on the programme recommended by the recent (1966) Achievement Audit Committee. However, the staff position remained difficult and, as a result, some of the items in the programme recommended by that Committee could not be taken up for investigation and were, therefore, not included in the Proposals. No items of special equipment could be procured this year also due to non-availability in India and difficulties of foreign exchange. The progress of

work was naturally handicapped and, in consequence, the tempo of work anticipated by the Achievement Audit Committee could not be achieved. Nevertheless, progress was maintained.

Among the more important findings of the year, mention may be made of developments perhaps for the first time, (i) of a simple scientific method for distinguishing between the two strains of lac, namely, *Kusmi* and *Rangeeni*, (ii) of a water thinned red oxide primer for steel based entirely on indigenous raw materials which has been found to possess satisfactory anti-corrosive properties as well as good adhesion to substrate and finishing coats and resistance to natural weathering, (iii) of attractive, heat and water-resistant, quick-drying paints for display panels and shop windows, and (iv) of a dressing for hessian possessing adequate heat resistance which shows promise of suitability for packaging cement, fertilizers and other moisture sensitive materials. (v) An important finding on the fundamental side was an observation that, during heat treatment involved in the processing of seedlac into shellac by heat or solvent process, no chemical modification takes place in the resin or its constituents.

A detailed report on the results of the various items is given below.

RESEARCHES COMPLETED

1. Study of the reaction of urea and other similar chemicals with shellac

Urea is one of the most efficient accelerators for shellac. However, when urea present exceeds about 33 per cent on the weight of lac, it acts as a retarder and the two could be cooked together for any length of time without fear of gelling. A thermoplastic resin was formed, the hardness and melting points of which progressively decreased with increasing time of the cooking (*Annu. Rep.* 1966, p. 31.).

The properties of the material obtained with the minimum duration of cooking, consistant with solubility, was therefore studied. The material, obtained by heating together shellack and urea in the ratio 3:1 at 165°C for 2 hours, was completely soluble in alcohol, and was hard, and had a melting point of 80–85°C. It had a high content of water solubles. When freed from this, the melting point rose to 92°C. Acid value of this product was 30.95.

Film properties of the material, with and without water solubles, were examined in spirit and aqueous media. Air-dried films were slightly inferior to those of the parent lac whereas baked films showed better elasticity and good water resistance.

2. Differentiation between *Kusmi* and *Rangeeni* lacs

A scientific method has been evolved, perhaps for the first time, to differentiate between *Kusmi* and *Rangeeni* lacs. Usually, the differentiation is done by colour and smell and, to some extent, fusibility, life and flow. But these change with the age of samples and consequently are not dependable.

Steam distillation was found promising and it was noticed that the first 50 ml

of the distillate was always turbid in the case of *Kusmi* lacs (seedlac or shellac) whereas *Rangeeni* lacs always gave clear distillates. This finding has been confirmed with over 30 samples each of the two varieties including a few commercial samples received from a manufacturer of repute.

The test is carried out by dissolving 20 g of the sample in 200 ml of water containing 2 g sodium hydroxide and subjecting the solution to steam distillation.

3. Shellac modified with saturated and unsaturated polyesters

Work on blending shellac with saturated and unsaturated polyesters had been reported last year. A suitable composition consisting of an unsaturated polyester and shellac in aqueous ammonia and incorporating cobalt naphthenate as drier had been developed.

These varnishes were pigmented with titanium dioxide to a pigment volume concentration of 20 per cent. It was found that though hardness was satisfactory and gloss moderate, flexibility was not adequate. No substantial improvement could be obtained by varying the compositions.

4. Water-thinned red oxide primer

A promising water-thinned red oxide primer for ferrous metals based entirely on indigenous raw materials namely shellac, linseed oil, fatty acids and glycerine had been formulated last year (*Annu. Rep.* 1966, p. 33). The primer was further studied during the period under report.

Two sets of panels of mild steel (passivated by dipping for a minute at room temperature in 50 per cent phosphoric acid) were coated with this primer and one dried by baking at 150°C for 30 minutes and the other in air for 7 days. They were then partly coated with finishing coats and subjected to the usual tests.

No rust spots were found on exposure in a humidity cabinet for 500 hours and no corrosion on continuous immersion in water for 30 days. They were also unaffected by natural weathering for nearly 13 months so far.

Results of all the above items of investigation have been compiled into papers and submitted for publication.

RESEARCHES IN HAND

1. Study of the constitution of lac

At present, this study is being simultaneously carried out at this Institute as well as, as a scheme, in two other centres, namely, at the National Chemical Laboratory, Poona and in the Delhi University.

The report below relates to the results of investigations carried out at this Institute. Summaries of the findings of the other two centres are given in Appendix I (vide pages 61).

(a) **Separation and analysis of the components of lac resin.** In the study of components of lac resin, it was of interest to find out if the resin could be resolved into its components with the help of thin layer chromatography (TLC).

The following three solvent systems were found to give good resolution:

(i) Ethyl acetate: acetic acid (100 :1, v/v),

(ii) Chloroform : methanol : acetic acid (90 :10 :2, v/v), and

(iii) Ethyl acetate: ether: chloroform: methanol: acetic acid (30 :30; 30 :10 :2, v/v).

On resolving seedlac and shellac of various types and grades using these solvent systems, it was found that all of them gave identical chromatograms indicating that (i) the chemical nature of lac resin is independent of the host or the strain of the insect which produced the lac, and (ii) lac resin does not undergo any noticeable change in its constituent/chemical nature by the heat treatment it undergoes during the processing of seedlac into shellac by heat or solvent process. Bleached lac, however, showed some differences, quite understandably, because of the chemical treatment involved.

(b) **Constitution of soft resin.** Study of the constitution of soft resin, the ether-soluble fraction of lac, has been in progress in the Institute for the past three years. Both paper chromatography and TLC have been applied. Soft resin had been hydrolysed and methyl esters of the acids had been fractionated by adductation with urea. Acetylation of the adducted fraction (A) and separation of the acetylated product, again with urea, into adducted (A.1) and non-adducted (A.2) fractions had been described already in the previous report.

During the current year, A.1 was refractionated in several lots over silicic acid impregnated with silver nitrate by means of increasing proportion of ether in petroleum ether (40–60°C). The fractions monitored (A.1.1 to A.1.7) were ultimately obtained. The first fraction was a pure saturated non-acetoxy ester, the second a mixture of saturated and unsaturated non-acetoxy esters, while the third and fourth were pure saturated and unsaturated acetoxy eseters respectively. The fifth, sixth and seventh fractions were mixtures.

The third fraction (A.1.3), which was a solid, on hydrolysis and recrystallization from ether by slow evaporation at room temperature, gave a monohydroxy acid melting at 89–90°C. It was identified as w-hydroxypalmitic acid.

The fourth fraction (A.1.4) contained a trace of *w*-hydroxypalmitate which was removed by running the material once again over silicic acid impregnated with silver nitrate. The pure unsaturated material was hydrolysed and a liquid acid was obtained which, on oxidation with a mixture of permanganate and periodate, yielded mainly pimelic and azelaic acids indicating that it was *w*-hydroxypalmitoleic acid. The position of the double bond is being investigated.

The original acetylated non-adducted esters (A.2) which showed a number of spots on the TLC plate, were fractionated over silicic acid by means of increasing proportion of ether in benzene. Five fractions (A.2.1 to A.2.5) were obtained which were further examined by TLC. The second fraction (A.2.2) was a solid and almost pure while the other fractions were mixtures. A.2.2 was hydrolysed and the acid, on recrystallization, melted at 42–43°C and had an acid value of 260. A.2.3 was again fractionated over silica gel and five fractions were obtained. The first two fractions were similar and were, therefore, mixed and hydrolysed. The

resulting acid, on recrystallization, melted at 93–94°C and had acid, saponification and hydroxyl values of 183, 190, 521 respectively. This acid appears to be an isomer of aleuritic acid.

Further identification is in progress.

(c) **Esterification of lac.** Systematic study by TLC had shown that during esterification of lac with methyl alcohol in the presence of the usual acid catalysts, alcoholysis takes place and that the ultimate product is not the ester of lac but is a mixture of esters of the constituent acids of the resin (*Annu. Rep.* 1966, p. 27).

It has now been found that phosphoric acid too acts as an esterification catalyst and that during esterification with ethyl, butyl and allyl alcohols also, alcoholysis takes place.

2. Modification of shellac

By grafting, copolymerisation with vinyl monomers. The grafting/copolymerisation of shellac with synthetic monomers has been reported in patents. Mixtures of two monomers, namely, ethyl acrylate and acrylamide, and styrene and acrylamide had been studied in detail for grafting on to lac and film properties of the resulting emulsions were described in the last report (*Annu. Rep.* 1966, pages 27).

During this year, a mixture of three monomers, namely, ethyl acrylate, styrene and acrylamide was taken up for the study. These monomers were chosen in such a way that each one imparts a specific property to the polymerized film, ethyl acrylate imparting flexibility, and styrene hardness. Acrylamide was intended to form cross links on baking resulting in improved properties. As a result of a series of experiments, it was found that a total of 60 per cent of the monomers on the weight of lac, made up of 45 parts of ethyl acrylate, 10 parts of styrene and 5 parts of acrylamide give the best films. These films were superior to those of the parent shellac in respect of flexibility and impact resistance.

Methyl methacrylate and acrylonitrile were then used in place of styrene as these two monomers also generally impart hardness. It was, however, found that whereas acrylonitrile was as good as styrene, methyl methacrylate was inferior.

The results have been compiled into a paper which has been submitted for publication.

Side by side, a new study, namely, copolymerization of lac with vinyl monomers in non-aqueous medium was also started. Copolymerization was attempted by adding a mixture of methyl methacrylate and acrylic acid in presence of benzoyl peroxide to a refluxing solution of lac in a mixture of *n*-butyl alcohol and toluene (30:70). Film properties of the resulting product were found to be inferior to those of the parent lac.

3. Improvements in manufacture of seedlac and shellac

(a) **Fractionation of shellac by aqueous electrolytes.** In order to separate lac into various fractions of different molecular complexities, fractionation by addition of aqueous electrolytes to an alcoholic solution of lac was resorted to. Several fractions were obtained by the addition of various proportions of 1 per cent

aqueous solution of sodium chloride to a 10 per cent (w/w) solution of lac and the physical properties of these fractions had been determined (*Annu. Rep.* 1966, p. 28).

Larger quantities of the fractions were obtained by precipitation from 500 ml of the lac solution by addition of 250 and 500 ml of the electrolyte respectively. Yields of the fractions were 66 and 85 per cent and their melting points approximately 102° and 94° C respectively.

Air-dried films of these fractions from alcoholic solutions were found to be remarkably water resistant.

(b) **Preparation of hydrolysed lac.** A method had been developed for the preparation of total hydrolysed lac from seedlac and shellac and this was later successfully applied to *molamma* lac also (*Annu. Rep.* 1966, p. 29).

In this method, for obtaining hydrolysed lac, the alkali hysdrolysate was neutralised with the exact equivalent of alcoholic sulphuric acid. However, it was difficult to ensure complete removal of the last traces of the acid from the final product. A modification of the process, which obviates this difficulty has been developed.

In the modified process, the hydrolysate was treated with a slight excess of sulphuric acid over that needed for exact neutralization, followed by treatment with calcium carbonate at room temperature. The insolubles including sodium sulphate and wax settled down and the clear supernatant liquid filtered easily. Yield was 103–105 per cent and acid and saponification values 201 and 211 respectively.

Hydrolysed lac was also prepared from seedlac and *molamma* lac by the conventional method in aqueous medium for comparative study. Yield was 74–76 per cent and acid and saponification values 198 and 201 respectively.

Life under heat of the various hydrolysed lacs in presence of catalysts such as oxalic, phosphoric and *p*-toluene sulphonic acids and maleic anhydride was determined. The results are brought out in Table 4. It would be seen that whereas maleic anhydride had no noticeable effect on the polymerization, the other three acted as accelerators. The samples obtained by calcium carbonate treatment and by the use of ion-exchange resin had almost similar lives under heat, thus indicating complete removal of the free mineral acid in the former process. No differences were observed for the different hydrolysed lacs, from different starting materials.

(c) **Recovery of wax lost during the processing of sticklac into seedlac.** A substantial quantity of wax is lost into the wash water in lac factories during the processing of sticklac into seedlac. On treatment with mineral acid, the effluent precipitates a sludge containing 6–8 per cent of this wax. This wax could be extracted in a yield of 90 per cent from the sludge by successive extractions with *n*-hexane (*Annu. Rep.* 1966, p. 30). It has been now found that if the sludge was stirred in the solvent at 60°C for about 10 minutes, complete recovery could be affected in three extractions as against nine in the earlier process.

(d) **Recovery of lac dye.** The sludge mentioned above also contains the major portion of the water-soluble dye of sticklac. A small portion, however, remains in the mother liquor and conditions were worked out last year to reclaim this also in the form of its calcium salt.

TABLE 4. LIFE UNDER HEAT OF HYDROLYSED LACS IN PRESENCE OF 5 PER CENT OF THEIR WEIGHTS OF CURING AGENTS

(Life, in minutes, at 150°C)

Sl. No.	Curing agents	Parent seedlac (control)	Conventional (water insoluble) hydrolysed lac	Total hydrolysed lac			Condition of the cured material after cooling**
				I*	II*	III*	
1.	None	42	230	275	395	380	A tough spongy mass
2.	Oxalic acid	5	18	32	230	268	Dark coloured and brittle
3.	Phosphoric acid	8	12	25	78	83	Light coloured and elastic
4.	*p*-toluene sulphonic acid	4	5	12	15	11	Dark coloured and spongy rubber like
5.	Maleic anhydride	41	220	250	365	370	Dark coloured and brittle

*I = Hydrolysed lac solution neutralised with alcoholic sulphuric acid.
*II = Hydrolysed lac solution neutralised with alcoholic sulphuric acid and traces of excess acid removed by treating with calcium carbonate.
*III = Hydrolysed lac solution passed through cation exchange resin.
** = Seedlac cured to a horny brittle resin.

The two processes have now been combined and the following details worked out for recovering all the dye in one operation.

The (sticklac) wash water is acidified as usual with concentrated sulphuric acid and the precipitate allowed to settle. The supernatent clear liquor is decanted and treated with powdered calcium carbonate or lime till it becomes colourless. The calcium salt which separates is collected and dried. The acid precipitated sludge is separately extracted twice with boiling water, and from the aqueous extract the dissolved dye precipitated as the calcium salt. The combined calcium salts may then be treated, for reclaiming the dye, either (i) with sulphuric acid, or (ii) by conversion into the sodium salt and passing through an ion exchange resin. Average yield of the dye from *Rangeeni* sticklac (*phunki*) was 0.8–0.9 per cent.

The amounts of dye present in *palas*, *ber* and *kusmi* sticklacs were also determined. It was found that, in *ari*, it was present to the extent of 1.1, 1.16 and 0.82 and, in *phunki*, 0.93, 0.91 and 0.5 per cent, respectively. This would confirm that recovery of dye from the wash water was almost complete under the above conditions.

On a laboratory scale, the dye obtained had an ash content of 0.3 per cent and hot water insolubles of 0.11 per cent. When larger (1 kg) batches of the calcium salt were handled, the dye produced had a rather high ash content. This was reduced

to 0.8–1 per cent on recrystallization from acetone-water mixture or 25 per cent aqueous hydrochloric acid.

(e) **Recovery of wax and lac from autoclave kiri.** *Kiri* obtained in the autoclave process is rich in wax and resin. These were determined and found to be 13 and 55 per cent respectively. The following simple method has been evolved to recover these from this *kiri*.

The *kiri* is coarsely crushed and extracted with four times its weight of boiling soda solution (containing 10 per cent of washing soda on the weight of lac content of the *kiri*). The extract is filtered hot and again boiled for a few minutes and allowed to stand overnight. The wax that floats up is scooped out. The remaining solution is acidified and the precipitated lac thoroughly washed to free from acid. The material is then mixed with an equal weight of seedlac and melted in an autoclave. Recovery of both lac and wax by this process was 50 per cent of the quantities present.

4. **Chemical changes in the bleaching of seedlac by different methods.** The colour of seedlac and shellac is due to the presence of erythrolaccin. For some purposes, colour is undesirable and an almost colourless product can be obtained by bleaching lac with sodium hypochlorite.

To study the chemical changes that take place during this bleaching, the colouring matter, erythrolaccin (0.2 g), was treated with sodium hypochlorite under the same conditions as lac bleaching. The colourless solution thus obtained after acidification was extracted with ether to give a light yellow oily liquid admixed with some white solid particles (0.17 g). The product contained chlorine and carbonyl and was acidic in nature. On examination by paper chromatography in the solvent system *n*-butanol saturated with 1.5N ammonia and bromophenol blue as developer, the product was found to give four spots having Rf values of 0.1, 0.24, 0.33 and 0.41.

The I.R. Spectra showed the following bands:

2960, 2920, 2860, 1720, 1590, 1570, 1480, 1380, 1280, 1130, 1070, 1030, 970, 810, 740 and 660 cm^{-1}.

5. **Improvements in the analytical methods of lac and problems connected with specifications**

Correlation of specific heat with the age of lac. It is well known that lac resin deteriorates slowly and steadily on storage. There is no any known scientific method yet to determine the 'age' or state of deterioration of any particular lot of lac. It is known that specific heat of lac falls with progressive periods of storage. This property is being investigated for possible use for the determination of the 'age'. Seedlac samples of known history had been in storage in this laboratory since July 1964 and their specific heats were being determined at regular intervals. The determinations were continued. There was a drop of 13–20 per cent in the values after 36 months' storage (*Annu. Rep.* 1966, p. 32).

After 42 months, that is after a further six months' storage, the values were practically the same. There was also no deterioration in the physical condition of the samples.

6. **Aqueous lac varnishes**

(a) **Water thinned red oxide primers.** A water thinned red oxide primer based on maleinised linseed oil and water-soluble shellac had been described earlier (*Annu. Rep.* 1966, p. 33). The effect of corrosion inhibiting chemicals, both inorganic and organic, had been investigated at length. A satisfactory formulation had been developed. However, the above composition suffered from the defect of thinning of the primer with time. This could be overcome by modifying the method of blending. Incorporation of cellosolve and increasing the quantity of wet ground mica improved the properties of the composition. This could then be applied by spray at 30 lb per square inch pressure. It satisfies Indian Standard Specification No. 3538 and 3539/1966 for anticorrosive primers and has also been found satisfactory by a leading paint manufacturer.

(b) **Water-soluble wood finish.** It had been observed earlier that a blend of aqueous ammoniacal solution of lac with water-soluble melamine resin produced a hard, smooth and glossy finish on wood. It had better heat resistance than shellac but the water resistance was not adequate.

Since melamine resin cures in the cold in the presence of acidic catalysts, the advantages of using the composition under acidic conditions were investigated. A sulphited lac solution was prepared and blended with trimethoxy trimethylol melamine resin. Air-dried films of this composition showed improved water resistance apart from retaining the other desirable properties of the previous composition. This composition, however, showed a tendency to gell after 24 hours. It can, therefore, be used only as a two-pack system.

7. **Rubber-Shellac Combinations**

Ethylene glycol modified lac-SBR 1502

(i) **With gum stock.** Shellac and, better still, epoxy resin modified shellac have been found to be valuable additives to synthetic (SBR 1502) rubber, the incorporation resulting in improvement in most of the desirable properties. Both MBT and CBS are suitable accelerators, the latter being the better. Ethylene glycol modified lac was found to be even better than the epoxy modified resin, improving the properties still further and reducing the adverse effect on abrasion resistance (*Annu. Rep.* 1966, p. 35).

The study using another accelerator system, namely, combination of MBTS and TMTD was made during this year.

A comparison of the results obtained with those (of last year) using MBT and CBS indicated that this combination is better than MBT or CBS used individually.

The properties improved are mooney viscosity, modulus, tensile strength, hardness and impact resilience. Another notable improvement is lowering of swelling in benzene and petroleum ether.

(ii) **With clay.** The effect of incorporation of clay as the filler in the above composition was also investigated. Improvements were again noted in respect of mooney viscosity, modulus, tear resistance and hardness. Tensile strength was also increased up to 5 parts of clay per 100 parts of the rubber.

8. **Use of lac and modified lacs in surface coatings**

(i) **Solventless coatings.** Solventless coatings are becoming increasingly popular because of obvious advantages. These are based usually on unsaturated polyesters dissolved in a monomer, usually styrene, which get both of polymerized *in situ* on initiation. Shellac is insoluble in styrene, but both shellac and styrene are soluble in glycerol monoallyl ether. Solutions of shellac in this solvent failed to air dry even in the presence of cobalt as drier and, on baking, the solvent was lost completely by volatilization.

A study of polymerization systems containing shellac, glycerol monoallyl ether and styrene or methyl methacrylate and initiated by a redox pair, benzoyl peroxide and dimethyl aniline, revealed that, in spite of unsaturation, the glycerol monoallyl ether failed to take part in the polymerization but functioned merely as a solvent. Substitution of the ether by ethyl alcohol was tried. The product obtained from methyl methacrylate and shellac in the latter solvent gave a cloudy emulsion on dilution with more alcohol, which clarified on heating but became cloudy again on cooling. Addition of toluene gave a clear solution but films prepared from it were translucent and cloudy. No improvements could be obtained by addition of other solvents or even of plasticizers like dibutyl phthalate.

(ii) **Shellac linseed oil combinations modified with polyisocyanate.** Attempts to treat shellac with polyisocyanates have met with certain difficulties due to poor solubility of the resin in common non-hydroxylic solvents as well as its comparatively higher reactivity. Shellac modified with castor oil had been found more suitable (*Annu. Rep.* 1966, p. 41). This work was now extended to shellac linseed oil combinations.

As is well known, shellac is not compatible with linseed oil under the usual conditions but combines readily with the mixed glycerides of the oil.

For the study, the glyceride was prepared by cooking linseed oil (100 parts) with glycerol (60 parts) in the presence of litharge (0.5 part) at 220°C for 60 minutes. The resulting glyceride was cooked with 30–60 per cent of shellac at about 250° C for one hour. Similar compositions were also prepared from the glyceride mixture after it was washed with hot water to remove unreacted glycerol. Acid values of the products varied between 3.5 and 7. Hydroxyl values of the products from unwashed glycerides varied between 136.5 and 169.6 and from the washed glycerides between 78.5 to 102.20, depending upon the proportion of shellac used.

The products were diluted with white spirit and 0.02 per cent cobalt (as naphthenate) added as drier. The requisite amounts of toluene diisocyanate (calculated on the basis of acid and hydroxyl values) were then added and well mixed. After allowing to stand for 10 minutes at room temperature (25°–30° C), films were prepared on glass and tin panels. The films air dried in 3–4 hours. The pot life of these compositions varied between 3 to 8 hours depending upon the proportion of shellac to oil; with higher proportions of shellac, the pot life was lower. Compositions with washed glycerides showed better pot life but the film properties were inferior.

The films (from the shellac unwashed glyceride combination) possessed

excellent hardness, gloss and elasticity and resistance to water and even alkalies. With 50–60 per cent shellac on the weight of the glycerides, the films remained perfectly unaffected on continued immersion in 5 per cent caustic soda for 10 days.

(iii) **Shellac esters and their modifications.** Shellac esters are easily prepared derivatives of considerable promise for further modification into useful industrial products because, unlike shellac, they have a fairly long life under heat and are soluble in aromatic hydrocarbons. Modification can thus be effected by fusion without fear of gelling or by azeotropic distillation.

The preparation of the ethyl ester was attempted by the standard Fischer Method of esterification, using concentrated sulphuric acid as the catalyst. The catalyst was removed as barium sulphate by reacting with barium carbonate. The ester had an acid value of 29.4, hydroxyl value of 158.3 and life of more than 72 hours at 150 °C.

(iv) **Modification of shellac allyl ether/ester with toluene diisocyanate.** Shellac allyl ether/ester varnishes in toluene or methyl isobutyl ketone solution, on modification with toluene di-isocyanate were found to be cold-curing and produced films of good gloss, hardness and alkali resistance. Pigmentation of the varnishes followed by curing yielded films of outstanding levelling besides having good gloss and hardness (*Annu. Rep.* 1966, p. 44).

The modified pigmented varnish had a pot life of nearly 8 hours and drying time of 30 minutes at room temperature. It had, therefore, necessarily to be used as a two-pack system. The films had good water resistance but poor elasticity. Addition of cobalt naphthenate detracted the gloss.

In order to find out the role of unsaturation in shellac allyl ether/ester in respect of film performance, the shellac ether/esters of ethyl and butyl alcohols were prepared and are under study.

(v) **Copolymerization with synthetic monomers.** It had been observed earlier that shellac allyl ether/ester dissolves in vinyl monomers such as methyl methacrylate, and polymerization could be effected by the use of benzoyl peroxide—dimethyl aniline redox system (*Annu. Rep.* 1966, p. 44).

Films prepared from the allyl ether/ester (30 parts) and methyl methacrylate (70 parts) as above after curing at room temperature or baking remained soft. Similar results were obtained by using styrene as the monomer.

(vi) **Shellac etch primer.** Since zinc is an imported item, zinc chromate, which is the conventional pigment for etch primer, was successfully replaced by indigenous barium potassium chromate. When used to the extent of 50 per cent on the weight of lac, other components remaining the same, etch primers could be prepared having the same performance as the zinc chromate based primer (*Annu. Rep.* 1966, p. 44).

The use of another indigenous pigment, barium chromate, has now been investigated. The optimum proportion of this pigment was found to be 120 parts for every 100 parts of dewaxed lac. The primer thus consists of dewaxed lac (100 parts), methylated spirit (200 parts), barium chromate (120 parts), *n*-butanol (82 parts) and phosphoric acid (30 parts). It did not thicken or deteriorate in film

properties on storage up to 2 months so far. Films could also be painted over with oil paints or synthetic enamel after 24 hours air drying without any bleeding, etc.

Further shelf life of these two primers are under study.

(vii) **Lacquered containers for shellac varnishes.** It had already been observed (*Annu. Rep.* 1966, p. 48) that dewaxed lac varnishes modified with urea resin produce on metals like tin plate, highly flexible, glossy and adherent films which, on baking at 150°C for 30 minutes, show excellent resistance to the action of water dilute acids, alkalies and solvents including alcohol. It had also been indicated that this lacquer might satisfactorily be used for coating tin containers used for packaging of shellac varnishes.

A systematic study has revealed that at the end of two years of storage, the stored shellac varnish did not show any appreciable variation in viscosity, colour and performance. It was also found that the coatings on the container were also unaffected.

(viii) **Melfolac (Melamine/formaldehyde resin modified shellac).** The development of an excellent composition of heat, water and liquor proof varnish for wooden furniture had been reported earlier. This varnish has been reported as satisfactory by a large number of consumers and manufacturers of French polish, and a toy manufacturer for coating wooden dolls.

Recent experiments made on pigmentation of this varnish have shown that this can satisfactorily be used for the production of quick-drying paints for display panels, shop windows, etc. This lacquer not only protects the extremely thin metal surface from abrasion but also makes the coated articles resistant to water, acids, solvents, etc.

The nature of the chemical reaction taking place between melamine resin and shellac during the curing process was studied by determining the acid value of the resulting films at intervals up to seven days, after which no change was perceptible. The reaction probably takes place between the methylol groups of the melamine resin and the carboxyl of shellac. This was also confirmed by I.R. spectra.

9. Electrical properties of lac and its modifications.

Electrodeposition is the latest technique for the application of paints and varnishes and is exclusive for water-based coatings. Shellac, being readily soluble in aqueous solutions of bases, holds out considerable promise as a suitable ingredient for application by electrodeposition. A systematic study was, therefore, undertaken.

The best results were obtained by taking a 15 per cent solution of dewaxed lac in aqueous ammonia at a pH of 8.5. Any DC voltage from 40 to 100 volts could be used. The current (amperage), however, influenced the mass deposited. Temperature in the range 35°–45°C was found the most suitable and smooth and uniform films could be obtained in 2 minutes at a current rate of about 40 amperes per square metre.

The films were found to flake off on air drying but on baking at 150°C for 30 minutes, after a flash off period of only 10 minutes, adherent and water and heat-resistant films were obtained.

A blend of dewaxed lac and self dispersing alkyd in the proportion of 1:1 was found to be the optimum for electrodeposition. Incorporation of red oxide pigment in the blend was found not to develop adequate film resistance. When, however, ammonia was replaced by triethanolamine, substantial improvement was noticed.

AD-HOC RESEARCH

(i) Microporous separators for storage batteries

(a) **For ordinary batteries.** Imported microporous separators are used in manufacture of storage batteries. The following study was taken up to evolve a composition to replace the imported material.

Non-woven jute fabric impregnated with a lac-cashewnut shell oil liquid combination modified with urea and formalin and pressed hot was found to have adequate resistance to dilute sulphuric acid but lacked the necessary quick wettability. Surface active agents (ollyl hydroxamic acid and fatty hydroxamic acid) were incorporated into the composition but no improvement was noticed.

(b) **For heavy duty batteries.** In manufacture of heavy duty storage batteries, glass-wool sheets are used. These sheets are produced from glass-wool felt bonded with imported resin. As a substitute to the imported material, shellac-cashewnut shell liquid combinations modified with urea and formalin were tried. Samples prepared were found to possess the requisite resistance to sulphuric acid.

(ii) **Adhesive for lamination of polythene and paper on hessian cloth.** The same varnish had also been used to produce a water-resistant film on hessian by the technique of film transfer. The coating has now been found to resist heat also (up to 150°C) thus indicating possible use of such coated bags for the package of cement (which at the time of packing in factories is generally at a temperature of 120°–130°C), apart from other moisture sensitive materials.

(iii) **Jute non-woven fabric for boxes and containers.** Jute non-woven fabric sheets were pressed into boards after impregnating with Melfolac varnish as well as aqueous lac solutions and air drying. The former board was found to remain unaffected on immersion in water for 24 hours but to blush in 48 hours. Baking at 100°C for 60 minutes eliminated this blushing. Air-dried sheets made with-water based solution also blushed in water within 24 hours.

(iv) **Floor tiles.** The possibility of producing floor tiles by impregnation of jute felt with the aqueous as well as Melfolac varnish was investigated. The impregnated material was air dried and pressed at 85°C and 5,000 lb per square inch. The resulting tile showed a tendency to swell in contact with water but improved considerably on baking for 1 hour at 100°C.

(v) **Insulating composition.** At the request of the technical experts of a Coal Washery for a substitute for imported PVC lacquers for use in their cable joints, insulating compositions based on shellac, rosin, castor oil and hydrolysed lac were prepared and supplied. After tests, they were reported as satisfactory and,

on their request, further lots of 150 kg each of the following two compositions were supplied.

Solid composition		*Liquid composition*	
Dewaxed shellac	— 300 g	Dewaxed shellac	— 25 g
Rosin	— 100 g	Castor oil	— 5 g
Castor oil	— 50 g	Methylated spirit	— 75 g

Their further report is awaited.

(vi) **Shellac bond powder.** Studies have been taken up to develop a shellac bond powder for micanite manufacture by the dry process.

Possibility of using hydrolysed lac as plasticizer was first investigated. It was found that when hydrolysed lac is mixed with shellac, the composition is brittle up to 30 per cent and becomes soft with further increase. The flow and life under heat also increase with increase in the proportion of hydrolysed lac, while softening point decreases. However, shellac bond powder with hydrolysed lac does not give good adhesion to mica splittings.

(vii) **Water-proof ink for marking on hessian and crates.** The following composition was developed for use as water-proof ink for marking on hessian and crates. This composition could also be used in polythene bottles with suitable wick.

The various constants were as follows:

Vehicle		*Ink*	
Dewaxed shellac	— 26 g	Vehicle	— 100 g
Dilute ammonia (1 : 4)	— 200 g	'Teepol'	— 8 g
Phenol	— 0.4 g	Dye or pigment	— as required
Borax	— 1.2 g		

(viii) **Modification of lac by treatment with concentrated sulphuric acid.** It has been claimed that when concentrated sulphuric acid is added to a solution of lac in industrial spirit, a modified resin of improved properties is precipitated. In view of the simplicity of the treatment, a systematic study was taken up in order to determine the optimum conditions for the treatment and improvements obtained in the properties of the products.

The precipitation was carried out by gradual addition of sulphuric acid (80 parts) to a solution of dewaxed shellac (100 parts) in rectified spirit (250 parts) at

room temperature (Sample 1). The experiment was repeated using methylated spirit at room temperature (Sample 2) as well as at a lower temperature (16–20°C) (Sample 3). The precipitated lacs were filtered, washed free of acid and dried. In another experiment, the solution after precipitation was kept in a refrigerator for 6–8 hours before filtration and drying (Sample 4). Yields of the samples were 95–97 per cent on the weight of lac used.

The dried samples were found to be insoluble in methyl, ethyl and isopropyl alcohols, acetone, hydrocarbons and in (1 :1) mixtures of methyl acetate and glycol, ethyl acetate and acetone, *n*-butyl alcohol and acetone, and *n*-butyl alcohol and ethyl alcohol. They were, however, completely soluble in *n*-butyl alcohol.

The work carried out during the year under report is described below:

	Treated lacs	*Parent shellac*
Softening point (°C)	142–176	69
Melting point (°C)	147–180	73
Life at 150°C (minutes)	5–9.5	38
Iodine value	16–16.9	16.65
Acid value	56–59.5	72.25
Saponification value	254–265	233.60
Intrinsic viscosity in *n*-butanol at 30±0.2°C	0.081	0.071

Hydroxyl values could not be determined due to the partial insolubility of the samples in acetylation mixture.

(ix) **Use of lac in rocket fuels.** The use of lac and modified lac as binder for solid rocket fuels was investigated at the suggestion of the Birla Institute of Technology, Mesra, Ranchi.

Fused lac was found to be too stiff as a binder whereas incorporation of hydrolysed lac suffered from the drawback of cold flow. Various shellac-stearic acid combinations were also examined but found to be unsuitable. Several other compositions based on copolymers of shellac esters and methyl methacrylate were prepared and studied. The information has been passed on to Birla Institute of Technology for testing with oxidisers.

18. **Compilation of literature: Shellac formulary.** A compilation has been made of all the formulae published in literature up to the end of 1965 regarding modifications and utilisations of lac. Nearly 60 per cent (296 pages) of the "press-ready" copy has been typed out and Author Index, Patent Number Index and Subject Index for that portion prepared.

RESEARCHES CONTEMPLATED

(a) **Entomology Division**

Three of the studies and a part of a fourth have been completed amongst those which were being continued from the past. The studies already in progress will be continued in the following year, a few of which are expected to be completed. Besides, the following are also proposed to be taken up.

1. The item "Permanent field experiment for working out economics of cultivation of *Kusmi* lac on *M. macrophylla* under different conditions of manuring and irrigation" had been kept in abeyance as irrigation facilities were not available (*Annu. Rep.* 1965-66). The facilities have now been arranged and the experiment is proposed to be initiated next year. Attempts are also afoot for procuring a site at Dharamjaigarh for a similar experiment.
2. Another experiment, namely, 'Studies on the proper time of harvesting-cum-coppicing on *M. macrophylla*' will be started as the bushes already available have been, in the meantime, brought to proper condition for use.
3. The following arboricultural studies are also proposed to be taken up:
   (i) Effect of colchicine treatment on *M. macrophylla.*
   (ii) Finding out a suitable teachnique to render *M. macrophylla* plants resistant to drought.

(b) **Chemistry Division**

Studies of the reaction of lac with urea and other similar chemicals, differentiation between *Kusmi* and *Rangeeni* lacs by a scientific method, and shellac modified with saturated and unsaturated polyesters have been completed and the results submitted for publication. The rest of the studies already on hand will be continued. Besides, the following are also proposed to be taken up to be investigated with the existing staff.

1. Molecular weight of lac and its fractions
2. Production of shellac directly from sticklac
3. Reaction of lac with metal alkoxides
4. Determination of shellac in presence of other resins
5. Allyl ethers/esters as convertible solvent plasticisers for lac
6. Modification of lac with polyvinyl alcohol
7. Use of lac for coating fertilizers

In case the staff position improves, it is also proposed to take up the remaining items recommended by the 1966 Achievement Audit Committee.

III. List of Papers Published during the Year 1967

Sl. No.	Authors	Title of paper	Name of Journal/date of publication
1	2	3	4
A. Entomology Division			
1.	Chauhan, N.S.	A study of possible correlations among some of the economic attributes of the lac insect *Kerria lacca* (Kerr)	*Indian J. Ent.*, **29** (2), 1967
2.	Chauhan, N.S.	A colour mutant in the Indian lac insect	*Indian J. Ent.*, **29** (2), 1967
3.	Chauhan, N.S.	On the abnormal celled female lac insects	*Indian J. Ent.*, **29** (4), 1967
4.	Chauhan, N.S. and Mazumdar, N.	Genetic evidence of spurious emergence in the *Aghani* generation of *Kerria lacca* (Kerr)	*Indian J. Ent.*, **29** (2), 1967
5.	Dasgupta, J. and Mehra, B.P.	Recorded and unrecorded lac hosts from W. Bengal	*Indian For.*, **93** (5), 1967
6.	Mehra, B.P. and Paradis, R.O.	*Polynema striaticoma* Girault (Hymenoptera : Mymaridae), a parasite of the Buffalo tree hopper *Strictocephala bubulus* (F). (Homoptera and Membracidae) in Quebec	*Ann. Ent. Soc. Quebec.* **12** (2), 1967
7.	Mehra, B.P. and Gokulpure, R.S.	Preliminary observations on the use of *palas* for fortification of *ghont* lac in Madhya Pradesh	*Indian For.*, **93** (7), 1967
8.	Mehra, B.P. and Gokulpure, R.S.	Recorded and unrecorded lac hosts from M.P.	*Indian For.*, **93** (10), 1967

9.	Prasad, U.N. and Mehra, B.P.	A new record of *Rangeeni* lac on *Grewia robusta* A. Cunn. (Fam : Proteaceae) from Namkum, Ranchi	*Indian For.*, **93** (6), 1967
10.	Purkayastha, B.K.	Optimum age of shoots for inoculations of lac crop on the Indian Lac Tree	*Indian J. agric. Sci.*, **37** (3), 1967
11.	Varshney, R.K., Griyaghey, U.P. and Sundaram, R.M.	On some parasites of lac insect	*Indian For.*, **93** (4), 1967
12.	Varshney, R.K. and Teotia, T.P.S.	A supplementary list of the host plants of lac insects	*J. Bombay nat. Hist. Soc.*, **64** (3), 1967

B. Chemistry Division

1.	Chopra, S.S. and Sankaranarayanan, Y.	Water thinned shellac alkyd media for paints Part—I. Shellac self-dispersing alkyd combination	*Indian J. Tech.*, Vol. V, No. 6, 1967, p. 190
2.	Ghosh, A.K. and Sengupta, S.C.	Reclamation of lac wax from lac effluents	*Research & Ind.*, Vol. 12, No. 3, 1967, p. 168
3.	Ghosh, A.K. and Sengupta, S.C.	Utilisation of by-products of lac industry Part—I. Manufacture of bleached lac from *Molamma*	*Research & Ind.*, Vol. 12, No. 3, 1967, p. 171
4.	Kumar, Shravan	Water thinnable lac drying oil finishes Part—II	Paint Technology, Vol. 31, No. 1, 1967, p. 15
5.	Kumar, Shravan and Misra, G.S.	Shellac an excellent resin for modern surface coatings	Economics Times 16, Jan., 1967, p. 3

IV. Extension

ENTOMOLOGY DIVISION

1. Cultivation of Lac.

As already mentioned in the last year (*Annu. Rep.* 1966, p. 54), all activities relating to extension of lac cultivation are now the responsibility of the newly constituted Regional Office for Lac Development under the Ministry of Food and Agriculture. The functions of this Institute, as before, are limited to providing necessary technical assistance to those interested. The principal activity in this regard during the period under report was forecasting of the date of larval emergence during the different seasons and determination of causes of excessive mortality of lac insects and failure of crops on the basis of examination of samples received from different lac-growing areas. The other major activity was the collaboration with the Forest Department of the Bihar Government in their large-scale cultivation experiments on lac at Kundri (Palamau District) and the establishment and maintenance of a *Kusmi* broodlac-cum-demonstration farm at Maheshpur-Sirka (Ranchi District). In both cases, the Forest Department provides the host trees, labour and other incidental requirements and produces lac and this Institute provides the necessary technical guidance.

(a) **Large-scale cultivation experiments on *palas* at Kundri (District Palamau).** These experiments have been going on in Kundri Lac Orchard for the past several years. The orchard has a total of about 20,000 *palas* trees. During 1967, a total of 2,057.85 kg of scraped lac and 4,335 kg of broodlac was produced in this orchard. These were the lowest yields for the past several years because of the unprecedented drought and extremely hot summer in the region. The entire yield of broodlac was utilised in the same orchard for raising the subsequent crop. No surplus broodlac was available. The sticklac was sold at the rate of Re. 1 per kg which fetched a revenue of Rs. 2,075.85 only as against the total expenditure of Rs. 2,776.

(b) **Establishment and maintenance of *Kusmi* broodlac-cum-demonstration farm at Maheshpur-Sirka (Dist. Ranchi).** As indicated earlier (*Annu. Rep.* 1966, p. 54) the farm has been set up to stimulate *Kusmi* lac production and to study the behaviour of *kusum* trees in the production of lac during different seasons.

A total of 600 trees are available in the area. These have been divided into two blocks, one of 300 for carrying out lac cultivation under the established practice, namely, division into four coupes, inoculation with normal rate of broodlac

after 18 months rest and harvesting the crop every season. The other block of 300 trees is being subjected to a modified schedule. For this purpose, the block is divided into four coupes of 100, 50, 100 and 50 trees respectively (A, B, C and D). A and C are inoculated with half normal brood rate after12 months' rest, the crop partially harvested after six months and fully after another six months. B and D are given 18 months' rest and inoculated with normal rate of broodlac and completely harvested after six months. This procedure ensures the main harvesting and pruning in both sets of trees in June–July which stimulates better growth of shoots suitable for lac cultivation. It results in a larger proportion of the available trees being under lac cultivation at any time and also involves less operational costs and less broodlac requirements.

Sustained production of broodlac has been maintained since the work was taken up in 1965.

2. **Training and Advisory Service**

(a) **Training in improved method of lac cultivation.** Twelve trainees admitted for October 1966–March 1967 session completed their course. Of these, 6 were from Madhya Pradesh, 3 from Maharashtra, 2 from Uttar Pradesh and 1 from Rajasthan.

No trainees were sponsored by any State for the April–September session. For the October 1967–March 1968 session, five trainees, all from Forest Department, Madhya Pradesh, have been admitted.

Lectures were also delivered to the trainees of the Forest Training School, Chaibasa and the Forest Guard Training School at Mahillong and Betla.

(b) **Advisory services.** Specimens of lac insects and their predators and parasites, samples of lac encrustation on different hosts, brochures and literature on lac cultivation were despatched to colleges, vijnan mandirs and schools, as requested. Other technical queries on mortality of the insects, crop failures, cultivation techniques, method of raising host plants, etc., were also attended to.

CHEMISTRY DIVISION

Unlike that of cultivation, extension activities regarding processing and utilisation aspect of lac is the complete responsibility of this Institute as far as industries in India are concerned. For this purpose, the Institute maintains a Utilisation Section, the main activities of which are technical service, developmental activities, publicity and propaganda, etc.

(a) **Technical service.** Technical assistance was, as usual, provided to various Government Organisations and private institutions and individuals interested in using shellac and shellac compositions. A few of the more important of these are listed below:

(i) The Indian Institute of Foreign Trade were interested in making stencil marking ink. Samples of black and blue inks with the following compositions were prepared and supplied.

Vehicle

Dewaxed shellac	— 26 g
Dilute ammonia	— 200 ml
Phenol	— 0.4 g
Borax	— 1.2 g

Ink

Vehicle	— 100 g
Teepol	— 8 g
Basic dye	— Required amount

Performance of these was reported as satisfactory.

(ii) The Heavy Electricals Limited, Bhopal had been supplied a shellac composition for use in place of an imported material for the production of micanite by the dry method. They reported that our sample did not give proper adhesion in segment micanite. The problem is being investigated.

(iii) On request, the Municipal Corporation of Greater Bombay was supplied the following composition for use as capping material for filter beds.

Lemon Shellac No. 2	— 100 g
Urea (Tech.)	— 1 g
Barytes (off colour)	— 90 g

They reported that the material was satisfactory and asked for a bulk supply. As this was beyond the capacity of this Institute, they were advised to contact a few other parties to get the material manufactured. Their requirement was, it is learnt, of the order of 10 tonnes for the time being.

(iv) A suitable composition is being developed to stop leakage under vacuum of rubber hoses in collaboration with the Research Designs and Standard Organisation of Indian Railways, Lucknow.

(v) A few diamond cutting firms were supplied the know-how regarding a suitable composition for fixing diamond during grinding.

(vi) An Industrial Unit of Community Project (Rural Industries), Ranchi and the Bihar State Co-operative Lac Marketing Federation, Ranchi have been assisted regarding the manufacture of sealing wax of good quality.

(vii) M/s Waxpol Industries Limited, Ranchi were given a drawing of the plant and the necessary technical know-how for the extraction of shellac wax from the sludge obtained from lac factory effluents.

(viii) Several enquiries were received regarding water-soluble lac, bulb capping cement, pealable coating in silk screen painting, heat and water-proof French polish (Melfolac), insulating varnish etc. The necessary information was supplied.

(b) **Development work.** The Bihar State-Co-operative Lac Marketing Federation has been assisted in setting up their processing factory for the manufacture of seedlac and shellac. Lac development officers of Bengal and Bihar have been provided with details regarding the setting up of suitable units in their States for the manufacture of bleached lac.

The Community Project Officer, Ranchi has been assisted in setting up a unit for the manufacture of seedlac and shellac. He has also been advised to start the manufacture of shellac varnish.

(c) **Propaganda and publicity.** Due to shortage of staff, the Institute could not participate in any exhibitions. Nevertheless, exhibits including charts were sent to several exhibitions organised by public and private organisations including the Khadi and Village Industries Commission.

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

During the year under report, the total sales amounted to Rs. 29,423.46 P. as detailed below:

Material		Quantity sold (kg)	Sale value (Rs. P.)
BRF grade bleached lac	—	397.95	2,941.56
BR grade bleached lac	—	494.00	3,316.95
DL grade water-soluble lac	—	202.00	1,406.65
AL grade water-soluble lac	—	18.00	108.00
ASK grade shellac	—	3,074.00	16,351.00
Misc. (hydrolysed lac, French polish, Melfolac, etc.)	—		5,299.30
Total	—		29,423.46

V. Summary

ENTOMOLOGY DIVISION

The work on various problems carried out during the year was as per Project Proposals for the Division submitted for 1967.

During the year, studies on three problems and a part of a fourth were concluded and four new problems taken up for investigation. The studies already in hand were also continued.

1. Potentialities studies

(a) **On** *palas*. Studies were made for determining whether harvesting of the crop from these can also serve as pruning of the host during April–May in order to cut down the cost of cultivation. This study has been concluded. It was found that harvesting can profitably be utilised to serve as pruning also and that the maximum yield of sticklac is obtained if the crop is harvested as *ari* between 15th and 20th April.

In the case of a similar experiment during October–November and using different rates of broodlac for inoculation, the highest yield of broodlac as well as sticklac was obtained from trees inoculated at the rate of 200 g per tree when harvested in October. Further, it was also confirmed that a lighter inoculation (100 g per tree) is preferable if only brood production is desired, since the ratio of broodlac used to broodlac obtained is higher at this rate. This study has also been concluded.

The study towards evolution of improved cultivation practices for *palas* in comparison with the methods adopted by villagers in hot areas was also completed.

This experiment was carried out on a large scale. It was observed that adoption of the villagers' method is disadvantageous since sufficient broodlac is not produced. It was again established that, for broodlac multiplication, a light inoculation, at 100 g per tree, in October–November and complete harvesting in the following October–November is preferable. For sticklac production, higher rates of brood (300–400 g per tree) may be used.

The study to determine how early, before larval emergence, broodlac can be safely harvested from *palas* for despatch to distant places was continued. As in the previous year, emergence of larvae was observed from broodlac harvested up to 2 weeks prior to larval emergence and lac crops developed from these. Sticklac yield, however, declined with increase in the period of the advance cutting. No emergence took place from broodlac harvested earlier than two weeks.

(b) **On** *ber*. In an identical experiment with the same object regarding broodlac from *ber*, lac crop was obtained from broodlac cut only one week prior to larval emergence and not earlier. Here also, the yield of sticklac was more in the crop from broodlac harvested at the time of larval emergence than from the one harvested one week before.

Study of the relative merits of broodlacs from *ber* and *palas* was taken up during this year. The idea was to find out the suitability of these for use on either of the hosts for the *Baisakhi* and *Katki* crops since it had been found earlier that *palas* broodlac was suitable for *Baisakhi* on *palas* and *ber* broodlac for *Katki* on *ber* only. The respective hosts have been given first inoculations.

(c) **On** *bhalia*. During the year, fresh transplanting of approximately 3,200 saplings were carried out. The work will be taken up when the plants attain suitable age.

2. Evolution of cultivation practices

Evolution of newer cultivation techniques are being attempted to maximise yield with simultaneous reduction in the cost of cultivation on *Kusum*. Two new schedules (A and B), namely, allowing the trees one and two years' rest before inoculation and harvesting the crop after every second season are being examined in comparison with the current method (C) of harvesting in every season. Higher crop ratios have been obtained in both A and B than in C in both the crops harvested during the year.

3. Arboricultural studies

Experiments were continued to determine the optimum spacing for *bhalia* bushes for lac cultivation on plantation basis. Three spacings were investigated, namely, 1.83×1.83 m, 1.83×1.22 m and 1.22×1.22 m. A spacing of 1.22×1.22 m was found to be the best. With this spacing, yield of sticklac worked out to 156 kg per acre.

The effect of manuring of *bhalia* with organic and inorganic manures was also studied. It was found that the yield of lac increased by 100 and 142 per cent in the *Aghani* and *Jethwi* crops respectively when farmyard manure was applied at the rate of 36 quintals per acre. The corresponding increases were 50 and 80 per cent when 36 kg N, 40 kg P and 40 kg K were applied as ammonium sulphate, superphosphate and muriate of potash, respectively.

Studies were continued to train the conventional hosts into bushes for reducing the cost of lac cultivation and providing agronomical treatments for maximising yield. Suitability of these bushes for lac cultivation on plantation basis was also studied. *Galwang* and *ber* had been successfully trained earlier and lac was grown on these. A few *palas*, which were since trained into bushes, were also used for raising lac. It was found that yield of lac on *palas* bushes in *Baisakhi* was higher than in *Katki*. Results of two successive *Katki* crops also indicated that *palas* bushes are not suitable for *Katki* crop.

Ber bushes showed a better result during *Katki* this year than last year.

Galwang bushes, which are being used for *Baisakhi* in alternation with *ber* for *Katki*, also showed a better result this year than the previous year.

Experiments were continued for finding out alternate hosts for raising *Kusmi* lac. One experiment has been concluded in which it was confirmed that *Kusmi* lac can be successfully produced on *galwang* during *Jethwi* crop and alternated with *bhalia* for the *Aghani*. The average crop ratios from these two hosts in the respective crops were comparable to that from *kusum* itself.

The other alternates studied were *galwang* and *sandan*. They were satisfactory for the *Jethwi* crop in alternation with *kusum* in the *Aghani*. They were, however, not satisfactory as an alternative for *kusum* for both the crops.

4. Physiological studies

The study of the amino acids and sugar contents of the lac insect body at different stages of the insect's development was resumed in November with the start of *Baisakhi* season. Chromatograms were developed from the material collected from the early stages. Five to six spots were detected which are yet to be identified.

For determining the effect of host plant differences on the size, fecundity and resin secretion efficiency of the lac insect, work was initiated, again in November. Five *Rangeeni* hosts were inoculated for the purpose.

5. Genetical studies

The two new studies initiated last year were continued.

In one, namely, evolution of a high quality strain for cultivation on *palas*, the *Kusmi* strain of insects is being successively developed on this more abundantly available host. The second and third generations developed and matured according to *Kusmi* schedule and producing a *Kusmi* type encrustation. The progeny was in its fourth generation during the year, in which nearly 300 females were surviving till the end of December. Survival rates had improved.

In the other study, namely, pleiotropic effects of yellow gene, yellow females mated to crimson males produced yellow F_1 which turned crimson in their immature stages. These were used to raise a large F_2 generation.

6. Biological and ecological studies

Life history studies of the pests of host trees were continued. Studies on two of these were completed.

Survey of enemies of lac insect and their parasites was continued in all the four crops during the year on four different hosts. In *Aghani* 1966–67 crop on *kusum*, parasites emerged in larger numbers than predators from samples collected towards maturity. Emergence of predators was more in the crop from *bhalia* than from *kusum*. The same trend was observed in *Aghani* 1967–68 crop. In the *Baisakhi* crops on *galwang* and *palas*, emergence of predators was steady from the eighth fortnight onwards and increased towards maturity of the crop. The parasites, however, mostly emerged during the latter part of the crop. The predators were maximum in *Katki* crop and the largest number emerged from August to November.

With regard to incidence of *E. amabilis* and *H. pulverea* on lac crops raised on *bhalia*, incidence was less in *Jethwi* than in *Aghani* though natural mortality of lac insects was higher in the former. The incidence increased six weeks after male emergence in both the crops and attack by *H. pulverea* was more prominent. The peak of incidence of both the predators was from September onwards.

7. Biological control of lac enemies

Field-scale trials with *Bacillus thuringensis* for the control of predators were continued. Predators were practically absent in all lac samples from sprayed crops. The yield of sticklac also improved substantially. The spraying, however, had no effect on Hymenopterous insects. In the laboratory, effectiveness of the thuricide was found to decrease with the age of the predators.

With regard to the survey of pathogenic organisms, it was found that *E. amabilis* was more susceptible to the attack of polyhedrosis and cocci infection than *H. pulverea*. Infection by the latter was also more frequent.

8. Chemical control

Stomach poisons (cryolite and sodium fluosilicate) were sprayed on lac developing on *bhalia* during *Aghani* 1966–67 and *Jethwi*. They were effective in reducing incidence of predators by 50–60 per cent but not parasites. Dieldrex was somewhat effective against both preadators and parasites.

9. Micro-biological studies

Micro-biological studies on lac insects were taken up in July. So far, six micro-organisms have been isolated of which pure cultures are being maintained. These are yet to be identified.

10. Regional Field Research Station

The routine problems under investigation were continued at Damoh and Mirzapur on the local host *ghont* in addition to *palas*. At both centres, the different crops raised either failed or were too poor to justify any inference. During the year, the Field Station from Umaria was shifted to Dharamjaigarh where the experiments have been laid out and the trees were pruned according to schedule.

A survey was also carried out of the various insects associated with lac in both the crops of all the Stations.

11. Ad-hoc studies

The study of the effect of herbicides was again taken up in the Institute plantation during the monsoon. Among the various herbicides used, Spontox and Varitox were found to be effective against herbs and undershrubs, and Stam F-34 against grasses.

Chemistry Division

The research in the Chemistry Division had embraced all aspects of interest

to the processing, standardising and utilisation of lac and its by-products as well as fundamental chemical and physico-chemical studies in order to understand the constitution and behaviour of lac to facilitate its further modification in order to enhance its properties. The following summary is arranged serially in the same order as the main report.

Researches completed

1. Urea, one of the most efficient and cheapest accelerators for shellac, is a retarder when used in large proportions. The material obtained by heating shellac with a third of its weight of urea at 165 °C for 2 hours was found to be slightly inferior to the parent lac in respect of properties of the air-dried films. Baked films, however, had better elasticity and water resistance.

2. Steam distillation of a caustic soda solution of seedlac and shellac has been found to be a simple and dependable scientific method to differentiate between *Kusmi* and *Rangeeni* lacs. Turbid distillates are obtained with the former whereas *Rangeeni* lacs give clear distillates.

3. Shellac varnishes modified with unsaturated polyesters in aqueous ammonia were pigmented with titanium dioxide. Hardness was found satisfactory, gloss moderate but flexibility was poor.

4. A water-thinned red oxide primer had been formulated last year based entirely on indigenous raw materials, namely, shellac, linseed oil fatty acids and glycerine. This was further tested for anticorrosive properties and natural weathering which were all found quite satisfactory.

Researches in hand

1. (a) Three solvent systems were evolved which gave good resolution of various samples of shellac and seedlac of different types and grades by thin layer chromatography. Such resolutions indicated that the chemical nature of lac resin is independent of the host plant and strain of the insect and that the resin does not undergo any appreciable chemical change during the processing of seedlac into shellac by heat or solvent process.

(b) As a result of further studies on the mixed esters of hydrolysed soft resin using various techniques of chromatography, a few constituent acids were isolated. Three of these have been identified as *w*-hydroxypalmitic and *w*-hydroxypalmitoleic acids and an isomer of aleuritic acid.

(c) It was established that phosphoric acid also acts as catalyst for the esterification of lac with alcohols and that during esterification with ethyl, butyl and allyl alcohols also, alcoholysis takes place like in the case of methyl alcohol reported last year.

2. Shellac was grafted/copolymerised with a mixture of three monomers, namely, ethyl acrylate to impart flow, styrene for hardness and acrylamide to serve as a cross linking agent. It was found that a total of 60 per cent of the monomers on the weight of lac gave the best film properties in respect of flexibility and impact resistance and that acrylonitrile could replace styrene to produce films of the same hardness.

3. (a) Fractions were obtained by the precipitation of 10 per cent alcoholic solutions of lac with varying amounts of aqueous 1 per cent sodium chloride solution. Air-dried films of these fractions were remarkably water resistant and superior to the parent lac in this respect.

(b) An improvement has been affected in the preparation of total hydrolysed lac. The slight excess of sulphuric acid left after neutralisation of lac hydrolysate could be removed by treatment with calcium carbonate. The samples thus obtained were entirely free from mineral acid and had properties similar to those obtained by passing through cation exchange resin.

(c) An improvement was also effected in the recovery of wax from the sludge obtained by treatment of lac factory wash water with mineral acid. It was established that if the sludge was stirred in the solvent at 60°C for 10 minutes, the recovery was almost complete in three extractions as against nine by the earlier technique.

(d) An easy method has been standardised for the recovery of all the lac dye present in sticklac wash water. It was also determined that lac dye is present in *ari* to the extent of 1.1, 1.16 and 0.82 and in *phunki* 0.93, 0.91 and 0.5 per cent, of *palas*, *ber* and *kusum* sticklacs, respectively.

(e) A method has been worked out for the recovery of both lac and wax (up to 50 per cent) from autoclave *kiri*.

4. Erythrolaccin, the colouring matter of seedlac, has been found to rupture on treatment with sodium hypochlorite under the same conditions as of lac bleaching. The degradation products were acidic in nature and gave four spots on paper chromatography.

5. Specific heat of lac, which is known to fall with progressive period of storage, is being investigated as a possible means to determine the age of seedlac. The values, determined for six samples, dropped by 13–20 per cent after 36 months storage but there was no further change after another six months.

6. (a) The defect of thinning with time observed in the case of anticorrosive water-thinned red oxide primer was overcome by modifying the method of blending. The modified primer has been found satisfactory by a leading paint manufacturer and to satisfy Indian Standard Specification for anticorrosive primers.

(b) A composition for water-soluble wood finish was formulated from sulphited lac solution and trimethoxytrimethylol melamine resin. It produced, on wood surface, a hard, smooth and glossy finish with better heat and water resistance than shellac. This composition, however, showed a tendency to gell after 24 hours. Consequently, it can only be a two-pack system.

7. It has been determined that for curing shellac/synthetic rubber combinations, MBTS/TMTD combination is better as accelerator than MBT or CBS. The incorporation of clay (as the filler) up to 5 parts per 100 parts of the rubber further improved most of the desirable properties of the rubber.

8. (i) Glycerol monoallyl ether was used as a common solvent to dissolve both shellac and styrene or methyl methacrylate in order to produce a "solventless" coating by polymerisation with redox system. It was found that the ether failed

to take part in the polymerisation in the presence of benzoyl peroxide and dimethyl aniline. Its replacement with ethyl alcohol, on the other hand, and similar treatment resulted in a cloudy solution which could be clarified with toluene but the films prepared from it were translucent.

(ii) The possibility of improving the performance of shellac linseed oil combinations modified with polyisocyanate was investigated. It was found that when the unwashed glycerides were combined with shellac and treated with the requisite amount of diisocyanate, the films produced possessed excellent hardness, gloss, elasticity and resistance to water and alkalies.

(iii) Shellac ethyl ester has been prepared for further modification. The ester produced had a low hydroxyl value and long life under heat.

(iv) Shellac allyl ether/ester also was modified by treatment with toluene diisocyanate in toluene or methyl isobutyl ketone solution and this also produced hard, glossy and alkali-resistant films. Addition of cobalt naphthenate as a drier detracted the gloss.

(v) The copolymerisation of shellac allyl ether-ester with methyl methacrylate or styrene in the presence of redox system was also attempted but the films were found soft after curing at room temperature and even on baking.

(vi) As zinc is an imported item, the possibility of using, in shellac etch primers, alternate chromate pigments produced from indigenous raw materials was investigated. It was found that replacing zinc chromate with barium chromate, etch primers could be obtained having the same performance as the standard etch primer, the optimum proportion being 120 parts of this pigment for every 100 parts of lac.

(vii) Tin plate containers coated with shellac urea resin varnishes and baked at 150°C for 30 minutes were found to store shellac varnishes very satisfactorily up to 2 years without any change in properties and performance of the varnishes or the coating.

(viii) The nature of the chemical reaction taking place during film formation of dewaxed lac varnishes modified with spirit soluble melamine resin has been investigated. A polycondensation type of reaction appears to take place between the methylol group of the melamine resin and the carboxyl group of shellac.

9. Application of aqueous ammoniacal solution of shellac, paints and varnishes were carried out by the latest electrodeposition technique. The optimum concentration of lac, pH and voltage (DC) were found to be 15 per cent, 8.5 and 40–100, respectively. A fairly good and uniform film could be deposited in two minutes at 35°–40°C using a current of 40 amperes per square meter. It was also observed that triethanolamine is much better than ammonia and particularly for pigmented compositions.

10. (i) (a) Non-woven jute fabric impregnated with lac/cashewnut shell oil liquid modified with urea and formaldehyde and pressed hot was found to resist battery acid but lacked the necessary quick wettability.

(b) Glass wool felt similarly treated also possessed adequate resistance to battery acid.

(ii) This varnish was coated on hessian. The coating was resistant to water and heat up to 150°C indicating possible use of such coated bags for packaging of cement and other moisture sensitive materials.

(iii) Jute non-woven fabric sheets, impregnated with dewaxed lac varnish modified with melamine resin, were pressed into boards and were found to remain unaffected on immersion in water for 24 hours, indicating possible use of the fabrics for boxes and containers.

(iv) Attempts were made to impregnate jute felt with various modified shellacs for use as floor tiles. The resulting tiles were found to swell in contact with water but improved considerably on baking at 100°C for one hour.

(v) A satisfactory insulating composition for use in cable joints, as a substitute for PVC lacquers, was prepared and supplied to the technical experts of a Coal Washery.

(vi) The possibility of using hydrolysed lac to develop a shellac bond powder used in the manufacture of micanite was investigated. The composition, however, did not give good adhesion to mica splittings.

(vii) A suitable water-proof ink for marking on hessian and crates was developed and sample supplied to an interested party on request.

(viii) Lac was modified by treatment of its solution in methyl and ethyl alcohols with concentrated sulphuric acid under different conditions. The modified lacs had softening and melting points about 70°–100°C higher than those of the parent lac and much shorter life under heat.

(ix) The possibility of using lac and modified lac as binder for solid rocket fuels was investigated. Compositions based on copolymers of shellac esters and methyl methacrylate were also studied and information passed on to the workers at the Birla Institute of Technology for testing with oxidisers.

VI. Appendices

APPENDIX I

SPONSORED RESEARCH SCHEMES

1. Constitution of lac

(a) **At Delhi University.** A study of thin layer chromatographic behaviour of different aleuritic acid derivatives was carried out as a preliminary step to the investigation of some oxidation products of the resin. For this purpose, a number of derivatives of aleuritic and 9:10 dihydroxy hexadecane 1:16 dioic acids were prepared from both *threo* and *erythro* isomers. Their TLC separation was successfully carried out.

The vicinal dibromo (9:10) compounds of the isomeric aleuritic acids after debromination were examined by TLC and IR studies and found to be a mixture of *cis*- and *trans*-isomers.

It appeared that bromination was not stereospecific. Hence, the earlier reports of the synthesis of pure *cis*- and *trans*-civetones as well as the *cis*- and *trans*-ambrettolides might actually be mixtures of both the isomers.

(b) **At National Chemical Laboratory, Poona.** In an earlier report, a tentative picture of the molar ratios of the components obtained during the oxidative degradation of pure fraction was put forth. Out of the unidentified portion (2.2 mols in 9 mols) a compound (0.89 mol), terpenic in nature, was isolated in the pure state (m. p. 93–94°C) and its structure has been finalised. In the total esters of hydrolysed fraction F_8 another compound of the same series is suspected and its isolation is in progress.

Since identity of the keto aleuritate obtained from oxidised hydrolysed pure fraction has been established through its diacetate by preparing authentic sample and from their mixed GLC, the third mol of aleuritic acid in the pure fraction has now been accounted for.

From the oxidative-degradation experiments it may be said that in the majority of cases jalaric acid in the lac molecule is linked to other molecules through its secondary hydroxyl group. It has already been suggested that one aleuritic acid molecule and two jalaric acid molecules form a basic unit. This together with the experimental evidence that after oxidation of pure fraction, pimelic acid (2 mols) was obtained, suggests that in pure fraction molecule two aleuritic acid mols are esterified with secondary hydroxyl group of the terpenic acid.

According to the above findings, condensation reactions were planned and considerable progress was made in obtaining condensation products from (i) *epi*-shellolate and triacetyl aleuritic acid and (ii) *epi*shellolic acid and triacetyl aleuritic acid. An ester in which the latter is linked to the secondary hydroxyl group of

*epi*shellolic acid was isolated. These experiments would form the basis for preparing similar condensation products from jalaric and aleuritic acids.

2. Lac dye scheme at National Chemical Laboratory, Poona

(a) **Desoxyerythrolaccin.** Erythrolaccin, the main pigment of seedlac has been found to be accompanied by desoxyerythrolaccin and *iso*erythrolaccin which have been isolated from jalari sticklac in an yield of 0.02 and 0.003 per cent, respectively.

The ether soluble portion of seedlac was successively extracted with hexane and benzene to remove waxes. The residue was shaken with cold ethanol, the ethanol extract concentrated and diluted with water when erythrolaccin separated. The filtrate was evaporated and the residue submitted to column chromatography on polycaprolactam powder, using ethanol-formic acid-water (8.5 : 0.5 : 1.0) as solvent. The fast-moving band gave desoxyerythrolaccin which was followed by *iso*erythrolaccin and erythrolaccin. Desoxyerythrolaccin crystallised in orange needles (dec. above 300°C) from methanol and had the molecular formula $C_{15}H_{10}O_5$ (mass spectral *M* and elemental analysis), max 1965 and 1631 cm^{-1}, corresponding to non-bonded and bonded carbonyl groups. It gave a triacetate, m.p. 172°C, and a trimethyl ether, m.p. 205°C. Methylation with diazomethane in dry ether gave a dimethyl ether, m.p. 208°C, indicating that two hydroxyl groups are in β-position. The NMR data leads to structure I for desoxyerythrolaccin which was confirmed by synthesis.

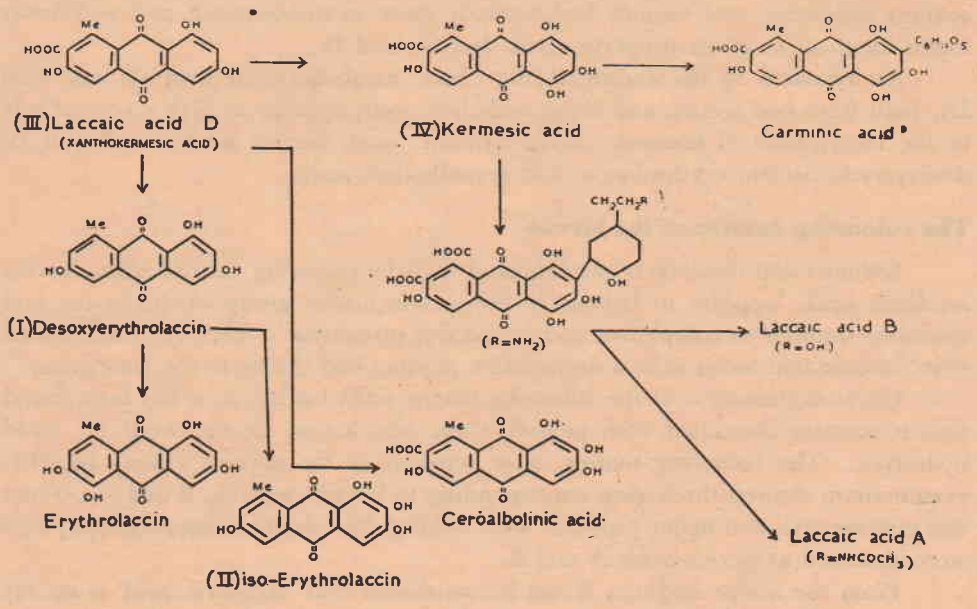
(b) **Isoerythrolaccin.** Isoerythrolaccin was crystallised from methanol in orange needles (dec. above 320°C). It formed a tetra-methyl ether, m.p. 174°–176°C, and had the molecular formula $C_{15}H_{10}O_6$. The NMR data and other considerations made it clear that isoerythrolaccin has the structure II which was confirmed by synthesis.

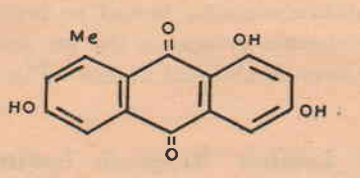
(c) **Laccaic acid D.** Evidence for the structure of laccaic acids A and B have been presented earlier from *Rangeeni* sticklac. Laccaic acid D has been now isolated. An acetone solution of laccaic acid was passed through a short column of silica gel, and a fast-moving yellow band was eluted with the same solvent. Removal of the solvent and crystallisation from water gave yellow needles (dec. above 300°C). Laccaic acid D, $C_{16}H_{10}O_7$ (*M* 314, mass spectrum), exhibits colour reactions and other properties characteristic of hydroxyanthraquinone carboxylic acid. Methylation yielded an ether-ester, m.p. 226°C with the molecular formula $C_{20}H_{18}O_7$ (*M* 370).

The NMR and available data suggested two possible structures III or the isomer with the B-ring hydroxyl groups in the 5,7-positions; but the structure III is supported by the acetate route of biosynthesis, and has been confirmed by unequivocal chemical evidence. Decarboxylation by refluxing with diethylaniline for two hours gave a compound identical in all properties with desoxyerythrolaccin; the two trimethyl ethers were also identical.

In view of the similarity of the lac pigments with kermesic acid (the pigment of kermes, a dye of very great antiquity), the structure of kermesic acid was examined

BIOSYNTHESIS OF SOME INSECT PIGMENTS DERIVED FROM ANTHRAQUINONE





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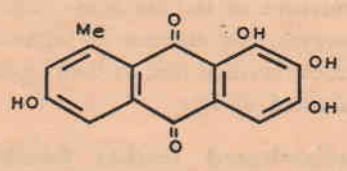

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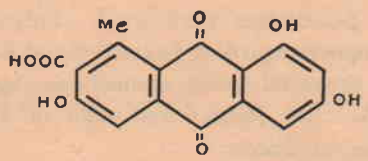
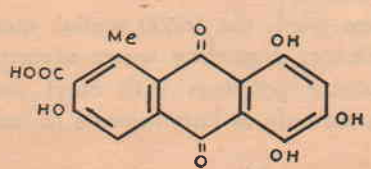


III



IV

and has now been shown to have the structure IV. On reduction with aqueous sodium dithionite and sodium hydroxide it gave xanthokermesic acid which was found identical in all its properties with laccaic acid D.

As indicated in the accompanying chart, xanthokermesic acid (laccaic acid D), built from one acetate and seven malonate units, appears to play a central role in the biosynthesis of kermesic acid, carminic acid, laccaic acids A, B and D, desoxyerythrolaccin, erythrolaccin and ceroalbolinic acid.

The colouring matter of lac larvae

Seshadri and co-workers have claimed that the colouring matters of lac larvae, lacciferic acid, 'appears to belong to the ommochrome group of pigments and resembles ommins in complexity and in spectral properties.' They have also stated that "laccaic acid seems to be a degradation product and belong to the same group".

On re-examination of the colouring matter from lac larvae it has been found that it remains associated with peptide chain which may be removed by acid hydrolysis. The colouring matter, after removal of the peptide chain, on TLC examination, showed three spots corresponding to laccaic acids A, B and C. From this mixture, the two major products were isolated by column chromatography and were identified as laccaic acids A and B.

From the above findings, it can be concluded that 'lacciferic acid' is merely a mixture of laccaic acids, which are hydroxyanthraquinones, bound to protein. However, the absence of pigments of the ommochrome groups in the lac insects cannot be ruled out, as their presence has already been established in most of insects examined so far.

Shellac-based leather finishes at Central Leather Research Institute, Madras

(a) **Use of lac products for leather finishing.** Work was carried out to improve the production of top dress MS, MSS and wax emulsions. To improve the quality of top dress MS, plasticizers were tried. Polyethylene glycol (10–15 per cent) gave the best performance regarding flexibility and fastness to wet rubbing. Shellac wax emulsions were prepared using emulsifying agents like sulphotan, Calsoline oil H.S., Noigen L.A. 120, Jadinol and white oil W.S. All but Noigen L.A. 120 gave reasonably stable emulsions.

(b) **Shellac copolymerisation with acrylic monomers.** Copolymerisation of bisulphite lac, sulphite lac, borax lac, ammoniacal lac and triethanolamine lac with methyl acrylate was tried. Copolymers from lac triethanolamine and methyl acrylate were found to be the most suitable for leather finishing having high storage stability, stability towards mechanical agitation and the films having good elasticity and moderate water resistance.

Of the various compositions tried, the 50:50 shellac methyl acrylate modification was found to be satisfactory regarding water absorption and finishing characteristics. Lac triethanolamine polymers with ethyl and butyl acrylates gave soft resin which could be used only as bottom-coats in leather finishing.

(c) **Lac retanning agent.** The retanning potency of lac was tested by treating chromed hide powder with 10 per cent of hydrolysed lac and borax-seedlac solutions and it was observed that the tanning potency increased with increasing amounts of chrome present. Lac retanned cycle saddle leather was found to harden on moulding. Rechroming (with 20 per cent Cr_2O_2) reduced the hardness. Pretreatment with syntan pN, however, improved the lac retanned upper leathers due to better penetration of lac.

It was further observed that lac retannage improved the tightness of nap, filled the loose portions increasing the fullness and cutting values, and did not affect the dyeing properties of full chrome, semichrome and glace kid leathers.

Lac impregnated chrome split leathers could be stiffened and hardened by heat treatment. Therefore, these leathers could be moulded into shoe stiffeners and are expected to be more durable than conventional ones.

Since the lac retanned chrome leathers were found more resistant towards tongue tear, stitch tear and bursting strength, their use for foot ball leathers are indicated.

Manufacture of suede leathers from semi- and full-chrome goat and sheep skins

The suede leathers were retanned under various conditions, and it was observed that skins retanned with lac after fatliquoring gives softer skins than those retanned before fatliquoring. Leathers treated with 3 per cent lac were found more suitable for suede garment leather while 4 and 5 per cent lac treated ones were much heavier and hence suitable for shoe upper leathers. These leathers could be dyed in different shades suggesting that lac retanning does not interfere much in dyeing.

APPENDIX II

METEOROLOGICAL REPORT FOR THE YEAR 1967

The average meteorological data for each month during the year were as follows :

Month	Mean Barometric pressure (mm)	Mean wind speed (Km/hr)	Mean maximum temp.(°C)	Mean minimum temp.(°C)	Mean dry bulb temp.(°C)	Mean humidity (%)	Mean sunshine (hrs/day)	Total rainfall (mm)	Highest maximum temp. (°C)	Lowest minimum temp. (°C)
January	708.0	0.57	24.5	9.3	20.2	58.0	6.85	20.06	28.7	6.0
February	706.7	1.73	29.0	11.7	24.4	45.0	9.08	4.32	35.5	5.3
March	706.1	2.02	30.0	15.7	25.6	55.0	7.04	57.66	34.0	11.0
April	703.5	2.58	34.9	20.0	31.1	44.0	8.50	41.66	39.3	16.0
May	700.0	2.39	38.1	23.1	34.0	47.0	9.26	73.66	41.5	19.5
June	697.6	2.14	37.0	24.9	32.8	59.0	5.88	54.10	42.2	21.0
July	697.4	1.90	30.6	23.1	29.4	73.0	4.20	372.38	34.5	22.0
August	697.2	0.94	28.8	22.8	26.1	89.0	2.30	484.12	31.0	21.0
September	700.3	1.45	29.6	22.1	27.3	80.5	4.93	311.37	32.0	19.5
October	705.6	0.60	29.9	16.6	27.4	84.5	8.40	28.70	32.6	12.5
November	708.1	1.10	27.2	11.5	24.7	54.0	8.76	Nil	29.5	8.5
December	708.5	0.87	25.2	12.2	22.7	68.0	6.20	39.62	27.5	8.0

The highest maximum temperature recorded was 42.20°C on 4th June and the lowest minimum 5.3°C on 2nd February. The total rainfall during the year amounted to 1,487.65 mm of which the monsoon (June–Sept.) rainfall was 1221.97 mm. The rainfall during the year was higher than that of 1966 (1,360 mm). The highest windspeed recorded during the year was 177.8 km/day on 8th July and lowest 0.2 km/day on 23rd August. There were hailstorms on 14th March and 23rd April.

APPENDIX III (PERSONNEL)

Statement showing appointments, promotions, resignations, retirements, etc., during January–December, 1967

Division/Section	Name	Post to which appointed	Date
1	2	3	4
A. Appointments			
Entomology Division	1. Shri Madhusudan Prasad	Research Assistant	3-10-1967
	2. ,, Mritunjay Mishra	—do—	16-11-1967
	3. ,, B.P. Sah	Fieldman	7-8-1967
	4. ,, R.C. Singh	Lab. Asstt.	7-8-1967
	5. ,, K. Divakaran	Steno-typist	18-2-1967
	6. ,, Jharia Pahan	Field Chowkidar	21-6-1967
Chemistry Division	1. ,, D.K. Guha Sircar	Research Sp.	21-10-1967
	2. ,, Ashis Das Gupta	—do—	22-10-1967
	3. ,, R.N. Pandey	—do—	22-10-1967
	4. ,, K.B. Lal	—do—	20-11-1967
	5. ,, M.K. Singh	Lab. Assistant	7-8-1967
Administrative Section	1. ,, M.P. Potty	Lower Division Clerk	14-3-1967
	2. ,, C.V. Joseph	,,	15-3-1967
	3. ,, K.N. Sinha	,,	15-3-1967
	4. ,, A.S. Prasad	,,	18-3-1967
	5. ,, R.B. Pradhan	,,	29-3-1967
	6. ,, Sudarshan Ram	,,	10-4-1967
	7. ,, B.N. Samadar	Boiler Attendent	4-11-1967
B. Promotions			
Chemistry Division	1. ,, P.C. Gupta	Senior Research Assistant	19-9-1967
C. Resignations			
Entomology Division	1. ,, S.M. Kulkarni	Senior Research Assistant	4-3-1967
	2. ,, Madhusudan Prasad	Research Sp.	11-10-1967
D. Retirements			
Chemistry Division	1. ,, Birsa Oraon	Peon	1-7-1967
Admin. Section	1. ,, Md. Saheb Ali	Estate Care Taker	1-11-1967
E. Deaths			
Entomology Division	1. ,, Mukund Pahan	Field Chowkidar	11-7-1967

APPENDIX IV (STAFF POSITION)

Sl. No.	Name of the post	Sanctioned strength	Staff in position as on 31-12-1967
1.	Director	1	Dr. G.S. Misra
	Entomology Division		
2.	Entomologist	1	Dr. A. Bhattacharya
3.	Scientific Officer (Cultivation)	1	Shri B.P. Mehra
4.	Scientific Officer (Field Station)	1	Shri C.P. Malhotra
5.	Scientific Officer (Insect Genetics)	1	Shri N.S. Chauhan
6.	Scientific Officer (Arboriculture)	1	Vacant
7.	Scientific Officer (Physiology)	1	Vacant
8.	Scientific Officer (Biology)	1	Vacant
9.	Senior Research Assistants	8	1. Shri B.K. Purkayastha 2. ,, R.S. Gokulpure 3. ,, A.H. Naqvi 4. ,, N. Majumdar 5–8. Vacant
10.	Instructor	1	Vacant
11.	Research Assistants	16	1. Shri R.C. Misra 2. ,, P. Sen 3. ,, A.K. Sen 4. ,, Saligram choudhary 5. ,, U.P. Griyaghey 6. ,, B.N. Sah 7. ,, M.K. Chowdhury 8. ,, J.M. Das Gupta 9. ,, R.C. Maurya 10. ,, Mritunjay Misra 11–16. Vacant
		J.R.A's working against the vacancies of R.As.	
12.	Senior Artist-cum-Photographer	1	,, R.L. Singh
13.	Junior Artist-cum-Photographer	1	,, Pyare Das
14.	Junior Field Assistants	4	Vacant
15.	Steno-typist	1	,, K. Divakaran
16.	Fieldman	17	1. ,, A.C. Chatterjee 2. ,, S.N. Sharma 3. ,, H.R. Munda 4. ,, Sant Kumar 5. ,, R.K. Paul 6. ,, R.S. Maliya 7. ,, K.C. Jain 8. ,, Jawahar Lal 9. ,, B.D. Tiwary 10. ,, Shiv Sankar Prasad 11. ,, B.P. Shah 12-17. Vacant

17. Field, Plantation and Store Assistant	1	Shri G. Lakra
18. Insect Collection Tender	1	,, Md. Ali Ansari
19. Laboratory Assistants	10	1. Smt. N. Nandy 2. Shri Azmer Hussain 3. ,, K.L. Chowdhury 4. ,, D.D. Prasad 5. ,, G.K. Jha 6. ,, R.D. Pathak 7. ,, R.C. Singh 8-10. Vacant
20. Museum Assistant	1	Smt. Sati Guha
21. Laboratory Attendant	10	1. Shri Mani Mahto 2. ,, Jagarnath Oraon 2. ,, Dema Oraon 4. ,, Yakub Tirkey 5. ,, Md. Sharif 6. ,, Kamal Prasad 7. ,, S.K. Chatterjee 8. ,, H.N. Shukla 9. ,, Mohar Sahu 10. ,, Gendu Bowri

Chemistry Division

1. Senior Scientific Officer (Organic)	1	Shri Y. Sankaranarayanan
2. Senior Scientific Officer (Utilisation)	1	Dr. T. Bhowmik
3. Scientific Officer (Physical)	1	Dr. P.R. Bhattacharya
4. Scientific Officer (Applied)	1	Shri S.C. Sengupta
5. Scientific Officer (Decorative Coatings)	1	,, Shravan Kumar
6. Scientific Officer (Factory)	1	,, B.B. Khanna
7. Scientific Officer (Utilisation)	1	Vacant
8. Junior Scientific Officer	1	Shri P.K. Ghosh
9. Senior Research Assistants	6	1. Shri A.K. Ghose 2. ,, P.C. Ghose 3. ,, A. Kumar 4. ,, P.C. Gupta 5-6. Vacant
10. Research Assistants	17	1. Shri A. Rahman 2. ,, T. Sahu 3. ,, R.K. Banerjee 4. ,, S.K.M. Tripathi 5. ,, August Pandey 6. ,, M. Mukherjee 7. ,, Md. Islam 8. ,, S.C. Agarwal 9. ,, G.C. Sharma

		10. Shri D.K. Guha Sircar
		11. ,, Ashis Das Gupta
		12. ,, R.N. Pandey
		13. ,, K.B. Lal
		14-17. Vacant
11. Senior Analyst	2	Vacant
12. Analyst	3	1. Shri L.C. Mishra
		2. ,, B. Prasad Banerjee
		3. ,, R. Prasad
13. Junior Analyst	3	1. ,, B.C. Srivastava
		2 and 3. Vacant
14. Glass Blower	1	Shri S.K. Dey
15. Steno-typist	1	Shri P.N. Sivankutty
16. Laboratory Assistant	11	1. Shri Dominic Runda
		2. ,, N. Minz
		3. ,, G.M. Borkar
		4. ,, B.B. Chakraborty
		5. ,, Nagendra Mahto
		6. ,, U. Sahay
		7. ,, B. Majumdar
		8. ,, B.P. Keshri
		9. ,, M.K. Singh
		10-11. Vacant
17. Laboratory Attendant	10	1. Shri Masidas Minz
		2. ,, Siba Baraik
		3. ,, Mangta Oraon
		4. ,, Gopeswar Misra
		5. ,, P.B. Sen
		6. ,, Md. Ghaseet
		7. ,, Chinmoy Sengupta
		8. ,, Dukha Oraon
		9. ,, Chedilal
		10. ,, Ram Charita Tiwary

Administrative and Audit and Accounts Sections

1. Administrative Officer	1	Shri Uma Datta
2. Accounts Officer	1	,, H.N. Prasad
3. Superintendent	2	Shri K.K. Mustaufi
4. T.A. to Director	1	Vacant
5. Assistants	8	1. Shri S.K. Sirkar
		2. ,, L.M. Nandy
		3. ,, S.N. Sharma
		4. ,, S.N. Prasad
		5. ,, R.K. Singh
		6. ,, P.K. Chowdhury
		7. ,, R.N. Prasad
		8. Vacant

6. Librarian	1	Shri R.P. Indwar
7. Stenographer Grade I	1	Shri M.T. Rughani
8. Upper Division Clerk	6	1. Shri D.P. Sen Gupta 2. ,, H.S. Munda 3. ,, R.P. Singh 4-6. Vacant.
9. Store Keeper	1	Shri Enamul Haque
10. Lower Division Clerk	15	1. Smt. Sibani Pattadar 2. Shri Musafir Singh 3. ,, Samiullah 4. ,, A.K. Choudhury 5. ,, E. Tirkey 6. ,, A. Haque 7. ,, S.K.P. Keshri 8. ,, Rambaran Singh 9. ,, Kuldip Pandey 10. ,, M.P. Potty 11. ,, C.V. Joseph 12. ,, K.N. Sinha 13. ,, A.S. Prasad 14. ,, R.B. Pradhan 15. ,, Sudarshan Ram

Mechanical Section

1. Chief Mechanic	1	Shri K.N. Sinha
2. Assistant Mechanic	1	Vacant
3. Instrument Maker	1	Shri M. Kujur
4. Turner	1	,, A.S. Manoranjan
5. Boiler Attendant	1	,, B.N. Samadar
6. Tindal	1	,, Tulsi Ram
7. Gas Plant Attendant	1	,, Lachman Oraon

Estate

1. Estate Care Taker	1	Vacant
2. Labour Supervisor	1	Shri Dharam Nath Mahto

Medical Unit

1. Authorised Medical Attendant	1	Dr. S.S. Sahay
Compounder	1	Shri B.N. Munda