INDIAN LAC RESEARCH INSTITUTE
NAMKUM, RANCHI, BIHAR, INDIA

Annual Report
1969

INDIAN COUNCIL OF AGRICULTURAL RESEARCH
NEW DELHI
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1. INTRODUCTION

A brief historical introduction

The Indian Lac Research Institute came into existence as a result of the recommendation of an enquiry committee, comprising Mr. H. A. F. Lindsay and Mr. 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 Committeee was published in 1921 in which they observed, *inter alia*, that the two major ills from which 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 the time constituted themselves into a private registered body under the name of the 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 kilometres east of Ranchi. The laboratories of the Institute consist of three buildings housing the Chemistry Laboratory, the Entomology Laboratory and the Experimental Factory. The Institute Library adjoins the Entomology building. The Administrative Section and Museum are housed in another block. The waterworks, workshop, gas plant etc. are located in small constructions between the Chemistry and Entomology Laboratories. The Audit and Accounts Section and a unit of the Administrative Section are temporarily accommodated in two small rooms adjoining the workshop previously occupied by the Chemistry Division. There is a dearth of accommodation.

Apart from these, the Institute also has an adjoining plot of over 35 hectares for use as an experimental plantation. The total estate of the Institute at Namkum including the plantation covers an area of about 49 hectares. 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.

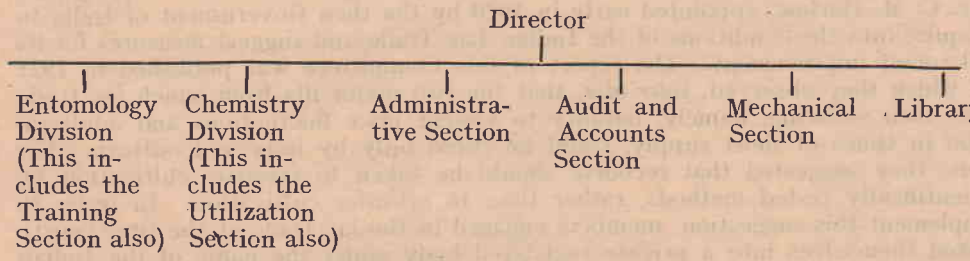
Objectives

The main objective of the Institute is to carry on research towards effecting improvements in the cultivation, processing, standardization 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.

Organizational structure

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



Achievements

Among the major achievements during the year in the field of lac cultivation may be mentioned the successful raising of *galwang* bushes from cuttings with the use of growth hormones. It may be recalled that this bush has already been shown to be a very promising host for a mixed plantation (with *bhalia*) for cultivation of the superior *Kusmi* variety of lac. The above observation is thus an important development, as apart from slashing the time required for raising such a plantation, the lac growing potentialities of the parent bush is also ensured in the plantation raised.

Another important finding is the presence of two additional amino acids in the body fluid of *Kusmi* strain of lac insects, in addition to the five found in *Rangeeni* strain. Valuable information has been obtained in the field of breeding and genetical studies of lac insects.

In the field of lac technology, the new process for the production of shellac directly from sticklac, preliminary experiments which had been reported last year, was standardised. This process eliminates all lac containing by-products and results in a 20 percent increase in the yield.

Library

The number of books and bound volumes of journals accessioned during the year was 697. This brought the total number of books and bound volumes of journals in the library as on 31st December, 1969 to 13407. One hundred and thirteen periodicals were subscribed in addition to a few received in exchange or as gift. Some miscellaneous publications and reports were also received.

The library also maintains an adequate stock of books and reprints of articles published by the Institute and by the erstwhile Indian Lac Cess Committee for sale/distribution to those interested.

Honours and awards

Shri C. P. Malhotra, Scientific Officer (Field Station) was awarded a Senior Fellowship of Indian Council of Agricultural Research with retrospective effect from October, 1967. Shri Malhotra is continuing his study there. Shri N. Majumdar, Senior Research Assistant (Entomology) was awarded a Junior Fellowship of the ICAR for his further studies at Kalyani University. He has returned and joined the Institute on 1st January 1970, after successfully completing his M.Sc. studies and securing a First Class First and gold medal. Shri A. Kumar, Senior Research Assistant (Chemistry) received a Senior Fellowship from Indian Association for the Cultivation of Science, Calcutta, for research in their laboratory. Shri Kumar has also returned on 20th July, after working for 12 months there.

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, delegates and other distinguished persons. This included among others:

(i) Mr. Golland, President, United States Shellac Importers Associations, New York.

(ii) Dr. R. C. Kaushik, President, Forest Research Institute, Dehradun.

(iii) Dr. J. S. Kanwar, Deputy Director General, Indian Council of Agricultural Research, New Delhi.

(iv) Shri S. K. Bagchi, Curator, Birla Museum of Science and Technology, Calcutta.

(v) Dr. N. A. Kachibaiya, Agricultural Experimental Station, Sukhumi, Georgia (Leader).

(vi) Mr. Y. K. Chekmenev, Lac Specialist, Senior Agronomist, USSR, Ministry of Agriculture and

(vii) Dr. Mrs. E. F. Kosarjevscaia, Interpreter,

(viii) Dr. Kalinin, Counsellor for Agricultural Affairs, Embassy of the USSR, New Delhi.

Research 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, study is in progress on the development of shellac based leather finishes at the Central Leather Research Institute, Madras under a separate scheme.

A scheme of co-operative research has been taken up with the National Metallurgical Laboratory, Jamshedpur for investigating the possibilities of shellac as binder for sand moulds and cores of Foundries.

Another scheme on "Constitution of lac dye" has just been completed in the National Chemical Laboratory on 31.3.1969.

The Institute continued to avail of the testing facilities so kindly provided by the Indian Institute of Technology, Kharagpur, for our work on shellac rubber combination as during the last three years. The Indian Agricultural Research Institute, New Delhi also helped in the irradiation of our seeds and lac samples in their laboratories by their own staff for our mutation studies.

Facilities were also sought for and obtained from the Agricultural Research Institute, Kanke, Ranchi and Jute Agricultural Research Institute, Barrackpur, Calcutta for agronomical studies on maize and wheat, and jute respectively with coated urea fertiliser.

The Institute is represented in the Lac Development Council of the Ministry of Food and Agriculture, Government of India, in the Shellac Export Promotion Council and various Technical Committees of the Indian Standards Institution. At the request of the Shellac Export Promotion Council, the Director of the Institute also served as Chairman of a Committee of the Council to review the minimum export prices for seedlac and shellac.

Research collaboration at international level

The Institute has also taken advantage of International Technical Co-operative Scheme to provide specialised knowledge to its employees. Six scientists of the Institute have so far been provided advanced training in various disciplines under the Colombo Plan, five in the United Kingdom and one in Canada.

Advisory Services

The Institute provides technical assistance to all those interested in the cultivation, processing, grading and utilisation of lac (see page 57).

The Institute also provides two courses of training of six months duration on (i) Improved methods of lac cultivation and (ii) industrial uses of lac. The training is usually given to deputees of Central and State Governments and Industrial undertakings. In addition, short term training on specific lines are also provided on request.

For the regular October 1969 to March 1970 session six candidates have joined for training in "Improved methods of lac cultivation" of whom four are from Purulia, West Bengal, and other two from Gaya and Patna, Bihar. Two more candidates, one from Bilaspur, Madhya Pradesh, and the other from Madras, Tamilnadu also joined for training in "Industrial Uses of Lac".

For the benefit of the trade and industry, the Institute also maintains Regional Analytical Laboratory in the major lac processing centres of the country. During the period under report, two laboratories were functioning. one at Namkum (Ranchi) and the other at Balarampur (Purulia District, West Bengal).

Finance

Since its inception, the Institute was being financed through a cess levied on all exports of lac. Since 1962-63, however, some grants were also received from the Govt. of India as the income from the cess was found inadequate. Since the takeover with effect from 1st April 1966, the Institute is being wholly financed by the Indian Council of Agricultural Research, New Delhi.

The revised budget estimates of the Institute for 1969-70 amounted to Rs. 11,67,000. The actual expenditure during the same period was, however, Rs. 12,03,861.85.

2. PROGRESS OF RESEARCH

(A) ENTOMOLOGY DIVISION

(Entomologist — Dr. A. Bhattacharya)

Work on the various problems continued as per Project Proposals submitted for the year 1969. The position as regards staff was perhaps the best so far as by November, the maximum number of staff was in position. Except, however, Shri C. P. Malhotra, Scientific Officer (Field Station) and Shri N. Majumdar, Senior Research Assistant both of whom were persuing their studies at Indian Agricultural Research Institute and Kalyani University, for their Ph.D. and M.Sc. courses respectively, a few posts of Senior Research Assistant remained vacant throughout the year. After many years, the climatic conditions in lac growing areas were normal and favourable and there was hardly any adverse effect on the production of lac. All studies on hand progressed smoothly.

Itemwise report of the various projects now follows in detail:

(a) RESEARCHES COMPLETED

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

To boost production of the better quality *Kusmi* lac, the possibility of adapting the superior *Kusmi* strain of lac insect to the more abundantly available host of otherwise little economic value, namely, *palas* was being examined since 1966. *Palas* trees were inoculated with *Kusmi* broodlac and the rare survivors of the insects were used to rear their subsequent generations on *palas* itself. The first culture, set up in February 1966, survived for four generations and, in the fifth, suffered almost complete mortality. Another culture, started a season later, was also carried through five generations before that also was lost due to complete mortality of the insects.

During the course of this study, it was observed that only a small number of these insects survive till maturity in each generation. The survivors however retained their *Kusmi* life periods throughout the successive generations, and produced resin of *Kusmi* characteristics. Their survival behaviour, however, was rather erratic through the successive generations, and differed particularly with their inoculation time and to a lesser extent from plant to plant in the same generation. Thus, earlier inoculations always showed better survival in the dry season (*Jethwi*) generation. As the inoculation time was delayed, the survival was adversely affected; inoculations after middle of March often resulted in total mortality of the insects. It was also observed that the growth rate of the insects was slightly slower on *palas* than on *kusum*, so that after four to five generations the time of emergence was delayed by about a month. This, appears to be the reason for the ultimate loss of cultures in the present studies. The survival differences in the same generation on individual plants are possibly due to differences in the physiological condition of the plants at the time of inoculation. It appears, therefore, that the inability of *palas* to sustain large colonies of *Kusmi* insects is because *palas* is possibly not in the right physiological state throughout their life periods. The *Rangeeni* strain of lac insects, on the other hand, appears to have adjusted itself to *palas* by having unequal spans of life in the two seasons to start and complete its life when *palas* is in a favourable physiological condition to support them.

Since, however, there is evidence to show that differences in the life periods and in the resin quality of *Rangeeni* and *Kusmi* strains of lac insects are of genetic origin, it would now be of considerable practical interest to see whether these differences are genetically independent of each other. If so, it should be possible to combine the *Rangeeni* life periods with the *Kusmi* resin characteristics through hybridisation of these insects. Work along these lines has now been taken up as a separate study.

(N. S. Chauhan)

2. Study of pleiotropic effect of the yellow gene

Economic evaluation of the first detected mutation in lac insects, namely yellow, was made by crossing yellow females to crimson males and raising a large F_2 to recover the two parental forms and then comparing their fecundity, life period and resin output. No significant difference was noted in any of these attributes.

(N.S. Chauhan)

3. Seasonal incidence and extent of damage caused by the predators, *Eublemma amabilis* and *Holcocera pulverea* on *Kusmi* lac grown on *bhalia*

The study had been carried out for three *Aghani* and three *Jethwi* seasons.

Twenty five random lac stick samples, each 10 cm. long, were collected at fortnightly interval from the time of male emergence till the time of crop maturity and examined for (i) Lac insect population including dead insects, (ii) incidence of predators, (iii) number of lac cells damaged or eaten up by the predators and (iv) area of lac encrustation damaged by the predators. The following conclusions have been arrived at:

(a) Incidence of the predators differs with the season, being higher in the *Aghani* than in the *Jethwi*.

(b) *E. amabilis* is most prevalent during September to December in the *Aghani* season and during June in the *Jethwi*, whereas the peak periods of *H. pulverea* are towards the time of crop maturity in *Aghani* and during June in *Jethwi*.

(c) *H. pulverea* causes more damage to lac crops than *E. amabilis*. The extent of damage caused by these two predators are as below:

Crop	Damage % of lac crop by	
	E. amabilis	*H. pulverea*
Aghani	7·42-26·78	13·78-27·01
Jethwi	0·18-7·86	0·38-19·75

(A. K. Sen and A. Bhattacharya)

4. Control of the predators by the use of *Bacillus thuringiensis* Berl

Preliminary experiments with *Bacillus thuringiensis* in the laboratory as well as in the field had indicated that larvae of *E. amabilis* and *H. pulverea* are highly susceptible to this bacterial insecticide. Trials were, therefore, continued in the

field to determine the optimum concentration of the thuricide, spray interval and the number of sprays required for effective control of these predators.

The schedules tried were 0·02, 0·04, 0·06, 0·12 and 0·25 per cent concentrations of the thuricide sprayed at 10, 20 and 30 day intervals and with varying number of total sprays under each. Incidence of the predators was determined by collecting random lac samples (300-500 g) from the treated and untreated crops at three stages in their development namely, after 2 sprayings, at the time of male emergence and 15 days before the time of crop maturity. These were caged separately in parasite cages and emergence of the insects noted.

These trials were conducted on both *Rangeeni* and *Kusmi* crops. It has been confirmed that *B. thuringiensis* offers an effective means of control for these predators. The control efficiency of the thuricide improved with concentrations. However, since the differences with doses higher than 0·06 per cent were not much, 0·06 per cent concentration of the thuricide sprayed at 10 days interval throughout the crop period appears to be the optimum control schedule. Under these conditions the predator population was reduced by 77·2 to 83·3 per cent which resulted in increasing the yield of lac by 81·6 to 92·5 per cent.

(S. G. Choudhary)

5. Control of the predators and parasites of *Kusmi* lac on *bhalia* by chemical sprays

The chemicals (insecticides) studied were cryolite, sodium flucosilicate, and Dieldrex. The spray schedules were cryolite and sodium fluosilicate both at 0·40 per cent concentration and Dieldrex at 0·25 per cent concentration sprayed at 10, 20 and 30 day intervals. Random lac samples (300 to 500 g) of both the treated and untreated crops were collected at the three different stages of their development described as above. These were caged separately in parasite cages and emergence of the various insects noted.

Cryolite and sodium fluosilicate were effective only against the predators, reducing their incidence by 42 to 62 per cent. Dieldrex reduced incidence of the predators by 15 to 40 per cent and was slightly effective against the parasites of lac insects as well.

(S. G. Choudhary)

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

The experiment has been in progress at Kundri since 1965 with the aim of determining how early, before the time of larval emergence, broodlac can be safely harvested from *palas*, if need be, for purposes of despatch to distant places.

Broodlac samples (2 kg each) were harvested at weekly intervals starting from 15th September upto the time of larval emergence on 16th October, 1969 and were used for inoculation of 10 trees with each sample.

Larval emergence was noted from the sample harvested upto three weeks earlier than the usual normal larval emergence, but crops including broodlac developed only in the cases of lots harvested two weeks or less before. It has been found that the broodlac can be safely harvested upto one week before the time of larval emergence and that earlier harvestings adversely affect the yield in the resulting crops.

(A. K. Sen and A. Bhattacharya)

(b) RESEARCHES ON HAND

LAC CULTIVATION STUDIES

1. Studies on the relative merits of *ber* and *palas* broodlacs for use on *ber* and *palas* hosts

This study has been in progress since November 1967 with a set of 5 trees each of *palas* and *ber* appropriately pruned and inoculated with *ber* broodlac and a second similar set with *palas* broodlac.

Palas broodlac gave a better yield of sticklac in the *Baisakhi* 1968-69 crop on both the hosts (vide Table 1). This is contrary to last year's result where *ber* broodlac gave better yield. On the other hand, the performance of *ber* broodlac was better than *palas* broodlac on both the hosts during *Katki* 1969 which is in conformity with last year's findings.

(A. H. Naqvi and B. P. Mehra)

2. Studies on proper time of harvesting-cum-coppicing *bhalia* (*Mohgania macrophylla*) with January-February

It has now been fairly established that *bhalia* does not sustain a normal crop through the summer months up to July (*Jethwi* crop) nor does it show proper growth after crop harvesting in July. A study was, therefore, initiated during 1968 to see if this bush can be used to raise a crop which can be harvested as *ari* in May or whether it will at least sustain a partial or light crop to brood stage in July.

The following four practices were therefore tried with different brood rates each on 20 bushes with 5 replications i.e. 150 bushes under each treatment: (A) Heavy inoculation with 400 g/bush and complete harvesting as *ari* in May, (B) Medium inoculation with 200 g/bush with partial harvesting as *ari* in May and complete harvesting in January/February next, (C) Medium-light inoculation with 100 g/bush and the rest as in (B) and (D) and light inoculation with 50 g/bush and complete harvesting after one year in January/February.

Inoculations were thus always made during Jan./Feb. Crop from A was harvested completely and those from B and C partially in May as per schedule. Rest of the crop in B and C and complete crop in D will be harvested in Jan./Feb. 1970, after which the full data will be reported for presenting a complete picture.

(J. Dasgupta and A. Bhattacharya)

3. Finding out alternative hosts for *Kusmi* and *Rangeeni* strains of lac insect and conducting cultivation experiments on them

(i) *For Kusmi strain*

Galwang (*Albizzia lucida*), *Sandan* (*Ougeinia oojeinensis*) and *Moghania chappar* were tried.

For alternation with *Kusum*, *galwang* continued to give the best results (Table 2) which confirms previous years findings. The other two were complete failures.

As an alternative to *kusum* also, *galwang* was better than the other two.

TABLE 1 — STUDIES ON THE RELATIVE MERITS OF BER AND PALAS BROODLACS

Broodlac used		Weight of scraped lac from broodlac used Kg	Crop studied	Host	Broodlac obtained Kg		Total scraped lac from broodlac obtained (col. 6 & 7) Kg	Yield of usable broodlac (col. 6) per kg. of broodlac used (col. 2) Kg	Yield of total scraped lac (col. 8) per kg of lac from broodlac used by (col. 3) Kg
Type	Quantity Kg				Usable	Reject			
1	2	3	4	5	6	7	8	9	10
Palas	5·0	1·220	*Basiakhi* 1968-69	*Palas*	16·900	5·300	4·165	3·38	3·41
do	5·0	1·190	do	*Ber*	3·000	16·900	2·430	0·60	2·01
Ber	5·0	1·270	do	do	Nil	15·500	2·050	0·00	1·77
do	5·0	1·260	do	*Palas*	15·400	4·000	3·500	3·08	2·77
Palas	5·0	1·110	*Katki* 1969	*Palas*	11·700	6·200	3·240	2·34	2·91
do	5·0	1·220	do	*Ber*	14·800	3·900	3·570	2·91	3·03
Ber	5·0	1·240	do	do	18·000	4·500	4·290	3·60	3·50
do	5·0	1·260	do	*Palas*	13·300	5·800	3·500	2·61	2·77

(ii) *For Rangeeni strain*

Studies in regard to the *Rangeeni* strain were initiated with the start of the *Baisakhi* 1968-69 season.

Albizzia richardiana, *siran* (*Albizzia chinensis*), *siris* (*Albizzia lebbek*), *putkal* (*Ficus glabella*) and *gular* (*Ficus racemosa*) were inoculated with both *ber* and *palas* broodlacs. *Putkal* and *gular* produced a poor crop while the others produced no crop at all.

For *Katki* 1969, *F. cunia* was also used. Only this host gave a satisfactory crop. The *Albizzia* species produced no crop at all while *putkal* and *gular* produced poor crops.

Pakur (*Ficus virans*) has also been included for trial for *Baisakhi* 1969-70. Only *F. cunia* is carrying a satisfactory crop.

(M. L. Bhagat and A. Bhattacharya)

TABLE 2 — PERFORMANCE OF OTHER HOSTS IN ALTERNATION VITH KUSUM

Crop year	Crop history	Brood-lac used kg.	Broodlac yield kg.		Yield of usable brood-lac per kg. broodlac used kg.	Sticklac		Brood to yield ratio (Col. 7:8)
			Usable	Total		Brood used kg.	Total yield kg.	
1	2	3	4	5	6	7	8	9
Aghani (1968-69	G(K×G×K) ×K×G	7·00	14·8	21·8	2·1	4·34	6·9	1·6
Jethwi 1969	K(G×K×G K×K×G×G	13·8	21·8	35·6	1·58	3·15	5·3	1·7
Jethwi 1969	S×K	8·00	0·0	8·0	0·0	4·2	1·5	0·03
Jethwi 1969	MC×K	5·00	0·0	5·00	0·0	2·70	0·8	0·08

G=*Galwang*; K=*Kusum*; S=*Sandan*; MC=*Moghania chappar.*

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

The study, which has been in progress since 1961, was continued, as hitherto, with the different practices described in Table 3. The study is intended to compare the practice of light inoculation made in Jan./Feb. and in June/July on shoots of different ages with the conventional practice of inoculating and harvesting in each season. The comparison is made of the crops obtained per *annum*,

i.e., of one crop each in A and B with two crops (which are each of six months duration) in C.

From the crop data for the year (Table 3), it was clear that much higher crop ratios (ratio of the weight of sticklac of the crop to that of broodlac used for inoculation) are obtained when the crops are harvested once a year after inoculation in June/July than by the conventional technique. But the results of similar treatment after Jan./Feb. inoculation was slightly different from previous years' results.

(A. Bhattacharya and J. Dasgupta)

5. Studies to ascertain the most appropriate time for harvesting *ber* broodlac for crop inoculation

In lac cultivation, it is important that broodlac is harvested at the most opportune time because early harvesting deprives the gravid mother insects of their food supply which can adversely affect their vitality and, consequently the progeny, while late harvesting results in loss of brood value because of loss of emerged larvae. Advance cutting is often necessary when the broodlac has to be transported to distant places. A study was, therefore, taken up in 1966 and has been in progress to determine how early prior to larval emergence, broodlac from *ber* can be harvested and will still be suitable for raising a subsequent crop.

A similar study in regard to *palas* has just been completed and is reported earlier in this volume (see page 7).

For the purpose, 5 kg lots of broodlac were harvested 3, 2 and 1 week before and at the time of larval emergence. Each lot so harvested was used for inoculating 5 trees.

Larval emergence took place from lots harvested 2 and 1 week before and at the time of larval emergence. However, only in the last two cases the insects survived till maturity and yielded broodlac. These results are slightly different from those of last year in that no larval emergence took place from the lot harvested 3 weeks before larval emergence.

(A. H. Naqvi and B. P. Mehra)

6. A comparative study of different techniques of lac cultivation on *Kusum* at Hesal

The study was started in 1968 at Maheshpur Sirka in collaboration with the Forest Department, Bihar, with a view to compare the new method of lac cultivation on *kusum*. The experiment which was to be conducted, could not be carried out there from January 1969 onwards due to certain technical difficulties faced by Forest Department. During the period under report, therefore, the same was shifted to Hesal and a proper layout was made and trees were grouped in required number of coupes for resuming the study. Preliminary inoculations were carried out on the available pruned trees for raising the *Aghani* 1969-70 crop. Pruning of other trees were also carried out according to schedule. All the trees will come under regular operation from July 1970 inoculation.

(M. K. Chowdhury and A. Bhattacharya)

TABLE 3 — CORP DATA OF DIFFERENT CULTIVATION PRACTICES STUDIED FOR *Kusum*

Treatment	Period of rest for the host Years	No. of coupes	No. of trees in each coupe	Broodlac rate used	Inoculation	Cultivation practice			Crop data	
						Self inoculation allowed	Harvesting	Period between initial inoculation and harvesting Months	Yield of sticklac Kg	Crop ratio
1	2	3	4	5	6	7	8	9	10	11
A_1	1	2	15	0·5N*	Jun/Jul	Jan/Feb	Jun/Jul	12	99·2	4·5
A_2	1	2	15	0·5N	Jan/Feb	Jun/Jul	Jan/Feb	12	53·15	2·02
B_1	2	3	15	0·67N	Jun/Jul	Jan/Feb	Jun/Jul	12	125·5	4·18
B_2	2	3	15	0·67N	Jan/Feb	Jun/Jul	Jan/Feb	12	38·25	0·9
C	1·5	4	15	N	Jan/Feb	—	Jun/Jul	6	100·7	1·04
(Control)					Jun/Jul	—	Jan/Feb	6	100·4	1·04

N*: Normal, which is 1 cm of broodlac per 12·5 cm of inoculable shoots.

AGRONOMICAL AND GENETICAL STUDIES ON LAC HOSTS

7. Studies on training of major lac hosts into bushes for cultivation of lac

The studies were conducted on four hosts, *ber*, *galwang*, *kusum* and *palas* in order to investigate the possibility of exploiting the trained bushes for lac cultivation with a view to reduce the cost of cultivation operations and to facilitate agronomical treatments to maximise yield of lac.

(a) *Training into bushes*

Ber and *galwang*, as reported earlier (*A. Rep.*, 1968, p. 14), had already been successfully trained and the bushes are under use for lac cultivation. Studies regarding *palas* and *kusum* are, however, continued.

Palas trees which were initially coppiced in February and April 1967, were again coppiced in March 1969. An average of 17 shoots of a total length of 1027·6 cm developed per plant by December.

Kusum

(i) In one set of trees, which was coppiced in January 1968 (initially coppiced in July 1966), the primaries did not show any additional or linear growth during the period but remained at 10·3 shoots and 583·3 cm per plant, as reported in 1968. However, the secondaries appeared in Feb./Mar. of the year under report and continued to grow till June, attaining a total length of 425·0 cm per plant. The plants were again coppiced in June.

(ii) In a second set, which was coppiced in July 1968 (initially coppiced in January 1967), the primaries showed the second phase of growth after February 1969 and attained a length of 495·5 cm by December. Some of the primaries gave rise to secondaries in March and attained an average length of 330·1 cm per plant by the end of December.

(iii) In a third set, which was coppiced in July of the current year for the third successive season (initially coppiced in July 1965 and again in July 1967), the shoots recorded, by December 1969, an average length of 563·2 cm per plant.

(b) *Lac cultivation on trained bushes*

Since *galwang* and *ber* are particularly suited for the dry and rainy season crops respectively, lac was grown alternately on *galwang* bushes in the *Baisakhi* season and *ber* bushes in the *Katki*. The average yield of sticklac from these bushes were 224·0 g from *galwang* and 256·0 g from *ber* per bush, which is in conformity with the previous years' results.

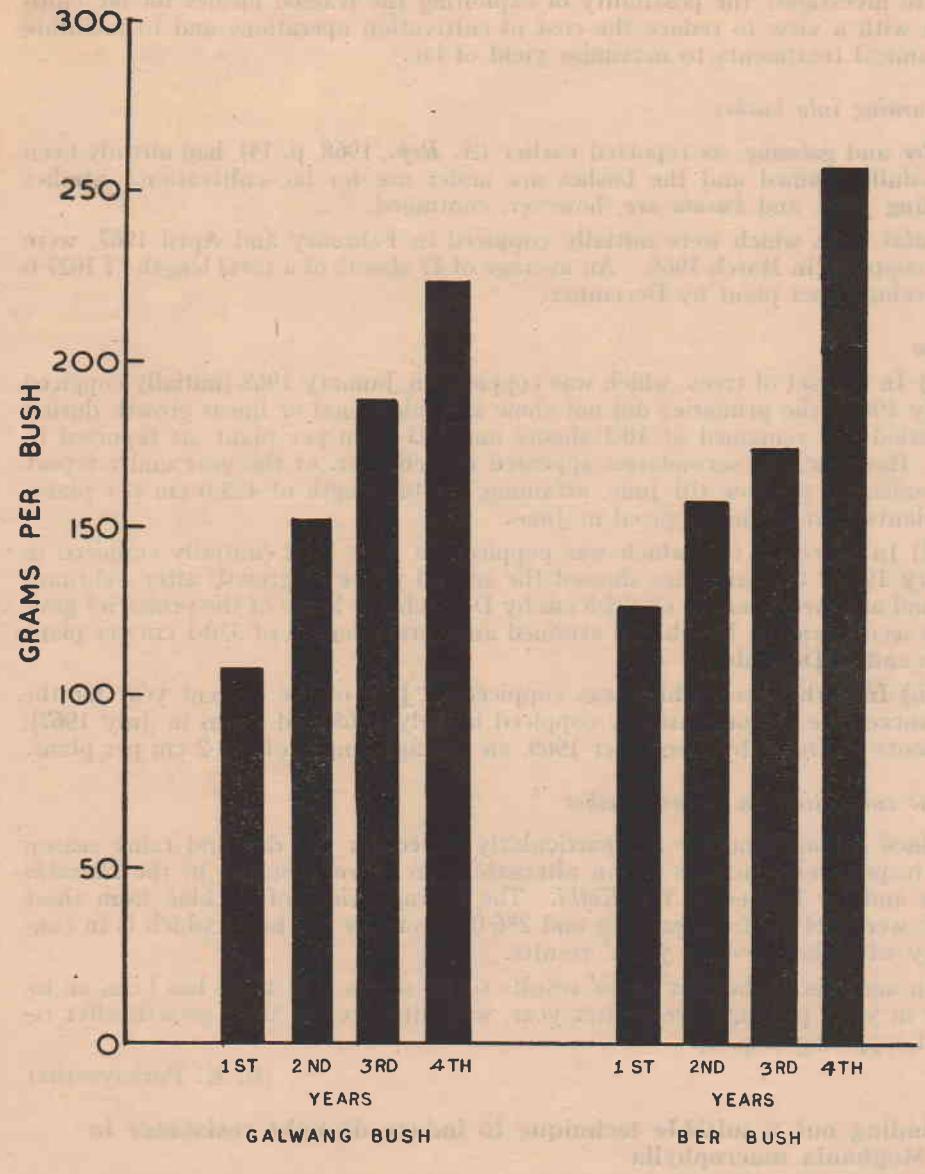
An analysis of the four years' results so far shows that there has been an increase in yield per bush, year after year, without affecting their growth after repeated coppicing (Fig. 1).

(B. K. Purkayastha)

8. Finding out a suitable technique to induce drought resistance in Moghania macrophylla

As has now been fairly well established, *bhalia* is a successful alternative host for the superior *Kusmi* lac in the *Aghani* season but not in the *Jethwi* because this

bush cannot sustain both itself and lac insects during the drought condition of the summer months. In view of the other attractive features of this bush as a *Kusmi* host, study was taken up in March 1968 to examine the possibility of inducing drought resistance in this host by exposing its seeds to high temperatures. Exposure for 24 hours at 40°, 45° and 50°C had been studied and reported (*A. Rep.*, 1968, p. 15).



STICKLAC PRODUCTION ON LAC HOSTS TRAINED INTO BUSHES

FIG. 1

Among the plants raised in July 1968, the best growth was from seeds exposed to 50°C. The plants from these recorded, in December 1969, an average height of 151·2 cm and total shoot length of 420·3 cm as against 108·9 and 261·3 cm in the case of the control, i.e. an increase of 38·8 and 60·8 per cent in height and total shoot length respectively.

During the current year, the seeds were subjected to still higher temperatures, e.g. 50°, 60° and 70°C for 24 hours (Treatment t_2, t_3 and t_4 and t_1, the untreated seeds, being the control). After 4 days of these treatments, plants were raised from these seeds in July 1969 and their growth observed under field conditions.

The four treatments were replicated six times with nine plants in each treatment. The plants have shown satisfactory growth.

Plants from the treated seeds were also raised in pots and were studied for their capacity to withstand drought resistance by restricting the water supplied to them, namely, by watering them at 4, 8, 12 and 16 day intervals. Transpiration rate and percentage of wilting of the plants, as recorded after 6 months growth, are given in Table 4 below:

TABLE 4 — WILTING AND TRANSPIRATION RATE OF BHALIA BUSHES RAISED FROM HEAT TREATED SEEDS

Intervals of watering	Mean transpiration per plant per day (ml)			
	t_1 (Control)	t_2 (50°C)	t_3 (60°C)	t_4 (70°C)
4 days	119·3	126·6	122·4	120·5
8 ,,	90·5	88·7	91·5	83·3
12 ,,	68·7	68·2	66·2	58·7
16 ,,	54·1	55·9	53·6	51·4
Percentage wilting	25·0	12·5	12·5	Nil

It will be seen that transpiration rate is the lowest in the case of t_4 and that wilting of the plants takes place in all cases except t_4, irrespective of the intervals of watering.

(B. K. Purkayastha and P. Kumar)

9. Studies on vegetative propagation of major lac hosts to obtain the plants of desired characters

Lac hosts show wide individual differences within the same species in respect of their capacity to sustain lac insects, thereby affecting regular lac production. Also, raising a plantation of hosts from seeds is a time consuming process. A study was, therefore, initiated in January 1969 to investigate the possibility of raising the plants from stem cuttings of proved good hosts with the help of growth hormones.

Ten cuttings each of *ber*, *galwang*, *kusum* and *palas* from one year old shoots were treated with IBA, IPA, NAA, 2, 4-D and 2, 4, 5-T at 10 and 100 ppm concentrations respectively for 24 hours with one set of cutting dipped in water only

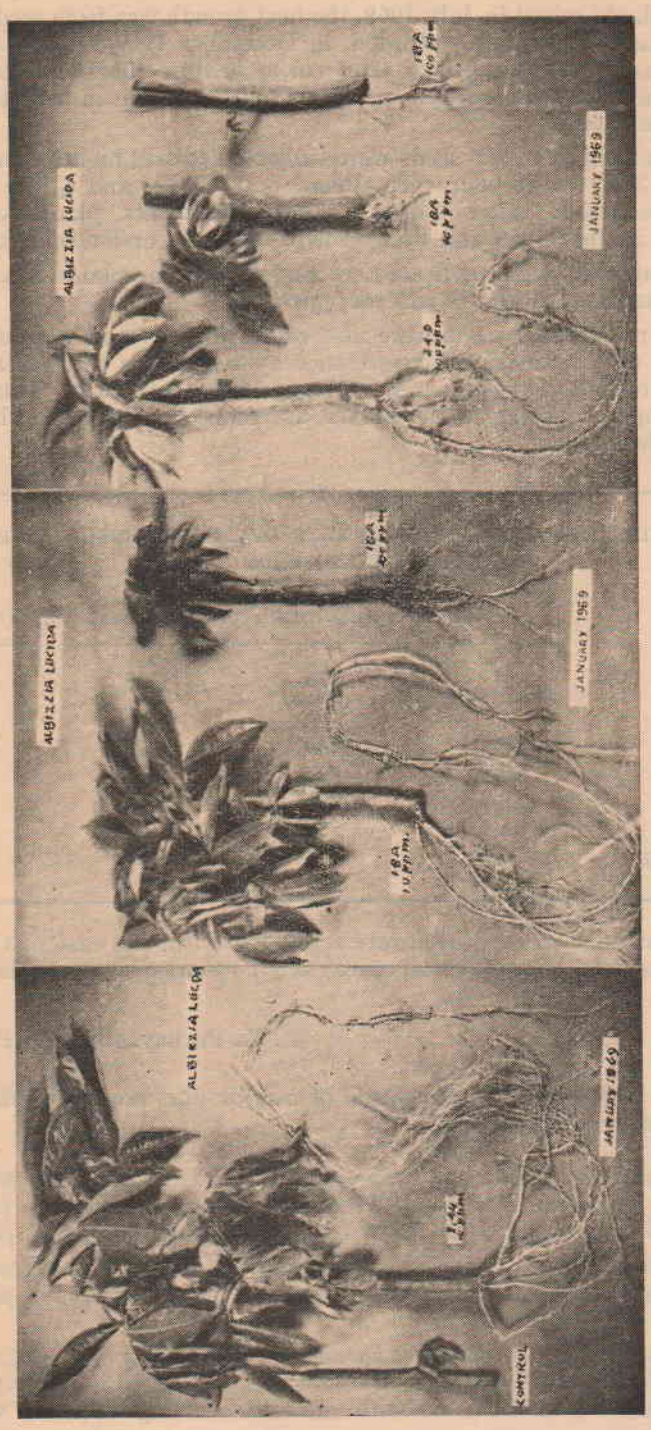


FIG. 2 — Root formation and root length by different growth regulators

for the same period to act as control. These were, thereafter, planted in nursery beds under uniform natural conditions.

Of the four species, only *galwang* survived. Of the growth hormones, IBA was found to be the most effective as regards root formation and length of root (see Fig. 2). *Ber* and *kusum* cuttings, treatd with IBA, developed shoots in the initial stages but they all died within two months. The other cuttings did not develop any roots at all.

(B. K. Purkayastha and P. Kumar)

10. Cytotaxonomic and Mutation studies on lac hosts

It has been observed that some of the lac hosts do not sustain satisfactory lac crops in extreme climatic conditions and, therefore, constitute a serious handicap for lac cultivation. Studies were therefore, taken up to develop suitable varieties possessing greater resistance to climatic variations.

(i) *Irradiation of seeds*

Ten sets of *bhalia* seeds with 100 seeds in each set, were exposed to doses of irradiation varying from 3 to 30 kr from a cobalt 60 source*. Seedlings were raised from these in nursery beds along with a set of untreated seeds as the control.

Plants thus raised did not show any difference in morphological characters, though seed formation was found lowest (17·8%) under 30 kr treatment and highest (39·1%) under the control. Seeds were collected from all the treatments for further study.

(ii) *Colchicine treatment*

For this purpose, the seeds were kept immersed in 0·10, 0·15, 0·20, 0·25 and 0·30 per cent solution of colchicine for 16 hours alongwith untreated ones to serve as control. Two sets of plants were raised from these. One set was allowed to grow as it is, while in the other set the required number of seedlings at two leaf stage were given a further colchicine treatment by dipping the shoot tips in 0·25, 0·50 and 0·75 per cent solution respectively for 6 hours and provided again with suitable controls.

All plants of both the sets were examined for any morphological differences in respect of size of flowers, pollen grains, stigma and ovary. No differences in regard to these were found in any of the plants arising out of treated seeds or those subsequently treated at the seedling stage except the one from the control which was given the seedling treatment of 0·5 per cent solution of colchicine. Flower buds of this plants are under examination for cytological studies.

(P. Kumar)

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*Irradiations of seeds and also lac insect material (p. 19) were so kindly carried out in the Division of Genetics of the Indian Agricultural Research Institute by the staff there whose co-operation is hereby gratefully acknowledged.

PHYSIOLOGICAL STUDIES

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

The body extracts of both *Rangeeni* and *Kusmi* lac insects at different stages of their development were examined, after freeing from proteins and dye, by subjecting them to two dimensional paper chromatography. Glycine, histidine, tyrosine, valine, lysine and methionine were found in both the strains, whereas proline and hydroxyproline were present in addition only in the *Kusmi* insect.

(U. P. Griyaghey)

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

To study the effect of host plant differences on the fecundity and resin secretion efficiency of *Rangeeni* and *Kusmi* lac insects , their cultures were raised on four potted plants each of *bhalia*, *galwang*, *ber*, *rain tree* and *sandan*. Ten mature females were collected at random about a week in advance of the time of larval emergence from each culture and kept separately in glass vials to maintain records of individual fecundity and resin output.

Data are being collected for analysis.

(U. P. Griyaghey)

13. Microbiological studies

(i) *Study of lac insect microflora*

Study of microorganisms associated with lac insects has been in progress since 1968. Microorganisms were isolated from lac insect reared on *ber* in *Katki* season and their pure cultures maintained on nutrient agar at 0°C. Routine identification tests were carried out.

Biological studies were also undertaken to ascertain the role of these microorganisms by studying their proteolytic, saccharolytic and lipolytic characteristics and are in progress.

Microorganisms were also isolated and their pure cultures obtained from the *Kusmi*, *Rangeeni* (yellow and crimson) lac insects, to see whether the different lac insects differ in this regard.

(ii) *Use of lac insect microorganisms as food for insects*

Lac insect microorganisms cultured on nutrient agar, agar agar powder and bactopeptone were offered alone as well as in various combinations, as food to rear larvae of major lac predators, *E. amabilis* and *H. pulverea*, in the laboratory. The predators completed their development only on medium containing all the three ingredients. Thus the predators were reared for the first time in the laboratory on an artificial medium consisting of bacterial cultures and the bacterial diets.

(iii) Lac insect microorganisms cultured on nutrient agar were also tried as food for an unidentified insect associated with lac. This insect also completed its development satisfactorily.

(A. H. Naqvi)

BREEDING AND GENETICAL STUDIES

14. Mutation studies on lac insects

The effect of irradiation on male fertility was determined by exposing lac insect males in their pupal stage to 500, 1000, 2000 and 3000 r X-rays. These males, on emergence, were mated each to a virgin female and the size of the progeny was scored. While no significant difference was in evidence in the lower doses upto 1000, the size of the progeny was reduced by 63·0 and 72·6 per cent at 2000 and 3000 r respectively.

(Y. D. Misra)

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

15. Collection of pests of lac hosts and study of their life history and control operations against important pests

(a) *Life history studies*

Pests of bhalia

Life history studies of *Amsacta lactinea* Cram. (Arctidae) were continued.

The pest,, diapausing in the pupal stage, emerged as adult during May/June. Data on the five diapausing specimens are shown in Table 5.

TABLE 5 — DATA ON THE FIVE DIAPAUSING SPECIMENS

	Range (days)	Average (days)
Incubation period	—	4·0
First instar larva	2-3	2·7
Second do	3-4	3·4
Third do	3-4	3·5
Fourth do	3-4	3·8
Fifth do	3-5	4·1
Sixth do	4-6	4·5
Seventh do	8-11	8·8
Total larval period	30-33	31·5
Prepupal period	2-3	2·2
Pupal period	205-227	212·6
Egg to adult period	242-264	252·6

(b) *Control aspects*

(i) *Laboratory trials against pests of bhalia*

For selecting suitable contact insecticides with regard to their efficacy, studies on the under mentioned pests of *bhalia* were continued this year.

Number of insecticides used for each pest species depended upon the number of larvae available. Where required, when sufficient number of larvae for all the

treatments were not available, insecticides not already tried were tried. Aldrex 30 E.C., Dieldrex 18 E.C., Endrex 20 E.C., D.D.T. 25 E.C., Thiodan 35 E.C., Chlordane 65% dust, B.H.C. 50% W.P. and D.D.T. 50% W.P. were tried against *Nephopteryx leucophaella* Zell; Aldrex 30 E.C., Thiodan 35 E.C. and B.H.C. 50% W.P. against *Hemithea tritonaria* Walk; and only Thiodan 35 E.C. against *Platypepulus aprobola* Meyr and *Hypena iconicalis* Walk. Initially a single dose of 0·25 per cent concentration of all the insecticides used were given a trial.

Larvae of all the four species mentioned were collected from the field and preconditioned for 24 hours by feeding them on *bhalia* leaves under laboratory conditions. Forty larvae of each were then collected and grouped into four batches of ten each to form three replications and a control for each insecticide. A filter paper about 10 cm in diameter was dipped in the insecticide solution, dried for about 2 min under a ceiling fan and placed in a petri dish. The pest larvae were then released and their mortality recorded 24, 48, and 72 hours after their release. Moribund larvae were considered as dead for the purpose.

Control efficacy of each insecticide was judged on the basis of 100 per cent mortality 24 hours after the release and is indicated below:

H. tritonaria — Aldrex 30 E.C.

H. iconicalis — Thiodan 35 E.C. (Dieldrex 18 E.C. in 1968)

N. leucophaella — Endrex 35 E.C.

P. aprobola — Thiodan 35 E.C. (Endrex 20 E.C. and D.D.T. 25 E.C. in 1968)

(ii) *Field trials against pests of bhalia*

The experiment was carried out on 1000 bushes of *bhalia*. The pests appeared in the field in July.

The first spraying and dusting of the insecticides all in 0·25 per cent concentration were done on 16th August, the second on 16th September and the last on 1st October. Incidence of the pests was assessed 24 hours before, and 24 and 48 hours after each spray on five random bushes under each treatment. The control efficiency of each insecticide was judged on the basis of mortality of the insects after 24 hours of application. The pests found, insecticides used and their effects are set out in Table 6.

It will be seen that Endrex 20 E.C. was most effective against all the pests.

(B. P. Mehra and B. N. Sah)

SURVEY OF LAC ENEMIES

16. Seasonal incidence of and extent of damage by predators *E. amabilis* and *H. pulverea* on the *Rangeeni* strain of lac insects grown on *palas*

Having studied the seasonal incidence of *E. amabilis* and *H. pulverea* on the *Kusmi* strain of lac insects (see page 6) the study was extended to the *Rangeeni* strain.

Seasonal incidence of these predators is being studies in a hot and dry area (at Kundri) on *Rangeeni* lac grown on *palas* under different conditions of host concentration in the area, (A) dense, (B) Medium and (C) thin, with 15 trees in each and 5 replications. Three lac stick samples, each 10 cm in length, are col-

TABLE 6 — FIELD TRIALS ON THE EFFICACY OF VARIOUS INSECTICIDES FOR THE CONTROL OF PEST OF *Bhalia*

Pests	Percentage control							
	Aldrex 30 E.C.	B.H.C. 50% W.P.	Chlordane 65% dust	D.D.T. 18 E.C.	D.D.T. 50 E.C.	Dieldrex 18 E.C.	Endrex 20 E.C.	Thiod. an 35 E.C
Dasychira mendosa Hubn. *fusiformis*	85·7	42·9	Not tried	33·3	75·0	100·0	100·0	Not tried
H. tritonaria	68·1	44·4	25·0	50·0	79·2	50·0	88·9	22·2
H. iconicalis	94·0	56·3	17·6	50·0	100·0	96·0	100·0	100·0
N. leucophaella	85·7	60·0	16·6	100·0	55·5	60·0	94·7	83·3
P. aprobola	41·5	29·5	13·4	45·4	75·8	36·9	79·8	73·3

lected at fortnightly interval from the time of male mergence till the time of crop maturity from each treatment and are examined for incidence of these predators.

The first crop was raised during the *Katki* season. Data are presented in Table 7.

TABLE 7 — INCIDENCE OF AND DAMAGE BY LAC INSECT PREDATORS ON *Palas*

Crop — Katki 1969

Host plant concentration	Incidence of and damage by predators per 450 cm lac encrustation			
	E. amabilis		*R. pulverea*	
	Number present	Percentage damaged cells	Number present	Percentage damaged cells
A (Dense)	59	8·04	106	11·46
B (Medium)	194	18·80	107	11·70
C (Thin)	106	15·55	75	12·72

Dense — 120 trees per 100 sq m
Medium — 50 trees per 100 sq m
Thin — 5 trees per 100 sq m

It will be seen from Table 7 that of the two predators *H. pulverea* was more prevalent in A, and *E. amabilis* in B and C. Incidence of *E. amabilis* decreased towards the time of crop maturity.

(A. K. Sen)

ECOLOGICAL STUDIES ON LAC INSECTS

17. Influence of Photoperiod

This study is intended to determine the effect of photoperiod on the growth of lac insect. This was carried out by exposing 50 isolated insects on potted *bhalia* plants to varying hours of day, night and artificial lights and observing the times of moulting, alongwith measurement of length and width at each moult, male emergence and life-cycle period. The different conditions of exposure and the results obtained are presented in Table 8.

(B. P. Mehra and R. S. Gokulpure)

REGIONAL FIELD RESEARCH STATIONS

Damoh, M.P.

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

The following cultivation schedules were studied.

TABLE 8 — INFLUENCE OF PHOTOPERIODS ON LAC INSECTS

Sl. No.	Exposure conditions		Effect on the insects			
			Kusmi		*Rangeeni*	
	Light	Duration hours	*Jethwi* 1969	*Aghani* 1969-70	*Katki* 1969	*Baisakhi* 1969-70
1	2	3	4	5	6	7
1	Natural light	24	Total mortality by March 1969	Insects living	Insects lived through to maturity	Insects living
2	Daylight	13	do	Insects died by November 1969	do	do
3	do	11	Total mortality by May 1969	do	Plant and insects died in August 1969 after male emergence	do
4	do	10	Not tried	Not tried	Not tried	do
5	do	9	Total mortality by May 1969	Insects died by November 1969	Insects lived through to maturity	do
6	do	7	do	do	do	do
7	Darkness	24	Total mortality by March 1969	Insects living	do	do
8	40 Watt Fluorescent Tube light	24	do	Insects died by November 1969	Plant and insects died by September 1969	Plant and insects died by December 1969
9	Nightlight	11	do	Insects living	do	Insects living
10	Plant exposed to daylight before inoculation and with insects after inoculation	12	Not tried	Not tried	Insects lived through maturity	Not tried
11	do	7	do	do	do	do

Treatment	Time of pruning	Inoculation		Time of harvesting		Period from inoculation to harvesting months
		Month	Broodrate per tree	Partial	Complete	
A	Apr	Oct/Nov	0·5 N*	—	Oct/Nov	12
B	,,	,,	N	Jun/Jul	,,	8 and 4
C	,,	,,	2 N	—	Apr	5
C_1			2 N	—	May	6
D	Oct/Nov	,,	0·5 N	—	Oct/Nov	12
E	,,	,,	N	Jun/Jul	,,	8 and 4

*N stands for Normal broodrate which was arbitrarily fixed as 0·4 Kg per tree.

Each treatment was tried on 5 trees with 10 replications. There were 500 trees under this experiment.

With regard to crop ratio, *ari* cutting in May (Treatment C_1) was better than in April (Treatment C) with crop ratios of 1: 1·77 and 1: 1·51 respectively. This is in conformity with last year's result. Among the remaining treatments, E gave the highest crop ratio of 1: 0·66, followed by A(1: 0·59), B(1: 0·52) and D(1: 0·35). This is not in conformity with last year's result, where Treatment D gave the highest crop ratio of 1: 2·05. No broodlac was obtained from any treatment.

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

Of the plant species tried *airma, dhobein* and *,khair* carried *Baisakhi* 1968-69 crop through maturity and gave some yield in *Katki* 1969 by self-inoculation but did not produce any broodlac. *Bansa, bija, karai, kargai, kathmohli* and *renja* did not take *Baisakhi* settlement.

(iii) *General survey of the enemies of the lac insect and their parasites*

The following insects emerged from five crops which were more or less the same and with the same distibution as last year.

ENEMIES

Parasites

1. *Coccophagus tshirchii Mahd.*
2. *Erencyrtus dewitzi* Mahd.
3. *Eupelmus tachardiae* How.
4. *Marietta javensis* How.
5. *Parechthrodryinus clavicornis* Cam.
6. *Tachardiaephagus somervilli* Mahd.
7. *Tachardiaephagus tachardiae* How.
8. *Tetrastichus purpureus* Cam.

FRIENDS

Parasites

12. *Apanteles fakhrulhajiae* Mahd.
13. *Apanteles tachardiae* Cam.
14. *Brachymeria tachardiae* Cam.
15. *Bracon greeni* Ashm.
16. *Bracon hebetor* Say.
17. *Chelonella cyclopyra* Franz.
18. *Elasmus claripennis* (Cam.)
19. *Eurytoma palidiscapus* Cam.
20. *Perisierola pulveriae* Kurian.

Predators

9. *Eublemma amabilis* Moore.
10. *Holcocera pulverea* Meyr.
11. *Chrysopa* sp.

21. *Pristomerus sulci* Mahd. & Kolu.

Miscellaneous

22. Coleoptera.
23. Tineidae.

Their distribution is indicated in Table 9, where the numbers refer to those in the above list.

Further, a new insect emerged from mature *Katki* 1968 crop collected from Forest Compartment no. 109, Rajnagar and Indrana at Damoh (M.P.) and has been identified as *Apanteles angaleti* Muesbeck (Braconidae) at the Commonwealth Institute of Entomology, London, in September 1969.

The Regional Field Station at Damoh was wound up in December 1969 as all the studies were completed and the staff transfered to Namkum.

(B. P. Mehra and P. Sen)

Dharamjaigarh, M.P.

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

All the trees under this experiment have now come under the regular pruning cycle and will be utilized for comparison of treatments from next year onwards.

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

Aghani 1969-70

Bahera, bansa, bargad, bhirra, char, dhaura, dhobein, dumar, khair, kheni, sarai, tendu and *tewar* were tried.

Only *Khair* carried lac through maturity. *Dhobein, dumar* and *sarai* carried lac till maturity but all lac insects died before larval emergence. Lac insects on other species died by November 1969.

(iii) *General survey of enemies of lac insects and their parasites*

The data are furnished in Table 9.

(B. P. Mehra and R. C. Maurya)

Ad-hoc observations

The parasitized mature lac insects of the *Baisakhi* 1968-69 and *Jethwi* 1969 crops of photoperiod experiment were caged for emergence of inimical and friendly insects. It was observed that 3 specimens of probably *Marietta javensis* (Hymenoptera, Chalcididae, Eulophidae) emerged in June 1969. It may be pointed out that the primary host of this parasite has been recorded as "Chiefly male lac insect". Since male emergence was over by March/April they must have emerged from female lac insects.

Four specimens of *Tyndarichus* sp. (Hymenoptera; Chalcididae; Encyrtidae) emerged from mature *Katki* 1968 crop on *palas* at Mirzapur caged in October 1968.

TABE 9 — EMERGENCE OF INIMICAL AND FRIENDLY INSECTS OF LAC INSECT

Month	At Damoh						At Dharamjaigarh		
	Katki 1968		Baisakhi 1968-69		Katki 1969		Aghani 1968-69 Kusum	Jethwi 1969 Kusum	Aghani 1969-70 Kusum
	Ghont	Palas	Ghont	Palas	Ghont	Palas			
December 1968	2, 9, 10, 13, 15, 21, 22 & 23	2, 3, 5, 6, 7, 8, 9, 10, 13, 21, 22 & 23							
January 1969	9 & 10	9, 10, 22 & 23					3, 5, 6, 7, 8, 10, 12, 13, 20 & 21		
February 1969	9, 10, 13, 21, & 22	9, 10, 13, 21 & 22	8				9, 10, 12, 13, 21 & 22		
March 1969	9, 10, 13, 17, 21 & 22	3, 5, 9, 10, 13, 17, 21 & 22	2, 4, 5, 7 & 8	2, 3, 5, 7, 8, 9 & 22			9, 10, 13, 21 & 22		
April 1969	10 & 22	3, 8, 10 & 22	2, 4, 7 & 9	2, 4, 7, 8 & 22				2, 3, 6 & 8	
May 1969	22	2, 3, 8, 10, 20 & 22	2, 8 & 22	22				3, 5, 7, 8, 9, 10, 12, 13, 16, 22 23	
June 1969	22	22	22	10 & 22				9, 10 & 22	
July 1969	9, 10, 13 & 21	2, 3, 5, 6, 8, 9, 10, 13, 15, 19, 20, 21 & 22		8, 10, 17, 21 & 22				6, 7, 9, 10, 12 & 13	
August 1969				9, 10, 21, 22 & 23				9, 10 & 22	
September 1969				10, 21 & 22	2, 7, 8, 9 & 15	7, 8, 10, 12, 13 & 14			9, 10, 12 & 13
October 1969					3, 4, 8, 9, 10, 15, 22 & 23	2, 3, 4, 5, 8, 9, 10, 11, 12, 13, 14, 17, 21, 22 & 23			10, 12 &
November 1969					2, 3, 6, 7, 8, 9, 10 & 21	1, 2, 3, 4, 5, 8, 9, 10, 12, 13, 14, 21 & 22			7, 8, 9, 10, 12 & 13
December 1969					7, 9, 10 & 22	8, 9, 10, 21 & 22			

This species was later observed also from *palas* lac samples of *Katki* 1969 collected from Kundri. And two specimens of *Scatopse* sp. (Diptera; Scatopsidae) emerged from immature *Katki* 1968 crop on *palas* caged in September 1968.

(R. S. Gokulpure and B. P. Mehra)

Observations taken from all the four crops over a number of years by inoculating single cell on potted *bhalia* plants show that alate and wingless males emerge from the same mother.

(B. P. Mehra and B. N. Sah)

Bracon fletcheri Silv., *Bracon* sp. (group of *fletcheri*) (Braconidae) were recorded as larval parasites and *Eurytoma* sp. (Eurytomidae) as a pupal parasite of *Melanagromyza obtusa* Malloch (Diptera, Agromyzidae) a pest of *bhalia* seeds.

(B. N. Sah and B. P. Mehra)

(c) RESEARCHES CONTEMPLATED

Six of the various studies in progress during the previous year were completed during the year under report. The remaining ones will be continued of which a few are expected to be completed. Besides, out of the ten items contemplated for the year (A. Rep. 1968, p. 28) seven were taken up for investigation and are now in progress.

Following studies are contemplated to be taken up during the next year.

1. Breeding for better lac insects (the possibility of combining the *Kusmi* resin characteristics and the *Rangeeni* life periods through hybridization and selection will now be examined).
2. Survey of genetic variation in lac insect.
3. Sex ratio studies in lac insects.
4. Studies on the artificial rearing of parasites of lac predators.
5. Seasonal incidence and behavioural studies on beneficial insects in association with lac insects.
6. Studies of Limacodid pests of lac host trees.
7. Determination of the appropriate time of harvesting broodlac in different regions through the use of biometer on thermohygrograph records.

B. CHEMISTRY DIVISION

Research activities of the Chemistry Division, like those of the Entomology Division were as per Project Proposals for the year submitted to the Indian Council of Agricultural Research. These were largely based on the programme recommended by the recent Achievement Audit Committee (1966).

A detailed report on the results of the various items now follows:

(a) RESEARCHES COMPLETED

1. Age of Seedlac

It has been known that specific heat of lac falls gradually with the degree of polymerization of the resin. It is also known that lac gradually polymerises

with the period of storage, the speed of polymerization depending upon the conditions of the storage. As specific heat is a property which can be determined with a high degree of accuracy, it was considered worthwhile to investigate if there is any correlation between the specific heat and the period of storage of any sample of lac.

Samples of sticklac of known history were collected from the different lac growing regions of the country and processed into seedlac which were then stored under normal laboratory conditions for 52 months. Their specific heats were determined from time to time. Their flow and hot alcohol insoluble were also determined.

The data have now been statistically analysed. The results are highly significant and given in Table 10.

TABLE 10 — CORRELATION COEFFICIENTS BETWEEN AGE OF LAC AND SPECIFIC HEAT, FLOW AND INSOLUBILITY PERCENTAGE

Correlation between	Sample No. 1	Sample No. 2	Sample No. 3	Sample No. 4	Sample No. 5	Sample No. 6
1. Specific heat and age	−0·96	−0·93	−0·93	−0·93	−0·93	−0·96
2. Flow in m.m. and age	−0·98	−0·96	−0·92	−0·95	−0·96	−0·98
3. Insoluble percentage and age	0·97	0·99	0·75	0·97	0·97	0·98

2. Shellac ester and their modifications

Shellac is one of the best popular film formers and already finds considerable use in surface coatings. The use of modified lacs which, naturally, have properties somewhat different, is another means of extending the use of lac in this field which, by common consent, is the most promising field for consumption of lac.

The preparation and properties of a partial butyl ester of lac (AV, 50·1 and HV, 180·0) was reported last year (*A. Rep.* 1968, p. 44). This ester was prepared using no catalyst and, consequently, necessitated a reaction time of 20 hours. As this is too long a time for practical purposes, attempts were made to carry out the esterification within a six to eight hours schedule using the minimum quantity of acid catalyst.

The esterification was carried out in presence of various amounts of concentrated hydrochloric acid for different periods and using an azeotropic leg. A refluxing period of 4 hours using 2 ml concentrated hydrochloric acid per 100 g of lac in 200 ml of butyl alcohol yielded the desired partial ester. The catalyst could be removed by boiling the reaction mixture, after esterification, with excess of barium carbonate before boiling off the solvent. The resulting ester, like the one produced without using any catalyst, was a tough and non-tacky solid. Acid and hydroxyl values and molecular weight were 42·5, 185·6 and 1082 respectively. The butoxyl content was 14·8 per cent indicating that the material is really an

*Statistical analysis of these data were carried out by Shri A. K. Sharan, Assistant Director, Directorate of Lac Development, Ranchi to whom our thanks are due.

ether/ester with 30·55 per cent of its carboxyl esterified, and 31·69 per cent of its hydroxyl etherified. The molecular weight would also indicate that the resin had not undergone any alcoholysis during the esterification reaction.

The ester was easily soluble in the usual shellac solvents. For practical purposes, it was not necessary for the ester be made solvent free. The solution, after esterification and removal of catalyst if used, needed only to be distilled to such extent that the residue was a 66 per cent solution in the solvent (butanol) like the usual commercial synthetic resins. Such a solution was a thick syrup which gave a clear solution on dilution with alcohol or toluene, or with aqueous ammonia for use as spirit or aqueous finishes. The film properties were identical with those of the partial ester produced without catalyst.

Films prepared from 25-30 per cent of the syrup solution in toluene and in aqueous ammonia, after air drying and baking at 150°C for 30 minutes, possessed better hardness, elasticity and impact resistance than dewaxed shellac films. The baked films did not blush in water even after 48 hours immersion and were resistant to alcohol, acetone, ethylacetate and toluene.

Partial butyl ester (dark coloured) was also prepared from seedlac by this technique. Addition of activated charcoal (optimum quantity, 10 g/100 g of lac) during the refluxing period was found to reduce the colour index of the ester from 13 to 5.

Ethyl esters of shellac of similar acid values were also prepared adopting the above procedure. Film properties of these, however, were not satisfactory.

(M. Mukherjee and Y. Sankaranarayanan)

Bleaching of shellac wax

Condition for the bleaching of shellac wax with sodium hypochlorite solution had been described in the report for the year (*A. Rep.* 1968, p. 58).

Properties of the bleached wax produced were studied during the year under report. Acid value, saponification value, melting point and solvent retention power did not differ very much from the values of the unbleached parent wax but hardness was improved. (Penetration value 2-2·5 mm as against 5-6 mm of the parent wax).

(L. C. Misra and T. Bhowmik)

(b) RESEARCHES ON HAND

1. Study of the constitution of lac

As is well known, lac resin is composed of a number of components which are inter- and intra-esters of various aliphatic and terpenic polyhydroxy acids. Up till now, by the application of various techniques such as alkaline hydrolysis, esterification and adsorption, thin layer (TLC) and gas liquid chromatography (GLC) etc., a number of these acid constituents have been isolated and characterized. Studies at present in progress include attempts to resolve the resin into individual components by TLC and precipitation methods, and the constituent acids of one (the ether soluble) fraction of lac, namely soft resin.

(a) *Separation and analysis of the components of lac resin*

The successful resolution of lac resin by TLC into a number of components has been described already in an earlier report (*A. Rep.* 1967, p. 30). It has now been found that the resolution is better on silver nitrate impregnated plates than on ordinary plates, the former giving very distinct spots.

The resolution of a sample of dewaxed decolourized lac by preparative layer chromatography by the solvent systems (a) ethyl acetate: acetic acid (100: 1, v/v) and (b) chloroform: methanol: acetic acid (90: 10: 2, v/v) were also carried out a number of times and standardized. In these solvent systems, the resin was found to resolve into five zones. However, with the former solvent system the zones were sharper. The components were recovered from the zones by scraping off the silica gel and extracting with methanol. The respective components were obtained in the proportion of 12·8, 8·8, 41·3, 23·0 and 7·8 per cent on the load. Analysis of these components are in progress.

Rf values of the methyl esters of the known constituent acids of lac had been determined last year in two solvent systems (*A. Rep.* 1968, p. 32). A few more solvent systems were studied during the year under report for better resolution, especially of the terpenic esters. The system, benzene: ethyl acetate: acetone (7: 4: 4, v/v) as reported by Sukh Dev *et al.* (unpublished report), was found to be the best.

(S. C. Sengupta)

(b) *Molecular weights of lac and its fractions*

The molecular weights of soft resin and its fractions had been determined by Rast, acid value and viscosity methods and reported (*A. Rep.* 1968, p. 34). The studies were continued with hard resin and its fractions. The determinations were carried out in dioxane with the help of vapour phase osmometry. The molecular weights of shellac, decolourized lac, hard resin and soft resin were found to be 1090, 1060, 1830 and 558 respectively.

Hard resin was then separated into eleven fractions from dioxane solution with benzene as non-solvent. Yield, acid value and molecular weights of the fractions are brought out in Table 11.

(P. C. Gupta and P. R. Bhattacharya)

TABLE 11 — YIELD, ACID VALUE AND MOLECULAR WEIGHTS OF FRACTIONS OF HARD RESIN

Fraction No.	Yield on hard resin (%)	Acid value	Molecular weight
1	2·34	56·00	1,830
2	15·86	53·00	3,537
3	10·50	66·60	2,750
4	12·58	72·50	1,930
5	19·78	75·40	1,665
6	9·52	80·10	1,415
7	13·63	84·90	1,345
8	7·24	92·60	1,140
9	4·36	97·70	1,057
10	2·13	106·70	1,072
11	2·00	108·00	780
Total	100·04		

(c) *Constitution of soft resin*

As pointed out already, soft resin is the ether soluble fraction of lac resin and is present in the latter to the extent of 25-30 per cent. Constitution of soft resin has been under investigation for a very long time but the findings have been somewhat contradictory. The present study was taken up in 1965.

The technique employed is fractionation of the urea adduct of the methyl esters of the acid constituents of the resin by column chromatography. The acids obtained from the urea adduct are myristic, palmitic, stearic, myristoleic, palmitoleic, oleic, 16-hydroxypalmitic, 16-hydroxypalimitoleic, 6-hydroxymyristic and isomeric aleuritic acids.

The non-adducted fraction had also been separated into nine fractions (B-1 to B-9) and examined, as a result of which 6-hydroxymyristic (butolic) acid was detected in fractions B-1 and B-2 which were similar and aleuritic acid in B-5, B-6 and B-7 (*A. Rep.*, 1966, p. 29).

During the period under report, fractions B-3 and B-4, which were found by TLC to be mainly composed of terpenic esters with traces of methyl aleuritate, were combined and fractionated over silica gel into four fractions. Fraction 1 was found to be a mixture of dimethyl shellolate and *epi* shellolate while fractions 2 and 3 were identical with dimethyl shellolate.

By similar systematic study six more acids could be isolated and identified of which three are new acids isolated from soft resin fraction for the first time.

This study has so far resulted in the isolation and identification of nearly 80 per cent of the constituent acids of soft resin. The various acids and their proportion in soft resin are listed in Table 12.

The isolation and characterization of the remaining constituent acids are in progress.

(S. C. Agarwal and S. C. Sengupta)

TABLE 12 — APPROXIMATE COMPOSITION OF SOFT RESIN

Sl. No.	Acid present		Percentage
1	Saturated and unsaturated non-hydroxy acids		1·3
2	16-Hydroxypalmitic acid		2·0
3	16-Hydroxypalmitoleic acid		1·0
4	Acid m.p., 83-84°C		0·25
5	6-Ketomyristic acid		2·5
6	6-Hydroxymyristic acid (butolic)		9·3
7	Isomeric aleuritic acid (m.p., 93-94°C)		1·3
8	Aleuritic acid (m.p., 100-101°C)		14·0
9	*Threo*-9, 10-Dihydroxymyristic acid		10·0
10	10, 16-Dihydroxypalmitic acid		1·5
11	Terpenic acids		
	Shellolic, *epi*Shellolic	5·3%	36·0
	Jalaric		
	Laksholic, *epi*Laksholic	3·1%	
12	Acids yet to be isolated and identified		20·9

2. Modification of Shellac

Notwithstanding its unquestioned versatility, shellac possesses certain shortcomings which restrict its extended use. These shortcomings include brittleness, whitening on prolonged contact with water and softening even under moderate temperatures. In order to overcome these drawbacks, lac has been modified in the past by the use of chemicals. The present approach is to modify the resin by grafting/copolymerization with monomers, blending with synthetic polymers etc. which have indicated considerable promise. Investigation on these lines carried out at this Institute are described below:

(a) *Graft Copolymerization with vinyl monomers*

This study has been going on since 1964 but had to be suspended during the year under report because of the departure of the investigator. It will be resumed as soon as a substitute is appointed.

(b) *Modification with amino resins*

Amino resins had been found to yield remarkable results on blending with shellac varnishes. A varnish containing dewaxed lac and butylated melamine resin in the ratio of 100:40 (on solid basis), forms an excellent heat, water and liquor proof French polish and also serves as a satisfactory vehicle for attractive rapid drying paints for display panels. A varnish containing dewaxed lac and urea resin (100:20) has been found to be an excellent vehicle for baked finishes particularly as tin plate lacquers. Chemical reactions taking place during film formation of such blends were being investigated.

It has been found that when lac urea resin films are baked at 150°C, polycondensation takes place between the carboxyl and hydroxyls of lac and the methylol and butoxy groups of the urea resin (*A. Rep.*, 1968, p. 36).

The studies were continued. Ester values of the films were determined at different stages of baking and it was found that the increase in ester value was very sharp in the first 10 minutes therafter it became very slow. Very similar increase was also noted in the case of catalysed films. These data support the previous postulation that the esterification reaction proceeds faster in the beginning and that thereafter ether exchange predominates.

The possible reactions taking place during film formation are represented below:

1. $Lac-COOH+HOCH_2-UF \rightarrow Lac-COO-CH_2-UF+H_2O$
2. $Lac-OH+H_9C_4OCH_2-UF \rightarrow Lac-O-CH_2-UF+C_4H_9O_2H$

It is seen from the reaction 2 that, during ether-interchange, a molecule of butanol is liberated which goes off from the film during baking. It is because of this that the hydroxyl value falls sharply at the later stage of baking. Since the ether-exchange is catalysed by acid, this reaction proceeded faster in catalysed films.

(Shravan Kumar)

(c) *Modification of lac with concentrated Sulphuric acid*

Precipitation occurs when concentrated sulphuric acid is gradually added to a solution of lac in alcohol under certain conditions. The precipitates are modified lacs possessing properties different from those of the present lac. The preparation of six such modified lacs and their physical properties and chemical constants were reported earlier (*A. Rep.*, 1967, p. 41 and 1968, p. 40).

In view of the tendency of the four butanol soluble products to polymerize within six months, they were prepared afresh and their suitability along with that of the other two, investigated for use as surface coating materials. The four were dissolved in *n*-butanol and the remaining two in water. Films were prepared on glass plates and tin panels by flowing. Air dried films of the first four samples had excellent flexibility and impact resistance but poor hardness and water resistance. On baking at 150°C for half an hour, however, in addition to flexibility and impact resistance, the water, solvent acid and alkali resistance also improved but hardness and gloss were poor. The air dried and baked films from the water soluble samples had the same flexibility and hardness as those of the parent lac but resistance towards water, and alkali or solvents was poor.

(A. Rahman and P. R. Bhattacharya)

(d) *Isopropylidene derivative of aleuritic acid*

Aleuritic acid is one of the major constituent acids of lac resin being present, reportedly, to the extent of about 40 per cent. It is a colourless crystalline solid having three hydroxyls and one carboxyl in its average molecule and is thus a very promising starting material for modification into useful products. Autocondensation of the isopropylidene derivative of aleuritic acid obtained by treating the acid with acetone to block the vicinal hydroxyls, under heat was studied to get a product of high molecular weight which may be used in the field of plastics or surface coatings.

The isopropylidene derivative (5 g) was autocondensed under nitrogen atmosphere by heating in a test tube at oil bath temperature of 140°, 160°, 180° and 200°±1°C. Samples were drawn at timed intervals and chilled over ice. From the differences in saponification and acid values, the percentage of esterification was calculated. The reaction appeared to be of the second and third orders. Energy of activation was calculated as 15·19 kcal/mol. which is very characteristic of esterification reactions.

Precipitability and solubility of the various products resulting from this autocondensation were also studied at 32°C in dioxane water system. This study confirmed that polyesterification did take place during the autocondensation.

(P. C. Gupta and P. R. Bhattacharya)

3. Improvement in manufacture of seedlac and shellac

Refining of sticklac to seedlac is carried out by washing with water, and seedlac to shellac mostly by a process of hot filtration. During these treatments, a large proportion of lac resin (estimated at about 20 per cent) is lost in the form

of several by-products. Elimination of these by-products, if possible, and their economic utilization, if unavoidable, will naturally improve the economy of the industry.

Attempts have, therefore, been in progress to improve the refining, including bleaching, methods in order to achieve the above objectives.

(a) *Preparation of shellac directly from sticklac*

It has already been reported (*A. Rep.*, 1968, p. 39) that shellac of satisfactory properties can be produced directly from sticklac by extraction of the latter with alcohol or acetone and recovering the resin either by precipitation with 1 per cent aqueous salt solution or by distilling off the solvent.

During the year under report, the method was standardized by carrying out a number of experiments with different types of sticklacs. The properties and yield of shellac obtained in typical experiment from 1 kg of *Rangeeni* sticklac are brought out in table 13.

TABLE 13 — YIELD AND PROPERTIES OF SHELLAC PRODUCED DIRECTLY FROM STICKLAC

Process	Yield (%)	Colour	Life at at 150°C (minute)	Flow (mm)	Wax (%)
Acetone	75·55	21	60	143	0·44
Alcohol	75·05	21	62	144	0·12
Bhatta	52·00	19·5	43	85	4·54

It will be seen that the yield of shellac is about 23 per cent higher by the new process and the life and flow distinctly superior. Only the colour is slightly inferior.

(b) *Shellac wax*

Shellac wax, a by-product of the lac industry is a valuable product of commerce and is only slightly inferior in properties to the costly and imported carnauba wax. Study was, therefore, initiated to modify shellac wax in order to upgrade its performance in respect of hardness, solvent retention power and colour so that it can more effectively substitute carnauba wax.

The first approach was to fractionate the wax with various solvents, and study the properties of the fractions. The solvents tried were acetone, methyl ethyl ketone, benzene, alcohol, xylene and a mixture of alcohol and benzene. The wax was first dissolved in the respective solvent under heat and then allowed to precipitate out at various temperatures. Acetone was found to be the best solvent for the fractionation. Wax samples from different sources were fractionated with boiling acetone into an insoluble fraction (I), a fraction (II) soluble in hot acetone but insoluble in the solvent at room temperature and a soluble fraction (III). Properties of the different fractions are brought out in Table 14.

(A. K. Ghosh and S. C. Sengupta)

TABLE 14 — PROPERTIES OF LAC WAX AND ITS FRACTIONS

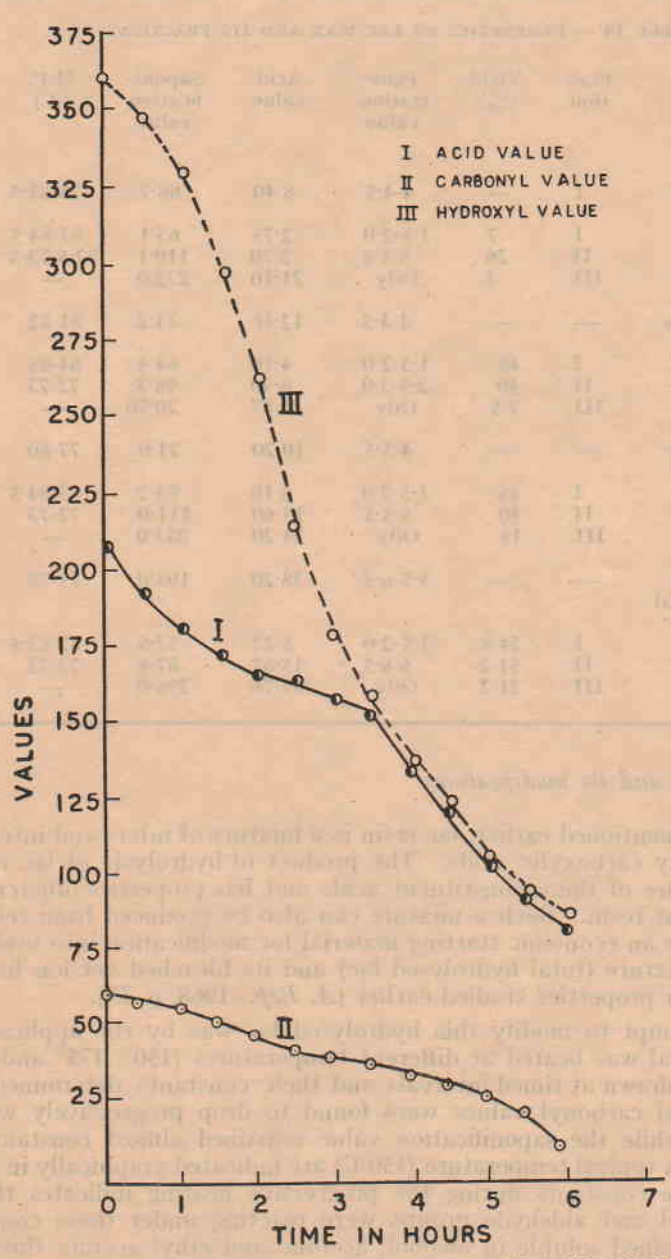
Sl. No.	Sample	Fraction	Yield (%)	Penetration value	Acid value	Saponification value	M.P. (°C)	Solvent retentivity power
1	Commercial Lac Wax	I	—	4-4·5	8·40	68·7	78-81·5	28
		I	7	1·5-2·0	2·75	63·1	83-84·5	16
		II	26	5-5·5	2·70	110·1	72·5-73·5	64
		III	3	Oily	21·10	272·0	—	1·6
2	Commercial Wax (black variety)	—	—	3-3·5	12·16	74·2	81-82	11·0
		I	48	1·5-2·0	4·10	64·4	84-85	13·5
		II	40	2·5-3·0	6·90	98·3	72-73	68·6
		III	7·5	Oily	20·87	20·70	—	0·4
3	Wax from wash water at ILRI	—	—	4-5·5	10·20	71·0	77-80	19·2
		I	46	1·5-2·0	5·10	83·2	83-84·5	17·7
		II	40	5-5·5	13·60	111·0	72-73	64·0
		III	11	Oily	24·20	283·0	—	0·5
4	Wax from wash water (commercial sample)	—	—	5·5-6·5	38·20	108·0	75-78	23·0
		I	24·8	1·5-2·0	5·22	57·6	82-83·5	16·0
		II	51·2	6-6·5	15·65	87·8	72-72	68·0
		III	21·2	Oily	67·76	296·0	—	0·6

(c) *Hydrolysed lac and its modifications*

As has been mentioned earlier, lac resin is a mixture of inter- and intra-esters of various hydroxy carboxylic acids. The product of hydrolysis of lac resin is, therefore, a mixture of these constituent acids and has properties different from those of the parent resin. Such a mixture can also be produced from refuse lac and would thus be an economic starting material for modification into useful products. Such a mixture (total hydrolysed lac) and its bleached version had been prepared and their properties studied earlier (*A. Rep.*, 1968, p. 39).

The first attempt to modify this hydrolysed lac was by the application of heat. The material was heated at different temperatures (150°, 175° and 200°C) and samples were drawn at timed intervals and their constants determined. The acid, hydroxyl and carbonyl values were found to drop progressively with the time of heating while the saponification value remained almost constant. The data obtained for a typical temperature (150°C) are indicated graphically in Fig. 3). The drop in these constants during the progressive heating indicates that the carboxyl, hydroxyl and aldehyde groups were reacting under these conditions. The products remained soluble in alcohol, acetone and ethyl acetate throughout the period of heating upto the period of gelation.

The material obtained by heating total hydrolysed lac at 150°C for 6 hours seems to have very interesting properties. It is similar to shellac in many respects and different in a few. It is a tough, slightly tacky solid, soluble in all the usual shellac solvents and, again like shellac, in aqueous alkalies also. It has a melting



PROGRESSIVE FALL WITH TIME OF ACID, CARBONYL, AND HYDROXYL VALUES OF HYDROLYSED LAC AT 150°C

FIG. 3

point of 55-60°C, and acid value of 82 and saponification value of 212·1. However, the hydroxyl value is only 87 as against about 260 of shellac.

Like shellac, the reconstituted lac cured melamine resin in the cold and also readily reacted with toluene diisocyanate. It is, however, a considerable improvement over shellac in respect of the film properties of its aqueous varnishes.

Varnishes in aqueous ammonia produced smooth films of outstanding adhesion which was retained even after baking at 150°C for 30 minutes. This is in direct contrast to aqueous varnishes of shellac itself which under these conditions would have cracked and flown off the surface. The gloss of the air dried and baked films of the new resin, with and without pigment was also outstanding.

(R. K. Banerjee and S. C. Sengupta)

(d) *Bleaching of lac with chlorine free oxidising agents*

Bleached lac, also known as white shellac, is one of the forms in which lac resin is put to use in very large quantities. Almost the entire quantity of bleached lac (as distinct from decolourized lac) produced in the world today is by hypochlorite bleaching and the product invariably has very little life under heat and practically no flow. These changes in properties from those of the parent lac resin have been shown to be due to the entry of chlorine into the lac molecule during the bleaching process. It is expected, therefore, that if bleaching can be effected without this chlorine entry, the bleached lac produced would retain its life and flow unimpaired. The use of chlorine free bleaching agents is thus indicated.

A study was, therefore, initiated to investigate bleaching of lac using alternate (chlorine free) bleaching agents. Hydrogen peroxide has been tried to start with.

The effects of temperature, time and amount of hydrogen peroxide on the bleaching of lac in aqueous sodium carbonate solution were studied.

The bleaching was found to proceed slowly below 40°C and the product obtained was free flowing. At higher temperatures, bleaching was faster but the product was sticky and reversion of colour took place on drying the product. With the progress of bleaching, the pH of the solution also gradually decreased from 8·5 to 6·5. When bleaching was carried out at room temperature (22 ± 2°C) for 7 hours, the product had a colour index of 7 as against 20 of the control.

Acid, saponification and iodine values of this bleached lac (reclaimed by acidification, washing etc. as usual) were, 74·83, 225·7 and 7·1 respectively. Life was 66 minutes and flow 51 mm. The corresponding values for lac precipitated under the same conditions but without bleaching were 67·74, 221·8, 12·6, 14 minutes and 59·00 mm.

(R. S. Prasad and B. B. Khanna)

4. Determination of shellac in presence of other resins

A method was under study during the previous year (*A. Rep.*, 1968, p. 40) for the determination of shellac in presence of other resins by boiling shellac with urea in acetone solution. During the year under report, several modifications, were tried. However reproducible results could not be obtained.

(R. Prasad and T. Bhowmik)

5. Water thinned wood finish

The use of alcohol as the solvent for lac for wood finishing is well known. Alcohol is in short supply and costly and is anyway, a waste as far as the finish is concerned. It would obviously be worthwhile, if possible, to replace it by cheaper and more readily available solvent. Lac dissolves readily in aqueous alkaline solutions, water thus suggesting itself the obvious first choice for the study. Attempts were therefore made to develop lac based wood finishes with water as the principal if not, the sole solvent. Considerable study has already been made of the film properties of aqueous lac varnishes. They generally lack adequate adhesion and gloss, and are also poor in water resistance except after baking. Incorporation of water soluble resins in these varnishes was, therefore, investigated.

A shellac composition containing 20 per cent urea resin and 10 per cent meleic resin on the weight of lac was found to produce air dried films which were hard, non-tacky, smooth and glossy and resistant to water upto 3 hours and to heat upto 75°C (*A. Rep.*, 1968, p. 41).

Alternate bases for dissolution of lac were also tried and it was found that shellac varnish prepared in aqueous ammonia gave the best performance. Further experiments showed that the *quantity* of ammonia used for the preparation of the varnish played an important role on the performance of the films, especially water resistance. It was found that a varnish prepared by dissolving 25 g dewaxed lac in 4 g (liquor ammonia sp. gr. 0·88) and 96 g water at 70-75°C gave the best film properties.

With a view to improve further upon the levelling characteristics and gloss of the final finish, use of organic solvents was studied. As a result of a series of experiments, it was found that incorporation of 15 per cent alcohol on the weight of varnish improved the levelling characteristics substantially as also the gloss of the final finish. It also improved the water resistance to 4 hours and heat resistance upto 88°C.

Since urea resins are known to cure in the presence of acidic media or heat, experiments were made to stimulate the above conditions. Sulphited lac was used in place of ammoniated lac for this purpose but the varnish showed gelling within a few hours.

The effect of exposing the film to sunlight was investigated as an easy means of heat (and light) treatment. Sunlight exposure definitely improved the heat as well as water resistance of the films.

A detailed study in regard to (i) sunlight exposure for different periods of time, (ii) flash off baking in a heated chamber and (iii) low temperature baking at 65°C are being pursued.

(A. K. Dasgupta and Shravan Kumar)

6. Shellac Rubber Combinations

Enormous quantities of natural and synthetic rubbers are being used in the world today and their extent and fields of utilization are increasing day by day. A variety of resins, are used along with rubber to enhance specific properties. If lac can be incorporated into rubber with advantage even to a small extent a new outlet of considerable consumption potential for lac will be opened up. The study on the incorporation of lac with rubber was, therefore, initiated in 1965.

(a) *Incorporation of shellac in natural rubber*

(i) *In gum stock (without filler)* — Incorporation of shellac into *natural* rubber was first studied when it was found that the addition in gum stock using MBT (mercapto benzthiazole) as the accelerator improved many of the desirable properties of the rubber such as plasticity, anti-scorching tendency, tear resistance, hardness and ageing characteristic (*A. Rep.*, 1968, p. 42).

This year, the performance of shellac using another very popular accelerator, namely CBS (cyclohexyl benzthiazyl sulphenamide) was investigated. All the improvements noticed formerly were noticed in this case as well.

(ii) *Using clay as the filler* — The study was extended to compositions in which fillers were made use of. The effect of incorporation of shellac and ethylene glycol modified lac using clay as the filler is brought out in Table 15 from where it will be seen that there is a marked increase in the hardness of the resulting compositions. A notable feature is the fact that abrasion resistance remains constant whereas it has been noticed previously that in synthetic rubber abrasion resistance is invariably lowered when shellac is incorporated with fillers (*A. Rep.*, 1967, p. 37).

When ethylene glycol modified lac was used, an additional advantage obtained is increase in tear resustance.

TABLE 15 — EFFECT OF INCORPORATION OF SHELLAC OR ETHYLENE GLYCOL MODIFIED LAC ON THE RESULTANT PROPERTIES OF NATURAL RUBBER USING CLAY AS THE FILLER

Base Mix: Natural rubber, 100; clay, 100; mineral oil, 3; zinc oxide, 4; stearic acid, 1; sulphur, 2·5 MBT, 1; PNB, 1, the following:

Shellac	0	2·5	5	7·5	10	—	—	—	—
Ethylene glycol modified lac	—	—	—	—	—	2·5	5	7·5	10
Optimum cure time min. (at 140°C)	20	30	30	30	30	30	30	30	30
Modulus (at 200% elongation), kg/cm	47·9	46·4	45·3	42·1	39·1	47·7	42·4	40·1	38·4
Ultimate elongation, per cent	390	400	850	355	360	380	400	385	370
Tensile strength, kg/cm	120·2	97·4	92·6	93·0	93·7	103·0	94·0	94·1	94·7
Tear resistance, kg/cm	47·7	45·0	41·5	39·1	36·2	47·6	50·6	49·4	47·5
Durometer hardness	58	61	65	67	69	59	60	63	65
Impact resilience, per cent	64·6	48·8	45·8	43·7	41·5	50·5	45·8	43·7	43·7
Abrasion loss, ml/1000 revs.	2·03	1·9	1·93	1·95	1·99	1·82	1·81	1·85	1·9

(b) *Mechanism of interaction of shellac on incorporation in natural rubber*

Last year, the mechanism of interaction of shellac on incorporation into styrene-butadiene rubber was studied when it was found that with progressive increase in the amount of shellac, crosslink density decreased and free sulphur content increased. This year the course of vulcanization of natural rubber was studied in presence of plain and ethylene glycol modified lac.

(i) *Free sulphur content in natural rubber-shellac compositions*

To study the course of vulcanization on addition of shellac and modified lac to natural rubber, free sulphur content was estimated in the vulcanized samples according to A.S.T.M. Designation D 297-60T using MBT (mercapto benzthiazole) as the accelerator and carrying out the vulcanization at 140°C and 4000 psi pressure for four different periods of 20, 30, 45 and 60 minutes. It was found that free sulphur content decreased as the time of vulcanization increased, reaching a constant value after 45 minutes of vulcanization. It was also found that free sulphur content increased with increasing amounts of shellac.

Ethylene glycol modified lac was found to be similar to plain shellac in this respect.

(ii) *Measurement of crosslink density*

Measurement of crosslink density throws useful light on the number of cross-links created and thus helps to understand the extent of vulcanization. Cross-link density was determined by swelling in pure benzene till equilibrium was reached and calculated using Flory Rehner equation. It was found that cross-link density decreases by the addition of shellac and ethylene glycol modified lac, the decrease being less with unmodified shellac.

(iii) *Addition of magnesium oxide as an ingredient*

It has been reported by J. R. Scott (*J. Sci. indust. Res.*, **3** (1945), 345) that addition of magnesium oxide to rubber-shellac compositions has a beneficial effect on their mechanical properties.

However, when MBT (mercapto benzthiazole) was used as the accelerator, no such improvement in physical properties like modulus, tensile strength and tear-resistance was noticed. The free sulphur content also showed no improvement.

(D. K. Guha Sarkar and B. B. Khanna)

7. Electrical Properties of Modified Lacs

Amino resins have been shown to be valuable additives to shellac to improve heat and water resistance of its films. Melamine resin was particularly suitable because the improvements were produced even in air dried films. The optimum proportion was 40 per cent of the melamine resin on the weight of lac. Preliminary experiments had also indicated improved electrical properties of these films (*A. Rep.*, 1965-66, p, 47). This aspect was systematically studied during the year under report.

Varnishes were prepared of dewaxed shellac and (butylated) melamine resin blend in different proportions and tested for their break down voltage (BDV) under the usual condition (vide B.S. Specification 119/1933). Tests were made at 25° and 90°C after conditioning the samples at 95°C for 2 hours. BDV of the films was found to increase with increasing proportions of the melamine resin in the varnish reaching a maximum of 2280 volts/mil (parent lac, 800 volts/mil) for a varnish containing 60 parts of lac and 40 parts of melamine resin (Fig. 4). Further increase in the proportion of melamine resin resulted in a slight fall in BDV.

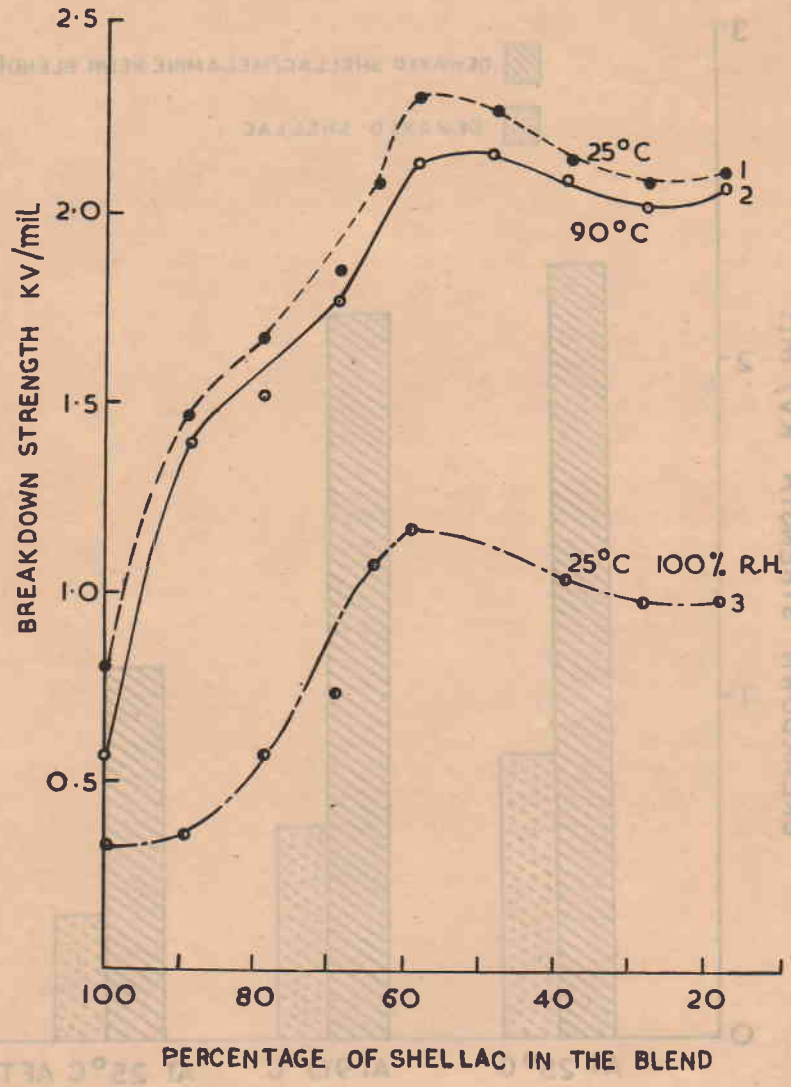
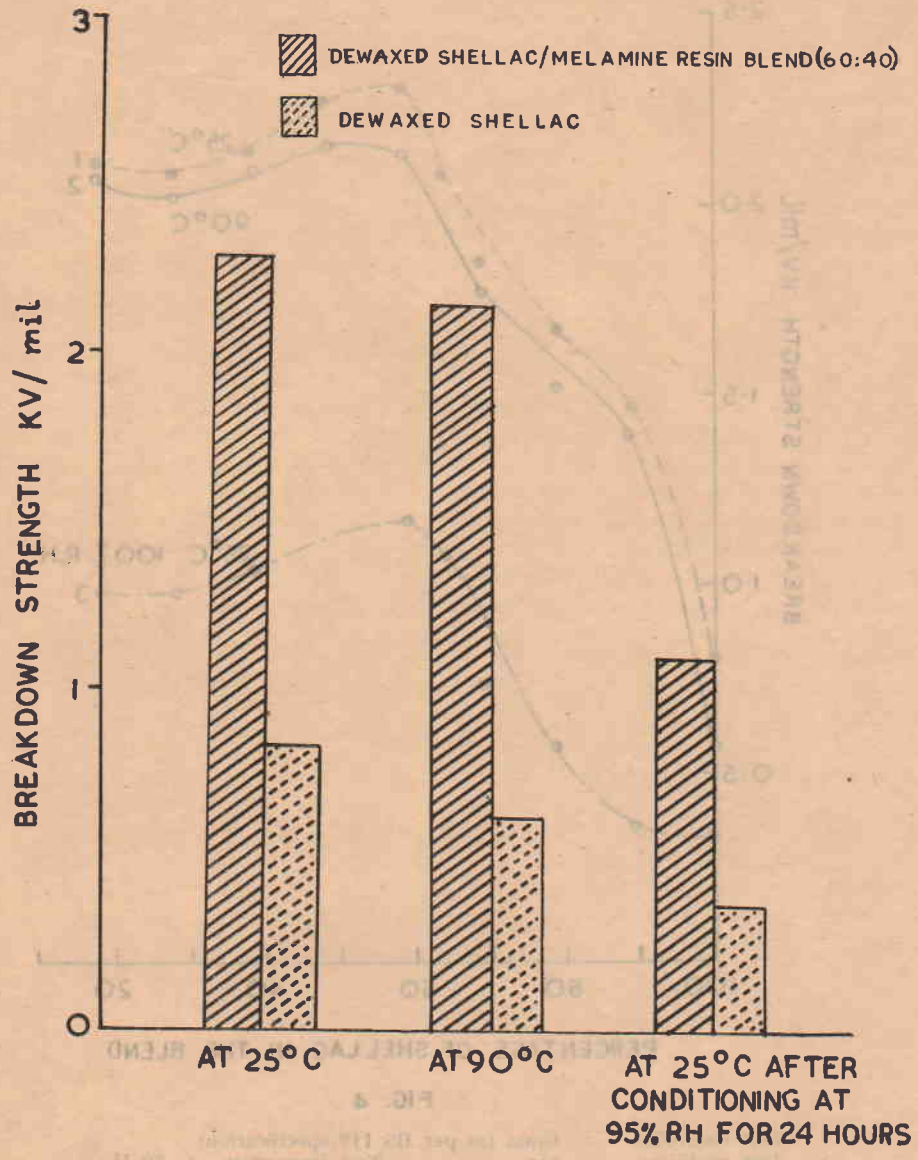


FIG. 4

Test electrodes	:	Brass (as per BS 119 specification)			
Test medium	:	Air	Test frequency	:	50 H
Test time	:	10 seconds	Thickness of film	:	6·5±1 mils

Moisture resistance was also considerably improved as will be evident from the BDV of a film tested at 25°C after conditioning at 100 per cent RH for 24 hours which was 1 kv/mil as against 300 of the parent lac. Thus a varnish containing dewaxed shellac (60 parts) and melamine resin (40 parts) is a very great improvement over straight dewaxed shellac varnish as far as breakdown voltage of the films is concerned (Fig. 5). Other electrical properties of the composition are under study.

(T. R. Laxminarayanan and Y. Sankaranarayanan)



BREAKDOWN VOLTAGE OF SHELLAC/MELAMINE RESIN VARNISH FILMS

FIG. 5

8. Use of lac and modified lacs in surface coatings

(a) *Electrodeposition of shellac varnishes, primers and paints*

Electrodeposition, also known as electrocoating, anodic coating etc., is the most recent technique for the application of paints and varnishes to conducting

surfaces. A systematic study of the possibilities of shellac for use as the vehicle for the formulation of such paints and varnishes has been under investigation since 1967.

A satisfactory coating composition based on shellac (100 g), triethanolamine (25 ml) and red oxide (100 g) had been developed for the purpose. The optimum electrical requirements has also been determined (*A. Rep.*, 1968, p. 46).

During the year under report, the properties of electrodeposited films on untreated and phosphated mild steel panels were studied. Panels, after degreasing with trichloroethylene, were pickled with 15 per cent hot sulphuric acid and finally phosphated with zinc phosphate solution. It was observed that films deposited on phosphated panels, though comparatively thin, were more corrosion resistant irrespective of the composition of the primer. Other properties of the films such as scratch hardness, flexibility and adhesion were, however, more or less of the same order both on untreated or phosphated panels. The coating characteristic of the primers was found to differ on different mild steels; the primer composition suitable for a particular steel was found unsuitable for another.

Films were also deposited at different voltages (25-150 volts), temperatures (25-45°C) and periods (2-4 minutes) in order to improve corrosion resistance but no significant differences were noticed.

Different formulations based on shellac alone, shellac/alkyd, shellac/maleinized oil, shellac/epoxy and partially esterified lac, with different proportions of red oxide and binder were tried. The most satisfactory were the last two. In the above primers, the best throwing power was obtained with pigment binder ratios of 1: 1, 1: 1, 1: 2, 2: 1·5 and 1: 1 respectively.

Hydrogen ion concentration (pH-value) and specific conductivities of different varnishes, pigmented and unpigmented, were also determined at different temperatures (25-40°C) at intervals of 5°C, in varying dilutions and base concentrations. The bases used were ammonia, triethanolamine and morpholine. Specific conductivities were found to increase with rise in temperature. On dilution from 25 to 20 per cent solid concentration, practically no change in specific conductivities was noticed, but on further dilution it decreased rapidly. The pH was found to increase with the increase in temperature and the amount of base, but remained unaltered on dilution.

(A. Pandey and Y. Sankaranarayanan)

(b) *Lac-oil combinations modified with polyisocyanates*

Film properties of shellac-linseed oil-glycerol compositions modified with toluene di-isocyanate were reported earlier (*A. Rep.*, 1967, p. 37). In order to minimise the proportion of unreacted glycerol in the composition, the proportions were modified by reducing the quantity of glycerol from 15 to 10 per cent and increasing the amount of litharge from 0·5 to 1·0 per cent. The following was the final composition tried:

Linseed oil	...	100 parts
Glycerol	...	10 ,,
Litharge	...	1 ,,
Shellac, dewaxed	...	55 ,,

The linseed oil, glycerol and litharge were heated together at 250°C for one hour and the dewaxed lac added proportionwise. Heating was continued for a

further one hour. Hundred parts of this product was diluted with 60 parts of a mixture of white spirit and xylene (3: 1) and pigmented with 70 parts of titanium dioxide, one part of cobalt naphthenate (6 per cent cobalt) was added and the resulting paint cured with 7 to 10 per cent (on the wt. of paint composition) of toluene diisocyanate. Films of this paint on mild steel and wood panels became touch dry in 2 hours. After one week of air drying, they were very hard (scratch hardness more than 2 kg), glossy and smooth and resistant to many organic solvents. They also resisted corrosion on exposure in a salt spray cabinet for 10 days.

(c) *Lac modified with epoxy resin*

It has already been shown that shellac could be modified with epoxy resins by fusing them together at 150°C for 15 to 20 minutes. A coating composition prepared by dissolving the fused product in a mixture of alcohol and toluene (45: 55) was found to give excellent performance after baking (*A. Rep.*, 1964-65, p. 16).

However, for purposes of this modification, the technique of fusion for such a short period is not satisfactory and is unsuitable for large scale production. Studies were, therefore, undertaken to find out conditions for carrying out this modification in a solvent system, with or without catalyst.

The common solvents for uncured epoxy resins are ketones, esters and ethers which, incidentally, are not good solvents for shellac. Solubility of shellac/epoxy resin mixture in different solvent mixtures such as alcohol: toluene or benzene or acetone, butanol: xylene, and benzene: methyl ethyl ketone was, therefore, tried. The most satisfactory was butanol: xylene mixture in the ratio of 1: 1 to 1: 2 which, incidentally has the additional advantages of immiscibility with water and higher boiling point (117°C).

Shellac (dewaxed) and epoxy resin (epikote 1001) in different proportions were refluxed in butanol: xylene mixture (1: 1) with simultaneous removal of the liberated water, for 2 to 8 hours. Acid values of these products were determined. The results are shown in Table 16.

TABLE 16 — SHELLAC EPOXY RESIN COMBINATIONS

Composition No.	Lac	Epoxy resin	Time of reflux (hours)	Acid values		Drop in acid value
				Before reaction (calculated)	After reaction (found)	
1	100	30	6	56·0	44·4	11·6
2	100	30	8	56·0	42·1	13·9
3	100	30	10	56·0	40·9	15·1
4	100	40	2	52·0	45·1	6·9
5	100	40	4	52·0	35·6	16·4
6	100	40	6	52·0	32·7	19·3
7	100	40	8	52·0	31·8	20·2
8	100	50	6	48·50	37·1	11·4

It was also found that if the reaction was carried out in presence of 1-2 per cent of dicyandiamide, there was rapid increase in the viscosity of the solution which started gelling in 2 hours.

Film properties of these products were also studied. The compositions showed considerable improvement over shellac in respect of hardness, flexibility and resistance to chemicals and solvents. These properties could be further improved by dissolving 1 per cent dicyandiamide in the coating composition.

(d) *Water based lac/epoxy coatings*

It will be seen that the lac/epoxy combinations described above have substantial acid values. The possibility of their use in water thinned composition was, therefore, investigated. Composition 5 (of Table 16) was quite suitable. For this purpose, dicyandiamide (1 per cent on total solids) was added to this and a portion of the solvent distilled off to give a product with 60-70 per cent solid content. This was added to water containing triethanolamine (10 per cent on solid content).

A clear solution was obtained. The resulting varnish produced clear films which, after baking at 150°C for 30 minutes, were hard, glossy and possessed outstanding adhesion, elasticity and solvent resistance. This was also pigmented with red oxide (30 per cent PVC). The resulting primer composition, when coated on mild steel by sray or brush, and baked at 150°C for 30 minutes was found to be quite hard and flexible and stood salt spray test for 10 days.

This primer was also found to be suitable for application by electrodeposition technique.

(S. K. M. Tripathi and Y. Sankaranarayanan)

(e) *Water thinned red oxide primers*

In the earlier reports, production of a baking type primer based on dewaxed lac, maleinized linseed oil and red oxide and other anticorrosive pigments and their mixtures was reported (*A. Rep.*, 1968, p. 30).

Preparation of the maleinized linseed oil used in these involved the washing out of the unreacted maleic acid from the reaction mixture. Further work was carried out in order to avoid this step and to reduce the baking time of the primer, if possible, as is desired by the industry.

A maleinized oil prepared under the following conditions was found satisfactory. To 100 parts of alkali refined linseed oil, heated to 220 ± 5°C in a closed system with an air condenser and under continuous mechanical stirring 30 parts of maleic acid was gradually added in small lots and after the addition, heating continued for 4 hours. The product was then cooled to 50°C and dissolved in twice its weight of aqueous ammonia (1 volume ammonia, sp. gr. 0·91, diluted with 3 volumes of water). A homogeneous transparent solution was obtained.

The primer was prepared as usual with the following ingredients.

Aqueous lac maleinized linseed oil varnish (25 per cent solid) containing 60 parts dewaxed lac and 40 parts maleinized linseed oil	100
Pigment	100
Talc	1
Zinc oxide	0·5
n-Butylamine	2

The best performance was observed with following pigment mixtures.

i)	Red oxide + mica powder (200 mesh)	75 : 25
ii)	Titanium dioxide + aluminium powder	30 : 70
iii)	Red oxide + barium potassium chromate + mica powder (200 mesh)	75 : 3 : 22

These primers could be baked either at 150°C for 30 minutes or at 175°C for 10 minutes. The baked films compared well in performance with the earlier primers produced after washing the maleinized oil with water in all respects including salt spray corrosion test.

(P. C. Ghosh and Shravan Kumar)

(f) *Solvent release of shellac films*

As is well known, films of shellac produced from its varnish in alcohol retain minute proportions of the solvent for a considerable time and this naturally affect the properties of the films. It is also known that solvent release can be accelerated or retarded by using other solvents along with alcohol. A systematic study to investigate conditions for the most rapid release of the solvent, used alone or in admixture, from such films will thus be of much practical importance. Such a study was taken up in 1968. The extent of solvent release was determined by estimating the ethoxyl content of the films from time to time. Some preliminary results were reported last year (*A. Rep.*, 1968, p 29).

During the year, the rate of decrease in ethoxyl contents from films (1·3 mil thick) prepared with 40 per cent solution of dewaxed decolourised lac (platina) and dewaxed lemon were studied. The films were exposed at 40°C in an oven or stored at room temperature. The films from platina shellac were found to dry to a constant ethoxyl content of 0·53 and 1·05 per cent in 34 days at 40°C and 106 days at room temperature respectively (Fig. 6).

The parent platina lac, after drying to constant weight free from solvent, had an ethoxyl content of 0·53 per cent presumably because of chemically combined alcohol.

(Radha Singh and P. R. Bhattacharya)

(g) *Lac modified with melamine resin (Melfolac)*

(i) *Accelerated curing of Melfolac*

Mention has been made that Melfolac (dewaxed lac varnish modified with butylated melamine resin) when catalysed with 1·25 per cent *p*-toluene sulphonic acid or hydrochloric acid produced hard, smooth and glossy films and acquired satisfactory heat and water resistance within 24 hours of the preparation of the film.

Further experiments were carried out to find out the optimum percentage of the above catalysts. It was found that addition of even 0·5 per cent HCl or *p*-toluene sulphonic acid produced water resistance of the films within 24 hours but heat resistance was obtained in 24 hours only when the catalyst was at least 1·25 per cent.

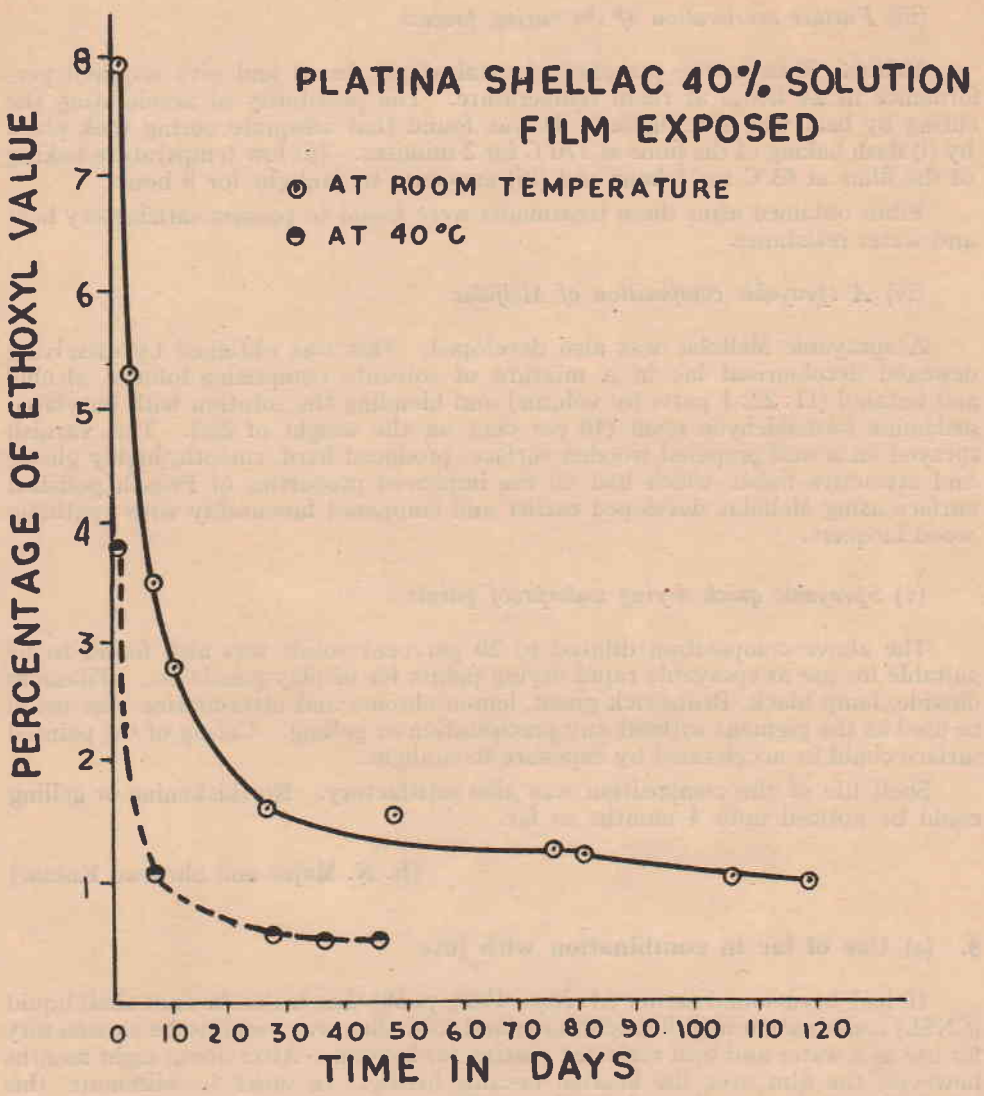


Fig 6

(ii) *Performance of Melfolac in different slovents and solvent mixtures*

With a view to find out alternate solvents for Melfolac, shellac varnishes were prepared in different solvents such as methanol, ethanol, propanol and *iso*propanol and blended with the requisite quantities of melamine resin. Turbidity appeared in the varnish in methanol while all others were perfectly clear. These varnishes were catalysed with 1·25 per cent *p*-tolune sulphonic acid and films were prepared on wood, tin and glass and examined. Only the varnish in *iso*propanol was found to be the most satisfactory. Solvent mixtures were also tried in different proportions. Toluene and ethanol in the ratio of 1: 2 appeared to be the most suitable.

(iii) *Further acceleration of the curing process*

Melfolac films in the presence of catalyst get cured and give required performance in 24 hours at room temperature. The possibility of accelerating the curing by heat was investigated. It was found that adequate curing took place by (i) flash baking of the films at 170°C for 2 minutes. (ii) low temperature baking of the films at 65°C for 1 hour and (iii) exposure to sunlight for 8 hours.

Films obtained after these treatments were found to possess satisfactory heat and water resistance.

(iv) *A sprayable composition of Melfolac*

A sprayable Melfolac was also developed. This was obtained by dissolving dewaxed decolourised lac in a mixture of solvents comprising toluene, alcohol and butanol (11: 22: 1 parts by volume) and blending the solution with butylated melamine formaldehyde resin (40 per cent on the weight of lac). This varnish sprayed on a well prepared wooden surface, produced hard, smooth, highly glossy and attractive finish, which had all the improved properties of French polished surface using Melfolac developed earlier and compared favourably with synthetic wood lacquers.

(v) *Sprayable quick drying waterproof paints*

The above composition diluted to 20 per cent solids was also found to be suitable for use as sprayable rapid drying paints for display panels etc. Titanium dioxide, lamp black, Brunswick green, lemon chrome and ultra-marine blue could be used as the pigment without any precipitation or gelling. Curing of the painted surface could be accelerated by exposure to sunlight.

Shelf life of the composition was also satisfactory. No thickening or gelling could be noticed upto 4 months so far.

(R. N. Majee and Shravan Kumar)

9. (*a*) Use of lac in combination with jute

It had been found earlier (*A. Rep.*, 1968, p. 50) that lac/cashewnut shell liquid (CNSL) combination modified with urea and formaline was found to be satisfactory for use as a water and heat resistant coating for hessian. After about eight months however, the film over the hessian became brittle. In order to eliminate this brittleness, the proportion of CNSL was increased keeping the other ingredients same. But no improvement was observed. Several other plasticizers like castor oil, dibutyl phthalate and linseed oil fatty acids were tried but without success. Shellac was then partially and totally replaced by ester of lac but the films became brittle after eight months. Ethers of lac were also tried but in this case also the film did not stand the temperature and the portion which remained over the hessian was also brittle.

Moulding powder

In order to improve the moulding properties of shellac compositions phenol/formaldehyde resin was incorporated in different proportion with lime and hexa-

methylene tetramine as accelerator for the phenolic resin. It was found that on increasing the proportion of phenol/formaldehyde resin from 0 to 50 per cent, and reducing the curing time from 21 to 3·5 minutes the impact strength increased from 1·12 to 2·22 cm kg/sq cm. Further work is under progress.

(M. Islam and T. Bhowmik)

(b) Use of lac for coating urea fertilizer

Studies had been initiated to investigate the suitability of shellac for coating fertilizer granules in order to reduce their hygroscopicity and caking tendency and to retard their leaching rate in the soil to effect economy in their use.

A composition based on lac and linseed oil was developed to coat urea fertilizer, which reduced the hygroscopicity of the granules by 75 per cent (*A. Rep.*, 1968, p. 51). During the year under report, a few agronomical studies were conducted for evaluation of the usefulness of this coated urea..

(i) *Jute*

Fourteen treatments using nitrogen at two levels, namely control (two, coated urea (40 and 80 kg N/ha), uncoated urea (40 and 80 kg N/ha) and ammonium sulphate (40 and 80 kg N/ha) with 4 replications were studied and were carried out with an improved *Corchorus olitorius* jute crop (variety J.R.O. 632). These were conducted in pots containing six plants each. Fertilizers were applied by two methods, viz. basal (before sowing) and top dressed (at 4 weeks crop age). It was found (Table 17) that coated urea was superior to the uncoated fertilizer in respect of plant growth, base diameter and crop yield. Base diameter was found highest with coated urea at 80 kg N/ha (basal). Average fibre content per plant was also better at both levels of nitrogen as well as method of application.

(ii) *Hybrid maize*

Six different treatments namely control, coated urea-100 (split and full dose), uncoated urea-100 (split and full dose) and coated urea-75 (split dose) replicated five times, were also carried out on hybrid maize (Ganya safed-2) crop sown in microplots (12′×9′) of randomized block design. Plant height was recorded first after one month of sowing and thereafter two times at every twenty days. The matured crop was harvested and grain and dry foliage yield were recorded for statistical analysis.

Besides, agronomical studies on wheat (Kalyansona S-227), spinach and leafy crops are also being carried out with the above mentioned six treatments. Transformation studies, leaching behaviour and caking properties are also under study.

(B. C. Srivastava and T. Bhowmik)

10. Lac and modified lacs as adhesives

Shellac has been used in varying quantities as a thermoplastic adhesive and cement for a variety of surfaces but not much attention appears to have been paid for a systematic study of the resin and its modifications in this promising field of application. This study was therefore, initiated during the year under report.

The effect of temperature, pressure and time on the adhesive property of different kinds of shellac (*Kusmi*, *Rangeeni* and dewaxed) between steel panels have been studied making use of a Hounsfield Tensometer.

TABLE 17 — USE OF COATED UREA FOR JUTE CROP

Sl. No.	Fertilizer used		Fertilizer applied Basal (before sowing)			Fertilizer application Top dressed (at 4 weeks crop age)		
	Material	Rate kg N/ha	Average base diameter (cm)	Average plant height (cm)	Average fibre yield (g)	Average base diameter (cm)	Average plant height (cm)	Average fibre yield (g)
1	Control	40	1·277	229·7	10·10	1·277	229·7	10·10
2	Coated Urea	40	1·410	225·5	12·67	1·420	239·7	13·05
3	Uncoated Urea	40	1·357	224·0	11·22	1·332	226·5	12·52
4	Ammonium Sulphate	40	1·315	238·0	11·95	1·255	241·0	12·52
5	Coated Urea	80	1·530	240·0	13·70	1·455	231·0	13·40
6	Uncoated Urea	80	1·417	225·0	13·55	1·310	234·2	12·82
7	Ammonium Sulphate	80	1·395	243·2	13·03	1·372	230·0	13·30

Five readings for each set were recorded by changing one variable after another and keeping the other two constant. The following method was used:

0·5 ml of a 10 per cent (w/w) alcoholic solution of the shellac was spread over an area of 2·5×2·5 cm as uniformly as possible on two polished and cleaned (free from oil and grease) mild steel panels. After over night drying the panels were baked at 90-95°C (steam oven) for an hour, placed exactly one over the other and hot pressed in a press under different pressure, temperature and time. After 24 hours the bond strength of each pair were determined with the help of the Tensometer. The results are reproduced in Table 18.

TABLE 18 — NUMBER OF BEAM IN TENSOMETER — D19, NUMBER OF SCALE IN TENSOMETER — 0·5 TON

Sl. No.	Temperature in °C	Pressure in lbs/ sq. inch	Duration of pressing in hours	Force in ton		
				Rangeeni	*Kusumi*	D1
1	150	2000	0·5	0·085	0·072	0·090
2	150	2000	1	0·070	0·110	0·183
3	150	2000	1·5	0·150	0·198	0·065
4	150	2000	2	0·198	0·165	0·160
5	150	2000	2·5	0·140	0·266	0·150
6	150	400	1	0·122	0·102	0·219
7	150	800	1	0·132	0·140	0·209
8	150	1200	1	0·118	0·125	0·195
9	150	1600	1	0·090	0·104	0·171
10	150	2000	1	0·070	0·110	0·183
11	100	2000	1	0·065	0·057	0·120
12	125	2000	1	0·069	0·108	0·138
13	150	2000	1	0·072	0·110	0·183
14	165	2000	1	0·130	0·173	0·220
15	185	2000	1	0·162	0·210	0·268

The highest bond strength (0·628 tons) was obtained with DL lac by pressing for 1 hour at 185°C and under 2000 lbs/sq inch pressure. The bond strength of 'Araldite' (Epoxy adhesive) bonding obtained by slight clamp pressure at room temperature for 24 hours was incidentally determined to be 0·446 tons.

Shellac modified at 150°C with various proportions of epikote (828) resin using dicyandiamide as catalyst was tried for the preparation of micanite sheets. It was found that good micanite sheets can be prepared with the compositions containing shellac and epikote resin in the proportion of 7:3 and 8:2.

(N. Prasad and T. Bhowmik)

(c) RESEARCHES CONTEMPLATED

Studies on the determination of the age of seedlacs, preparation of shellac esters and their modifications, and bleaching of shellac wax have been completed during the year. The rest of the studies already in hand will be continued. Besides, the following are also proposed to be taken up for investigation during 1970.

1. Studies on the Blocking of lac.
2. Depolymerization of lac.
3. Formulation and properties of shellac emulsions and emulsion paints.
4. Application techniques of French polish.

SPONSORED RESEARCH SCHEME

1. Constitution of lac

(a) *At Delhi University*

A preliminary series of oxidation experiments were carried out on aleuritic acid and the various breakdown products were isolated and identified (*A. Rep.*, 1968, p. 52).

The basic information thus obtained has been utilised in a study of the oxidative degradation of lac resin. Oxidation with potassium permanganate and hydrolysis under different conditions have led to some useful information regarding the mode and positions of linkages of aleuritic acid, in the resin formation. The results provide positive evidences for the presence of alkali stable links in the resin. In general, polymerisation seems to involve mainly 9 and 10 hydroxyls in both alkali stable and labile links, with partial involvement of 16 hydroxyl through ester links.

A sequence of reduction and hydrolysis experiments have been carried out with lac resin. These experiments are expected to give useful informations regarding the degree of primary contribution by the different terpenic acids in the resin formation.

(T. R. Seshadri and coworkers)

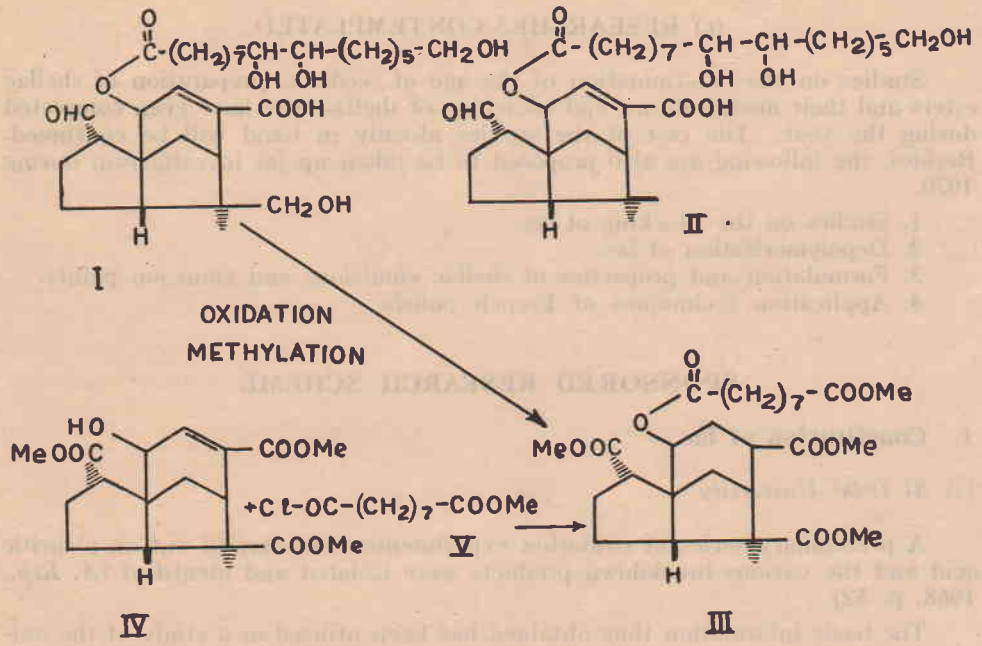
(b) *At National Chemical Laboratory, Poona*

The isolation and characterization of laccijalaric acid, a new aldehydic acid in the terpenic series (m.p. 164-65°C), from hard resin, prepared from *palas* seedlac, were reported (*A. Rep.*, 1968, p. 52).

During the period under report, smaller basic units of lac, esters, composed of (a) one mol. each of aleuritic and jalaric acid and (b) one mol. each of aleuritic and laccijalaric acid, were isolated from soft resin of *palas* seedlac, by fractional.

precipitation procedure. They were further purified by careful chromatography on silica gel. Based on the spectral data of these pure compound and their oxidative degradation products, structures have been assigned to them (I and II).

Oxidation of (I) with Jones reagent and methylation of the oxidised product gave the ester (III) which has been synthesized from hydroxy triester (IV) and the acid chloride of azelaic acid half ester (V).



(Sukh Dev and coworkers)

2. Shellac based Leather Finishes at Central Leather Research Institute, Madras

A series of acrylic polymer emulsions based on shellac and acrylic monomers in varying proportions with additional advantages like improved gloss, adhesion and water resistance were developed for leather and shoe finishing (*A. Rep.* 1968, *p.* 54). The harder type of resins are highly suitable for top coats and shoe finishes owing to their better properties like high gloss, nontack and flexual endurance. The softer varieties with higher amount of acrylic esters could be used as normal leather finishing agents.

A small scale production of these hard and soft varieties of shellac acrylic resins has been successfully standardized in the experimental production unit. The products have been tested widely with satisfactory results. The product is expected to cost about Rs. 10/- per kg.

Preparation of tanning agent from shellac by oxidising it to aldehyde was tried. For this purpose shellac was hydrolysed and aleuritic acid, was separated. Then aleuritic acid was oxidised with the required amount of sodium metaperiodate at pH 6-7. The aldehyde thus formed was analysed qualitatively and quantitatively. Similarly aldehydes were prepared from sulphated lac and ammoniacal

lac. Oxidation of sulphated lac by hydrogen peroxide was also tried. All these products contained 1%, 2% and 5% aldehyde respectively.

A new lac syntan was prepared by preparing novalac syntan first, then condensed with lac, followed by sulphonation with sulphuric acid. Tannery trials showed that the syntan can be used for retanning and neutralization of upper leather. A composition based on hydrolysed lac was tried for grain impregnation of upper leather by pad application. It is found to improve the break and cutting value.

In reclaiming mica sheet, from mica pieces top dress MSS was tried as an adhesive. The method of application, concentration of adhesive to be used, method of drying, temperature and pressure at which it should be pressed were standardized. Samples were prepared and sent to Japan for testing report. These sheets are used in aleuritic insulations.

Shellac based detergent and emulsifier was successfully prepared. One mole of shellac was modified with one mole of maleic acid and subsequently bisulphated, with one mole of sodium bisulphite. The resulting compound was soluble in water having pH 5·5. It is stable at pH 2·0 as well as pH 7·0. This compound can be used both as emulsifier and detergent. When it was used as a retanning material in chrome sandwich, the leather thus obtained was tight, full and smooth.

The dyeing properties of lac retanned suedes were compared with full chrome and wattle retanned suedes. It has been observed that lac retanning improved the fullness and feel and resulted in better nap and affected only to a small extent the dyeing property. When compared with wattle retanned leather the dyeing property of lac retanned leathers was better. However the grain pattern was affected if it was not shaved.

Attention wasc oncentrated on the problem "nonaqueous shellac based varnishes for leather and leather goods". viz. modifications of shellac with ethylene glycol and polythylene glycol etc. and thinning with suitable solvents to act as a plasticizer for free lac. The optimum conditions for the reaction, compatibility, stability and suitability of solvents were studied.

To reduce the tackiness of solvent based top dress composition action of carbowax, diisocyanate, cobalt and lead dress, urea formaldehyde resin, maleic and silicon modified lac were tried without success.

Pilot plant production and sales of wax emulsion, top dress MS and MSS were continued.

(Y. Nayudamma and coworkers)

3. PAPERS PUBLISHED

Publications and Patents

(a) *Publications*

The Institute used to publish its research findings in the form of bulletins, technical notes, research notes etc. Nowadays, these are generally first published in leading Scientific Technical journals and re-issued in the form of bulletins, research notes etc. In addition, a few books and one monograph have also been published and some of these in Hindi and other Indian languages too.

The total number of publications as on 31st December 1969 are as below:

1. Bulletins	
i) Chemical	92
ii) Entomological	29
2. Technical notes	30
3. Research notes	
i) Chemical	70
ii) Entomological	36
4. Miscellaneous technical publications	
i) Physico-chemical	25
ii) Entomological	48
5. Books	14
6. Pamphlets and leaflets	24

(b) *Patents*

A complete list of the Institutes' publications together with those of a sister organization, the erstwhile London Shellac Bureau, is supplied free on request.

3. LIST OF PAPERS PUBLISHED DURING 1969

A. ENTOMOLOGY DIVISION

Sl. No.	Authors	Title of paper	Name of the journal/ date of publication
1	Gokulpure, R. S.	Studies on the larval emergence from the *Rangeeni* lac insect *Kerria lacca* (Kerr)	*Proceedings of the Indian Science Congress Association* 1969, Part III (Section of Agricultural Science), p. 617
2	Gokulpure, R. S.	Record of Tachinids from Central India	*Indian Forester*, **93** (3), 1969
3	Majumdar, N.	Paddy Stemborers and feasibility of their biological control	*Farmer*, Vol. **1** (1), 1969
4	Mehra, B. P. and Dasgupta, J. M.	New record of Dragon-Flies as a predator of Green Lacewings	*Indian Journal of Entomology*, Vol. **31** (Part 3), 1969
5	Mishra, R. C. and Mehra, B. P.	First record of *Ficus tinctoria* Forst. f. ssp. *parasitica* (Willd) Corner. as a host of *Kerria lacca* (Kerr), from India	*Indian Journal of Entomology*, Vol. **31** (Part 2), 1969
6	Purkayastha, B. K.	Studies on the introduction of *Moghania macrophylla* for cultivation of lac	*Indian Forester*, **95** (8), 1969

7	Purkayastha, B. K. and Bhattacharya, A.	Alternation of *Albizzia lucida* Benth with *Moghania macrophylla* (Willd) O. Ktze for cultivating *Kusmi* strain of lac insects	*Proceedings of the Indian Science Congress Association*, 1969, Part III (Section of Agricultural Science), p. 617
8	Sah, B. N. and Mehra B. P.	Bionomics of *Hypena iconicalis* Walker, a pest of *Moghania macrophylla* (Willd.)	*Indian Journal of Entomology*, Vol. 31 (Part 4), 1969, p. 354

B. CHEMISTRY DIVISION

1	Dasgupta, A. K. and Shravan Kumar	Study of the nature of reaction between lac and urea resin	*Proceedings of the Indian Science Congress Association*, 1969, Part III (Section of Chemistry), p. 166
2	Gupta, P. C. and Sankaranarayanan, Y.	Shellac Allyl ether/ester	*Paintindia*, Vol. **19**, No. 1, Jan. 1969
3	Gupta, P. C., Mukherjee, M. and Sankaranarayanan, Y.	Modification of Alkyl ester with Toluene Diisocyanate	*Paintindia*, Vol. **19**, No. 9, Sep. 1969
4	Ghosh, P. C. and Shravan Kumar	Effect of solvents on the film properties of lac	*Paintindia*, Vol. 19, No. 10, Oct. 1969
5	Ghosh, P. C. and Shravan Kumar	Water thinned Shellac Primer for Steel — Effect of corrosion inhibitors	*Paintindia*, Vol. **19**, No. 11, Nov. 1969
6	Ghosh, A. K. and Sen Gupta, S. C.	Utilization of byproducts of Lac Industry: Part II — Manufacture of shellac from refuse lacs	*Research and Industry*, Vol. **10**, No. 1, 1969
7	Khanna, B. B.	Modified lacs as compounding ingredients of Styrene-Butadiene Rubber: Part III — Ethylene Glycol Modified lac in Gum Stock	*Research and Industry*, Vol. **10**, No. 4, 1969
8	Prasad R. and Bhowmik, T.	A method of differentiating *Kusmi* and *Rangeeni* lacs	*Research and Industry*, Vol. **10**, No. 1, 1969
9	Srivastava, B. C. and Bhowmik, T.	On few tried Industrial Shellac Formulations	*Paintindia*, Vol. **19**, No. 11, Nov. 1969
10	Tripathi, S. K. Mani and Misra, G. S.	Oil Modified Urethane Coatings from shellac, Part II	*Research and Industry*, Vol. **10**, No. 3, 1969

4. EXTENSION

(a) ENTOMOLOGY DIVISION

As already indicated in the previous reports (A. Rep. 1968, p. 58) all activities relating to extension of lac cultivation are the responsibilities of the Directorate of Lac Development under the Ministry of Food & Agriculture, Government of India, the functions of this Institute being limited to providing necessary technical assistance to those interested. The principal activity in this regard during the year under report was forecasting of the data of larval emergence during the different seasons and determination of the causes of excessive mortality of lac insects and crop failures on the basis of examination of samples received from different regions.

The other major activity was assistance rendered to the Forest Department of the Government of Bihar in regard to " Large scale cultivation of lac on *palas* at Kundri (a hot area). However, another project namely " Establishment and maintenance of *Kusmi* broodlac demonstration farm at Maheshpur Sirka " had to abandoned due to certain technical difficulties faced by the Forest Department, Bihar.

Large Scale cultivation on *palas* at Kundri

These experiments have been going on in Kundri Lac orchard for the past several years. The orchard has a total of about 40,000 *palas* trees.

During the year approximately a total of 14,700 trees were pruned in April/ May for raising the *Baisakhi*-cum-*Katki* crop and were inoculated with 4164 kg of brood produced in the area itself. The existing crop on another, 12,000 trees were harvested which yielded 8160 kg broodlac of which 3996 kg of surplus broodlac was scraped as there was no market for broodlac. The total sticklac yield was 6623 kg fetching a revenue of Rs. 3552.75 to the Forest Department.

(R. C. Mishra)

Namkum Plantation

General upkeep of the plantation was maintained as far as possible. Hoeing and weeding were carried out as and when necessary. Seedlings of various lac hosts were raised in nursery beds for restocking vacant places and for use in pots for laboratory experiments. Infestation of termites could be controlled to a large extent by periodical spraying of aldrex.

(B. K. Purkayastha)

(B) CHEMISTRY DIVISION

Unlike extension of cultivation, extension activities regarding processing and utilization aspects of lac are the complete responsibility of this Institute. The Institute has a " Utilization Section ", for this purpose, the main functions of which are technical service, developmental activities, and demonstration of and publicity and propaganda for the Institutes' research findings.

During the year, increasing interest was noticed in the use of shellac as water based compositions and compositions without use of spirit. Several enquiries for supply of shellac and bleached lac in large quantities were received, part supplies were assured from the Production Unit.

Technical Service

Literature and Technical information were, as usual, supplied to several interested parties on request. Free samples of newer products developed were also supplied to interested organizations for their trial. In a few cases practical assistance was also provided by deputing our staff to the premises of the interested parties to demonstrate processes or offer assistance to solve their technical problems.

A few of the more important parties who were thus assisted are indicated below:

Sl. No.	Party	Item of interest	Sample/information supplied
1	Ceylon Institute of Scientific and Industrial Research	Gasket Shellac Compound	Method for testing Gasket Shellac Compound
2	(a) M/s. A. M. Jordon P Co. Calcutta (b) Shellac Corporation of India Gondia (c) M/s. Sukhdeo Agarwal & Sons, Gondia	Mechanization of lac processing units	Technical information
3	National Metallurgical Laboratory Jamshedpur	Shellac Compositions for use as binder for sand moulds and cores	Samples
4	Research Design & Standard Organization, Indian Railways, Lucknow	Composition for stopping leakage in vacuum hoze pipes	Sample impregnated into a 20 per cent solution hydrolyzed lac and water soluble lac (80: 20) in aqueous ammonia. This was found satisfactory
5	M/s. S. R. Industries, Bangalore-5	Water based paint for fibre boards	Sample: Water soluble shellac (30) Water (70) Hydrolyzed lac (2) Triethanolamine (1) Redoxide (30)
6	Precision Shoe Lasts Factory, Ministry of Industry, Govt. of India	Formulations for polishing shoe lasts	Samples: *For polishing* 25 per cent shellac solution *For filling* A mixture of shellac and bees wax (75: 25)
7	Micanite Manufacturing Industry, Kodarma, Hazaribagh	Adhesive Composition to replace PVA	Samples: 25 per cent shellac (DW) and 5 per cent hydrolysed lac solution in aqueous triethanol mine
8	Forest Department, M.P.	Analysis of sticklac samples	Test results of 200 samples for disposing off by suggesting market value
9	Glaxo Laboratories, Bombay	Bleached lac for coating pills	Sample of bleached lac
10	Industrial Advisor, Govt. of Bhutan	Lacquers for wooden bowls used for taking food	Sample. Pigmented melfolac. This was approved

11	(a) M/s. Liluah Iron Works, Calcutta-16 (b) M/s. Sukhdeo Agarwal, Gondia	Autoclave Method of making shellac	Technical information
12	Director of Industries U.P.	Manufacture of dry mounting tissue paper	Process supplied
13	(a) Director, Small Scale Industries Service Institute, Patna (b) Andhra Pradesh Industrial Technologist Forum, Hyderabad	Lac based industries	Technical information
14	Deputy Industrial Adviser (Chemicals), Govt. of Bihar	Insulating varnishes	Technical information
15	Additional Director of Industries, Chotanagpur Division, Ranchi	Industries based on lac	Schemes

In addition, a few parties were supplied with drawings of autoclave for making shellac, sheet making machine, wax extraction plants and plants for making varnishes and gasket shellac compounds. Samples of shellac produced directly from sticklac and water soluble lac dye were sent to a few shellac exporters for collecting overseas consumers assessment of their quality.

Development Work

The Department of Agriculture, Bihar and some private parties have been supplied details for the use of lac mud as fertilizer. Samples of coated urea fertilizer were supplied to the Agricultural College, and Research Institute, Ranchi and the Jute Agricultural Research Institute, Barrackpore, West Bengal for agronomical studies on maize and jute.

Propaganda and Publicity

Due to paucity of Staff the Institute could not participate in any exhibitions but exhibits and charts have been sent to a few organizations for display.

(T. Bhowmik)

Pilot Production Unit

During the period under report, the Pilot Production Unit continued the production and sale of the two grades of bleached lacs (BRF & BR), two grades of water soluble lacs (DL & AL) and autoclave shellac (ASK grade) together with other lacs and lac products like hydrolysed lacs, lac varnishes, Melfolac etc.

Due to rise in the price of Dewaxed lemon, the production of DL grade water soluble lac was found uneconomical and was replaced w.e.f. 1st January 1970 by a new DXO grade, which was produced from cheaper quality Dewaxed orange shellac. The other variety, viz., AL grade water soluble lac which had very poor sale figures for the last two years was also replaced by a new DXG grade water soluble lac which was prepared from Dewaxed garnet lac.

A drop in the sale figure of bleached lacs and autoclave shellac is noticed during the period under review. This is probably due to scarcity of methylated spirit, the most common solvent for lac.

The main purchasers of autoclave shellac were the Central Water & Power Research Station, Poona, and Heavy Electricals, Bhopal, where they used this shellac without any solvent.

The sale figures of the different grades during 1969-1970 are given below:

Material	Quantities sold in kg	Sale value Rs.
1. BRF grade bleached lac	388·30	2,465·36
2. BR grade bleached lac	182·50	647·50
3. DL grade water soluble lac	480·30	3,250·10
4. AL grade water soluble lac	28·00	168·00
5. DXO grade water soluble lac	67·00	496·88
6. DXG grade water soluble lac	16·00	96·00
7. ASK grade Autoclave shellac	2,622·80	10,551·20
8. Miscellaneous (hydrolysed lac, lac polishes & varnishes, Melfolac etc.)	—	1,013·00
	Total:	18,688·04

Thus during the year under report, the unit has sold a total of 3784·90 kg of special shellac for Rs. 17,675·04 and other miscellaneous lac based products valued at Rs. 1,013·00. The total sale value from the Pilot Production Unit during the year 1969-70 thus amounted to Rs. 18,688·04.

(P. K. Ghose)

5. CONFERENCES AND SYMPOSIA

Nil

6. SUMMARY

(A) ENTOMOLOGY DIVISION

Entomological researches were aimed, as hitherto, at intensification of lac cultivation and improving the quality of lac produced. The physiological and genetical aspects of the insect as well as development of convenient and drought resistant host bushes also received attention. The items studied closely followed the project proposals formulated for the year.

(A) RESEARCHES COMPLETED

1. In order to boost production of the superior *Kusmi* lac, attempts were made to adapt the superior *Kusmi* strain of lac insects to the commoner host *palas*, by using the rare survivors for continuing the progeny on *palas* itself. The progeny did not survive more than 4-5 generations. The studies have, however, shown that *palas* does not lack in nutrients essential for the *Kusmi* strain of the insects. The host is, however, not suited for the propagation of *Kusmi* insects because it is not in the right physiological state to support these insects during the "*Kusmi*" periods. The possibility of combining the *Kusmi* resin characteristics with the *Rangeeni* periods through hybridization and selection is indicated.

2. Economic evaluation of the first detected mutation in lac insects was made by crossing yellow females with crimson males and raising a large F_2 to recover the parental forms for comparison of their fecundity, life period and resin output. No significant difference was noted in any of these attributes.

3. Incidence of the lac predators *Eublemma amabilis* and *Holcocera pulverea* differs from season to season, being significantly higher in the *Aghani* than in the *Jethwi*. Of the two predators, *H. pulverea* is more destructive in the field than *E. amabilis*.

4. Field trials were conducted for the control of these major lac predators with *Bacillus thuringiensis*. These have confirmed that this thuricide, in a concentration of 0·06 per cent, sprayed at 10 day intervals throughout the crop reduces the predator population by 77·2-83·3 per cent and results in increasing the yield of lac by 81·6-92·5 per cent, thus indicating an effective control of these predators.

5. Insecticides were also studied with the same objective. The stomach poisons, cryolite and sodium fluosilicate, reduced the predator-population by 42-62 per cent and Dieldrex by 15-40 per cent. The latter was effective against the parasities of lac insects to some extent also.

6. Experiments to determine the appropriate time of harvesting *palas* broodlac have shown that this broodlac can safely be harvested upto one week before the time of larval emergence. Earlier harvesting adversely affects the yield in the resulting crop.

(B) RESEARCHES ON HAND

1. In the studies aimed at determining the relative performance of *palas* and *ber* broodlac for lac cultivation on *palas* and *ber*, it has been found that the yield

of lac was higher with *palas* broodlac in *Baisakhi* and with *ber* broodlac in *Katki* season on both the hosts.

2. As it has already been determined that *bhalia* is unable to sustain lac crop to brood stage during the summer months, the possibility of raising a crop on this bush to be fully or partially harvested as *ari* in May is being investigated. Crops in May have been harvested and the data collected will be evaluated after the next harvesting in Jan./Feb.

3. Studies on *galwang*, *sandan* and *Moghania chappar* as an alternative to and also in alternation with *kusum* were continued. *Galwang* alone was found to show promise.

As alternative *Rangeeni* hosts, *Albizzia richardiana*, *A. chinensis*, *A. lebbek*, *Ficus glabella*, *F. racemosa* and *F. cunia* were under study. *Ficus* species alone produced some lac.

4. In the trials with various schedules for lac cultivation on *kusum*, the highest crop ratios were obtained from the practice involving inoculation during June/July and harvesting the crop a year later, that is after two seasons.

5. Advance cutting of *ber* broodlac and its subsequent use for inoculations have shown that although larval emergence took place in broodlac harvested up to two weeks in advance, the insects survived to maturity only in the cases where broodlac had been harvested up to one week before larval emergence.

6. Field trials were initiated for a study of a new method of lac cultivation on *kusum* in comparison with the other practices.

7. Attempts were continued to train the conventional tree hosts into bushes and cultivate lac on these trained bushes. Results with *ber* and *galwang* bushes were quite satisfactory when used in alternation, the former for the *Katki* and the latter for the *Baisakhi* crop. It was also found that the yield of lac per bush increased from year to year without affecting the growth of the bush. Training of *kusum* and *palas* into bushes was continued.

8. An attempt is being made to induce drought resistance in *bhalia* by exposing seeds of the plant to various temperatures prior to sowing. The best growth of the plants was observed from seeds exposed to 50°C for 24 hours.

Exposures to still higher temperatures showed that the transpiration rate was lowest and wilting minimum in plants raised from seeds exposed to 70°C.

9. An interesting development during the year has been the successful raising of *galwang* bushes from shoot cuttings using growth hormones. This method not only slashes the time required to raise a plantation but also ensures the lac growing potentialities of the parent stock in the plantation raised from it.

10(i) *Bhalia* plant raised from seeds exposed to dosages of 3 to 30 Kr gamma-ray from a Co^{60} source showed that pod formation was lowest with highest dose and lowest in plants whose seeds were not irradiated at all.

(ii) Studies to develop polyploid varieties of *bhalia* were continued using colchicine treatment.

11. A comparative study of the free amino acid contents of body extracts of *Rangeeni* and *Kusmi* strains of lac insects showed that the *Kusmi* has two amino acids (proline and hydroxy proline) not found in the *Rangeeni* strain.

12. Study of the effect of host plant differences on lac insect fecundity and resin secretion efficiency was continued.

13(i) Microorganisms were isolated from lac insects on *ber* and *kusum* and their pure cultures maintained.

(ii) The larvae of the lac predators *E. amabilis* and *H. pulverea* were reared successfully for the first time on a medium containing lac insect microorganisms, agar agar and bactopeptone. This medium was also tried for another (unidentified) insect associated with lac.

14. Irradiation of lac males with X-ray showed that dosees higher than 1000r adversely affect their fertility.

15. Biological, ecological and control studies on the pests of lac hosts, lac enemies and their parasites were continued.

16. Study of the incidence of the lac predators *E. amabilis* and *H. pulverea* under different conditions of host plant concentrations showed that *E. amabilis* was most prevalent under conditions of medium and thin concentration and *H. pulverea* in dense concentration of host plants in the area.

17. Exposure of developing lac insects to varying periods of day, night and artificial lights were initiated during the year. There was no significant difference in the lac insect growth and development so far.

REGIONAL FIELD RESEARCH STATION

Routine problems under investigation were continued at Damoh and Dharamjaigarh. The station at Damoh was however, wound up in December on completion of studies there.

(B) CHEMISTRY DIVISION

The researches in the Chemistry Division were aimed at among others, improving the processing techniques and developing economic methods for utilization of the by-products, investigation of newer methods of grading and analysis, developing improved and newer modifications and avenues for utilization of lac. Fundamental studies were also carried out in order to understand the constitution and behaviour of lac as well as its physico-chemical properties.

(A) RESEARCHES COMPLETED

1. Specific heats of seedlacs from lac samples collected from different lac growing regions, were determined with the progressive period of storage for developing a possible method of estimation of the age of seedlac. The data obtained have been statistically analysed and found to be significant.

2. Esterification of lac with *n*-butyl alcohol was carried out at reflux temperature for four hours in presence of concentrated hydrochloric acid (2 ml/100 g lac) as the catalyst. The resulting partial ester, like the one (reported last year) produced without any catalyst, was a tough and non-tacky mass. Films from aqueous varnishes psosessed better hardness, elasticity and impact resistance than dewaxed shellac. The baked films were resistant to water, alcohol, acetone, ethyl acetate and toluene. Addition of activated charcoal (10 g/100 g of lac) during esterification reduced the colour index from 13 to 5.

3. Shellac wax which has been bleached with sodium hypochlorite has been found to have the same acid and saponification values, melting point and solvent retention power as the unbleached wax. Hardness however was somewhat improved.

(B) RESEARCHES ON HAND

1. (a) Lac resin, which is composed of inter- and intra-esters of various polyhydroxy acids, was resolved into individual components by the application of Thin layer chromatography (TLC). Resolution was found better on silver nitrate impregnated plates than on ordinary plates. The resin was resolved by prepa-

rative layer chromatography into five fractions, which were obtained in the proportion of 12·8, 8·8, 41·3, 23·0 and 7·8 per cent on the load.

(b) Hard resin was fractionated into eleven fractions by dissolving it in dioxane and progressive precipitation with benzene as non-solvent. Molecular weights of these fractions were determined by vapour phase osmometer and found to vary from 3,537 to 780. Incidentally, the molecular weights of shellac, decolourized lac, hard resin and soft resin by the above method were found to be 1090, 1060, 1830 and 558 respectively which are in close agreement with the values obtained by Rast method.

(c) The study of the constitution of the soft resin (ether soluble) fraction of lac was continued. So far 80 per cent of the constituent acids have been isolated and identified. These total 19 in number of which twelve have been isolated for the first time from soft resin.

2. (a) Study of the graft/co-polymerization of lac with vinyl monomers had to be suspended as the investigator left the Institute during the year under report.

(b) It has been found that during baking at 150°C of films prepared from dewaxed lac (butylated) urea resin (100: 20) varnish, ester values increased in the first 10 minutes and slowed down thereafter. This finding confirmed the previous postulation that the esterification reaction proceeds at a faster rate in the beginning and that thereafter ether exchange predominates. Similar observations were made in catalysed films also.

(c) Air dried films of sulphuric acid modified lac samples in butanol showed excellent flexibility and impact resistance, but poor hardness and water resistance. Baking at 150°C for 30 minutes, however, improved water, solvent, acid and alkali resistances but hardness and gloss were poor. Air dried and baked films from water soluble samples had the same flexibility and hardness as those of parent lac.

(d) Aleuritic acid is one of the major constituent acids of lac resin reportedly present to the extent of 40 per cent. Product of reaction of this acid with acetone (the isopropylidine derivative), on heating at high temperatures, autocondensed through polyesterification into products of high molecular weights.

3. (a) The yield of shellac prepared directly from *Rangeeni* sticklac (1 kg) by extracting with alcohol or acetone was much higher (75·5 per cent) than that obtained by the conventional *bhatta* method (52·1 per cent). Life and flow were also distinctly superior but the colour was a little inferior.

(b) Shellac wax is slightly inferior to the costly and imported carnauba wax in respect of hardness and solvent retention power. In order to upgrade its performance and to effectively substitute the carnauba wax, lac wax was fractionated with acetone into three fractions, two being solid and the third oily. The solid fraction insoluble in hot acetone was hard (penetration value 1·5-2). and possessed high melting point (82-85°C) but a comparatively lower solvent retention power (13·5-18). The second solid fraction soluble in hot acetone but insoluble at room temperature was of lower hardness (5-6·5) and melting point (71-73°C) but had a high solvent retention power (64-68·6).

(c) *Total* hydrolysed lac (product of hydrolysis of lac resin) was modified by heating at different temperatures. The drop in acid, hydroxyl and carbonyl values indicated that the carboxyl, hydroxyl and aldehyde groups had reacted under the heating condition. The partially polymerised product obtained by heating at 150°C upto the pregelation stage showed very interesting properties. Like shellac it cured melamine resin in the cold and reacted readily with toluene di-isocyanate. Films from ammoniacal solution showed outstanding flexibility, gloss and adhesion which was in direct contrast to aqueous shellac-varnish.

(d) with a view to prepare bleached lac of good life and flow, bleaching with chlorine free bleaching agents is being studied. Seedlac solution in aqueous sodium carbonate was bleached with hydrogen peroxide at different temperatures. The product, bleached at room temperature for 7 hours, had a colour index of 7 as against 20 of the unbleached material.

4. A method was under study during the previous year for the determination of shellac in presence of other resins by reacting shellac with urea in boiling acetone solution. Several modifications, were carried out. Reproducibility of the results could not be obtained.

5. Water based French polish has been prepared by incorporating urea and maleic resin (20 and 10 per cent respectively on the weight of lac) into a solution of dewaxed lac (25 g) in ammonia (4 g) and water (96 g) at 70-75°C. Incorporation of 15 per cent alcohol on the weight of varnish improved the levelling characteristic, gloss and water and heat resistance. Sunlight exposure, also improved the heat as well as water resistance of the films.

6. (a) Improvements in tear resistance, hardness and ageing properties were noticed on incorporation of shellac into natural rubber using CBS as an accelerator. Incorporation of shellac and ethylene glycol modified lac in natural rubber (using clay as the filler) also improved hardness and tear resistance whereas abrasion resistance was found to remain constant.

(b) Free sulphur contents were estimated in vulcanized samples of shellac and ethylene glycol modified lac/natural rubber combinations containing MBT as the accelerator. Free sulphur content was found to reach a constant value after 45 minutes. Crosslink density was found to decrease with increasing amounts of shellac and ethylene glycol modified lac. Addition of magnesium oxide to rubber/shellac composition did not effect any improvement in the mechanical properties.

7. Electrical properties of dewaxed shellac varnish were found to increase remarkably when blended with butylated melamine resin reaching a maximum when the varnish contained 60 parts of lac to 40 of the melamine resin. Break down voltage of films of this varnish (2280 volts/mil) was about 3 times that of regular dewaxed shellac films.

8. (a) Properties of electrodeposited films on untreated and zinc phosphated mild steel panels were studied. Different formulations were used based on shellac with and without alkyd, maleinised oil or epoxy resin and with partial butyl ester in place of shellac. Films on phosphated panels were found more corrosion resistant than on untreated panels, while scratch hardness, flexibility and adhesion were more or less the same. Variation in voltage, temperature and baking time did not affect corrosion resistance.

Hydrogen ion concentration (ρH) and specific conductivities of different pigmented and unpigmented varnishes were found to increase with rise in temperature. The ρH was found to remain constant on dilution while the specific conductivity decreased rapidly.

(b) Lac/linseed oil glycerol composition was modified by reducing the quantity of glycerol and increasing the amount of litharge in order to reduce the proportion of unreacted glycerol in the glyceride mixture. A paint prepared from a lac oil combination from such a glyceride required less toluene diisocyanate (7-10 per cent on the weight of the modified composition) for proper curing and gave films which became touch dry in 2 hours. After one week's air drying, these films were very hard, glossy and smooth and resistant to many organic solvents.

(c) Shellac was modified with epoxy resin (epikote 1001) by reacting them together in different ratios (10: 3, 10: 4, 10: 5) in various solvent mixtures at reflux temperature for 2 to 10 hours. Baked films of the resulting compositions

were hard, flexible and resistant to chemicals and solvents. Addition of 1 per cent dicyandiamide, during refluxing, further improved these properties.

(d) The possible use of the above products in water based primers was studied. Baked films from primers prepared by dissolving lac/epoxy compositions in aqueous triethanolamine pigmented with red oxide, were found to be hard and flexible withstood salt spray test for 10 days.

(e) Another red oxide primer studied was based on shellac maleinised linseed oil vehicle. For maleinisation of the oil for this purpose, a modified process was developed which eliminated the need for washing out the unreacted acid from the reaction mixture. This new oil (produced by heating 100 parts of linseed oil and 30 parts maleic acid at 220° ± 5°C for 4 hours) in aqueous ammonia along with shellac produced a primer comparable in all respects with that using the conventional maleinised oil wherein the unreacted maleic acid has been washed out.

(f) Solvent retained by shellac films exposed at 40°C in an oven or stored at room temperature was determined by estimating the ethoxyl content of the film. Films (1·3 mil thick) from 40 per cent solution of dewaxed decolourise lac (platina) in alcohol were found to dry to a constant ethoxyl content of 0·53 and 1·05 per cent in 34 days at 40°C and 106 days at room temperature respectively. The ethoxyl content of the parent platina itself was 0·53 per cent.

(g) Air dried Melfolac (dewaxed shellac/butylated melamine formaldehyde resin varnish) films acquired adequate water resistance in 24 hours with 0·5 per cent of HCl or '*p*'-toluene sulphonic acid. But adequate heat resistance was obtained in 24 hours only when the catalyst present was 1·25 per cent. Isopropanol and mixture of toluene and ethanol (1: 2) was found to be good alternate solvents. The catalysed curing process was found to be accelerated on drying of the films at 170°C for 2 minutes at 65°C for 1 hour or by exposing to sunlight for 8 hours. A sprayable Melfolac varnish was also developed. This on dilution to 20 per cent solids, was also found suitable as a vehicle for rapid drying paints for display panels, etc.

9. (a) Films of shellac/cashew nut shell liquid (CNSL) combination modified with urea and formalin over hessian reported last year, became brittle after about eight months. Increase in the proportion of CNSL or addition of plasticizers into the composition did not show any reduction in brittleness.

An increase in the impact strength from 1·12 to 2·22 cm. kg/sq. cm was found by increasing the proportion of phenol/formaldehyde resin from 0 to 50 per cent in shellac moulding composition.

(b) A lac/linseed oil composition and a technique had been developed for coating fertilizer (urea) granules to reduce hygroscopicity, caking tendency and leaching rate. During the year, agronomical studies were carried out on jute crop. [It] was found that coated urea had better effect on plant growth, base diameter and crop yield. Similar studies were carried out with hybrid maize and the results are awaited.

10. The effect of temperature, pressure and time on the adhesive property of *Kusmi*, *Rangeeni* and dewaxed shellacs between steel panels were studied. The highest bond strength (0·268 tons) was obtained with dewaxed lac by pressing for 1 hour at 185°C and under 2000 lbs/sq inch pressure. The bond strength of 'Araldite' (epoxy adhesive) bonding obtained by slight clamp pressure at room temperature for 24 hours was 0·446 tons. It was found that good micanite sheets can be prepared with compositions containing shellac and epoxy resin (828) in the ratios of 7: 3 and 8: 2.

Shri Y. Sankaranarayanan
Director

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

Month	Mean barometric pressure mm	Mean maximum temp. °C	Mean minimum temp. °C	Mean dry bulb temp. °C	Mean wet bulb temp. °C	Mean humidity percent	Mean sunshine hrs/day	Total rainfall mm	Highest maximum temp. °C	Lowest minimum temp. °C
1	2	3	4	5	6	7	8	9	10	11
January	707·9	24·3	7·8	20·6	16·7	66	8·6	14·22	29·0	3·9
February	707·5	28·4	11·5	23·7	17·5	53	8·5	31·75	33·0	7·5
March	705·1	34·2	17·5	29·6	20·8	44	7·7	3·05	38·0	14·5
April	703·0	37·1	20·7	32·1	23·7	48	7·2	80·01	39·5	16·4
May	700·7	34·5	22·3	30·8	25·7	65	7·8	127·77	41·0	17·8
June	697·2	34·7	23·9	30·8	26·6	71	5·8	116·30	38·0	21·7
July	696·5	30·3	23·4	27·4	25·5	86	3·7	365·17	34·5	21·9
August	699·1	28·8	22·4	26·4	24·6	86	2·6	386·85	33·0	20·5
September	700·4	29·4	22·1	26·7	24·9	86	5·0	217·10	33·0	20·0
October	705·4	30·2	17·8	26·9	22·8	69	7·7	56·00	31·5	14·5
November	707·5	28·2	14·6	23·4	19·5	69	7·6	5·60	31·5	9·5
December	709·6	24·8	8·4	17·8	13·7	60	7·8	Nil	27·7	4·3

The highest maximum temperature recorded was 41·0°C on 27th May and the lowest minimum 3·9°C on 15th and 16th January. The total rainfall during the year amounted to 1403·82 mm of which the monsoon (June to September) rainfall was 1085·42 mm. The rainfall during the year was lower than that of 1968 (1575·15 mm). There was hailstorm on 18th April.

7. PERSONNEL

Dr. G. S. Misra, Director, left the services of the Institute on the afternoon of Monday the 16th June, 1969 on one year lien to join as Professor and Head of the Post Graduate Department of Chemistry at Jabalpur University. Shri Y. Sankaranarayanan, Senior Scientific Officer (Organic) in the Institute has been appointed on an ad-hoc basis to take over as Director in place of Dr. Misra.

STATEMENT SHOWING APPOINTMENTS, PROMOTIONS, RESIGNATIONS, RETIREMENT ETC. DURING JANUARY-DECEMBER, 1969

Name	Post to which appointed	Date
A. Appointments		
1. Sri Y. Sankaranarayanan	Director	16-6-1969
2. Sri B. C. Lakra	Museum Assistant	1-9-1969
3. Sri S. K. Jaipuriar	Research Assistant	30-9-1969
4. Sri T. R. Lakshminarayanan	Sr. Research Asstt. (Physicist)	27-2-1969
5. Sri R. S. Prasad	Research Assistant	25-7-1969
6. Sri N. Rangachari	Research Assistant	18-8-1969
B. Promotions		
1. Sri Jawahalal	Research Assistant	4-11-1969
2. Sri L. C. Misra	Senior Analyst	3-4-1969
C. Resignations		
1. Dr. G. S. Misra	Director	16-6-1969
2. Sri Kamal Prasad	Lab. Assistant	20-6-1969
3. Sri G. C. Sharma	Research Assistant	14-2-1969
4. Sri T. Sahu	Research Assistant	24-2-1969
5. Sri N. Rangachari	Research Assistant	30-9-1969

RESEARCH STAFF DIVISIONWISE

Sl No.	Name of the post	Sanctioned strength	Staff in position as on 31.12.1969
1.	Director	1	Sri Y. Sankaranarayanan
Entomology Division			
2.	Entomologist	1	Dr. A. Bhattacharya
3.	Scientific Officer (Cultivation & Training)	1	Sri B. P. Mehra
4.	Scientific Officer (Field Station)	1	Sri C. P. Malhotra
5.	Scientific Officer (Insect Genetics)	1	Sri N. S. Chauhan
6.	Scientific Officer (Arboriculture)	1	Vacant
7.	Scientific Officer (Physiology)	1	Vacant
8.	Scientific Officer (Biology)	1	Vacant
9.	Senior Research Assistant	8	1. Sri B. K. Purkayastha 2. Sri R. S. Gokulpure 3. Sri A. H. Naqvi 4. Sri N. Majumdar 5. to 8. Vacant
10.	Instructor (Lac Cultivation)	1	Sri R. C. Mishra
11.	Research Assistant	14	1. Sri Parimal Sen 2. Sri A. K. Sen 3. Sri S. G. Choudhary 4. Sri U. P. Griyaghey 5. Sri B. N. Sah 6. Sri J. M. Dasgupta 7. Sri R. C. Maurya 8. Sri Pranaya Kumar 9. Sri Y. D. Misra 10. Sri M. L. Bhagat 11. Miss Kanta Rani 12. Sri S. K. Jaipuriar 13. Sri Jawahirlal *14. Sri M. K. Chowdhury
12.	Insect Collection Tender	1	1. Sri Md. Ali Ansari
13.	Laboratory Assistant	8	1. Mrs Namita Nandy 2. Sri Ajmer Hussain 3. Sri K. L. Chowdhury

*Junior Research Assistant working against the vacancy of Research Assistant.

Sl. No.	Name of the Post	Sanctioned strength	Staff of position on 31,12.1969
13.	Laboratory Assistant		4. Sri D.D. Prasad 5. Sri G. K. Jha 6. Sri R. D. Pathak 7. Sri R. C. Singh 8. Vacant
Chemistry Division			
1.	Senior Scientific Officer (Organic)	1	Vacant
2.	Senior Scientific Officer (Utilization)	1	Dr. T. Bhowmik
3.	Scientific Officer (Physical)	1	Dr. P. R. Bhattacharya
4.	Scientific Officer (Applied)	1	Sri S. C. Sengupta
5.	Scientific Officer (Decorative Coatings)	1	Sri Shravan Kumar
6.	Scientific Officer (Factory)	1	Dr. B. B. Khanna
7.	Scientific Officer (Utilization)	1	Vacant
9.	Senior Research Assistant	6	1. Sri A. K. Ghose 2. Sri P. C. Ghosh 3. Sri A. Kumar 4. Sri P. C. Gupta 5. Sri T. R. Lakshminarayanan 6. Vacant
10.	Senior Analyst	1	Sri L. C. Misra
11.	Research Assistant	17	1. Sri A. Rahman 2. Sri R. K. Banerjee 3. Sri S. K. M. Tripathi 4. Sri August Pandey 5. Sri M. Mukherjee 6. Sri M. Islam 7. Sri S. C. Agarwal 8. Sri D. K. Guha Sarkar 9. Sri A. K. Dasgupta 10. Sri B. C. Srivastava 11. Sri Niranjan Prasad 12. Sri Radha Singh 13. Sri R. N. Majee 14. Sri R. S. Prasad 15. Sri N. Rangachari 16. & 17. Vacant
12.	Analyst	2	Sri B. P. Banerjee Sri Ramesh Prasad
13.	Junior Analyst	1	Vacant
14.	Glass Blower	1	Sri S. K. Dey
15.	Laboratory Assistant	10	1. Sri Dominick Runda 2. Sri Noas Minz 3. Sri G. M. Borkar 4. Sri B. B. Chakraborti

Sl. No,	Name of the Post	Sanctioned strength	Staff in position as on 31.12.1969
15.	Laboratory Assistant		5. Sri Nagendra Mahto 6. Sri Umeshwar Sahay 7. Sri Balaram Majumdar 8. Sri B. P. Keshri 9. Sri M. K. Singh 10. Vacant
16.	Museum Assistant	1	Sri B. C. Lakra

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