INDIAN LAC RESEARCH INSTITUTE
NAMKUM, RANCHI, BIHAR, INDIA

Annual Report
1972

INDIAN COUNCIL OF AGRICULTURAL RESEARCH
NEW DELHI
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CONTENTS

1. DIRECTOR'S 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 committee 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 adultration in times of short supply, could be cured only by improved out-turn. 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 " 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 kilometers east of Ranchi. The laboratories of the Institute consist of three buildings housing the Chemistry laboratory, the Entomology laboratory and 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 out-station experiments, areas/trees have been taken on long term basis.

The Institute is headed by the Director and he also used to function as Head of the Chemistry Division, and so did the Entomologist as Head of the Entomology Division. However, as a result of the implementation of some of the recommendations made by the Seshadri Committee set up in 1966 to strengthen the activities of the Institute during the Fourth Plan, the Institute

has been reconstituted into four Research Divisions and an Extension Division under the overall control of the Director of the Institute and the following additional posts were provided. These posts were mostly filled up last year and the rest in the year under report.

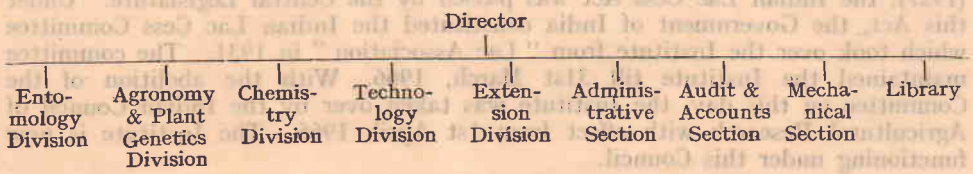
1) Head of the Division of Entomology
2) Head of the Division of Chemistry
3) Agronomist
4) Technologist
5) Insect Geneticist
6) Junior Chemist (Polymer)
7) Senior Research Assistant (Agronomy)

Objectives

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

Organisational Structure

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



Achievements

Entomology

Among the major achievements during the year in the field of lac entomology, particular mention may be made of the integrated control studies which have demonstrated the selective action of the insecticide, endosulfan, for the control of the lac predators, alone and in combination with Bactospeine (a *Bacillus thuringiensis* preparation). A cheap substitute for brass wire-net broodlac container was also found in the 60-mesh synthetic net container which proved equally effective in checking the carry over of the lac pests.

Another important finding has been the evidence for considerable variation in growth rate and resin quality, as judged by the dye-level, obtained in the study of crosses of distinct races of lac insects.

Chemistry

The successful introduction of epoxy group in aleuritic acid and subsequently in shellac has opened a new avenue of research for lac as a substitute for the imported epoxy resins. The products obtained under different conditions are under study for diverse objectives.

Preparation of a cation exchange resin from shellac has immense potentiality in this country for substitution of imported products. So far, a product having an exchange capacity of 5·5 m. eq/g has been obtained which may be slightly better than the imported Amberlite IR-120 (exchange capacity 4·25 m. eq/g). Other properties like stability, colour discharge etc. are under investigation.

Technology

A rapid method for the bleaching of lac making use of a combination of sodium hypochlorite and hydrogen peroxide has been evolved in which the reagents are added to lac kept in the form of a fine suspensoin. The method is quick, cuts down the consumption of hypochlorite to one fourth and gives a product with much less chlorine and very improved life and flow.

Agronomy

This is the first year of working of the Division. Experiments planned could not be conducted as per the programme for want of infra-structure and research facilities. However, some preliminary trials conducted revealed that a breakthrough in lac production technology is possible by bringing down lac cultivation from wild and unmanageable host trees to specifically planted shrubs: *Moghania macrophylla* (*bhalia*) and *Cajanus cajan* (*arhar*). The possibility of integrating lac cultivation with general agriculture and converting competition from agricultural crops into co-operation was also indicated.

Library

The number of books and bound volumes of journals accessioned during the year was 414. This brought the total number of books and volumes of journals in the library to 15,093. One hundred twenty seven periodicals were subscribed for 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 B. P. Mehra, Junior Insect Ecologist, was awarded Ph.D. degree of the Calcutta University in July, 1972 for his work on " Studies on the bionomics and control of certain insects associated with lac cultivation in India and other cognate problems ".

Shri T. R. Laxminarayanan, S.R.A. (Physicist), was awarded Ph.D. degree of the Ranchi University in August, 1972 for his work on " Studies on the dielectric and related properties of some shellacs and shellac compounded rubbers ".

Dr. J. N. Chatterjea, Director, was elected F.N.A. in the month of October, 1972.

Shri A. Pandey, Research Assistant (Chemistry), was awarded Ph.D. degree of the Ranchi University in December, 1972 for his work on " Electro-deposition of shellac primers and paints ".

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, the following:

1. Dr. M. S. Swaminathan, Director General, I.C.A.R., New Delhi.
2. Dr. J. S. Kanwar, Dy. Director General, I.C.A.R., New Delhi.
3. Sri K. R. P. Sinha, Dy. Director of Industries (E & P), Bihar.
4. Sri V. B. Manikar, Director (W & M), Govt. of India, New Delhi.
5. Sri Chandra Prakash Shastri, Controller, (W & M), New Delhi.
6. Sri S. W. Singh, Principal, All India Training Institute of weights & Measures, Patna.
7. Mr. F. M. Baharabadi, Director, Regional Planning Department, Ministry of Planning, Kabul, Afghanistan.
8. Sri Bibhuti Bhusan Mukhopadhaya, Litterateur, Darbhanga, Bihar.
9. Dr. H. Fujuwara, Tohoku University, Faculty of Agriculture, Japan.
10. Dr. S. K. Mukherjee, Member, National Commission on Agriculture New Delhi.
11. Dr. N. Aditya Chaudhury, Faculty of Agriculture, University of Kalyani, Kalyani, West Bengal.
12. Sri Randhir Singh Choudhary, Non-Official Member, National Commission on Agriculture, Govt. of India, New Delhi.
13. Sri C. S. Paspatih, Dy. Chief Conservator of Forests, Bihar.
14. Sri F. R. Bhaller, S.R.O., Planning Commission, New Delhi.
15. Sri O. P. Verma, Agricultural Commissioner, Ministry of Agriculture, Govt. of India, 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 in progress 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. The Institute continued to avail the testing facilities kindly provided by the Indian Institute of Technology, Kharagpur for our work on shellac-rubber combination.

The shellac coated urea fertiliser developed at the Institute was got tested for agronomical trials on maize and wheat at Ranchi Agricultural College, Kanke and on jute at Jute Agricultural Research Institute, Barrackpur, Calcutta.

The Institute is represented in the Lac Development Council of the Ministry of Food and Agriculture, Government of India, Ranchi, Shellac Export Promotion Council, Calcutta, and various Technical Committees of the Indian Standards Institution.

Research collaboration at International level

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

Training and advisory services

The Institute provides two courses of training of six-month duration each on (i) Improved Method of lac cultivation (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 is also arranged on request.

The Institute also provides technical assistance to all those interested in cultivation, processing, grading and utilisation of lac.

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 take over with effect from 1st April, 1966, the Institute is being wholly financed by the Indian Council of Agricultural Research.

The final revised budget estimates of the Institute for 1972-73 amounted to Rs. 12,93,000/-. The actual expenditure during the same period was, however, Rs. 12,57,169/-.

2. PROGRESS OF RESEARCH

A. ENTOMOLOGY DIVISION

(a) RESEARCHES COMPLETED

Lac Cultivation Studies

Determination of optimum broodlac requirement for maximising ari yield on palas in hot areas

As in the previous seasons, the brood rates tried were 0·4, 0·5, 0·6, 0·7, 0·8, 1·0, 1·2, 1·4, 1·6, 1·8 and 2·0 kg per tree. The *baisakhi* 1971-72 crop was harvested as *ari* in the last week of April. In the previous two seasons, the yield of sticklac was highest with the brood rates of 1·8 and 1·4 kg per tree. This year also, the yield of sticklac was highest with the brood rate of 1·8 kg per tree.

The optimum brood rate for *palas* (*Butea monosperma*) in a hot area is thus found to range between 1·4 and 1·8 kg per tree when the crop is harvested as *ari* in the *baisakhi* season.

(R. C. Mishra and C. P. Malhotra)

Breeding and genetical studies on lac insects

Cytogenetical analysis of chromosome behaviour

Cytological studies of Indian Lac insects had resulted in contrary reports suggesting two quite distinct chromosome systems, namely, a normal and the unorthodox 'Lecanoid' system as unravelled in the mealy bug *Planococcus citri* (Risso). In this latter system of chromosome behaviour the paternal chromosome set becomes heterochromatic from an early embryonic stage of the male, which is then retained as a genetically inert component during development and is finally eliminated during the formation of sex-cells, so that the male expresses and transmits only the maternal genes through the sperm. Subsequent studies with the colour genes suggested yet a different situation in that while an unorthodox system was confirmed, unlike in the 'Lecanoid' system, both maternal and paternal chromosomes were found to be somatically active. This was confirmed in subsequent cytological observations which showed that heterochromatization and elimination of one set of chromosomes is confined to the male germ line.

Further observations with the colour genes and the characteristic physiological difference in the *rangeeni* and *kusmi* strains of lac insects with regard to their ability to survive on *kusum* (*Schleichera oleosa*), as also the cytological observations made during the year under report provided additional evidence that the heterochromatization and elimination of the paternal chromosomes is confined to the male germ line. The male lac insect is thus somatically a diploid, but it breeds as a haploid and transmits only the maternal genome through the

sperm. The genes in these insects are thus transmitted like the sex-linked genes, but the system differs from that of sex-linked inheritance in that the male inherits and expresses the paternal genes.

(N. S. Chauhan)

(b) RESEARCHES ON HAND

Lac cultivation studies

1. Evolution of cultivation schedules

(a) *Studies to evolve a suitable method for producing lac on bhalia (Moghania macrophylla) regularly during both the seasons*

Bhalia, being a bushy plant species, possesses several attractive features as a host to supplement production of the superior *kusmi* lac. Its drawbacks, however, lie in its inability to sustain the summer (*jethwi*) crop and its poor response to coppicing in July to receive inoculation for the summer crop. An experiment was thus planned to examine whether this host species can be utilised to raise *ari* (immature) or at least a partial summer crop by inoculating the bushes once in January/February on 12-month-old shoots arising from January/February coppiced/harvested bushes, with varying amounts of broodlac.

The experiment is laid out on a randomised block design with 5 bushes in each treatment and 5 replications. The cultivation schedules are as follows:

Inoculation (Brood rate)	Harvesting
1. 400 g/bush	Complete harvesting as *ari* in the following May.
2. 200 g/bush	Partial ari harvesting in the following May and complete harvesting in Jan/Feb next.
3. 100 g/bush	——————do——————
4. 50 g/bush	Complete harvesting in Jan/Feb next.
5. 400 g/bush	——————do——————

The experiment could not be carried out due to non-availability of broodlac.

(R. C. Maurya and A. Bhattacharya)

(b) *A comparative study of different techniques of lac cultivation on kusum (Schleichera oleosa) at Hesal*

Cultivation experience had shown that *kusum* does not respond well to pruning in January/February for successful operation of the standard four-coupe system. A new cultivation schedule involving complete harvesting-cum-pruning in July is thus being tried and the performance compared with that of the standard four-coupe system.

The experiment is laid out on a randomised block design with 5 trees in each treatment and 13 replications.

The experiment, however, could not be taken up due to non-availability of broodlac.

(R. C. Maurya and A. Bhattacharya)

2. Selection and utilization of new-hosts

(a) *Finding out alternate hosts for kusmi and rangeeni strains of lac insects and conducting cultivation on them*

(i) *For kusmi strain*

Rain tree (*Samania saman*) and *putri* (*Croton oblongifolius*) remained under trial as alternate hosts of the *kusmi* strain of lac insects in the *jethwi* season. None, however, could sustain the lac insects till the completion of their life cycle. Similar trials in the following *aghani* 1972-73 were not possible due to non-availability of the *kusmi* broodlac.

(ii) *For rangeeni strain*

Rain tree, vilaiti babul (*Acacia farnesiana*) and *putri* remained under trial as *rangeeni* hosts in the *baisakhi* 1971-72 season. The insects, however, failed to survive on any of these plant species.

Rain tree and *putri* were again tried as alternative *rangeeni* hosts in the following *katki*, but none could carry the insects till the completion of their life cycle. Fresh trials with these plant species are being made in the following *baisakhi* 1972-73 season. The experiment for *rain tree* is carried out at Namkum and Chianki and that for *putri* at Amjharia and Turhamu.

(M. L. Bhagat and A. Bhattacharya)

(b) *Studies on the efficacy of different lac hosts on the survival of lac insects and degree of preference and antibiosis, if any*

Kusum, galwang (*Albizzia lucida*), *ber* (*Ziziphus mauritiana*), *sandan* (*Ougenia oojienensis*), *palas, arhar* (*Cajanus cajan*), *rain tree, khair* (*Acacia catechu*), *vilaiti babul and bhalia* remained under study for their performance as host of the *rangeeni* and *kusmi* strains of lac insects. Five plants of each host species are used to culture each of the *rangeeni* and *kusmi* strains and the average insect survival and fecundity noted on each host species.

In the summer season, the study was restricted to the *rangeeni* strain due to non-availability of the *kusmi* broodlac. Only *kusum* and arhar failed to sustain the *baisakhi* 1971-72 (*rangeeni*) insects. The survival was noted to be best on *palas*, but the fecundity was highest on *galwang*.

In the rainy season generation the host performance was studied for both the strains of lac insects. For the *rangeeni* strain, *kusum* alone failed to sustain the *katki* insects. Data on survival and fecundity are being collected. The development of the *kusmi* strain in the *aghani* 1972-73 season was observed to be satisfactory on all the host species studied till the end of December.

(M. K. Chowdhury and A. Bhattacharya)

3. Intensive lac cultivation under bushy condition

This experiment is designed to study the performance of trained bushes of three hosts species, namely, *palas, ber* and *galwang* as compared to that of the tree host *palas* under the conventional 3-coupe system, 2-coupe plan and villagers' method of lac cultivation. The experiment is laid out on a split-plot design with three main plot treatments (brood rates) and three sub-plot treatments (fertilizer application).

This experiment, however, could not be taken up due to non-availability of broodlac.

(M. L. Bhagat, A. Bhattacharya and B. K. Purkayastha Co-operator)

Physiological studies on lac insects and associated insects

4. Nutritional studies on lac insects and associated insects

(a) *Qualitative estimation of amino acids in the body fluid of the lac insect at different stages in relation to different host plants*

The amino acid content of the body fluid of both *rangeeni* and *kusmi* strains of lac insects, the former cultured on *palas* and *bhalia* and the *latter* on *bhalia*, was determined at two stages in their development, namely, larval and adult (mature female) stages, following two dimensional paper chromatography. The body fluid was passed through a cation exchange resin column and then treated with 6N ammonia and dried on a water bath. Ethanol was added to the residue which was then centrifuged. The supernatant layer was concentrated and spotted on a Whatman No. 1 filter paper. The solvent systems used were phenol: water (4: 1 w/v) in the first and n-butanol: acetic acid: water (30: 6: 14 v/v/v) in the second dimension, and the presence of amino acids was established by carrying out Co-chromatography.

Table 1 shows that while serine, glycine, threonine, alanine, cysteine, tyrosine, valine and iso-leucine are common to both the strains of lac insects, proline, hydroxyproline and glutamic acid are present exclusively in the *kusmi* strain and methionine and aspartic acid in the *rangeeni*. The presence of aspartic acid was detected only at a late stage in the development of the *rangeeni* insect.

(R. S. Gokulpure, A. H. Naqvi and T. P. S. Teotia, Co-operator)

TABLE 1 — AMINO ACID CONTENT OF THE LAC INSECT BODY FLUID

Amino acids	*Rangeeni* strain on				*Kusmi* strain on *kusum*
	bhalia		*palas*		
	Immature	Mature	Immature	Mature	Immature
1. Serine	+	+	+	+	+
2. Glycine	+	+	+	+	+
3. Threonine	+	+	+	+	+
4. α-alanine	+	+	+	+	+
5. Cysteine	+	+	+	+	+
6. Tyrosine	+	+	+	+	+
7. Valine	+	+	+	+	+
8. Methionine	+	+	+	+	−
9. Iso-leucine	+	+	+	+	+
10. Aspartic acid	−	+	−	+	−
11. Proline	−	−	−	−	+
12. Hydroxyproline	−	−	−	−	+
13. Glutamic acid	−	−	−	−	+

(b) *Evolution of a suitable synthetic diet for artificial rearing of lac insects*

The problem involves (i) finding out a suitable substrate to settle the lac larvae and (ii) formulation of a synthetic diet which could support these insects throughout their life period. Different kinds of rubber balloon, synthetic sponges, soft nipple, french leather, rubber tubings of varying thickness, parafilm, polythene, wax paper and agar agar in various shapes were tried as a substrate for the settlement of the newly emerged lac larvae. Only 2 per cent sterilized agar agar covered by parafilm, polythene or wax paper under aseptic condition was found suitable for this purpose.

Table 2 shows the composition of diets offered to the lac larvae. It was found that the lac larvae survived for a maximum period of 28 days on diets D_2 and D_4 in the *baisakhi* 1972-73 season. The major difficulty in the rearing work appeared to be the fungal growth, preventive measures against which are under study.

(R. S. Gokulpure, A. H. Naqvi and T. P. S. Teotia, Co-operator)

(c) *Nutritional requirements of the predators, Eublemma amabilis and Holcocera pulverea and evolution of a suitable artificial diet*

Studies have been taken up to develop a technique for artificial rearing of lac predators that could provide a continuous supply of their larvae for laboratory experimentation.

To start with, field-collected third instar larvae of *Holcocera pulverea* of uniform size were offered the following diets, releasing 10 larvae on each diet.

Diet 1

Fish meal — 10 parts
Sticklac — 15 parts.

Diet 2

Fish meal — 10 parts
Sticklac — 15 parts
Bajra flour — 10 parts.

Diet 3

Fish meal — 10 parts.
Bajra flour — 10 parts.

Diet 4

Fish meal alone.

While *H. pulverea* larvae failed to survive on diets 2, 3 and 4, five adults emerged on diet 1. The fertility of these moths and viability of their progenies could not be tested as the sexes appeared at different times. This diet when offered to field-collected larvae of *Eublemma amabilis* (2·0-2·5 mm in length), however, was found unsuitable. When fortified with cholesterol, sugar mixture, amino acid mixture, vitamin mixture and salt mixture individually as well as in combination and each tried on 100 *E. amabilis* larvae, 18 per cent larvae pupated and 2 adults emerged when kept on diet 1 fortified with cholesterol and amino acid mixture of arginine, histidine, iso-leucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan and valine. This diet, however, was found unacceptable to the newly hatched *E. amabilis* larvae.

(A. K. Sen, A. H. Naqvi and T. P. S. Teotia, Co-operator)

TABLE 2 — COMPOSITION OF SYNTHETIC DIETS OFFERED TO LAC INSECT

Ingredients	Diets				
	D_1	D_2	D_3	D_4	D_5
Amino acids & Amides (mg)					
Valine	200	80	60	200	—
Tyrosine	20	40	120	—	—
Tryptophan	100	80	60	100	—
Threonine	200	140	240	200	—
Serine	100	80	120	—	—
Phenylalanine	100	40	15	100	—
Methionine	100	40	—	100	—
Lysine	100	120	240	200	—
Leucine	200	80	—	200	—
Isoleucine	200	80	120	200	—
Histidine	200	80	—	200	—
Glycine	20	80	30	—	—
Glutamic acid	600	150	240	—	—
Cystine	5	—	15	50	—
Cysteine	50	40	15	—	—
Aspartic acid	100	140	240	—	—
Asparagine	300	550	960	—	—
Arginine	400	270	480	400	—
Alanine	100	100	60	—	—
Vitamins (mg)					
Riboflavin	2·5	2·5	—	5	—
p-amino benzoic acid	10	—	10	—	—
Nicotinic acid	10	10	10	10	—
Inositol	50	50	50	50	—
Folic acid	1	0·5	1	1	—
Choline chloride	50	50	50	50	—
Calcium pantothenate	5	5	5	5	—
Biotin	0·1	0·1	0·1	0·1	—
Ascorbic acid	10	100	100	10	—
Salts etc. (mg)					
Sequesterene NA2ZN	—	0·8	—	—	—
Sequesterene NA2CU	—	0·4	—	—	—
Sequesterene NAFE 13%	—	1·5	—	—	—
Magnessium chloride	200	200	200	200	—
Potassium phosphate (tribasic)	500	—	500	500	—
Cholesterol benzoate	2·5	—	2·5	—	—
Sugar (g)	35	15	30	10	25
Distilled water	To make 100 ml.				

5. Studies on the role of microorganisms present in lac insect

Work on the isolation of microorganisms harboured by the *rangeeni* and *kusmi* strains of lac insects, the former cultured on *palas*, *bhalia* and *jallari* (*Shorea talura*) and the latter on *kusum*, was continued during the year under report. The *rangeeni* insect, cultured on different host plants, showed the presence of four different microorganisms as reported earlier. In the *kusmi* insect, however, apart from these, the presence of a fifth coccoidal shaped micro-organism was also detected. Pure cultures of these microorganisms are being maintained for biochemical studies.

(A. H. Naqvi and T. P. S. Teotia, Co-operator)

6. Studies on sex-attraction in major lepidopterous lac predators

The nature and occurrence of sex attr ction in the major lac predators, *Eublemma amabilis* and *Holcocera pulverea*, were studied to provide basic information for possible use in the control of these predators. It was observed that mating occurs only in darkness. Tests with an olfactometer, fabricated in the laboratory, have suggested that the female of *E. amabilis* contains the sex-attractant.

(A. K. Sen and T. P. S. Teotia)

Breeding and Genetical studies on lac insects

7. Breeding for superior strains of lac insects

(a) *Adaptation of the kusmi lac insect to a common food plant to boost production of the superior lac*

The *kusmi* strain of lac insects produces the better quality lac, but its production is greatly restricted largely due to its limited choice of food plants. The *rangeeni* strain, on the other hand, prefers a variety of plant species and does particularly well on *palas* (*Butea monosperma*) which produces the bulk of lac of commerce. Rearing experience had suggested that the conventional *rangeeni* host *palas* does not lack in nutrients essential for the growth and reproduction of the *kusmi* insect, but it is unable to sustain the *kusmi* insect probably because it is not in the right physiological state during the *kusmi* cycles.

Experiments are now in progress in which attempts are being made to recover *kusmi* type insects at about the *rangeeni* time in crosses of the *rangeeni* and *kusmi* strains. A few *kusmi* type insects which appeared in a segregating progeny reproduced at about the *rangeeni* time in the rainy generation. Their progeny behaviour is being studied.

(Jawahir Lal and N. S. Chauhan)

(b) *Study of crosses*

(i) A large number of lines have been derived from segregating progenies of crosses between distinct races of lac insects originating from widely separated regions. These lines differed in their growth rate and resin dye level and are now being maintained for a comparative study of their economic performance. The fastest growing line took less than 11 months to complete two generations and the slowest more than 13 months.

(ii) A few lines derived from crosses of the *rangeeni* and *kusmi* stocks of lac insects comprised insects which behaved like the *rangeeni* strain with regard to their growth rate and host preference but had about 48 per cent lesser dye in their resin than has the *rangeeni* stock. This result is of considerable practical significance, since colour in lac resin is a serious drawback and so the lighter coloured resin is preferred and valued higher by the consumer industries. The progeny behaviour of these lines is now under study.

(Y. D. Mishra, S. K. Jaipuriar, Jawahir Lal and N. S. Chauhan)

Ecological studies on lac insects and associated insects

8. Influence of environmental factors on the lac insect

(a) *Studies on the effect of photoperiod on growth, life cycle, sex ratio, fecundity and wing polymorphism*

The effect of photoperiod was studied by exposing two potted *bhalia* plants to each of the varying photoperiods, namely, 24-hour exposure to natural light and 13-, 10- and 7-hour exposure to day light, one to two weeks after transplantation in July 1971. These plants were subsequently used to culture the *katki* 1972 and *aghani* 1972-73 insects and continued to receive the photoperiod treatment till the insects completed their life cycle. Twenty five isolated insects were marked on each plant to record observations on their size, growth, life period, proportion of sexes and dimorphic males, fecundity and resin dye level. Data are set out in Table 3.

It would appear from the available results that reduction in photoperiod probably leads to slower development of the insects.

(D. C. Srivastava and B. P. Mehra)

(b) *Determination of the appropriate time of harvesting broodlac in different regions through the use of Biometer and thermograph records*

In order to forecast the time of crop maturity on the basis of temperature records, the development of the *rangeeni* lac insects is being studied at 27·5° and 30·0°C. The test insects were cultured on potted host plant and the desired temperature maintained in an airtight wooden cabinet fitted with thermostatic control. The insects used were obtained from the early, middle and last batches of larval emergence.

The *baisakhi* 1971-72 insects died in their immature stages. Data for the *katki* 1972, however, indicated that the insect development was fastest at 30·0°C whereas fecundity was highest at 27·5°C.

(B. N. Sah, Beche Lal, B. P. Mehra and T. P. S. Teotia, Co-operator)

9. Ecological studies on the inimical and beneficial insects of lac insects

(a) *Relative dominance of the inimical and beneficial insects associated with lac insect in different seasons on different lac-hosts plants*

With a view to controlling the inimical insects which cause extensive damage to lac crops, a study has been taken up to obtain precise information on the relative seasonal incidence of the various inimical and beneficial insects of

TABLE 3 — EFFECT OF PHOTOPERIOD ON LAC INSECT

Treatment	Crops	Time taken (days)					Sex-ratio	
		1st moult	2nd moult	3rd moult	male emergence	Total life period	Male:	Female
24-hr exposure to natural light	*katki* 1972	23·4	35·3	47·4	48·0	128·9	1:	1·3
	aghani 72-73	24·1	35·9	57·5	51·0	Insects died	1:	0·3
13-hr exposure to day light	*katki* 1972	24·1	36·3	47·8	40·0	142·5	1:	1·1
	aghani 72-73	20·1	35·0	48·0	47·0	Insects died	1:	0·5
10-hr exposure to day light	*katki* 1972	24·0	30·4	—	—	Insects died	—	—
	aghani 72-73	19·3	39·2	—	—	Insects died	—	—
7-hr exposure to day light	*katki* 1972	26·9	37·6	—	—	Insects died	—	—
	aghani 72-73	23·8	47·0	—	—	Insects died	—	—

lac. The experiment is laid out on a randomised block design with three replications using three host plant species to culture the lac insects, namely, *palas* and *bhalia* for the *rangeeni* strain and *kusum* and *bhalia* for the *kusmi* strain. The host plants are operated on a 4-coupe system for *kusum* and 3-coupe for the other host species. Five hundred grams sample of lac stick is collected fortnightly from the time of *phunki* removal till the crop is harvested and caged in the laboratory for noting emergence of the various insects for the respective fortnight. The host plants undergo the usual seasonal operations for their proper use to culture the lac insects.

Due to non-availability of the *kusmi* and shortage of the *rangeeni* broodlacs, only a preliminary trial could be initiated during the *katki* 1972 season. Table 4 shows that (i) the inimical parasites were dominant from the second fortnight of September to the first fortnight of November, (ii) the predators appeared from the first fortnight of October and were dominant from the second fortnight of November to the first fortnight of December, although their total number was much less than that of the inimical parasites and *Eublemma amabilis* outnumbered *Holcocera pulverea*, (iii) *Coccophagus tschirchii* was the most dominant inimical parasite and (iv) the beneficial parasites in descending order of incidence were *Elasmus claripennis*, *Pristomerus sulci*, *Chelonella cyclopyra*, *Bracon greeni* and *Brachymeria tachardiae*.

(D. C. Srivastava, B. P. Mehra and T. P. S. Teotia, Co-operator)

(b) *Effect of host-density and age of host on the incidence of the predators in different crop seasons*

The experiment has been laid out on a randomised block design. The lac insect is cultured on *palas* and *bhalia* for the *rangeeni* strain and *kusum* and *bhalia* for the *kusmi* strain. The host plants are operated for maintenance of lac insects on a 4-coupe system for *kusum* and 3-coupe for the other host plant species. The density of lac insects is varied by using different rates of broodlac, namely, 0·250, 0·500, 1·000 and 2·000 kg per tree for *kusum*, 0·125, 0·250, 0·500 and 1·000 kg per tree for *palas* and 0·025, 0·050, 0·100 and 0·200 kg per plant of *bhalia*. Each treatment comprises 5 plants for the tree host species (*kusum* and *palas*) and 2 for the bushy host (*bhalia*). The lac insect cultures on six branches on each tree and two on each bush are maintained under cover of a muslin cloth sleeve and two pairs each of *Eublemma amabilis* and *Holcocera pulverea* introduced in each culture for artificial infestation by the lac predators. The lac cultures on the remaining branches are maintained for natural infestation. Sample of 3 lac-bearing twigs from each tree and one from each bush is collected from natural as well as artificial infestations by lac predators at two stages in the development of lac insects, namely, at the times of sexual and crop maturity and caged in the laboratory for noting emergence of the lac predators.

The experiment has been initiated in the *baisakhi* 1972-73 season.

(B. N. Sah, Beche Lal, B. P. Mehra and T. P. S. Teotia, Co-operator)

10. Analysis of environmental and edaphic factors responsible for differential behaviour of lac insects and hosts of regional importance at Ranchi

To analyse the factors responsible for differential behaviour of the *kusmi* strain of lac insects at Namkum and Vannathiparai in Tamil Nadu, broodlac was obtained from the Vannathiparai lac farm and used to inoculate 6 *kusum*

TABLE 4 — Relative dominance of inimical and beneficial insects associated with the lac insect in *kathi* 1972 crop on *palas*

	September 1972		October 1972		November 1972		December 1972
	1st fortnight	2nd fortnight	1st fortnight	2nd fortnight	1st fortnight	2nd fortnight	1st fortnight
Parasites							
Coccophagus tschirchii	—	97	352	90	56	11	—
Erencyrtus dewitzi	—	8	1	—	—	1	—
Eupelmus tachardiae	—	—	—	1	—	—	—
Marietta javensis	—	2	1	—	—	—	—
Parechthrodryinus clavicornis	—	12	10	8	4	—	—
Tachardiaephagus somervilli	—	—	—	—	—	—	—
Tachardiaephagus tachardiae	—	2	30	19	17	5	—
Tatrastichus purpureus	—	32	21	39	9	—	—
Predators							
Eublemma amabilis	—	—	12	8	11	10	1
Holcocera pulverea	—	—	—	3	1	7	—
Beneficial Insects							
Brachymeria tachardiae	—	—	—	—	—	1	—
Bracon greeni	—	1	—	—	—	—	—
Chelonella cyclopyra	—	—	—	—	1	—	—
Elasmus claripennis	—	—	3	3	—	—	—
Pristomerus sulci	—	—	1	—	—	1	—

trees in the Institute plantation at Namkum in October. The insects have survived satisfactorily till the end of December.

(B. P. Mehra and B. K. Purkayastha, Co-operator)

11. Regional Field Research Station

The field research station at Dharamjaigarh (M.P.) continued to function during the year under report. The progress made in the various items of investigation is reported below.

(a) *Evolution of a suitable technique for culturing lac on kusum under local conditions*

To determine the optimum age of shoots for use in lac cultivation, the lac is grown on 1-year (Treatment A), 2-year (Treatment B) and 1½-year old shoots (Treatment C) and also according to the villagers' practice (Treatment D) which involves nothing more than keeping the trees under continuous lac cultivation through self-inoculation and partial harvest in each crop season. These practices are tried in the July to July and January to January cycles to find out which of these cycles is more favourable for lac production. The crop is harvested once in two crop seasons allowing self-inoculation in the preceeding season in treatments A and B, whereas in treatment C the crop is harvested and artificially inoculated in each crop season. The data obtained showed that the crop in general was poor, affording no clear indication regarding the relative merits of the practices studied.

(b) *Investigation of likely alternative hosts to supplement production of kusmi lac in the region*

(i) *Trials on indigenous plant species as a kusmi host*

One plant each of *jhera* (*Ficus* sp.), *bansa* (*Albizzia odorassima*), *salga*, *salai* (*Boswellia serrata*), *dhobein* (*Dalbergea paniculata*), *pipal* (*Ficus religiosa*), *ghui* (*Ficus* sp.), *mahua* (*Madhuca indica*) and two each of *gular*, *dumar* (*Ficus racemosa*) and *ruli-sindoor* (*Mallotus philippinensis* were inoculated in July 1972. Only *jhera* could sustain a few insects.

(ii) *Introduction of exotic lac hosts*

3,200 and 200 plants of *bhalia* and *galwang* respectively are being raised. The growth of the *bhalia* bushes was satisfactory whereas that of *galwang* was rather slow.

(c) *General survey of the inimical and beneficial insects of the lac insect*

The emergence records of various insects from the *aghani* 1971-72 and *jethwi* 1972 crops are shown in Table 5. These results show that the incidence of the insects associated with lac insects has been extremely low and that the inimical parasites could be recorded only in *jethwi* crop.

(J. M. Das Gupta and B. P. Mehra)

TABLE 5 — GENERAL SURVEY OF INIMICAL AND BENEFICIAL INSECTS OF LAC INSECT AT DHARAMJAIGARH

Date of caging	Period of examination	*Eupelmus tachardiae*	*Apanteles tachardiae*	*Pristomerus sulci*	*Eublemma amabilis*	*Holcocera pulverea*	*Coleoptera*	*Tineidae*
				aghani 1971-72				
22-11-1971	22-30-11-1971	—	—	—	3	5	—	—
	1-31-12-1971	—	—	—	10	16	—	—
	1-31-1-1972	—	—	—	7	10	—	—
	1-29-2-1972	—	—	—	7	20	—	—
	1-31-3-1972	—	—	1	3	9	—	1
	1-15-4-1972		No emergence					
				jethwi 1972				
1-3-1972	1-31-3-1972	3	1	2	1	4	—	—
	1-30-4-1972	2	—	—	1	3	—	—
	1-5-7-6-1972		No emergence					
23-3-1972	23-31-3-1972	—	—	—	1 (one)	3 (three)	—	—
	1-30-4-1972	—	—	—	1	2	—	—
	1-5-7-6-1972		No emergence					
15-4-1972	15-30-4-1972	—	—	—	1	4	1	—
	1-5-22-6-1972		No emergence					
3-5-1972	3-5-22-6-1972		No emergence					
17-5-1972	17-5-7-7-1972		No emergence					
7-6-1972	7-6-7-7-1972		No emergence					

Integrated control of the enemies of lac insects

12. Field trial of an envisaged control schedule against the lac predators

Trials with various control measures, individually and in combination, were initiated in the *katki* 1972 and *aghani* 1972-73 crops in order to work out a suitable integrated control schedule against the lac predators. The field experiments were laid out on a randomized block design.

Katki 1972

The experiment was carried out on *palas* bushes with following treatments, each replicated four times with 5 bushes under each treatment.

Treatments:

A — Single spray of 0·05 per cent endosulfan, 3 weeks after crop inoculation.
B — As in ' A ' followed by one spray of Bactospeine (*Bacillus thuringiensis* W.P.) 3 weeks after the endosulfan spray.
C — Single spray of 0·05 per cent Bactospeine, 6 weeks after crop inoculation.
D — Single combination spray of 0·05 per cent endosulfan and 0·05 per cent Bactospeine in equal proportion, 6 weeks after crop inoculation.
E — No spray (Control).

Although the crop in general has been sub-normal, it was best with the combination spray (treatment D), the yield of sticklac and broodlac being, respectively, 4 and 6 times that of the control.

Aghani 1972-73:

The experiment was carried out on *bhalia* bushes at Taimara State Broodlac Farm, with the following treatments, each replicated four times with 10 bushes under each.

A — Use of synthetic net (40 mesh) broodlac containers for crop inoculation (Mechanical control).
B — As in ' A ' and a single spray of 0·05 per cent endosulfan, 3 weeks after crop inoculation.
C — As in ' A ' and a single spray of 0·05 per cent Bactopseine, 6 weeks after crop inoculation.
D — As in ' A ' and a combination spray of 0·05 per cent endosulfan and 0·05 per cent Bactospeine mixed in equal proportion, 6 weeks after crop inoculation.
E — As in ' A ' and one spray of 0·05 per cent endosulfan 3 weeks after crop inoculation, followed by one spray of 0·05 per cent Bactospeine 6 weeks after crop inoculation.
F — No spray (Control).

The crop data will be available in January 1973 with the harvest of the *aghani* 1972-73 crop.

(R. C. Mishra, C. P. Malhotra and T. P. S. Teotia, Co-operator)

13. Evolving cultural control for the enemies of lac insect

(i) *Finding out a cheap broodlac container for crop inoculation*

As a mechanical control measure, the use of brass wirenet broodlac containers has hitherto been recommended for crop inoculation, to prevent carry

over of the lac pests to the next crop. Brass containers are rather costly. Hence in order to find out a cheaper substitute synthetic net, perforated water-proof packing paper, jute cloth and plastic materials were tried. 60-mesh synthetic net proved equally effective and is much cheaper, the cost per container being Rs. 0·70 as against Rs. 2·50 for the brass container.

(R. C. Mishra and C. P. Malhotra)

(ii) *Trap cropping*

Earlier work had shown that oviposition by the lac predator, *Eublemma amabilis*, is dependent on the density of lac insect. This observation has been made use of in a field experiment designed to control *E. amabilis*. The experiment is laid out on a 30 acre pure patch of *palas* trees at Kundri Forest in Daltonganj District. The main crop is inoculated lightly along with the trap crop which is heavily inoculated to trap *E. amabilis*. The latter is harvested as *ari* to produce sticklac which incidentally also destroys the predators. The distribution of the two crops (main crop and trap crop) is made according to the following designs:

A — The main crop is bordered by trap crop.
B — The two crops are raised in alternate strips.
C — The main crop is interspersed with trap crop.
D — The entire crop is raised through light inoculation (Control).

The experiment has been initiated in the *baisakhi* 1972-73 crop.

(R. C. Mishra and C. P. Malhotra)

(iii) *Effect of varying the time of crop inoculation*

In order to determine whether the time of crop inoculation influences the incidence of lac pests, efforts are being made to procure broodlacs maturing at distinctly different times. To start with, broodlacs were procured from Chandwa and Kundri which differed in their maturity time by 15 days. The crops raised from these broodlacs showed that the incidence of *E. amabilis* was higher in the crop raised earlier with the broodlac from Chandwa.

(P. Sen and C. P. Malhotra)

14. Evolving mass rearing techniques for important beneficial parasites on alternative hosts for inundative releases in field trials and their behavioural studies

Efforts to rear *Pristomerus sulci* on an alternative laboratory host, namely, *Corcyra cephalonica* were not successful since the parasite failed to mate under confinement.

(P. Sen and C. P. Malhotra)

Exploratory studies on the application of modern pest control technology against the predators of the lac insect

15. Laboratory studies on the sterilisation of E. amabilis and H. pulverea with chemosterilants

Three candidate compounds, namely, tepa, thiotepa and hempa were obtained from U.S.A. Experiments will now be taken up on the dipping treatment of

prepupae and pupae of *E. amabilis*, using different concentrations and dipping periods to observe their effects on mortality, fecundity and egg hatchability.

(N. Majumdar and T. P. S. Teotia)

16. Laboratory screening of antifeedants and repellants against major lepidopterous predators

Studies were taken up with 5 candidate compounds, namely, Brestanol, Brestan, Cycocel, mercuric chloride and copper resinate, at 0·05, 0·10, 0·15, 0·20 and 0·25 per cent concentrations for their effects on lac insects as well as newly hatched *E. amabilis* larvae. Table 6 shows that the first three are quite safe to the lac insects and hence these were studied for their effects on *E. amabilis*.

TABLE 6 — EFFECT OF ANTIFEEDANTS ON THE DIFFERENT DEVELOPMENTAL STAGES OF LAC INSECT

Treatment	Concentration (%)	*Average 7-day cumulative mortality (%)			
		4-day stage	10-day stage	20-day stage	40-day stage
Brestanol	0·05	4·10	3·60	6·40	4·90
	0·10	4·70	3·09	4·40	4·10
	0·15	4·70	5·10	3·40	4·70
	0·20	5·30	4·90	3·60	6·40
	0·25	5·90	6·40	5·10	5·30
Brestan	0·05	3·40	4·80	4·10	5·10
	0·10	4·90	5·70	3·40	4·90
	0·15	4·90	4·70	5·30	4·70
	0·20	4·10	5·30	4·90	6·40
	0·25	5·10	4·70	5·60	5·30
Cycocel	0·05	5·30	4·70	3·09	6·40
	0·10	4·90	4·80	6·40	7·50
	0·15	4·90	5·70	5·70	6·40
	0·20	6·40	5·70	6·40	4·90
	0·25	5·10	4·90	6·40	7·50
Mercuric chloride	0·05	87·40	88·40	85·60	81·90
	0·10	91·50	92·60	87·40	81·90
	0·15	96·91	94·90	94·60	85·60
	0·20	97·30	95·10	94·60	88·40
	0·25	98·30	95·90	94·90	88·40
Copper resinate	0·05	26·30	25·60	26·30	21·80
	0·10	34·70	26·30	26·30	27·20
	0·15	47·90	39·20	34·70	27·20
	0·20	47·90	46·40	47·90	34·70
	0·25	50·00	48·20	48·30	44·20
Control	Spray with water	5·40	3·80	5·80	7·50
Control	Spray with Kerosine Oil	8·30	8·50	7·50	8·40

*Average of 3 replicates.

TABLE 7 — EFFECT OF ANTIFEEDANTS ON *Eublemma amabilis* LARVAE

Treatment	Concentration (%)	Inhibition of feeding after 24 hr (%)
Brestanol	0·05	50·00
	0·10	70·00
	0·15	72·20
	0·20	80·00
	0·25	80·00
Brestan	0·05	43·40
	0·10	47·30
	0·15	66·60
	0·20	72·20
	0·25	73·60
Cycocel	0·05	25·00
	0·10	30·00
	0·15	40·00
	0·20	45·00
	0·25	60·00
Control (Water spray)	—	5·00

*Average of 3 replicates.

It will be seen from Table 7 that at the concentrations tested Brestanol and Brestan respectively, resulted in 50.0 to 80.0 and 43.4 to 73.6 per cent inhibition of feeding and resultant mortality among the larvae of *E. amabilis*, 24 hours after treatment.

(S. G. Choudhary, T. P. S. Teotia and C. P. Malhotra, Co-operator)

17. Laboratory evaluation of the efficacy of the microbial agents for the control of the lepidopterous predators

The study could not be taken up due to non-availability of the test materials.

(S. G. Choudhary and C. P. Malhotra)

18. Relative toxicity of newer synthetic insecticides and plant poisons to lepidopterous predators of the lac insect

Technical grades of Phosphamidon, BHC, Lindane, Chlordane, Phorate, DDT, Ambithion, Dipterex, Lebaycid and Folithion were procured to study their effect on the lac insects and the predators.

Studies with Thiodan 35 EC, Phosphamidon, phorate, Ambithion and Folithion showed that, except Thiodan 35 EC, all others were toxic to the early instar lac larvae. Thiodan 35 EC was thus selected for further studies.

(R. C. Mishra, C. P. Malhotra and T. P. S. Teotia, Co-operator)

(c) RESEARCHES CONTEMPLATED

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

1. Protein polymorphism and genetic heterozygosity in lac insect populations.
2. Chromosomal studies in lac insects.

B. AGRONOMY AND PLANT GENETICS DIVISION

During the period under report it was indicated that shrubs viz. *arhar* and *bhalia* may serve as good lac hosts and may form symbiotic association with other crops.

(a) RESEARCHES COMPLETED

Nil

(b) RESEARCHES ON HAND

1. Intercropping of cereals, legumes and grasses under rainfed and irrigated farming with lac host plants

Preliminary experiments with arhar (*Cajanus cajan*) and bhalia (*Moghania macrophylla*) were started on a plot which was not properly cleared. Consequently the growth of plants, both host and crop plants, was neither regular nor uniform. However, some observations revealed the possibility of intercropping, and in the case of *arhar* the October inoculated plants could carry lac crop satisfactorily at best up to *ari* stage. The experimental area will be cleaned and statistically sound experiments will be started from July, 1973.

2. Drought resistance studies on bushy lac hosts

Drought resistance studies in *bhalia* and *arhar* could not be conducted for want of clear area, broodlac and other research facilities. It was also considered that Ranchi with its moderate climatic conditions and almost regular winter rains would not be ideal for such studies.

Dharamjaigarh (M.P.) was thought to be a better place for drought resistance studies. Hence it was decided to initiate experiment at Dharamjaigarh from June-July '73.

(Sohan Lal)

3. Cyto-taxonomic and mutation studies in lac host plants

(a) *Cytotaxonomic studies*: This work was undertaken to investigate the cytotaxonomic relationship amongst various lac host plants.

(i) *Mitotic studies*: The karyotype study of *palas* was completed. The chromosome number was confirmed as $2n = 18$.

(ii) *Meiotic studies*: These studies were completed in 11 varieties of *arhar*. The haploid chromosome number in all the varieties was found as $n = 11$. Both ring and rod bivalents were found in 10 varieties but in the variety C 11 only ring bivalents were observed.

Also, the haploid chromosome number was found as n = 9 for *palas*, n = 11 for *bhalia* and *barasalpan* (*M. chappar*) and n = 10 for *takoli* (Dalbergia lanceolaria).
(b) *Mutation studies*: This work was taken up to induce mutation in 2 varieties of *Cajanus cajan* (Ranchi and Assam collections) and 2 species of *Moghania* (*M. macrophylla* and *M. chappar*) with the object of evolving plants with potentials for high lac yield. Gamma rays (Co^{60}) and ethyl methanesulfonate (E.M.S.) were used as physical and chemical mutagens respectively.

(i) *Effect of Gamma-irradiation on Moghania* spp. *and arhar varieties*

Field study: Seeds collected from M_1 generation were sown in the field for further study. The effect exercised by various treatments on germination of seeds is shown in Table 8.

TABLE 8 — PERCENTAGE OF GERMINATION IN M_2 GENERATION FOLLOWING IRRADIATION OF DRY SEEDS OF *M. macrophylla* AND *M. chappar*

Treatment	*M. macrophylla*			*M. chappar*		
	No. of seeds sown	No. of seeds germinated	Percentage of germination	No. of seeds sown	No. of seeds germinated	Percentage of germination
Control	200	127	63·50	60	18	30·00
5 Kr	200	136	68·00	60	19	31·60
10 Kr	200	115	57·50	60	17	28·30
15 Kr	200	144	72·00	60	14	23·30
20 Kr	200	131	65·50	60	12	20·00
25 Kr	200	138	69·00	60	11	18·30
30 Kr	200	126	63·00	60	13	21·60
35 Kr	200	132	66·00	60	12	20·00
40 Kr	200	135	67·50	60	14	23·30

In M_1 generation the percentage of germination had decreased with increase in doses in both the species. In M_2 generation, while in *M. chappar* a similar trend was observed particularly at higher doses, the inhibiting effect disappeared and germination reverted to normalcy in *M. macrophylla*.

Laboratory study: The seeds of 2 varieties of *arhar* (Ranchi and Assam collections), irradiated at the doses mentioned in Table 8, were germinated in the petridishes and length of root and shoot was measured for six days.

It is apparent from the results that the growth of root and shoot was adversely affected with increase in doses of irradiation.

(ii) *Effect of Ethyl methanesulfonate on Moghania* spp.

Seeds of *M. macrophylla* and *M. chappar* were first soaked in tap water for 24 hrs. These seeds were treated with E.M.S. for six hours at various concentrations viz. 0·125, 0·250, 0·500, 0·750, and 1·000 per cent. For the control,

seeds were kept for the same period in water blank. Thereafter seeds were sown in earthen pots.

The germination percentage decreased with increase in doses.

(Pranay Kumar)

4. The possibility of interspecific crosses in Moghania spp.

The study has been taken up to combine the vigorous growth and profuse branching habit of *M. chappar* and better lac-bearing capacity of *M. macrophylla* through hybridisation. Since the two species flower at different times (*M. macrophylla* flowers in the months of July to September and *M. chappar* in the months of November to January) the coinciding of flowering is a pre-requisite. Experiments were started for delaying the flowering in *M. macrophylla* and hastening it in *M. chappar*.

M. macrophylla: Plants were sprayed with NAA (Nephthoxyacetic acid) at three concentrations viz. 50, 100 and 200 ppm to delay the flowering at fortnightly intervals between June and October. Each treatment consisted of 10 plants.

No definite effect could be obtained.

M. chappar: Plants were sprayed with 4 concentrations of Cycocel (100, 200, 300 and 400 ppm) and 3 concentrations of NAA (50, 100 and 200 ppm) at weekly interval from August to October. Each treatment consisted of 10 plants.

None of the treataents hastened the flowering.

(Pranay Kumar)

5. Studies on various vegetative propagation methods

(a) *On kusum*

(i) Three different methods of treatment, namely, soak-method, quick dip method and dust method were tried to raise *kusum* plants from stem cuttings using mixture of plant growth regulators IBA and NAA. None of the methods was found successful in inducing roots.

(ii) *Air layering*

Air layering was carried out on selected shoots of *kusum* in the months of January, March, June and September, but no rooting response was observed.

(b) *On other hosts*

The study was conducted on rain tree (*Samanea saman*), *pansaura* (*Grewis serrulata*), *sandan* (*Ougeinea oogeinensis*) and *palas* (*Butea monosperma*) in the months of January, March, June and September. The growth regulators tried were IBA, NAA and IAA in various combinations each at 50 and 100 ppm. The rooting response was observed only on rain tree and *pansaura* while the other hosts did not develop roots at all.

The results in Table 9 show that the rooting response of cuttings treated with growth regulators and planted in June was best for both rain tree and *pansaura*. The mixture of IAA and NAA at 100 ppm was found most effective for rain tree and that of IBA and IAA at 50 ppm for *pansaura*.

(B. K. Purkayastha)

TABLE 9 — EFFECT OF GROWTH REGULATORS ON THE ROOTING RESPONSE OF *rain tree* AND *pansaura*

Host plant	Growth regulators	Concentration (ppm)	Rooted plants (%)			
			January	March	June	September
Raintree (*samanea saman*)	IBA and IAA	50	Nil	Nil	20	10
		100	,,	10	20	Nil
	IBA and NAA	50	,,	10	30	10
		100	,,	Nil	10	20
	IAA and NAA	50	,,	30	60	30
		100	,,	10	80	20
	Control	—	,,	Nil	Nil	Nil
Pansaura (Grewia serrulata)	IBA and IAA	50	,,	30	60	10
		100	,,	10	40	Nil
	IBA and NAA	50	,,	10	50	20
		100	,,	20	30	20
	IAA and NAA	50	,,	Nil	20	Nil
		100	,,	Nil	30	Nil
	Control	—	,,	Nil	Nil	Nil

(B. K. Purkayastha)

6. Optimum season of pruning and age of shoots for inoculation of lac on various hosts

The study is kept in abeyance for the present and will be taken up as soon as the plants are available after reorganisation of the Institute plantation.

(c) RESEARCHES CONTEMPLATED

1. Integrating lac cultivation with general land use patterns of lac growing regions.
2. Lac cultivation on shrubs.
3. Introduction of rain tree for lac cultivation:
   (i) Growing of rain tree under fertilised and irrigated conditions.
   (ii) Growing of rain tree into bushes.
4. Role of plant growth regulators on the growth of plants:
   (i) Influence of pre-treatment of *Moghania* seeds with growth regulators in relation to lac yield.
   (ii) Effect of GA on the growth of plants.

C. CHEMISTRY DIVISION

(a) RESEARCHES COMPLETED

Adhesion of shellac with mica

Different types of shellac (40 g each) were dissolved in distilled methylated spirit (95%, 60 g) separately at room temperature (25 ± 2°C) and each used to affix a strip of tissue paper (1·0 cm × 15·0 cm) to mica splitting. Increasing

loads were applied to the paper until it completely parted off the mica splitting and the optimum weight was recorded.

Shellac used were:

1. Hand made shellac (*kusum*)
2. Machine made shellac
3. Autoclave shellac
4. Dewaxed lemon shellac
5. Dewaxed decolourised shellac
6. Seedlac (after separating wax and impurities)

Two types of tissue paper were used, one indigenous and the other electrical grade (U.K.). The indigenous tissue paper was not found suitable as in most cases it did not adhere properly on the mica surface and where it adhered, the bond strength was poor as compared to the U.K. paper. With the latter paper, the bond was proper and recorded higher and uniform optimum weight. Out of various types of lac used, dewaxed lemon and dewaxed decolourised shellacs gave the best bonding strength.

(R. Prasad & S. C. Sengupta)

(b) RESEARCHES ON HAND

1. Modification of shellac

(a) *Grafting of shellac with vinyl monomers*

It was reported previously (A. R., 1971) that the grafted product from methylmethacrylate and shellac was insoluble in alcohol, benzene, dioxane, acetone, chloroform etc. The grafted product was obtained by precipitation with sulphuric acid from its aqueous ammoniacal solution. Normally a soluble product was expected. The insolubility may be due to the action of sulphuric acid on the grafted product.

Hence the experiment was repeated and acetic acid was used for precipitation instead of sulphuric acid. Usual washing of the precipitated product with benzene and alcohol, to remove homopolymer and unreacted shellac afforded the grafted polymer. The acid value of the product was found to be 2·5 to 3· Though it softened between 85-90°C, it did not melt even up to 200°C. It was found to be soluble in acetone after standing for 2-3 days and readily in diacetone alcohol, hot dimethylformamide, a mixture of hot benzene and alcohol but insoluble in either benzene or alcohol alone.

The viscosity of this product and shellac was also determined in a mixture of benzene and alcohol at 33°C. The intrinsic viscosity of shellac was found to be 0·1 whereas of the grafted product 1·28 and 1·92 after a polymerisation time of 1 and 2 hr respectively.

IR spectra of graft copolymer, shellac and polymethyl methacrylate were also taken. However no discernible variation was noticed.

An attempt was also made to graft methyl methacrylate on jalaric acid, a major constituent acid of shellac, but without any appreciable succcss.

(K. M. Prasad & P. R. Bhattacharya)

(b) *Modification of shellac with epichlorohydrin*

It was reported earlier (A. R., 1971) that the reaction between aleuritic acid or its sodium salt and epichlorohydrin resulted in products having only one epoxy group and hence cross linking did not take place by the addition of amines. Attempts with the dicarboxylic acid (9,10-dihydroxy hexadecane-1,16-dioic acid) prepared from aleuritic acid were also not successful.

Fresh attempts were, therefore, made for the introduction of more than one epoxy groups in the aleuritic acid molecule in order to get the desired cross linking with amines. Different proportions of aleuritic acid and epichlorohydrin at various temperatures were reacted in presence of boron trifluoride etherate and a successful method was ultimately evolved. Aleuritic acid or its sodium salt (1 part), epichlorohydrin (1 part) and boron trifluoride (0·03 part) were reacted at 70-80°C for 3 hr and the resulting product was finally treated in dioxane solution with sodium aluminate. Removal of volatiles resulted in a light yellow, viscous, sticky and neutral mass having epoxide value 0·25/100 g. The product cured to a hard mass at room temperature in presence of usual amine catalysts.

The above successful method was then extended to dewaxed shellac and a sticky semi solid was obtained whose epoxide and acid value were found to be 0·198/100 g and 0 respectively. This product also cured hard at room temperature with amine catalysts.

(S. K. M. Tripathi & S. C. Sengupta)

(c) *Systematic studies on Lac-linseed oil-glycerol combination and their utilisation*

Varnishes prepared from the lac-linseed oil-glycerol combination on air drying do not produce hard films. Paints of this type are of much importance due to their increasing use in the field of surface coating. A systematic study on the subject was taken up to find the causes of persistent tackiness of the films. Aleuritic acid, a major constituent acid present in lac was thought to be suitable as starting material in studying the reaction mechanism of lac-linseed oil-glycerol combination.

Aleuritic acid was heated with glycerol at 225 ± 5°C for 2 hr using various catalysts such as *p*-toluene sulphonic acid, sulphuric acid and zinc dust and samples were withdrawn at regular interval of 10 minutes and washed to remove excess of aleuritic acid, catalyst and glycerol. The acid and hydroxyl values were found to drop with the progress of reaction indicating the esterification reaction.

TLC examination of the final products using various solvents confirmed the presence of mono-, di- and tri-glycerides of aleuretic acid.

Attempts were then made to prepare the mono-glyceride only. After conducting several experiments, the following condition was found suitable for its preparation.

Aleuritic acid was heated with glycerol (excess) at 225 ± 5°C for 45 minutes with zinc dust as catalyst. The final product was a solid m.p. 63-65°C. TLC examination indicated almost pure mono-glyceride while IR spectrum showed band for ester carboxyl at 1715 cm. It was further confirmed through its elementary analysis. For the formation of specifically di- and tri-glycerides of aleuritic acid, several experiments were also carried out by (i) heating aleuritic

acid with glycerol in molar proportions, and (ii) reacting monoester of the same with aleuritic acid again, but these were not successful.

In the second part of the study, linseed oil (alkali refined acid value 1) was heated with glycerol at 225 ± 5°C for 1 hr. Samples were withdrawn at regular interval of time and examined by TLC after washing. TLC examination showed five to six clear spots indicating mixture of esters. The same reaction was carried out using sodium hydroxide as catalyst (0·1 percent on the weight of linseed oil) for the formation of monoester, but there was no clear indication of its formation.

(R. N. Majee, S. Kumar & S. C. Sengupta)

2. Study of the constitution of lac

(a) *Separation and study of components of lac-resin*

The preparation of hard resin from different seedlacs, determination of their chemical constants, percentage estimation of aleuritic acid and jalaric acid in different hard resins before and after hydrolysis and preliminary TLC examination of hard resins and their methyl esters were reported last year (A. R., 1971). The fractionation of hard resin was done during the year under report.

Palas hard resin was fractionated into three fractions (A, B and C) through urea-complex formation. In order to find out the extent of fractionation, small portion of each was hydrolysed and the constituent acid converted to methyl esters for TLC examination. The TLC examination revealed that A contained most of the aliphatic esters while B and C, the terpenic esters.

Refractionation of B wss carried out by urea and again three fractions (B-1, B-2 and B-3) were obtained. Each fraction was examined by TLC after esterification. B-1 gave two spots, B-2 eight spots and B-3 only one prominent spot, which appeared to be of methyl aleurititate.

B was hydrolysed by alcoholic sodium hydroxide, the free acids recovered by passing through cation exchange resin and subsequently the free acids converted to methyl esters. The mixed esters were fractionated into adducted and non-adducted esters by urea. TLC examination revealed that the adducted one is a mixture of nine constituents while the non-adducted of four only. The non-adducted esters were fractionated over silicic acid into five fractions. None of these fractions was pure. The third fraction consisted mainly of w- and mid-hydroxy C_{16} esters. It was refractionated but no pure constituent could be obtained.

The 5th fraction, which appeared to be a mixture of aleuritate, shellolate and epi-shellolate, was refractionated into five fractions. The third one was solid and was confirmed as methyl aleuritate by its mixed m.p. and TLC examination.

(N. Prasad & S. C. Sengupta)

(b) *Studies on self-esterification of aleuritic acid derivatives*

(i) *Self-esterification of* 16-*hydroxy*-9: 10-*dioxohexadecanoic acid*

The acid (16-hydroxy-9: 10-dioxohexadecanoic acid) was first prepared according to the method of Ansell *et al.* [J. chem. Soc. (C), (1971) 1850]. The m.p. of the product was 87-88° and yield 27%. The acid and hydroxyl values were found to be 192·0 as against theoretical 187·0.

The acid (5g) was then polymerised in a thin walled pyrex test-tube in an oil-bath maintained at the desired temperature. Samples were withdrawn from the melt at definite intervals of time and analysed for acid value. From this, the extent of reaction p and degree of polymerisation $\frac{1}{1-p}$ were calculated using the relation $p = \frac{no-n}{n}$ where no = the initial acid value n = the acid value after time t and p—the extent of reaction.

The uncatalysed reaction was studied at 120°, 140°, 160° and 180°C.

From the data it was found that the maximum conversion corresponds to 51% at 180°C after 1·25 hours beyond which the product gelled.

It was also observed that uncatalysed kinetics followed third order rate. The energy of the activation was found to be 20·52 Kcal/mol.

In view of lower conversion (51% as compared to of previous derivative IPDA, isopropylidene derivative of aleuritic acid), it was considered unlikely to yield any high molecular weight compounds by polycondensation reaction. The reason for earlier gelling may be due to the participation of carbonyl group in the reaction at some stage. In view of our objective primarily in building a high molecular weight polyester, this study was not pursued further.

(ii) *Self-esterification of trans-16-hydroxy-9-hexadecanoic acid*

This acid was prepared according to the method of Hunsdiecker [Ber, **76**, (1943) 142]. The yield was 30 percent and m.p. 69-70°C. The acid, iodine and hydroxyl values were 207·8, 92·0 and 207·8 respectively.

The uncatalysed reaction was studied at 140°, 160°, 180° and 200°C and the catalysed one at 120°, 140°, 160° and 180°C in the presence of 0·2 percent *p*-toluenesulphonic acid.

The maximum percentage of esterification in case of uncatalysed reaction was 79 percent at 200°C after 1 hr and in case of catalysed, 92 percent at 180°C after 50 minutes.

The uncatalysed and catalysed reactions were found to follow third and second order rate, the activation energies being 18·24 and 11·40 Kcal/mol respectively.

Intrinsic viscosity-molecular weight relationship:

Four polyesters were prepared at 180°C at different intervals of time. Their physical and chemical constants are given below:

Sl. No.	Temp. °C	Time (mts)	M.P. °C.	A.V.	[η] in chloroform at 25°C	Mol. wt. by end group	Mol. wt. by Rast
1.	180	15	44-45	138.2	0.0460	405.9	427.3
2.	do	30	44-45	86·90	0·0615	645·5	641·2
3.	do	75	51-52	52·70	0·1010	1,064	949
4.	do	105	53-54	43·05	0·1170	1,303	1,264

It will be seen that the molecular weights obtained by two different methods are in good agreement within the limits of experimental error.

On plotting the log of $[\eta]$ ag inst the log of Mn (obtained by end group), the graph was found linear. From the intercept and slope of the straight line, the values of k and α were calculated respectively. The following relationship was found in the Mark-Houwink equation.

$$[\eta]=[14{\cdot}12\times10^{-5}M^{0,95}]^{25°C}\ \text{chloroform}$$

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

3. Depolymerisation of polymerised shellac

During this period, an attempt was made to analyse the aqueous extract left over after precipitation of acid hydrolysate of polymerised shellac with 1·0% sodium chloride solution.

For this purpose, the extract was heated in the presence of excess lead oxide on a waterbath upto the neutral point with the help of the universal indicator paper but on account of certain technical difficulties, the presence of shellac in the extract as lead salt could not be ascertained. Apart from this, an attempt was also made to optimise the hydrolytic process.

The experiments were run with the optimal amounts of acid and polymer both in the presence and absence of the optimal amount of water. It was observed that the additional water always leads to a decrease in the yield.

The optimisation of the hydrolytic process with respect to time is in progress.

(A. Kumar & P. R. Bhattacharya)

4. Electrical properties of shellac modified with epoxy resin and rubber

(a) *Electrical properties of shellac/epoxy resin blends*

The purpose of these studies is to evolve new moulded insulators having good insulating properties. Several compositions of different weight ratios of shellac and " Epikote 1001 " were prepared by heating the blends at 150°C for 35 min. The cure time was determined by repeated experiments by moulding the compositions at 120°C for 30 min and examining the homogeneity and brittlenes of the moulded discs. It was observed that the compositions after curing were not purely thermosetting as expected. Since the Epikote resin used happened to be old, it was decided to repeat the experiments with fresh epoxy resin.

(b) *Electrical properties of shellac/rubber cable compositions*

It was observed that the electrical properties of rubber gumstocks improve (A. R., 1971) with additions of small quantities of shellac in the blend. The purpose of these studies is to study the properties of filled stocks of shellac/natural rubber so that these can be used in the cable industry.

The rubber filled stocks contained natural rubber-100 parts, zinc oxide-5 parts, stearic acid-0·5 part, whiting-45 parts, clay-50 parts, sulphur-1·5 parts, accelerator-1·5 parts, antioxidant-1·0 part and shellac in varied proportions. The mixing and vulcanisation methods have been described earlier (A. R., 1971).

The studies indicated that whiting is not compatible in the stock as filler. Hence the properties of these filled stocks without whiting are being studied.

(T. R. Laxminarayanan, P. R. Bhattacharya & B. B. Khanna)

5. Use of shellac and modified shellac in surface coatings

(a) *Water thinned shellac emulsion paints for interior decorations*

It was reported last year that stable emulsion paint had been obtained from the resultant mass of aqueous shellac solution, mixed glycerides of linseed oil with non-ionic emulsifiers and large quantity of ammonia, possessing excellent resistance to wet abrasion and good adhesion on limed surfaces.

But due to the presence of ammonia in high proportion, this paint did not appear to have much use. Moreover, after storage for 6 months, it was observed that the paint thinned down and the viscosity reduced from 75 to 25 sec, other performances remaining the same.

Therefore, fresh investigations were made to overcome these difficulties and after a series of experiments improvements were made making a stable emulsion paint from shellac and mixed glycerides of linseed oil.

To a mixture of 60 ml of 10 per cent ammonia, 5 ml of 10 per cent triethanolamine and 15 ml of distilled water, powdered dewaxed shellac (20 g) was added in small lots, warmed and allowed to stand overnight.

Mixed glycerides of linseed oil (30 g), non-ionic emulsifiers (1 g) and cobalt naphthenate (2·5 g) were mixed under efficient stirring. The mixture was then emulsified by slowly adding the aqueous solution of shellac under continuous stirring till an water-in oil emulsion paste was formed. The paste was next thinned by adding 14 ml of distilled water.

This emulsion was then pigmented by incorporating a requisite quantity of aqueous paste of titanium dioxide. A right proportion of carboxymethyl cellulose was also added as thickener and the whole mass mixed with a coloured pigment homopaste according to the desired shade. After allowing to stand for 24 hrs, the viscosity (Ford's cup) was found 110 sec. Films were prepared by brushing or spraying on cemented blocks and limed surfaces. The film properties were studied as usual and are indicated below:

1. Uniformity and smoothness	— good
2. Touch dry	— 20 minutes
3. Hard dry	— 10 hrs
4. Wet abrasion test	— 995 rubs

It appears from the above that shellac emulsion paint compares favourably with the commercial plastic emulsion paint. In case of plastic emulsion paint, the resistance to wet abrasion was found very low.

A slight improvement in viscosity in this emulsion paint was found after storage for 6 months (using 0·2% of carboxy-methyl cellulose); the viscosity changed from 100 to 50 sec without changing other constants or performances.

(M. Mukherjee & S. Kumar)

(b) *Water based red oxide primers and their application by electrodeposition*

It was observed that film produced on mild steel from only modified shellac (partial esterified lac, product of shellac/epoxy, etc) showed very good anti-corrosion properties. The film thickness was within one mil in both the cases

i.e. shellac and modified shellac (A. R. 1967-1971). It was presumed that if the film thickness is increased, equivalent properties could be obtained from plain shellac alone and thus the cost would be reduced considerably. To increase the thickness of the film, conductive pigments were tried. Conducting pigments would also lead to second coat or top coat over the first coat.

With these ideas, shellac varnish containing 20% shellac was pigmented with carbon black/lamp black (pigment/binder = 1·2) and deposited on steel panels at 50 volts with 40 amp/sq. m current density. The deposition took place within 90 sec and showed better uniformity in the case of lamp black. The adhesion, however, was found poor in both air dried and baked films. Thickness of the film was also increased considerably. When the current was passed for longer period, thicker but non-uniform film was obtained. A second coat of shellac varnish was applied which was neither uniform nor smooth.

To improve the anticorrosive properties of red-oxide primer, strontium chromate was incorporated but the deposition of pigments was not uniform on both sides of the panel.

(A. Pandey, P. R. Bhattacharya & S. Kumar)

6. Cation exchange resin from modified shellac

Some preliminary work on the preparation of cation exchange resin from shellac and its exchange capacity was reported last year. The details of its preparation and properties were undertaken this year and are reported below.

Cation exchange resin was prepared from sulphonated lac, resorcinol and *p*-formaldehyde as follows:

Sulphonated lac (22 g) was dissolved in 4% sodium hydroxide, *p*-formaldehyde (1·5 g) added and boiled for 1 hr. After this, resorcinol (11 g) was added and heating continued for a further period of 1 hr. The solution was then cooled to 50°C and a further lot of *p*-formaldehyde (1·5 g) added with stirring. After half an hr of boiling, a further lot of *p*-formaldehyde (1·5 g) was added with stirring. This solution did not form a gel when heated on a water bath but when another lot of *p*-formaldehyde (1·5 g) was added, it formed a gel (at 85°-90°C), within 2 min. The gel was broken up and further hardened in an oven at 100°-105°C for 4 hr. The resin was washed to remove colouring matter as well as unreacted materials first with water, then with spirit and finally with 10 per cent sodium hydroxide solution. The resin was then leached with 10 per cent hydrochloric acid to convert it to H form. A black resin was finally obtained having the following properties:

Moisture content — 3%
Sulphur content — 4·5%
Mesh size — 20·40 (ASTM)

The cation exchange capacity of this resin along with that of Amberlite IR-120 is as follows:

Resin	In presence of NaCl at 25°C, pH_7	From $BaSO_4$ determination	From Limiting exchange value with $BaCl_2$ soln.
Amberlite IR-120	4·18	4·15	4·19
Modified shellac	9·94	9·90	9·92

This resin is completely insoluble in water, spirit and alkali. It can be safely used from 1-13 pH, without any colour throw and is not attacked by acids or alkalies and remains unchanged upto 170°C. It can be regenerated with 10% hydrochloric acid and was found to exchange cations from both aqueous and alcoholic media.

(A. Rahman & P. R. Bhattacharya)

7. Shellac in rocket fuel

The current solid fuels used for rocket propellants are mainly based on polyvinyl chloride (PVC) compounded with suitable oxidants. P.V.C. suffers from two main disadvantages: (1) it contains chlorine which is harmful for the metallic surfaces of the rocket nozzles and since chlorine is a heavy atom, chlorine and its compounds such as hydrochloric acid, are not desirable as products of combustion, (2) although it is manufactured in this country it is largely imported and is more expensive than many of the commonly used polymer products.

Shellac does not contain any chlorine and is cheaper than many plastic products including P.V.C. Experiments have been conducted to compound shellac with suitable oxidants in such a manner so as to simulate the rocket fuel based on P.V.C. The preliminary results obtained so far are very encouraging. The products compare well with the conventional fuels as regards burning length, flame length and ash content. A more detailed and systematic study in this direction may eventually lead to an excellent fuel independent of the erstwhile P.V.C. compounded materials. Utilisation of lac in this field will increase the internal consumption of lac.

(S. Kumar, A. K. Dasgupta & J. N. Chatterjea)

Sponsored Research Scheme

Use of shellac for coating chemical fertilisers

This scheme is being continued by the Retired Scientist in this Institute. The working efficiency of the semipilot plant, set up at this Institute, has been further improved. About 5 quintals of lac coated urea fertiliser produced have been supplied to different Institutions for agronomical evaluation and trials.

The reports of trials from the All India Coordinated Rice Improvement Project, Hyderabad (A.P.) have been received. Further work is being continued for arriving at a conclusion.

To bring down the coating cost of the fertiliser, it has been seen after trials that oil (2% on the weight of urea) for anchorage of resin and conditioner (2%) for making urea pills free flowing, are the optimum amounts.

To study the slow releasing characteristics of lac coated urea, several experiments were carried out in pot culture with paddy (variety IR-8) at Planning and Development Division, FCI, Sindri, Bihar. The test crop was grown under wet land conditions. The nitrogen levels were 100 and 200 kg per ha, both from normal uncoated urea and lac coated urea. The yield of average dry matter from different treatments are as follows:

1. Control	34·5 g
2. U_1	41·4 g
3. U_2	47·6 g
4. LU_1	36·7 g
5. LU_2	39·3 g

Where, U-uncoated urea and LU-lac coated urea.

The experiment showed that because of slow release of nitrogen from LU, nitrogen was available in lesser quantity during the effective growth period.

(B. C. Srivastava & T. Bhowmick)

(c) RESEARCHES CONTEMPLATED

The following problems are to be included in the next year's programme.

(i) Estimation and identification of shellac in presence of other resins.
(ii) Use of shellac in Decorative laminates.

D. TECHNOLOGY DIVISION

(a) RESEARCHES COMPLETED

1. Lac as a source of fine chemicals: Preparation of aleuritic acid

Aleuritic acid to the extent of nearly 25 per cent could be obtained by passing hydrogen chloride gas through a solution of lac in glacial acetic acid (A R.. 1971). Alternate methods to increase the yield were attempted as given below:

(a) *Salt preparation method*

After hydrolysis of dewaxed lac with 5*N* caustic soda, precipitated sodium aleuritate was separated and from the mother liquor, barium and zinc salts were successively prepared. Further amount of aleuritic acid could not be obtained from these salts. In another attempt, calcium salt was prepared from the mother liquor obtained after separating sodium aleuritate. Only a very small amount of crude aleuritic acid, m.p. 95-96°C, could be obtained from this calcium salt. The methods were repeated but aleuritic acid could be obtained to the extent of 20 per cent only.

Further Na, Ba, Ca, Mg, Zn, Al, Cu, Ni, Co and Ph salts of aleuritic acid were prepared by double decomposition of sodium aleuritate and corresponding water soluble metallic salts. The solubilities of these salts in various solvents were studied.

Once again, water insoluble Ba, Ca, Al and Zn salts were prepared separately from the mother liquor left after separation of sodium aleuritate from lac hydrolysate. The salts were extracted with suitable solvents. The extracts on decomposition yielded very little aleuritic acid.

(b) *Other methods*

In the following methods, the mode and medium of hydrolysis were varied to increase the yield of sodium aleuritate.

(i) hydrolysis of lac in alcoholic solution and separation of sodium aleuritate;
(ii) acid hydrolysis of lac in alcoholic medium followed by alkaline hydrolysis and separation of sodium aleuritate;
(iii) alkaline hydrolysis of lac in aqueous medium in presence of sodium sulphite and separation of sodium aleuritate.

None of the above methods were found satisfactory for improved yield of aleuritic acid.

(B. C. Srivastava & S. C. Sengupta)

(b) RESEARCHES ON HAND

1. Improvements in processing of lac and utilisation of byproducts

(a) *Dewaxing of lac*

A simple and quick process for dewaxing lac in aqueous medium was reported last year, with an addition of lac wax (10% on the weight of seedlac) to the lac solution in sodium carbonate. After boiling the solution for 2/3 min and then cooling at a temp. of 10 ± 2°C for 1 hr, most of the wax present in lac accumulates in the top 15 per cent solution in a hard and compact form and can be removed easily. The remaining solution which is practically clear (wax content 1%) is drained out and filtered through a cloth bag.

Various types of cloth viz., cotton, terylene, nylon and rayon were tried as filtering medium. Rayon gave the best performance (lowest wax content and reasonably fast rate of filtration, Table 10.

TABLE 10 — EFFECT OF VARIOUS FILTERING MEDIA ON THE RATE OF FILTERATION AND WAX CONTENT OF THE FILTERATE USING KISSELGHUR (5%) AS FILTERAID

Sl. No.	Nature of filtering medium	Time taken for filtration hr.	min.	Wax content of the filtrate (%)	Wax content of the filtrate after recycling 15% remaining solution (%)
1.	Rayon	—	45	0·2-0·25	0·2-0·25
2.	Drill	1	—	0·3-0·35	—
3.	Turkish	—	30	0·90-0·95	
4.	Terylene	—	35	0·75-0·80	
5.	Nylon	Very slow		0·58-0·60	

Further, out of many filteralds tried such as paper pulp, ghungi (lac refuse), brick dust and kisselghur, the last one gave the best performance. The optimum amount was found to be 5% on weight of lac.

It was also found that the upper 15 per cent solution, which was left over, could be worked up with the subsequent batch. Using this technique, the necessity of adding lac wax from outside can be avoided and dewaxed lac obtained in nearly 90% yield.

The process is under study on a semi-pilot scale.

(B. P. Banerjee & B. B. Khanna)

(b) *Bleaching of lac*

The object of the work is to study the bleaching of lac with chlorine-free bleaching agents so as to obtain a lac which is free of colour but retains other desirable properties such as life and flow. These properties are otherwise damaged if bleaching is carried out with chlorine containing agents.

It has already been reported (A. R. 1970) that the colour index of *rangeeni* seedlac could be reduced to 4·5 and that of *kusmi* to 2·0 by the action of hydrogen

peroxide alone using solution of lac in sodium bicarbonate. In order to increase the mild oxidative power of hydrogen peroxide, various activators such as ferrous sulphate, cobalt sulphate, copper sulphate, acetic anhydride, copper sulphate+nitrilotriacetic acid, cobalt sulphate+pyridine-2-carboxylic acid etc. were used along with hydrogen peroxide varying their amount and duration of reaction (Murrya, *T. J. Am. Oil C. Soc.* 45 (1968), 493). The temperature of reaction was maintained at 40±2°C, as higher temperatures gave a sticky product. Of all the activators used, the system cobalt sulphate+pyridine-2-carboxylic acid proved partially successful and gave a product with a colour of 3·0 using *rangeeni* seedlac. The results are indicated in Table 11.

TABLE 11 — EFFECT OF VARIOUS ACTIVATORS USED WITH HYDROGEN PEROXIDE ON THE BLEACHING EFFICIENCY

Sl. No.	Activators used and amount (g)	Duration of reaction (hr)	Colour index of the resultant product
1.	Ferrous sulphate (0·1 to 1)	18	5
2.	Copper sulphate (0·1 to 1)	18	7·5
3.	Cobalt sulphate (0·1 to 1)	18	5
4.	Acetic anhydride (0·1 to 10 ml)	18	12
5.	Copper sulphate + Nitrilotriacetic acid (0·1 to 1)	18	Colloidal solution and lump formation on precipitation with H_2SO_4 sol.
6.	Cobalt sulphate + Pyridine-2-carboxylic acid (0·02 to 0·04)	18	4
7.	Cobalt sulphate + Pyridine-2-carboxylic acid (0·02 to 0·04)	6	5
8.	Cobalt sulphate + Pyridine-2-carboxylic acid (0·02 to 0·04)	12	4·7
9.	Cobalt sulphate + Pyridine-2-carboxylic acid (0·05)	4	3

In an earlier work (A. R. 1961-62), it has been reported that if lac is bleached while in fine suspension, changes of chlorination are likely to be reduced. Consequently, attempt was made to bleach lac while in suspension with hydrogen peroxide alone or in combination with sodium hypochlorite. No success was observed with hydrogen peroxide alone, but the combined process gave very promising results. The bleached product thus obtained was free-flowing, having very little chlorine and consequently good life and flow. The details of the process are as follows.

A sodium bicarbonate extract of lac is treated with sodium chloride solution (10% w/v) with vigorous stirring till a fine suspension of sodium salt of lac is obtained. Subsequently one-fourth of the total requirement of the sodium hypochlorite (3% available chlorine) as per bleach index of lac is added to lac with vigorous stirring. After an hr, 150 ml of hydrogen peroxide (10% w/v) per 100 g of seedlac are added. The temperature during bleaching is maintained at 35°C. After 4 hr, the solution is diluted to 5 per cent lac content and precipitated with dil sulphuric acid (5%). The product is thoroughly washed with water to remove acid and dried. The results obtained are presented in Table 12.

TABLE 12 — PROPERTIES OF BLEACHED LAC OBTAINED BY VARIOUS METHODS OF PREPARATION

(*Rangeeni* seedlac 100 g, Bleachd index 100 ml.)

Sl. No.	Bleach liquour added (ml)	H_2O_2 added (ml)	Duration of reaction (hrs)	Yield (%)	Life (min.)	Flow (mm)	Colour Index	Chlorine content (%)	A.V.	Sap value	Cold alcohol insolubles (%)
1.	Original seed lac	—	—	—	45	48	15	—	70·4	220·8	5·0
2.	100	150	4	89	37	38	0·33	0·36	76·3	224·3	4·5
3.	85	150	4	89·3	39	40	0·4	0·27	74·9	226·8	4·26
4.	80	150	4	90	42	44	0·48	0·26	74·2	226·9	4·42

The process developed is quick, cuts down the consumption of hypochlorite to one-fourth and yields a product with only one-fifth of chlorine content of the conventional bleached lac. Another striking feature of the product is that, for the first time, a bleached lac having as good a life under heat and flow as that of a commercial decolourised lac, has been obtained.

A provisional patent for the process developed has been applied for.

(L. C. Misra & B. B. Khanna)

(c) *Modification of lac wax*

Lac wax is an important by-product of lac industry and finds extensive use in various types of polishes. If reclaimed from refuse lac or factory effluents, it is very dark in colour. It was reported last year that crude lac wax could be bleached to a sufficiently white colour with the help of potassium permanganate and hydrochloric acid and finally with sodium hypochlorite. During this year, the process was repeated several times and standardised, the details being as follows:

Crude lac wax (100 g) is boiled with 500 ml of water till it melts completely. Finely powdered potassium permanganate (2 g) is gradually added to it with thorough stirring while boiling is continued. This is followed by gradual addition of 5 ml of hydrochloric acid (10%). When reaction is complete, most of the black oxide is found to settle at the bottom, although a small amount remains suspended with the wax. To remove it, 0·5% of nitric acid is allowed to react with it in the same boiling condition. After reaction is complete, a pale yellow coloured wax is obtained. To bleach further, this wax is again reacted with 10 g of chlorine as sodium hypochlorite in the same boiling condition. The final product thus obtained is of light straw colour.

It has been further observed that if this light straw coloured wax is treated with activated carbon (10-12% on the wt. of wax) for six hr at 105-106°C, perfectly white coloured wax is obtained. The properties of waxes at diffeernt stages are recorded in Table 13

Attempts were also made to improve the hardness of the wax, particularly that obtained from wash water. As this wax is reclaimed by extracting with *n*-hexane, fractional precipitation with the same solvent was tried. It has been seen that if the portion soluble at 25°C is separated, the portion left (60-65%)

TABLE 13 — PROPERTIES OF LAC WAX OBTAINED BY DIFFERENT TREATMENTS

Sl. No.	Qualily of wax	Yield %	Colour Index	Melting point °C	Penitration Value
1.	Lac wax, crude	—	0·7	78	5·5
2.	No. 1, treated with $KMnO_4$ & HCl	97	0·3	80	3·5
3.	No. 2 treated with NaOCl	95	0·1	80	3·5
4.	No. 3, treated with activated carbon	85	Colourless	81	3·0

is of better hardness. The penetration value of this hard fraction is improved from 5·5 to 3·5. The details of fractional precipitation are being worked out. A commercial firm dealing with wax showed interest in the lac factory mud for extraction of lac wax and the process of preparation of the mud was demonstrated to them in a local lac factory. The mud thus obtained had a wax content of 10 per cent.

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

(d) *Modification of hydrolysed lac*

Investigations were carried out to study modifications of total hydrolysed lac obtainable from refuse lacs with maleic and phthalic anhydrides. Experiments were also made to study the formulations of water thinnable wash primers from Rebulac using zinc tetroxychromate as pigment.

(i) *With maleic anhydride*

Total hydrolysed lac containing 10, 20 and 30 per cent respectively of maleic anhydride was heated at 150°C till pregelation stage. End products obtained were hard, brittle but slightly tacky and readily soluble in usual lac solvents and ammonia. The end products with acid, saponification and iodine values varying from 183 to 238, 246 to 280 and 17 to 12 respectively were found to be suitable in formulating water thinnable paints using titanium dioxide as pigment. Hard films with good adhesion and flexibility could be obtained by air drying them at room temperature. Water resistance and scratch hardness of these films varied from 5 to 7 days and 1500 to 1800 g respectively. The product, modified with 20 per cent of maleic anhydride, gave the best performance when applied in surface coatings. Metallic naphthenates, however, did not appreciably improve the drying time and other properties of the films.

(ii) *With phthalic anhydride*

Total hydrolysed lac containing 10, 20, 25, 30 and 35 per cent respectively of phthalic anhydride was heated at 150°C till pregelation stage. End products were hard and slightly tacky and soluble in aqueous ammoniacal solution and usual lac solvents. The end products with 25-30 per cent of phthalic anhydride gave the best performance when used in water thinnable paint formulations. The films baked at 150°C were hard (scratch hardness, 1800-2000 g) and water resistant (7 days).

(iii) *Water thinnable wash primer*

Investigations were initiated to study the formulations of water thinnable wash primers from Rebulac using zinc tetroxychromate as pigment. Best results were obtained when resin and pigment were used in the ratio of 1 : 1 (v/v). The air dried films were hard (1800 g) and water resistant (4-5 days); flexibility passed the 1/4th conical mandrel test. Flexibility and adhesion, however, improved when instead of Rebulac, its modified form with linseed oil fatty acids was used.

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

2. Rubber shellac combinations

It was reported last year that Mg-salt of lac on incorporation into natural rubber behaved better than other modified lacs such as those modified with ethylene glycol and epoxy resin in effecting various mechanical properties.

During the course of the year, another modification of lac namely rosin lac ester (Acid value = 92·9 and Hydroxyl value = 86·3) obtained by reacting lac (25 parts) with rosin (50 parts) at 260°C for 35 min, was incorporated into natural rubber and the resultant properties studied.

A lowering in Mooney no. and an increase in scorch time was noticed (Table 14) indicating that rosin lac ester acts as a plasticizer and antiscorching agent. Other properties were however not favourably affected.

Next, shellac was fractionated into two fractions viz., hard and soft resins using ethyl acetate. The hard resin obtained had acid value 61·8 mp 85·8°C, while the soft resin had acid value 94·4. The effect of incorporation of hard and soft resins of lac into natural rubber was thereafter studied using CBS and MBT as accelerators. It was found that using either of the accelerators plastization and antiscorching effects were more pronounced with the soft resin than the hard one.

Tear resistance showed an increase when 2·5 parts hard resin per 100 parts rubber was compounded using CBS as accelerator.

(R. Singh & B. B. Khanna)

3. Shellac and modified shellacs as adhesives

(i) *For metal to metal surface*

Shellac was modified with some known adhesion promotors viz., tartaric acid, phathalic acid, maleic acid etc and adhesive strength determined with the help of Hounsfield Tensometer using the procedure reported earlier. It was derived that, in most cases, the adhesive strength of shellac improved by the addition of 3-5% of these adhesion promotors. It may be seen from Table 15 that maximum adhesive strength was obtained by modifying shellac with maleic acid (4%).

The adhesive strength of hydrolysed lac heated at 150°C for various durations was determined on iron, copper and brass surfaces. It was observed that samples taken out after heating for less than 4 hr did not show any adhesion. The adhesion improved with heating up to 8 hr, thereafter the product gelled. The maximum value for adhesive strength obtained was 0·38 tons/sq in. (Table 16).

TABLE 14 — EFFECT OF INCORPORATION OF ROSIN LAC ESTER AND HARD AND SOFT RESINS OF LAC ON THE PROPERTIES OF NATURAL RUBBER

(Base mix composition, natural rubber, 100; zinc oxide, sulphur, 2·5; stearic acid, 1; PBN, 1; and accelerator, 0·5; parts)

Modified lac added part/100 part	Optimum cure time at 140° (min)	Mooney No (ML1+4 at 120°C)	Scorch time (min. sec.)	Modulus at 200% (Kg/cm)	Ultimate elongation (%)	Tensile strength (kg/cm2)	Tear resistance (kg/cm)	Durome hardness (shore) Durometer	Impact resilience (%)
				Rosin lac ester: accelerater MBT					
0·0	15	25·0	10-30	9·1	820	178·1	33·0	35	81·9
2·5	30	23·0	15-30	8·8	900	157·7	32·4	32	78·5
5·0	40	21·0	19-20	8·2	870	151·8	29·9	32	75·1
7·5	40	20·0	21-30	8·4	850	141·5	29·5	33	72·3
10·0	40	20·5	24-25	8·7	860	151·0	35·1	34	76·1
				Rosin lac ester: accelerater CBS					
0·0	15	33·5	24-40	6·4	900	181·5	34·7	35	84·1
2·5	30	31·5	26-30	5·8	920	178·9	33·4	31	77·8
5·0	30	30·0	29-29	5·7	900	168·9	31·9	31	76·1
10·0	60	28·0	39-21	4·9	870	125·6	24·3	32	68·8
				Hard resin of lac; accelerator MBI					
0·0	20	35·5	17-18	6·2	830	157·9	32·8	30	74·1
2·5	30	30·5	30-15	3·4	850	70·7	24·2	29	65·2
5·0	30	26·0	39·15	3·4	820	58·5	31·6	29	65·2
10·0	40	24·5	39-30	4·5	800	70·9	25·5	30	63·5
				Hard resin of lac; accelerator CBS					
0·0	20	19·0	10-32	6·1	1000	211·5	34·2	34	81·9
2·5	20	18·0	14-32	5·4	910	169·6	35·2	34	79·8
5·0	30	16·5	15-30	5·6	940	177·4	33·7	34	77·8
10·0	40	16·5	16-13	5·7	930	135·6	31·1	35	74·1
				Soft resin of lac; accelerator MBT					
2·5	30	25·5	37-30	4·1	950	129·8	24·5	29	63·5
5·0	50	21·0	49-07	3·9	820	55·6	21·8	29	65·2
10·0	50	14·0	52-30	3·5	790	46·2	21·5	29	56·6
				Soft resin of lac; accelerator CBS					
2·5	30	13·0	12-27	5·8	910	143·3	29·0	35	74·1
5·0	40	11·5	21-43	3·5	940	64·6	19·3	30	32·3
10·0	40	10·0	31-30	3·2	950	60·0	18·4	30	71·0

TABLE 15 — EFFECT OF ADDITION OF ADHESION PROMOTORS ON THE ADHESIVE STRENGTH OF SHELLAC
(Ten percent shellac solution in spirit and Iron surface used)

Sl. No.	Adhesion promotors	Amount required for maximum adhesion (%)	Adhesive strength (Tons/sq inch)
1.	Blank	4	0·08
2.	Tartaric acid	4	0·19
3.	Phathalic acid	3	0·1
4.	Maleic acid	4	0·3
5.	Citric acid	3·5	0·16
6.	Succinic acid	4	0·13
7.	Malic acid	5	0·16

TABLE 16 — EFFECT OF HEATING HYDROLYSED LAC ON ITS ADHESIVE STRENGTH

Sl. No.	Percentage of time of polymerisation	Time of heating hrs	Adhesion sought on		
			Iron	Copper	Brass (Tons/ sqinch)
1.	50	4	0·20	0·21	0·21
2.	60	5	0·26	0·24	0·25
3.	70	6	0·28	0·25	0·26
4.	80	7	0·35	0·26	0·26
5.	90	8	0·38	0·28	0·28

(ii) *As binder for fabrics (Jute-lac boards for tea chest)*

A study to examine the possibility of replacing plywood with jute-lac laminated boards for tea chests was initiated and 27 Jute boards of 3 ply, size 100×56 cm were made with the help of M/s Mica and Micanite Factory, Jhumari Telaya, Koderma and sent to the Jute Industries Research Association, Calcutta for practical trials. The results are awaited.

(M. Islam & P. K. Ghosh)

(c) RESEARCHES CONTEMPLATED

It is proposed to take up pilot plant studies of the manufacture of bleached lac according to the technique developed during the course of this year using a combination of sodium hypochlorite and hydrogen peroxide.

3. EXTENSION

A. ENTOMOLOGY DIVISION

As already indicated in the previous reports, all activities relating to extension of lac cultivation are the responsibilities of the Directorate of Lac Development under the Ministry of Food and 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 date of larval emergence during the different seasons and determination of the causes of excessive mortality of lac insects 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)".

Large scale cultivation on palas at Kundri

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

During the year, 20,000 trees in both the coupes of the orchard were operated, incurring an expenditure of Rs. 4,000 approximately and obtaining a yield of 1000 kg dry sticklac. Out of a total of 1750 kg broodlac obtained from coupe ' B ', 95 kg surplus broodlac was sold fetching a revenue of Rs. 500 and the rest was utilized for inoculating coupe ' A '. On the whole, a net income of Rs. 1000/- is expected.

Namkum plantation

General upkeep of the plantation was maintained as far as possible. Seedlings of various lac hosts were raised in nursery beds for filling up vacant places and for use in pots for laboratory experiments.

Training in lac cultivation

Six candidates (3 Lac Demonstrators from Industries Department, West Bengal, and 2 Lac Supervisors and 1 Lac Kamdar from Agriculture Department, Uttar Pradesh) successfully completed the regular 6-month course of training in Improved Methods of Lac Cultivation.

Lectures were delivered at Kundri for the benefit of the trainees of the Foresters' Training School, Chaibasa. A Farmers' Day was organised under the 'Garibi-hatao' programme to demonstrate the improved methods of lac cultivation to the cultivators.

B. EXTENSION DIVISION

The staff position of the Division continued to be difficult as before. Although two officers have deen provided only one was in position during the entire period. The work of Museum Assistant was also carried out by a staff from Chemistry Division. Despite these handicaps, the Division undertook the following important activities.

A number of enquiries were received regarding possibility of using shellac and shellac compositions in different industries which were attended to. Some parties also sent samples of products for which they wanted shellac based substitutes. These were analysed and, wherever possible, shellac formulations were recommended. In addition, contacts made earlier were maintained and new contacts established with manufacturers and present and potential consumers of lac and lac products through correspondence, personal visits etc. A few of the more important of these are listed below:

(i) Ordnance Factory, Dehradun, was supplied with three shellac compositions for trial as a substitute for an imported material. Of these, one was found satisfactory. The information regarding the composition and source of raw materials was communicated to them.

(ii) The Heavy Electricals Ltd., Bhopal was supplied with a shellac based material for use as an adhesive in contact with transformer oil. The bond strength of the material was poorer compared to that of the imported synthetic presently in use. The problem is being looked into.

(iii) A sample of undisclosed origin was sent by S.E.P.C., Calcutta, for identification. The sample was analysed and was found to contain lac resin in fairly good quantity. The results were communicated to them.

(iv) Ranchi Agriculture College, Ranchi was supplied with water soluble lac for their researches on conservation of water.

Development work

Schemes for the manufacture of shellac and shellac based industries were prepared and supplied to the Small Industries Service Institute, Calcutta and Andhra Pradesh Small Scale Industries Development Corporation Limited, Hyderabad. A scheme for the manufacture of bleached lac was sent to the Director of Industries, Bihar, Patna.

Publicity and Propaganda

Exhibits were sent for display at Asia-72 exhibition at Delhi and also in several other exhibitions in the country.

The Institute celebrated the 25th Independence Jayanti for a week. Open days were arranged on this occasion for students, farmers and general public.

Farmer's day was organised on 19th November, 1972 which was attended by a large number of Lac growers. They were taken round the Experimental Plantation and Museum and the various improved techniques developed at the Institute were explained to them.

Training & Advisory service

One candidate from Forest Department, Madras and one from the trade, completed a 6-month training course on 'Industrial Uses of Lac'.

Regional Testing Laboratory

As usual a large number of samples were received for tests and a total number of 220 tests were carried out.

Pilot Production Unit

During the period under report, the unit sold 1370·50 kg of special shellacs for Rs. 11,941·75 P. and other miscellaneous lac based products like varnishes, hydrolysed lac, kiri etc. for Rs. 4,465·50. The total sale thus amounted to Rs. 16,407·25P as shown below itemwise:

Material	Quantity (kg)	Price Rs.
1. BRF grade Bleached Lac	468·5	4,374·50
2. BR grade Bleached lac	15·0	112·50
3. DXO grade water soluble lac	225·0	2,314·70
4. DXG grade water soluble lac	81·0	648·00
5. ASK grade Autoclave shellac	581·0	4,492·05
6. Misc. lac products (Melfolac, lac wax, cable dressing compound, *kiri* etc.)		4,465·50
Total		16,407·25

4. PAPERS PUBLISHED

Publications and Patents

(a) *Publications*

The Institute publishes its research findings in leading Scientific and Technical Journals. In addition, a few books and one monograph have also been published.

The total number of publications as on 31st December, 1972 is as below:

1. Bulletins	
i) Chemical	128
ii) Entomological	57
2. Technical notes	30
3. Research notes	
i) Chemical	85
ii) Entomological	52
4. Miscellaneous technical publications	
i) Physico-chemical	25
ii) Entomological	48
5. Books and Monograph	14
6. Pamphlets and leaflets	24

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

List of Papers Published during the Year 1972

Sl. No.	Authors	Title of paper	Name of journal
1	2	3	4
	A. ENTOMOLOGY DIVISION		
1.	Sah, B. N., Mehra B. P. & Naqvi, A. H.	Bionomics of *Euproctis fraterna* Moore on *Ziziphus xylopyra* willd.	*Indian J. agric. Sci.* **42** (7): 630-636.
2.	Mishra, R. C. & Malhotra, C. P.	A labour saving device for removal of *phunki* (used-up broodlac) from *palas* (*Butea monosperma*) (*Lamk. Taub.*) trees.	*Indian Forester* 89 (i): 67-68.
3.	Gokulpure, R. S.	Note on the hosts and parasites of *Phytomyza atricornis* Meigen (Diptera-Agromyzidae)	*Indian J. agric. Sci.* **42** (7): 638-640.
4.	Gokulpure, R. S.	Further collection of the syrphidae (Diptera) from Central India.	*J. Bombay nat. Hist. Soc.* 68 (3): 848.
	B. AGRONOMY AND PLANT GENETICS DIVISION		
1.	Kumar, P. and Purkayastha, B. K.	Note on germination of the seeds of lac hosts	*Indian J. agric. Sci.* **42** (5): 430-31

1	2	3	4

C. CHEMISTRY AND TECHNOLOGY DIVISIONS

1.	Sengupta, S. C.	Industrial uses of Shellac	*Jour. Industry & Trade* 22: 5. 4
2.	Sengupta, S. C.	Improved lac cultivation	*Indian Farming*, XXII (3): 11-14.
3.	Sengupta, S. C.	Twentyfive years of lac research	*Indian Farming*, XXII (8): 13-23.
4.	Kumar, Shravan	Water thinned shellac primer for steel	*Anticorrosion Methods & Anticorros. Meth. L Mater* 19 (2): 18.
5.	Kumar, Shravan	Shellac Lacquers in Vacuum metallizing	*Product Fin.* 125, (4): 25.
6.	Misra, L. C.	Utilization of polymerized bleached lac in French polishing	*Paintindia* 22, (4).
7.	Rahman, A., Islam, M. & Bhattacharya P. R.	Correlation of specific heat, flow behaviour & hot alcohol insolubles with age of seedlac	*Indian J. Technol.* 10 No.6: 243-244.
8.	Islam, M. & Bhowmik, T.	Lac/CNSL combination modified with urea and formalin for coating hessian	*Paintindia* XXII (2).

(b) Patents-Nil

5. SUMMARY

A. ENTOMOLOGY DIVISION

(a) RESEARCHES COMPLETED

1. On the basis of results obtained over three seasons, it has been concluded that the optimum brood rate for crop inoculation on *palas* in a hot area ranges between 1·4 and 1·8 kg per tree when the crop is harvested as *ari* in the *baisakhi* season.

2. Further cytogenetical studies of lac insects provided additional evidence of an unusual chromosome system in these insects in that the male lac insect is somatically a diploid but it breeds as a haploid and transmits only the maternal genome through the sperm due to heterochromatization and elimination of the paternal chromosome-set during the formation of male sex-cells. The genes in lac insects are thus transmitted like the sex-linked genes, but the system differs from that of the sex-linked inheritance in that the male inherits and expresses the paternal gene.

(b) RESEARCHES ON HAND

1. (a) Rain tree and *putri* remained under trial as a *kusmi* host in the *jethwi* season, but none of these sustained the insects till the completion of their life cycle. Similar trials could not be made in the *aghani* 1972-73 season due to non-availability of *kusmi* broodlac. These plant species along with *vilaiti babul* were also tried as a *rangeeni* host during the *baisakhi* 1971-72 season, but none of these could sustain the insects. Similar trials with rain tree and *putri* during the *katki* season also proved a failure.

(b) The relative performance of ten lac host plant species could be studied only for the *rangeeni* insect during the summer season when only *kusum* and *arhar* failed to carry the *rangeeni* insect. In the rainy season, the host performance of these plant species was studied with both the *rangeeni* and *kusmi* strains of lac insects. Only *kusum* failed to sustain the *rangeeni* insect in the *katki* season.

2. (a) Study of the amino acid content of the lac insect body fluid showed that while majority of the amino acids are common to the *rangeeni* and *kusmi* strains, they can be differentiated on the basis of a few amino acids which are strain-specific.

(b) In attempts to rear the lac insects on a synthetic diet in the laboratory, the insects survived for 28 days when settled on 2 per cent sterilized agar agar covered by parafilm, polythene or wax paper.

(c) In attempts to rear the lac predators on an artificial diet in the laboratory, 5 out of 10 third instar larvae of *Holcocera pulverea* developed into adults on a diet consisting of fish meal and sticklac, and 18 per cent of *Eublemma amabilis* larvae successfully pupated on the same diet fortified with cholesterol and amino acid mixture.

3. Isolation and identification of the microorganisms harboured by the lac insects showed the presence of 4 microorganisms in both the *rangeeni* and *kusmi* strains and a fifth of coccoidal shape exclusively in the *kusmi* strain.

4. Study of the nature and occurrence of sex attraction in lac predators showed that the female of *E. amabilis* possesses the sex attractant.

5. (a) Experiments remained in progress in which the possibility of obtaining the *kusmi* insects at the *rangeeni* time is being examined in crosses of the *rangeeni* and *kusmi* strains in an attempt to utilise *palas* for the propagation of the *kusmi* insect to boost production of the superior quality *kusmi* lac.

(b) Crosses of distinct races of lac insects have provided lines which showed interesting differences in growth rate and resin dye level. These are being maintained for a comparative study of their economic performance.

6. (a) Exposure of lac insects to varying photoperiods showed that reduction in photoperiod probably results in slower development of these insects.

(b) The lac insect development studied at 27·5° and 30·0°C showed that while the development is fastest at 30°C, the fecundity is highest at 27·5°C.

7. (a) A preliminary study on the relative dominance of inimical and beneficial insects of lac during the *katki* season showed that the inimical parasites appear earlier than the lac predators. The incidence of the inimical and beneficial insects was recorded.

(b) A field experiment was initiated during the *baisakhi* 1972-73 season to study the effect of density and age of host on the incidence of the lac predators.

8. A study was initiated to analyse factors responsible for the differential behaviour of the *kusmi* strain of lac insects at Vannathiparai lac farm in Tamil Nadu and at Namkum.

9. Routine investigations were continued at the Regional Field Research Station, Dharamjaigarh to supplement *kusmi* lac production in the region.

10. An integrated control schedule is being worked out against the inimical insects of lac by trying various control measures, individually and in combination. The *katki* crop was best with a single combination spray of 0·05 per cent endosulfan and 0·05 per cent Bactospeine (R) mixed in equal proportion and sprayed 6 weeks after inoculation.

11. (i) The 60-mesh synthetic net container was found equally effective and much cheaper than the brass wire-net container used hitherto for crop inoculation to check the carry over of the lac-pests.

(ii) An experiment was initiated in the *baisakhi* 1972-73 season to determine the field design for the main and the trap crops for the control of *E. amabilis*.

(iii) Two lac crops inoculated with a difference of 15 days showed that the incidence of the lac predator, *E. amabilis*, was higher in the crop inoculated earlier.

12. Attempts to rear the beneficial parasite, *P. sulci*, on an alternative host in the laboratory did not meet with success.

13. For the use of chemosterilants in the control of lac predators, 3 candidate compounds were procured to study their sterilising effects on the lac predators.

14. Of the 5 antifeedants tried for the control of lac predators, Brestanol (R) and Brestan (R) were found safe to lac insects and were also quite effective in inhibiting feeding by the larvae of *E. amabilis*.

15. Of the 5 newer synthetic insecticides tried, Thiodan 35EC(R) alone proved safe to lac insect larvae which was thus selected for further studies with the lac predators.

B. AGRONOMY & PLANT GENETICS DIVISION

1. Preliminary observations indicated the possibility of intercropping of lac-host shrubs—*bhalia* and *arhar* with agricultural crops.

2. The diploid chromosome number of *palas* as 2n = 18, and haploid chromosome number of *Dalbergia lacceolaria* as n = 10 was confirmed.

Haploid chromosome number of *Moghania* spp. (*bhalia* and *barasalpan*) was worked out as n = 11 for the first time.

3. Higher doses of gamma irradiation (Co^{60}) had depressed the germination percentage in *Moghania* spp. in M_1 generation. But in M_2 generation, while in *M. chappar* a similar trend was observed particularly at higher doses, the inhibiting effect disappeared and germination reverted to normalcy in *M. macrophylla*.

In *arhar* also in M_1 generation the shoot and root growth was adversely affected with the increase in doses.

4. In *Moghania* species the germination percentage was adversely affected with increase in concentration of Ethylmethanesulfonate (E.M.S.).

5. Spraying of plant harmones at different doses and intervals for synchronising the flowering times in two species of *Moghania*, gave no significant effect.

6. No rooting response was observed in *kusum* from air layering tried in January, March, June and September.

7. Growth regulators viz. IBA, NAA, IAA in various combinations were tried on stem cuttings of four lac hosts, namely, rain *tree*, *pansura*, *sandon* and *palas*. Rooting was observed only in rain tree and *pansura* and June Planting was found superior over January, March and September plantings.

C. CHEMISTRY DIVISION

(a) RESEARCHES COMPLETED

1. Adhesion of different varieties of shellac with mica splittings had been tried on two types of paper strips. The dewaxed lemon and dewaxed decolourised shellacs gave the best bonding strength.

(b) RESEARCHES ON HAND

1. A slightly modified method was adopted to graft vinyl monomer on shellac which gave a product indicating to be a grafted one. Its properties have been studied. Jalaric acid was attempted to be grafted with methyl methacrylate which was not successful.

2. Several reactions were carried out to study the modification of shellac with epichlorohydrin. The experiments proved that the reaction is essentially through carboxylic group and the products were always sticky and cured in presence of amines.

3. A systematic study has been taken up to find the reasons of persistent tackiness of varnishes prepared from lac-linseed oil/glycerol combination. To understand the mechanism, aleuritic acid-glycerol comibnation was studied followed by a study on linseed oil-glycerol. Intermediate products formed were examined by TLC.

4. *Palas* hard resin has been fractionated through urea-complex formation and later on as methyl esters. Out of the three, one was further fractionated. The presence of w- and mid-hydroxy C_{16} esters, methyl aleuritate, dimethyl shellolate and epishellolate was indicated in the fraction.

5. Kinetic studies of self-esterification of 16-hydroxy 9: 10-dioxohexadecanoic acid, a diketo derivative of aleuritic acid showed that uncatalysed reaction follows a third order and activation energy is 20·52 K cal/mol.

The kinetics of self-esterification of trans-16-hydroxy-9-hexadecanoic acid, prepared from aleuritic acid, revealed that the catalysed and uncatalysed reactions follow second and third order rate and activation energies are 18·24 and 11·40 K cal/mol. respectively. From the studies of intrinsic viscosity-molecular weight relationship of the polyesters, a Mark-Houwink equation was evolved.

6. An attempt to prove the presence of shellac in the aqueous extract left over after precipitation of the acid hydrolysate by means of 1·0% common salt solution did not meet with success.

7. (i) Several compositions were prepared from different weight ratios of shellac and " Epikote 1001 " resin by fusion. It was found that the blends were not thermosetting.

(ii) A study on filled stocks of shellac/natural rubber indicated that whiting, one of the constituents of the composition, is not compatible in the stock as filler.

8. Experiments were conducted to apply second coat or thick coat by electrodeposition technique using carbon black/lamp black as conducting pigments. Adhesion on the substrate was found poor in both cases. A second coat from shellac varnish was applied which was neither uniform nor smooth.

9. A cation exchange resin from conc.sulphuric acid treated lac has been developed which was found comparable with the imported Amberlite IR-120.

10. About 5 quintals of lac coated urea have been sent to various Institutions for evaluation and agronomical trials from where some of the reports have been received. It also appeared from one of the studies that due to its slow release, availability of nitrogen is less during effective growth.

11. Experiments have been conducted to compound shellac with suitable oxidants to simulate the PVC based rocket fuel. The results indicate that the products compare well in many respects with the conventional fuels.

D. TECHNOLOGY DIVISION

(a) RESEARCHES COMPLETED

Several methods were tried to prepare aleuritic acid in increased yield, e.g. through barium, calcium and other salts but with no appreciable success.

(b) RESEARCHES ON HAND

1. Several filtering media and filteraids were tried to improve the method of dewaxing lac. Rayon and kisselghur were found to give the best performance.

To bleach lac with chlorine-free bleaching agents without impairing its inherent properties, a few activators were tried to increase the oxidative power of hydrogen peroxide varying the amount of hydrogen peroxide as well as the duration of reaction. It was found that the system cobalt sulphate+pyridine-2-carboxylic acid is relatively successful.

Further, a method to bleach lac making use of a combination of sodium hypochlorite and hydrogen peroxide was evolved which gives a product with very low chlorine content and consequently excellent life under heat and flow.

2. To improve the colour of the dark coloured wax obtained from refuse lacs, a method reported last year was repeated several times and standardised. Further, a successful attempt was made to improve its hardness.

3. Several modifications of total hydrolysed lac obtained from refuse lacs in combination with maleic and phthalic anhydrides were tried and films examined. A water thinnable wash primer from Rebulac using zinc tetroxychromate has also been developed and is under examination.

4. Rosin-lac-ester and the two fractions of lac *viz.* hard and soft resins were incorporated into natural rubber and the resultant properties studied. The soft resin had a pronounced effect on Mooney viscosity and scorch time.

5. Adhesion strength of shellac improves by the addition of 3-5% of adhesion promotors (maximum with maleic acid). Polymerised hydrolysed lac instead of shellac was tried later on. The work on replacing plywood with jute lac laminated boards for tea-chest was also initiated.

6. METEOROLOGICAL REPORT FOR THE YEAR 1972

The average meteorological data for each month 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 %	Mean sunshine hr/day	Total rainfall mm	Highest max. temp. °C	Lowest min. temp. °C
January	709·4	24·4	7·5	17·8	13·6	61·0	7·90	6·0	27·8	3·0
February	707·3	23·8	9·7	17·9	14·6	69·5	7·02	56·5	30·5	4·4
March	705·9	33·2	15·8	27·5	19·4	46·0	8·82	Nil	38·0	9·7
April	704·8	36·3	20·0	30·0	22·1	48·5	7·93	20·4	40·0	16·8
May	701·4	40·5	24·8	33·9	26·9	57·0	8·54	3·2	43·5	22·0
June	699·2	38·5	25·5	31·9	28·6	77·0	5·65	37·9	43·0	22·0
July	698·3	29·9	23·2	26·3	25·1	90·0	3·23	419·7	34·4	20·0
August	699·6	29·7	22·7	26·5	24·7	86·0	3·65	364·0	35·5	20·0
September	703·7	29·5	21·3	26·5	24·5	83·9	5·21	254·8	32·5	17·5
October	707·8	29·9	17·5	25·9	22·3	73·1	7·60	134·6	32·4	13·0
November	709·2	27·0	13·8	23·1	19·7	72·5	7·26	23·4	30·1	10·5
December	710·4	25·1	10·9	20·4	17·2	72·0	7·46	Nil	29·5	7·0

The highest maximum temperature recorded was 43·5°C on 19th May and the lowest minimum 3·0°C on 10th January. The total rainfall amounted to 1320·5 mm of which the monsoon (June to Sept.) rainfall was 1076·4 mm. The rainfall during the year was much lower than that of 1971 (1845·4 mm). It was also lower than the average rainfall for this station (1500 mm).

7. PERSONNEL

STATEMENT SHOWING APPOINTMENTS, PROMOTIONS, RESIGNATIONS AND RETIREMENTS ETC. DURING JANUARY-DECEMBER, 1972

Division/Section	Name	Post to which appointed	Date
A. Appointments			
Entomology Division	1. Dr. T. P. S. Teotia	Head, Division of Entomology	13-3-72
	2. Dr. C. P. Malhotra	Jr. Insect Parasitologist	11-2-72
	3. Dr. B. P. Mehra	Jr. Insect Ecologist	15-12-72
	4. Sri S. G. Choudhary	Sr. Research Asstt.	2-5-72
	5. Sri A. K. Sen	Sr. Research Asstt.	2-5-72
	6. Sri Beche Lal	Sr. Research Asstt.	4-8-72
Agronomy & Plant Genetics Division	1. Dr. S. Lall	Agronomist	24-7-72
	2. Sri P. Kumar	Jr. Plant Geneticist	15-12-72
Chemistry Division	1. Dr. J. N. Chatterjea	Director	11-7-72
	2. Sri A. Kumar	Jr. Chemist (Polymer)	15-12-72
	3. Sri S. K. M. Tripathi	Sr. Research Asstt.	2-5-72
	4. Sri R. K. Banerjee	Sr. Research Asstt.	2-5-72
Extension Division	1. Dr. S. K. Saha	Scientist (Shellac Utilization)	22-5-72
B. Resignations			
Agronomy & Plant Genetics Division	1. Dr. P. N. Choudhary	Agronomist	26.2.72
Chemistry Division	1. Sri R. S. Prasad	Research Asstt.	

STAFF POSITION: DIVISIONWISE

Sl. No.	Name of the post	Sanctioned	Staff in position as on 31-12-1972
1	2	3	4
1.	Director	1	Dr. J. N. Chatterjea
	Entomology Division		
2.	Head, Division of Entomology	1	Dr. T. P. S. Teotia
3.	Entomologist	1	Dr. A. Bhattacharya
4.	Insect Geneticist	1	Sri N. S. Chauhan
5.	Jr. Insect Ecologist	1	Dr. B. P. Mehra
6.	Jr. Insect Parasitologist	1	Dr. C. P. Malhotra
7.	Jr. Physiologist	1	Sri A. H. Naqvi
8.	Jr. Entomologist (L.C.)	1	Vacant
9.	Sr. Research Assistant	10	1. Sri R. S. Gokulpure 2. Sri N. Majumdar

			3. Sri D. C. Srivastava
			4. Sri S. G. Choudhary
			5. Sri A. K. Sen
			6. Sri Beche Lal
10.	Instructor (Lac Cultivation)	1	Sri R. C. Mishra
11.	Research Assistant	9	1. Sri Parimal Sen
			2. Sri B. N. Sah
			3. Sri J. M. Dasgupta
			4. Sri R. C. Maurya
			5. Sri Y. D. Mishra
			6. Sri M. L. Bhagat
			7. Sri S. K. Jaipuriar
			8. Sri Jawahir Lal
			9. Sri M. K. Choudhury
12.	Artist-cum-photographer	1	Sri R. L. Singh
13.	Jr. Artist-cum-photographer	1	Sri Pyare Das
14.	Jr. Field Assistant	1	Vacant
15.	Fieldman	7	1. Sri S. N. Sharma
			2. Sri H. R. Munda
			3. Sri Sant Kumar
			4. Sri R. S. Maliya
			5. Sri K. C. Jain
			6. Sri B. P. Sah
			7. Sri S. S. Prasad
16.	Insect Collection Tender	1	Sri Md. Ali Ansari
17.	Laboratory Assistant	6	1. Mrs. Namita Nandi
			2. Sri A. Hussain
			3. Sri R. D. Pathak
			4. Sri R. C. Singh
18.	Store and Plantation Asstt.	1	Sri G. Lakra

Agronomy & Plant Genetics Division

1.	Agronomist	1	Dr. S. Lal
2.	Jr. Arboriculturist	1	Sri B. K. Purkayastha
3.	Jr. Plant Geneticist	1	Sri P. Kumar
4.	Sr. Research Assistant	1	Vacant
5.	Fieldman	1	Sri B. D. Tiwari
6.	Laboratory Assistant	1	Sri D. D. Prasad

Chemistry Division

1.	Head, Division of Chemistry	1	Dr. S. C. Sengupta
2.	Scientist	1	Sri Sravan Kumar
3.	Organic Chemist	1	Dr. P. R. Bhattacharya (Adhoc)
4.	Jr. Chemist (Polymer)	1	Sri A. Kumar
5.	Jr. Chemist (Physical)	1	Vacant
6.	Jr. Technologist (Surface coating)	1	Vacant
7.	Sr. Research Assistant	10	1. Sri P. C. Gupta
			2. Sri T. R. Lashminarayan
			3. Sri A. Rahman
			4. Sri S. K. Mani Tripathi
			5. Sri R. K. Banerjee
8.	Research Assistant	8	1. Sri August Pandey
			2. Sri M. Mukherjee
			3. Sri A. K. Das Gupta
			4. Sri B. C. Srivastava
			5. Sri Niranjan Prasad
			6. Sri R. N. Majee
			7. Sri K. M. Prasad
9.	Glass Blower	1	Sri S. K. Dey
10.	Laboratory Assistant	6	1. Sri B. B. Chakraverty
			2. Sri Nagendra Mahto
			3. Sri Umeshwar Sahay
			4. Sri B. P. Kesari

Technology Division

1.	Technologist	1	Dr. B. B. Khanna
2.	Jr. Technologist (Processing)	1	Sri A. K. Ghosh
3.	Jr. Technologist (Factory)	1	Vacant
4.	Research Assistant	3	1. Sri M. Islam 2. Sri Radha Singh 3. Sri R. S. Prasad
5.	Laboratory Assistant	2	1. Sri Noas Minz 2. Sri M. K. Singh

Extension Division

1.	Scientist (Shellac Utilization)	1	Dr. S. K. Saha
2.	Jr. Scientist (Shellac Utilization)	1	Vacant
3.	Asstt. Scientist (Production)	1	Sri P. K. Ghosh
4.	Sr. Analyst	1	Sri L. C. Mishra
5.	Analyst	2	1. Sri B. P. Banerjee 2. Sri Ramesh Prasad
6.	Laboratory Assistant	2	1. Sri Dominique Runda 2. Sri G. M. Borker
7.	Museum Assistant	1	Vacant.

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