INDIAN LAC RESEARCH INSTITUTE
NAMKUM, RANCHI, BIHAR, INDIA

Annual Report
1971

INDIAN COUNCIL OF AGRICULTURAL RESEARCH
NEW DELHI
1978

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 adulteration 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 Indian 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 the Experimental Factory. The Institute Library adjoins the Entomology building. The Administrative Section and Museum are housed in another block. The waterworks, workshop, gas plant etc. are located in small constructions between the Chemistry and Entomology Laboratories. The Audit and Accounts Section and a unit of the Administrative Section are temporarily accommodated in two small rooms adjoining the workshop previously occupied by the Chemistry Division. There is a dearth of accommodation.

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

The Institute is headed by the Director and he also used to function as the Head of the Chemistry Division, and so did the Entomologist as the 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, three new Divisions, namely, (i) Agronomy and Plant Genetics, (ii) Technology and (iii) Extension were created besides the two existing ones, and the following additional posts were provided. These posts were mostly filled up in the latter part of the year under report.

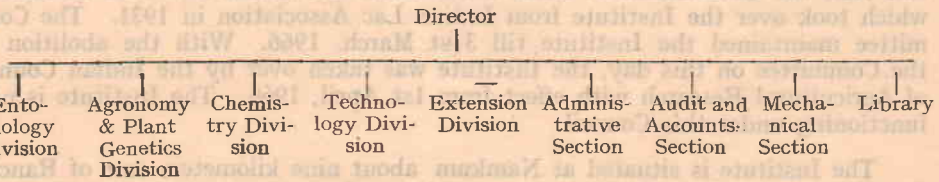
(i) Head of the Division of Entomology
(ii) Head of the Division of Chemistry
(iii) Agronomist
(iv) Technologist
(v) Insect Geneticist
(vi) Junior Chemist (Polymer)
(vii) Senior Research Assistant (Agronomy)

Objectives

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

Notable achievements in the field of lac entomology include (i) cytological confirmation of the unique genetic system in lac insects in which the male 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 set of chromosomes in the male germ line, (ii) evidence of considerable genetic variation in lac insects obtained in study of crosses and (iii) demonstration that the yield of sticklac was highest on *palas* with a brood rate of 1·4 kg per tree and when the crop is harvested as *ari* in April.

In the field of lac chemistry and technology, some of the findings which deserve attention are (i) a shellac-rubber (natural) composition of great use in the manufacture of cable industry, (ii) shellac based water-thinned decorative paints in emulsion for internal decoration, (iii) modification of lac wax from its darker colour to almost colourless, (iv) production of lac-coated urea fertilizer on a semi-pilot plant production level, (v) a successful method to utilise polymerised bleached lac in French polish.

Library

The number of books and bound volumes of Journals accessioned during the year was 709. This brought the total number of books and volumes of Journals in the library as on 31st December, 1971 to 14679. 127 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 C. P. Malhotra, Junior Insect Parasitologist, was awarded a Ph.D. degree from Indian Agricultural Research Institute for his work on the " Chemical control of *Eublemma amabilis* Moore (Noctuidae: Lepidoptera), a predator of the lac insect *Kerria lacca* (Kerr)".

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. Sri Madhusudan Chakraborti, Dy. Chief Reporter, Anand Bazar Patrika.
2. Sri Dhangopal Mukherjee (Jr.) G. F. Mc. Donald France III Rue-de-Paris, 92 Bonlognt Billan Court, Paris.
3. Sri Sunil Gangopadhya, Anand Bazar Patrika.
4. Prof. S. R. Palit, D.Sc. Prof. of Physical Chemistry, Indian Association for Cultivation of Sciences, Jadavpur, Calcutta
5. Dr. A. S. Srivastava, Senior Prof. of Entomology, Govt. Agricultural College, Kanpur, U.P.
6. Dr. (Mrs.) Ashima Chatterjea, Khaira, Prof. of Chemistry & Dean of Faculty of Science, Calcutta University, Calcutta.
7. Dr. Nirmalendu Nath, Regional Botanist (Horticulture), Botanical Survey of India, Calcutta.
8. Sri D. N. Lohani, Forest Research Institute, Dehradun.
9. Sri P. S. Mathur, Dy. Commissioner of Commercial Crops., Dept of Agriculture, New Delhi.
10. Sri S. M. Sibetain, Addl. Chief Conservator of Forests, U.P. Nainital.
11. Sri K. C. Roy Choudhury, Chief Conservator of Forests, W. Bengal, Calcutta.
12. Sri S. P. Mukherjee, Jute Commissioner, Govt of India, Calcutta.
13. Sri J. P. Yadav, Member of Parliament.
14. Dr. K. Sengupta, Director of Research, Central Sericultural Research Station, Berhampur, W. Bengal.
15. Prof. F. D. Gunstone, St. Andrews University, Scotland, U.K.

Research collaboration with other Institutions

Apart from work within its own premises, the Institute has always sought to take advantage of technical know-how and facilities available in other Institutions also for the furtherance of its objectives. A research Project is being implemented since 1960 under which the Constitution of lac is being studied simultaneously (i) at the Chemistry laboratory of the Delhi University under the guidance of Prof. T. R. Seshadri, F.R.S. and (ii) at the National Chemical Laboratory, Poona, under the guidance of Dr. Sukh Dev. The Institute continued to avail of the testing facilities kindly provided by the Indian Institute of Technology, Kharagpur for our work on shellac/rubber combination.

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

The Institute is represented in the Lac Development Council of the Ministry of Food and Agriculture, Government of India, Shellac Export Promotion Council, 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 Schemes to provide specialised knowledge to its employees. Six Scientists of the Institute have so far been provided advanced training in various disciplines under the Colombo Plan, five in the United Kingdom and one in Canada.

Training and Advisory services

The Institute provides technical assistance to all those interested in the cultivation, processing, grading and utilisation of lac. The Institute also provides two courses of training of six months duration on (i) Improved methods of lac cultivation and (ii) Industrial uses of lac. The training is usually given to deputees of Central and State Governments and Industrial Undertakings. In addition, short term training on specific lines is also provided on request.

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 budget estimates of the Institute for 1971-72 amounted to Rs. 12,37,300. The actual expenditure during the same period was, however, Rs. 11,35,400.

2. PROGRESS OF RESEARCH

A. ENTOMOLOGY DIVISION

(a) RESEARCHES COMPLETED

Integrated control of pests of lac hosts

1. Studies on limacodid pests of lac hosts

(a) *Bionomics of limacodid pests*

The following insects, comprising nearly 18 species falling under 11 genera, were studied and got identified from the Commonwealth Institute of Entomology (British Museum), London.

Parasa lepida Cram., *P. argalea* West., *Narosa doenia* Moore, *N. argentipuncta* Hamps., *Birthamoides junctura* Walk., *Cheromettia ferruginea* Moore (Syn: *Belippa laleana* Moore), *Macroplectara nararia* Moore, *Altha nivea* Walk., *Altha* sp. *Miresa albipuncta* H., *Phecoderma velutina* Kol., *Scopelodes testacea* Butl., *Thosea sinensis* Walk., *T. cana* Walk. and *Natada* sp., besides 2-3 yet to be identified.

Studies on bionomics and biology of M. *albipuncta, S. testacea, P. argalea, T. sinensis, C. ferruginea, A. nivea* and *N. doenia* were continued during the period under report. Out of the 30 larvae of *S. testacea* which pupated during October 1971, only 6 adults emerged during November 1971 and the rest were still under pupation. The details of observations have been furnished in Table 1.

The larvae of *P. lepida, P. argalea* and *S. testacea* are gregarious upto 4th instar stage and the adults lay eggs in batches of 20-50, 15-35, 20-50 respectively; whereas the larvae of *M. albipuncta, C. ferruginea, A. nivea, T. sinensis* and *N. doenia* are never gregarious and the adults lay eggs singly ranging from 2-7, 1-17, 1-6, 1-4 and 2-3 respectively. The larvae of *C. ferruginea* feed on the epidermal cells of the leaves of the hosts (*palas* and *kusum*), whereas the larvae of *M. albipuncta* feed on the upper surface of *palas* leaves and on both surfaces of *kusum* leaves. The larvae of *T. sinensis, P. lepida, P. argalea, A. nivea* and *N. doenia* are always found feeding on the lower surface of the leaves of the hosts. The larvae are active during the mid-day and rarely migrate from plant to plant.

This year, during the active period from June to December, *M. albipuncta* was encountered in maximum numbers, followed by *C. ferruginea, T. sinensis, P. argalea, S. testacea, A. nivea, N. doenia, P. velutina, B. junctura, M. nararia, T. cana* and *Natada* sp. However, the peak period of infestation was in July and October in the 1st and 2nd generations, respectively, of *M. albipuncta, C. ferruginea, P. argalea, P. lepida, A. nivea* and *T. sinensis*; but for *S. testacea* it was in August.

TABLE 1 — DURATION OF VARIOUS STAGES IN THE LIFE HISTORY OF DIFFERENT LIMACODIDS

(Based on 30 larvae each)

Limacodid species	Generations	Egg Stage (days)	Larval instars (days)									Pupal period (days)	Total period Egg to adult (days)
			1st	2nd	3rd	4th	5th	6th	7th	8th	9th		
M. albipuncta	I	6·9 (6-8)	6·4 (6-7)	6·8 (6-8)	6·4 (6-7)	7·2 (7-8)	6·4 (6-7)	6·2 (5-7)	6·2 (6-8)			33·8 (33-38)	85·7
	II	7·3 (7-8)	6·7 (6-8)	6·5 (6-8)	5·9 (5-7)	6·5 (6-8)	7·2 (7-8)	6·4 (6-8)	7·3 (7-8)			under pupation	—
S. testacea	I	7·5 (7-9)	8·5 (8-9)	7·6 (7-8)	7·5 (7-8)	8·3 (8-9)	8·4 (8-9)	8·4 (8-9)	7.6 (7-9)	7·9 (7-9)	7·5 (7-8)	28·6 (27-31)	107·8*
P. argalea	I	7·1 (6-8)	6·9 (6-8)	6·8 (6-8)	6·6 (6-7)	6·7 (6-8)	7·2 (7-8)	6·9 (6-8)				26·7 (25-28)	75·2
	II	7·5 (7-9)	8·4 (6-8)	6·5 (6-7)	6·4 (6-8)	6·4 (6-7)	7·3 (6-9)	7·3 (6-8)	6·4 (6-8)			under pupation	—
T. sinensis	I	7·2 (6-9)	7·3 (7-8)	6·7 (6-8)	6·5 (6-7)	7·3 (7-8)	6·9 (6-8)	7·3 (7-8)	7·2 (7-8)	6·5 (6-7)		28·4 (27-30)	93·7
	II	6·8 (6-8)	6·9 (6-8)	7·3 (7-8)	6·2 (6-7)	6·2 (6-7)	6·7 (6-8)	7·2 (7-8)	6·9 (6-9)	6·5 (6-8)		23·8 (22-25)	91·6
	III	6·9 (6-8)	7·3 (7-8)	6·8 (6-7)	Continuing							—	—
C. ferruginea	I	7·6 (7-9)	6·3 (6-7)	6·5 (6-8)	5·8 (5-7)	6·4 (6-7)	6·3 (6-8)	6·4 (6-8)	5·6 (6-8)	6·2 (6-7)	5·8 (6-7)	27·2 (25-29)	94·2
	II	7·3 (7-8)	5·9 (5-7)	5·8 (5-7)	6·6 (6-7)	6·7 (6-8)	7·2 (7-8)	6·4 (6-8)	5·6 (5-7)	5·8 (5-7)	6·5 (6-8)	30·4 (28-32)	94·7
	III	6·9 (6-8)	6·5 (6-8)	6·3 (6-7)	6·7 (6-8)	Continuing						—	—
A. nivea	I	7·2 (7-8)	6·7 (6-8)	6·6 (6-7)	6·7 (6-7)	6·9 (6-8)	6·2 (5-7)	6·7 (6-7)	6·8 (6-8)	6·5 (6-7)		24·7 (24-26)	84·9
	II	6·9 (6-8)	6·8 (6-8)	7·4 (7-8)	6·2 (5-7)	5·9 (5-7)	6·7 (6-7)	7·2 (6-9)	7·1 (6-8)	6·9 (6-8)		27·8 (27-29)	88·7
	III	7·9 (7-8)	6·6 (6-7)	6·7 (6-8)	6·5 (6-7)	Continuing						—	—
N. doenia	I	6·4 (6-7)	5·5 (5-6)	5·8 (5-7)	5·7 (5-7)	5·6 (5-6)	6·4 (6-8)	6·4 (6-7)				21·8 (20-23)	63·3
	II	6·8 (6-8)	6·4 (6-7)	6·6 (6-8)	5·8 (5-7)	6·4 (6-7)	5·3 (5-6)	6·4 (5-7)				20·5 (19-22)	64·1
	III	6·9 (6-8)	6·5 (6-8)	6·4 (6-7)	6·2 (6-7)	5·9 (5-7)	6·7 (6-8)	6·8 (6-7)				under pupation	—

*Data based only on six adults that emerged during November 1971.

(b) *Parasites and Diseases*

Parasitisation by ichneumonids, braconids, chalcids and other parasites varied from 12·0 to 34·5%, as recorded from 12 species of limacodid larvae. The parasites are yet to be identified. The details of parasitisation of limacodid larvae by various parasites are furnished in Table 2.

Further tests for identification of various causative organisms of diseases in limacodid larvae were continued and two more were encountered this year. The number and percentage of diseased limacodids by various organisms have been shown in Table 3.

TABLE 2— PARASITIZATION OF DIFFERENT LIMACODID LARVAE BY VARIOUS PARASITES

Limacodid species	Number of larvae examined	Host larvae parasitized by								Total host larvae parasitized	
		Ichneumonids		Braconids		Chalcids		Others			
		No.	%	No.	%	No.	%	No.	%	No.	%
M. albipuncta	120	—	—	12	10·0	6	5·0	3	2·5	21	17·5
C. ferruginea	120	15	12·5	12	10·0	9	7·5	3	2·5	39	32·5
P. lepida	120	—	—	9	7·5	18	15·0	3	2·5	30	25·0
P. argalea	100	—	—	6	6·0	9	9·0	3	3·0	18	18·0
T. sinensis	100	10	10·0	7	7·0	2	2·0	3	3·0	22	22·0
T. cana	90	9	10·0	14	15·7	5	5·5	3	3·3	31	34·5
A. nivea	120	10	8·3	9	7·5	3	2·5	3	2·5	25	20·8
P. velutina	100	—	—	9	9·0	9	9·0	3	3·0	21	21·0
S. testacea	120	—	—	12	10·0	—	—	3	2·5	15	12·5
N. doenia	100	—	—	6	6·0	2	2·0	4	4·0	12	12·0
Natada sp.	90	—	—	9	10·0	5	5·5	3	3·3	17	18·8
N. argentipuncta	90	—	—	7	7·7	4	4·4	3	3·3	14	15·4

TABLE 3—NUMBER AND PERCENTAGE OF DISEASED LIMACODID LARVAE BY VARIOUS ORGANISMS

Limacodid species	Number of larvae examined	Host larvae diseased by						Total	
		A		B		C			
		No.	%	No.	%	No.	%	No.	%
M. albipuncta	100	—	—	17	17·0	10	10·0	27	27·0
P. lepida	120	12	10·0	13	10·8	—	—	25	20·8
P. argalea	120	18	20·0	—	—	—	—	18	20·0
S. testacea	90	24	20·0	—	—	12	10·0	36	30·0
T. sinensis	20	12	10·0	—	—	—	—	12	10·0
C. ferruginea	120	—	—	6	5·0	3	2·5	9	7·5

A. *Serratia marcescens* Bizio (Chromogenic)
B. *Serratia marcescens* Bizio (non-chromogenic)
C Unidentified bacterium.

(c) *Effect of insecticides — their efficacy and relative toxicity*

Technical grades of the following 10 insecticides were tested: diazinon, methyl parathion, Thiodan, phosphamidon, carbaryl, endrin, isodrin, BHC,

heptachlor and D.D.T. Tween 80 was used as emulsifier and benzene as solvent for all the insecticides except carbaryl for which acetone was used. Levels of benzene and Tween 80 were maintained at 6% and 0·5% respectively throughout the experiment.

Six doses, namely, 0·001, 0·01, 0·025, 0·05, 0·1 and 0·2% of the insecticides mentioned above were tried against the larvae of *M. albipuncta* and *C. ferruginea*. The data are under probit analysis to obtain LC 50 values.

(S. G. Choudhary)

2. Control studies against important pests of *Moghania macrophylla*

(a) *Laboratory evaluation of some insecticides against the larvae of Dasychira mendosa* Hubn. form *fusiformis* Wlk. and *Nephopteryx leucophaella* Zell.

Under this experiment, control measures against the important defoliators of *Moghania macrophylla*, namely, *Dasychira mendosa* Hubn. form *fusiformis*, *Hemithea tritonaria* Walker, *Hypena iconicalis* Walker, *Nephopteryx leucophaella* Zell. and *Platypeplus aprobola* Meyrick are being studied by using Aldrex 30 EC, BHC 50% WP, DDT 25 EC, DDT 50% WP, Dieldrex 18 EC, Endrex 20 EC, Hexavin 50% WP, Paramar 50 EC and Thiodan 35 EC.

The studies were conducted according to the availability of caterpillars and insecticides in a particular year.

Previous study indicated that Thiodan at 0·1% gave 100% kill of *H. tritonaria*. Endrex and Thiodan at 0·01% gave 100% kill of *H. iconicalis* and the last two at 0·15% gave 100% kill of *P. aprobola* within 24 hrs.

This year the fifth instar larvae of *D. mendosa* and *N. leucophaella* collected during August 1971 and December 1971, respectively, were preconditioned for 24 hrs. These were then treated with commercial formulations of seven insecticides, namely, DDT and Hexavin (carbaryl) as WP and DDT, Dieldrex, Endrex, Paramar (parathion) and Thiodan (endosulfan) as emulsions. The per cent concentrations tested for each of the insecticides were as follows:

DDT 25 EC	— 0·01, 0·05, 0·1, 0·15
DDT 50% WP	— 0·1, 0·2, 0·3, 0·4
Hexavin 50% WP	— 0·05, 0·1, 0·15, 0·2
Dieldrex 18 EC	— 0·01, 0·05, 0·1, 0·15
Endrex 20 EC	— 0·002, 0·01, 0·03, 0·05
Paramar 50 EC	— 0·01, 0·05, 0·1, 0·15
Thiodan 35 EC	— 0·01, 0·03, 0·05, 0·1

Filter papers, dipped in the fixed volume of above mentioned concentrations of insecticides, were dried for two minutes and kept in petri dishes in which a batch of ten larvae each of *D. mendosa* and *N. leucophaella* were released for an hour only. Three replications of each of the concentrations of the insecticides, besides the control (no treatment), were run. The treated larvae were transferred to rearing jars (10·0×5·0 cm) and supplied with fresh leaves of *Moghania*. The mortality was recorded after 24 hours of treatment.

The data so obtained were subjected to Probit analysis which indicated that Endrex was most toxic to *D. mendosa* and Paramar (parathion) to *N. leucophaella* amongst all the insecticides tried (Table 4).

TABLE 4 — RELATIVE TOXICITY OF DIFFERENT INSECTICIDES AS CONTACT POISON

Insectcide	Heterogneity	Regression equation	L C 50	Fiducial limits	Relative toxicity
(i) *Dasychira mendosa* form *fusiformis* Wlk.					
Endrex 20 EC	$X^2(2) = 1.8019$	$Y = 1.0772x + 4.43497$	0.003467	0.00582 0.000114	4.8488
Thiodan 35 EC	$X^2(3) = 0.7254$	$Y = 0.8516x + 3.5573$	0.004942	0.01431 0.001039	3.4016
DDT 25 EC	$X^2(2) = 0.7348$	$Y = 0.7519x + 4.4774$	0.004954	0.00952 0.00125	3.3934
Dieldrex 18 EC	$X^2(2) = 0.668$	$Y = 0.9583x + 3.9960$	0.011158	0.02181 0.001571	1.50663
Paramar 50 EC	$X^2(2) = 2.3861$	$Y = 0.9661x + 3.8159$	0.016811	0.495 0.01037	1.0000
DDT 50% WP	$X^2(2) = 0.8105$	$Y = 1.3921x + 1.8962$	0.16962	1.40 0.0114	0.099109
Hexavin 50% WP	$X^2(2) = 2.322$	$Y = 2.5901x + 0.0049$	0.085567	0.1105 0.06053	0.19646
(ii) *Nephopteryx leucophaella* Zell.					
Paramar 50 EC	$X^2(2) = 1.2253$	$Y = 1.2253x + 3.82640$	0.0090689	0.02345 0.00328	2.2774
Endrex 20 EC	$X^2(3) = 7.5673$	$Y = 1.1492x + 3.8328$	0.01365	0.01599 0.00593	1.99266
Thiodan 35 EC	$X^2(3) = 6.8198$	$Y = 0.9471x + 3.9763$	0.012906	0.01695 0.00982	1.60041
DDT 25 EC	$X^2(3) = 13.6052$	$Y = 0.8788x + 3.843$	0.020654	0.03899 0.00919	1.0000
Dieldrex 18 EC	$X^2(2) = 3.7620$	$Y = 0.9519x + 3.4611$	0.041362	0.04942 0.02916	0.49934
Hexavin 50% WP	$X^2(2) = 2.1172$	$Y = 2.1172x + 0.9335$	0.08932	0.0921 0.0858	0.24831

(b) *Field trials to find out comparative efficacy of different insecticides against pests of Moghania macrophylla*

This experiment on the chemical control of pests of *M. macrophylla* was carried out on 1200 *Moghania* bushes pruned in January 1971 to encourage pest infestation.

Keeping in view the results obtained during 1970, the following two doses of seven insecticides were tried, namely, DDT 50% WP (0·3 & 0·4%) and Hexavin (carbaryl) 50% WP (0·15 & 0·2%) and DDT 25, Dieldrex 18, Endrex 20, Paramar (parathion) 50 & Thiodan (endosulfan) 35 as emulsions (0·01 & 0·05% each), in randomised block design, for the control of *D. mendosa*, *Hemithia tritonaria* Walk., *Hypena iconicalis* Walker, *N. leucophaella* and *Platypeplus aprobola* Meyr. There were three replications of each of the concentrations of the insecticide as well as of the control (unsprayed), and each plot consisted of 25 bushes. The population of pest in its larval stage was counted a day before and again one, seven and fourteen days after the spray on five randomly selected bushes in each plot.

Results indicated superiority of insecticidal treatments over control upto two weeks after spraying against *D. mendosa, H. iconicalis, H. tritonaria* and *N. leucophaella* but upto one week against *P. aprobola.* The pest-wise results are as follows:

D. mendosa

Endrex, Paramar and Thiodan each at 0·05% concentration gave 93·33, 91·66 and 86·9% kill of the pest one day after spraying and 100·0% kill a week after spraying.

H. iconicalis

Endrex and Paramar each at 0·05%, DDT (WP) at 0·4% and Hexavin at 0·2% were effective in reducing 100·0% population of *H. iconicalis* one day after spraying, whereas Hexavin at 0·15% was equally effective one week after spraying.

H. tritonaria

Hexavin at 0·2% concentration gave 100% kill one day after spraying. Endrex at 0·05% gave 93·3% kill one day after spraying and 100% kill a week after spraying. Hence these two insecticides proved superior to others, which did not give 100% kill.

N. leucophaella

Paramar at 0·05% concentration gave 93·33% kill while Hexavin at 0·2% gave 82·14% kill one day after spraying, and both resulted in 100% kill one week after spraying.

P. aprobola

No insecticide gave 100% kill even after a week. However, Paramar, Endrex and Thiodan each at 0·05% concentration gave more than 90% kill one week after spraying. Paramar gave 90·83% and 94·16%, Endrex 89·58% and 93·33% and Thiodan 82·04% and 91·66% kill, respectively, one day and one week after spraying. The foliage was affected adversely by their residues.

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

(b) RESEARCHES ON HAND

Lac cultivation studies

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

The brood rates tried were 0·4 to 0·8 kg per tree with an increment of 0.1 kg and 1.0 to 2.0 kg per tree with an increment of 0·2 kg (from treatment to treatment). The crop was harvested as *ari* in the last week of April. The yield of sticklac was highest with the brood rate of 1·4 kg per tree as compared to the brood rate of 1·8 kg per tree which had produced the best crop last year.

These trials are continued in the *Baisakhi* 1972-73 season.

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

2. Studies on proper time of harvesting-cum-coppicing *bhalia* (*Moghania macrophylla*) within January/February

Bhalia possesses many attractive features as a host to supplement production of the superior *Kusmi* lac. Its only drawback, however, lies in its inability to sustain a good summer (*Jethwi*) crop. It also does not respond well to coppicing/harvesting in July as compared to that carried out in January/February. Experiments were, therefore, planned to examine whether this plant species can be utilised to raise an *ari* (immature) or at least a partial *Jethwi* crop during summer. The various cultivation practices tried were as follows:

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

The experiment was laid out in a randomised block design with an experimental unit of 5 bushes and 5 replications.

Due to general failure of the *Jethwi* 1971 and *Aghani* 1971-72 crops throughout the Bihar State, the crop yields were extremely poor and hence the data obtained during the year were not comparable.

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

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

Based on the earlier findings that *kusum* does not respond well when pruned in January/February, a new cultivation schedule was planned which involved pruning and complete harvesting only in July. This schedule was compared with the standard four-coupe system. The experiment was laid out in a randomised block design with an experimental unit of 5 trees and 13 replications.

The experiment could not be carried out during the year due to crop failure and non-availability of broodlac.

(R. C. Maurya, C. P. Malhotra and A. Bhattacharya)

4. Finding out alternate hosts for *kusmi* and *Rangeeni* strains of lac insects and conducting cultivation on them

(a) *For Kusmi strain*

Putri (*Croton oblongifolius*), rain tree (*Samanea saman*) and *vilayati babul* (*Acacia farnesiana*) were tried in the *Aghani* 1971-72 season. None of these hosts, however, carried the crop till maturity.

(b) *For Rangeeni strain*

Putri, rain tree, *vilayati babul* and *porho* (*Ficus cunia*) were tried in the *Katki* season. All except *vilayati babul* carried the crop. The crop ratios (brood used

to total yield in stick-lac) were 1 : 3·6, 1 : 1·25 and 1 : 1·14 for rain tree, *porho* and *putri* respectively.

Putri, rain tree and *vilayati babul* were again tried in the *Baisakhi* 1971-72 season. The crop has developed satisfactorily on the first two species till the end of December.

(M. L. Bhagat and C. P. Malhotra)

5. Studies on the efficiency of different lac hosts on the survival of lac insects

Five plants each of ten host species, namely, *kusum*, *bhalia*, *galwang* (*Albizzia lucida*), *ber* (*Ziziphus mauritiana*), *sandan* (*Ougeinia oojeinensis*), *vilayati babul*, *palas*, *arhar* (*Cajanus cajan*), rain tree (*Samanea saman*) and *khair* (*Acacia catechu*) were raised in pots and used to culture the *Rangeeni* and *Kusmi* strains of lac insect. The insect survival and fecundity were noted on each host species.

All the host species (except *kusum*) sustained the *Rangeeni* insect till its reproduction in the *Baisakhi* 1970-71 season and all except *kusum* and *arhar* in the following *Katki* season. The survival was best on *sandan* in the *Baisakhi* and on *vilayati babul* in the *Katki* season. The fecundity was highest on *bhalia* in the *Baisakhi* and on *khair* and *galwang* in the *Katki* season.

The *Kusmi* insect was sustained till its reproduction on *kusum*, *bhalia*, *galwang*, *ber*, *sandan* and *vilayati babul* in the *Aghani* 1970-71 season and on *kusum*, *bhalia* and *ber* in the *Jethwi* season. The insect survival and fecundity were best on *kusum* in both the seasons.

(M. K. Chowdhary and C. P. Malhotra)

6. Intensive lac cultivation under bushy condition

For lac cultivation on the trained bushes of *palas*, *ber* and *galwang*, the following cultivation practices were tried.

Treatments	Inoculation		Harvesting
	Month	Brood rate	
A	October	200 g	Three-fourth in April and three-fourth in October and so on.
B	do	25 g	Nine-tenth in October next and complete in the following April.
C	do	do	One-fourth in June, nine-tenth in October next and complete in the following April.
D	do	50 g	Nine-tenth in October next and complete in the following April.
E	do	do	One-fourth in July, nine-tenth in October next and complete in the following April.
F	do	100 g	Three-fourth in April, nine-tenth in October next and complete in the following April.
G	do	do	Three-fourth in July, nine-tenth in October next and complete in the following April.
H	do	200 g	Complete harvesting after one and a half years in April.
I	do	do	Three-fourth in April, nine-tenth in October next and complete in the following April.

Inoculations were carried out in the *Baisakhi* 1971-72 season on 200 buses each of *palas* and *ber* and 80 bushes of *galwang*.

The larval mortality count on the experimental bushes of *palas*, *ber* and *galwang* were made towards the end of November after *phunki* removal. The maximum and minimum mortality, as revealed in the different treatments on the three bushes, were as follows:

Bushes	Treatments	
	Maximum	Minimum
Palas	90·3% (D)	68·3% (F)
Ber	78·2% (F)	46·1% (E)
Galwang	83·0% (E)	48·5% (F)

Due to heavy larval mortality the condition of the crop was rather poor.

(S. K. Jaipuriar, C. P. Malhotra and B. K. Purkayastha)

Physiological studies

7. Nutritional requirements of lac insects

Determination of free amino acid content of lac insects

The body fluid of the fully matured *Rangeeni* lac insects cultured on *bhalia*, *ber* and *galwang* was subjected to two dimensional paper chromatography after passing through a column filled with ion-exchange resin to retain the amino acids and then treating with 6*N* ammonia to free all the amino acids. The solvent systems tried were phenol: water (80: 20 w/v) and *n*-butanol: acetic acid: water (60: 12: 28 v/v/v).

The amino acids detected were glycine, histidine, tyrosine, valine, lysine, methionine, serine, threonine and cysteine. No difference was found in the amino acids due to the hosts.

(R. S. Gokulpure and A. Bhattacharya)

8. Nutritional requirements of the beneficial parasites

With a view to develop a synthetic diet for mass rearing of parasites of the lac predator, *Eublemma amabilis* Moore, the following aspects of biochemical differences in the healthy and parasitised host larvae were studied.

(i) *H-ion concentration of the haemolymph*

The pH was determined by the paper touch method using B.D.H. narrow range pH indicator papers. It was found to be 6·7 in the healthy haemolymph. But 24 hours after parasitisation by *Bracon greeni* Ashm. it rose to 8·5.

(ii) *Specific gravity of the haemolymph*

The specific gravity of the blood was determined by the Van Slyke's method. It was found to be approximately 1·063 in the healthy blood. Changes due to parasitisation, if any, are under study.

(iii) *Blood volume*

The methods adopted by Richardson *et al.* (1931) and Yeager (1932) were followed to determine the blood volume of the healthy host larvae. It was found that a gram of larval body contained about 1·584 mm^3 of blood. Changes due to parasitisation are still under study.

(iv) *Inorganic ions in the blood*

"Turnbull Blue" method was followed to determine the presence of iron in the blood of predatory larvae. A faint blue colour developed indicating the presence of iron.

(v) *Proteolytic enzyme in the blood of host larvae*

Parasites, while feeding on their hosts, cause rapid histolysis of the host tissues. It was, therefore, suspected that the parasites may secrete some proteolytic enzymes while feeding on the host.

The stained fibrin test followed by Swingle (1928) was carried out to detect the presence of protease. While results were negative for the healthy haemolymph, the enzyme was detected in traces 60 hours after parasitisation.

(vi) *Haemocytes*

Jenner's, Geimsa's, May Grunwald's, Leishman's and haematoxylin-Orange G stains were used to study the haemocytes. Results were best with Geimsa's and Leishman's stains.

The healthy haemolymph was found to contain oenocytes, adipohaemocytes, prohaemocytes and phagocytes (Figs. 1 & 2). Parasitisation by *Bracon greeni* resulted in increased phagocytic activity which destroyed the other cells and only phagocytes were found 60 hours after parasitisation.

The total and differential counts of the healthy and parasitised blood are being studied.

HAEMOLYMPH OF EUBLEMMA AMABILIS MOORE LARVA
PARASITISED AND HEALTHY

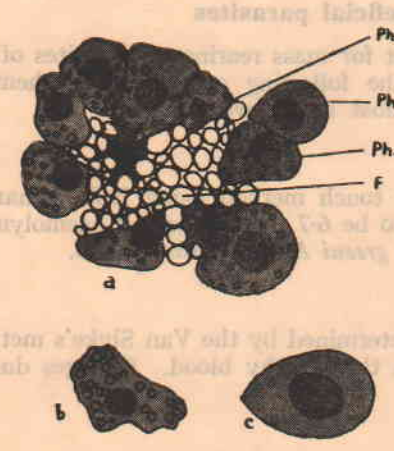


Fig. 1

Fig. 2.

Fig.1 Haemolymph 60hrs after parasitisation
Fig.2 Haemolymph from healthy larva

Ph.C - Phagocytosed cell Ph - young Phagocyte.
Ph.A - Phagocyte in action F - Fat droplets
i Oenocyte ii Spherule cell iii Phagocyte.
iv - Prohaemotocyte.

AKSen

(vii) *Carbohydrates in the blood of host larvae*

The blood sugars were studied using thin layer chromatography. Only one spot was detected which corresponded to that formed by glucose and galactose. The healthy blood may, therefore, contain either both or one of these sugars. Changes due to parasitisation are being studied.

It was found that in the haemolymph of healthy larvae there were at least seven ninhydrin positive spots of amino acids. From Fig. 3, it would be seen that after 48 hours of parasitisation there was a reduction of only one spot which was restored after 60 hours. However, the amino acids were increased quantitatively as revealed by the intensity of the colour spots. The amino acids are yet to be identified.

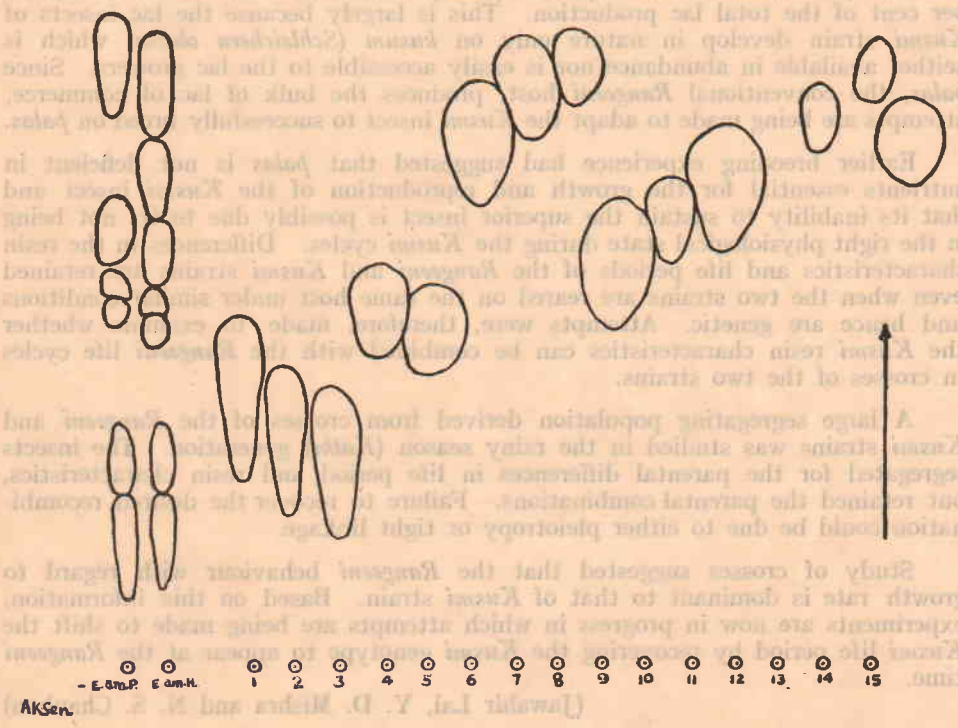


Fig. 3 — Chromatogram showing the ninhydrin positive spots in parasitized and healthy larvae of *E. amabilis* Moore.
Spot No. 1 — 15 known amino acids
E. am. P — *E. amabilis* parasitized
E. am. H — *E. amabilis* healthy.

(A. K. Sen and A. Bhattacharya)

(viii) *Free amino acid content in the haemolymph*

The alcoholic extracts of haemolymph from the healthy and parasitised host larvae were subjected to thin layer chromatography. The solvent system (*tert*-butyl alcohol: formic acid: water, 70: 15: 15 v/v/v) and spray reagent (0·2% ninhydrin in acetone) were used for the detection of amino acids.

9. Microbiological studies on lac insects

Microbiological studies on lac insects, reared on different hosts, have shown the presence of both cocci and rod-shaped organisms, the physiological characteristics of which remain to be studied.

(A. H. Naqvi)

Breeding and Genetical studies

10. Adaptation of the superior lac insect to a common food plant

The production of the superior quality *Kusmi* lac constitutes hardly 10 per cent of the total lac production. This is largely because the lac insects of *Kusmi* strain develop in nature only on *kusum* (*Schleichera oleosa*) which is neither available in abundance nor is easily accessible to the lac growers. Since *palas*, the conventional *Rangeeni* host, produces the bulk of lac of commerce, attempts are being made to adapt the *Kusmi* insect to successfully breed on *palas*.

Earlier breeding experience had suggested that *palas* is not deficient in nutrients essential for the growth and reproduction of the *Kusmi* insect and that its inability to sustain the superior insect is possibly due to its not being in the right physiological state during the *Kusmi* cycles. Differences in the resin characteristics and life periods of the *Rangeeni* and *Kusmi* strains are retained even when the two strains are reared on the same host under similar conditions and hence are genetic. Attempts were, therefore, made to examine whether the *Kusmi* resin characteristics can be combined with the *Rangeeni* life cycles in crosses of the two strains.

A large segregating population derived from crosses of the *Rangeeni* and *Kusmi* strains was studied in the rainy season (*Katki*) generation. The insects segregated for the parental differences in life period and resin characteristics, but retained the parental combinations. Failure to recover the desired recombination could be due to either pleiotropy or tight linkage.

Study of crosses suggested that the *Rangeeni* behaviour with regard to growth rate is dominant to that of *Kusmi* strain. Based on this information, experiments are now in progress in which attempts are being made to shift the *Kusmi* life period by recovering the *Kusmi* genotype to appear at the *Rangeeni* time.

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

11. Cytogenetic analysis of chromosome behaviour

Studies with the colour genes had suggested a unique genetic situation in lac insects. It was shown that the male transmits only the maternal allele through the sperm, although both paternal and maternal alleles are active somatically. Chromosome studies confirmed that while chromosomes are in the euchromatic state in the somatic tissues, one haploid set of chromosomes is in a heterochromatic state in the male germ line which does not take part in sperm formation. The elimination of the paternal allele is thus brought about through heterochromatization and elimination of the paternal chromosomes in the male germ line. In lac insects, therefore, the genes are 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 allele. This information now forms the basis of the current programme of genetic improvements in lac insects.

(N. S. Chauhan)

12. Survey of genetic variation

(i) *Study of crosses*

A large segregating population derived from crosses of the *Rangeeni* and *Kusmi* strains, collected from widely separated regions, was studied along with the parents and considerable variability was noticed in growth rate and resin productivity. The total life period of females varied from 106 to 267 days in comparison to parent females in *Katki* and *Aghani* seasons where it was 100 to 138 days and 178 to 230 days respectively; and the resin yield per female varied from 3·0 to 41·0 mg.

A new colour variant, deep saffron, was detected in a segregating progeny of another cross of these strains. This will now be studied in crosses with the known colour forms.

(ii) *Selection studies*

Growth rate

Four hundred and thirty three female lac insects were studied in a segregating progeny of the summer generation. The total life period varied from 217 to 271 days, the normal being 235 to 255 days. This increase in variability is, therefore, attributable to genetic segregation. Five extreme females were taken to establish the early and late maturing lines.

The average life periods of females in the early and late maturing lines after one generation of selection were 112·2 and 128·9 days, respectively, in the rainy season.

Resin dye content

Fifty mature females were drawn from the local *Rangeeni* population to provide fifty families cultured on potted *bhalia* plants under similar conditions during the summer season. A week before the time of reproduction, five females were drawn at random from each family and were scored for total cell weight and resin dye level. For the latter, the lac cells were dissolved in 5 ml of ethanol and the dye level read on a Spectronic 20 spectrophotometer at 450 mμ. The score for resin dye was taken as the ratio of optical density to the total cell weight. This ratio for the individual families varied from 2·87 to 6·09 showing considerable variation in resin dye content. Progenies of the highest and lowest five families were cultured in the rainy season to establish the high and low lines.

The average ratios (optical density/cell weight) in the low and high lines after one generation of selection were 3·42 and 4·58 respectively.

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

Insect control

13. Integrated control of inimical insects of lac insects

(i) *Survey of different diseases in lac insect predators, E. amabilis and Holcocera pulverea*

Nothing to report.

(ii) *Seasonal incidence and behavioural studies on beneficial insects associated with lac insect predators*

Seasonal incidence

With a view to screen the important beneficial parasites for use in the integrated control of lac pests, their seasonal incidence was studied under tree and bush condition by collecting 0·5 kg lac samples at fortnightly intervals from the time of *phunki* removal till the time of crop maturity and noting the emergence of beneficial insects both from *Rangeeni* and *Kusmi* lacs. Cropwise observations were as follows:

Jethwi 1971 — The crop was raised on 12 bushes and 12 trees of *kusum* using 45 kg of purchased *Kusmi* broodlac. The larval settlement, however, was extremely poor and the insects died soon after settlement, and therefore no data could be obtained.

Aghani 1971-72 — Eight trees and 16 bushes of *kusum* were inoculated with 25 kg *Kusmi* broodlac purchased from Jaipatna (Orissa). The emergence of larvae, however, was extremely poor in this season also and the insects died soon after settlement.

Baisakhi 1970-71 — Sixteen bushes and 16 trees of *palas* were inoculated with 45 kg of *palas* broodlac. The emergence of beneficial parasites was noted from samples collected from March onwards. Maximum number of beneficial parasites emerged from samples collected in July from trees and bushes, and these were *Bracon greeni* Ashm. [22(tree)/15(bush)], *Apanteles tachardiae* Cam. (25/2), and *Pristomerus sulci* Mahd. & Kolu (3/2).

Katki 1971 — In this season also 16 trees and 16 bushes of *palas* were inoculated with 45 kg of *palas* broodlac. The emergence of beneficial parasites was noted from samples collected from September onwards. Highest number of emergences were recorded in October samples and it was found that in the case of tree hosts larger number of parasites of *Holcocera pulverea* Meyr., viz., *Brachymeria tachardiae* Cam. (11), *A. tachardiae* (84) and *P. sulci* (51) emerged. On the other hand, the parasites of *Eublemma amabilis* Moore, namely, *B. greeni* (119) and *Elasmus claripennis* (Cam.) (63) were found in greater numbers in lac grown on bushes than on trees.

However, it may be mentioned that the incidence of both the predators was always relatively higher on the bushy hosts compared to the tree hosts. This leads to the conclusion that the predator attack is generally more on bushy hosts which indicates the restricted vertical flight of the predators. Further, it also revealed that the parasites of *H. pulverea* were able to reach higher vertical level than the parasites of *E. amabilis* since the former were capable to locate their hosts even on trees.

Behavioural studies

Attempts were made to rear the parasites, *P. sulci*, *Agathis coryphe* Nixon and *Eurytoma pallidiscapus* Cam., in the laboratory during the favourable rainy season. *Corcyra cephalonica* Staint. was offered as an alternate laboratory host to these parasites.

The first two failed to mate under confinement. When the hosts were offered, 50-60% of these were parasitised, producing only male progeny. The average development periods were 21 and 19 days for *P. sulci* and *A. coryphe*

respectively. Adults of *E. pallidiscapus* were found to mate immediately after emergence, though males emerged earlier (2 to 3 days) than the females. This parasite successfully parasitised the third and fourth instar host larvae and the host pupae as well. The development was somewhat slower when the host was offered as larvae (19 and 13 days). The sex-ratio in laboratory cultures was 40 males to 60 females.

(A. H. Naqvi, P. Sen, A. K. Sen and A. Bhattacharya)

Ecological studies

14. Influence of environmental factors on the lac insect

(i) *Influence of photoperiod on the lac insect*

To study the effect of photoperiod on the lac insect, the insects were allowed to settle on potted *M. macrophylla* plants, and then exposed to varying periods of natural day and night lights. The results indicated that the lac insects were not apparently influenced by photoperiod.

The experiment has since been modified. The potted *M. macrophylla* are now exposed to varying photoperiods (as before) from the time of transplanting (2-3 weeks after germination of seeds). These plants will continue receiving the photoperiod treatments even after inoculation with lac insects till the insects complete their life.

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

(ii) *Determination of the appropriate time of harvesting broodlac in different regions through the use of Biometer on thermohygrograph records*

To correlate growth rate with temperature, the lac insects were cultured at 27·5° and 30·0°C constant temperatures in the *Baisakhi* 1971-72 season. The temperature control units were improvised by fitting thermostats in wooden cabinets for maintaining the said temperatures.

Six potted *M. macrophylla* plants were inoculated on 23.10.71 for 24 hours when the larval emergence had just started, and another set of six such plants were inoculated towards the end of larval emergence. Two plants of each set were used for each temperature and the remaining two of each set served as control. Twentyfive isolated insects were allowed to develop on each plant to study their growth rate.

The growth rate was faster at both the temperatures than under control; but between temperatures, the difference was hardly discernible. The sexual maturity reached within 37-47 days at both the higher temperatures, when the insects under control entered the third instar.

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

15. Regional Field Research Station for Lac: Dharamjaigarh

(i) *Trial of new cultivation technique for kusum*

The study, which has been in progress since 1967, came under regular pruning cycle in 1969, and was continued as hitherto with the different practices described in Table 5. The ultimate object of the study is to evolve a suitable technique for culturing lac on *kusum* for adoption in the State by modifying the schedule of operations, and involves comparison of the results obtained by light

inoculations carried out in December/January and June/July on shoots of different ages and harvesting once in two years with that recommended by the Institute, namely, inoculating and harvesting in each season with normal requirement of broodlac and the villagers' method of continuously keeping the trees under lac by self-inoculation and harvesting the rest of the crop each season. The comparison is thus made between one harvest consisting of two crops as a result of one artificial and one self-inoculation each in A and B, two harvests as a result of two artificial inoculations in C and two harvests as a result of continuous self-inoculation of the trees in D, as shown in Table 5.

From the data in Table 6 it is observed that one-year rest between pruning/harvesting and inoculation (Treatment A) has shown the best results.

As all the experimental trees came under regular pruning cycle in 1969 and as inoculation of all the experimental trees could not be carried out in December 1969 due to non-availability of broodlac, no previous results are available.

(ii) *Investigation of likely alternative hosts to supplement production of lac*

(a) *Trials on indigenous species*

Sal or *Sarai* (*Shorea robusta*), *dumar* or *gular* (*Ficus racemosa*), *Jhera* (*Ficus* sp.), *ghui* (*Ficus* sp.), *amaltas* (*Cassia fistula*), *salai* or *salga* (*Boswellia serrata*) and *saja* (*Terminalia tomentosa*) were tried. Only *jhera* (*Ficus* sp.) carried *Aghani* 1971-72 crop to maturity.

(b) *Introduction of exotic lac hosts*

4800 *Moghania macrophlla* plants and 250 *A. lucida* plants were transplanted in an area of about 4 acres. They were progressing well.

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

No new insects were collected.

(J. M. Dasgupta and B. P. Mehra)

(c) RESEARCHES CONTEMPLATED

Research work on all projects in progress, except the one completed during the year under report, will be continued. Further, out of the four items contemplated for the year (*A. Rep.* 1970), only three were taken up for investigation and are now in progress. Besides, the following studies are contemplated to be taken up during the next year.

1) Studies on Sex Attraction in major lepidopterous predators.
2) Ecological studies on the enemies of lac insect and their parasites.
3) Analysis of environmental and edaphic factors responsible for poor lac growth at Ranchi on two hosts of regional importance, such as *Grewia serrulata* and *Shorea talura*.
4) Exploratory studies on the application of modern pest control technology against the enemies of lac insect, including the use of chemosterilants, antifeedants and repellants, microbial agents, and newer synthetic insecticides.

TABLE 5 — SCHEDULE OF CULTIVATION PRACTICES FOR *kusum*

Treatment	Period of rest for the host (years)	Number of coupes	Number of trees in each coupe	Broodlac rate used	Inoculation	Cultivation practice		
						Self-inoculation allowed	Harvesting	Period between initial inoculation and harvesting (Months)
A_1	1	2	15	0·5 N*	Dec./Jan.	June/July	Dec./Jan.	12
A_2	1	2	15	0·5 N	June/July	Dec./Jan.	June/July	12
B_1	2	3	15	0·5 N	Dec./Jan.	June/July	Dec./Jan.	12
B_2	2	3	15	0·5 N	June/July	Dec./Jan.	June/July	12
C I & C III	1·5	2	15	N	Dec./Jan.	—	June/July	6
C II & C IV	1·5	2	15	N	June/July	—	Dec./Jan.	6
D	Nil	1	15	N	Initially and as and when required	June/July and Dec./Jan.	June/July and Dec./Jan. (Always partial harvesting)	

*N = Normal, which is 1 cm of broodlac per 15 cm of inoculable shoots.

TABLE 6 — COMPARATIVE STATEMENT OF CROP DATA OF DIFFERENT CULTIVATION PRACTICES FOR *kusum*

Aghani 1970-71-cum-*Jethwi* 1971 crops during the period July 1970 to July 1971

Treatment/coupe	Broodlac used	Scraped phunki	Yield obtained		Ratio	
			Brood lac	Total scraped	Broodlac used: Broodlac obtained	Broodlac used: Yield obtained
	Kg	Kg	Kg	Kg		
A (A_2II)	27·00	7·0	50·5	17·5	1 : 1·88	1 : 2·50
B (B_2I)	40·00	10·6	20·0	7·1	1 : 0·50	1 : 0·66
C (CIII + CIV)	86·4	20·8	45·5	18·29	1 : 0·52	1 : 0·88
D (*Aghani* 1970-71 + *Jethwi* 1971)	48·0	11·0	5·0	2·4	Cannot be determined as artificial inoculation is not carried out every season; only self-inoculation is allowed.	

Jethwi 1971-cum-*Aghani* 1971-72 crops during the period January 1971 to January 1972

A (A_1I)	18·0	4·8	24·5	7·9	1 : 1·36	1 : 1·64
B (B_1 II)	27·5	7·2	12·3	7·5	1 : 0·44	1 : 1·04
C (CIV + CI)	103·9	25·3	41·8	18·6	1 : 0·39	1 : 0·73
D (*Jethwi* 71 + *Aghani* 71-72)	—	—	22·0	6·1	Cannot be determined as artificial inoculation is not carried out every season; only self-inoculation is allowed.	

B. DIVISION OF AGRONOMY AND PLANT GENETICS

The Division of Agronomy and Plant Genetics was created during the year under report (1971) with the main object of evolving integrated land use patterns through synergistic associations of trees and shrubs (lac-hosts), grasses and crops so that lac-hosts and agricultural crops may co-exist and competition between them may be converted into co-operation. The Section of Arboriculture which hitherto functioned under Entomology Division was merged in this new Division.

(a) RESEARCHES COMPLETED — Nil

(b) RESEARCHES ON HAND

Agronomical studies

1. Intercropping of cereals and legumes with bushy lac hosts under rainfed and irrigated conditions

Lac production can be increased manifold if improved agronomical technology is adopted. Under monoculture condition the application of agricultural

inputs like irrigation, fertiliser and labour is an expensive proposition. By growing food and cash crops in between the spaces of lac-host plants under fertilised, rainfed and irrigated conditions, the farm income per unit of time and area may be increased and the cost of lac cultivation may be lowered.

With this objective in view a study on the possibility of raising inter-crops in rotation with bushy lac-hosts, such as *bhalia* (*Moghania macrophylla*) and *arhar* (*Cajanus cajan*) was initiated in October, 1971. The experiment was conducted in split-plot design with four intercrops, namely, wheat, gram, mustard and linseed, as main plot treatments and two fertility levels as sub-plot treatments. The treatments were replicated four times. The size of the *bhalia* plot (spacing 1·8×1·2 m) was 40×24 m and *arhar* plot (spacing 1·8×1·2 m) was 40×32 m. The size of each main plot of intercrops was 10×6 m in *bhalia* and 10×8 m in *arhar*. Irrigation schedules were maintained as per requirements of the crops.

The intercrops were sown towards the end of October '71. The existing *bhalia* bushes were inoculated with *Rangeeni* broodlac.

(P. N. Choudhury)

2. Drought resistance studies

(i) *Induction of drought resistance in bushy lac-hosts*

Some of the host plants like *bhalia* and *arhar* are unable to sustain higher population of lac insects in summer months due to drought conditions, thus resulting in high mortality of plants. A study on the above problem was in progress since 1968 by exposing *bhalia* and *arhar* seeds to high temperatures prior to sowing.

Bhalia

In the 1970 set of plants, the differences in shoot growth between the treatments were statistically significant (Table 7). The treatment t_3 was found best and much superior to the treatment t_1 (control).

TABLE 7 — EFFECT OF TEMPERATURE TREATMENT ON PLANT SHOOT GROWTH

	Treatments				F. ratio	S.E.
Shoot length in cm per plant	t_1	t_2	t_3	t_4		
	448·9	505·0	720·1	700·6	7·78	50·59

Arhar

The *Baisakhi* '70-71 crop developed on *arhar* plants raised in June '70 (*A. Rep.* 1970) from seeds unexposed and exposed to temperature survived on these plants till maturity recording no mortality of plants irrespective of treatments. In spite of optimum lac inoculation, there has been no temperature effect on the survival of plants in summer season. It may be recorded that there was favourable climatic condition in summer months with moderately lower temperatures and occasional rains in the year under report.

In the second set of plants raised in June '71, the treatment differences were found statistically non-significant with regard to shoot growth.

(ii) *Screening of arhar varieties for lac cultivation under drought conditions*

With the adoption of intensive cultivation of lac on bushy hosts under agricultural conditions, the utilisation of *arhar* as a plantation crop for both lac and pulse crop is expected to be of considerable economic importance. Unfortunately, however, the Assam perennial variety (naturalised at Institute plantation) could not be exploited as successful lac host for the summer crop for its inability to withstand drought conditions.

Accordingly, a study was initiated since June 70 to screen the *arhar* varieties collected from different sources for their ability to sustain lac crops during summer months. Nine varieties of *arhar* raised in June '70 (*A. Rep.* 1970) were inoculated in Jan. '71 but their performance could not be judged due to very poor settlement of lac insects on these plants.

The experiment was repeated in 1971 with 14 varieties which includes 5 more varieties collected in this season. The results given in Table 8 show the varietal difference in regard to plant height, shoot number and shoot growth. Judging from shoot growth, NP 41 was found the best.

(P. Kumar & B. K. Purkayastha)

TABLE 8 — EFFECT OF FERTILIZER TREATMENTS ON THE NUMBER OF SHOOTS DEVELOPED AND TOTAL LENGTH OF SHOOTS

Varieties	Control (F_1)		NPK (F_2)		NPK + lime (F_3)	
	Average mean number of shoots	Average total length of shoots per plant in cm	Average number of shoots	Average total length of shoots per plant in cm	Average number of shoots	Average total length of shoots per plant in cm
T_1	6·0	311·8	9·0	549·6	6·0	365·6
NP-41	7·8	613·8	5·8	539·2	13·2	1059·8
NP-39	9·2	608·0	8·8	782·0	9·8	666·6
NP-80	9·0	572·0	14·2	724·0	9·0	566·7
BR-60	6·4	372·8	4·8	311·8	6·6	395·4
C-11	9·0	629·0	7·4	472·0	7·0	474·6
N. BIHAR	3·2	211·7	3·0	207·5	3·0	221·7
Motihari	7·6	432·3	5·7	327·0	6·5	402·7
7-S	7·2	500·5	5·5	338·5	10·5	758·2
148						
Parbhani	4·7	218·2	3·0	188·7	7·2	358·5
PT-301	6·0	381·0	6·3	354·0	6·0	398·3
ILRI(Local)	7·0	503·0	9·0	656·4	6·6	551·0
ILRI(Local)	8·2	528·0	7·0	335·0	6·4	387·8
ILRI(Assam)	7·0	455·0	10·0	694·0	8·0	686·3

Cytogenetical and breeding studies

3. Cytotaxonomic and mutation studies on lac-hosts

Lac is grown on a variety of host plants but the probable factors on which their degree of preference depends is not known. Moreover, there is a pressing

need to develop ideotype plants for sustained lac yield under varying climatic conditions. The study on these aspects were, therefore, taken up to analyse the lac-hosts with respect to their karyotype behaviour as also to develop improved varieties of lac-hosts for intensification of lac production.

(i) *Cytotaxonomic studies*

Chromosome number for the rest of the varieties, namely, NP-39, Motihari, T-1, NP-41, 7-S, NP-80 and C-11 was determined as 2n=22 in each case, but they differ in their karyotypes. The karyotype of *takoli* (*Delbergia lanceolaria*), *galwang* (*Albizzia lucida*) and *siris* (*A. lebbek*) was also studied and the chromosome number was found as 2n=20, 26 and 26 respectively. The flower buds of different varieties of *arhar* were collected and meiotic studies are under progress.

(ii) *Mutation studies*

(a) *With physical mutagens* — Seeds collected from M_1 generation of *arhar* (annual) plants raised in June, 1970 (*A. Rep.*, 1970) were sown again in June 1971 for raising plants of M_2 generation. In case of other three hosts, namely, *M. macrophylla*, *M. chappar* and *arhar* (perennial), seeds could not be collected as no flowering took place due to the immaturity of plants. The germination per cent and shoot growth as recorded from the M_2 generation of *arhar* (annual) plants did not show any significant difference between the treatments. The results are summarised in Table 9.

TABLE 9 — EFFECT OF Co^{60} SOURCE ON GERMINATION AND PLANT ATTRIBUTES OF *C. CAJAN* IN M_2 GENERATIONS

Treatments	Germination in percentage	Average height per plant	Average total shoot length
5 Kr	72·0	47·08 cm	103·4 cm
10 Kr	60·0	62·02 ,,	108·3 ,,
15 Kr	82·0	61·78 ,,	127·1 ,,
20 Kr	62·0	63·38 ,,	105·46 ,,
25 Kr	68·0	63·60 ,,	117·28 ,,
30 Kr	74·0	65·25 ,,	110·86 ,,
35 Kr	66·0	58·78 ,,	120·74 ,,
40 Kr	62·0	60·86 ,,	121·94 ,,
No treat(c)	70·0	92·54 ,,	127·46 ,,
S.E. ±	2·2	11·4	24·2
Variant ratio	N.S.	N.S.	N.S.

(b) *With chemical mutagens* — Seeds of *M. macrophylla* and *M. chappar*, soaked for 24 hrs in cold water, were treated with 0·125, 0·25, 0·50, 0·75, 1·0 per cent concentration of EMS solution for 1 hr and plants were grown in pots along with a control set. In both the host species, variation on plant characters between the treatments were found non-significant. The data are given in Table 10.

(P. Kumar)

TABLE 10 — EFFECT OF EMS ON PLANT ATTRIBUTE OF *M. MACROPHYLLA* AND *M. CHAPPAR* M_1 GENERATION

Treatments (in percentage)	Height per plant	Total shoot length per plant	No. of branches per plant	Height per plant
0·125	47·3 cm	97·2 cm	1·7	22·0 cm
0·25	41·0 ,,	104·05 ,,	2·1	30·6 ,,
0·50	51·96 ,,	115·3 ,,	2·5	35·7 ,,
0·75	50·1 ,,	123·5 ,,	2·3	23·4 ,,
1·0	41·5 ,,	85·7 ,,	1·3	36·0 ,,
No treat (C)	40·2 ,,	95·15 ,,	2·0	44·6 ,,
S.E. ±	4·19	16·7	0·11	4·5
Var. ratio	N.S.	N.S.	N.S.	N.S. for R.S.S.

4. Possibility of interspecific crosses of *Moghania* sp.

M. macrophylla, a potential lac host of *Rangeeni* and *Kusmi* strains, puts forth very few shoots and tillers compared to *M. chappar* which is a very poor host for lac production. Thus in order to develop ideotype lac-host with increased yield potential by combining all the desirable characters together, a study on this aspect was thought essential.

As the flowering time of both the species does not conicide, the study was carried out at the initial stage on the following lines from Sept. 1971.

Gibberellic acid and napthoxy acetic acid at 500, 1000 and 2000 ppm were sprayed on *M. macrophylla* in order to delay the flowering time from September to December when flowering of *M. chappar* starts. Unfortunately, there has been no flowering in the treated as well as untreated plants which may be due to the immaturity of plants.

Large number of pollen grains of *M. macrophylla* were collected for studying the storage longevity of pollen grains as well as for crossing with flowers of *M. chappar*.

Further studies like length of pollen tube and length of stigma, pollen viability, time of anthesis and stigma respectively are in progress.

(P. Kumar and P. N. Choudhury)

Arboricultural studies

5. Studies on various propagation methods

Following the failure to strike roots in cuttings of *palas*, *ber*, *kusum* and *sandan* with soak method of hormone treatment, attempts were made this year to raise plants of these species with powder mixture method using Seradix B_3. Four different seasons were tried and in each case the cuttings did not develop roots at all.

For *bhalia*, further trial in the second successive season was continued with the combinations of different hormones at 50 ppm. It was observed that like previous season the combination of IPA+NAA was found most effective when planted in June (Table 11).

(B. K. Purkayastha)

TABLE 11 — ROOTED PLANT PER CENT OF *BHALIA* FROM 10 STEM CUTTINGS WITH COMBINATIONS OF GROWTH HORMONES AT 50 ppm UNDER DIFFERENT SEASONS

Growth promoting hormones (Conc. 50 ppm. each)	Rooted plant percent			
	January	March	June	Sept.
IBA + IPA	20	20	60	30
IBA + NAA	×	20	80	40
IBA + IAA	10	30	60	30
IPA + NAA	20	40	100	60
IPA + IAA	×	30	80	50
IAA + NAA	×	20	50	20
Control	×	×	30	10

(B. K. Purkaystha)

(c) RESEARCHES CONTEMPLATED

1) Integrating lac cultivation with general agriculture.
2) Bringing down lac cultivation from trees to shrubs.
3. Developing brood preservation/production technology.
4) Evolving suitable ideotypes of plants by genetic engineering technique and by training/tending of plants.

C. CHEMISTRY DIVISION

(a) RESEARCHES COMPLETED — Nil

(b) RESEARCHES ON HAND

1. Modification of shellac

(a) *Modification of hydrolysed lac*

The preparation of Rebulac by heating *total* hydrolysed lac at 150°C for 5-5½ hours, its bleached version and their film properties from aqueous ammoniacal solution were reported last year. Modification of hydrolysed lac in conjunction with linseed oil-fatty acids (LOFA) and the properties of the films from aqueous solution were also reported last year.

Though the aqueous paints from hydrolysed lac-LOFA compositions had outstanding film properties, they lacked sufficient water resistance. To improve upon the defect, various metallic driers and their combinations were tried and only cobalt naphthenate could increase the water resistance of the films to 48 hours. Improved water resistance (7 days) could, however, be obtained if hydrolysed lac is first converted to Rebulac and then modified with LOFA.

In order to modify hydrolysed lac with various dicarboxylic acids, preliminary investigations were carried out to study their effects at various concentrations on the life of hydrolysed lac at 150°C. The results are summarised in Table 12.

TABLE 12 — EFFECT OF DIFFERENT PROPORTIONS OF CURING AGENTS ON THE LIFE OF HYDROLYSED LAC

Sl. No.	Curing agents	Life under heat at 150°C in minutes					
		Control hydrolysed lac only	Percentage of curing agents on the wt. of hydrolysed lac				
			10	20	30	40	50
1	Phthalic anhydride	380	240	285	300	372	405
2	Maleic anhydride		195	182	156	138	130
3	Adipic acid		315	360	375	385	430
4	Sebacic acid		250	270	280	310	330
5	Terephthalic acid		315	305	275	265	230
6	Azelaic acid		225	230	240	265	—

It will be found from the table that maleic anhydride acted as the best hardener of the six acids tried, and the products were hard and brittle. Hence modification of hydrolysed lac in combination with maleic anhydride was taken up. Hydrolysed lac containing 10 and 20 per cent maleic anhydride was heated at 150°C till pregelation stage and samples were drawn at regular intervals and their chemical constants determined. Acid and saponification values changed from 264 to 183 and 257 to 246 respectively in the former case and 308 to 238 and 305 to 280 respectively in the latter case. The end products obtained at pregelation stages were hard, brittle but slightly tacky and readily soluble in usual lac solvents and aqueous ammonia. Air dried films of these products from aqueous varnishes were hard, glossy with good adhesion and flexibility; scratch hardness and water resistance varied from 700 to 800 gms and 18-20 hours respectively.

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

(b) *Grafting of shellac with vinyl monomers*

The method of hydroperoxidation reported earlier was repeated both in aqueous and solvent media in presence of oxygen gas and it was found that it takes place more favourably in ketone solution than in aqueous ammonia (*A. Rep.* 1970).

Hydroperoxidation of lac was carried out by adding different concentrations of hydrogen peroxide to the ammoniacal solution of shellac and exposing the solution to ordinary light and UV-rays, in absence or in presence of oxygen. After 5 hours of exposure under different conditions, the precipitated lac was filtered, washed, dried and the hydroperoxide value determined. The value was found to increase with the increase of hydrogen peroxide concentration and still higher when exposed to UV-rays.

Shellac in ammoniacal solution was next grafted with methyl methacrylate at 25°, 40° and 45°C in presence of hydrogen peroxide. DL shellac (10 gm) was dissolved in a mixture of 87 ml water and 3 ml ammonia. Methyl methacrylate (7 ml) and hydrogen peroxide (30%) were added slowly and the mixture was allowed to stand for 3 hours in an atmosphere of nitrogen. The grafted product was recovered by precipitating with acidified water and washing with benzene and alcohol to remove homopolymer and unreacted lac.

It was found that percentage of grafting increased with the increase of temperature and the maximum value was obtained at 45°C. The product was found insoluble in alcohol, benzene and their mixture, dioxane, chloroform, acetone and pyridine. On refluxing with 0·1*N* alcoholic sodium hydroxide solution for 5 hours, the product dissolved and a solid material separated from the solution on cooling. The solid material on acidification yielded a yellow precipitate which had a softening range of 78-82°C and gave a smell of burnt lac on burning.

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

(c) *Modification of shellac with epichlorohydrin*

Epoxy resins are well known for their excellent performance in surface coating and adhesives. To improve upon the properties of lac, attempts were made to combine shellac with epoxy resin by fusion or by boiling under reflux in xylene/butanol solution. The products yielded varnishes of improved film properties (*A. Rep.* 1969 & 1970).

Next it was thought that if epoxy groups are introduced within the sellhac molecule, the resin itself can be utilised as a raw material for new uses. The reaction of shellac with epichlorohydrin for introduction of epoxy group was, therefore, taken up. Since shellac is very complex in nature and the reaction mechanism may not be clearly followed, preliminary study was taken up with aleuritic acid (9, 10, 16-trihydroxypalmitic acid), a major constituent acid of shellac. The acid or its sodium salt was reacted with epichlorohydrin under different conditions. The results indicated that epichlorohydrin reacted with only carboxyl group of aleuritic acid and not with the hydroxyl groups. As such only one epoxy group was introduced and hence polymerisation did not take place by the addition of amines. To introduce at least two epoxy groups, the 16-hydroxy group of aleuritic acid was oxidised to carboxyl group protecting the vicinal hydroxyl groups by acetonation. The acetonated dicarboxylic acid on being reacted with epichlorohydrin yielded a product which had an acid value of 14·8 and an epoxide value of 0·0849 equivalent/100 g.

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

(d) *Systematic studies on shellac, glycerol and oil combination and their utilisation*

Lac-glycerol-oil combinations prepared earlier were found to give tacky films having very poor drying characteristics and as such could not be used in surface coatings. Moreover, the nature of the reaction taking place during the combination is also not clearly known (*A. Rep.* 1970).

A systematic study was, therefore, initiated to formulate satisfactory oil based varnishes, paints, standardise the various steps of combination and also to evaluate the nature of reaction taking place during the combination. At the outset, the study of the reaction between aleuritic acid and glycerol was taken up. Esterification of aleuritic acid with glycerol at various temperatures for different periods in presence of catalyst, such as *p*-toluene sulphonic acid, sulphuric acid, and zinc dust was carried to find out the optimum reaction conditions. The progress of esterification was monitored with the help of thin layer chromatography. Best result was so far obtained by carrying out the reaction using zinc as catalyst at 220°-225°C for 1 hr and 15 minutes. The ester mixture was found to be composed of mono-, di- and tri-glycerides of aleuritic acid, the monoglyceride being predominant.

The reaction between linseed oil and glycerine at 230°C for one hour was also studied. It was found that with the progress of the reaction, as was expected, glycerolysis took place ultimately resulting in a mixture of mono-, di- and triglycerides.

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

(e) *Mechanism of reaction of lac with amino resins*

It was reported earlier (*A. Rep.* 1970) that films from lac-melamine resin varnishes acquire heat and water resistance after seven days of air drying indicating some chemical reaction between the two resins during film formation.

It has now been found that lac-melamine resin varnishes cure in the cold without the aid of any external catalyst; the carboxyl group of lac itself acts as a catalyst. If an external catalyst is used the rate as well as the extent of curing is sufficiently enhanced. It has also been found that in seven days about 82% of curing takes place in the film and during the curing process the carboxyl group of lac reacts first with the methylol group of melamine resin and at a latter stage some ether interchange type of reaction takes place between the hydroxyl of lac and butoxy groups of the resin.

Similar reactions were found to take place during baking of the films as well. By baking, however, almost complete curing (99%) could be reached in 30 minutes.

Infrared study of the baked film at different stages of curing supported the above findings.

For further confirmation, the reaction of melamine resin with aleuritic acid was studied. In this case also the acid and hydroxyl values were found to decrease with the progress of curing.

(S. Kumar)

2. Study of the constitution of lac

(a) *Separation and study of components*

By the application of various techniques such as alkaline hydrolysis, esterification and adsorption, thin layer (TLC) and gas liquid chromatography (GLC) a number of acid constituents of lac resin have been isolated and characterised. The successful resolution of a sample of dewaxed decolourised lac into eight fractions by preparative layer chromatography on freshly activated silica gel plate and the isolation and identification of 90% of the component acids of soft resin, the ether soluble portion of lac, were reported last year (*A. Rep.* 1970).

Studies were next initiated to separate and identify the components of hard resin, the ether insoluble portion of lac. Hard resins were prepared from *palas, ber, kusum, jalari* and *bhalia* seedlacs by the alcohol-ether precipitation method.

The acid, hydroxyl, saponification and carbonyl values of each of the hard resins were determined. The average values were 55, 260, 230 and 23 respectively.

T.L.C. analysis showed equal number of similar spots in ethyl acetate : acetic acid (100: 1) solvent system, thereby revealing that they are all similarly constituted. For a preliminary study, the mixture of constituent acids from hydrolysed hard resins was converted to methyl esters whose TLC examination showed eight spots in petroleum ether: ether : methanol (48: 50: 2) system; 5 spots were due to the presence of non, mono-, di-, tri-hydroxy (aleuritic) and shellolic acids esters.

The estimation of aleuritic and jalaric acids in the hard resins before and after hydrolysis showed nearly one third of the total amount of the vicinal hydroxyl groups and aldehyde group respectively free. The average values of these acids before and after hydrolysis were 12 and 35-36, and 14 and 38-39 per cent respectively.

Palas hard resin in acetone solution was fractionated through urea-complex formation into three fractions and the products are being studied.

(N. Prasad and S. C. Sengupta)

(b) *Fractionation and characterisation of the polyesters prepared from isopropylidene derivative of aleuritic acid*

A relationship between molecular weight and intrinsic viscosity of the auto-condensation products of isopropylidene derivative of aleuritic acid was established and reported last year (*A. Rep.* 1970).

Three samples of polyesters of low, medium and high degree of polymerisation (3·6749, 6·5019 and 9·825) having acid values of 44·3, 25·5 and 16·57 were prepared at 180° ± 1°C by heating at different intervals of time for 5, 9 and 18 hours respectively. These were fractionated by precipitation method using acetone as solvent and water as nonsolvent at 30°C in order to get an idea of polymolecular nature of the polyesters. The results are summarised in Table 13. It would be seen from the table that the acid values of the fractions increased with the progress of fractionation indicating that the fraction of lower acid value separated first due to its lower solubility.

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

TABLE 13 — FRACTIONATION DATA OF POLYESTERS OF ACETONATED ALEURITIC ACID WITH THEIR ACID VALUES

Polyester I A.V. (44·3) D.P. 3·6749			Polyester II A.V. (25·5) D.P. 6·5019			Polyester III A.V. (16·57) D.P. 9·825		
Wt separated in (g)	A.V.	D.P.	Wt separated in (g)	A.V.	D.P.	Wt separated in (g)	A.V.	D.P.
i) 0·0433	20·2	8·02	i) 0·0325	14·7	11·2	i) 0·0412	9·8	16·53
ii) 0·1727	25·9	6·26	ii) 0·1623	16·8	9·643	ii) 0·1213	12·5	12·96
iii) 0·1713	32·6	4·66	iii) 0·1524	24·2	6·69	iii) 0·1543	17·21	9·41
iv) 0·0697	36·3	4·45	iv) 0·0821	30·5	5·31	iv) 0·1121	25·41	6·375
v) 0·0549	39·0	4·436	v) 0·0432	42·3	3·83	v) 0·0862	33·56	4·824
vi) 0·0935	63·3	2·56	vi) 0·0522	48·1	3·368	vi) 0·0812	45·41	3·567
vii) 0·0287	78·2	2·07	vii) 0·0312	56·2	2·88	vii) 0·0832	54·32	2·982
viii) 0·075	70·6	2·3	viii) 0·0812	70·5	2·3	viii) 0·1141	63·2	2·563
ix) 0·0956	77·6	2·09	ix) 0·0621	87·4	1·853	ix) 0·0763	68·1	2·379
x) 0·0197	110·7	1·463	x) 0·0542	92·7	1·747	x) 0·0521	70·12	2·31
xi) 0·0983	126·8	1·277	xi) 0·0721	94·4	1·653	xi) 0·0546	72·4	2·237
			xii) 0·0689	105·3	1·54			

3. Electrical properties of modified shellac

(i) *With Amino resins*

The dielectric constant ϵ' of shellac, shellac melamine resin blends and shellac melamine formaldehyde (SMF) increases with temperature and similarly also does the $\Delta\epsilon'$ (the difference in ϵ' between the observed frequency limits) and reaches a maximum value between 70° and 90°C. The ϵ' of SMF, however, decreased with increasing frequency anticipated as in the case of shellac and other resinous systems.

The dielectric loss ϵ'' for all specimens increased above 70°C, the SMF 91 (shellac 90 and melamine resin 10 by weight) reached a maximum value of 1·2 at 120° whereas it was only 0·24 for SMF 46 (shellac 40 and melamine resin 60 by weight) tested at 0·1 kHz. In the ϵ''-log f curves of these blends two relaxations are observed, one in the low temperature range and the other in the high temperature range. The activation energies for the two relaxations have been computed to be 4·99 Kcal/mole for low and 11·1 Kcal/mole for high temperatures. The ϵ', tan δ and ϵ'' of SMF and SUF (Shellac/urea resin blend) with asbestos, china clay and cellulose pulp as filler were determined at various temperatures and frequencies and also their thermal conductivity and volume resistivity. X-ray diffraction patterns of these blends were photographed and the crystallinity and spacings evaluated. A correlation has been obtained between crystallinity and ϵ'.

(ii) *With Rubber*

When shellac is added in small proportion to natural or synthetic rubber, there is some increase in the hardness of the vulcanised gum and filled stocks such as natural rubber with MBT accelerator, the durometer hardness increases from 58 to 69 with the percentage of shellac at 0 to 10 percent. The following properties have been found satisfactory.

Mechanical properties	Good
Breakdown Dielectric constant Volume resistivity	Improvement in each was noticed

Samples of natural rubber gum-stocks containing 2·5, 5·0 and 10·0 per cent of shellac were vulcanised at 140°C for 30 minutes with CBS as accelerator and tested.

The following observations were made.

(i) Loss factor decreased from 25×10^{-3} to 1×10^{-3} as shellac content increased to 10 per cent

(ii) Dielectric constant decreased from 3·75 to 3·15
- no variation when temperature was changed from 20° to 120°C
- no variation when frequency changed from 100 Hz to 300 KHz

The lower dielectric losses and practically constant dielectric constant in shellac-rubber compounds, may find the product of great use in the manufacture of cables because of low power losses during electrical transmission.

The different electrical parameters for few modified and unmodified gumstocks were determined and are presented in Table 14.

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

TABLE 14 — GENERAL PROPERTIES OF MODIFIED AND UNMODIFIED SHELLAC-RUBBER GUMSTOCKS

Properties	Unmodified gumstocks				Selected modified gumstocks			
	NRMo	NRCo	SBRMo	SBRCo	NRM25	NRC50	SBRM 100	SBRC 50
ϵ'								
0·1 KHz 40°C	2·76	4·16	3·09	2·85	3·33	3·62	2·67	2·81
0·1 KHz 100°C	2·82	4·09	2·60	2·98	2·98	3·24	2·55	2·22
100KHz 40°C	2·61	3·35	3·08	2·82	3·22	3·23	2·65	2·57
100KHz 100°C	2·53	3·09	2·61	2·31	2·85	3·07	2·60	2·25
$\epsilon'' \times 10/^2$								
0·1 KH 40°C	—	10·19	—	—	—	9·94	—	—
0·1 KHz 100°C	—	16·00	—	—	—	2·17	0·25	—
100 KHz 100°C	2·70	5·15	1·89	2·68	4·94	3·53	1·48	2·33
100 KHz 100°C	2·70	8·98	2·84	—	1·04	3·49	0·25	—
BDS Constants								
A	47·5	15·4	13·8	30·6	32·7	34·3	52·6	35·7
n	0·43	0·30	0·64	0·48	0·48	0·46	0·41	0·46

NB: NR — Natural Rubber
SBR — Styrene-Butadiene Rubber
M — MBT
C — CBS

0-0 part of shellac
25-2·5 parts of shellac
50-5·0 parts of shellac
100-10·0 parts of shellac

4. Hydrolytic degradation of shellac polymers

The effects on the variation of concentration of acid, water and polymer on the degree of dissolution were reported last year. The work was continued and the kinetics and mechanism of the degradation reaction of thermally polymerised lac is reported below.

It was observed that in case of polymer II, the degrees of dissolution at 82°, 100° and 150°C were 52·27, 97·40 and 97·72 per cent with acid and polymer concentration at 2 and 0·4 per cent respectively. It was also found that temperature higher than 100°C had no advantage.

To determine the order of degradation reaction, hydrolysis was carried out with varying amounts of alcohol, water and polymer at water bath temperature. It was found that the rate constant of acid hydrolysis depended on the pH when water is participating in this reaction, otherwise depended on the acidity function when water is not participating. It was also observed that the rate is directly dependent on the concentration of acid, water and polymer molecules.

Some of the chemical constants of the reclaimed products were found out. To recover the reclaimed product itself, some difficulties were experienced to do it by evaporation in alcohol medium. Ultimately separation in phase proved successful in a particular composition. The resulting product contained one carboxyl, when two hydroxyl groups are set free during hydrolysis with a slight increase in the iodine value.

(A. Kumar and P. R. Bhattacharya)

5. Use of shellac and modified shellacs in surface coating

(a) *Water thinned paints for internal decoration*

Water thinned paints are the most modern materials used for decoration of interior walls of office and residential buildings. These paints are normally based on imported acrylic, polyvinyl acetate etc. Studies were, therefore, initiated to develop alternate cheaper water thinned paints based on indigenous materials.

(i) As a result of systematic studies, a satisfactory water thinned shellac paint was obtained by modifying the aquous shellac varnishes with maleinised linseed oil and pigmenting the resultant varnish with titanium dioxide and coloured pigment pastes. These paints on application to limed surfaces imparted hard, smooth, and highly adherent films with excellent resistance to water and abrasion. The painted surface also possessed good recoating properties.

These paints met most of the tests mentioned in the ISI specification (plastic emulsion paints) for interior use. Citric acid (available indigenously) modified linseed oil gave equally good results as the maleic acid modified one.

Unlike shellac emulsion paints (referred later), these paints are based on water soluble type of vehicle and, therefore, there is little chance of breaking the paint in this case.

(ii) There is also a possibility of utilisation of lac in emulsion form for internal decoration. Various lac-oil based formulations were tried last year but the emulsion did not give smooth and dried films presumably due to breaking of the emulsions during film formations. Experiments were, therefore, made to develop a stable emulsion paint with satisfactory film performance.

Linseed oil, litharge and lime, were heated together at 250°C till a transparent liquid was obtained. To this cooked linseed oil, a commercial emulsifier and cobalt naphthenate as drier were added and transferred to an ultrasonic emulsifier. Ammoniacal solution of shellac was added slowly and mixed well. This emulsion on pigmentation with titanium dioxide gave stable emulsion paint having the following film properties.

1. Unformity and smoothness — good
2. Touch dry — 20 minutes
3. Hard dry — 8 hours
4. Wet abrasion test — 760 rubs.

(A. K. Dasgupta, M. Mukherjee and S. Kumar)

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

A systematic study of the possibility of shellac for use in the formulation for paints and varnishes to be applied by the electrodeposition technique is

being carried out since 1967. A satisfactory composition based on lac and optimum conditions for deposition were investigated. The effect of *p*H and specific conductivity on storage of different varnishes and their throwing power were also studied. It was found that *p*H of varnishes increased on storage whereas there was no change in specific conductivities. The best throwing power was found in the case of lac-maleinised linseed oil primers (*A. Rep.* 1970).

To study the changes, if any, taking place during deposition, the hydroxyl and acid values of the deposited films from DL-shellac varnishes on mild steel panel were determined. The values were found practically the same as of the parent lac. The IR spectra of these samples were also similar confirming the presence of hydroxyl and carboxyl groups. The deposits were lighter in colour and were completely soluble in cold dioxane, warm alcohol, pyridine and partially in ether, ethyl acetate and methyl ethyl ketone.

With a view to increase the thickness of the deposited film-carbon black, a conducting pigment, was taken up for study. Shellac varnishes after pigmenting with carbon black was deposited as per standardised technique on mild steel panel. Except the edges and corners, a uniform and smooth film was obtained on the panel. The thickness of the film was found to increase with the period of deposition. A second coat of red oxide based primer was tried both on wet and baked first coat and it was found that only on the wet coat a second coat could be deposited.

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

6. Ion-exchange resin from shellac

Lac being a versatile natural resin can be converted to more useful products like ion-exchange resin by suitably modifying it through various functional groups. Studies were, therefore, initiated with a view to convert shellac, seedlac, *kirilac* etc. into a suitable ion-exchange resin which may replace costlier imported varieties of ion-exchange resins.

A cation exchange resin from sulphuric acid treated lac (22 g) was prepared by reacting with *para*-formaldehyde (6 g), and resorcinol (11 g). The resin was found insoluble in water and alcohol. This H-form resin which was black, hard and of irregular shape was found to be workable up to *p*H 7 and below 100°C in aqueous media. The cation exchange capacity of this resin was determined by three standard methods and was found to be nearly 3·0 m.e.q./g. of oven dry resin.

(c) RESEARCHES CONTEMPLATED

Besides continuing the existing problems as per programme, an item entitled "Adhesion of shellac with mica" is to be taken up from next year.

(d) SPONSORED RESEARCH SCHEME

Coating of urea fertiliser with lac — This work as reported in the last year (*A. Rep.* 1970) formed a regular project item in the programmes of this Institute, but in this year it is continued by Dr. T. Bhowmik, now a Retired Scientist at this Institute sponsored by the Indian Council of Agriculture Research Retired Scientist Scheme. A detailed study to find the most suitable lac based composition for coating urea and the optimum coating conditions for obtaining the best result was carried out.

To make shellac sufficiently water resistant, after several trials, a rosin ester of shellac was obtained by reacting 2 parts of rosin with 1 part of shellac which proved most effective. The melting point was 58-60°C and acid value 80. The yield was only 86 per cent as 14% was lost due to volatilisation.

A laboratory scale coating machine (cap. 200 g per charge) was designed and fabricated at ILRI workshop. Hot (55-60°C) urea globules were coated successively with double boiled linseed oil and finely powdered rosin ester of shellac and the coating process repeated twice more. Afterwards, the coated globules were dusted with soap stone as conditioner and finished with a final coat of coal tar (as microbiocide) and wax (as sealant) The ultimate proportions of different ingredients were as follows:

1. Lac-rosin ester — 25% on the weight of urea
2. D.B. linsed oil — 6% ,,
   (0·2% cobalt as drier)
3. Soap stone (conditioner)— 4% ,,
4. Coal tar — 0·25% ,,
5. Hard paraffin wax — 5·0% ,,

The above coated urea was compared with the sulphur coated one manufactured by TVA (U.S.A.) and the results on the total weight are as below:

	TVA	ILRI
1. Nitrogen content (%)	32·7	32·8
2. Dissolution in water in 5 days (%)	7·2	7·0
3. Dissolution in water per day (%)	0·7	0·6
4. Total coating (%)	29·65	28·7

The laboratory model was subsequently scaled to a semi-pilot plant with a capacity to coat 5 kg of urea per charge. Several lots of this coated fertiliser were supplied to different Institutes/collaborators on request. Besides, agronomical studies were undertaken at different centres to evaluate the usefulness and efficacy of lac coated urea. Agronomical experiments on jute crop (1970 and 1971) were conducted at Jute Agricultural Research Institute, Barrackpore (W. Bengal) and their comparative merits and yield data were statistically analysed. The treatment were found highly significant at 1% level with some merits using lac coated urea.

In the above coating composition, coal tar was used as microbiocide i.e. as nitrification inhibitor. The transformation behaviour of the above as well as of other microbiocide such as bitumens, CNSL-distillate residue, acetone extracts of karanj and neem cakes will be compared with the standard Nitrification inhibitor 'AM' of Japan.

(B. C. Srivastava and T. Bhowmik)

D. TECHNOLOGY DIVISION

The Technology Division was created to evolve improved and modern methods of lac processing and economic utilisation of byproducts such as dye, wax, refuse lac etc. The Division would work up to pilot-plant scale of the successful methods

thus evolved. It is to study the effect of incorporation of lac and modified lacs into natural and synthetic rubbers, plastics and adhesives, and employ full efforts for increasing utilisation of lac.

(a) RESEARCHES COMPLETED — No problem was completed.

(b) RESEARCHES ON HAND

1. Improvements in processing of lac and utilisation of by-products

(a) *Dewaxing of lac in aqueous medium*

The conventional process for the production of dewaxed lac from its aqueous medium is a laborious and time-consuming process. Studies were, therefore, initiated to develop an economic method for dewaxing shellac in aqueous medium. Preliminary investigations were made to find out the effect of alkali and of temperature for dissolution of shellac and addition of water insoluble material on precipitation of wax. It was found that the addition of lac wax to the boiling alkaline lac solution helped, on cooling, in forming a compact mass of hard wax (*A. Rep.* 1970).

During the year a detailed study was carried out. Addition of 10 per cent of lac wax (on the weight of seedlac taken) was found very effective to coagulate most of the wax present in the lac solution. Paraffin wax was also tried but without any success. Further a 10 per cent solution of lac was found to be the optimum concentration for quick filtration and better coagulation of wax at $10 \pm 2°C$; the time of cooling being one hour. The wax thus deposited was hard and compact. Here also some amount of wax remained in suspension (0·9%). Attempts were next made to remove the suspended wax with the help of various filter aids such as paper pulp, kieselguhr and fuller's earth etc.

The retention of wax and the rate of filtration at room temperature (28-29°C) through drill cloth were noted. Of the three kieselguhr (5 percent on the weight of lac) was found to be promising; the wax content of the precipitated lac was 0·25 only.

(B. P. Banerjee and B. B. Khanna)

(*b*) *Modification of lac wax*

Shellac wax, a by-product of the lac industry, is a valuable product of commerce. It is present to the extent of nearly 5 percent in lac. A substantial amount of this wax is lost in the lac effluents and *kiri* during the processing of sticklac to seedlac and seedlac to shellac respectively. A method was developed earlier in this Institute for the reclamation of shellac wax from refuse lacs and factory effluents (*A. Rep.* 1963-64). Fractionation of this wax with acetone had yielded a very hard wax with higher melting point which was found comparable to the costly and imported carnauba wax in some of its properties (*A. Rep.* 1969).

The wax from the above sources is dark in colour and as such a limited use. Its utilisation is therefore dependable upon its upgradation and decolourisation. Hence some preliminary oxidative work for its bleaching was carried out with the help of various oxidising and bleaching agents such as potassium or sodium dichromate, potassium permanganate, nitric acid, sodium hypochlorite, sodium

chlorite either alone or in combination. The action of a mixture of nitric acid and sodium hypochlorite (each 50% on the weight of wax) could lead to a yellow coloured wax. The addition of sodium nitrite (1·5-2%) as catalyst, however helped in reducing the proportion of nitric acid (to 10%) and hypochlorite (to 25%) to achieve the same kind of yellow wax. Different commercial varieties of dark coloured wax were bleached by the latter method which was found reproducible resulting in yellow waxes.

It was further found that under boiling condition and slight pressure an identical yellow wax could be obtained with even less amount of acid and hypochlorite (5 and 10%).

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

(c) *Production of shellac direct from sticklac*

The process developed earlier on laboratory scale (*A. Rep.* 1970) for the production of shellac direct from sticklac was standardised by repeated trials under the same condition by taking 10 kg of *Rangeeni/Kusmi* sticklac of various grades. Semi-pilot plant studies with 20 kg sticklac were also completed. Both regular and dewaxed shellac were prepared and found to have all the good properties as reported earlier (*A. Rep.* 1969, 1970).

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

(d) *Lac as a source of fine chemicals*

Aleuritic acid is one of the major constituent acids of lac and is believed to be present to the extent of 35-40 per cent. The acid is obtained to the extent of nearly 20 per cent by the conventional alkaline hydrolysis. If the acid could be produced on higher yield it may serve as raw material for the production of synthetic perfumes, clear and water white resins, adhesives etc.

With the above idea, attempts were made to develop methods for the preparation of aleuritic acid in high yield. In the beginning, the method developed by Delhi University was tried. The method consisted in passing hydrogen chloride gas through a solution of lac in glacial acetic acid and subsequent alkaline hydrolysis. The yield of aleuritic acid was nearly 25 per cent.

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

2. Rubber-shellac combination

(a) *Mechanism of interaction of modified shellac on incorporation with natural rubber*

Estimation of free sulphur and cross link density have indicated that the incorporation of shellac into natural rubber interfered during vulcanisation (vide *A. Rep.* 1970). Ethylene glycol modified lac was next tried in place of shellac and was also found to behave in a similar manner to shellac.

(b) *Incorporation of modified lacs into natural rubber* (*gumstock*)

(i) The effect of incorporation of epoxy-resin modified lac into natural rubber using various accelerators was studied. It was found that of the various properties only mooney number and scorch time were favourably effected. Magnesium

salt of lac (acid value — 37·0 and hydroxyl value — 43·8) was also tried which showed better results than epoxy resin modified lac in respect of its mechanical properties. Data have been compiled in Table 15.

(R. Singh and B. B. Khanna)

(ii) *Incorporation of lac and modified lac into natural rubber (with filler)*

The effect of incorporation of shellac and ethylene glycol modified lac into natural rubber using E.P.C. (easy processing channel black) as the filler was studied. A marked increase in hardness was noticed with shellac and the effect was even more pronounced with ethylene glycol modified lac. Tear strength also showed an increase when the latter was compounded.

(B. B. Khanna)

3. Shellac and modified shellacs as adhesives

(b) The possibility of using shellac as binder in replacement of phenol formaldehyde resin in the preparation of hard boards out of bamboo wood pulp was investigated.

TABLE 15 — EFFECT OF EPOXY RESIN MODIFIED LAC AND Mg SALT OF LAC ON PROPERTIES OF NATURAL RUBBR

Epoxidised lac or Mg salt of lac added parts/ 100 parts rubber	Optimum cure time (140°C) min.	Mooney viscosity (MLI+4) at 120°C	Scorch time min. sec.	Modulus at 200% elongation Kg/cm_2	Ultimate elongation %	Tensile strength Kg/cm_2	Tear resistance kg/cm	Durometer hardness	Impact resiliance %
Epoxy Resin modified lac: accelerator C.B.S.									
0·0	20	25·0	14·10	9·5	900	182·0	36·0	34	85·7
2·5	30	—	—	8·1	900	164·1	37·1	34	78·0
5·0	40	17·0	26·0	8·7	85·0	150·7	32·5	32	76·1
7·5	40	—	—	8·8	850	150·6	30·1	33	76·1
10	50	12·5	27·0	7·6	850	129·8	30·9	31	72·4
Epoxy Resin modified lac: accelerator M.B.T.									
0·0	20	27·0	16·30	9·6	870	178·6	31·8	32	83·7
2·5	50	—	—	7·3	900	129·9	30·5	30	74·1
5·0	50	20·0	21·30	7·3	870	120·5	31·9	31	74·1
7·5	50	—	—	6·2	830	85·2	27·2	30	68·7
10	50	13·0	20·30	5·7	800	58·9	20·0	28	61·7
Mg Salt of lac: accelerator M.B.T.									
0·0	20	27·0	16·30	9·6	870	178·6	31·8	32	83·7
2·5	30	—	—	8·7	850	149·3	29·9	32	78·5
5·0	30	25·5	15·20	7·2	890	131·2	33·6	30	75·1
10	40	25·5	11·25	7·5	880	120·5	33·6	31	71·6
Mg sa lt of lac: accelerator C.B.S.									
0·0	20	25·0	14·15	9·5	900	182·0	36·0	34	85·7
2·5	20	—	—	8·8	850	152·3	32·6	35	79·8
5·0	30	29·5	8·25	8·3	860	141·6	30·9	35	78·5
10	30	24·0	8·05	7·5	930	133·7	30·0	34	72·3

The boards were prepared from shellac impregnated bamboo fibres and were found to be poor in water resistance and to develop black patches on their surfaces probably due to non-uniform distribution of shellac during impregnation. Attempts were, therefore, made for uniform distribution of the resin by spraying instead of dipping. Hard board was obtained by impregnating fibres with aqueous triethylamine solution of lac. The boards were dried and pressed at 250°C under 10,000 lbs/sq. inch pressure. Slight improvement in surface texture was also noticed.

(a) The bond strength of different grades of shellac viz., *Kusmi*, *Rangeeni* and dewaxed shellac for bonding different metallic surfaces such as iron, brass, and copper under different conditions of temperature, pressure and time was reported earlier (*A. Rep.* 1970).

Further experiments on the bond strength of lac in presence of modifiers were continued by adopting the same method. Tartaric acid, a hardening agent for lac, was tried and incorporated to the extent of 0·0, 0·25, 0·5, 1·0, 2·0, 2·5, 3·0, 3·5 and 4·0 per cent on the weight of lac. The bond strength was found to be 0·08, 0·054, 0·038, 0·090, 0·11, 0·16, 0·17, 0·18 and 0·19 ton per square inch respectively. It is evident that the incorporation of tartaric acid above one percent increased the bond strength successively.

(M. Islam & P. K. Ghosh)

3. EXTENSION

A. ENTOMOLOGY DIVISION

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, and hence the functions of this Institute are 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 on the basis of examination of samples received from different lac-growing areas. The other major activity was assistance rendered to the Forest Department, Bihar in regard to large scale cultivation of lac on *palas* at Kundri.

Large scale lac cultivation on *palas* at Kundri

Technical help and guidance in running the Kundri Lac Orchard was rendered to the Bihar Forest Department, as usual. This year 2300 trees, out of approximately 40,000 *palas* trees, in both the coupes of the Orchard were operated, incurring an expenditure of Rs 3775 approx. and a yield of 3794 kg dry sticklac was obtained. Out of a total of 5200 kg broodlac obtained from coupe 'A', 60 kg was sold to the Indian Lac Research Institute fetching a revenue Rs 38 only and the rest was utilised for inoculating coupe 'B'. 1000 kg of sticklac has been sold @ Rs 1·25 per kg for an amount of Rs 1250 and the remaining 2794 kg has been utilised by the Bihar Forest Department for manufacturing sealing wax. Calculated @ Rs 1·25, an additional amount of Rs 3492·50 will be credited to the Orchard. Thus on the whole a net income of Rs 1000 approx. is expected.

(R. C. Mishra)

Namkum Plantation

General maintenance of the plantation was looked after as far as possible. Regular weeding and hoeing were carried out to keep down the weeds and provide soil in a mulched condition. Young trees and seedlings were manured with chemical and farm yard manures for better growth. Seedlings of various lac hosts were raised for filling up the gaps in the respective plots and for experimental studies in pots in the laboratory. Termites infesting the plantation area were kept down through application of insecticides.

(B. K. Purkayastha)

Training in improved methods of lac cultivation

Four trainees from Agriculture Department, U.P., (one Lac Supervisor and 3 Lac Kamdars) completed the six months' training course in improved methods of lac cultivation during the April to September session.

(R. C. Misra)

B. EXTENSION DIVISION

Unlike extension of lac cultivation, extension activities regarding processing and utilization aspects of lac are the sole responsibility of the Institute. For this purpose, the Institute maintains an Extension Division, the erstwhile Utilisation section having the main activities like technical service, developmental activities, publicity and propaganda etc. The staff position, however, remained difficult throughout the period under report and only a Junior Scientist (Shellac Utilisation) was in position. The main activities were therefore restricted to processing and Utilisation aspects of lac, technical service, participation in exhibition etc.

(a) *Technical service*

A large number of requests were received for formulations, technical assistance and other particulars from various government organisations, private institutions and individuals interested in using shellac and shellac composition. In all cases the necessary informations and assistance were provided. A few of the more important of these are:

(i) A paint manufacturer of Dhanbad was assisted in getting over his initial difficulties in the manufacture of Melfolac, the heat, water and liquour-proof varnish.

(ii) A leading printing press in Calcutta was supplied with, at their request, samples of a composition based on shellac to carry out the PICK test. It may be recalled that the above composition was developed by this Institute to replace imported Dennison waxes used for testing surface strength of p per.

(iii) Some formulae for preparing improved shellac varnish, to be used as superior finish for interior of railway coaches, were supplied to N.E. Rly workshop, Gorakhpur.

(iv) Heavy Electricals (I) Ltd., Bhopal was supplied with a sample of shellac adhesive which is intended to replace the imported vinyl adhesive used by them for joining synthetic rubber bonded cork sheets with each other and with metal surfaces which are in direct contact with transformer oil. The performance report is still awaited.

(v) Several enquiries were received regarding gasket shellac compound, insulating varnish, water soluble lac etc. The required informations were supplied.

(b) *Developmental activities*

Scheme for setting up small-scale shellac factories as well as for the manufacture of shellac products were supplied to several parties on request.

(c) *Publicity and propaganda*

During the year under report, the Institute actively participated in one exhibition held at Ranchi on the occasion of the first meeting of the Regional Development Board of Chotanagpur and Santhal Parganas. Besides, exhibits were also sent to several other exhibitions organised by Government and private organisations including the exhibition held in the lawns of Parliament House, New Delhi under the auspices of ICAR, New Delhi.

(d) *Training in Industrial uses of lac*

One trainee from Khadi and Village Industries Board completed a three months condensed course (October-December, 1971) on industrial uses of lac. Another trainee from the Directorate of Cottage and Small Scale Industries, W. Bengal is at present undergoing a two months' course on analysis and processing of lac. A private candidate from Andhra Pradesh was also given a short term training in preparation and testing of shellac varnishes.

(S. K. Saha)

Pilot production Unit

The Unit continued the production and sale of two grades of bleached lacs (BRF and BR), autoclave shellac (ASK grade) and two grades of water soluble lacs (DXO and DXG) together with other miscellaneous lac products such as hydrolysed lacs, lac varnishes and Melfolac.

A drop in sale figures of bleached lac, DXG grade water soluble lac, autoclave shellac and hydrolysed lac was noticed during the year. The sale figures for BRF, DXO grades and other miscellaneous products, however, showed upward trends.

The sale figures for the different grades during 1971 are given below:

Material	Quantities sold Kg	Sale value Rs
1. BRF grade bleached lac (dewaxed)	420·65	3,373·20
2. BR grade bleached lac (Regular)	91·50	682.88
3. DXO grade water soluble lac	356·30	2,929.35
4. DXG grade water soluble lac	94·00	658.00
5. ASK grade autoclave shellac	726·00	3,502.00
6. BHL grade hydrolysed lac	34·75	486.50
7. BOL grade hydrolysed lac	2·50	30.00
8. Miscellaneous (Melfolac, etc.)	—	2,399.00
	Total:	14,060·93

Thus during the year, the Unit has sold a total of 1725·70 kg of special shellac for Rs 11,145·43 and other products valued at Rs 2,915.50 amounting to a total sale value of Rs 14,060.93.

(P. K. Ghose)

4. PAPERS PUBLISHED

Publications and Patents

(a) *Publications*

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

The total number of publications as on 31st December 1971 are as below:

1. Bulletins	
i) Chemical	92
ii) Entomological	29
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	14
6. Pamphlets and leaflets	24

(b) *Patents*

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

List of Papers Published during the Year 1971

A. ENTOMOLOGY DIVISION

Sl. No.	Authors	Title of paper	Name of journal/Vol. No. and page
1	B. P. Mehra & B. N. Sah	Bionomics of *Amsacta lactinea* Cramer. (Lepidoptera: Antidae) a pest of *Moghania macrophylla*	*Proc. 58th Ind. Sci. Cong.* Part III: Abstract 1971 p. 770.
2	B. P. Mehra & B. N. Sah	Bionomics of *Thiacidas postica* Walk. (Lepidoptera-:Noctuidae), a pest of *Ziziphus mauritiana* Lamarck	*Indian J. Ent.* **32**(2): 145-151.

No.	Authors	Title of paper	Name of Journal/Vol. No. and page
3	B. P. Mehra, R. S. Gokulpure & B. N. Sah	Systematic trials of lac cultivation on *ghont* (*Ziziphus xylopyra* Willd.) in M.P. — requirements of broodlac for crop inoculations	*Indian Forester* **97** (2): 109-111.
4	C. P. Malhotra & R. C. Mishra	On the natural control of *Eublemma amabilis* Moore (Noctuidae: Lepidoptera) by *Elasmus claripennis* Cam. (Elasmidae: Hymenoptera)	*Indian J. Ent.* **33** (1): 103-105.
5	N. S. Chauhan	Sex in relation to the sequence of larval emergence in lac insect	*Indian J. Ent.* **32** (3): 273-275.
6	N. S. Chauhan & Jawahir Lal	Adaptation of the superior lac insect to a common food plant	*Indian J. Ent.* **32** (4): 386-387.
7	N. S. Chauhan & Y. D. Mishra	Genetic evidence of nutritional differences in lac insects	*Indian J. Ent.* **32** (4): 390-392.
8	R. S. Gokulpure	Record of braconids and ichneumonids from central India	*Indian J. Ent.* **32** (4): 383-385.
9	R. S. Gokulpure	Some new hosts of a juvenile Mermithid of the genus *Hexamermis* (Steiner)	*Indian J. Ent.* **32** (4): 387-389.
10	R. S. Gokulpure & B. P. Mehra	Record of two new lac hosts from Madhya Pradesh	*Indian Forester* **97** (1): 33.
11	R. S. Gokulpure & J. M. Dasgupta	Record of *Croton oblongifolius* Roxb, as a host of *Rangeeni* strain of lac insect, *Kerria lacca* (Kerr)	*Indian Forester* **93** (3): 149.
		B. AGRONOMY DIVISION	
1	S. N. Sinha & P. Kumar	Cytological studies in some varieties of *Cajanus cajan*	*J. Cytol. & Genet.* Vol. VI.
		C. CHEMISTRY DIVISION	
1	L. C. Misra & S. Kumar	Effect of mixed solvents on the film properties of lac	*Paintindia*, XXI, No. 12: 29.
2	L. C. Misra & Y. Sankaranarayanan	Shellac removers	*Paintindia* XXI No. 4.
		D. TECHNOLOGY DIVISION	
1	D. K. Guha Sarkar & B. B. Khanna	Modified lacs as compounding ingredients of styrene-butadiene Rubber Part V-Mechanism of Reinforcement	*Res. & Ind.* **16**: 181
2	R. K. Banerjee & S. C. Sengupta	Utilization of byproducts of lac industry Part III-Manufacture of total hydrolysed lac from refuse lacs	*Paintindia*, XXI, No. 10: 26

5. SUMMARY

A. ENTOMOLOGY DIVISION

(a) RESEARCHES COMPLETED

1. (a) Survey of pests of lac-hosts carried out in the Institute plantation revealed the presence of 18 species belonging to 11 genera of the limacodid group. Studies on the bionomics of seven species, namely, *Miresa albipuncta* H., *Scopelodes testacea* Butl., *Parasa argalea* West., *Thosea sinensis* Walk.; *Cheromettia ferruginea* Moore; *Altha nivea* Walk.; and *Narosa doenia* Moore were completed.

Studies on the degree of infestation of these pests on the plants of *kusum*, *palas* and *ber* showed that the species, *M. albipuncta*, predominated, peak period being the months of July and October.

Larvae of twelve species were found parasitised by various Hymenoptera to the extent of 12·0 to 34·5% and the larvae of six species were found to harbour various pathogens to the extent of 7·5 to 30%. Relative toxicity of 10 insecticides was ascertained against larvae of *M. albipuncta* and *C. ferruginea*.

(b) The effect of the insecticides Aldrex 30 EC, BHC 50% WP, DDT 25 EC, DDT 50% WP, Dieldrex 18 EC, Endrex 20 EC, Hexavin (carbaryl) 50% WP, Paramar (parathion) 50 EC and Thiodan (endosulfan) 35 EC was studied on the important lepidopterous defoliators of *Moghania macrophylla*, namely, *Dasychira mendosa* Hubn. form *fusiformis* Walker, *Hemithea tritonaria* Walker, *Hypena iconicalis* Walker, *Nephopteryx leucophaella* Zell. and *Platypeplus aprobola* Meyrick in the laboratory and of all these insecticides except the first two in the field.

Based on the LC 50 values, Endrex was found most toxic to *D. mendosa* and Paramar (parathion) to *N. leucophaella* amongst the insecticides tested in the laboratory.

In the field trials, the insecticides Endrex, Paramar (parathion) and Thiodan (endosulfan) at 0·05% concentration, Hexavin (carbaryl) at 0·15% and 0·2% concentrations and DDT WP at 0·4% concentration were found most effective in controlling the populations of the pests.

(b) RESEARCHES ON HAND

1. Brood rate trials for *palas* in hot areas had shown that the *ari* yield was maximum with a brood rate of 1·4 kg per tree as compared to the brood rate of 1·8 kg per tree which had produced the best crop last year.

2. The possibility of utilising *bhalia* for raising a *Jethwi* crop could not be judged due to general failure of crops throughout Bihar.

3. The field experiment designed to compare different techniques of lac cultivation on *kusum* could not be carried out due to crop failure and non-availability of broodlac.

4. In the search for alternate lac hosts to fortify production of *Kusmi* and *Rangeeni* crops, several hosts were tried but none of these were able to sustain the *Kusmi* strain up to maturity. On the other hand, rain tree, *porho* and *putri* behaved as *Rangeeni* host tolerably well.

5. In the study on the efficiency of different hosts on the survival of lac hosts, ten hosts were tried and it was observed that during *Baisakhi* season all hosts except *kusum* and during *Katki* all except *kusum* and *arhar* sustained *Rangeeni* strain. Likewise, the *Kusmi* strain could be sustained on *kusum, bhalia, galwang, ber, sandan* and *vilayati babul* during *Aghani* season, and on *kusum, bhalia,* and *ber* during *Jethwi* season. However, both insect survival and fecundity were best on *kusum* during both the seasons.

6. For intensification of lac production the first inoculations were carried out on trained bushes of *galwang, ber,* and *palas* with varying ratio of broodlac in October. There was severe mortality of the insects and the condition of the crop was rather poor.

7. In order to study the nutritional requirements of lac insects, a qualitative determination of free amino-acid contents of lac insect was made. Presence of glycine, histidine, tyrosine, valine, lysine, methionine, serine, threonine and cysteine could be detected. However, no difference in the amino acid contents due to difference in hosts on which insects were reared could be found.

8. Similarly, in order to ascertain the nutritional requirements of beneficial parasites for developing a synthetic diet for their mass rearing, studies were undertaken on biochemical differences in healthy and parasitised larvae of the host, *Eublemma amabilis*. Data were collected with respect to pH and specific gravity of the haemolymph, blood volume, inorganic ions, proteolytic enzymes and free amino acids in the haemolymph etc.

9. In the microbiological studies on lac insects, presence of both cocci and rod-shaped organisms could be found. Physiological characteristics of these organisms are yet to be studied.

10. To enable large scale production of superior *Kusmi* lac on *palas*, the pssibility of combining *Kusmi* resin characteristics with the *Rangeeni* life cycle was examined in crosses of *Rangeeni* and *Kusmi* strains of lac insects. The study of the crosses suggested that the *Rangeeni* behaviour with regard to growth rate is dominant to that of *Kusmi* strain. Based on this information further experiments are proposed in which it will be attempted to shift the *Kusmi* life period, by recovering the *Kusmi* genotype to appear at the *Rangeeni* time.

11. Cytogenetic analysis of chromosome behaviour was continued. Chromosome studies confirmed the earlier observation that the male transmits only the maternal allele through the sperm, although both paternal and maternal alleles are active somatically. It was found that while chromosomes are in the euchromatic state in the somatic tissues, one haploid set of chromosomes is in a heterochromatic state in the male germ line which does not take part in sperm formation. It is, therefore, concluded that the genes are 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 allele.

12. In the survey of genetic variation, the behaviour of crosses for growth rate, resin yield and resin dye contents were studied. The total life period of females in segregating populations derived from crosses of *Rangeeni* and *Kusmi* strains varied from 106 to 267 days in comparison to parent females in *Katki* and *Aghani* seasons where it was 100 to 138 days and 178 to 230 days respectively.

The resin yield per female varied from 3·0 to 41·0 mg. In the summer crop the total life period varied from 217 to 271 days, the normal being 235 to 255 days. This increase in variability is attributable to genetic segregation.

As regards the resin dye level the average ratios (optical density/cell weight) in the low and high lines after one generation of selection were 3·42 and 4·58 respectively.

13. With a view to developing an integrated control method against the inimical insects of lac insects, seasonal incidence of certain beneficial parasites and their behaviour were studied. During *Jethwi* 1971 and *Aghani* 71-72 seasons incidence could not be recorded as the cultures of lac insects died prematurely. However, during *Baisakhi* 70-71 and *Katki* 71 seasons the incidence of the parasites was noted both on trees and bushes where lac cultures were raised. During both the seasons larger numbers of parasites were found in lac on trees than on bushes, except in *Katki* season when *B. greeni* and *E. claripennis* were found in greater numbers in lac grown on bushes.

As regards behaviour, mating did not take place under confinement in the case of *P. sulci* and *A. coryphe*. They could parasitise 50 to 60 per cent of the host, *C. cephalonica*, producing only male progeny. *E. pallidiscapus* mated readily and parasitised 3rd and 4th instar host larvae as well as pupae. The total development periods of the three parasites were 21, 19 and 13 days respectively. The sex-ratio in the latter was 40: 60.

14. The experiment on the study of the influence of photoperiod on the lac insects has been modified in the sense that the potted *bhalia* plants are being exposed to varying photoperiods from the time of transplanting and will continue to receive the same treatments even after inoculation. Previously the photoperiod treatment was given only after inoculation.

In another experiment a study is being made to determine the appropriate time of harvest through the use of biometer. The experiment was carried out on potted *bhalia* plants inside cabinets maintained at 27·5°C and 30°C. The growth rate of insects was faster at both the temperatures than in the control. However, there was no appreciable difference between the two temperatures.

15. Routine investigations on the locally available lac hosts were continued at the Regional Field Research Station, Dharamjaigarh.

B. AGRONOMY AND PLANT GENETICS DIVISION

(a) RESEARCHES COMPLETED — Nil

(b) RESEARCHES ON HAND

1. The possibility of growing food and cash crops in between the spaces of lac-host plants under fertilised, rainfed and irrigated conditions, is being studied.

2. In order to induce drought resistance in bushy lac-hosts for raising summer lac crops, both *bhalia* and *arhar* plants were raised from seeds unexposed and exposed to 50°C, 60°C and 70°C temperatures.

The 1969 set of *bhalia* plants, inoculated with *Kusmi* lac for *Jethwi* 1971 crop, did not show any difference in their mortality rate. In the 1970 set of plants, the shoot growth was found best in plants raised from seeds exposed to 60°C.

In case of *arhar*, there has been no temperature effect on the survival of inoculated plants.

Varietal trials of *arhar* showed that the variety NP–41 was best with respect to growth of plants.

3. Chromosome number for different *arhar* varieties was determined as 2n = 22 in each case, but they differ in their karyotypes.

The germination per cent to shoot growth from the M_2 generation of *arhar* plants (from irradiated seeds) did not show any significant difference between the treatments.

The variation on plant characters between the treatments were found non-significant in case of plants of *M. macrophylla* and *M. chappar* raised from seeds treated with different concentrations of EMS

4. *Bhalia* has been successfully raised from stem cuttings, planted in June, using the mixtures of growth regulators, namely, IPA and NAA.

C. CHEMISTRY DIVISION

(a) RESEARCHES COMPLETED—Nil

(b) RESEARCHES ON HAND

1. (a) To improve the defects of compositions obtained from hydrolysed lac and linseed oil — fatty acids, several metallic driers and their combinations were tried. Of these, only cobalt naptthenate could improve the properties. Further attempts to modify hydrolysed lac with dicarboxylic acids were made and results presented. Maleic anhydride acted as the best modifier.

(b) Hydroperoxidation of lac was carried out in the ammoniacal solution of lac using different concentrations of hydrogen peroxide and exposing the solution to ordinary light and UV rays, in absence or in presence of oxygen. The properties of the products were studied.

Shellac in ammoniacal solution was grafted with methyl methacrylate at different temperature in presence of oxygen and the properties of the product were also studied.

(c) Preliminary study of the reaction of aleuritic acid with epichlorohydrin was taken up and it was found that epichlorohydrin reacts with carboxylic group only. To introduce two epoxy groups, acetonated dicarboxylic acid was reacted with epichlorohydrin and properties of this product studied.

(d) A systematic study of lac-glycerol-oil combination was taken up to formulate oil-based paints or varnishes and to understand their mechanisms of reaction. To start with aleuritic acid was taken instead of shellac and esterified with glycerol at various temperatures with and without catalysts. The reaction between linseed oil and glycerine was also studied.

(e) It has been found that complete curing takes place during baking of the lac-melamine resin films involving esterification followed by etherification. The results have been supported by infrared study. For further confirmation, the reaction of melamine resin with aleuritic acid was studied.

2. (a) The chemical constants of hard resins (ether insoluble portion of lac) prepared from seedlac of various host trees were determined. TLC analysis

revealed them to be similarly constituted. Palas hard resin was fractionated through urea-complex formation into trhee fractions.

(b) Three polyesters of isopropylidene derivative of aleuritic acid, having low, medium and high degree polymerisation, were prepared and fractionated by precipitation method at 30°C using acetone as solvent and water as non-solvent. The result showed that the fraction of lower acid value separated first due to its lower solubility.

3. (i) The dielectric behaviour of shellac and shellac-melamine resin blends at various temperatures have been studied. The parameters in particular, studied were the dielectric constant ϵ', the difference in ϵ' between the observed frequency limits expressed as $\Delta\epsilon'$ and the dielectric loss ϵ''.

(ii) The different electrical parameters of natural and styrene-butadiene rubbers with MBT and CBS accelerators were also determined.

4. The degree of dissolution of shellac polymer II was studied varying the temperature, acid and polymer concentration. The order of degradation reaction was also studied. Some of the chemical constants of the reclaimed product have also been reported.

5. (a) Water thinned shellac paint as well as an emulsion paint have been developed which imparted hard, smooth and highly adherent films on limed surface with excellent resistance to water and abrasion. The paints met most of the specifications of ISI. These could be successfully utilised for internal decoration.

(b) The acid and hydroxyl values of the electrodeposited films were found to be same as of the parent lac. The IR spectra also confirmed the presence of these functional groups. An attempt was made to increase the film-thickness of the deposited film.

6. A cation-exchange resin from lac has been prepared and its cation exchange capacity was determined to be nearly 3·0 meq/g.

7. In order to make shellac more water-resistant, a rosin ester of shellac was used to coat urea. A semi-pilot coating plant was fabricated and coated urea fertiliser was supplied to different Institutes for agronomical trials.

D. TECHNOLOGY DIVISION

(a) RESEARCHES COMPLETED — Nil.

(b) RESEARCHES ON HAND

1. (a) An aqueous method for dewaxing of lac was evolved adding 10% of lac wax itself to the lac solution which was able to take up most of the wax and filtering the solution through drill using kiselguhr (5%) as the filter aid. The wax content of the precipitated lac could thus be reduced to 0·20% only.

(b) To improve the dark colour of waxes obtained from the lac effluents and kiri lac preliminary oxidative bleaching was carried out by various oxidative and bleaching agents. A yellow coloured wax was obtained.

(c) The process for production of shellac directly from sticklac developed earlier was standardised with 10 kg of *Rangeeni Kusmi* sticklacs of various grades and further scaled to semi-pilot plant with 20 kg of sticklacs.

(d) Attempt were made to evolve a method to obtain maximum amount of aleuritic acid believed to be present (35-40 per cent) in shellac. A yield of 25 per cent could be obtained.

2. (a) It has been found that incorporation of ethylene glycol modified lac into natural rubber interferes during vulcanisation.

(b) (i) The effect of incorporation of epoxy resin modified lac and magnesium salt of lac into natural rubber was studied. The latter showed better results than the former in effecting the mechanical properties.

(ii) Shellac and ethylene glycol modified lac were incorporated in natural rubber using easy processing channel black as the filler. A marked increase in hardness was noticed.

3. (a) Bond strength of lac in presence of tartaric acid in different concentration was determined and the result reported.

(b) The use of shellac as binder, replacing phenol-formaldehyde resin, for the preparation of hard boards out of bamboo wood pulp was investigated.

6. METEOROLOGICAL REPORT FOR THE YEAR 1971

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

Month	Mean Barometric pressure mm	Mean Maximum temp. °C	Mean minimum temp. °C	Mean dry bulb temp. °C	Mean wet bulb temp. °C	Mean humidity per cent	Mean Sun shine hrs/day	Total rainfall mm.	Highest maximum temp. °C	Lowest minimum temp. °C
January	708·6	23·2	9·2	16·1	13·2	71·0	6·40	72·8	27·1	3·8
February	706·9	26·0	10·5	19·2	15·5	66·0	7·68	20·0	31·6	6·4
March	706·2	31·3	14·5	25·0	19·9	62·0	7·84	0·2	28·5	9·2
April	702·3	33·2	18·8	26·9	22·1	64·0	7·17	83·4	38·4	13·5
May	700·3	34·0	21·2	28·6	23·9	67·0	7·95	84·3	39·4	17·8
June	696·1	30·0	22·3	26·1	24·4	87·0	2·32	375·8	34·0	20·5
July	696·7	28·9	21·8	25·2	24·0	90·5	2·51	321·0	32·5	20·2
August	698·3	28·3	21·8	24·7	23·7	94·0	2·12	542·7	30·7	20·2
September	701·0	29·8	21·2	25·7	24·0	87·0	5·49	239·1	32·5	20·0
October	704·2	28·5	18·9	24·5	22·0	80·0	5·96	103·3	32·4	13·0
November	709·3	25·7	12·0	20·9	17·3	69·0	7·89	2·8	27·4	8·2
December	709·1	23·6	8·1	17·4	14·0	71·0	7·56	nil	25·2	6·0

The highest maximum temperature recorded was 39·4°C on 27th May and the lowest minimum 3·8°C on 2nd January. The total rainfall during the year amounted to 1845·4 mm of which the monsoon (June to Sept.) rainfall was 1478·6 mm. The rainfall during the year was lower than that of 1970 (2051·1 mm). There was hailstorm on 29th April.

(d) Attempt were made to evolve a method to obtain maximum amount of aleuritic acid believed to be present (35-40 per cent) in shellac. A yield of 25 per cent could be obtained.

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7. PERSONNEL

STATEMENT SHOWING APPOINTMENTS, PROMOTIONS, RESIGNATIONS, RETIREMENTS ETC. DURING JANUARY-DECEMBER, 1971

Division/Section	Name	Post to which appointed	Date
A. Appointments			
Entomology Division	1. Sri N. S. Chouhan	Insect Geneticist	4-9-71
	2. Sri A. H. Naqvi	Junior Insect Physiologist	28-8-71
	3. Sri D. C. Srivastava	Senior Research Asstt.	21-8-71
Agronomy and Plant Genetics Division	1. Dr. P. N. Choudhury	Agronomist	7-9-71
	2. Sri B. K. Purakayastha	Junior Arboriculturist	7-9-71
	3. Sri P. Kumar	Senior Research Asstt.	22-7-71
Chemistry Division	1. Dr. S. C. Sengupta	Head, Division of Chemistry	3-7-71
	*2. Sri S. Kumar	Scientist	1-1-69
	**3. Dr. P. R. Bhattacharya	Organic Chemist	10-10-71
	4. Dr. S. C. Agarwal	Senior Research Asstt.	31-7-71
Technology Division	1. Dr. B. B. Khanna	Technologist	4-9-71
	2. Sri A. K. Ghose	Junior Technologist (P)	7-9-71
Extension Division	1. Dr. S. K. Saha	Junior Scientist (S.U.)	21-7-71
B. Resignation			
Chemistry Division	1. Dr. S. C. Agarwal	Senior. Research Asstt.	19-8-71 (A/N)

*Merit Promotion (Supernumerary).
**Officiating.

RESEARCH STAFF: DIVISIONWISE

Sl No.	Name of the Post	Sanctioned strength	Staff in position as on 31-12-1971
1.	Director	1	Dr. S. C. Sengupta
	Entomology Division		
2.	Head of the Division of Entomology	1	Vacant
3.	Entomologist	1	Dr. A. Bhattacharya
4.	Insect Geneticist	1	Sri N. S. Chouhan
5.	Junior Entomologist (L.C.)	1	Dr. B. P. Mehra
6.	Junior Insect Ecologist	1	Dr. C. P. Malhotra
7.	Junior Physiologist	1	Sri A. H. Naqvi
8.	Junior Plant Geneticist	1	Vacant
9.	Junior Insect Parasitologist	1	Vacant
10.	Senior Research Assistant	7	1. Sri R. S. Gokulpure 2. Sri D. C. Srivastava 3. Sri N. Majumdar
11.	Instructor (Lac Cultivation)	1	Sri R. C. Mishra

Sl. No.	Name of the Post	Sanctioned	Staff in Position as on 31-12-1971
12.	Research Assistant	14	1. Sri Parimal Sen
			2. Sri A. K. Sen
			3.. Sri S. G. Choudhary
			4 Sri B. N. Sah
			5. Sri J. M. Das Gupta
			6. Sri R. C. Maurya
			7. Sri Y. D. Mishra
			8. Sri M. L. Bhagat
			9. Sri S. K. Jaipuriar
			10. Sri Jawahir Lal
			11. Sri M. K. Choudhury
13.	Artist-cum-Photographer	1	Sri R. L. Singh
	Junior. Artist-cum-Photographer	1	Sri Pyare Das
14.	Junior. Field Assistant	1	Vacant
15.	Fieldmen	7	1. Sri R. S. Maliya
			2. Sri H. R. Munda
			3. Sri S. N. Sharma
			4. Sri Sant Kumar
			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. Sri A. Hussain
			2. Sri R. D. Pathak
			3. Sri R. C. Singh
			4. Smt. N. Nandy
18.	Store and Plantation Assistant	1	Sri G. Lakra
	Agronomy and Plant Genetics Division		
1.	Agronomist	1	Dr. P. N. Choudhury
2.	Junior Arboriculturist	1	Sri B. K. Purkayastha
3.	Senior Research Assistant	1	Sri P. Kumar
4.	Fieldman	1	Sri B. D. Tiwari
5.	Laboratory Assistant	1	Sri D. D. Prasad
	Chemistry Division		
1.	Head, Division of Chemistry	1	Dr. S. C. Sengupta
*2.	Scientist	1	Sri Shravan Kumar
**3.	Organic Chemist	1	Dr. P. R. Bhattacharya
4.	Junior Chemist (Physical)	1	Vacant
5.	Junior Chemist (Polymer)	1	Vacant
6.	Junior Technologist (Surface Coating)	1	Vacant
7.	Senior Research Assistant	6	1. Sri A. Kumar
			2. Sri P. C. Gupta
			3. Sri T. R. Lakshminarayanan
			4. Sri A. Rahman
8.	Research Assistant	14	1. Sri R. K. Banerjea
			2. Sri S. K. M. Tripathi
			3. Sri August Pandey
			4. Sri M. Mukherjea
			5. Sri A. K. Das Gupta
			6. Sri B. C. Srivastava
			7. Sri Niranjan Prasad
			8. Sri R. N. Majee
			9. Sri K. M. Prasad
9.	Glass Blower	1	Sri S. K. Dey

Sl. No.	Name of the post	Sanctioned	Staff in Position as on 31-12-1971
10.	Laboratory Assistant	6	1. Sri B. B. Chakraborti 2. Sri Nagendra Mahto 3. Sri Umeshwar Sahay 4. Sri B. P. Keshri
	Technology Division		
1.	Technologist	1	Dr. B. B. Khanna
2.	Junior Technologist (Processing)	1	Sri A. K. Ghose
3.	Junior 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 (S.U.)	1	Vacant
2.	Junior. Scientist (S.U.)	1	Dr. S. K. Saha
3.	Asstt. Scientist (Production)	1	Sri P. K. Ghosh
4.	Senior. Analyst	1	Sri L. C. Misra
5.	Analyst	2	1. Sri B. P. Banerjee 2. Sri Ramesh Prasad
6.	Laboratory Assistant	2	1. Sri Dominic Runda 2. Sri G. M. Borkar
8.	Museum Assistant	1	Vacant

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