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Indian Lac Research Institute

NAMKUM, RANCHI, BIHAR, INDIA.

ANNUAL REPORT

For the year 1st. April 1935 to 31st. March 1936.

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INDIAN LAC RESEARCH INSTITUTE.

NAMKUM, RANCHI, BIHAR, INDIA.

Annual Report for 1935-36.

ADMINISTRATIVE SECTION.

General.—During the year under review, considerable activity both in the chemical and entomological sections is to be noticed. Several problems of trade usefulness were undertaken and, as far as possible, their solutions effected or advanced. The general activities of the Institute followed the lines of previous years. Reports, research notes, papers and bulletins were issued. Touring was undertaken when necessary and enquiries concerning both lac cultivation and manufacture were answered.

A large number of visitors were as usual shown round the Estate and the Institute, and the work being carried out demonstrated to them.

The demand for publications again showed an increase and the work of the Institute now receives world-wide recognition, as instanced by the numerous appreciative reviews received.

The Institute took part in exhibitions specially in Patna where the work of the Institute was greatly appreciated. The exhibits were in general of an instructive nature, such as illustrations of the bad effects of storing lac too long. The exhibits included goods containing shellac and a number of mouldings of different types prepared at Namkum.

Roads and Buildings.—Work on the construction of the air-conditioned room was undertaken, but due to various reasons the completion could not be effected during the financial year. Two new garages, as approved by the Committee, were constructed during the year. General repairs to roads and buildings were also undertaken.

Power House.—A duplicate electric power plant and a new storage battery set were installed.

Staff.—Mrs. Dorothy Morris, M.Sc., F.I.C., Director of the Institute proceeded on leave prior to retirement from January, 1936,and Mr. P. M., Glover, B.Sc., Entomologist of the Institute acted as Director during the remainder of the year.

Two temporary appointments as typist-clerks were made during the year in order to cope with the increased work. In accordance with the decision of the Indian Lac Cess Committee the services of the fitter, Sukra Tirkey were terminated. Mr. J. C. Bose was appointed as Assistant Mechanic during the year. Four Kamdars were appointed but one Kamdar (Syed Mohammad Tyab) resigned his post. Saheb Ali, Labour Supervisor, was appointed during the year under review.

Medical Aid.—Medical aid was rendered to members of the staff as usual.

Staff Club.—A grant of Rs. 450 to the Club was continued which resulted in various improvements of the Club in general.

Audit.—The Institute accounts were audited as usual and the report satisfactory.

CHEMICAL SECTION.

Manufacture of lac.—The attention of the Institute was drawn to the appearance on the market of a type of seedlac with a very light colour. Methods of lightening the colour of seedlacs by superficial bleaching were tried. A short treatment with a weak hypochlorite solution, or treating with dilute sulphuric acid and permanganate of potash followed by washing with sodium sulphite solution to remove the precipitated manganese dioxide, or merely washing with dilute sulphuric acid were found to lighten the colour. In no case was there any marked improvement in *bleachability*. Simple acid treatment resulted in a poor quality bleached lac.

In the experimental lac factory of the Institute, several samples of shellac were prepared, under varying conditions, to improve the indigenous method of shellac manufacture and for providing authentic samples for investigations at Namkum and London.

Numerous commercial samples of shellac were analysed with a view to grade them on the basis of their chemical and physical properties. These results are incorporated in two pamphlets to be issued shortly.

Analytical Methods.—Experiments were conducted to decide on whether a sample of seedlac would be suitable for bleaching. It was found that samples could be classified as good, allowable and unsuitable according to the bleach required and final colour. Suggestions were made to use N/100 iodine solution as a colour standard for guiding the endpoint during addition of bleach and to adopt coarser grinding (10 mesh) in the preparation of the seedlac sample. Several other important details of carrying out the test were also worked out.

While bleached lac by itself gives no fluorescence, the colouring matter in shellac gives a marked fluorescence which changes from orange-red in the acid region to pale green in the alkaline. It was found possible to accurately determine the acid value of shellac in alcoholic solution by observing this fluorescence change during titration. The method is more accurate on using B-naphthol as a fluorescent indicator.

Plasticisers.—Compatibility of various plasticisers with shellac was examined and results are being published in Technical Paper No. 9 of the London Shellac Research Bureau. Tensile strength tests are considerably affected by varying degrees of solvent retention unless the films are very thin, in which case it is difficult to handle them during the tests. Preparation of films by flowing molten compositions is being tried. Optimum additions of plasticiser and accelerator are being worked out. The films exposed to weathering tests in the open are giving interesting results.

Heat Curing of lac.—Heat curing of lac in the presence of ammonium salts and urea derivatives was studied and the results incorporated in the 2nd. edition of Bulletin No. 14.

Shellac mouldings.—Shellac mouldings prepared under a variety of conditions and with different fillers were examined for strength, heat resistance and moisture resistance. The lack of gloss retention due to fibrous fillers was studied.

Film studies.—Preliminary experiments were carried out on the determination of contact angles which shellac films make with water with a view to determine the orientation of hydroxy groups in shellac varnish films. This is expected to give some clue to the production of water-resistant films.

A study of the cold hardening of shellac in acetone solution.—It has been recognised that solvents for shellac tend to act as retarders of polymerisation. Nevertheless it has been observed that if a solution of shellac in alcohol is fairly concentrated, *i. e.*, with more than 30% shellac, then addition of an accelerator, *e. g.* urea will result in an appreciable increase in viscosity and may even result in the solution 'gelling'. This effect is very much more marked in the case of water-free solvents such as acetone and mesityl oxide. With solution of these latter solvents a small addition of urea will cause 'gelling' in a few minutes.

A study of the optimum concentration of urea required to give the maximum polymerisation was made. It was found that the curve obtained by plotting the time required for 'gelling' at room temperature against the concentration of urea on the shellac present reached a minimum about 7-8% urea. It is significant that this concentration is approximately the amount of urea required to neutralise the free shellac acids. Although 'gelling' occurs in a few minutes with the optimum addition of urea the maximum insolubility of the shellac is not reached until about 4 days. In the early stages of the change the gel is thixotropic.

During the different stages of reaction with urea it has been observed that a portion of the lac in solution always remains unpolymerised irrespective of the time allowed for the reaction. This unpolymerised portion could be easily extracted with acetone leaving the hard polymerised portion as an insoluble residue. The extract was found to have properties similar to the ether-soluble portion of shellac. It was always found that never more than about 70% of the shellac was polymerised by treatment with urea. This polymerised lac could be readily brought to a soluble state by boiling in water. The two portions were separated and analysed and the data compared with the results obtained for pure and ether-soluble resins obtained by direct extraction of shellac with ether and toluene. The close resemblance of all the properties of these components showed that this method could be utilised for preparing pure lac resin. The process can also serve as a new means for separating shellac constituents.

The properties of this form of pure lac resin are interesting. The resin is light brown in colour and is of a lower colour index than its parent shellac. It is readily soluble in alcohol and a sample stored for 1½ years showed no loss in solubility nor any change in viscosity. The air dried varnish films on metals lack in adhesion and elasticity, but these

properties are very much improved by baking for a short time. On copper the varnish coating shows no 'greening' or other defects even after prolonged baking.

Condensation of shellac with organic acids.—Condensation of shellac with certain organic acids, *e. g.* maleic, malic, citric, oxalic, phthalic acids etc. in presence of solvents and non-solvents have been found to give improved properties as regards gloss, adhesion, elasticity, water resistance etc. to the shellac film on metals and glass. In a typical case, incorporation of 0.5-5% of maleic acid in shellac varnish under proper conditions gave a product which completely prevented the 'greening' effect on copper on baking and at the same time possessed good gloss, adhesion, and flexibility. The improved properties in gloss, adhesion, elasticity etc , were also noted on other metal sheets like brass, aluminium and tin.

The process was used to prepare improved coloured lacquers for tin foil. Various synthetic dyes of heat resistant type were added to the maleic-acid-treated varnishes and films prepared on tin foil. After baking the coatings were water resistant and had good adhesion and elasticity.

The possibility of increasing the elasticity of these improved varnishes by adding suitable plasticisers was investigated. It was observed that addition of castor oil, glycolphthalate etc., up to 5% increased the elasticity without affecting the other properties. Addition of more than 5% of castor oil had a darkening effect, especially on copper.

Factors which affect the keeping quality of bleached lac.—Stored bleached lac becomes insoluble in alcohol rapidly, the period of useful life varying from a few days to a few years. The 'life under heat' of the bleached lac also comes down with age. Some of the factors which affect the keeping quality of bleached lac have been studied, the results of which are summarised below :—

1. The life at 140°C of freshly prepared bleached lac (varying between 4 and 30 minutes) gives a fair idea of its keeping quality.

2. Heat-treated or acid-treated seed lacs give bleached lacs of poor keeping quality.

3. Higher concentrations of soda used for dissolving lac give bleached lacs of better keeping quality but of poorer colour.

4. Rapid addition of bleach or its addition in one lot gives a bleached product with poor 'life'. Subsequent alkali-treatment by allowing the bleached lac to remain for sometime in the alkaline solution before precipitation mitigates to some extent the harm done by rapid addition ; but the colour of the resulting bleached lac would be poorer.

5. Precipitation on the slightly alkaline side always gives a product with long life but, if definitely alkaline, a certain amount of loss in the yield is incurred. Precipitating on the acid side gives a product with comparatively poor life.

6. When precipitated with acetic acid bleached lac appears to have longer 'life' than when precipitated with mineral acid.

7. The presence of wax has little influence on the keeping quality of bleached lac.

8. In a majority of cases bleached lacs containing relatively high chlorine content are the ones which become insoluble early. While it is desirable to avoid high chlorination due to over-bleaching, under-bleaching is not a sure remedy for extending the life of bleached lac.

9. With each additional washing with boiling water the life under heat of bleached lac and its colour come down on account of the longer duration of heat-treatment. Cold water washing retains both the colour and the life of the bleached lac better.

Factors which affect the bleaching of seed lac.—The study of the bleachability of various types of seed lacs of known origin was undertaken in co-operation with the U. S. Shellac Research Bureau. The results arrived at in both places are incorporated in a paper (to be published) entitled, 'Factors which affect the bleaching of seed lac.' The following are the important conclusions which have been drawn from the above study.

1. The quantity of bleach consumed by seed lac is in general dependent upon the nitrogen content, especially that of the soda extract.

2. Next in order, the colour index of seed lac is a fair indication of its bleaching quality. This generalisation includes Burma and Siam seed lacs which are notable exceptions to conclusion No. (1).

3. The greater the proportion of resin to insect remains, the better will be the bleaching quality of seed lac. On this basis and also from experimental evidence kusum and khair seed lacs fall into the best bleaching grades, while palas and ber form the poor bleaching grades.

4. When stored as seed lac age has no influence on its bleaching quality, while storing as stick lac, especially under blocky conditions brings down the bleaching quality.

5. There is no relationship between hot alcohol insolubles and bleachability; neither does any relationship appear to exist between hot acetone insolubles and bleachability. But the hot acetone insolubles bear a good relation to the total age of lac.

6. Finely ground seed lacs consume more bleach than coarsely ground ones.

7. The higher the concentration of soda, the higher the temperature and longer the period employed in dissolving, the greater will be the quantity of bleach consumed.

8. Bleaching solutions of high alkalinity increase the quantity of bleach required, especially of poor quality seed lacs.

9. Bleached lacs (especially those samples which have been hydrolysed or exposed to the action of alkali during bleaching) darken when exposed to ultra-violet light.

The action of the chlorine-bleach on the resin constituents of lac.—As a result of bleaching, chemical changes are brought about in the resin constituents of lac. These changes have been followed by determining the various analytical constants of lac at

different stages and conditions of bleaching. The following are the conclusions drawn from the above study.

1. Bleaching is accompanied by an increase in the acid value, saponification value and ester value of lac.

2. The chlorine content increases steadily as bleaching proceeds, while the iodine value decreases rapidly in the beginning and then tends to attain a minimum.

3. The chemical changes are brought about in the resin constituents almost immediately after the addition of bleach ; but the changes in the colouring matter, although proceeding simultaneously, take some time to manifest themselves. The bleach acts on the colouring matter better at higher temperatures than at low temperatures.

4. When bleached lac is allowed to remain in solution after the consumption of all the available chlorine the following changes take place, the extent of these changes depending upon the duration of action, the temperature and the alkalinity of the medium.

(*a*) The chlorine content decreases, unsaturation increases and the colour of the bleached lac tends to return.

(*b*) The acid value increases and the ester value decreases due to hydrolysis.

(*c*) The (apparent) saponification value also decreases.

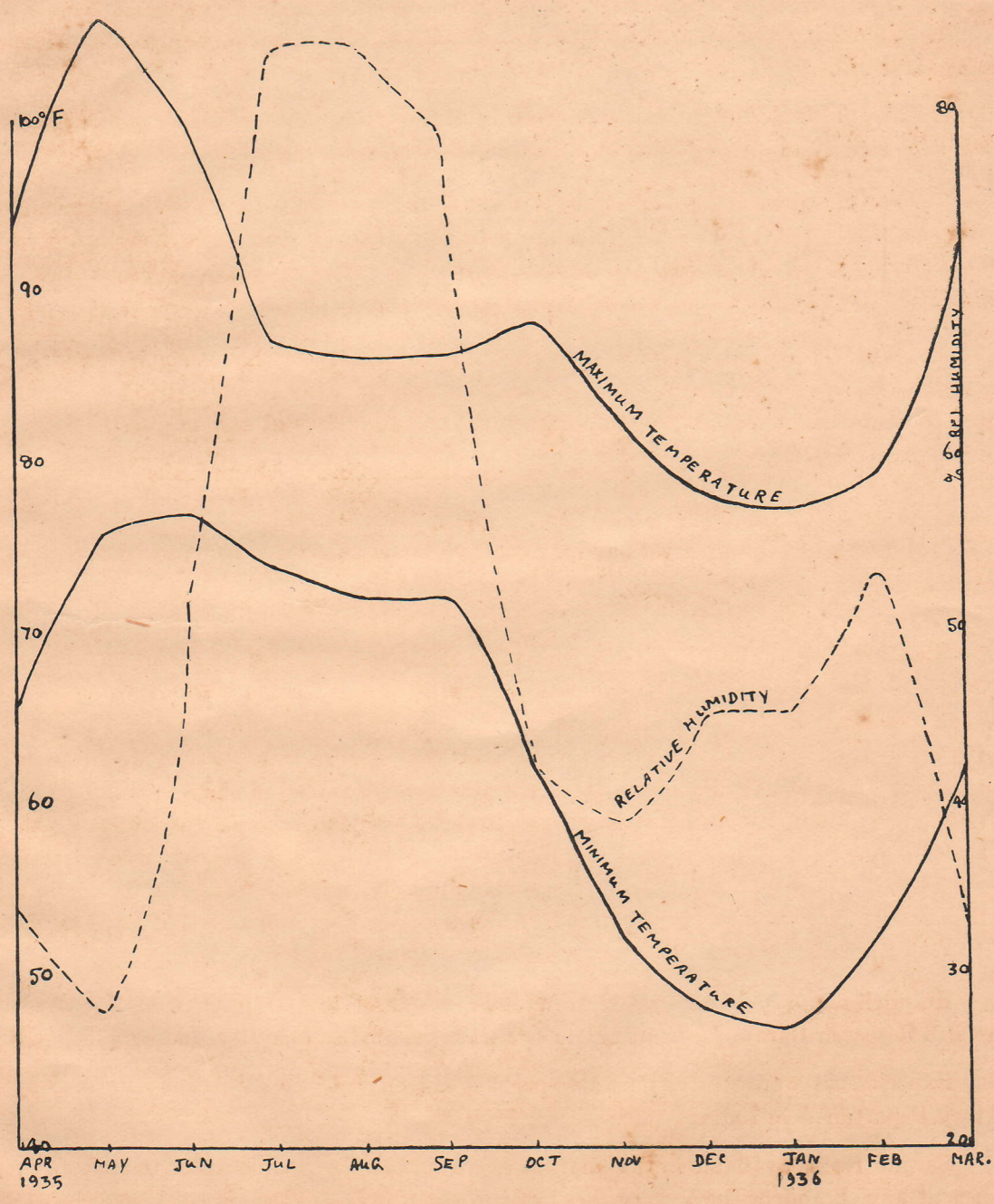
Bleaching of shellac varnish with oxalic acid.—The slight bleaching action which oxalic acid has on shellac varnish has been attributed by the London workers to the removal of the colouring matter by oxalic acid in the form of a white precipitate. Experiments done in this Institute show that calcium and iron are responsible for the darkening of shellac varnishes and their removal by oxalic acid is responsible for the lightening of colour. The conductivity minimum noticed by London workers when oxalic acid is added to shellac varnish is due to the removal of the ionisable salts of calcium and (ferric) iron with shellac acids in the form of insoluble calcium oxalate and weakly ionised ferrous oxalate respectively. These results will appear incorporated in Technical Paper No. 7 of the London Shellac Research Bureau.

Enquiries and 'ad hoc' experiments.—In response to a request from the American Shellac Research Bureau lead salt of lac dye was prepared in quantity and supplied.

Experiments were started on water-proofing cotton and jute fabrics as requested by the Army Department in India.

Several rosins available in the market were tested for iodine value to trace the existence of any brand with a very low value which, it is alleged, is being used by certain manufacturers. If true, addition of such rosin cannot be correctly estimated by iodine value alone but so far no evidence could be obtained of its availability or use.

Shellac dental plate compositions, one with a high shock resistance and another with a slow setting-time were wanted and two types were prepared and sent.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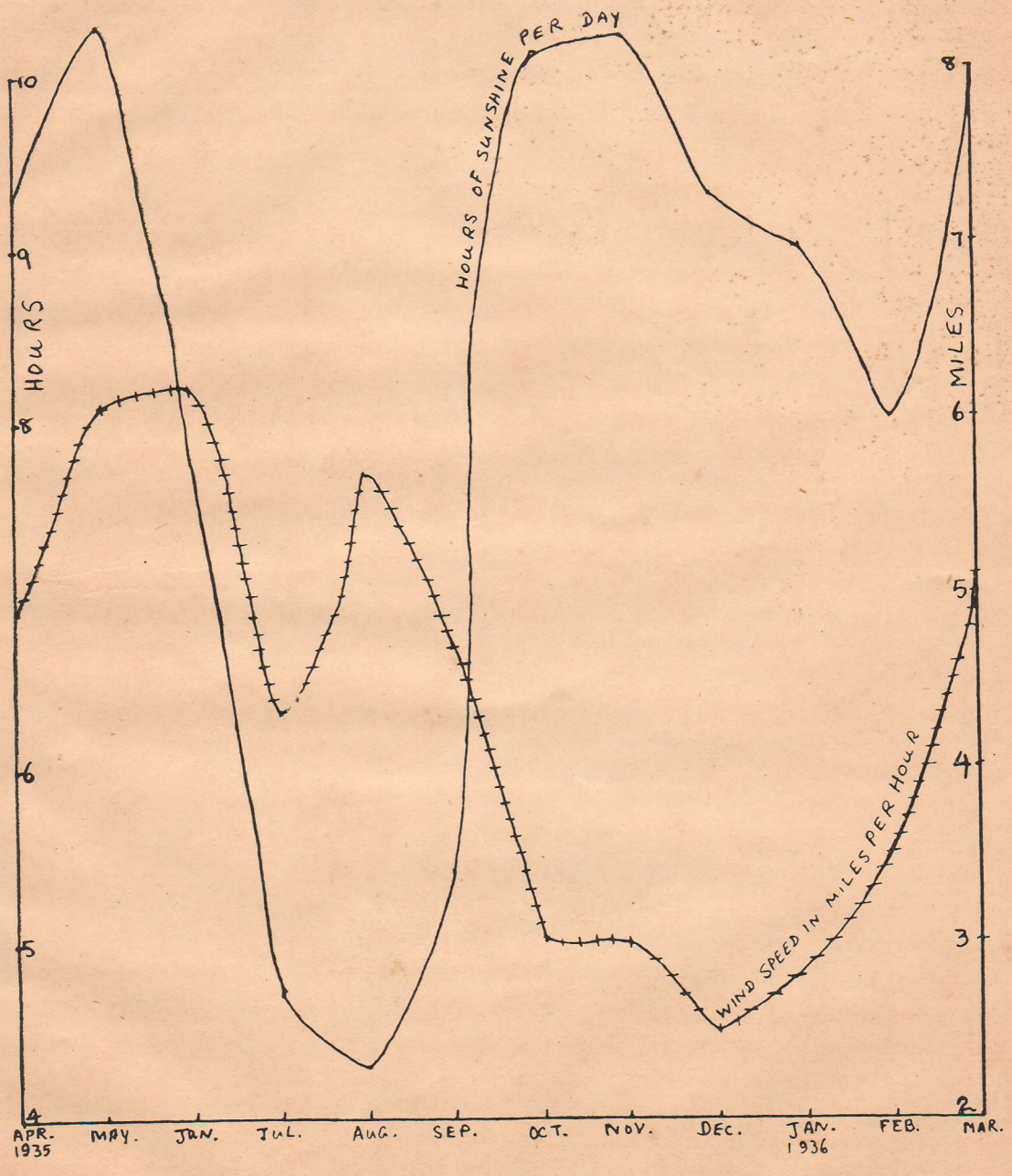
HOURS OF SUNSHINE PER DAY
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Meteorological Report.—The summary of weather conditions is graphically represented in the accompanying pages.

1. The summer was very severe as in last year.

	Average Max. temperature.	Hours of sunshine per day.	Rainfall.
April	94·2°F	9·3	1·0″
May	106·2°F	10·3	Nil

2. The monsoon rainfall (June to September) was much below normal at 33·23 inches. The total rainfall for the year was as low as 37·06 inches.

3. The cold weather was marked by unusually clear skies and low rainfall and humidity.

4. The wind velocity was the highest in May and June as usual.

5. The distribution of rainfall was as follows :—

April 1935	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan. 1936	Feb.	Mar.
1·0	...	2·98	10·80	12·84	6·61	...	...	...	1·29	0·36	1·18 in.

DEPARTMENT OF ENTOMOLOGY.

I. General.

The Department supplied advice as regards lac cultivation, and identified and recommended controls against insect enemies of lac and of the host trees on which it is grown.

Dates of swarming were forecasted and brood lac was arranged and despatched to cultivators on request.

Exhibits were arranged and demonstrations of the work of the Institute were given at the following exhibitions.

1. The Bihar and Orissa Provincial Exhibition.
2. The Ranchi Mela.

A large number of visitors were shown round the Department. The Entomologist gave lantern lectures on lac cultivation and on the work of the Indian Lac Research Institute at the Bihar and Orissa Provincial Exhibition and at the Raj Kumar College, Raipur, Central Provinces.

Kamdars.—During the year a scheme has been put into operation whereby a number of kamdars, *i.e.*, travelling teachers, will undergo intensive training at Namkum. When trained they will be sent out on tour in the lac growing districts demonstrating to the villagers and cultivators the results of immediate practical importance obtained by the Entomological Department. These results are mainly improved cultivation methods, particularly, pruning and cropping methods, and also simple methods of insect pest control, etc.

Training of four kamdars was started in December 1935. The kamdars are picking up the work well. A number of practice and experimental demonstrations, mainly of pruning and infection methods, have been given. The majority of these have so far been given in Forest Department lac plantations. It has been very gratifying to note that villagers came and watched some of these demonstrations and were sufficiently interested to ask to examine the pruning instruments used and even to be allowed to use them.

The scheme is at the moment only in the experimental stage and it is intended in the first place that the four kamdars, at present undergoing training, shall confine their attentions to the major lac growing area, *i.e.* Chota Nagpur. Should the scheme prove a success it is hoped to increase the number of kamdars and to extend the scheme to include other lac producing districts, at a later date.

The following Forest Department plantations were visited during the year. Pelwal and Horhap in the Ranchi district, Mako at Latehar and Kundri at Daltonganj in the Palamau district, and Bichagutu near Chaibassa in Singhbhum.

A short article on Lac Cultivation and the work of the Indian Lac Research Institute entitled 'The Shellac Industry' was published in 'The New Review', Vol. II No. 11. November 1935.

A second edition, with various amendation and additions, of 'Lac and the Lac Research Institute' was published during the year, the first edition having been entirely exhausted.

II. Plantation.

During the year, it was decided to combine the Entomological and Biochemical Department's plantations and to place the plantation as a whole under the charge of the Entomologist. The amalgamation took place in June 1935.

The plantation is in excellent condition and the hosts are extremely healthy. *Butea frondosa* (Palas) and *Schleichera trijuga* (Kusum) are still too small for the commercial production of lac. Most of the lac produced in the plantation is required by the Institute for the regular entomological examinations and caging, and for breeding predator larvae to be used as hosts in the oviposition cages. Further lac also, is required for use in the experimental factory attached to the Institute.

During the year 29 maunds of brood were purchased for use in the plantation, and from this brood 6¼ maunds of scraped lac were sent to the Institute Factory. The yield from the plantation was utilised in part as explained in the previous paragraph for entomological research work; of the remainder 7 maunds of brood lac were supplied for use elsewhere, and 22½ maunds of scraped lac were sent to the Institute Factory.

The Institute also arranged the purchase of 26½ maunds of brood lac for various cultivators who wrote in requesting for brood lac to be arranged for them.

Experimental light pruning of *Z. Jujuba* (Ber) during the Baisakhi crop was again repeated during the Baisakhi 1934-35 crop. Of each, Ber and grafted Ber, 74 and 12 were chosen both for treatment and as control. That this treatment is beneficial is clear

from Table I in which the yields from the control and experimental trees are recorded. This experiment will again be repeated during the Baisakhi 1935-36 crop, as the yields from both experimental and control trees are poor, as also are the scraped lac yields.

TABLE I.

Yields from Control and experimental Ber trees. Baisakhi crop 1934-35.

	Brood yield.		Scraped lac yield.	
	Seers.	Chtks.	Seers.	Chtks.
74 Ber Experimental	12	11½	1	0
74 Ber Control	3	1½	0	4½
12 grafted Ber experimental ...	4	1½	0	8
12 grafted Ber control	3	½	0	5½

In January 1936, 52 kusum trees growing gregariously at a village called Lat Ratu were rented. They were infected, unpruned, for the Jethwi 1936 crop with 11 maunds of kusum × khair brood ; of this 4 mds. was from Namkum and 7 mds. from the Forest Department plantation Pelwal. The resulting brood will be utilised for the infection of khair in July 1936. The trees are being utilised in connection with the biological control work. They have also been used for the instruction of the Institute kamdars. This area has caused a certain amount of trouble as the villagers have been difficult and stole some of the lac, however steps have been taken to prevent this recurring and the results appear to be satisfactory.

The results obtained from the experimental infections in the plantation, again show the value of cross strains in producing good yields and healthy lac.

Important data obtained were the following. Infection of kusum brood on other host than kusum, for the Jethwi crop is likely to result in complete failure. Of particular interest during the Katki crop was the excellent yield obtained by the infection of khair with palas brood ; Ber brood on khair although satisfactory did not yield anything like so good a result, this is at variance with last year's results where Ber × Khair proved a better cross. The importance of this lies in the fact that khair, previously recommended only as an Aghani host, can also be used as a Katki host, when kusum brood is not available to infect it for the Aghani crop. It is still to be considered as an Aghani rather than a Katki host, provided kusum brood is available. As in previous years all infections on Ghont, *Zizyphus Xylopyra* proved a complete failure.

As regards the Aghani crop the cross kusum × khair maintained its reputation for a high quality lac and a satisfactory yield. Points of special interest were an excellent crop obtained from the infection of *Dalbergia lanceolaria* with kusum brood, being the

first time that such a crop has been obtained, although repeated infections of this host have been carried out. Other satisfactory infections were kusum on *Dalbergia latifolia*, on *Albizzia lucida* and to a much less extent on *Ougeinia dalbergioides*.

During the Baisakhi crop infections of particular interest were Palas × *Ougeinia dalbergioides* which give a good yield as also Palas × *Albizzia lucida* and Palas × *Flemingia congesta*.

The *Dalbergia* sps. are not suitable hosts for use during the Baisakhi crop.

The following hosts have given poor results or have been failures throughout the year. *Zizyphus Xylopyra*, *Anona squamosa*, *Grewia laevigata*, *Ficus* sps., *Dalbergia sissoo*, *Albizzia stipulata*, *Kydia calycina*.

III. Pests of Host Trees.

The plantation as a whole has been singularly free from host-tree pests throughout the year. The following only have occurred on a scale necessitating the taking of control measures.

1. **Aspidiotus orientalis,** Newst. *(Coccidae)*.—In previous years this *Coccid* has been a serious pest, the severity of attack has however been diminishing from year to year. This appears to be partly due to rigorous control measures and partly due to a gradual development of immunity by the hosts attacked.

A slight attack was observed in October 1935, the host affected was *Zizyphus Jujuba* (Ber). Spraying was not necessary and affected shoots were cut and burnt.

2. **Tessaratoma javanica,** Thumb *(Pentatomidae)*.—Adults of this species were observed in August and September 1935 sucking the sap of the shoots of *Schleichera trijuga* (Kusum). The attack was not very serious, hand collecting was used as control and found to be very satisfactory, as it is not difficult to hand pick 100% of so big an insect on trees of fairly small size.

3. **Termites.**—White ant attack was observed in the plantation in October and the two following months. Fumigation of Termitaria and removal of the tunnels from affected trees was utilised as control. Systematic fumigation of Termitaria has successfully kept Termite damage under control.

To discover whether it would be possible to deter Termites from attacking trees a number of experiments were started, the trees being banded near the base of the trunk with cloth bands soaked in tar, oil etc. and also with grease bands of a proprietory product made by the Imperial Chemical Industries. It is too early yet to form any conclusions.

IV. Bionomics of L. lacca

1. **Parthenogenesis.**—The strain from which males have been eliminated in each successive generation, and which was initiated during the Katki crop in 1929, is still continuing to develop satisfactorily. The 13th asexually produced generation is developing normally and will mature in July 1936. The average fertility per female in the 11th and 12th generations were 330·6 and 559·5 respectively. *L. lacca* may therefore be described as Deuterotokous, unfertilised females giving rise to a progeny of both males and females.

2. **Fertility.**—Table II summarises the average fertility per female in various strains throughout the year.

TABLE II.

Average number of eggs laid per female: April 1st 1935 March—31st 1936.

Baisakhi 1934-35.		Jethwi 1935.		Katki 1935.		Aghani 1935-36.	
Strain.	Average No. eggs laid per female.	Strain.	Average No. eggs laid per female.	Strain.	Average No. eggs laid per female.	Strain.	Average No. eggs laid per female.
Palas × Palas ...	482·2	Kusum × Kusum...	392·7	Palas × Palas ...	232·0	Kusum × Kusum ...	514·6
Palas × Ber ...	453·7			Palas × Khair ...	319·0	Kusum × Khair ...	376·3
Ber × Ber	388·6			Ber × Ber	491·7	Kusum × *D. latifolia*	538·1
				Ber × Khair ...	313·3		
				Ber × Palas ...	157·0	Kusum × *D. lanceolaria* ...	292·3

3. **Selection.**—The mixed red and yellow strain has been further bred and selected during the year, it has not however been possible to isolate a pure yellow strain.

4. **Mortality.**—The mortality among the various strains of *L. lacca* is given in Table III, the number of cells surviving at the end of the crop being recorded as a percentage of the original settlement, mortality from all causes is therefore included.

TABLE III.

Mortality due to all causes in various strains, April 1st 1935—March 31st, 1936.

Baisakhi 1934-35.		Jethwi 1935.		Katki 1935.		Aghani 1935-36.	
Strain.	Mortality.	Strain.	Mortality.	Strain.	Mortality.	Strain.	Mortality.
Palas × Palas ...	63·4%	Kusum × Kusum ...	87·8%	Palas × Palas ...	58·5%	Kusum × Kusum ...	88·3%
Palas × Ber ...	77·8%			Palas × Khair ...	63·3%	Kusum × Khair ...	78·9%
Ber × Ber ...	64·3%			Ber × Ber ...	68·1%		
				Ber × Khair	67·7%		
				Ber × Palas	66·5%		

5. **Forecast of emergence.**—Hindi, Bengali and Oriya translations of the paper on this subject were issued during the year.

V. Insect Enemies.

A. Predator Enemies.

1. **Eublemma amabilis,** Moore. *(Noctuidae).*—Previous work on *E. amabilis* has been further confirmed. Hand picking of the larvae and pupae from the lac crop was again tested as a control against *E. amabilis* at the Pelwal plantation. Results obtained were promising. This control would however be impossible in any but extremely small areas.

2. **Holcocera pulverea,** Meyr. *(Blastobasidae).*—A few cages only for longevity and life history were started to confirm previous results, which have already been published, as stated in last year's annual report.

The usual routine examinations and regular caging of lac samples were continued for both predators. These are important as they form a basis for the estimation of control measures and for comparision of damage in other areas, they also act as a control in the experimental work on the reduction of insect enemy damage, by biological methods.

3. **Eublemma scitula,** Ramb. *(Noctuidae).*—This species was not observed during the year.

4. **Ephestia sp.** *(Pyralidae).*—*Ephestia sp.* was not observed during the period under report.

B. Parasite Enemies.

The following parasites have been bred from *L. lacca* during the year :—

Eupelmidae.

Eupelmus tachardiae, How.

Encyrtidae.

Tachardiaephagus tachardiae, How.
Tachardiaephagus tachardiae, Var *somervilli,* Mahd.
Parechthrodryinus clavicornis, Cam.
Erencyrtus dewitzi, Mahd.

Aphelinidae.

Coccophagus tschirchii, Mahd.
Marietta javensis, How.

Eulophidae.

Tetrastichus purpureus, Cam.

Dr. Ch. Ferrière of the Imperial Institute of Entomology has now published a detailed paper* on the parasites of *L. lacca,* in which considerable use has been made of material sent to the Imperial Bureau by this Institute. Dr. Ferrière includes in his paper also the following species, so far not recorded at Namkum, they are recorded as having been bred from lac, host unknown, except *A. hautefeulli* recorded as a parasite of lac. All are from Bangalore.

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* Bull. Ent. Res. Vol. XXVI, Part III, Sept. 1935.

Encyrtidae.

Atropates hautefeuilli, Mahd.

Anicetus dodonia, sp. nov.

Prolearocerus fulgoridis, sp. nov.

During the year a further paper was published on the parasites of lac, Institute Bulletin No. 22, adding a further year's evidence to that given in Bulletin No. 21.

The conclusions given in Bulletin 21 are confirmed. During the 7 years under review the average percentage parasitism was 4·8% and the average maximum only 9·9% based on examination of over 550,000 cells in over 5,000″ of lac.

Table VI records the average monthly percentage damage by parasites during the 12 months under review.

TABLE VI.

Monthly percentage damage by Parasites to the lac crops.

April 1st, 1935 to March 31st, 1936.

Month and year.	Baisakhi.		Jethwi.		Katki.		Aghani.	
	No. of cells *L. lacca* examined.	% parasitised.	No. of cells *L. lacca* examined.	% parasitised.	No. of cells *L. lacca* examined.	% parasitised.	No. of cells *L. lacca* examined.	% parasitised.
April 1935 ...	6412	10·1%	2087	2·3%	...	...	...	...
May 1935 ...	4694	12·3%	2147	5·0%	...	...	...	...
June 1935 ...	3719	9·1%	1265	5·7%	...	...	...	...
July 1935 ...	1835	6·3%	1024	6·7%	6418	0·0%	3211	0·0%
August 1935 ...	...	...	...	...	14508	3·1%	5745	0·9%
September 1935	...	...	...	...	11515	4·1%	4657	5·9%
October 1935 ...	1298	0·0%	...	...	6403	5·8%	2927	3·3%
November 1935	8026	0·0%	...	...	...	...	1663	6·4%
December 1935	6625	0·0%	...	...	...	...	2827	3·4%
January 1936 ...	8907	5·9%	...	...	...	...	3569	6·3%
February 1936	6473	12·7%	1645	0·0%	...	...	2827	5·5%
March 1936 ...	6753	14·8%	2415	0·6%	...	...	2849	3·4%

The maximum parasitism, 14·8%, occurred in March in the Baisakhi crop, previous years maxima were 15% April 1933 and 16·6% in March 1932, in each case in the Baisakhi crop.

The average monthly damage to lac cells by parasites amounted to only 4·5%, comparing with 6·0%, 6·0% and 7·4% in the last three years. Over 1,34,000 lac cells were examined.

N. B.—It must be made clear that since the period for the Annual Report is from April 1st to March 31st, the figures for the Baisakhi and Jethwi crops are not from single consecutive crops, but from the end of one crop and the beginning of another. The months April to July 1935 for the Baisakhi and Jethwi 1935 crop, refer to the Baisakhi 1934-35 crop and the Jethwi 1935 crop. The months October 1935 to March 1936 for the Baisakhi crop and the months February to March 1936 for the Jethwi crop refer to the Baisakhi 1935-36 crop and the Jethwi 1936 crop. (Same applies to Hyperparasite table).

Eupelmus tachardiae, How. (*Eupelmidae*)—This species is in primary function a parasite of *L. lacca*, it occurs also as a hyperparasite of the late larva within the cocoon of *Microbracon greeni* and *Apanteles tachardiae.* It has also been discovered hyperparasitic on two primary parasites of lac *Tachardiaephagus tachardiae* and *Erencyrtus dewitzi.* Finally it has been bred from the calcareous tubes of the *Cercopid, Machaerota planitiae.*

During the year two letters were published by Mahdihassan in Current Science disputing our claim that *E. tachardiae* is parasitic on *L. lacca* and hyperparasitic on *M. greeni* and claiming that it actually is parasitic on *E. amabilis*, based on a single observation.

Replies were published in Current Science giving records of *E. tachardiae* observed as a parasite of *L. lacca* and detailed life history data of *E. tachardiae* bred in the laboratory as a hyperparasite of *M. greeni* over a considerable period. It must also pointed out that although during the last eight years many miles of lac encrustation and many thousands of *E. amabilis* larvae have been examined, in no single instance has *E. tachardiae* been observed parasitic on *E. amabilis.*

VI. Control Measures.

Control measures fall into two classes: Artificial control and Natural or Biological control.

A. Artificial control.

A paper has been submitted for publication entitled 'Some simple methods of reducing the damage done by insect enemies to the lac crops', it will be published as an Institute Bulletin, and will be translated into Hindi, Bengali and Oriya.

The damage to the lac crops by insect enemies is estimated at approximately 30 to 40% of the lac cells, the control measures recommended are all extremely simple and cost nothing more than the labour involved. They may be described as controls by cultural practice, their wide adoption would go along way towards the cutting down of insect damage to a minimum, and would aid considerably in the production of lac of a superior quality. They are described in detail in the above Bulletin.

B. Biological control.

Biological control consists of keeping enemy insects in check by means of their own natural enemies. A number of indigenous enemies of *E. amabilis* and *H. pulverea* are under investigation, of these the most promising is *Microbracon greeni* parasitic on the larva of *E. amabilis.* These indigenous species are already controlling agents in the field but are unable under present conditions to keep the damage done by the predators at an economic level. Research aims at increasing the value of these species, in control.

Microbracon hebetor is an introduced species parasitic on both *E. amabilis* and *H. pulverea* larvae and is showing great promise.

1. **Microbracon greeni,** Ashm.—During the year specimens of *Microbracon tachardiae,* Cam. sent to the Imperial Bureau of Entomology for confirmation of identification

were received after determination by Dr. Ch. Ferrière as *Microbracon greeni* Ashm. syn. *Microbracon* (*Bracon*) *tachardiae*, Cam. This species will therefore be referred to as *M. greeni* in future.

In last year's report it was recorded that one, two and three pair oviposition cages had been started, but that results from them had been inconclusive. During the year 0-70 eggs were laid per month in single pair cages, 7-144 eggs were laid in two pair cages, and 44-215 eggs were laid in three pair cages per month. One and two pair cages were therefore discontinued as from December 1935, and two further three pair cages were started. The eggs laid were transferred in all cases to capsules for development. The percentage of adults obtained from eggs thus treated was between 32% and 63% and averaged 49.5%.

In February 1936 a number of large mass breeding cages were started containing roughly 12-15 pairs of adults. Oviposition in these cages was satisfactory. During February the average number of eggs laid per host was 4, and in March 5. From eggs caged in February the percentage of adults was not recorded, from March caged eggs 56% adults were bred of which 23% were males.

It was found that the number of larvae which spin cocoons could be raised to 92% by placing larvae about to spin in sub-compartmental pith or wood combs. Individual cells, being about 0·25″ square, provided the mechanical support needed by the larvae to aid them in spinning. This technique was found to reduce larval mortality appreciably, as many of the larvae which fail to spin cocoons fail to develop into adults.

The average percentage parasitism for the period under review was 13·1%, compared with 10·8% and 7·10% in the two previous years. Parasitism in the Baisakhi and Jethwi crops was very low, parasitism was however higher than in previous years in the Katki and Aghani crops. In the latter particularly, where a maximum of 60·0% was observed in the month of December 1935.

Results indicate promise of increased control by liberation of laboratory bred adults at critical periods during the year. It is hoped to carry this work to a final conclusion during the coming year.

2. **Apanteles tachardiae,** *Cam.*—This species is an important endoparasite of *H. pulverea*. Attempts to get *A. tachardiae* to oviposit in the laboratory were not successful. A technique however has been evolved which it is hoped will yield results in the near future.

The average percentage parasitism for the 12 months under review was 6·6% compared with 3·3% and 4·7% in the two previous years. Parasitism in the Katki and Aghani crops was very low. The Aghani crop has in previous years shown a high *H. pulverea* mortality due to *A. tachardiae*. The maximum percentage parasitism was 60% occurred in July 1936 in the Baisakhi crop. It is this single abnormally high figure which is responsible for the increase in the average percentage parasitism this year.

3. **Microbracon hebetor,** Say.—It was reported last year that a strain of *M. hebetor* obtained from Ceylon died out at Namkum during May 1934, due to intense heat in the laboratories due to lack of fans, owing to the failure of the battery.

A further consignment of *M. hebetor* was received from Ceylon, thanks to the kindness of Mr. C. B. Redman King of the Tea Research Institute, during November 1935. Generation cages containing three pairs, and mass breeding cages, were started. The parasite has bred extremely satisfactorily, six generations having been bred by the end of the year under report. Hosts utilised in the main were *E. amabilis* and *H. pulverea* larvae supplied in domes and in infected sticks. A small consignment of *Ephestia kühniella* larvae was also received from Ceylon, this species is the regular host of *M. hebetor*. These larvae were introduced naked into the oviposition cages in capsules. The original adults and those of the F1. generation appeared to breed more satisfactorily on *E. kühniella* larvae than on *E. amabilis* or *H. pulverea*. later generations have become acclimatised to the predator larvae and are breeding on them satisfactorily.

An interesting discovery during the year was that *M. hebetor* will oviposit and breed freely on the larvae of *Platyedra gossypiella* the pink boll worm of cotton. The larvae were introduced naked into the oviposition cages in capsules.

A number of cocoons of *M. hebetor* were taken to Pelwal where an Aghani crop kusum × khair was being grown, during the months November to February. From these it is estimated that 150 adults emerged. Examination of short stick samples did not reveal colonisation. During March 1936, a number of adults of this *Braconid* were captured on a window pane of a room in the experimental lac factory, where some Pelwal lac was in store prior to manufacture, indicating that colonisation must have occurred. Several parasite cages were started containing Pelwal lac and from these 2 females *M. hebetor* were obtained towards the end of March and 3 males and 2 females during April. This is certain proof that colonisation had occurred. The brood from Pelwal has been transferred to kusum at Lat Ratu, results will be available in July 1936.

The paper referred to in the last Annual Report on *Microbracon hebetor* has been published during the year (Proc, Ind. Academy Sci. Vol. III. No. 3, March 1936). The conclusions arrived at may be summarised by saying that *M. hebetor* is considered to be a potentially ideal parasite for acclimatisation to *E. amabilis* and *H. pulverea* as hosts and for introduction into lac growing areas.

Particular attention will be paid to this species during the coming year.

4. **Hyperparasites.**—The following hyperparasites of the primary parasites of *L. lacca* were recorded during the year.

1. **Tetrastichus purpureus.** Cam. (*Eulophidae*).
2. **Eupelmus tachardiae.** How. (*Eupelmidae*).
3. **Marietta javensis.** How. (*Aphelinidae*).

A further paper, Institute Bulletin No. 22 was published during the year confirming the results recorded in Bulletin No. 21. The average hyperparasitism for the 5 years under review amounted to 3·6% with an average maximum of only 10·1% based on an examination of over 41,000 host stages in over 44,000″ of lac.

These three species occur also as primary parasites of lac and are therefore not to be encouraged.

Table VII summarises the monthly percentage of primary parasites of lac attacked by hyperparasites.

TABLE VII.

Monthly percentage chalcidoid parasites of lac hyperparasitised.

Month and year.	Baisakhi.		Jethwi.		Katki.		Aghani.	
	No. hosts present.	% hyper parasitised.	No. hosts present.	% hyper parasitised.	No. hosts present.	% hyper parasitised.	No. hosts present.	% hyper parasitised.
April 1935	743	13·4%	50	0·0%	...	...	...	...
May 1935	592	8·2%	108	3·7%	...	...	...	...
June 1935	429	0·2%	72	0·0%	...	...	...	...
July 1935	260	8·4%	80	0·0%	...	...	...	...
August 1935	...	...	...	...	452	0·2%	49	0·0%
September 1935	...	...	...	...	537	1·5%	275	1·1%
October 1935	...	...	...	...	1,617	0·0%	97	0·0%
November 1935	...	...	...	...	...	...	113	1·8%
December 1935	...	...	...	...	...	...	414	1·4%
January 1936	...	...	...	...	...	...	715	12·7%
February 1936	863	4·2%	...	...	...	...	556	9·3%
March 1936	1,000	39·8%	15	0·0%	...	...	318	6·7%

N.B.—The explanation printed under Table VI applies to the above Table also.

The maximum percentage hyperparasitism was 39·8% in March 1936 in the Baisakhi crop comparing closely with last year's maximum of 36·35% in March 1935.

The average monthly percentage hyperparasitism was 5·4% comparing with 3·7% in 1934-35, 1·7% in 1933-34 and 6·0% in 1932-33. Over 9,000 host stages were examined.

5. **Pristomerus testaceicollis.** Cam.

This species is an important endoparasite of *H. pulverea*. All efforts to get *P. testaceicollis* to oviposit in the laboratory have so far been a failure. The average maximum longevity among males was 67 days, adult emerged in December, among females the average maximum was 50 days, adult emerged in July.

6. **Bethylid.**—Specimens of this *Bethylid* which is ectoparasitic on *H. pulverea* have been sent to the Imperial Bureau of Entomology for identification. In previous years it has occurred only during the months November-March, during the last year it occurred between January and March, and also in June, July-August.

7. **Apanteles fakrulhajiae.** Mahd.—Very few specimens of this *Braconid* were observed during the year. It is believed to be endoparasitic on *H. pulverea.*

8. **Brachymeria tachardiae,** Cam.—Two varieties occur, a large and a small, the former is endoparasitic on the pupa of *E. amabilis* and the latter on the pupa of *H. pulverea.* This species is not an important agent in the control of these enemies.

9. **Eurytoma palidiscapus,** Cam.—An endoparasite of the pupa of *H. pulverea.* A few adults only emerged during the year.

10. **Elasmus claripennis,** Cam. Ectoparasitic on the pupa on *E. amabilis,* this species is not at present a parasite of major importance. It can however be bred in the laboratory, and it is hoped to be able to take up this work in the near future.

VII. Miscellaneous Work.

A short paper was published during the year in the Journal of the Bombay Natural History Society, Vol. XXXVIII. No. 1, 15th August 1935. In this paper the discovery of the Californian Red Scale, *Chrysomphalus aurantii* on pomelo and grape fruit in the Ranchi district is recorded. *L. lacca* was also observed on grape fruit. A description of the scale is given, and kerosene soap emulsion is recommended as a control. The following important parasites of *C. aurantii* and *Aspidiotus orientalis* are recorded.

1. **Aphytis chrysomphali** parasitic on *C. aurantii* and *Aspidiotus orientalis.* Recorded from India for the first time.

2. **Comperiella bifasciata** parasitic on *A. orientalis.* Recorded from India for the first time.

3. **Physcus** sp. (near **flaviventris**) from *A. orientalis.*

4. **Tetrastichus purpureus** and **Marietta javensis,** both of which are parasites of *L. lacca* are also recorded as parasites of *A. orientalis.*

The original edition of 'A Practical Manual of Lac Cultivation' is completely exhausted. Revision and bringing up to date of this book has been put in hand and it is hoped that it will be ready for publication towards the end of next year.

LIST OF INSTITUTE PUBLICATIONS.

1935-36.

I. Reports.

*1. Comprehensive Report from 1921 to March 1926.

*2. Annual Report from April 1925 to 31st March 1926.

*3. Annual Report from April 1926 to 31st March 1927.

*4. Annual Report from April 1927 to 31st March 1928.

*5. Annual Report from April 1928 to 31st March 1929.

6. A short account of the work of the Indian Lac Research Institute, 1930.

*7. Annual Report from April 1929 to 31st March 1930.

8. A report on the state of lac cultivation and general condition of the lac industry in Burma, by Dorothy Norris, 1931.

9. Annual Report from April 1930 to 31st March 1931.

10. Annual Report from April 1931 to 31st March 1932.

11. Annual Report from April 1932 to 31st March 1933.

12. Annual Report from April 1933 to 31st March 1934.

*13. Annual Report from April 1934 to 31st March 1935.

II. BULLETINS.

*1. Bulletin No. 1. Physical Properties of Shellac Solutions, Part I. By M. Rangaswami and M. Venugopalan 1928

*2. Bulletin No. 2. Physical Properties of Shellac Solutions, Part II. By M. Rangaswami and M. Venugopalan. 1929

*3. Bulletin No. 3. Wax and Resin Secretion by the Lac Insect on Butea frondosa. By M. Venugopalan 1929

*4. Bulletin No. 4. Properties of Shellac Films. I. Resistance of Shellac Films from various varnishes to action of water and chemicals. By M. Venugopalan and M. Rangaswami. Reprinted from Industrial and Engineering Chemistry, Vol. XXII, No. 8, Industrial edition, August 1930 1930

5. Bulletin No. 5. Humidity and Storage of Button Lac. By R. W. Aldis. Price 8 annas 1930

6. Bulletin No. 6. The effects of Temperature and Humidity on oviposition, incubation and emergence in the lac Insect, *Laccifer* (*Tachardia*) *lacca*, Kerr, (*Coccidae*) and on the resulting crop. By P. M. Glover, P. S. Negi, M. P. Misra and S. N. Gupta. Price Rs. 1-4-0 1932

7. Bulletin No. 7. Orpiment and the Iodine value of Shellac. By M. Rangaswami and R. W. Aldis. Price 8 annas 1932

*Not available.

8. Bulletin No. 8. The Iodine Value of Shellac. By R. W. Aldis. Price 8 Annas 1932

9. Bulletin No. 9. Comparative study of lac hosts with special reference to Acacia Catechu and Cassia Florida. By A. K. Thakur. Price 8 Annas ... 1932

10. Bulletin No. 10. The Influence of Orpiment in Shellac on the protective properties of the varnish. By M. Rangaswami. Price 8 Annas ... 1932

11. Bulletin No. 11. Resin secretion on different host plants by the Lac Insect. By M. Venugopalan. Price 8 Annas 1932

12. Bulletin No. 12. Shellac Drying—Oil Combinations. By R. W. Aldis. Price Rs. 1-8-0 1933

13. Bulletin No. 13. Orpiment in Shellac. By R. W. Aldis. Price Re. 1-0-0 1933

*14. Bulletin No. 14. "The Heat Curing of Shellac", Part I. The "Life under heat". By S. Ranganathan and R. W. Aldis. Price Rs. 1-8-0 ... 1933

*15. Bulletin No. 15. Notes on the use of *Schleichera trijuga* (Kusum) in lac cultivation, Pruning and Cropping. By Dorothy Norris. Price Rs. 1-4-0 ... 1933

*16. Bulletin No. 16. *Aspidiotus* (*Furcaspis*) *orientalis*, Newstead, (*Coccidae*), its economic importance in Lac Cultivation and its control. By P. M. Glover. Price Rs. 1-4-0 1933

17. Bulletin No. 17. The Refractive Index of Shellac. By A. K. Thakur and R. W. Aldis. Price Re. 1-0-0 1934

*18. Bulletin No. 18. Modification of Shellac. Part I. The effect of Sulphur. By M. Venugopalan. Price Rs. 1-0-0 1934

*19. Bulletin No. 19. The Heat Curing of Shellac. Part II. "Depolymerisation". By M. Rangaswami and R. W. Aldis. Price Re. 1-0-0 1934

*20 Bulletin No. 20. Further Notes on the use of *Schleichera trijuga* (Kusum) in lac cultivation. By Dorothy Norris. Price 8 Annas 1934

*21. Bulletin No. 21. A Check-list of the *Chalcidoidea* bred at Namkum from the lac insect, *Laccifer lacca* with some notes as regards their function, economic importance and control. By P. M. Glover. Price Re. 1-0-0 ... 1934

*22. Bulletin No. 22. Further Notes on the *Chalcidoid* parasites *Laccifer lacca*, Kerr. By P. M. Glover. Price Re. 1-0-0 1935

III. Research Notes.

*1. Research Note No. 1. A Note on Bleaching Shellac. By N. Narasimha Murty and R. W. Aldis 1932

2. Research Note No. 2. A Note on Determination of Shellac Fluidity. By R. W. Aldis 1932

3. Research Note No. 3. A Note on the Swelling of Shellac. By R. W. Aldis ... 1932

*Not available.

4. Research Note No. 4. Some effects of Baking Shellac Varnish Films. By M. Rangaswami and R. W. Aldis 1933

5. Research Note No. 5. Shellac—Castor oil combinations. By R. W. Aldis ... 1933

6. Research Note No. 6. A Note on the use of Lithopone in Shellac paints. By R. W. Aldis 1933

7. Research Note No. 7. Reconditioning Shellac. By R. W. Aldis ... 1933

8. Research Note No. 8. A Note on Wax-free Shellac. By M. Rangaswami ... 1933

9. Research Note No. 9. Tricresyl phosphate and water resistance of shellac. By M. Rangaswami and R. W. Aldis 1933

10. Research Note No. 10. Sulphur treatment of shellac. By M. Venugopalan ... 1933

11. Research Note No. 11. Further notes on reconditioning shellac. By R. W. Aldis 1933

12. Research Note No. 12. Treatment of shellac varnish with sulphur monochloride. By M. Venugopalan 1933

13. Research Note No. 13. Improvement in the heat resistance of shellac mouldings. By S. Ranganathan and R. W. Aldis 1933

14. Research Note No. 14. Treatment of shellac varnish with thiourea and urea. By M. Venugopalan, S. Ranganathan and R. W. Aldis 1934

15. Research Note No. 15. The Influence of nitrogenous substances on shellac bleaching. By N. Narasimha Murty 1934

16. Research Note No. 16. Utilisation of Kiri for Plastic Mouldings. By S. Ranganathan and R. W. Aldis 1934

17. Research Note No. 17. A further means of Dispersing Polymerised shellac. By M. Venugopalan and R. W. Aldis 1934

18. Research Note No. 18. Some effects of Hydrochloric Acid on shellac varnish. By R. W. Aldis 1934

IV. Pamphlets and Leaflets.

*1. Lac Research in India. By Dorthy Norris 1927

*2. Instructions for crop cutting (Hindi) 1929

*3. Instructions for crop cutting (Bengali) 1929

4. Advice on the more profitable use of the Kusum tree as a lac host. By Dorothy Norris 1934

5. Advice on the more profitable use of the Kusum tree as a lac host. By Dorothy Norris (Oriya) 1934

6. Advice on the more profitable use of the Kusum tree as a lac host. By Dorothy Norris (Hindi) 1934

*Not available.

7. A simple method for the forecast of emergence of lac larvæ. By P. S. Negi 1934

8. A simple method for the forecast of emergence of lac larvæ. By P. S. Negi (Oriya) 1935

9. A simple method for the forecast of emergence of lac larvæ. By P. S. Negi (Hindi) 1935

10. A simple method for the forecast of emergence of lac larvæ. By P. S. Negi (Bengali) 1935

V. Articles in other papers and journals.

*1. The Lac and Shellac Industry of India. By Dorothy Norris. ('Capital', Indian Industries and Trade Supplt.) 13th December 1928 1928

*2. A Contribution to the life-history of the lac insect. By Pratap Singh Negi. Reprinted from the Bulletin of Entomological Research, Vol. IX, part 4, March 1929 1929

*3. An investigation into the plant requirements of *Ziziphus Jujuba* during growth and under Lac Cultivation, Part I. By Dorothy Norris, M. Rangaswami, M. Venugopalan, and S. Ranganathan. Reprinted from the Indian Forester, October 1929 1929

*4. A Preliminary Note on the Use of *Acacia Catechu* (Khair) as a host alternative with *Schleichera trijuga* (Kusum) for the Cultivation of *Tachardia lacca* (Lac). By Dorothy Norris, H. T. Bates and M. Rangaswami. Reprinted from the Indian Forester, January 1930 1930

5. Hindi Translation of the above, June 1930 1930

6. Oriya Translation of the above, December 1930 1930

*7. Ants and the Lac insect (*Laccifer lacca*). By P. S. Negi, M. P. Misra and S. N. Gupta. Reprinted from the Journal of the Bombay Natural History Society, March 1st 1930 1930

*8. A Note on the determination of the melting point of resins. By M. Rangaswami. Reprinted from the Journal of the Oil and Colour Chemists Association. Vol. XIII, page 287, 1930 1930

9. The *Noctuid* Moth (*Eublemma amabilis*, Moore). By M. P. Misra, P. S. Negi and S. N. Gupta. Reprinted from the Journal of the Bombay Natural History Society, January 15th, 1930 1930

*10. The Lac Industry in India. By Dorothy Norris. (Journal of the Oil and Colour Chemists' Association, Vol. XIII, July 1930) 1930

*Not available.

*11. Entomological aspects of Lac Research in India. By P. M. Glover. Reprinted from the Bulletin of Entomological Research, Vol. XXI, Part 3, October, 1930 1930

*12. Shellac. By Dorothy Norris. ('Capital' 20th March 1930) 1930

*13. Paper on Lac Plantations. By P. M. Glover. (Proceedings of Bihar and Orissa Forest Conference, Ranchi) 1930

*14. The Lac and Shellac Industry of India. By Dorothy Norris. ('Capital' December 1930) 1930

*15. Shellac. By P. M. Glover. (The Oil and Colour Trades Journal, Vol. LXXVII, page 1884, 1930) 1930

16. Some Aspects of the Bionomics of the Lac Insect. By P. S. Negi, M. P. Misra and S. N. Gupta. Reprinted from the Journal of the Bombay Natural History Society, 15th June 1931 1931

*17. Some simple methods of controlling the insect enemies of lac. By P. M. Glover. (Published by the Agricultural Department, Bihar and Orissa. Leaflet No. 2 of 1932) 1932

18. Research for Shellac. Reprinted from 'Capital', 2nd February 1933 ... 1933

19. The small red ant *Solenopsis geminata* sub sp. *rufa*, Jerdon, and its usefulness to man. By P. S. Negi. Reprinted from the Journal of the Bombay Natural History Society, December 15th, 1933 1933

20. A simple method for the forecast of emergence of lac larvae, and a description of the myology of the adult female lac insect, *Laccifer lacca* Kerr, (*Coccidae*). By P. S. Negi. Reprinted from the Indian Journal of the Agricultural Science, Vol. III part 6, December 1933 1933

21. The Biology of *Holcocera pulverea* Meyr, its predators, parasites and control. By M. P. Misra and S. N. Gupta. Reprinted from the Indian Journal of Agricultural Science, Vol. IV part 5, October 1934 1934

22. The Developmental Stages of *Bracon tachardiae*, Cam. (Hym.) By P. M. Glover. Reprinted from the Bulletin of Entomological Research. Vol. XXV, part 4, December 1934 1934

23. The Alimentary canal, its appendages, salivary glands and the nervous system of the adult female lac insect, *Laccifer lacca*, Kerr. (*Coccidae*). By P. S. Negi. Reprinted from Bulletin of Entomological Research, Vol. XXV part 4, December 1934 1934

*Not available.

*24. Lac Cultivation and the Shellac Industry. By P. M. Glover. Reprinted from the Tisco Review, Vol. III, No. 1, 1935 1935

*25. Specificity of parasitism by *Eublemma amabilis*. By P. M. Glover and P. S. Negi. (Current Science Vol. III, No. 9th March 1935) 1936

26. The Hosts of *Eupelmus tachardiae*, How. By P. M. Glover, P. S. Negi and S. N. Gupta. Reprinted from Current Science Vol. IV, No. 1, July 1935 ... 1935

27. An account of the occurrence of *Chrysomphalus aurantii*, Mask., and *Laccifer lacca*, Kerr, on Grape fruit in Ranchi District Chota Nagpur, with a note on the *Chalcidoid* parasites of *Aspidiotus orientalis*, Newst. By P. M. Glover. Reprinted from the Journal of the Bombay Natural History Society, 15th August, 1935 1935

28. A Preliminary note on the bionomics and economic importance of *microbracon hebetor* Say., a *braconid* new to North India. By P. M. Glover and K. C. Chatterji. Proceedings of the Indian Academy of Sciences, Vol. III, No. 3, March 1936.

VI. Books.

*1. A Practical Manual of Lac Cultivation. By P. M. Glover, Price Rs. 2-0-0 ... 1931

2. Bibliography of Lac. By A. C. Chatterjee. (Published by the Indian Lac Cess Committee.) Price Rs. 2-8-0 1933

3. Lac and the Indian Lac Research Institute. By Dorothy Norris, P. M. Glover, and R. W. Aldis. 2nd Edn. Price Rs. 2-8-0 1935

4. Shellac Patent Index. Compiled by R. W. Aldis Price Rs. 2-8-0 ... 1936

VII. Tung Oil literature.

1. Notes on the Establishment of *Aleurites Fordii* (Tung Oil) in the Ranchi District of Chota Nagpur. By Dorothy Norris and H. T. Bates. Reprinted from the Indian Forester, June 1930 1930

2. The Establishment of *Aleurites Fordii* (Tung Oil) in the Ranchi District of Chota Nagpur. By Dorothy Norris and H. T. Bates. 1933

In the Press.

1. Shellac Industry.
2. Some Analytical Data for Pure Shellacs.

*Not available.

3. Some information and advice to shellac manufacturers.

4. Instructions for cultivation of *Aleurites Fordii*, Tung Oil, in Chota Nagpur. By Dorothy Norris.

5. Hindi Translation of the above.

6. Some simple method of reducing the damage done by insect enemies to the Lac crop. Bulletin No. 23. By P. M. Glover.

7. The use of *Schleichera trijuga* (Kusum) in lac cultivation. Bulletin No. 24. By Dorothy Norris.

8. "The Heat Curing of Shellac" Part I. The "Life under heat." Revised edition. To replace Bulletin No. 14. By S. Ranganathan and R. W. Aldis.

List of the staff employed at the Indian Lac Research Institute, Namkum, during 1935-36.

Name.	*Designation.*	*Date of appointment.*
ADMINISTRATIVE SECTION.		
Mrs. D. Norris, M.Sc., F.I.C ...	Director and Biochemist ...	28th October 1923 (on leave from 1st January 1936).
Mr. S. N. Sahay, B.A. ...	Librarian & Indexer ...	7th July 1930.
„ M. Bose	Head Clerk & Cashier ...	14th April 1927.
„ J. K. Guha Roy ...	Second Clerk ...	1st April 1928.
„ G. B. Thapa ...	Accounts Clerk ...	18th August 1925.
„ J. M. Hazra ...	Typist ...	1st March 1927.
„ Md. Sharfuddin ...	Stores Clerk ...	18th March 1933.
„ K. C. Guha Roy ...	Chief Mechanic ...	8th June 1925.
„ J. C. Bose ...	Assistant Mechanic ...	1st March 1935.
„ Saheb Ali ...	Labour Supervisor ...	15th May 1935.
„ S. P. Chatterjee ...	Temporary Typist ...	8th May 1935 to 13th July 1935, 17th July 1935 to 20th July 1935.
„ C. D. Gupta ...	Temporary Typist ...	2nd September 1935 to 30th November 1935.
BIOCHEMICAL SECTION.		
Mr. A. K. Thakur, M.Sc., ...	1st Asstt. to the Biochemist	1st April 1929.
„ N. N. Murty, M.Sc ...	2nd do. ...	15th January 1931.
„ M. Venugopalan M.Sc. A.I.C.	1st Field Chemist ...	2nd June 1925.
„ S. Ranganathan, B.A. ...	2nd do. ...	2nd August 1926.
„ L. Rahaman ...	Laboratory Assistant ...	1st August 1925.
ENTOMOLOGICAL SECTION.		
Mr. P. M. Glover, B. Sc. ...	Entomologist ...	27th July 1929 (offg. Director from 1st January 936).
„ P. S. Negi, M. Sc. ...	Assistant Entomologist ...	3rd July 1926.
„ M. P, Misra, M. Sc. ...	1st Field Assistant ...	7th September 1926.
„ S. N. Gupta, M. Sc. ...	2nd do. ...	9th September 1926.
„ E. Heber ...	Artist & Photographer ...	27th August 1924.
„ J. N. Singh ...	Senior Fieldman ...	25th February 1926.
„ K. C. Chatterjee ...	Junior do. ...	19th February 1926.
„ Ramprashad ...	Do. do. ...	23rd October 1926.
„ A. C. Chatterjee ...	Do. do. ...	9th December 1929.
„ B. Tirkey ...	Setter & Lab. Asstt. ...	30th July 1928.
PHYSICO-CHEMICAL SECTION.		
Dr. R. W. Aldis, Ph. D. ...	Physico-Chemist ...	8th February 1930.
Mr. M. Rangaswami, B. A. ...	1st Asstt. to Phy. Chemist	2nd June 1925.
„ S. C. De, B. Sc. ...	Analytical Chemist ...	23rd September 1930.
„ B. Misra ...	Laboratory Assistant ...	22nd April 1930.

The menial establishment comprises 25 persons.

APPENDIX.

General Final Crop Report by N. K. Sarkar, Crop Statistician.

Baisakhi and Jethwi (1935). (All estimates are in maunds of stick lac.)

	Preliminary estimate 1935.	Final 1935.		Final Last 2 years' Crops.		Estimated Normal (Revised)	Approximate quantity of shellac expected from 1935 Baisakhi and Jethwi.
		Baisakhi.	Jethwi.	1934.	1935.		
1. Pakur	75,000	75,000	...	55,000	17,500	1 00,000	37,500
2. Jhalda	63,000	65,000	3,000	84,000	72,000	1,10,000	35,000
3. Balrampur ...	1,00,000	1,00,000	3,000	87,000	85,000	90,000	55,000
4. Ranchi	85,000	80,000	5,000	80,000	57,500	1,10,000	45,000
5. Singhbhum ...	52,500	50,000	4 000	37,000	35,000	60,000	28,000
6. Kota-Pendra ...	35,000	30,000	...	27,500	25 000	40,000	15,000
7. Rajim-Dhamtari ...	6,000	6,000	8 000	5,300	8,000	10,000	7,500
8. Gondia ...	34,500	30,000	...	34,000	25,500	25,000	14.000
9. Katni-Damoh ...	8,000	8,000	...	11,000	5,000	15,000	4,000
10. Umaria ...	17,000	15,000	...	17,500	35,000	35,000	7,500
11. Daltongunj ...	1,10,000	1,10,000	500	1,15,000	60,000	1.10.000	50,000
12. Other Minor ...	60,000	64,000	6,500	83,500	55,500	95,000	35,000
Total of 12 Divisions	6,46,000	6,33,000	30,000	63,7000	4,91,000	8,00,000	3,33,500
13. Non-reporting areas	7,000	7,000	...	9,000	9,000	10.000	3,500
Grand Total ...	6,53,000	6,40,000	30,000	6,46 000	5,00,000	8,10,000	3,37,000

APPENDIX

General Final Crop Report by N. K. Sarkar, Crop Statistician.

Kusmi Crop (1935). (All estimates are in maunds of stick lac.)

Divisions.	Preliminary Estimate 1935.	Final 1935.	1934.	1933.	Estimated Normal.
1. Pakur	...	...	...	...	...
2. Jhalda	30,000	30,000	10,000	13,000	1,00,000
3. Balrampur	43,000	30,000	12,250	17,000	70,000
4. Ranchi	70,000	80,000	35,000	36,500	80,000
5. Singhbhum	35,000	30,500	10,750	19,500	65,000
6. Kota-Pendra	1,250	1,250	750	1,500	1,000
7. Rajim Dhamtari ...	16,000	16,000	23,000	17,000	20,000
8. Gondia	250	250	250	250	...
9. Katni-Damoh	...	...	...	...	...
10. Umaria	500	500	50	500	1,000
11. Daltongunj	2,500	2,500	500	3,000	4,000
12. Other Minor	12,000	12,000	11,000	13.000	10,000
Total of 12 Divisions ...	2,10,500	20,300	1,03,550	1,21,250	3,51,000
13. Assam	...	...	...	...	...
14. Non-reporting areas ...	1,500	1,500	1,450	1,750	1,500
TOTAL KUSMI ...	2,12,000	2,44,500	1,04,900	1,23,000	3,52,500

APPENDIX.

General Final Crop Report by N. K. Sarkar, Crop Statician.

Katki Crop (1935). (All estimates in maunds or stick lac.)

Divisions.	Preliminary Estimate.	Final.	Final last two years' crops.		Estimated Normal.
			1934.	1933.	
1. Pakur	30,000	25,000	8,000	37,500	50,000
2. Jhalda	10,000	10,000	28,000	28,000	45,000
3. Balrampur	10,000	10,000	20,000	13,000	35,000
4. Ranchi	21,000	23,500	25,000	21,500	35,000
5. Singhbhum	6,500	7 500	6,250	10 000	25,000
6. Kota-Pendra ...	15,000	15,000	16,000	32,000	25,000
7. Rajim-Dhamtari ...	5,000	5,000	7,500	10,000	10,000
8. Gondia	27,500	26,000	30,000	43,750	50,000
9. Katni-Damoh ...	12,000	12,000	9,500	20,000	20,000
10, Umaria	10,000	10,000	7,000	5,500	20,000
11. Daltongunj	16,000	17,500	21,500	40,000	50,000
12. Other-Minor ...	30,000	30,000	35,000	57,000	35,000
Total of 12 Divisions ...	1,93,000	1,91,500	2,13,750	3,18,250	4,00,000
13. Assam	36,000	36,000	45,000	22,000	47,000
14 Non-reporting areas ...	3,000	3,000	3,250	3,750	5,500
Total Katki ...	2,32,000	2,30,500	2,62,000	3,44,000	4,52,500

APPENDIX.

Total of all lac crops for the year 1935.

(All estimates are in maunds of stick lac.)

Divisions.	Baisaki.	Jethua.	Katki.	Kusmi.	Total.
1. Pakur	75,000	...	25,000	...	100,000
2. Jhalda	65,000	3,000	10,000	30,000	108,000
3. Balarampur	1,00,000	3,000	10,000	30,000	143,000
4. Ranchi	80,000	5,000	23,500	80,000	188,500
5. Singhbhum	50,000	4,000	7,500	30,500	92,000
6. Kota-Pendra	30,000	...	15,000	1,250	46,250
7. Rajim-Dhamtari ...	6 000	8,000	5,000	16,000	35,000
8. Gondia	30,000	...	26,000	250	56,250
9. Katni-Damoh	8,000	...	12,000	...	20,000
10. Umaria	15,000	...	10,000	500	25,000
11. Daltongunj	1,10,000	5,00	17,500	2,500	130,500
12. Other minor	64,000	65,00	30,000	12,000	112,500
Total of 12 Divisions ...	63,3000	30 000	1,91,500	2,03,000	10,57,500
13. Assam	...	...	36,000	...	36,000
14. Non-reporting	7,000	...	3,000	1,500	11,500
Grand Total ...	6,40,000	30,000	2,30,500	2,04,500	11,05,000