

TRIALS WITH THE INDIAN LAC INSECT
IN CEYLON DURING 1938-39

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IN CEYLON

VARIOUS attempts have been made in the past to cultivate the Indian lac insect, *Laccifer lacca*, Kerr., in Ceylon but without success. This has also been the experience of certain other countries such as Egypt, Japan, and Malaya. Recent observations made in Ceylon indicate that it may not be possible to cultivate this introduced insect in the Island, chiefly owing to the death of the young larvae following the degeneration of the insect which occurs in this country shortly after its introduction from India and also on account of the damage caused to the insect by its natural enemies.

No precise information has been available as to the cause, or causes of the devitalization of the insect in Ceylon but, rightly or wrongly, it has been attributed to unfavourable climatic conditions. Although climate, undoubtedly, has an important controlling influence upon the development of an insect species, mortality of a similar nature to that associated with this species in Ceylon has been observed to occur in certain parts of India where the climate is known to be favourable to the insect. The failure to establish this insect in Ceylon may, therefore, be due to some factor which has not previously been considered or to a combination of unfavourable conditions.

OBJECT AND METHOD OF TRIALS

Before finally abandoning the attempt to grow lac in Ceylon it has been considered desirable to determine, if possible, the cause of the mortality of the lac larvae and to ascertain if this could be prevented or at least minimized.

It was thought possible that one, if not the main, cause of the devitalization of the insect has been the repeated cutting at each season of brood lac a few days prior to the commencement of swarming. It is a recognized fact that premature cutting of brood lac is extremely harmful. If it is cut too early the vitality of the larvae is adversely affected as they are

deprived of nourishment through the mother who is cut off from her own food supply. Brood lac should, therefore, be cut as late as possible.

To determine whether the repeated and possibly premature cutting of brood lac has been a cause of failure or not, trials were undertaken at Nikaweratiya, Dambulla and Angoda (Katugas-tota), the main centres where the earlier experiments were conducted. In these trials the system of cutting brood lac a few days prior to the emergence of larvae was abandoned and the lac was cut a few days (about four) after the actual emergence of the larvae had begun. Natural infection (*i.e.*, allowing the insects to swarm *in situ* and settle on other available branches of the same tree) was also tried.

In undertaking these trials, certain obvious objections to their adoption were not overlooked. One of the most important of these is the loss of a certain number of larvae which are unable to find a suitable place for settlement but this loss should not be serious if cutting is not unduly delayed. All larvae do not swarm simultaneously. Swarming continues for about three weeks so that the loss need not be very great. The object should be to obtain healthy and vigorous larvae which have not been weakened by premature cutting of the branches from which their mothers obtain nourishment.

The main objection to natural infection is that it is believed to encourage natural enemies of the lac insect. To what extent this is the case it is difficult to say. Even where artificial infection alone is practised, predators and parasites cause very heavy losses, and, indeed, instances are known where an entire crop has been lost owing to the predators. During certain seasons very extensive damage by enemies in certain localities must be expected irrespective of the method of infection adopted. Such outbreaks of lac predators and parasites are due to environmental factors, including an abundance of food, momentarily advantageous to their development or a decrease in the number of their own enemies.

THE TRIALS

To make observations on these various points the main experiments could not be undertaken until a supply of brood lac was received from India. This was not possible in January/February, 1938, owing to a scarcity of brood material in the Ranchi district but the Indian Lac Research Institute, Namkum, Ranchi, was able to send a supply in the following season.

FIRST GENERATION CROP

The consignment of brood lac was received in Ceylon on June 17, 1938, in fairly good condition. It was of the *kusum-*

(*kon*) strain and consisted of 208 lb. The material was inoculated on the previously pruned *kon* trees (*Schleichera trijuga*) on June 17 and 18, 1938, at Inamalawa (Dambulla) and Nikaweratiya, respectively.

- The brood material was of second grade quality, and on receipt the insects were found to have commenced emergence; about 118 lb. were tied on to eight *kon* trees at Inamalawa and the balance (90 lb.) was used for infecting five *kon* trees at Nikaweratiya. Later examination showed that settlement of larvae at both the centres was satisfactory and the subsequent development was good. A fair amount of damage, which was to be expected, was caused by predators. The weather during the period of development was drier than normal.

Larvae commenced to emerge on November 15, 1938. The crop at Inamalawa was harvested on November 18, 1938, *i.e.*, five months after inoculation. The encrustations were good and considering the inferior quality of the brood lac received from India the crop was satisfactory. A yield of 178 lb. was obtained excluding an estimated amount of 28 lb. left uncut on the trees for natural infection. The total yield would, therefore, be about 207 lb. or a little over 1½ fold.

Of the 178 lb. harvested, 104 lb. were transferred to six other *kon* trees at Inamalawa while the balance (74 lb.) was removed to Mirisgonioya (Dambulla) and used for inoculating four *kon* trees. All these trees had been previously pruned.

The crop at Nikaweratiya was harvested on November 20, 1938; 82 lb. were cut from the trees and about 36 lb. were left uncut for natural infection. The total yield was, therefore, estimated to be about 118 lb. or slightly more than 1-fold. The crop gathered was put on to five *kon* trees at the same centre.

Heavy infestations by red ants (*Oecophylla smaragdina*) and a black ant *Kodaya*, S., (*Cremastogaster* sp.) made it very difficult for the labourers to harvest the crop on some trees.

SECOND GENERATION CROP

The settlement of larvae at both centres was very good. The crop at Nikaweratiya developed most satisfactorily. At Inamalawa it was heavily attacked, during the later stages, by predacious caterpillars. Observations also indicated that the black ant *Kodaya*, S., (*Cremastogaster* sp.) may also possibly be an enemy of the lac insect by causing the death of lac larvae soon after settlement. The condition of the crop at Mirisgonioya was good. The weather during the period of development of the insects was normal.

The lac encrustations formed very well at all the centres, particularly at Nikaweratiya. Emergence of larvae commenced

on April 24, 1939, at Nikaweratiya and two days later at Dambulla, the life-cycle of the insect thus occupying slightly over five months.

The crop at Nikaweratiya was harvested on April 28, 1939. It was most satisfactory. From the artificially-infected trees 389 lb. were harvested representing a yield of nearly 5-fold. From two naturally-infected trees where about 20 lb. were left uncut it was possible to gather 168 lb. or over 8-fold. The crop on the third naturally-infected tree was poor and was left uncut.

Of the brood lac harvested, 517 lb. were transferred to twelve other *kon* trees at the same centre. Most of these had been previously pruned. Only two trees which carried crops this season were utilized for natural infection.

About 40 lb. were removed to Angoda (near Katugastota) and were given to lac workers for inoculation there. Of this quantity 10 lb. had been sent by them to Ratnapura and the remainder (30 lb.) was used for infecting three *kon* trees at Angoda. These trees had been previously pruned and possessed branches of suitable growth.

The crop at Inamalawa was harvested on April 30, 1939. It was poor owing to the serious injury wrought by the predators in the later stages and by the black ant (*Cremastogaster*) on a few trees in the early stages. Only 42 lb. of second-grade brood lac was harvested from a single tree. About 24 lb. of second-grade lac on six other trees were left uncut. The 42 lb. harvested were transferred to another tree at the same centre.

At Mirisgonioya the crop was more satisfactory. It was harvested the following day and amounted to about 142 lb. or nearly 2-fold including about 12 lb. left uncut for natural infection. The damage by natural enemies here was not so significant as at Inamalawa.

The harvested crop of 130 lb. was transferred to five *kon* trees at the same centre. All these trees had been pruned about $2\frac{1}{2}$ -3 years earlier.

THIRD GENERATION CROP

The settlement of larvae on all the infected trees in the various centres, *viz.*, Nikaweratiya, Mirisgonioya, Inamalawa and Angoda, was very good. The later development of the insects was also very satisfactory, indicating that there had been no devitalization. Shortly afterwards, however, an abundance of predators was noticed in all the localities except at Angoda, where there had been no lac immediately preceding the present crop. As the lac insects developed, the number of enemies rapidly increased, causing very extensive damage resulting in

very poor crops except at Angoda, where it was excellent. The weather during the development of the crop was drier than normal.

Larvae commenced to emerge at Nikaweratiya and Dambulla on October 4, 1939, the life-cycle thus occupying nearly five and a half months. At Angoda emergence was delayed till October 20, and the insect thus completed its development in nearly six months.

The crop at Nikaweratiya was harvested on October 9, 1939. Owing to the heavy damage by enemies, most of the lac was of second-grade quality and not suitable for brood purposes. From the artificially-infected trees only 148 lb. were cut compared with 517 lb. inoculated. From naturally-infected trees an additional crop of 6 lb. was gathered. A fairly good crop on one tree could not be collected owing to a heavy infestation by red ants which attacked the labourers. Generally, the damage caused by predators was no greater on natural infestations than on the others. In fact, some of the lac encrustations on the naturally-infected trees were better formed than those on the artificially-infected trees.

The 154 lb. harvested were transferred to ten *kon* trees at the same centre.

The crop at Mirisgoniyoa was also poor, but was better than at Nikaweratiya. The damage by predators was not as extensive as at Nikaweratiya. A yield of 20 lb. was obtained from a tree inoculated with 80 lb. of brood lac. The small quantities of lac on other trees were left for natural infection. From a tree where about 6 lb. were left uncut for natural infection, 37 lb. were harvested.

The 62 lb. gathered were transferred to seven *kon* trees at the same centre. The trees had been previously pruned.

At Inamalawa, too, the crop was poor, again owing to the action of the predators. From the tree infected with 42 lb. only 11 lb. were harvested, while from a naturally-infected tree where about 15 lb. were left uncut last season 36 lb. were reaped. Most of the encrustations on the latter tree were very well formed.

The crop gathered at this centre was tied on to three other *kon* trees, all previously pruned. Five other trees which had very little lac on them, mostly damaged by enemies, were left uncut to see if larvae would emerge from them and produce a crop.

The crop at Angoda was most satisfactory. The encrustations were very well formed. Damage by enemies was not heavy. The crop was gathered on October 21, 1939. A yield of 225 lb. was obtained by the lac workers including about 10 lb. left uncut

for natural infection. This represents a yield of $7\frac{1}{2}$ -old. The brood lac was used for infecting four suitable *kon* trees in the same area.

Settlement of larvae in Mirisgonioya and Inamalawa was very good. At Nikaweratiya, too, it was satisfactory although on three trees it was only fair. There was continuous wet weather at Angoda during swarming but, in spite of the heavy rains, the larvae established themselves very satisfactorily. Although the settlement of larvae was good the young insects are being destroyed by enemies in all the centres except at Angoda where the crop is developing very satisfactorily.

SUMMARY

The following table summarizes the various inoculations and the crops obtained from the consignment of the Indian lac imported in June, 1938 :

Place.	Date of inoculation.	No. of lb. inoculated.	Date of harvest.	No. of lb. harvested.	Remarks.
<i>1st Generation.</i>					
Inamalawa	.. 17.6.38 ..	118..	18.11.38..	178+29* =207	*Left uncut for natural infection.
Nikaweratiya	.. 18.6.38 ..	90..	20.11.38..	82+36* =118	..
<i>2nd Generation.</i>					
Inamalawa	.. 19.11.38..	104..	30.4.39..	42+24* =66	a=From naturally-infected trees.
Mirisgonioya	.. do. ..	74..	1.5.39..	130+12* =142	b=A small quantity left uncut not included.
Nikaweratiya	.. 20.11.38..	82..	28.4.39..	389+168 a =547 b	c=Part of crop on a tree could not be gathered.
<i>3rd Generation.</i>					
Inamalawa	.. 30.4.39..	42..	11.10.39..	11+36 a =47 b	
Mirisgonioya	.. 1.5.39..	130..	10.10.39..	20+42 a =62 b	
Nikaweratiya	.. 29.4.39..	517..	9.10.39..	148+6 a. c. =154 b	
Angoda	.. 30.4.39..	30..	21.10.39..	215+10* =225	
<i>4th Generation.</i>					
Inamalawa	.. 11.10.39..	47			
Mirisgonioya	.. 10-11.10.39	62			
Nikaweratiya	.. 9-10.10.39	154			
Angoda	.. 22-25.10.39	215			

OBSERVATIONS AND CONCLUSIONS

The present series of trials has not been conducted long enough to warrant definite conclusions being drawn ; nevertheless the results so far achieved, in conjunction with those of the earlier experiments, indicate what may reasonably be anticipated in cultivating lac in Ceylon.

The results of the experiments suggest that the climatic conditions in Ceylon, where the *kon* trees naturally occur, viz., the mid-and low-country districts of the Island, are not unsuitable for the development of the Indian lac insect. The present trials indicate that the devitalization of the insect that occurs in this country shortly after its introduction from India is due to causes other than climatic. This is definitely illustrated by the second generation crop harvested at Nikaweratiya when a yield of about 5-fold was obtained and the following generation crop at Angoda where the crop gathered was $7\frac{1}{2}$ -fold, the best ever obtained in Ceylon. The encrustations in both these centres were excellent. Further, observations made in the laboratory on the number of larvae which emerged from single lac tests also confirmed this conclusion.

In the earlier experiments the first generation crop, resulting from the imported brood material, had always been good. Thereafter it rapidly deteriorated. The second crop was less satisfactory and the insects entirely disappeared in the third or fourth generation. A noticeable feature in this progressive deterioration was the heavy mortality of the young larvae within a month or two after inoculation. In the present trials no such heavy mortality was observed.

The only important difference between the present and past trials was in the time of inoculation. As has been stated earlier, the brood lac in the present trials was cut a few days after the commencement of emergence of a few larvae or they were allowed, where possible, to swarm naturally on the same tree. In other words, the lac was cut a few days later than had been the practice in the earlier trials or natural infection was tried. The reasons for this variation have already been explained. The only important difference thus being in the time of inoculation, the better results achieved may be due to the later cutting of the brood lac, an operation which permitted the mother insects to continue to obtain nourishment and thus give rise to healthy offspring.

There are two definite periods of swarming of the *kon* lac in North India. They are January/February and June/July. The life-cycle of the insect thus occupies six months. In Ceylon, however, owing to difference in climate, no such definite seasons occur, and the insects swarm at irregular intervals. The experiments indicate that the life-cycle here is slightly shorter and is reduced to a period of from five to six months depending on local weather conditions. This necessitates a very careful watch being kept on the development of the insect so as to decide when the brood lac should be harvested. The swarming may occur in any month of the year, unlike in India where the insects experience a cold winter and a severe summer when their activities are considerably affected.

The development of lac insects is dependent to a very large extent on their natural enemies. A large number of them, both parasites and predators, occur in Ceylon as they do in India. Of these the most destructive are the two predacious caterpillars *Eublemma amabilis* and *Holcocera pulverea*, which devour the lac insects. The injury caused by other enemies, particularly parasitic wasps, is comparatively small.

Eublemma and *Holcocera* develop freely in Ceylon throughout the year, an abundance of the host insect being an important factor favouring their increase. In North India the marked cold weather in winter and the hot summer check to some extent their activities, but in Ceylon owing to the more equable climate no such natural checks exist.

Natural infection, practised to some extent by the raiyats of India, has been condemned by some authorities, as it is believed to encourage natural enemies. Observations made during the course of the present trials did not reveal that such crops are any more heavily attacked than the artificially-infected ones. Even when artificial infection alone is practised, predators and parasites are known to cause very heavy losses and, indeed, an entire crop was destroyed by predators at Angoda, just before the commencement of the present trials. Serious damage must, therefore, be expected in certain localities irrespective of the method of inoculation adopted. Such abnormal outbreaks of lac parasites and predators may be due either to a decrease in the number of their own enemies or to environmental factors, including an abundance of food, momentarily advantageous to their development. Even in India such outbreaks of enemies occur and this possibly accounts for the scarcity of brood lac in some localities during certain seasons.

Although, as indicated earlier, the entire larval mortality of the lac insects may possibly be avoided, yet the continued cultivation of lac in a locality does not seem to be possible owing to the destruction caused by natural enemies. The trials indicate that the limiting factor in Ceylon's lac cultivation is the abundance of natural enemies, mainly the caterpillars *Eublemma* and *Holcocera*. These insects may ruin an entire crop in a locality after two crops have been successfully raised. The period to some extent may be accelerated or retarded according to local weather conditions favouring or inhibiting the development of the predators. For practical purposes it may be assumed that not more than two successive crops can be raised in the same locality. The third crop would be seriously attacked and perhaps completely destroyed by enemies.

The main reason for the predator outbreaks in the third generation lac crops is that with each successive crop the number of enemies rapidly increases owing to the abundance of their

prey. Thus in a centre the number of enemies during the commencement of a first generation lac crop would not be considerable but would increase, as time goes on, to such an extent as to destroy almost entirely the third generation crop.

The only possible way of growing lac successfully in Ceylon would appear to be to raise two crops in a locality and then "rest" it by excluding lac from that centre for a short period. This would starve out the enemies and reduce their powers of multiplication. When the population level of the enemies has been brought low enough to prevent a serious outbreak or even an increase of damage the following season the centre could be utilized again.

This is illustrated in an experiment reported above. The second generation crop harvested at Nikaweratiya was very highly satisfactory. Most of this crop was inoculated on trees at Nikaweratiya while a small quantity of the same brood material was transferred to Angoda, near Katugastota. The larval settlement at both the centres was good. But as the insects developed, *Eublemma* and *Holcocera* ruined almost the entire crop at Nikaweratiya while at Angoda it was possible to gather an excellent crop, the best ever obtained in Ceylon. Somewhat similar results also appear to have been obtained in the earlier experiments when the young larvae did not die.

Thus, it would seem that in order successfully to grow lac in Ceylon it is necessary for the cultivators to raise only two crops in a centre and then remove the brood lac for inoculation to a distant locality to obtain the third crop. The original centre would again be ready for use the next season when most of the enemies have died of starvation.

It is problematical whether village cultivators will take this trouble to grow lac. They may be sufficiently interested to raise two crops in the same locality but they may consider it not worth their while to transfer the brood material to a distant place for the third crop. The swarming season may sometimes coincide with their busy time on paddy fields or chenas. When swarming starts harvesting and inoculation cannot be delayed. A little delay may result in failure.

Although there is a satisfactory market abroad for shellac (refined lac) and seed lac, prices have declined very considerably during the last decade. The increased use of synthetic substitutes, such as bakelite, has threatened the lac industry and owing to such competition the production of the natural resin is not now as profitable as it has been in the past.

There is practically no local demand for seed lac and Ceylon's shellac requirements are very small. As lac cultivation requires very careful attention and is not likely to provide a profitable source of income to the local peasant, the possibilities of developing this industry in Ceylon do not appear to be very promising and it is doubtful whether there is any advantage in continuing the present trials.

SUMMARY OF CONCLUSIONS

The following conclusions have been drawn from the experiments so far as they have progressed.

1. The climatic conditions of the mid- and low-country districts of Ceylon are not unfavourable for the development of the Indian lac, *Laccifer lacca*. It is in certain parts of these districts, particularly the dry zone areas, that *kon* (*Schleichera trijuga*), a most important host plant of the insect, naturally occurs.

2. The *kon* lac strain of the lac insect "swarms" in North India at two definite periods, *viz.*, January/February and June/July. Its life-cycle occupies about six months. In Ceylon the insect may swarm in any month of the year and the insect completes its development in a period varying from five to six months.

3. No devitalization of the insect was observed in the recent trials. The larval mortality which was a feature of the earlier experiments could possibly be avoided by cutting brood lac 3-6 days after the commencement of the larval emergence. Natural infection may also be adopted, where possible, with advantage.

4. Crops originating from natural infection do not appear to be any more seriously affected by natural enemies than those from artificial infection.

5. Of the various enemies of the lac insect, the greatest damage is wrought here, as in India, by the predacious caterpillars of *Eublemma amabilis* and *Holcocera pulverea*. These insects multiply rapidly under local conditions. With each successive lac crop their population also increases. In North India their activities are checked to some extent during the severe winter and the very hot summer.

6. The limiting factor in the successful cultivation of lac in Ceylon is the abundance of natural enemies. Generally, not more than two crops may be successfully raised in one locality. The third crop would be very heavily attacked or completely ruined.

7. To grow lac in Ceylon successfully, a locality must be "rested" for a short time after two crops have been raised. The lack of food will appreciably reduce the number of enemies. This means that the brood material harvested at the second crop has to be transferred to a new locality.

8. The prices of shellac and seed lac have declined very considerably owing to competition from synthetic substitutes. The production of lac in India is not now as profitable a source of income as it has been in the past. There is very little local demand for seed lac and that for shellac is also very limited. In view of the unremunerative prices and the careful attention it needs, lac cultivation in Ceylon does not appear to offer any prospects of success.