

The Symbiotes of some important lac insects.

By

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(With 13 figures in the text and plate 13.)

AS MATHESON states, "the annual value of the Indian lac in 1923 exceeded 20 000 000 Dollars", which would imply a large geographical area of production. In fact the lac insects are found as far North as the valleys of Kashmir and down to the Southernmost limit of India, in Travancore. They occur in Sind, India's most western Province while Eastwards they extend from the valleys of Nepal and Bhutan over Assam and South China down to Burma, Siam and French Indo-China. After weighing such facts, says HAUTEFEUILAE (1924), "it is necessary that a classification of the races of *Coccus lacca* to which G. WATT has already called attention should be correlated with geographical distribution", for "different races correspond to different qualities of lac" and gives a typical example of it in so far as "the Tonkin product is always more coloured than the Indian variety which is not due to any defect in the process of manufacture". He further quotes from Brenier, "each species would differ from others and would have its own special requirement of climate and host plant" and finally concludes "the insects of each race reproduce themselves only on medium peculiarly suitable to them. We shall have to return to this important point for the purpose of adjusting contradictions which have arisen among writers".

In view of the strong circumstantial evidence which lead HAUTEFEUILLE and others to such a decisive opinion it would appear nothing

is further required than direct morphological evidence to support it. Such, however, is wanting in the best monographs on the subject including those of CHAMBERLIN (1923) and IMMS and CHATTERJEE (1915) while the further possibility is excluded by the verdict of the Official Committee appointed by the Government of India to report on Lac where HOWLETT expresses the belief that the lac insects probably do not require any special plant product like gum and where independtly of this no hint is offered of there being more than one species, or race.

However the trade does differentiate between different sorts of lac and I have shown at least two South Indian Lac insects are new to Science and show specificity in the choice of host plants.

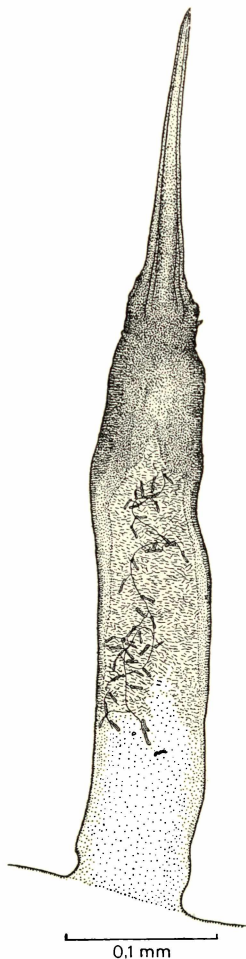
The examination of blood smears of lac insects revealed not only polymorphism among their symbiotes but, if I may so express it, a specificity of polymorphism. This has enabled an additional criterion of differentiating their host insects.

As elsewhere explained (1926) at length what was formerly known as *Lac Summatri*, now almost forgotten, came from Indo-China, Burma and Siam and was exported from Sumatra, just as Calcutta exports to day the so called *Indian Lac*. The former product is produced by the species *Lakshadia chinensis* and the insects are large sized and hence contain the highest content of lac dye. The best representative of the Indian species is *L. nagoliensis* which gives the best and highest yield of resin as contrasted with the dye.

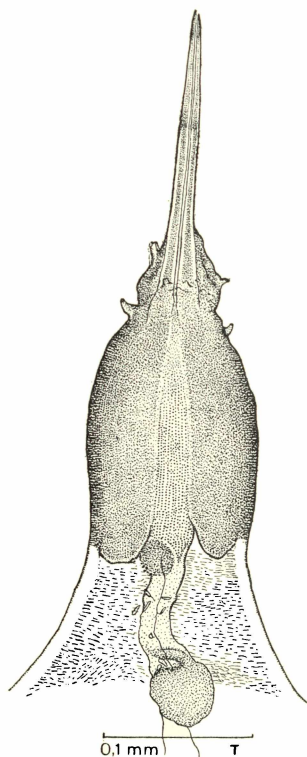
COMSTOCK, as early as 1881, gives a typical lac encrustation of *L. chinensis* with anatomical details characterising this species. It is strange no comment has yet been offered upon COMSTOCK's findings by CHAMBERLIN and other specialists who have written on the lac insects from a morphological stand point. Likewise TOZETTI (1894) figures structures belonging to the same species although in his figures the smaller size makes it difficult to appreciate specificity. The fact that both COMSTOCK and TOZETTI illustrate the same species is indirectly supported by the consideration that when stick lac was then exported it was still used for dyeing and as such was derived from the species that gives the best yield, viz. *L. chinensis*, while there could be no question of *L. nagoliensis* being sent as stick lac for it is not rich in dye and its main product, the resin, is best exported as shellac. This explains how NEWSTEAD (1901), much later, gives in his Classical work a photograph of the encrustation of *L. chinensis* which however on account of its small size shows

nothing specific. Prof. NEWSTEAD kindly presented me with the original specimen and I have been able to identify the species.

Lac insects differ from most other coccids in having a spinoid character on the back. Text-Fig. 1 shows such a structure characterising *L. chinensis*. It was derived from monsoon grown stick lac on *Cajanus indicus* in Assam, further history unknown. Text-Fig. 2 is the spinoid tubercle of *L. nagoliensis* from a fresh specimen similarly treated with alkali and stains. It was sent late



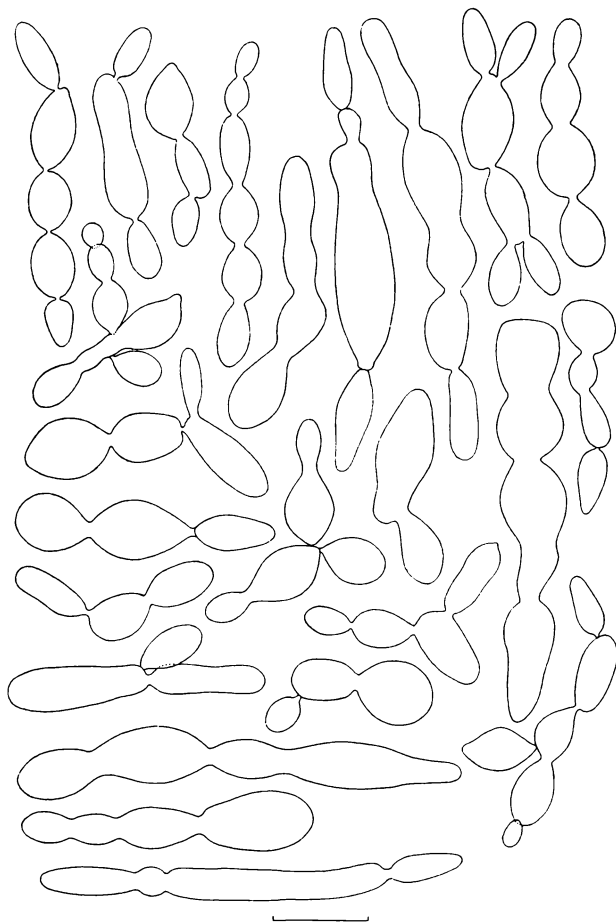
Text-Fig. 1. The Spinoid tubercle of *L. chinensis*, on *Cajanus indicus*, monsoon crop, Assam.



Text-Fig. 2. The Spinoid tubercle of *L. nagoliensis* prepared from a fresh specimen of a monsoon crop on *Schleichera trijuga* in Raipur.

in December 1922 from Raipur. C. Prs., growing there on *Schleichera trijuga*. In Text-Fig. 2 some more glandular structures are seen

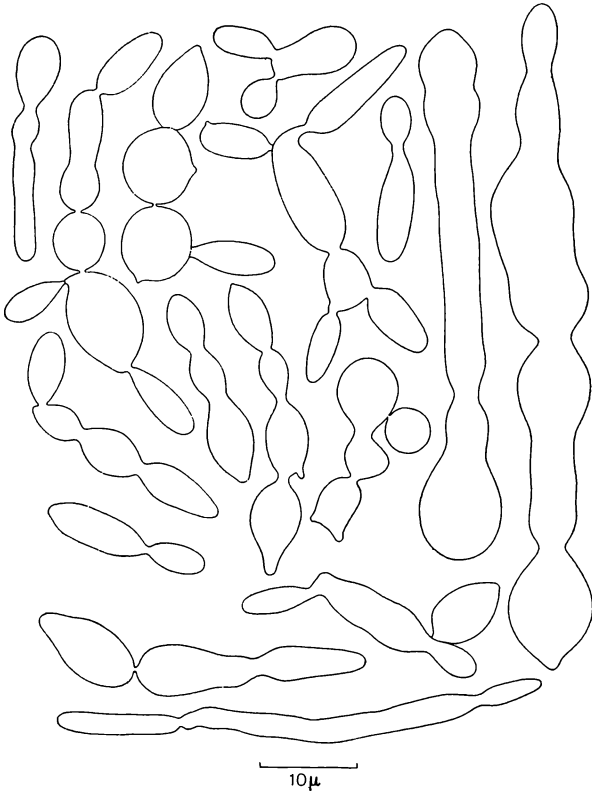
which however have no bearing on specificity. These two illustrations are so different that it is taken for granted the reader would feel the value of the figures by COMSTOCK and TOZETTI as indicating one definite species enhanced. A colour illustration



Text-Fig. 3. The Symbiote of *L. chinensis* on *C. indicus*, Bangalore. The brood was introduced on 29 Oct. 1924 and specimen collected 30. Dec.

Pl. 13 Fig. 1 shows a dry encrustation of *L. chinensis* on a dipterocarpous tree grown during the monsoon season of 1922 in Tonkin from where it was sent to Bangalore by the special favour of the Director of Agriculture in Indo-China. It is the darkest of the encrustations shown here although not so dark as those of the south Indian encrustations of *L. communis* and *L. mysorensis*. At the top

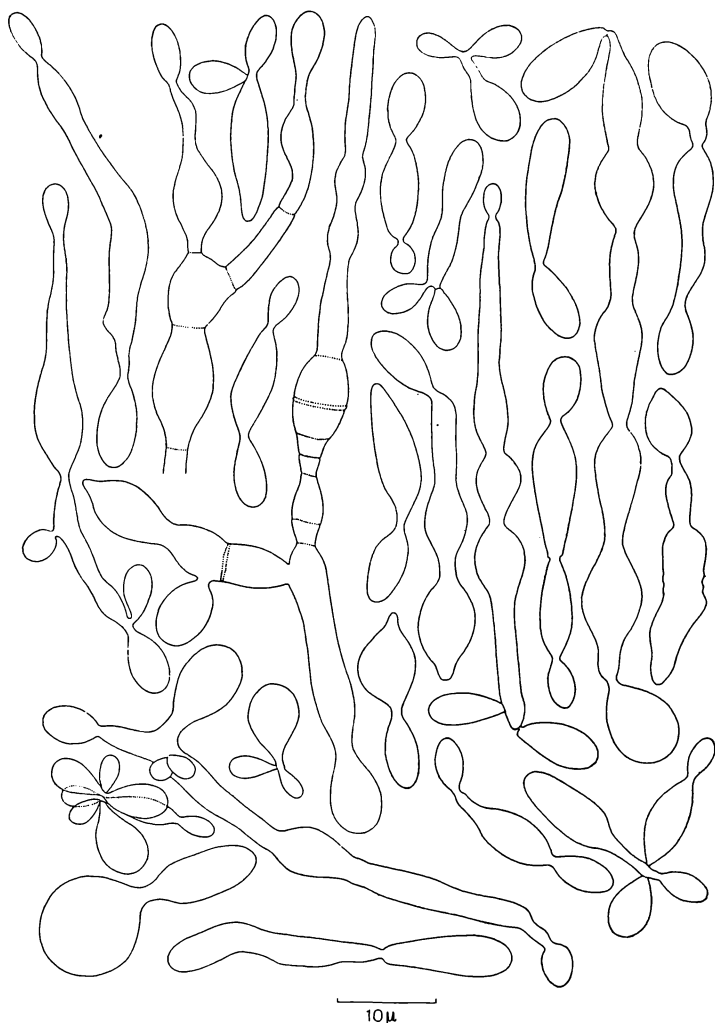
is seen a yellow smooth pill like projection on the encrustation which really represents one insect beneath. This exudation of lac corresponds to the flat broad posterior surface of the body and is really a thin layer protecting the insect although, to look at, it cannot be distinguished from a solid grain of lac exudation.



Text-Fig. 4. The Symbiote of *L. chinensis* on *Acacia farnesiana*, Bangalore, 20 June 1925. The original brood was obtained from Nowgong in Assam from a *Ficus* sp.

Pl. 13 Fig. 4, is an encrustation of *L. nagoliensis* which differs from the former species in secreting more resin inspite of the individual body surface being smaller. In this encrustation may be seen two solid globules of lac which could be broken like dried gum drops on barks. A close observation would show that the present encrustation has a different structure of nodules; they are wavy or undulating not so polished and puffed as in the former case, besides being relatively smaller in size.

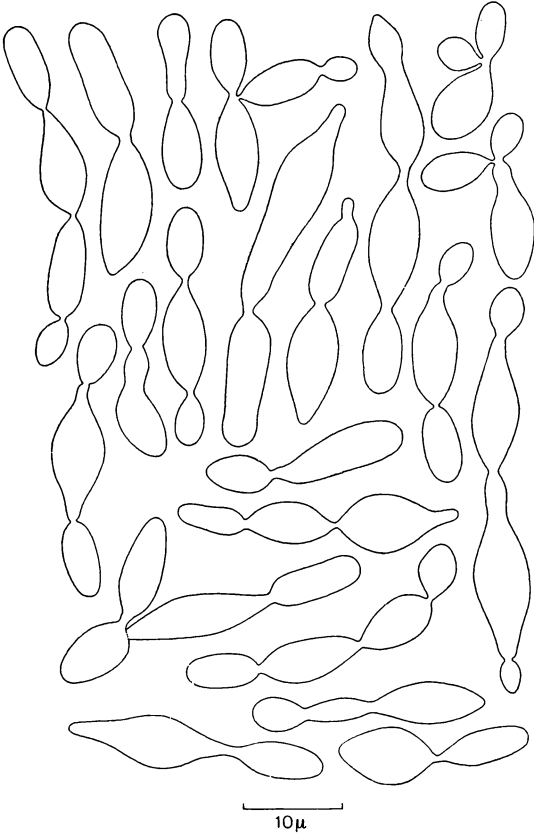
In the literature is mentioned that the darkest lac comes from Assam, Burma and Indo-China or in other words the product of *L. chinensis*. I have already illustrated (1929) the encrustation of *L.*



Text-Fig. 5. The symbiote of *L. sindica* on *A. arabica*, Miani, Hyderabad Sind, received fresh in Bangalore, on 20 July 1925.

communis as a much deeper shade. The encrustation of *L. mysorensis* would be illustrated on a future occasion and would be seen as also darker than that of *L. chinensis*. Incidentally it may be pointed out over again that the colour of the resin or the encrustation has

little connection with the high dye content, although it is often mentioned the darker the sort of encrustation the greater the dye content. In Pl. 13 Fig. 1 the encrustation is seen not all uniform piece but in several partitions, the third portion from the top shows two dark spots, being the exits made by the specific chalcid parasite



Text-Fig. 6. The symbiote of *L. sindica* on *A. farnesiana*, Bangalore, 14 Sept. 1925 from a full grown third stage female larva.

Lakshaphagus Haute-feuillei. I first considered it a *Microterys* but Dr. A. B. GAHAN very kindly pointed out that it would be nearer *Atropates* and would perhaps require a new genus to which conclusion I have been finally lead.

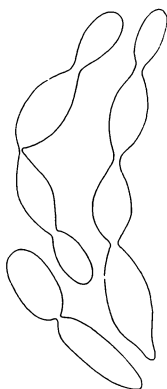
Brood lac of *L. chinensis* was received at Bangalore from Assam where it was growing on *Flemingia congesta* and inoculated on 29 Oct. 1924 on *Cajanus indicus*, the tall Assam variety. On 30 Dec. a microscopic preparation was made of its blood smear and Text-Fig. 3 was drawn. The symbiote appears much more rounded or circular as compared with others, the different types are all shown

in the figure. Some brood lac sent by the Assam Forest Department growing on a species of *Ficus* in Nowgong Range was introduced in Bangalore on *Acacia farnesiana* on which it grew for two generations and during the second generation on 20 June 1925 a blood smear was made from a second stage male larva when its cell was just quite full grown or about the time when the females of the

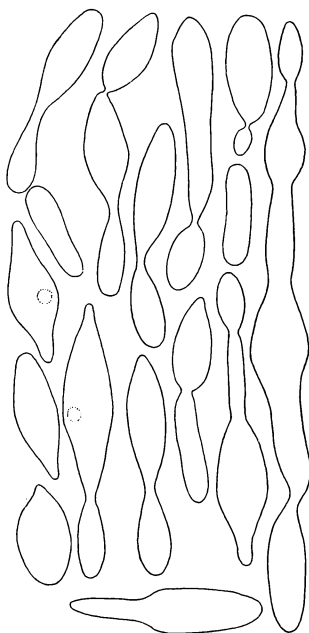
same colony had shortly moulted for the second time. Text-Fig. 4 was made from such a blood smear and shows the specific symbiote. It is self evident that as compared with illustration Text-Fig. 3 this was derived from an individual quite different except that it was specifically the same.

Blood smears were likewise examined of living crawling larvae and the specific symbiotes with characteristic round cells easily recognised. Crawling larvae preserved in alcohol were treated with alkali and later with the usual stains e. g. fuchsin, when it was

found the symbiotes withstood the alkali treatment and were in the end well stained and showed their characteristic shape easily. When most specialists are still doubting the identity of this species even



Text-Fig. 7. The symbiote of *L. nagoliensis*, brood lac received fresh in Bangalore on 20 Dec. 1924 from Raipur.



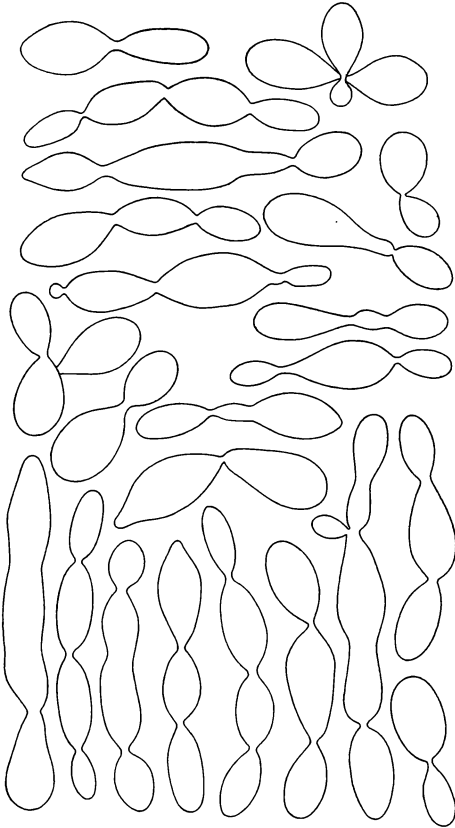
Text-Fig. 8. The symbiote of *L. nagoliensis* on *A. farnesiana* artificially irrigated, Bangalore, 5 May 1924.

in examining the full grown adult females the present method of identification the crawling larvae is particularly recommendable.

Next to *L. chinensis* lac grown in Sind is the darkest. The host plant is *A. arabica* and the insect is named *L. sindica*. An encrustation collected in November 1922 is given in Pl. 13 Fig. 2, showing the slight shade of difference between the first and this. The insects are not so large as *L. chinensis* and hence the pill like appearance here and there on lac encrustations seen in *L. chinensis* encrustations already mentioned are never seen in Sind lac while the insect, not being a good resin producer, is not comparable with *L. nagoliensis* and the large solid globules of lac resin are likewise wanting in Sind lac. Like in all other sorts of encrustations the

exudation of lac from the main surface of the encrustation may be seen in the form of pin's head and such globules on Sind lac encrustation show the real colour of this variety as "Indian Yellow" in WINSOR and NEWTON'S water colour paints.

Of all North Indian species this insect is most allied to *L. communis*, in so far as it shows a very variable sex ratio, the



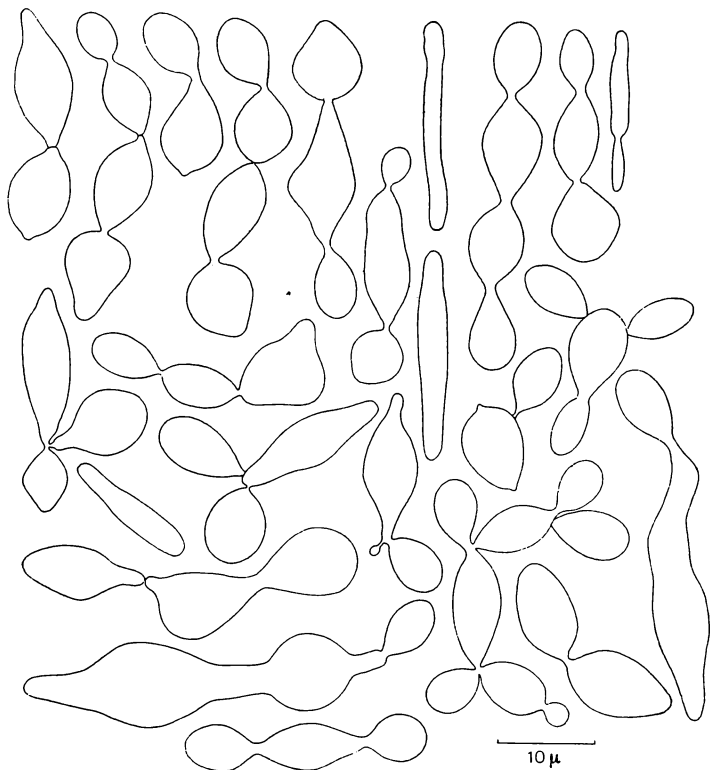
Text-Fig. 9. The symbiote of *L. nagoliensis* on *A. farnesiana*. Insects long habituated to this host and collected on 12 Sept. 1925.

males highly preponderating in the generation following the monsoons. This character has been so often observed that as in the species *L. communis* it may be taken as a permanent character of the species. The symbiote, however, is rather difficult to distinguish being very allied to other North Indian species. In 1925 I was able to receive through the kindness of the Forest Officer in Charge of Hyderabad Sind Forest Range brood lac of the non-monsoon season which was introduced on *A. farnesiana* in Bangalore. The brood lac was received on 20 Juli 1925 when some insects were found still quite living and the young ones not quite ready for emergence although the embryos were quite healthy and developed. Text-Fig. 5 was made from such a blood smear and shows the potentiality on the part of the symbiote of *L. sindica* to show special forms so far not obtainable from any other lac insect. The colony infected on *A. farnesiana* showed the females about to moult for the third time on 14 Sept. while the males had as yet not emerged. A female supplied a blood smear from which

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Text-Fig. 6 was drawn, which shows the normal appearance of the symbiote.

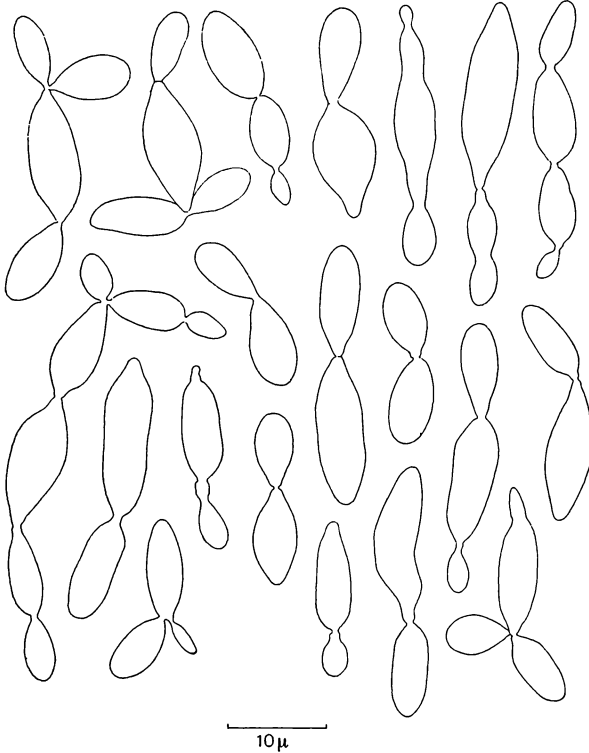
I have elsewhere explained the lac insects grow completely around a vertical twig, Pl. 13 Fig. 4, but when the branch is inclined they grown better on the lower side than away from gravity.



Text-Fig. 10. The symbiote of *L. nagoliensis* from a second generation on *A. farnesiana* 9 Dec. 1924.

On a horizontal twig the insects develop only on the side facing the ground. However twigs may be so found that represent a combination of the above two modes of growth partly inclined partly horizontal as in Pl. 13 Fig. 3 and Fig. 5 where the encrustations are seen partly covered and partly the surface of the twig unoccupied by the insects. Pl. 13 Fig. 3 shows on the upper third portion a long seam-like exudation which is due to a thin long space unoccupied by the insects but nevertheless covered by the secretion of lac exuded by the neighbouring rows of insects thus bridging over

to form a uniform circular exudation. This is a typical instance of the great resin secreting power of *L. nagoliensis* and not seen any where else. Pl. 13 Fig. 3 in its middle third portion shows two rows like maize seeds spearated by a cleft of open space. These are rows of insects with their thick resin coats of lemon yellow colour. In passing it may be remarked Pl. 13 Fig. 3 shows the insects better developed on the lower portion than on the upper



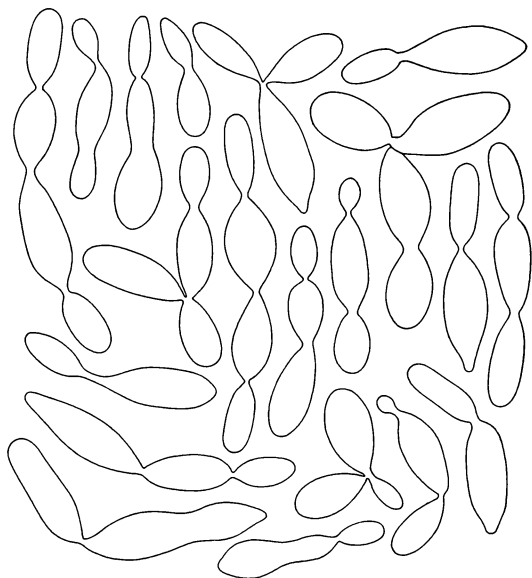
Text-Fig. 11. The symbiote of lac insects growing originally in Palamau on *Butea frondosa* and habituated on *Nephelium litchi* in Bangalore, 6 Jan. 1925.

which is much more the case when the twig is long, however the present illustration well brings out this phenomenon. It represents a brood stick of *L. nagoliensis* with the young ones not yet swarmed and as sent from Raipur and received in Bangalore on 4 Febr. 1924.

Pl. 13 Fig. 4 shows the encrustation of *L. nagoliensis* of a monsoon fed generation but after the larval swarming or as raw-material imported by shellac manufacturers. The stick lac was collected by my friend Mr. BASAPPA, the lac expert to the Government of Mysore, while on tour in the Rewah State. In this illustration are to be seen two large exudation drops of lac which, like drops of gum on a bark, could be cut out or otherwise removed from the encrustation with the greatest ease, a contrast with what appears to be similar in the encrustation of *L. chinensis* in Pl. 13 Fig. 1.

Mr. BASAPPA also kindly presented me with the specimen illustrated as Pl. 13 Fig. 5 representing the encrustation of *L. nagoliensis* grown during the non-monsoon season and was likewise collected in Rewah. The encrustation of the dry season is always darker and the individual cells smaller than those growing during the humid season. This encrustation shows three cells injured where the dark dried skins of the insects are seen in sharp contrast to the orange yellow encrustation.

On the symbiote of *L. nagoliensis* Prof. PRZIBRAM (1925) has already published an interesting communication. Text-Fig. 7 shows three chains of the organism prepared from the encrustation received fresh from Raipur in Bangalore on 20 Dec. 1924. The same brood lac was introduced on *A. farnesiana* artificially irrigated and practically when full grown a blood smear preparation was made on 5 May from which Text-Fig. 8 was made

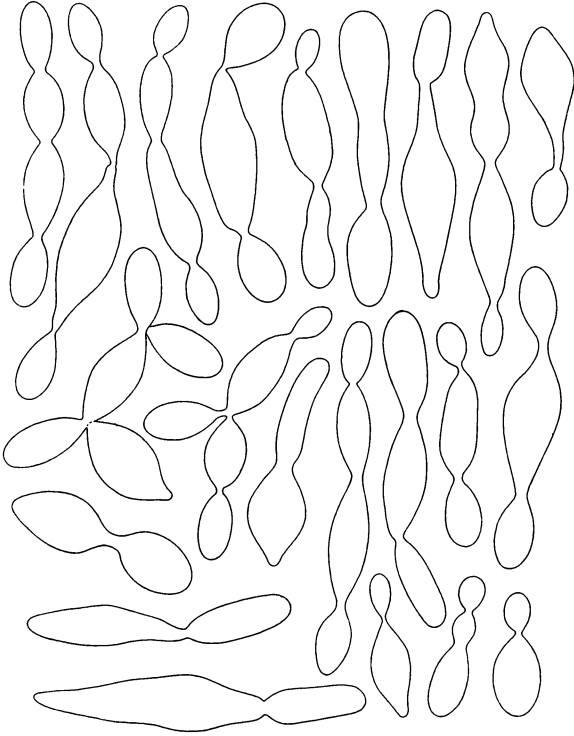


Text-Fig. 12. The symbiote of Palamau lac insects on the litchi tree 1 Sept. 1925.

where the cells appear elongated or narrower. Other *A. farnesiana* plants were already infected with *L. nagoliensis* brood in 1923 and the fourth generation on this plot supplied on 12 Sept. 1925 the material for Text-Fig. 9 and shows their more normal form. On the same lot of *A. farnesiana* plants during the second generation the larval swarming occurred on 27 Nov. 1924 but as late as 9 Dec. a specimen was collected which so far had not swarmed and the symbiotic microorganism is illustrated in Text-Fig. 10. They offer a picture quite unlike what has been so far observed and may be interpreted as bringing out the potentiality of a specific symbiote. The insect could not be taken as a normally healthy individual particularly on account of the delayed swarming stage but it may

be mentioned that search has been made among all species of lac insects for polymorphism and the present picture was not offered by others under similar conditions.

When *L. nagoliensis* brood lac is introduced from *S. trijuga* on to *Butea frondosa* the latter acts as a good host of the insect but the reverse is stated not to be the case. Such an experimental proof is to my satisfaction not been published and personally was



Text-Fig. 13. The symbiote of lac insects growing originally on *B. frondosa* in Jubbulpore grown at Bangalore on *A. farnesiana*.

unable to undertake such an interesting work on account of the scarcity of these host plants in the vicinity of Bangalore. Under *L. indica* I have designated the insect growing on *Zizyphus jujuba* on the basis of the statement that this brood has not enabled artificial transference on *Schleichera trijuga*. As the same is said to be the case with brood lac from *Butea frondosa* on to *S. trijuga* the species has been believed to be the same. The present paper would throw some doubt as to the existence of a distinct *L. indica* and

requires definite evidence before the question can be finally settled. Brood lac from Palamau in Bihar where the insects were growing on *Butea frondosa* were introduced in Bangalore on *Nephelium litchi* on 3 Aug. 1923. On 6 Jan. 1925 a specimen furnished blood smear for Text-Fig. 11 and another from the colonies tracing origin to the same brood for Text-Fig. 12 on 1 Sept. 1925. Jubbulpore brood lac growing there on *B. frondosa* was infected on *A. farnesiana* in Nov. 1924 and on 10 June 1925 furnished a blood smear for Text-Fig. 13. It will be seen Text-Figs. 11, 12 and 13 show nothing special or specific.

Conclusions.

The simple examination of blood smears of lac insects shows specific symbiotes with a characteristic polymorphism, in other words specificity in spite of the polymorphism. The best example is furnished by *Lakshadia chinensis*, the lac insect of Indo-China and Assam where circular and definitely rounded forms of symbiotic cells are seen in blood smears in all stages. Alcohol fixed crawling larvae afterwards treated with alkali and stained with the usual entomological stains bring out the characteristic shape of the symbiotes and enable its specific identification. *L. sindica* and *L. nagoliensis* have shown peculiar variation of symbiotes in blood smears and may be interpreted as possessing specific symbiotes with a potentiality of differing under peculiar or rare conditions. The existence of *L. indica* has not been established so far by this technique.

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Explanation of Plate Figures.

Plate 13.

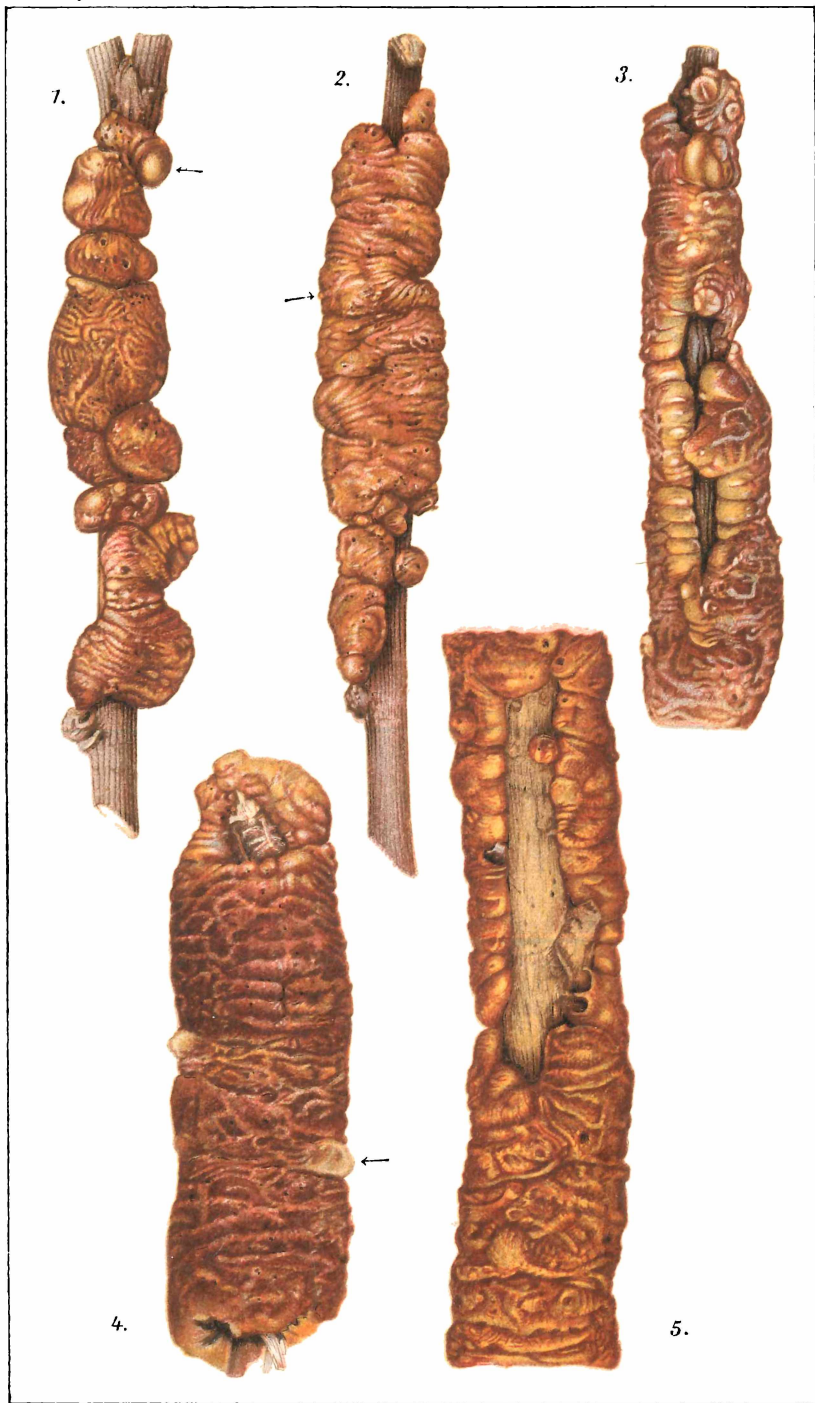
Fig. 1. Dry stick lac of *L. chinensis* on a Dipterocarpous tree growing in Tonkin during the monsoon season of 1922.

Fig. 2. Stick lac of *L. sindica* on *Acacia arabica*. Minai, Hyderabad Sind, monsoon crop of 1922. The arrow shows a pin-head exudation of resin.

Fig. 3. Fresh brood lac stick of *L. nagoliensis* on *Schleichera trijuga* Raipur. C. P., monsoon crop collected in Feb. 1924. The encrustation is seen from above growing on a semi-horizontal twig.

Fig. 4. Dry stick lac of *L. nagoliensis*, monsoon crop, growing on a vertical twig and completely enveloping it.

Fig. 5. Stick lac of *L. nagoliensis* of the non-monsoon crop on an inclined twig and the encrustation seen from above.



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