

The third stage larva of the female lac insect (Hem. Cocc.)

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The lac insects, being cultivated as an industry in many parts of India, their biology deserves an intensive study. Among other problems it was found necessary to find the rate of growth in two or more colonies. For this purpose it was further required to determine the periods of moulting and also the intermediate steps between two definite stages. For example it is proposed to show here how a female larva after its second moult gradually develops until it is transformed into a young adult female. It may not be out of place to mention that in the literature on coccids usually two moults of the female are generally recorded and the existence of three moults which I previously observed (1927) has been even contradicted by Negi (1929). The present communication has therefore this general interest that it goes to establish three moults of a female coccid and is a continuation of an article on the second stage female lac insect (1931).

In the literature on lac all important contributors, Misra (1923), Imms and Chatterjee (1916) and Negi (1929), while illustrating the different stages prefer to state only the age of the larvae or the time after fixation to the host plant. What, however, is more important is the stage and the age seems to be indicated in the absence of the exact knowledge of metamorphosis. It is easily conceived that conditions may stimulate the early casting of the first moult while less favourable circumstances may unusually delay the next moult and although the age may be the same in two cases yet one cell or colony may be more developed than the other. Although the larval stages can be morphologically established the intermediate steps can only be well expressed by means of copious illustrations and it is hoped this deficiency in the present literature is supplied by the accompanying figures.

Imms and Chatterjee (1916) illustrate in colour a colony of larval cells of lac insects one month old but without indicating the stage. All the female cells appear to be in their third stage and in order to increase the value of their beautiful illustration, Fig. 3, I have undertaken to show something very similar. One of these cells is further shown enlarged in Fig. 4, upon which they remark, «the thin colour-

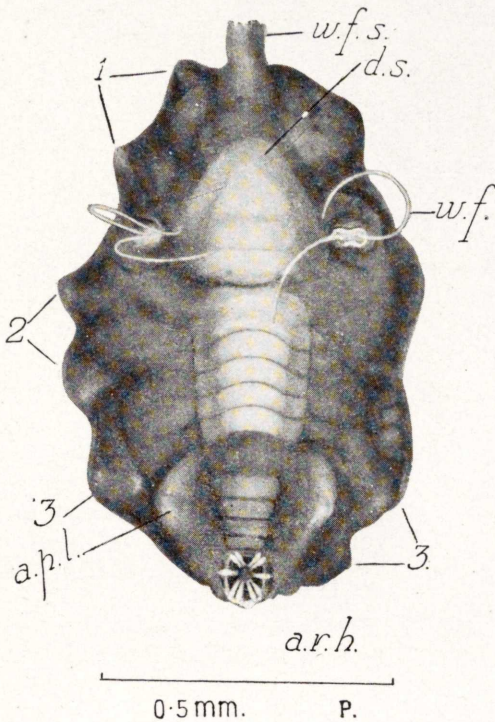


Fig. 1.—*L. communis*, larval cell immediately after the second moult. The cell was constructed by the second stage larva but the present occupant is the early third stage larva. Relics of the first stage larval cell are marked *w. f. s.*, and *d. s.* explained in the text.

less coating of lac has been removed with the aid of a needle. At this stage the spiracular filaments are well developed. The first larval skin (indicated by *s*) is seen attached along the middle of the dorsal region of the insect». To me however it appears all that has been done to the cell (their Fig. 4) is that it has been removed in toto from the bark and from among the rest of the colony and illustrated again. Dorsally, at any rate, there is no evidence of the removal of any secretion product and the ventral side is not shown. Again what they indicate as skin is really the dorsal wax-shield which is divisible into eleven segments and which once protected the crawling larva. It is possible they were led to this view on consulting Comstock

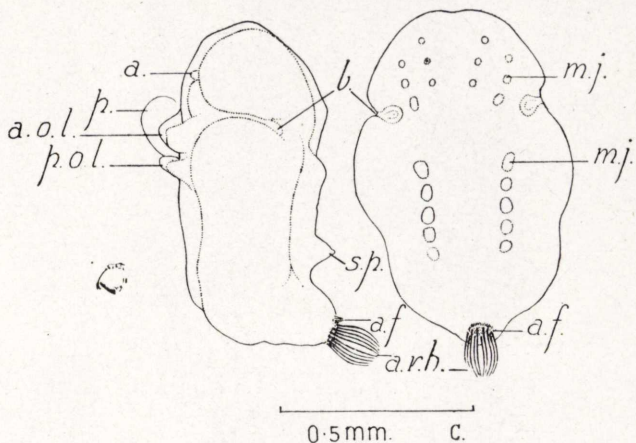
(1882) who illustrates the lac insects on plate 19 and on the opposite page states with regard to his figure of *Cerococcus* insect «the larval skin occupies the center of the dorsal surface and the excretion forms a thick ring round the skin». Imms and Chatterjee thus corroborate for the lac insect what Comstock offers for a different coccid.

Negi's contribution is accompanied by a plate of illustrations which not being referred to in the text have rather a decorative value

than an explanative one; however they bring out some features which must be analysed in order to throw definite light upon the problem of metamorphosis. In the text he figures as 4, *e.*, an advanced second stage larva without mentioning the age while in Fig. 10, plate 16, is shown a six week old larval cell of which the stage is not stated. His Fig. 4, *e.*, is full grown third stage larva while the cell represented in Fig. 10, pl. 16, is a much lesser developed insect also of the third stage. In the text

he mentions that in the sixth week the female moults for the last time so that when one moult is added to the number he found, his Fig. 4, *e.*, may be safely considered as being in the sixth week although this fact is not given by him. But it is also apparent that the cell Fig. 10, pl. 16, although of the same age is not biologically identical with the former representation.

In the text he mentions nothing with regard to the cells in the third week except that after the third week of fixation the larvae moult for the first time. He figures in Fig. 8, pl. 16, a cell three weeks old and in the absence of any further information to the contrary I take it as a clear representation of the early second stage larval cell. I have particularly drawn the attention of the reader to Negi's figures for he unwittingly shows a very important point, namely the copious secretion of wax filaments first most prominent in the third larval stage; his early second stage larva, Fig. 8, and his early third stage larva, Fig. 10, differ from each other in the latter alone having copious wax filaments from the brachial plates. The brachial plates increase in size with every moult but after the second moult they seem to be sufficiently large to secrete the wax filaments copiously. With regards to their Fig. 4, pl. 1, Imms and Chatterjee remark «at this stage (and as if not befo-



Figs. 2 and 3.—Early third stage larva of *L. communis* from the same colony as Fig. 1, freed from exudation material by treatment with alcohol and seen in two positions.

re) the spiracular filaments are well developed», which I have already mentioned is none else than the third stage. When Negi illustrates for one cell copious wax filaments and not for the other it may be taken at least as a happy accident that he selected a very representative cell supporting Imms' and Chatterjee's observation and thereby further

supporting its own identity as a third stage larval cell.

In passing it may be further remarked how important it is to give the stage of the larvae for Imms and Chatterjee find a much developed stage within four weeks while even after six weeks the stage represented by Negi (Fig. 10, pl. 16) is younger. When such a case occurs in the same colony or on two branches on the same tree and therefore under the same external conditions it indicates difference in nutrition. Such has been actually observed and in fact already illustrated by Imms and Chatterjee, Fig. 3, pl. I, where one cell below

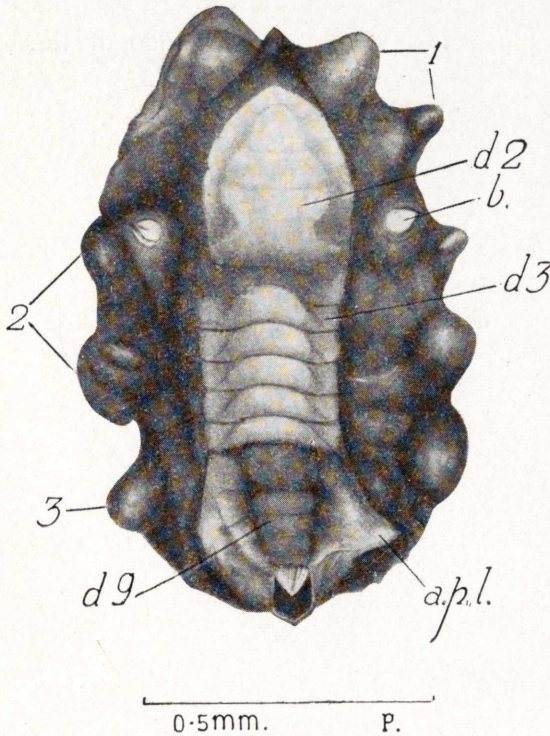


Fig. 4.—*L. communis*, early third stage larval cell slightly more developed than fig. 1, and belonging to the same colony.

is much less developed than the rest above.

From a similar colony, as that shown by Imms and Chatterjee, growing on *Guazuma tomentosa*, Bangalore, 17 Jan. 1923, the species *Lakshadia communis* furnished the first four cells of the third stage shown here. Fig. 1 was originally intended to show full grown second stage larval cell but within three hours of its removal from the tree it moulted as the drawing was being made. It however shows the cell as formed by the second stage larva while the anal ring hairs, *a. r. h.*, alone belong to the third stage. The anal opening in the cell is really intended for the anal ring hairs of the second stage larva which are much smaller than those of the third stage and hence the new set of

hairs seems to be too big for the old opening. The hairs are shown open as is sometimes to be observed before the insect brings outside the body a drop of the honey dew.

At the anterior region the two openings on each side contain a pair of white cotton like threads which are wax filaments secreted by the brachial plates or plates formed by fused ducts of wax glandular pores characteristic of lac insects and not found in other coccids. Wax filaments during the second stage are not so conspicuous as in the third stage, a fact already observed and illustrated by Imms and Chatterjee and unwittingly illustrated also by Negi.

The crawling stage larva is accompanied by a dorsal shield of wax divisible into 11 plates. These form like tiles on a roof and persist as relics in later stages. In Fig. 1 is seen the dorsal wax shield, *d. s.*, disarranged into three main regions; between the brachial openings lie the first two wax plates, then follows a partition with wax plates 3 to 7 forming one unit which ends with a separation followed later by wax plates 8 to 11. Three wax plates d^2 , d^3 and d^9 are thus lettered in Fig. 4. The wax shield of crawling stage larva has been mistaken by Imms and Chatterjee (their Fig. 4 *s.*) for the moult skin while the characteristic disarrangement of the old wax shield is not truly represented in their otherwise excellent illustration.

The first stage larva after fixation secretes wax also from the sides in the form of pencils or like asbestos fibres. They go to form the skeleton of the cell and serve as support for the main secretion of lac

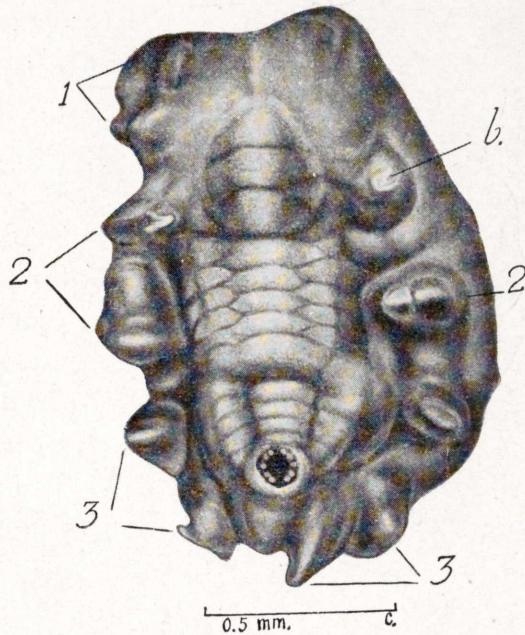
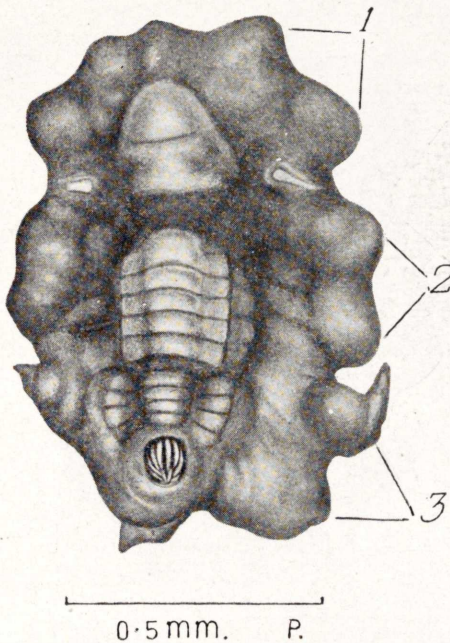


Fig. 5.—*L. communis*, again from the identical colony further representing an early third stage larval cell. The anal ring hairs are drawn roughly to show their mutual position. The longitudinal right half of the cell which was facing the force of gravity is better developed.

which otherwise would flow in one direction instead of being distributed all over uniformly. In a former communication (1925) I have illustrated the wax pencils secreted by the first larval stage. In addition to the pencils from the sides wax is also produced directly in front; such a ribbon of wax pencils is seen as a relic, *w. f. s.* (wax pencils of the first stage) in Fig. 1 here. In the second stage there are



three pairs of wax pencils on each side, of which two are indicated in pairs on the left side in Fig. 1 and the third pair is numbered on the right. It may be again remarked, although the larva within the cell belongs to the third stage, it has hardly been long enough to have taken any part in its formation so that the cell as seen is the construction of the old occupant, the second stage larva.

In order to keep the anal opening in the cell clear from the secretion of lac which would otherwise block it the anal tubercle is provided with a pair of wax plates on each side. These anal plates Fig. 1, *a. pl.*, of wax grow gradually with the cell beginning with the first

Fig. 6.—*L. communis*, a still more developed early third stage larval cell from the same colony as the previous cells.

larval stage where however only one plate on each side is to be found. When several species are examined all freshly collected with the insects within the cells still living the species *L. communis* is most conspicuous in exhibiting the anal plates of wax externally and for this reason this species has been selected for the purpose of illustration. It would be observed the point marked *a. pl.* in Fig. 1 is far away from the anal opening and without further explanation does not show the real function of the wax plates hidden beneath. This however would be clear later on.

Another cell from the same colony, apparently identical with Fig. 1, was treated with alcohol and the insect body, cleared from

secretion products, is seen in two positions, Figs. 2 and 3. The dorsal view shows two rows of muscular joints, *m. j.*, in the middle portion of the body while two rows on each side at the anterior region beyond the brachial plates, *b.* The anal ring hairs, *a. r. h.*, are clearly seen as well as the anal fringe, *a. f.*, of small spines. The anal tubercle bearing the anal ring hairs moves up and down the anal opening of the cell and the anal fringe functions in fixing the anal tubercle to the ceiling of the cell while the anal brush broadens the opening. For each new brush of anal ring hairs the cell opening formed by the preceding stage larva is too tight and the necessary enlargement is made jointly by the anal ring hairs and the anal fringe. The anal fringe, it would be noticed, is not all round the anal tubercle but only on the side facing the main body and really acts like a pivot to the anal brush functioning as lever; the anal fringe is better seen in profile Fig. 2, *a. f.* The hump like spine of the early third stage is also shown in profile Fig. 2, *sp.* (spine). The antenna, *a.*, the proboscis, *p.* and the four lobes around the mouth, one pair of anterior oral lobes, *a. o. l.*, and a pair of posterior oral lobes, *p. o. l.*, are also indicated; the mouth is not seen among them in this figure and is usually best seen in alkali treated preparations when the body shows much distension of parts.

Lastly, it may be remarked, the brachial plate, *b.*, is seen at the top of a groove which contains the major spiracle and the connective canella wax pores which would be mentioned better later on.

Imms and Chatterjee (1916) illustrate in Fig. 3, eight cells of which one alone is far below the rest; this compares very well with Fig. 1 shown here and leaves me in no doubt as to their illustration also representing a very early third stage larval cell.

Fig. 4 here shows a step more developed than Fig. 1, and belongs to the same colony. The wax filaments were brushed away from the brachial openings to show the dorsal surface clearly but while the cell was drawn late the insect had died and the consequent contraction

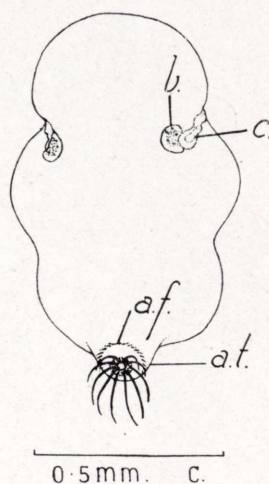
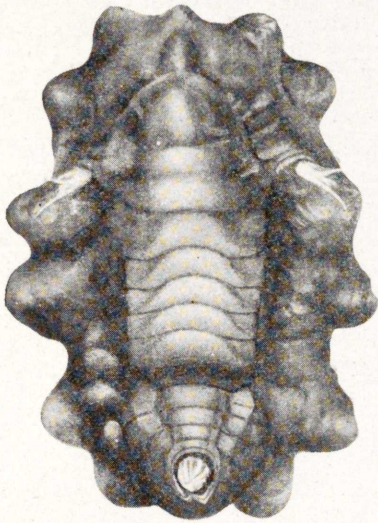


Fig. 7.—*L. communis*, early third stage larva after treatment with cold caustic alkali, the cell which furnished it had an identical appearance to that seen in Fig. 6, and belonged also to the same generation.

of the anal tubercle within the cell opening just shows the lowered tip of the anal hair brush. The dorsal wax shield belonging to the crawling stage larva occupies the median position of which plates d^2 , d^3 , d^9 , are marked. Not the anal wax plates within so much as the enveloping lac secretion outside shows as great asymmetry in Fig. 4, that of the right side marked, *a. pl.*, being better developed; but it



0.5 mm. P.

Fig. 8.—*L. mysorensis*, early third stage larval cell.

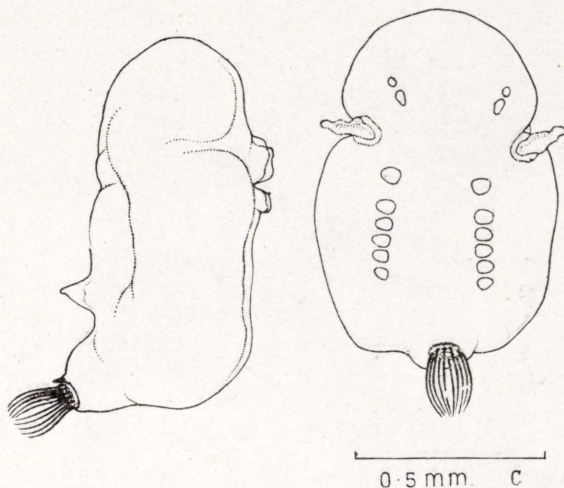
would be noticed the whole cell shows a better growth and better lac secretion on the right half due to the position of the cell on the twig where the cell lay more to one side, the side of the cell facing away from the force of gravity, *i. e.*, the left side of Fig. 4 is poorer developed than the right half. The three pairs of wax pencils from the circumference of the cell are shown by the following indications; on the right side the first pair is marked, 1, the second pair is likewise marked on the left side, so also the third where only one large globule instead of the dual nature is exhibited.

Fig. 5 likewise represents a cell from the same colony showing unequal secretion on the two sides, the right side being broader while the left less spread out. The seats of the wax pencils from the sides are numbered better on the left side. One of the second pair marked, 2, on the right is seen as though a small bud was emerging. This is just mentioned to indicate that the wax pencils in the species *L. communis* are very striking in all stages when the corresponding ones of other species are compared. The brachial opening, *b.*, was also freed from wax filaments while the cell opening at the posterior extremity shows diagrammatically the positions of the anal ring hairs. The median line on the dorsal surface is occupied by the dorsal wax shield which, strange enough, shows no separation longitudinally but notwithstanding shows the characteristic disarrangement and upheaval particularly of the posterior four wax plates 8 to 11. In this connection Imms' and Chatterjee's Fig. 4 may be mentioned

as showing, instead, the dorsal wax shield in its original unaltered shape which has never been observed by me; this portion of their figure may be taken as not true to nature. Fig. 5 here shows the dorsal wax shield least disturbed yet sufficiently altered from the original shape. The region of the anal plate marked *a. pl.* in Fig. 4 on comparison with the corresponding portion in Fig. 5, shows instead of a projection the lac secretion has formed a swelling, as it were, on the right side. Whatever shape the secretion may assume there is a distinct general asymmetry in Fig. 5 as in Fig. 4, and particularly in the region where the anal wax plates are found, *i. e.* where lac secretion is rich.

Fig. 6 again shows a cell from the same colony exhibiting a like asymmetry, there being more secretion on the right half than on the left side. It may be mentioned this figure is a very near representation to Fig. 4, pl. I, of Imms and Chatterjee whose figure seems only slightly more developed. Fig. 6 here shows the dorsal wax shield divided into three regions which is the more usual and not as in Fig. 5 where all the three parts are in close contact with one another.

Another cell for all practical purposes identical with Fig. 6 was treated with cold caustic alkali and the body, partly swollen on account of the treatment and bulged upwards, is seen in Fig. 7. The anal tubercle, *a. t.*, bears the anal ring hairs on a dotted ring within which lies a white circle, the actual anal opening. The anal tubercle also bears the anal fringe, *a. f.*, of small spines which lie not all around but only on the side facing the body. Fig. 7 shows the specimen faintly tilted to the left which thereby shows the shape of the right



Figs. 9 and 10.—*L. communis*, early third stage larva seen in two positions; the cell which furnished the larval body was comparable with that of *L. mysorensis* seen in Figs. 8, 9 and 10, represent a more developed larva than that shown in Figs. 2 and 3.

brachial plate better, being more like three quarters of a circle than circular. From the brachial plate, *b.*, towards the ventral side is found immediately below it the major spiracle and following it the canella wax pores. Around the spiracle are also wax pores which secrete soft wax, while the canella pores secrete hard wax, the joint

product is seen like one white tract marked *c.*, in Fig. 7.

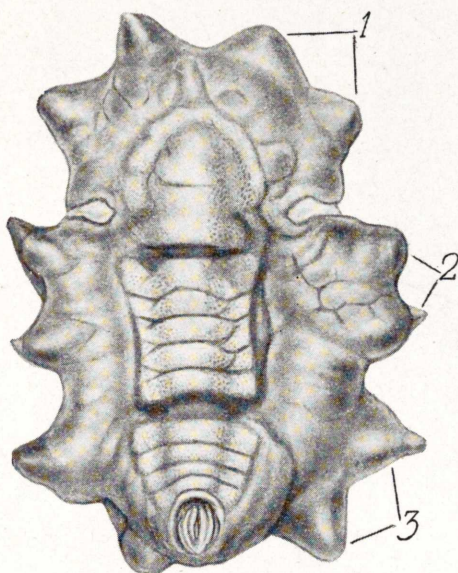


Fig. 11.—*L. mysorensis*, third stage larval cell more advanced than Fig. 8.

All the above mentioned cells have been taken together as they belonged to the same colony and their representations support the two beautiful illustrations of Imms and Chatterjee already mentioned. It is proposed now to consider *L. mysorensis* growing on *Shorea talura* near Bangalore. Brood lac was inoculated on 6 Nov. 1922, a cell removed on 22 Dec. and illustrated as Fig. 8, which appears to have moulted for the second time only a few days earlier to its removal. The filaments of the brachial regions were first brushed off and the growth as seen here shows the development while the cell was still attached to the twig kept in a

moist Petri dish. The thick growth of wax filaments at the brachial region in spite of their short life offer a contrast to those of the late second stage larval cell as seen in Fig. 1, and confirm the observation of Imms and Chatterjee to which attention has been already drawn. At the posterior dorsal region of the cell the crawling larval wax plates 8 to 11, offer a different view to that of Figs. 1, 4 and even 5, which approaches Fig. 8, best in this respect. The difference is specific and enables the separation of *L. communis* from *L. mysorensis* even in the third larval stage. What is remarkable is that neither of these two species have been yet confirmed by any other worker, nor by Chamberlin (1923) who has taken so much pains with these insects.

A cell of *L. mysorensis* with its cell outline identical with Fig. 8, was treated with alcohol and the body afterwards was drawn from two positions as seen in Figs. 9 and 10. On comparison with Figs. 2 and 3, it will be seen Figs. 9 and 10, represent a slightly more developed stage. Fig. 7 shows the body of the insect swollen on account of alkali and cannot well be compared with Figs. 9 and 10.

Just a little more advanced than Fig. 8, is a cell shown in Fig. 11, collected from *S. talu-
ra*, Bangalore, 21 Aug. 1922. Another cell from the same co-

lony but a slightly more advanced than Fig. 11, is shown sideways in Fig. 12, to supplement more or less Fig. 11. The wax filaments have been cleared off for the purpose of illustration while attention may be

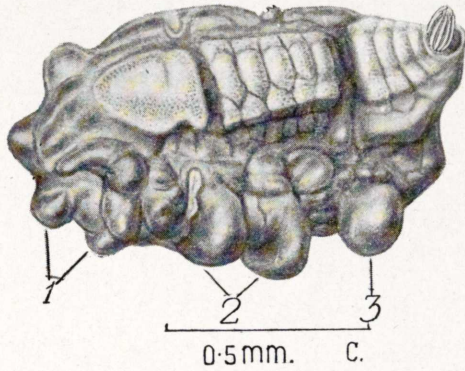


Fig. 12.—*L. mysorensis*, another third stage larval cell seen mainly sideways, the cell was comparable in development to that seen in Fig. 11.

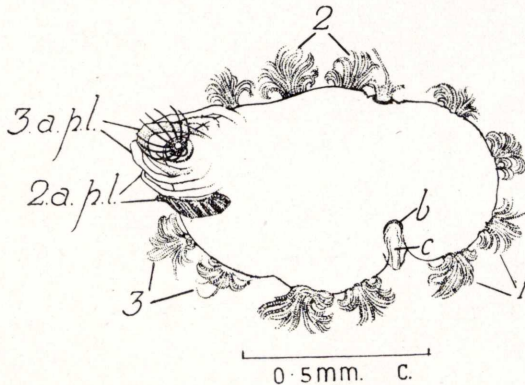


Fig. 13.—*L. communis*, third stage larval body showing the secretion of wax pencils from the sides and wax plates 3, a. pl., around the anal tube. Below are to be seen two similar anal plates of wax as relics from the second stage larval cell. The cell was treated very carefully with alcohol and is seen in the same position as Fig. 12.

called to the shape of the dorsal shield wax plates 8 to 11, which may be compared with the corresponding ones in the cells of *L. communis* where the inner wax plates around the anal tube are very well expressed externally.

A cell even more advanced than Fig. 12 and seen in the same position but belonging to *L. communis* after treatment with alcohol is seen in Fig. 13, with the skeleton of wax on which the main exudation of lac rests. Over-

looking the fact that Figs. 12 and 13, belong to two different species and slightly different in development they supplement each other,

Fig. 13, shows the skeleton, one may say, the other, Fig. 12, the flesh and skin clothing the skeleton. Fig. 13, shows on one side three pairs of wax pencils in bunches; Fig. 12, shows the corresponding three pairs covered with lac where they are also indicated with numbers.

Mention has been made earlier that the anal opening in the cell is kept free from lac, which would otherwise block it, by wax plates around the anal tube.

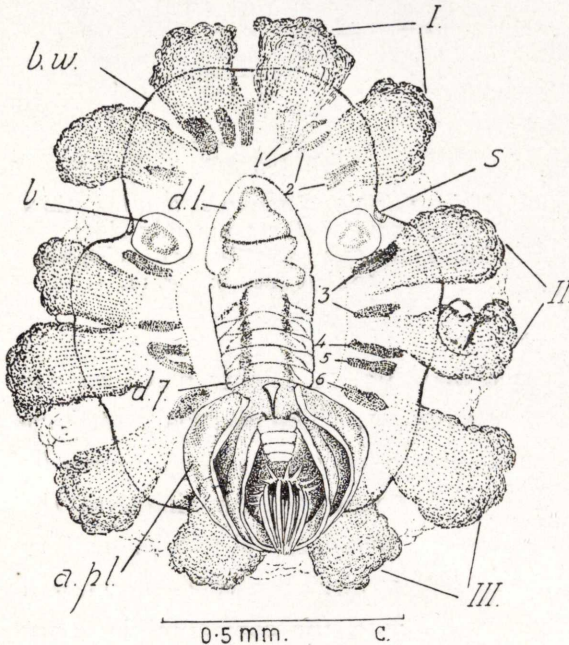


Fig. 14.—*L. nagoliensis*, cell treated with alcohol to show the secretion of wax pencils from the sides and above the relics of the crawling and first stage larvae. The insect had just moulted into a young adult, therefore the wax plates, *a. pl.*, around the anal tube are those belonging to the third stage larva and are the same as those indicated as 3, *a. pl.* in Fig. 13.

stage larval cell and marked 3, *a. pl.*, are seen in their real position. They are not fully developed yet as the cell represents an early stage. The same when fully developed are seen in Fig. 14, where the two anal plates, the outer marked, *a. pl.*, have such dimensions that the other relics being forced away have been lost from position. In Fig. 13, the brachial plate is just seen as a small cres-

During the first stage the cell has one wax plate around the anal tube but in the second and third larval stages there are secreted two of these by the larva. Fig. 13, shows four wax plates around the anal tube. The pair belonging to the second stage larval cell is marked 2, *a. pl.*, the lower plate seen shaded is seen slipped off and inclined which enables the object being represented better, the upper anal plate is always the smaller and seen at a different angle to that in which the lower one is seen seems incomparable with each other. The upper two anal plates belong to the early third

cent, *b.*, while the general exudation of wax from the canella pores and the spiracular region is represented together and indicated *c.*

L. nagoliensis was selected to show, Fig. 14, a cell immediately after the third moult and after treatment with alcohol. The cell or the exudation products are those secreted by the last larval stage but the body within now belongs to a young adult female. The cell margin shows on each side three pairs of wax pencils in bundles; of the right are marked with Roman figures. The median dorsal line is occupied by the shield left by the crawling larva. In this case the first seven wax plates of the shield are continuous, followed by the spine of the young adult female which thus separates the first part from the remaining four plates 8 to 11, looking like a piece of back bone. Of the dorsal wax shield plates first and seventh are marked *d. 1* and *d. 7* respectively. The anal ring hairs appear seemly large for they have just emerged after metamorphosis and are too large for the new cell; the anal hairs are now of the same size as those in the full grown adult female, in short they do not grow further with the development of the insect body. The anal tube is surrounded as seen here by the two anal plates of wax secreted by the last larval stage. The inner pair of anal plates is smaller, the larger and outer is indicated *a. pl.* and are those which in a less developed stage are shown in Fig. 13 as 3 *a. pl.*

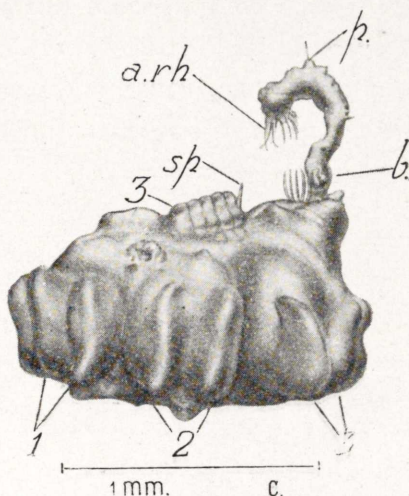


Fig. 15.—*L. mysorens*, cell casting the last moult; the spine *sp.*, is present only in the adult stage.

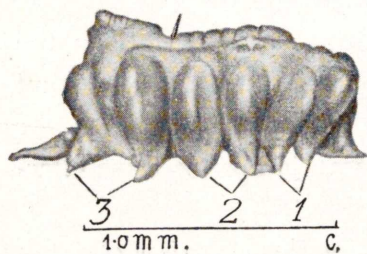


Fig. 16.—*L. communis*, cell formed by the third stage larva which has just moulted and has given rise to a spine piercing the roof.

Between the dorsal wax shield *d. 1* and the circumference of the body or body wall, *b. w.*, are seen long shaded wax pencils. They are all marked on the right side. Beyond the large circular brachial

plate (marked *b.* on the left side) and the adjoining spiracle marked, *s.*, are two pairs indicated by numbers. Following the brachial disc is a third pair and then follows single rows numbered 4 to 6. In order to appreciate this an earlier illustration of the wax pencils secreted by the full grown first stage larva Fig. 5, pl. I (Early Recognition of Sex, 1925), must be consulted. In the last mentioned figure a foremost single wax pencil is seen which is also marked as a relic

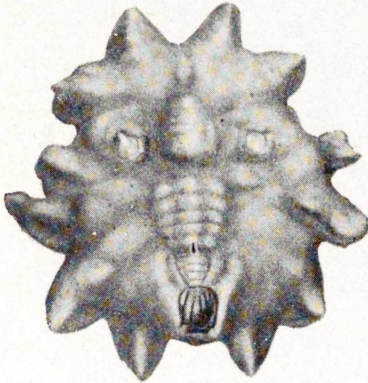


Fig. 17.—*L. communis*, cell same as in Fig. 16, seen dorsally; the insect was meanwhile dead.

wax pencil of the first stage, *w. f. s.*, in Fig. 1, but here lost from position and therefore not shown in Fig. 14. Likewise the anal plates have forced away all the wax pencils of the first stage larva more posterior than those secreted by the sixth segment.

It may strike a critical reader when the relics of the first stage larva and even of the crawling larva are found in the third stage larval cell there should also be the wax pencils secreted by the second stage larva. Although these are present in the material constituting the architecture of the third stage larval cell the relics of the second stage are not in a position dorsal enough to be seen and being more to the side fall off on the cell being treated with alcohol. Also the anal plates of the second stage larva shown as, 2 *a. pl.*, Fig. 13, are not shown in Fig. 14, for the simple reason that the large anal plates seen in Fig. 14, have offered no room for others.

While a drawing was being made to show the side view of a full grown third stage larval cell the insect moulted and Fig. 15, represents a cell of *L. mysorensis*, Bangalore, 27 July 1921, in the act of casting its last moult. The skin shows the anal ring hairs, *a. r. h.*, bending over the brush of anal ring hairs of the young adult. The head with the proboscis, *p.*, comes next and finally the brachial plate, *b.*, is seen just leaving the cell opening. On the dorsal surface is marked, the spine, *sp.*, close to dorsal wax plate 7 which itself is not marked but as the third instead is indicated, the seventh can be easily

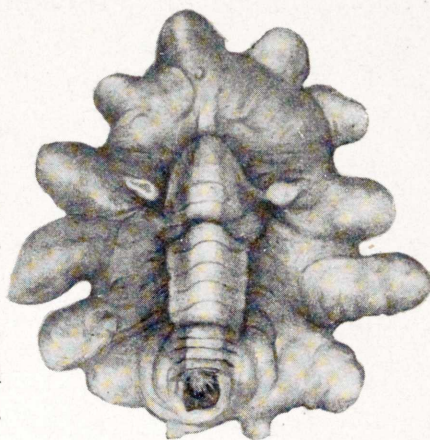
counted as such. The brachial opening is self evident and is not lettered. The three pairs of wax pencils in columns enveloped with lac are marked and should be compared with those of a sister species seen in Fig. 16.

This figure represents *L. communis*, growing in the Lalbag, Bangalore, late in July 1921, on *Nephelium Litchi*. The cell had likewise moulted after it was removed from the tree so that the age of the insects in Figs. 15 and 16, was identical for the present purpose. The spine is again well shown and the three columns of wax pencils from the sides appear to be longer, thicker and their ends at the lower surface pointed. *L. communis* really has such pronounced exudation of wax that this is well expressed externally and differentiates it from *L. mysorensis*.

The same cell Fig. 16, is shown again dorsally in Fig. 17, but by this time the insect was dead so that the anal hair brush is seen withdrawn within the cell. The position of the spine is seen between the dorsal wax plates

7 and 8, the spine is indicated here much bolder than it really did, otherwise the illustration is a very true presentation of what was to be seen. The wax pencils form tooth wheel like projections different to the appearance of a younger cell Fig. 18, of *L. mysorensis* which has not yet moulted for the last time and where the cell is dorsally free from the spine. Fig. 18, it would be seen, although younger, has more lac enveloping the wax pencils and therefore the outline of the cell has not the tooth wheel like appearance as that of Fig. 17.

Comparing the front or the first anterior pairs of wax pencils seen in Figs. 17 and 18, it would be noticed that right at the front margin there is a V-like spacing where the two pairs in Fig. 17, meet while in Fig. 18, it is difficult to say which of the projections go in pairs, the spacing between them being relatively undecisive. It is a very deli-



1mm.

P.

Fig. 18.—*L. mysorensis*, cell of a full grown third stage larva which not having moulted shows the absence of a spine dorsally.

cate observation and the interested reader should compare Carter's illustration for the young female where the cell shows right in front a clear angular area of separation corresponding to that of Fig. 17, here; Carter's illustration is also reproduced by Blanchard (1883) Fig. 9. Misra (1923) and others reproduce Maxwell Lefroy's famous illustration of the female lac cell 13 weeks old. His Fig. 5, Pl. 1, shows in front a much shallower cleft than those on the sides, a great

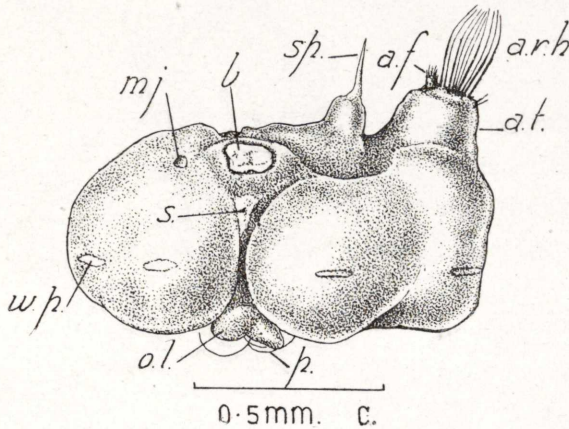


Fig. 19.—*L. nagoliensis*, young adult female shortly after the last larval moult seen sideways, after treatment with alcohol.

contrast with the illustration of Carter who gives broader and shallower curvatures for the side invaginations between the wax-pencils. I have elsewhere pointed out (1927) that Carter was dealing with *L. communis* represented here by Figs. 16 and 17 and therefore Fig. 17, should be comparable with his illustration just mentioned.

Of all species the spinoid tubercle is most developed in *L. nagoliensis*. A cell soon after its last moult was treated with cold alcohol and the young adult female is shown sideways in Fig. 19. The anal ring hairs, *a. r. h.*, which do not grow further are at this stage incomparably large for the small size of the body. The anal tube bearing these hairs, has at its anterior surface solid spines forming one continuous piece or plate, the anal fringe, *a. f.*; at its posterior surface are seen two fine hairs which deserve no particular notice here. The spinoid tubercle bearing the actual spine marked *sp.*, is a hump like structure peculiar to the lac insects. The circular brachial plate, *b.*, with the major spiracle just below marked *s.*, and accidentally also a muscular joint, *mj.*, near by, are all shown in the front dorsal region. The side is seen with four long patches from where wax pencils arise, *w. p.*; already in the young adult there are only six patches around the girdle or the equatorial region of the body. The ventral surface shows the proboscis, *p.*, and two oral lobes, a larger anterior

of one side, marked *o. l.*, and a posterior one not indicated. Between the mouth and the brachial plate there is a groove well seen which contains the canella pores mentioned earlier in this article. The insect had recently moulted so that not enough wax was secreted from the canella pores to be evident at this stage.

To complete the presentation of the subject, Fig. 20 shows a very early adult cell of *L. communis*

seen three fourths dorsally very soon after fertilisation and therefore just a little older than that seen in Fig. 16. The dorsal surface of the cell would be seen with globules of lac very well defined and the wax pencils likewise giving rise to sharply pointed finger like projections in one instance, the anterior one of the third pair. It may be recalled this additional projection is that just secreted by the adult female and the three pairs of wax pencils marked in Fig. 20, really belong to the last larval stage

cell. The dorsal globules of lac particularly above the third pair of wax pencils are those secreted by the young adult female. The cell shows the insect as dead, *i. e.*, the cell opening as empty and wax filaments are absent; it was intentionally so drawn particularly to show the shape of the cell opening. The cell was collected during Aug. 1921 at Bangalore.

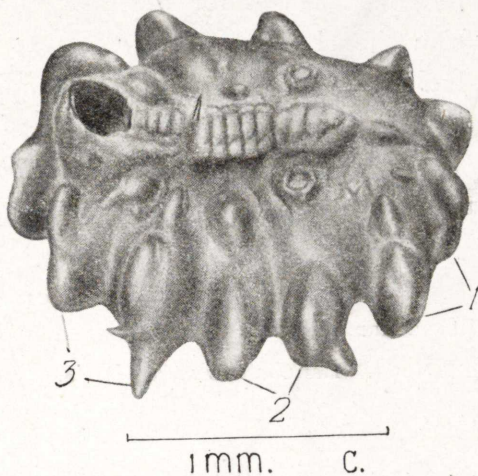


Fig. 20.—*L. communis*, cell of a fertilised female in the very earliest stage; the cell shows dorsally two or three globules of lac otherwise it is like a third stage larval cell.

Summary.

Lac insects soon after the second moult up to the third and transformation into young adult female are illustrated without the secretion material as well as their cells. Likewise insects with wax alone or as freed from the accompanying lac or resin are also shown. This wax goes to form the skeleton of the cell architecture. Incidentally

the observations of Imms and Chatterjee and for Carter are mentioned and extended. The paper is a continuation of other articles and implies three moults of the lac insect which so far has not been substantiated by most workers on coccids and particularly so by those who have written on lac insects.

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