

LAC INSECT AND ASSOCIATED FAUNA - A PRACTICAL MANUAL



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Cover page photographs

Anticlock wise from left top : *Aprostocetus purpureus*, *Bracon greeni*, *Chrysopa sp.*, *Eublemma amabilis* and Lac insect secreting wax

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PREFACE

Three commercially potential products obtained from lac insects *viz.*, resin, dye and wax find application in diverse areas such as food industries, pharmaceuticals, cosmetics, paints and varnishes. In view of bio-safety and stress on natural products, the demand potential of lac is upbeat. Lac, the only natural resin of insect origin is derived mostly from a few species of *Kerria* (Coccoidea: Tachardiidae) belonging to a specialized group of scale insects. It is a major source of livelihood to millions of economically backward population especially tribals in Jharkhand, Chhattisgarh, Madhya Pradesh, Maharashtra and West Bengal etc. Indian lac insect, *K. lacca* alone contributes more than 80 per cent of the national lac production.

A large pest complex comprising mainly of predatory and parasitic insects are associated with lac insects. Lac insect sucks the sap from specific plants known as lac hosts and being of sedentary nature is more vulnerable to the attack by number of pests and diseases. The parasitoids and predators of the *K. lacca* have been held responsible for causing about 50 per cent crop loss. Thirty five species of primary and 45 species of secondary parasitoids have been reported in lac insect ecosystem. With changing climatic conditions coupled with discovery of newer parasitoids, problem of parasitization is becoming more acute leading to frequent crop failure.

Identification and proper documentation of different stages of lac insect and associated fauna *viz.*, parasitoids and predators is, therefore, required for characterization and recording the damage caused by these. Early stages of lac insect and associated parasitoids are tiny and difficult to be easily identified. Therefore, an attempt has been made to prepare catalogue of different stages of lac insect, major parasitoids and predators using good quality photographs under high resolution microscope. The bulletin contains valuable information on detailed description of lac insect, lac associated fauna and data sheet for recording observations on various parameters. It is hoped that the bulletin will be useful to the researchers, academicians and farmers alike. We would like to sincerely thank Miss Sweta Verma, Senior Research Fellow for her help in sample collection. We also wish to record our sincere thanks to Dr. V V Ramamurthy, Network Project on Insect Biosystematics, Indian Agricultural Research Institute, New Delhi for identification of lac associated parasitoids.

April, 2016

Authors

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1. THE LAC INSECT

Lac insects, under Family Tachardiidae (=Lacciferidae), Order Hemiptera, Superfamily Coccoidea are commercially important species for resin, dye and wax production. Lac insects are naturally distributed in tropical and subtropical areas of south and south-east Asia. Out of the nine genera and 99 species of lac insects reported from the world, two genera and 26 species are found in our country. The family Tachardiidae is divided into two sub-families, i) Tachardiinae including true lac insects of resinous cell and ii) Tachardininae including pseudo-lac insects of non-resinous cells. In India, lac is cultivated in Jharkhand, Chhattisgarh and parts of Madhya Pradesh, Maharashtra and West Bengal primarily using *Kerria lacca* (Kerr). However, natural populations of *Kerria* spp. are distributed throughout India and *K. chinensis* in the north eastern states is also cultivated to a certain extent. They are characterized by the presence of a special type of mouth-parts, intended for sucking plant juices- this is the sole mode of their feeding. The voyage of life of lac insects begins with the completion of embryonic development within the body of the mother when eggs change their position in the ovariole. Eggs then travel through oviducts and come out of the mother into the specially built “incubation chamber” formed by making sufficient gap between the body and resinous cell. Hatching of eggs mostly takes place after reaching the incubation chamber and is called as ovo-viviparity.

The crawler after coming out of the incubation chamber looks ovate in outline, slightly more pointed posteriorly, soft-bodied, crimson in colour and very small in size, being usually 0.4-0.6 mm long (excluding the antennae and caudal setae) and 0.15-0.2 mm wide across the thorax (Figs. 1a and b). The mouth-parts which are of piercing and sucking type as in all Hemiptera, are thrust into the bark of the twig.



1a. Nymphal stage settled on plant



1b. Microscopic view- Nymph



The first instar larva

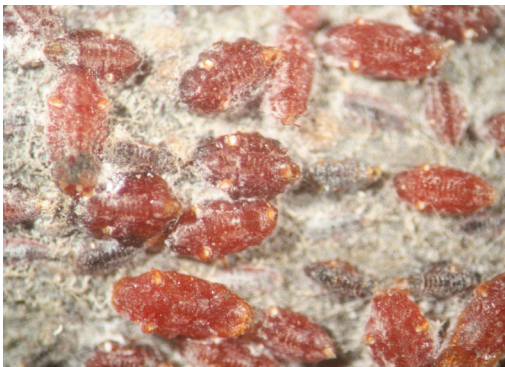
A day or so after settling, the larva start secreting lac resin from almost all over the body except near the rostrum, and the brachial plates. Thus, it gets encased in a cell of lac which keeps on increasing with the increase in size of the insect. The insect moults thrice before reaching maturity, the duration of each instar being dependent on several environmental factors such as temperature, humidity, host plants etc.

The second and third instar

After the first moult, the male as well as the female larvae lose their legs, antennae and eyes. From this stage onwards, sexual dimorphism becomes pronounced.

The male insect

The lac cell of the male assumes a slipper like appearance at the final stage and has a loose operculum at the rear end. While still inside the cell, the larvae cast off the second moult, which is pushed out of the cell from the rear end. Subsequently, the larvae pass through the prepupal and pupal stages when appendages which eventually develop into legs, antennae, eyes, wings, (except in apterous males), penial stylus etc. are easily seen. However, during the last stage, the male insect stops feeding and its mouthparts become atrophied. The male emerges with the hind end of the body first by pushing the operculum. They may be winged or wingless; the relative number of the two forms varying considerably in different seasons of the lac crops. They copulate with the females, which remain enclosed in the lac cell and by the time of the emergence of males, generally become pear-shaped (Figs. 1c to f).



1c. Sexual differentiation stage



1d. Closer view- Male (elongate) and female (roundish)



1e. Male Winged and wingless



1f. Microscopic view – Male winged and wingless



The female insect

The female larva also casts off antennae, eyes, legs etc after the first moult, but unlike the male, these do not develop these organs again except the rudimentary antennae instead of certain other organs, which are peculiar to the female become conspicuous. The size of brachial plates and the number of openings in them increases, the number of setae from the anal ring plates also increases from six to ten. Openings of the marginal and perivaginal ducts are seen in clusters for the first time but the branchia, anal tubercle and the dorsal spine are yet undeveloped, though the upturned terminal segments of the abdomen may be regarded to mark the beginning of the anal tubercle. Two further moults are cast and the cast skins in each case being pushed out of the lac cell at the rear end. During the second and subsequent third instar, the larva becomes more swollen and loses all traces of segmentation. Besides the increased rate of growth along the vertical axis the terminal segments of the abdomen are directed upward. Areas around the brachial plates are demarcated and constitute what may be called the beginning of the anal and brachial lobe. Changes in the position of the organs, such as shifting of anterior pair of the spiracles towards aboral end, orientation of the alimentary canal, nervous and tracheal system, etc also takes place during this instar. The insect, thus, generally assumes the appearance of a pear-shaped structure or roundish bag, completely occupying the space inside the lac cell. Openings in the clusters of ducts of the ventral, marginal and perivaginal glands also make their appearance.

After the final (third) moult, the dorsal spine, which is born on an elongate tubercle appears in the center of the triangular, lying between the two brachial and one anal tubercle. At this stage, the female is sexually mature and is fertilized by the male, the emergence of which synchronizes with this stage in the development of the female. The males die within few days of their emergence and copulation. From this time onwards lac is secreted at a faster rate and the size of the female insects and of the enveloping lac cells increase at a faster rate than in the case during the earlier stage and reaches a size several times more than that of the male lac cell (Figs. 1g to i).



1g. Mature female lac cell



1h. Microscopic view – female after removing the cell

This state of activity lasts for a varying number of weeks depending upon the season, place and host plants. The female lac insects that live for relatively longer period after fertilization, are therefore, the chief sources of lac secretion. As the lac insects are usually situated close together, the lac secretion from adjacent cells coalesce with each other and form a continuous



11. Template for morphometrics – Lac insect female

Body

1. Length
2. Width at region 1
3. Width at region 2
4. Width at region 3

Antennae

5. Length
6. No. of segments
7. No. of setae

Ventral duct cluster

8. No. of patches

Mouth parts

9. Length of clypeolabral shield
10. Length of oral lobe
11. Length of stylet

Marginal duct cluster

12. No. of ducts in each

Branchium

13. Length

Branchial plate

14. Diameter
15. Crater rim
16. Crater width
17. No. of dimples

Anterior spiracles

18. Length
19. Width
20. Distance from crater rim
21. No. of pores

Canellar band

22. Length

Posterior spiracles

23. Length
24. No. of pores

Dorsal spine

25. Length
26. Pedicle length
27. Pedicle basal width
28. Pedicle apical width
29. Length of spine

Perivulvar pore cluster

30. No. of pores
31. No. of openings in each

Anal tubercle

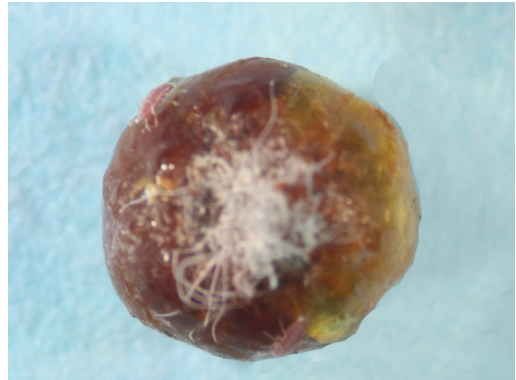
32. Length
33. Width
34. Length of non-sclerotized region
35. Length of supra-anal plate
36. Anal fringe height
37. No. of setae



encrustation on the branches. The rate of secretion of waxy filaments, which protrude out of the anal and the brachial pores, and of the excretion of honey dew also increases during this period. The cottony appearance of certain healthy encrustation of lac is due to the long filaments of wax, while the sooty mould appearance on the leaves of trees bearing lac is due to the growth of certain black fungi (*Capnodium* and *Fumago* species) on the honey-dew that falls on the leaves. The living female insect secretes white wax filaments. As the crop maturity period approaches, the rate of wax secretion slows down and appearance of a yellow spot takes place. The growth of the yellow spot in the female insect, enables one to forecast the date of emergence of larvae in all crops (Figs. 1 j and k).



1j. Indication of maturation of lac insect
(Female cell showing Yellow spot)



1k. Larval emergence from matured lac insect

Sticks with the lac encrustation containing gravid females are called “broodlac” sticks (Fig. 1l), which are generally tied together for purpose of inoculating other trees for the succeeding crop. The duration of life cycle and numbers of generation per year depends on various factors, such as, the species/strain of the lac insect, the season of development and climatic condition of the area. Qualitative variations with regards to body colour of lac dye has been reported in lac insects showing crimson, yellow, cream and albino (white) body colours (Figs. 1 m to o)



1l. Lac encrustation
(broodlac)



1m. Lac insects - Crimson



1 n. Lac insects - Yellow



1o. Lac insects - Cream

Fig. 1 (a-o). Different developmental stages of Lac insects

2. LIFE CYCLE OF LAC INSECT

Observation to be recorded

Duration of pre sexual stages (Days)

Time elapsed between date of inoculation to male and female of lac insect differentiation

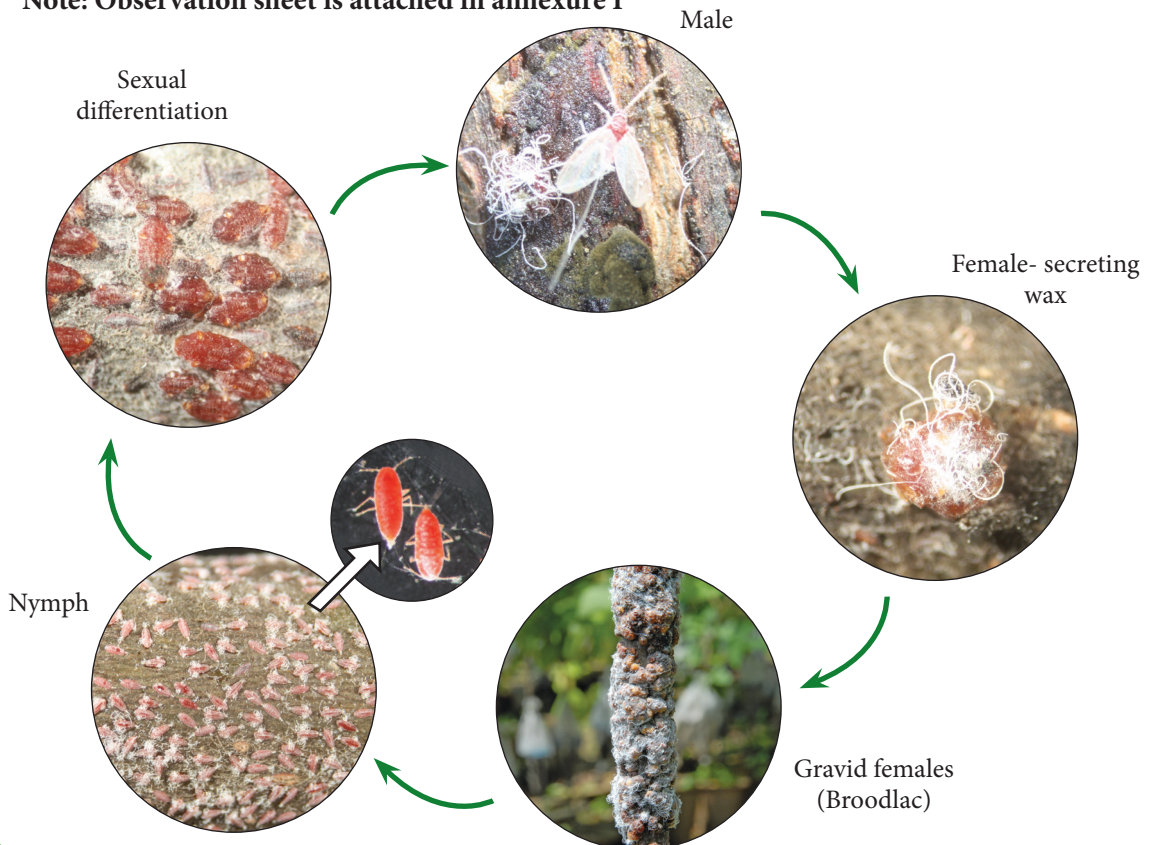
Duration of male emergence (Days)

Observation should be recorded from date of male emergence till male emergence is completed

Life period of female (Days)

Time elapsed between date of inoculation and crop harvesting to be counted as life duration of the female lac insect

Note: Observation sheet is attached in annexure I



Lac insect life cycle

3. PRODUCTIVITY LINKED PARAMETERS OF LAC INSECT

The parameters to be studied are: Initial density of settlement, initial mortality, sex ratio, density at crop maturity, life period, weight of female lac cell, fecundity and total yield.

Methodology

Initial density of settlement (number per square cm)

One square cm area to be selected at random and numbers of lac larvae settled counted. At least three such sites to be selected (preferably lower, middle and upper part of settlement) from the same host plant and average taken as density of settlement (Fig. 2a).

Initial mortality (%)

The above process to be repeated at 21-days after inoculation of broodlac. Under field conditions, process of larval emergence continues upto two weeks. The larvae, which are not able to find suitable sites for settlement, die due to starvation. Observation at this stage is the true indication of the number of larvae actually settled and which have started feeding (Fig. 2a).

$$\text{Initial mortality} = \frac{\text{Initial density} - \text{Density after 21 days of settlement}}{\text{Initial density}} \times 100$$

Sex ratio (% of male insects)

At the time of emergence, larvae cannot be differentiated into males or females. After a certain period of growth, larvae can be differentiated into male and female lac insects based on their morphological differences (male are elongated and females are round shaped). The process (as in initial density of settlement) repeated for recording male and female numbers (Fig. 2b).

$$\text{Male \%} = \frac{\text{Number of male insects}}{\text{Total number of insects}} \times 100$$

Density at crop maturity (number per square cm)

Surviving female lac insects (after initial mortality and emergence of male lac insects) to be counted as above at crop maturity (appearance of yellow spot) (Fig. 2c).

Life period (in days) of the female cell

Time elapsed between date of inoculation and crop harvesting to be counted (in days) as life duration of the female lac insect.



Weight (in mg) of the female cell and resin output

Weight of individual female lac insect is recorded after larval emergence has completed using electronic balance. The resin produced by an individual female cell recorded after removing the dead insect body from the cell. 50 cells (10 each from five plants/replicates) should be collected.

Fecundity (number of young ones produced by the female insect)

The collected mature female cells are stored individually into glass vials plugged with cotton for about a month and the emerged larvae to be counted. The cells are then broken/opened and larvae, which could not emerge, counted. Total count is taken as fecundity of the female lac insect (Fig. 2d).

Total yield (kg)

Total yield per plant should be recorded after harvesting.

Broodlac output ratio

Ratio of quantity of broodlac obtained at crop harvest to broodlac used at inoculation is broodlac output ratio.

Broodlac and scrappedlac ratio

Ratio between broodlac and scrappedlac obtained after harvesting lac crop.

Note : Observation sheet is attached in annexure II

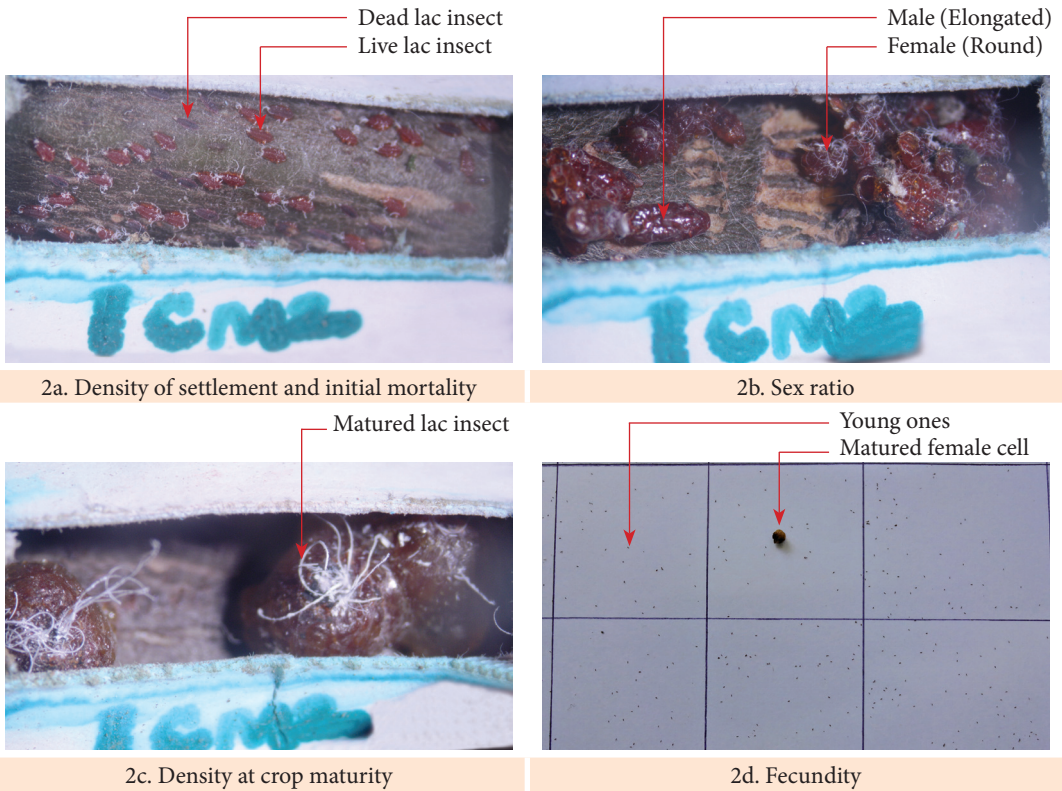


Fig. 2 (a to d). Observations for biological attributes of lac insect

4. SAMPLE COLLECTION OF LAC ASSOCIATED FAUNA

Inoculation of lac insect strain *i.e rangeeni* (*katki & baisakhi*) and *kusmi* (*aghani & jethwi*) on respective host plants

Rangeeni is cultured on *palas* (*Butea monosperma*) and *ber* (*Ziziphus mauritiana*) while *kusmi* is reared on *kusum* (*Schleichera oleosa*) and *Semialata* (*Flemingia semialata*)

Phunki (used-up broodlac sticks after complete emergence of lac larvae from female cells) should be removed 21 days after inoculation (DAI)

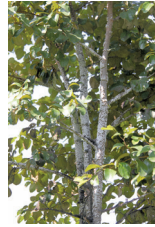
Lac insect samples are collected randomly with 5 replication after *phunki* removal at every 15 days interval till harvest

Lac insect sample (1 meter lac encrustation) is caged in wooden box (20×20×30cm) with glass tubes. Glass tubes are fitted towards sun light to collect more numbers of parasitoids because of phototropic behaviour of parasitoids

Lac associated fauna (parasitoid and predators) are collected from parasitoid emergence cage at every day continuously upto one month

Lac associated fauna are separated and the numbers recorded based upon morphological identification characters

Observation sheet is attached in annexure III to V



Lac crop on *ber*



Parasitoid emergence cage



Collection of lac associated fauna



Identification of lac associated fauna

Collection and identification of lac associated fauna

5. LAC ASSOCIATED FAUNA

Lac insect sucks the sap from specific plants known as lac hosts and being of sedentary nature is more vulnerable to be attacked by number of pests and diseases. Thirty five species of primary and 45 species of secondary parasitoids have been reported in lac insect ecosystem. Lac insect, like any other insect has its own natural enemies, namely, insect parasitoids and predators. The parasitoids are tiny wasps belonging to the superfamily Chalcidoidea. List of reported insect pests associated with lac insect fauna are given below. Identification of parasitoids and predators of lac insects with distinguished characters are very much important and much confusion still prevails in the name and identity of lac associated parasitoids. Most of the parasitoids are very in small size, have similar colour patterns which is not easily identifiable. Therefore, an attempt has been made to prepare catalogue containing distinct characters and photos for major parasitoids and predators.

Insect pests associated with lac insect

Sl. No	Family	Insect	Host(s)
A. Harmful parasitoids			
1	Aphelinidae	<i>Coccophagus tschirchii</i> Mahd.	<i>Kerria lacca</i>
		<i>C. nigropleurum</i> Girault	<i>Tachardina africana</i>
		<i>C. scutatus</i> Howard	<i>T. africana</i>
		<i>Eurymyiocnema aphelinoides</i> Compere	<i>K. lacca</i>
		<i>Marietta javensis</i> How. (= <i>M. leoperdina</i>)	<i>K. lacca</i> and <i>Aspidiotus orientalis</i>
		<i>Marietta leopardina</i> Nietner	<i>Paratachardina lobata</i>
2	Braconidae	<i>Aphrastobracon flavipennis</i> Ashmead	<i>K. lacca</i> , <i>K. albizziae</i>
		<i>Bracon</i> sp.	<i>K. javana</i>
		<i>Bracon greeni</i> Ashmead	<i>K. lacca</i> , <i>K. albizziae</i>
		<i>Campyloneurus indicus</i> Ayyar	<i>K. lacca</i>
3	Cecidomyiidae	<i>Cecidomyid</i> sp.	<i>K. lacca</i> , <i>K. javana</i>
		<i>Dentifibula lacciferi</i> Barnes	<i>K. lacca</i> , <i>K. javana</i>



Sl. No	Family	Insect	Host(s)
4	Encyrtidae	<i>Aenasiella africa</i> Girault	<i>Tachardina africana</i>
		<i>Anicetus dodonia</i> Ferrire	<i>K. lacca</i>
		<i>Atropates hautefeuilli</i> Mahd.	<i>K. chinensis, K. lacca</i>
		<i>Erencyrtus dewitzi</i> Mahd.	<i>K. lacca, K. communis, K. fici, K. nagoliensis, Metatachardia conchiferata</i>
		<i>Lyka lacca</i> Agarwal	<i>K. lacca</i>
		<i>Parageniaspis indicus</i> Mashhood Alam	<i>K. lacca</i>
		<i>Parechthrodryinus clavicornis</i> Cam.	<i>K. lacca, K. communis, K. chinensis, K. lacca mysorensis, K. fici, K. nagoliensis, K. sindica</i>
		<i>Protyndarichus submettalicus</i> Mashhood Alam	<i>K. lacca</i>
		<i>Tachardiobius nigricans</i> Timberlake	<i>Tachardiella larreae</i>
		<i>Tachardiaephagus tachardiae</i> How.	<i>Kerria albizae, K. lacca, K. nagoliensis, K. sindica, K. chinensis, K. lacca mysorensis, K. fici, K. communis, K. javana and Paratachardina lobata</i>
		<i>T. tachardiae somervilli</i> Mahd.	<i>K. lacca, K. lacca mysorensis, K. nagoliensis</i>
<i>Tachardiobius nigricans</i> Timberlake	<i>K. lacca</i>		
<i>Thomsonisca</i> sp.	<i>K. lacca</i>		
5	Entedontidae	<i>Holcopelte</i> sp.	<i>K. albizae</i>
6	Eulophidae	<i>Aprostocetus</i> (Syn. <i>Tetrastichus</i>) <i>purpureus</i> (Cam.)	Primary hosts <i>Tachardia lacca, T. albiziae, Ceroplastes rubens, Pulvinaria psidii, Aonidiella aurantii, Aonidiella orientalis, Aspidiotus</i> sp., <i>Aspidiotus orientalis, Chionaspis</i> sp., <i>Chrysomphalus aonidum, Melanaspis glomerata, Pseudaulacaspis</i> sp., <i>Pseudaulacaspis barberi, Pseudaulacaspis pentagona, Laccifer (= Kerria) chinensis,</i>



Sl. No	Family	Insect	Host(s)
			<i>Laccifer</i> (= <i>Kerria</i>) <i>javanus</i> , <i>Laccifer</i> (= <i>Kerria</i>) <i>lacca</i> , <i>Laccifer</i> (= <i>Kerria</i>) <i>sindica</i> , <i>Icerya aegyptiaca</i> , <i>Icerya zimmermani</i> , <i>Ferrisia virgata</i> , <i>Planococcus citri</i> , <i>Planococcus lilacinus</i> , <i>Phenacoccus solenopsis</i> , <i>Dactylopius</i> sp. Hyperparasitoid <i>Coccophagus tschirchii</i> , <i>Leptomastix dactylopii</i> and <i>Tachardiaephagus tachardiae</i>
		<i>Tetrastichus</i> sp.	<i>K. albizziae</i>
7	Eupelmidae	<i>Eupelmus tachardiae</i> (How.)	<i>K. lacca</i> , <i>K. albizziae</i> , Hyperparasite of <i>Bracon greeni</i> , <i>Apanteles tachardiae</i> and alternate host of <i>Machaerota planitiae</i>
8	Mymaridae	<i>Camptoptera</i> sp.	<i>K. lacca</i>
9	Pteromalidae	<i>Pteromalus</i> sp.	<i>K. lacca</i>
10	Scatopsidae	<i>Scatopse</i> sp.	<i>K. lacca</i>

B. Beneficial Parasitoids

1	Bethylidae	<i>Perisierola</i> sp.	<i>Pseudohypatopa pulverea</i>
		<i>Perisierola</i> (= <i>Goniozus</i>) <i>pulveriae</i> Kuerten	<i>P. pulverea</i>
2	Braconidae	<i>Agathis bischoffi</i> Fabr	<i>P. pulverea</i>
		<i>A. coryphe</i> Nixon	<i>P. pulverea</i>
		<i>A. festiva</i> Muesebeck	<i>P. pulverea</i>
		<i>Apanteles angaleti</i> Muesbeck	<i>P. pulverea</i>
		<i>Apanteles fakhrulhajiae</i> Mahd.	<i>P. pulverea</i>
		<i>A. tachardiae</i> Cam.	<i>P. pulverea</i>
		<i>Aphrastobracon flavipennis</i> Ashm.	<i>Eublemma amabilis</i> , <i>E. coccidiphaga</i> , <i>E. scitula</i> , <i>Coccidiphaga scitula</i>
		<i>Bracon greeni</i> Ashm.	<i>E. amabilis</i> , <i>P. pulverea</i>
		<i>B. hebetor</i> Say	<i>E. amabilis</i> , <i>C. scitula</i> , <i>P. pulverea</i>
		<i>B. tachardiae</i> Cam.	<i>E. amabilis</i>



Sl. No	Family	Insect	Host(s)
		<i>Cedria paradoxa</i> Wlkn.	<i>E. amabilis</i>
		<i>Chelonus</i> sp.	<i>P. pulvereana</i>
		<i>Chelonella cyclopyra</i> Franz.	<i>P. pulvereana</i>
		<i>Phaneratoma buchneri</i> Fabr.	<i>P. pulvereana</i>
3	Cerephronidae	<i>Conostigmus</i> sp.	<i>Chrysopa madestes</i>
4	Chalcidae	<i>Brachymeria tachardiae</i> Cam.	<i>E. amabilis</i> , <i>P. pulvereana</i>
5	Elasmidae	<i>Elasmus albomaculatus</i> Gahan	<i>P. pulvereana</i>
		<i>E. claripennis</i> Cam.	<i>E. amabilis</i>
		<i>E. colemani</i> Mahd.	<i>E. amabilis</i>
		<i>E. indicus</i>	<i>E. amabilis</i>
6	Encyrtidae	<i>Anagyrus breeni</i> Howard	<i>C. madestes</i>
		<i>Cheiloneurus</i> sp.	<i>C. madestes</i> , <i>C. lacciperda</i>
		<i>Thomsonisca</i> sp.	<i>Encyrtid parasitoids</i>
		<i>Tyndarichus</i> sp.	<i>E. amabilis</i> and <i>P. pulvereana</i>
7	Eupelmidae	<i>Brasema annulicaudis</i> Cam.	<i>E. amabilis</i>
		<i>Eupelmus tachardiae</i> (How.)	<i>E. amabilis</i> , <i>P. pulvereana</i>
8	Eurytomidae	<i>Eurytoma pallidiscapus</i> Cam.	Pupae of <i>P. pulvereana</i> and <i>E. amabilis</i>
9	Ichneumonidae	<i>Brachycyrtus</i> sp.	<i>C. madestes</i> , <i>C. lacciperda</i>
		<i>Brachycyrtus eublemmae</i> Rao	<i>C. madestes</i> , <i>C. lacciperda</i>
		<i>Pristomerus sulci</i> Mahd. & Kolub.	<i>P. pulvereana</i>
10	Perilampidae	<i>Perilampus</i> sp.	<i>C. lacciperda</i>
11	Scelionidae	<i>Telenomus</i> sp.	<i>C. madestes</i> , <i>C. lacciperda</i>
12	Trichogrammatidae	<i>Trichogramma</i> sp.	<i>E. amabilis</i> , <i>E. coccidiphaga</i> , <i>E. scitula</i>
		<i>Trichogrammatoidea nana</i> Zehnt.	<i>E. amabilis</i> and <i>P. pulvereana</i> eggs



C. Predators of lac insect

Sl. No	Family	Insect
1	Blastobasidae	<i>Pseudohypatopa (=Holcocera) pulverea</i> Meyr.
2	Blattellidae	<i>Ischnoptera fulvastrata</i> Chop.
		<i>Phyllodromia</i> sp.
		<i>Phyllodromia humbertiana</i> Sauss.
3	Chrysopidae	<i>Chrysopa</i> sp.
		<i>Chrysopa madestes</i> Banks
		<i>C. lacciperda</i> Kimmins
4	Cosmopterygidae	<i>Pyroderces falcate</i> Staint
5	Cucujidae	<i>Silvanus iyeri</i> Grouv.
6	Heliodinidae	<i>Oedematopoda</i> sp.
		<i>Stathmopoda theoris</i> Meyr.
7	Momphidae	<i>Lacciferophaga yunnanea</i> Zagulyaev
8	Mycetophagidae	<i>Berginus maindroni</i> Grouvelle
9	Noctuidae	<i>Catablemma sumbavensis</i> Hampson
		<i>Eublemma amabilis</i> Moore
		<i>E. coccidiphaga</i> Meyrick
		<i>E. cretacea</i> Hampson
		<i>E. roseonivea</i> Walk
		<i>E. scitula</i> Rambr.
10	Phycitidae	<i>Cryptoblades ephestialis</i> Hampson
11	Pyralidae	<i>Ephestia</i> sp.
12	Tenebrionidae	<i>Tribolium ferrugineum</i> Fabr.



D. New records of lac associated fauna

Sl. No	Family	Insect
Parasitoids		
1	Braconidae	<i>Cotesia</i> sp.
		<i>Dolichogenidea</i> sp.
2	Eulophidae	<i>Mischotetrastichus</i> sp.
		<i>Necremnus leccarthros</i> Nees
3	Eutorymidae	<i>Plutarchia indefensa</i> Walker
4	Halticidae	<i>Sphecodes</i> sp.
5	Ichneumonidae	<i>Diplazon lactatorius</i> F.
6	Pteromalidae	<i>Pachyneuron ahlannse</i> Mani & Saraswat
		<i>Pachyneuron aphidis</i> Bouček
		<i>Pachyneuron stom</i> Narendran & Jilcy
		<i>Pteromalus pupareum</i> Bouček
7	Torymidae	<i>Pseudotorymus</i> sp.
Predators		
1	Silvanidae	<i>Oryzaephilus surinamensis</i> (L.)
2	Syrphidae	<i>Episyrphus viridaureus</i> (Wiedemann)
		<i>Episyrphus</i> sp.
		<i>Eupeodes</i> sp.
		<i>Sphaerophoria</i> sp.
3	Tephritidae	<i>Bactrocera tau</i> (Walker)

6. DESCRIPTION OF MAJOR PARASITOIDS OF LAC INSECT

1. *Aprostocetus (Tetrastichus) purpureus* (Cameron)



Adult female



Adult male

Family : Eulophidae

Order : Hymenoptera

Synonyms :

Aprostocetus (Aprostocetus) purpureus (Cameron, 1913)

Hadrothrix purpurea Cameron, 1913

Tetrastichus imsii Mahdihassan, 1923

Tetrastichus purpureus (Cameron)

Common names :

Parasitic wasp (English)

Porojibee boltaa (Bangla)

Host

Primary hosts

Tachardia lacca, *T. albizziae*, *Ceroplastes rubens*, *Pulvinaria psidii*, *Aonidiella aurantii*, *Aonidiella orientalis*, *Aspidiotus* sp., *Aspidiotus orientalis*, *Chionaspis* sp. *Chrysomphalus aonidum*, *Melanaspis glomerata*, *Pseudaulacaspis* sp., *Pseudaulacaspis barberi*, *Pseudaulacaspis pentagona*, *Laccifer* (= *Kerria*) *chinensis*, *Laccifer* (= *Kerria*) *javanus*, *Laccifer* (= *Kerria*) *lacca*, *Laccifer* (= *Kerria*) *sindica*, *Icerya aegyptiaca*, *Icerya zimmermani*, *Ferrisia virgata*, *Planococcus citri*, *Planococcus lilacinus*, *Phenacoccus solenopsis* and *Dactylopius* sp.



Hyperparasitoid

Coccophagus tschirchii, *Leptomastix dactylopii* and *Tachardiaephagus tachardiae*

Distribution

It has been found to have wide distribution and is direct parasite of the coccid and not an hyperparasite. (Bangladesh; India, Pakistan, Australia and Malaysia).

Immature stages of *A. purpureus*



Grub



Immature stage



Adult

Grub is apodus pink colour with outer white cover, yellowish body with **pink colour eye** of immature stage and black colour body with pink colour eye before emergence.

Female

Length 1.5-1.8mm

Head

Black colour and shining, very slightly punctulate, rounded, vertex very short. **Eye pink in colour.** Antennae brown, elongate, scape reaching a little beyond ocelli; the 8 funicle joints and the pedicellus nearly all of equal length, the club 3-jointed, the last joint short and pointed.



Thorax

Mesonotum and scutellum slightly reticulate, the median groove of the mesonotum and the two longitudinal grooves of the scutellum well marked. **Wings large hyaline, reaching beyond the end of the abdomen.** Marginal nerve longer than submarginal; **pterostigma as long as a third of the marginal nerve and pubescence not in rows.** Legs yellow, the base of the coxae stripes above and below the femora and the end of tarsi brownish with 4 segmented, a shortened, straight fore tibial spur, marginal and stigma nerves light yellow

Abdomen

Abdomen a little longer than the thorax, slightly broadened until beyond the middle then sharply pointed, **ovipositor slightly protruding.** Black with purplish and greenish reflection, base of abdomen more or less yellow.

Male

Length 1.2mm

Similar to female, **antennae with long bristles arranged in half-circles,** abdomen shorter than the thorax with **male genitalia,** with the 1st segment yellow, legs clear yellow; coxae, part of femora, and of tarsi brown.

2. *Tachardiaepagus tachardiae* (Howard)



Adult female



Adult male

Family : Encyrtidae

Order : Hymenoptera

Synonyms :

Encyrtus tachardiae, Howard

Tachardiaepagus thoracicus, Ashmead

Lissencyrtus troupe, Cameron

Host : *Kerria albizae*, *K. lacca*, *K. nagoliensis*, *K. sindica*, *K. chinensis*, *K. lacca mysorensis*, *K. fici*, *K. communis*, *K. javana* and *Paratachardina lobata*

Distribution :

Sri Lanka (=Ceylon), India, Pakistan, Malaysia (=Malaya), Thailand, China and Taiwan



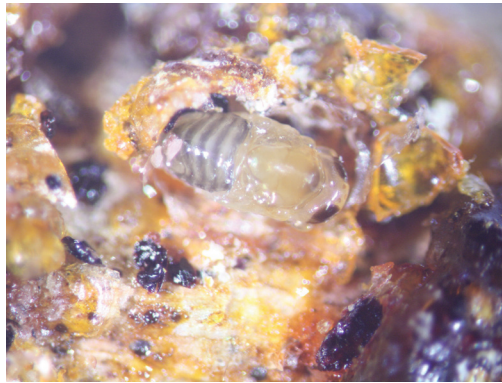
Immature stages of *T. tachardiae*



Grub



Immature stage



Adult

Grub is apodus brown colour, whitish body with **yellow colour eye** of immature stage and yellow colour thorax with black colour eye before emergence.

Female

Head

Black colour with shining eyes, Antennae brown, 11-segmented antennae, funicle with an apparent single segment (i.e. an enlarged club).

Thorax

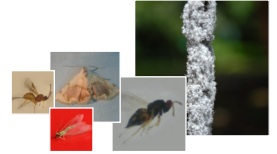
Black colour, **wings are large hyaline and membranous** and very short marginal vein. Legs yellow, 4 segmented tarsi, **tibial spur is present in both fore and middle legs**.

Abdomen

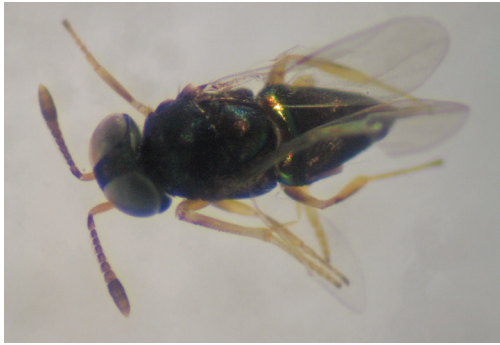
Black colour with protruding ovipositor and transverse axillae which meet medially and the positioning of the cerci anterior to the tip of the abdomen.

Male

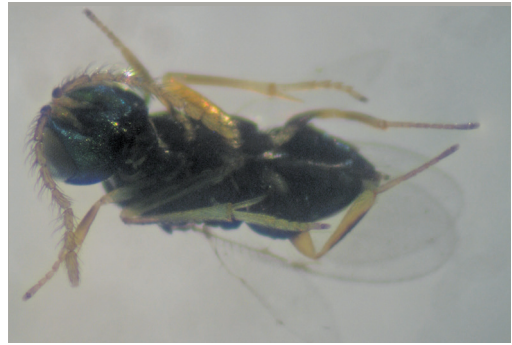
Similar to female, antennae with **small hair**.



3. *Parechthrodryinus clavicornis* (Cameron)



Adult female



Adult male

Family: Encyrtidae

Order: Hymenoptera

Synonyms: *Copidosoma clavicornis*, Cameron

Host: *K. communis*, *K. lacca mysorensis*, *K. lacca*, *K. chinensis*, *K. nagoliensis*, *K. sindica* and *Paratachardina lobata*

Distribution: India and Pakistan

Description

Body black with metallic reflections, bluish green on the head, dark green or more or less black on the mesonotum, **abdomen with the first segment shining green**. Antennae yellow, the pedicel and the first three funicle joints more or less brown above, the club dark brown. Antennae of male entirely yellow, only the pedicel slightly brown above. Legs yellow, the coxae and hind femora above brown, wings hyaline.

Female

Length 1.0 – 1.6mm

Head

Head transverse, eyes large, vertex and frons narrow; ocelli forming a high triangle, the lateral ocelli very near the eye-margins. Antennae inserted a little above the clypeus; scape rather short, not nearly reaching the front ocellus, pedicel about twice as long as broad, 1st funicle joint small, rounded or subquadrate, club with 3 joints, about as long as 5 preceding joints together.

Thorax

Propodeon very short in the middle, covered by the tip of the scutellum. **Wings large, reaching beyond the tip of the abdomen**; submarginal vein with a row of 7 to 9 long hairs and a small triangular expansion; marginal vein about twice as long as broad; stigma vein



narrow and about as long as the marginal, the knob small and oval; postmarginal vein as long as the stigma; discal ciliation small, with an oblique hairless line below the marginal vein.

Abdomen

Abdomen as broad as the thorax at the base, pointed behind, the sensorial placed before the middle. Ovipositor slightly protruding.

Male

Length 0.9 – 1.33mm

Similar to the female, from which it **differs only by the form of the antennae**; these are elongate, with the pedicel rounded, the **1st funicle joint about 4 times as long as broad**, the following joints a little shorter and all covered **with long hair**; club narrow, as long as two preceding joints together.

4. *Eupelmus tachardiae* (Howard)



Adult female



Adult male

Family: Eupelmidae

Order: Hymenoptera

Synonyms: *Anastatus tachardiae*, Howard
Brasema annulicaudis, Cameron
Pteromalus sp.

Host : *Kerria albizzae*, *K. lacca* and *Machaerota planitiaie*

Distribution : Sri Lanka (=Ceylon), India, Pakistan, Thailand and China

Female

Length : 2.5 – 3.3mm

Head

Black with green and brassy reflections and more or less purple, especially on the face, vertex and scutellum; abdomen violaceous with the base shining green; antennae black with the scape yellow and green reflections on the pedicel



Thorax

Legs reddish yellow, the coxae black with metallic reflections, the front and hind femora brownish black except at tip, the anterior tibiae brown in the middle above and the hind tibiae also more or less brown in the middle. Scape cylindrical, not reaching to the front ocellus; pedicel elongate, twice as long as broad; club as long as 3 preceding joints together. Thorax finely shagreened, dull, scutellum slightly striate. Propodeon very short, transverse. **Wings large, reaching beyond the tip of the abdomen**; marginal vein a little longer than submarginal narrow; stigma vein as long as one-fourth of the marginal; postmarginal vein as long as stigma. Fore legs with the femora not much thickened, the tibia shorter than the femora; **spur of middle tibiae** as long as the metatarsus, which is thick and short and with black spines below.

Abdomen

Abdomen as long as or a little shorter than the thorax and not broader, finely shagreened above and rounded behind. **Ovipositor is long.**

Male

Length :1.3 – 2.3mm

Head

Smaller, black with greenish reflections; antennae entirely black, greenish on scape and pedicel; legs black, only the anterior tibiae below and at tip, the middle and hind tibiae at tip, and the tarsi at base yellow. Scape broadened in the middle; pedicel a little longer than broad; the 7 funicle joints subequal in length, the last a little shorter; club as long as 2 preceding joints together.

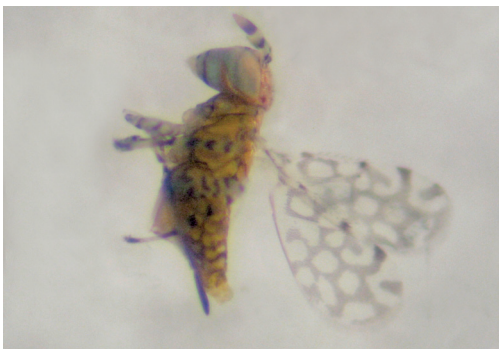
Thorax

Thorax normal, mesonotum convex with the parapsidal furrows complete; scutellum almost as long as the mesonotum; **Wings with the marginal vein about four times as long as the stigma.**

Abdomen

Abdomen shorter and narrower than the thorax, slightly broadened behind, triangular.

5. *Marietta javensis* (Howard)



Adult female



Adult male



Family: Aphelinidae

Order: Hymenoptera

Synonyms: *Perissopterus javensis* Howard, 1907
Perissopterus sp. Glover, (1935)
Microterys hautfeuillei Mahd. vide Glover (1935)

Host: *Kerria lacca* (Male) and *Aspidiotus orientalis*

Distribution: India, Malaysia

Female

Length : 0.72mm., expanse 2.2mm

Head

Orange colour, eyes naked. Antennae with club brown, scape cylindrical and the two funicle joints well developed, yellowish at tip; third funicle joint brown at tip; first and second funicle joints brown; pedicel brown at base, white at tip.

Thorax

Mesonotum and mesoscutellum hexagonally reticulate punctuate. Sides of thorax marked with whitish. **Wings are smoky with rounded hyaline spots**, pattern of forewings of the reticulated type. Legs pallid; femora with two narrow bands of brown; tibiae with three broad brown bands and with a narrow brown tip; first and fifth tarsal joints brownish, others pallid

Abdomen

Sides of the abdomen marked with whitish and cross-bands of brownish. Ovipositor well extruded.

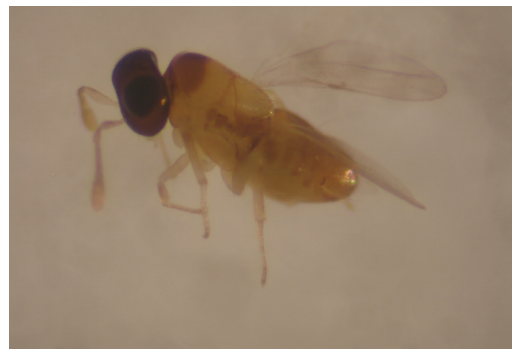
Male

Smaller, colour similar to female, but with small white thorax. **Entire club brown** except lighter at tip; pedicel whitish at tip.

6. *Erencyrtus dewitzi*, Mahd.



Adult female



Adult male



Family: Encyrtidae

Order: Hymenoptera

Synonyms: *Eretmocerus dewitzii*, Mahdihassan (1924)

Host: *Kerria communis*, *K. fici*, *K. lacca*, *K. nagoliensis* and *Metatachardia conchiferata*

Distribution: Sri Lanka (=Ceylon), India, Pakistan and Indonesia

Female

Length: 0.8-1.4mm

Head

Head transverse, as broad as the thorax; vertex broad, the lateral ocelli situated near the eyes. **Green with purple reflection**; antennae yellow, slightly brownish on the upper sides of pedicel and funicle joints; inserted just above the clypeus; scape a little broadened in the middle; pedicel twice as long as broad; the first funicle joints small, **6th joint a little larger, club oval**.

Thorax

Orange yellow, with the pronotum brownish in front and a green oval spot covering the posterior part of the pronotum and anterior third of the mesonotum; propodeum and metanotum brownish on the sides. Legs yellow, with a small brown spot on the middle and hind tibiae near the base, spurs of middle tibiae almost as long as metatarsus. **Wings hyaline, large, reaching beyond the tip of the abdomen**.

Abdomen

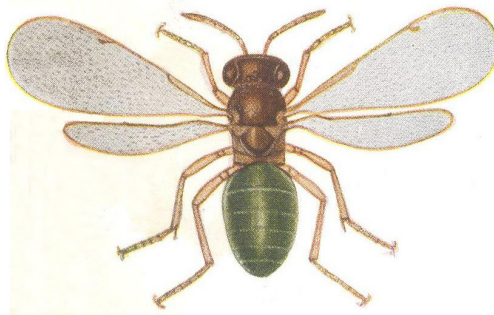
Brown, more or less yellowish at base. **Ovipositor not protruding**.

Male

Length :0.9-1mm

Similar to the female, from which it **differs only by the form of antennae**; these are formed by the scape, about thrice as long as broad in the middle, the short pedicel as long as broad, two small funicle joints, transverse, not easily seen, and a club formed by one very elongate joint, 3 times or more as long as the scape, covered with short hairs.

7. *Coccophagus tschirchii*, Mahdihassan





Family: Aphelinidae

Order: Hymenoptera

Host: *K. lacca mysorensis*, *K. lacca*, *K. javana*

Distribution: India, Malaysia

Female

Length: 1-1.7mm

Head

Small size (1 mm or less). Yellow, broad as the thorax, vertex very short, eyes black, ciliate, lateral ocelli nearer to the eye margin. Antennae brown with 8 joints, inserted near the clypeus, scape elongate, pedicellus short, flagellum 5 segmented, jointed.

Thorax

Lemon-yellow, rounded, finely reticulated on the mesonotum, the scutellum almost polished with a large black spot near the pronotum. Propodeum short without lateral grooves. Thorax covered with black hairs; the mesonotum with several rows of small hairs. Wings broad, hyaline, reaching beyond the the abdomen, covered with short ciliae, the fringes also very short. Marginal nerve much longer than the submarginal, stigma and postmarginal nerve very short. Legs entirely light yellow, not broadened, normal; spurs of middle tibiae as long as the metatarsus and 5 segmented tarsi.

Abdomen

Black, rounded as long as thorax, ovipositor very little exerted.

Male

Length :1.2mm

Darker than the female, with mesonotum, except along the parapsidal furrows, axillae and scutellum, except on the sides, dark brown; abdomen brown; legs and antennae entirely yellow. The antennae are more elongate, the pedicel rounded, the 3 funicle joints similar to those the female, but the club joints longer.

7. DESCRIPTION OF MAJOR HYPERPARASITOIDS OF LAC INSECT

1. *Elasmus claripennis* (Cam.)



Adult female



Adult male

Family: Elasmidae

Order: Hymenoptera

Synonyms: *Cyclopleura claripennis* Cameron
Elasmus colemani, Mahdihassan

Host: *Eublemma amabilis*

Distribution: India, Thailand, China

Female

Length: 3mm

Head

Black, with a green reflection. Face and vertex finely punctuate, lateral ocelli separated from the eye-margins. The elongated, overhanging flange of the scutellum. Antennae brown, scape yellow with the pedicellus shorter than the funicular joints.

Thorax

Pronotum without a transverse carina; mesonotum punctuate and covered with short black hairs; scutellum and propodeum slightly rugulose, without hairs. Mesonotum and propodeum; the scutellum and sides of the thorax more bluish-violet. Wings hyaline with a faint brownish cloud around the stigma. Legs pale yellow, almost whitish, except the base of the middle and



greatly enlarged hind coxae and the **wavy lines or diamond-shaped patterns of setae on the hind tibiae**, which is greenish black and a small black stripe on the upper part of the hind femora. The tibiae with rows of black hairs; on the hind tibiae they form four regular lozenges.

Abdomen

Dark brown, with the base of the 1st segment greenish; the end of segments 1 and 2, the base of segments 3 and 4, and the sides of the abdomen, reddish yellow. Elongate and pointed, ovipositor very short.

Male

Length: 1.7-2.2mm

Structure and colour similar to female. **Antennae with 3 long branches**, abdomen shorter, legs darker; the base of all the coxae and the middle and hind femora black.

2. *Eurytoma pallidiscapus*, Cam.



Adult female



Adult male

Family: Eurytomidae

Order: Hymenoptera

Hosts: Pupae of *P. pulverea* and *E. amabilis*

Distribution: India

Female

Length: 2.8-3.8mm

Head

Head finely reticulated, the punctuation shallow; face and cheeks covered with white ciliae. Black; antennae with the narrow scape and short pedicel with yellow colour, the flagellum black with 5 jointed funicles

Thorax

Thorax more strongly reticulated than the head. **Legs yellow, coxae black, hind femora black except at base and tip**; the base and tip of tibiae and the tarsi lighter yellow; tegulae and wings broad, wing nervature light yellow; end of valve brownish.



Abdomen

Abdomen quite smooth; petiole very short, broader than long. Ovipositor scarcely protruding.

Male

Length: 1.5-3 mm

Similar to female; femora more blackish, only yellow at tip; antennae with the scape short, pedicel rounded, the 5 funicle joints with two whorls of hairs and narrow petiole. **Abdomen shorter than the thorax.**

3. *Brachymeria tachardiae*, Cam.



Adult female



Adult male

Family: Chalcididae

Order: Hymenoptera

Synonyms: *Chalcis tachardiae* Cameron

Host: Pupae of *Pseudohypatopa pulverea* and *Eublemma amabilis*

Distribution: India

Female

Length: 3.0-3.5mm

Head

Broader front, antennal grooves rather deep, carinated. Vertex and frons finely reticulated. Antennae with the scape elongate; pedicel small, rounded; funicle broader and club shorter.

Thorax

Thorax more strongly reticulated than the vertex. Black; tegulae, tip of femora, base and tip of tibiae and all tarsi yellow; the anterior tibiae are entirely yellow in front. Wings hyaline. **Hind femora ovate, as broad as 0.56mm of the length**, finely punctate.

Abdomen

Abdomen as long as the thorax, pointed tip, the tergites smooth, the last two segments slightly shagreened. Ovipositor scarcely protruding.



Male

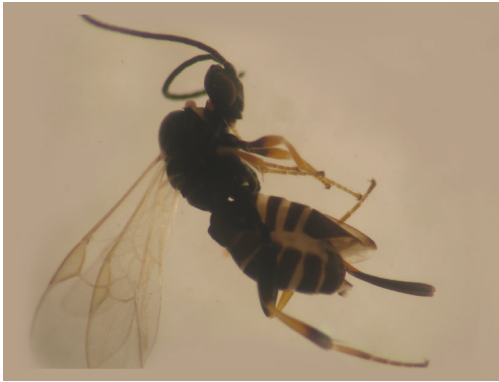
Length: 2.2 to 3.3mm

Similar to female. **Abdomen shorter than the thorax** and rounded behind.

Brachmeria sp.

Adults robust, coloration mainly black or brownish, with yellow, reddish or white markings. Head and thorax heavily sclerotized and usually coarsely and densely unctuate. Antennae 13-segmented, with 1 or 2 ring segments and with club segments not markedly different from the funicle. Parapsidal sutures usually well developed, sometimes incomplete ovipositor horizontal.

4. *Apanteles tachardiaae*, pp. nov.



Adult female



Adult male

Family: Braconidae

Order: Hymenoptera

Female

Length: 2 mm

Head

Black, Front and vertex finely, closely punctured, the mesonotum more opaque, more strongly punctured; the lower part of the mesopleurae and the metapleurae smooth, shining, bare, the rest of the pleurae pilose, aciculated.

Thorax

Black, the palpi and spurs white, the apex of the anterior femora, the anterior tibiae and tarsi, the middle tibiae to shortly beyond the middle, their tarsi and the hinder tibiae and tarsi testaceous, the hinder darker in tint than the others; metanotum opaque, strongly aciculated, a longish oval shining depression in the centre, the sides margined by a keel. Wings clear hyaline, the costa, **parastigma and front of stigma fuscous**, the rest and the nervures pallid white; the basal abscissa of the cubitus is thinner than the other nervures; the nervures bounding the apex of the 1st cubital cellule form an almost continuous curve; there is a short, but distinct stump of the cubitus female.



Abdomen

Abdomen shorter than the thorax, the sheath of the ovipositor three-fourths of its length; the basal segment a little longer than it is wide at the apex, opaque and aciculated to near the apex, where there is a square shining space in the centre; the 2nd segment is wider than long; there is a curved transverse furrow near its base; **the segments are fringed with white hair; the ventral are entirely black.**

Male

Length: 2.2 to 3.3mm

Similar to female. **Ovipositor is absent.**

5. *Apanteles* sp.



Adult female



Adult male

Apanteles sp.



Adult female



Adult male

Apanteles fakhrulhajiae

Mostly solitary endoparasitoids of Lepidopterous pests. Adults have a predominantly black body with some yellow colouring on the abdomen and legs, and are 2.0-2.5mm long. Females have a short, pointed ovipositor through which eggs are injected into host. Small size 2- 4 mm, black appearance, reduced wing venation and 18-segmented antennae 66 species of *Apanteles* have been reported from India.



6. *Bracon greeni* Ashmead



Adult female



Adult male

Family: Braconidae

Order: Hymenoptera

Distribution : Bangladesh, China, India, Sri Lanka

Description

Black-brown colour, one or no recurrent veins, unlike other members of the Ichneumonoidea, which usually have two. Wing venation patterns are also divergent to apparent randomness. The antennae have 16 segments or more; **the hind trochanters have two segments**. Females often have long ovipositors, an organ that largely varies intraspecifically.

7. *Pristomerus sulci* Mahdihassan & Kolubajiv



Adult female



Adult male

Family: Ichneumonidae

Order: Hymenoptera

Synonyms : *Pristomerus laccae* Cushman, 1934
Pristomerus testaceicollis Cameron, 1935

Distribution: India

Description : Head and thorax are black in colour with long antennae (**more than 18 segments**). **They have two recurrent veins on wings**, Female has long ovipositor than their its body.

8. DESCRIPTION OF MAJOR PREDATORS OF LAC INSECT

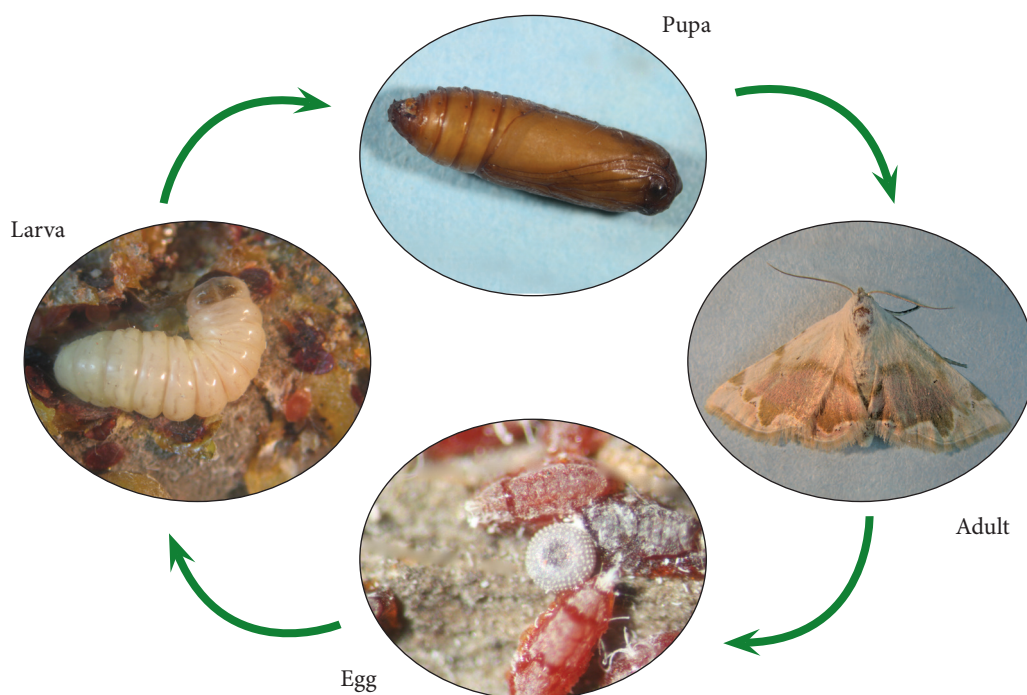
1. White moth: *Eulemma amabilis* Moore

Family: Noctuidae

Order: Lepidoptera

The predator is widely distributed in all the major lac growing regions of the country and is considered as the most destructive. The moth lays grayish white, flat round eggs, depressed in the center measuring about 0.35 to 0.37 mm across the center and blessed with beautiful sculptured chorion. Eggs are generally laid singly on the lac encrustation and turn white prior to the emergence of larvae. The larva hatches out of the egg shell by gnawing a hole at the side of the chorion. The first instar larva measures 0.51 to 0.54 mm in length. Under laboratory conditions egg laying of the moth can easily be done on plain paper by confining the adult moths in battery jars.

The newly hatched larva gets at the lac insect either through one of the openings in the test or by tunneling a hole through the encrustation. The attacked lac cell becomes hollow inside



Life cycle of *Eulemma amabilis*



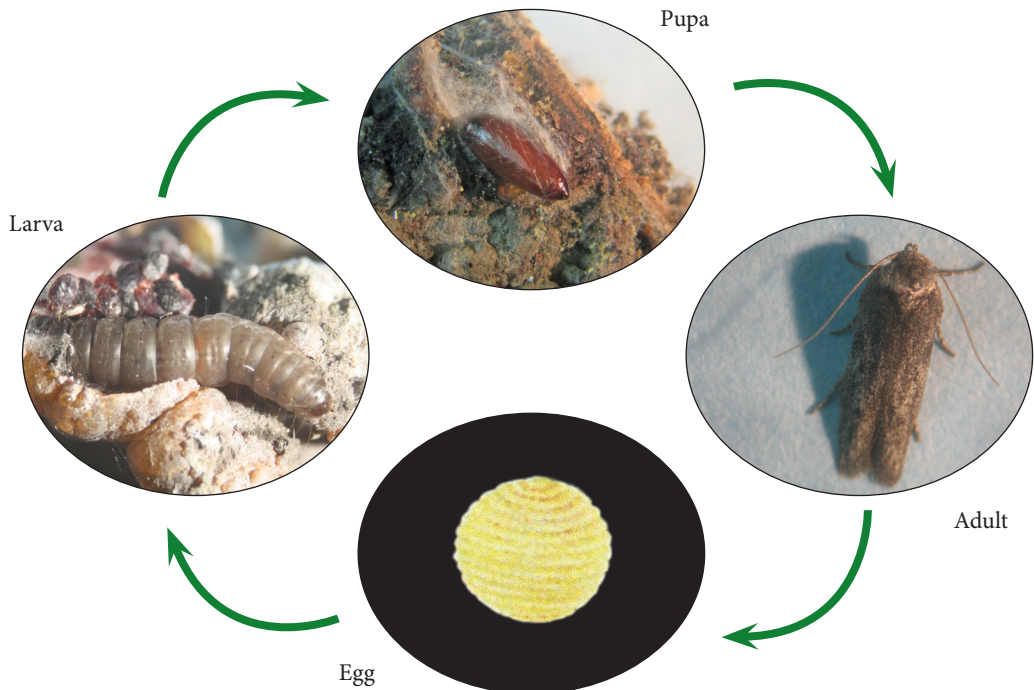
containing pink coloured discs of excreta and can be easily differentiated from the healthy cell. A single larva generally destroys 40-60 cells during various instars before preparation. Pupae are dark brick-brown in colour and obdect type. Adult female is white colour with brown patches on margin of wings. Generally smaller and duller colour, bulges out a little in the middle and then gradually tapers posteriorly and male is bigger & brighter in colour and gradually tapers posteriorly. The predator causes the most damage during the *katki* and *aghani* lac crops *i.e.* during the rainy season in comparison to the other two crops. It has been observed that the predator has six generations in a year. The duration of the generations from July onwards are about 37, 45, 42, 125, 80 and 40 days respectively. Hibernating larvae have been observed during the winter generation, which covers about 125 days. However, some of the adults emerge during November – December while the rest hibernate and emerge during January to March.

2. Black moth: *Pseudohypatopa (Holcocera) pulverea* Meyr

Family: Blastobasidae

Order: Lepidoptera

This predator is also widely distributed and found in all the lac growing areas of the country. The adult moths are blackish in colour and smaller in size than *E. amabilis*. The predator feeds on the live and dead lac insects. It is also abundantly found in stored lac. The eggs are oval and laid singly on the cell of the lac insect. Measuring about 0.5 mm x 0.3 mm, the freshly laid egg is colourless, which later on turns to deep pink with growth of the embryo. Under laboratory conditions the females can lay eggs on emery/sandpaper strips in dark



Life cycle of *Pseudohypatopa pulverea*



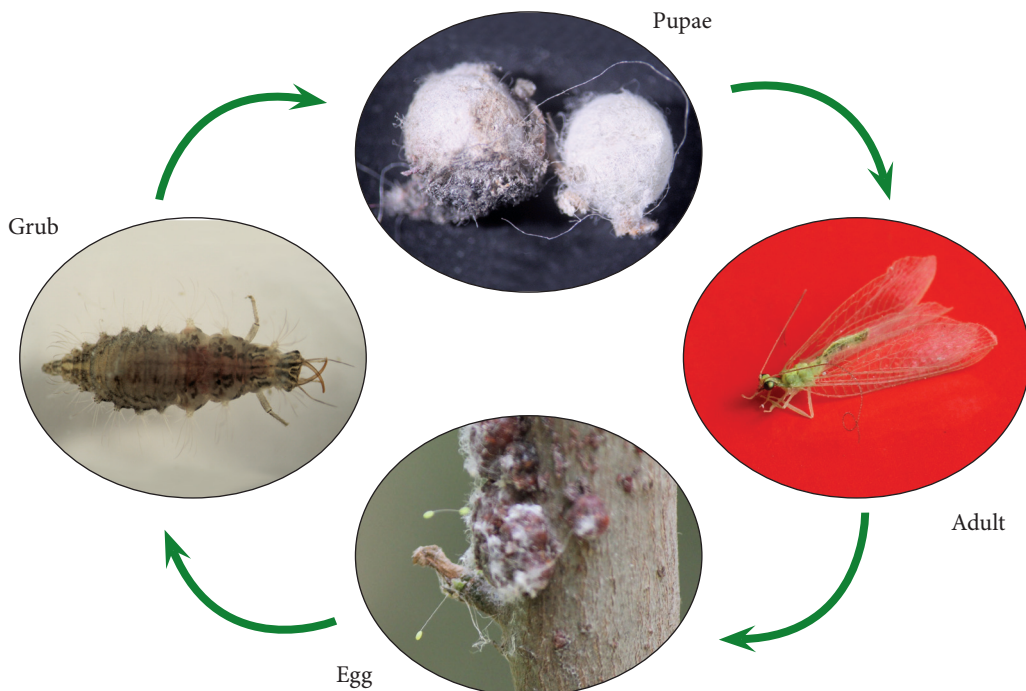
background. The newly hatched larva is about 1.35 mm in length, which after passing through several instars (5-9) depending on season, the larva measures about 10-12 mm in length and 2 mm in breadth before pupation. Pupa is brown in colour, smaller in size than *E.amabilis* and obtect type. The adult moths are blackish in colour and smaller in size than *E. amabilis*. The predator completes five generations in about 381 days. The duration of the generations from July onwards are about 53, 104, 119, 57 and 49 days respectively. The predator feeds on the lac larvae and spins a loose web. Since a single predator is capable of destroying 45 to 50 mature lac cells, it is considered to be a very important in view of inflicting damage to the standing lac crop and qualitative and quantitative deterioration of the stored lac.

3. Green lace wing: *Chrysopa* sp.

Family: Chrysopidae

Order: Neuroptera

Preying upon various stages of the lac insect, the larvae of the lace-wing flies are considered to be sporadic pest. Females lay long stalked light green eggs either on the lac encrustation or on any part of the host trees, which then turned to brownish at the time of hatching. The larvae emerge out of the eggshell with the aid of an “egg buster”, climb down the stalk and start feeding immediately on the insect by inserting its long pair of mandibles. It does not tunnel its way through the lac encrustation but move freely in the lac colony with body under a heap of wax filaments and insect debris. The larva passes through three instars. The first instar grub is pale, somewhat translucent with faint margin which darkens progressively in 2nd and 3rd larval instars.



Life cycle of *Chrysopa* sp.



The larva pupates outside the lac encrustation and pupae are white in colour. Adults are greenish colour wings with golden eyes. The predator takes 21 to 27 days to complete its life cycle during the rainy season and about 54 days during the cold weather. These predators are very destructive during the second and third instars of the lac insect, that is before the emergence of male insects.

4. *Oryzaephilus surinamensis* Linn.



Family: Silvanidae

Order: Coleoptera

Common name : Saw-toothed grain beetle

Synonyms

Colydium frumentarium Fabricius, 1792

Dermestes sexdentatus Fabricius, 1792

Dermestes surinamensis Linnaeus, 1758

Silvanus bicornis Erichson, 1846

Silvanus surinamensis Linnaeus, 1758

Distribution

The saw-toothed grain beetle is distributed throughout the world and frequently transported in grain products

Description

The saw-toothed grain beetle is a slender dark brown beetle 2.4-3 mm in length, with a flattened body, and six saw-toothed projections on each side of the prothorax. The abdomen tapers towards the tip and it rarely flies. Its antennae are long and moniliform (“bead-like”).

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Observations to be recorded for productivity linked parameters of lac insect

Host Plant : Insect/Strain : Crop : Date of inoculation :

Parameters		Replication																																									
		1			2			3			4			5																													
		L	M	U	L	M	U	L	M	U	L	M	U	L	M	U																											
Initial density settlement (No/cm ²)																																											
Initial mortality (No/cm ²) (21 days after inoculation)																																											
Sex ratio (% of male insects)																																											
Survival at maturity (No/cm ²)																																											
Size of lac insect cell (mm)																																											
Weight (mg)	Female cell																																										
	Resin output																																										
Fecundity (No of young ones produced by female)																																											
Broodlac yield at harvest (Kg)																																											
Broodlac ratio Output/Input																																											
Broodlac – scrappedlac ratio																																											
Weight of one meter	Broodlac																																										
	<i>Phunki lac</i>																																										
	Scrappedlac																																										
	Wood weight after scrapping																																										

L - Lower, M - Middle, U - Upper

Recording of lac associated fauna (Parasitoids)

Host plant :		Quantity of lac sticks caged:	
Insect/Strain and crop:		Date of caging:	
Date of inoculation:		Date of clearing the cage:	
Treatments:			
Observations on parasitoids of lac insect (Numbers)			
S l. No.	Date of observation (Daily)	Species	Unidentified species
		<i>Aprostocetus purpureus</i> <i>Cocophagus tschirchi</i> <i>Erencyrtus dewitzi</i> <i>Eupelmus tachardiae</i> <i>Marietta javensis</i> <i>Parethrodryinus clavicornis</i> <i>Tachardiephagus somervillei</i> <i>Tachardiephagus tachardiae</i>	
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Recording of lac associated fauna (Hyper parasitoids)

	Host plant : Strain and crop: Date of inoculation: Treatments:	Quantity of lac sticks caged: Date of caging: Date of clearing the cage:																	
Observations on hyper parasitoids of lac insect (Numbers)																			
S I . No.	Date of observation (Daily)	Species										Unidentified species							
		<i>Apanteles fakhruhlhajjia</i>	<i>Apanteles tachardia</i>	<i>Bracon greeni</i>	<i>Bracon hebetor</i>	<i>Brechymeria tachardia</i>	<i>Chelonella cyclopyra</i>	<i>Elasmus claripennis</i>	<i>Eurytoma paldiscapus</i>	<i>Goniozus pulveriae</i>	<i>Pristomerus sulci</i>								
1																			
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Recording of lac associated fauna (Predators)

Host plant :		Quantity of lac sticks caged:	
Strain and crop:		Date of caging:	
Date of inoculation:		Date of clearing the cage:	
Treatments:			
Observations on predators of lac insect (Numbers)			
S I . No.	Date of observation (Daily)	Species	Unidentified species
1		<i>Chrysopa spp.</i>	
2		<i>Eublemma amabilis</i>	
3		<i>Ephestia sp</i>	
.		<i>Pseudohypatopa pulverea</i>	
.		<i>Oryzaephilus surinamensis</i>	
.		<i>Silvanus iyeri</i>	
.		<i>Tribolium ferrugineum</i>	
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