

Lac Insect Life Cycle, Lac Crop Cycle and Natural Resins and Gums Related Terminology

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Lac insect life cycle

Lac insect, *Kerria lacca* are placed under the order Hemiptera, superfamily Coccoidea, family Tachardiidae. They are characterized by the presence of a special type of mouth-parts, called the sucking type, intended for sucking plant juices- this is the sole mode of their feeding. The voyage of life of lac insects begins with 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 vagina into the specially build "incubation chamber" formed by making sufficient gap between the body and resinous cell. Hatching of eggs mostly takes place before reaching the incubation chamber has called as viviparity.

The crawler nymph 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 (Fig. 1).

The first instar larva

A day or so after settling, the larvae start secreting lac 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 the 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 details are given in the Table 1.

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 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 the 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 (Fig. 1).

Male and female

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, assumes generally 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 area lying between the two brachial and one anal tubercle. At this stage the female is sexually matured 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 fast 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 (Fig. 1). 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 coalesces with each other and forms a continuous 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 shoots 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.

Sticks with the lac encrustation containing gravid females are called “broodlac” stick (Fig. 1), which are generally tied together for purpose of infecting 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.

Table 1. Stages of bivoltine lac insects and their life span (in days)

Strain	Crop (Season)	Young ones			Male		Female	
		I	II	III	Adult	Total	Adult	Total
Rangeeni	Katki (Rainy)	0 (3)	14 (2)	8 (1)	2	44 (6-7)	67 (10)	109 (16)
	Baisakhi (Summer)	0 (7)	40 (6)	15 (2)	3	108 (15-16)	145 (21)	250 (36)
Kusmi	Aghani (Winter)	20 (3)	15 (2)	14 (2)	2	51 (7-8)	150 (21)	199 (28)
	Jethwi (Summer)	32 (5)	25 (4)	12 (2)	2	71 (11-12)	90 (13)	159 (24)

Figures in parentheses in indicate period of time in weeks

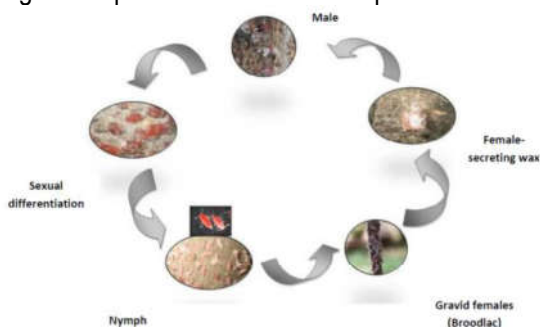


Fig. 1 Lac insect life cycle

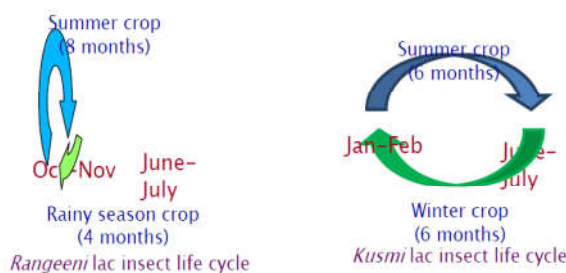


Fig. 2 Lac insect crop cycle

Lac crop cycle

Lac is a natural resin secreted by the tiny insects, mainly *K. lacca*. The insects are cultured on tender shoots of several plants called hosts. It derives its nutrition by sucking the saps from the host plants. Lac insect strains have been commonly related with the life-cycles of the insects and with their respective host plants. There are two strains of the lac insect viz., *rangeeni* and *kusmi*. Each strain completes the life-cycle twice a year, thus producing two crops in a year. However in coastal region of West Bengal and Odisha, a tri-voltine insect, *Kerria sharda* is found which produce three crops in a year. But in each case the duration of the life-cycle and the seasons of maturity differ, as will be seen from table 2 and the figure 2. *Kusmi* insect grows well mainly on *Kusum* (*Schleichera oleosa*) and also on a few other trees but not on *palas* (*Butea monosperma*), whereas *rangeeni* strain grows well mainly on *palas* and also on a few other trees but not on *kusum*.

Table 2. Different crops and their life period

Name of strain	Name of crop	Season	Period		Approx. duration (Months)
			Month of inoculation	Month of harvesting	
<i>Rangeeni</i>	<i>Baisakhi</i>	Summer	Oct.-Nov.	June- July	8
	<i>Katki</i>	Rainy	June- July	Oct.-Nov.	4
<i>Kusmi</i>	<i>Aghani</i>	Winter	June- July	Jan. - Feb.	6
	<i>Jethwi</i>	Summer	Jan. - Feb.	June –July	6
Trivoltine	-	Winter	Oct.-Nov.	March-April	5
		Summer	March-April	July-August	4
		Rainy	July-August	Oct.-Nov.	3

Natural Resins and Gums (NRG) related terminology

Natural resins and gums occupy a prime place among Non-Wood Forest Produce (NWFP) and are known to mankind since time immemorial. These are perhaps the most widely used and traded NWFP's other than items consumed directly as food, fodder and medicine. These NWFPs are of local and global importance as it has a vital role in livelihood security of forest dependants, tribal economy, commerce and traditional system of medicine including Unani, Ayurveda and Homeopathy. Thousands of forest dwellers particularly in the central and western Indian states depend on gums and resins as a viable source of income. Resins and gums are metabolic byproducts of plant tissues either in normal course or often as a result of disease or injury to the bark or wood of certain plants, with the exception of *lac*, which is derived from a few species of *Kerria* (Coccoidea: Tachardiidae) belonging to a specialized group of scale insects, all other natural gums and resins are of plant origin. These day gums find their use in paper, textile, confectionaries and cosmetic industries due to their ability to stabilize emulsions, retain moisture and impart a smooth texture.

In India, trees that exude gum and resins are in plenty. However, some of them that have gained commercial importance are gum karaya (*Sterculia urens*), gum arabic (*Acacia senegal*), guggul gum (*Commiphora wightii*), gum ghatti/dhawara (*Anogiessus latifolia*), guar gum (*Cyamopsis tetragonolobus*), salai gum (*Boswellia serrata*), dammar (*Agathis dammara*; *Vateria indica*; *Shorea robusta* etc.), khair gum (*Acacia catechu*), babool gum (*Acacia nilotica*), rosin (*Pinus* spp.) and asafoetida gum-resin (*Ferula* spp.). Apart from these there are numerous gum and resin yielding plants in India of economic importance viz., masquite gum (*Prosopis juliflora*), neem gum (*Azadirachta indica*), gum katira (*Cochlospermum religiosum*), palas gum (*Butea monosperma*) and tamarind gum (*Tamarindus indica*) etc.

NRG Related Terminology

Natural Resins: Resin secretion occurs in special cavities or passages in many plant species. There are formed in the specialized structures called ducts. Resins exude or ooze out from the bark of the

trees and tend to harden on exposure to air. With the exception of lac, which is produced by few species of *Kerria* (Coccoidea: Tachardiidae) belonging to a specialized group of scale insects, all other natural resins are of plant origin.

The principal characteristics of resins are:

- They are insoluble in water.
- They are soluble in ordinary solvents like alcohol, ether and turpentine.
- They are brittle, amorphous and transparent or semi-transparent.
- They have a characteristic luster, are ordinarily fusible and when ignited, resins burn with a smoky flame.

Natural Gums: Gums are a group of plant products, formed primarily due to the disintegration of plant cellulose. This process is known as gummosis. Gums are produced by members of a large number of families but commercial exploitation is restricted to a few tree species of leguminosae, sterculiaceae and combretaceae families. Gum is also extracted from seeds of certain plants like *Cyamopsis tetragonolobus*, *Tamarindus indica*, *Cassia tora* etc. *Guar* gum is the prominent seed based natural gum.

The principal characteristics of gums are:

- They consist of polysaccharides or their derivatives.
- They are soluble in water or at least become soft and swollen when mixed with water. However they are insoluble in alcohol and other organic solvents.
- They decompose completely on heating without melting and tend to become charred.
- Most gums emanate from plants in a liquid form. They dry up into translucent, amorphous, tear shaped bodies or flakes on contact with air.

Natural Gum-resins: Gum resins are a mixture of both gums and resins and possess the properties of both the groups. They contain traces of essential oils. These are usually derived from the plant growing in dry and arid regions. Some of the commonly used gum-resins are asafoetida, myrrah, salai, guggul etc.

Oleo-resins: Resins obtained from tree family, Pinaceae, which contain essential oils, and are softer than other resins are termed as oleo-resins.

Resinoid: A viscous liquid, semi-solid or solid prepared from a natural resin by extraction with a hydrocarbon-type solvent. They contain any volatile oils originally present in the resin and are often used for fragrance purposes.

Balsam: A resin or oleoresin exudate characterized by a high content of benzoic or cinnamic acids and their esters. They have a characteristic "balsamic" odour.

Latex: A fluid, usually milky white in colour, which consists of tiny droplets of organic matter suspended or dispersed in an aqueous medium. The most well-known example is rubber latex, in which the solids content is over 50% of the weight of the latex. The solids can normally be coagulated to form a solid mass by boiling the latex. Latexes are usually obtained by cutting the plant to make it bleed. Latex-yielding plants occur in fewer families than those which produce gums and resins; Apocynaceae, Euphorbiaceae and Sapotaceae are among the important ones.

Amber: This is fossil resin found principally on the shores of the Baltic Sea. The principal source was the now extinct *Pinus succinifera*. Amber is an exceedingly hard and brittle substance. The larger and finer pieces are used for jewellery, beads, trinkets, cigar holders, etc., and the smaller pieces and waste from carving for varnish.

Dammar: Dammar designates a group of resins obtained from Indian or East-Asian trees belonging to dipterocarpaceae and burseraceae families. The principal dammars of India are sal dammar obtained

from *Shorea robusta*, white dammar obtained from *Vateria indica* and black dammar obtained from *Canarium strictum*. Sal dammar occurs in a nearly opaque, brittle, pale yellow form. It has faint resinous balsamic odour. It is commonly known as –Dhup.

Rosin: Rosin also known as colophony, is the solid form of resin obtained from pines and some other plants (*Pinus roxburghii*, *P. wallichiana*, *P. keyisia*), mostly conifers belonging to family, pinaceae. Its colour varied from light yellow to red, brown, blue or black.

Gum Arabic: Gum arabic is the natural gum exuded by various species of *Acacia* tree. The main source of commercial gum arabic is *Acacia senegal* and *A. seyal*. It dissolves completely in hot or cold water, forming a clear, mucilaginous solution. It is nontoxic and odourless.

Guar Gum: Guar gum is the gum derived from seeds of the guar plant, *Cyamopsis tetragonolobus*. Rajasthan in western India is the major guar producing state, accounting for 70% of the production. The colour of guar gum powders varied from white to cream.

Gum Ghatti: Gum ghatti is the dried exudates of *Anogeissus latifolia*, a tree found in India and Sri Lanka. The colour of gum ghatti varies from whitish yellow to amber; though the presence of impurities sometimes imparts a brownish colour. It is partly soluble in water and forms colourless mucilage.

Gum Karaya: Gum karaya also know as Indian tragacanth is the dried exudates obtained from trees of *Sterculia* species, mostly from *Sterculia urens*. It is white or intense ruby in colour and solidifies into large, roundish tears. It is not soluble in water but swells into a jelly like mass in water. It absorbs water very rapidly to form viscous mucilages at low concentrations, although it is one of the least soluble among exudates gums.

Bahera gum: Bahera gum is a natural product harvested from the plant *bahera*, *Terminalia bellerica*. Bahera gum is a kind of natural gum of inferior quality. The harvested gum is usually dark in colour and is inferior in thickening and adhesive qualities.

Moringa Gum: Moringa gum is one of the newly discovered gums. With huge demand of natural gums in various industries, it is going to be a promising natural gum. When a drumstick tree (*Moringa oleifera*) is injured, its stem exudes a mucilaginous gum with a bland taste.

Tamarind seed gum: Tamarind gum is derived from seed which is byproduct of tamarind pulp industry (harvested from tamarind tree, *Tamarindus indica*). The terms tamarind gum and tamarind kernel powder are used interchangeably as they are technically the same product. Tamarind kernel powder is bio-degradable, non-toxic and a natural polymer.

Psyllium seed gum: Psyllium seed gum is a natural product extracted from the seeds of Psyllium plant. Psyllium is the common name used for several members of the plant genus *Plantago* whose seeds are used commercially for the production of mucilage. The genus *Plantago* contains about 200 species. *Plantago psyllium* and *Plantago ovate* are the most important species used for commercial purposes. Psyllium is produced mainly for its mucilage content which is highest in *Plantago ovata*.

Carob bean gum: Carob bean gum is an important seed gum. It is also known as locust bean gum, carubin or algaroba. It is obtained from the endosperm of seed of carob (locust) tree, *Ceratonia siliqua*. The gum is white to yellowish white, nearly odourless powder. It consists of high molecular weight polysaccharides composed of galactomannans.

Guggul: Guggul or Indian Myrrh is a gum-resin produced by the stem of guggul tree, *Commiphora* spp. Mainly from *C. wightii* and *C. mukul*. The colour of guggul varies from transparent golden brown to dark brown. It burns readily and diffuses and gives pleasant odour.

Salai: Salai gum or Indian olibanum is the gum-resin obtained from the species of *Boswellia* of which *Boswellia serrata* occurs in India. Colour varies from transparent golden brown to dark brown or dark

greenish brown depending on the season of collection and impurities present. It is commonly known as –Luban.

Asafoetida: Asafoetida is the dried aromatic gum-resin exuded from the living rhizome, rootstock or taproot of varied plant species of genus *Ferula* (*F. asafoetida*, *F. foetida*, *F. narthex*). It is commonly known as –Hing.

Lac related terminology

Insects

Insects are the six legged flying arthropods coming under the phylum Arthropoda and class Insecta.

Lac insect

Lac insects are placed under the order Hemiptera, superfamily Coccoidea, family Tachardiidae. They are characterized by the presence of a special type of mouth-parts, called the sucking type, intended for sucking plant juices- this is the sole mode of their feeding.

Univoltine

Produces single crops in a year *eg. Paratachardina spp*

Bivoltine

Produces two crops in a year *eg. Kerria spp*

Trivoltine

Produces three crops in a year *eg. Kerria sharda*

Rangeeni and Kusmi

Strains of lac insect, *Kerria lacca*

Lac

Lac, an important versatile commercial resin of wide utility, is the natural heritage of India. It is secreted by tiny gregarious scale insects as a protective covering around their body. Thriving on succulent shoots of a number of plant species, these insects form a thick encrustation around the twigs, which are collected, scrapped for obtaining raw lac or sticklac.

Wax

Long waxy filaments are a striking feature of a healthy encrustation of *K. lacca*. These filaments protrude out of the anal and brachial pores of the female lac cells. It is the mixture of higher alcohol, esters, acids and hydrocarbons.

Honey-dew

The secretion of honey-dew is known to be a waste product excreted into the colo-rectum from the loops of the intestine (Filter-chamber).

Lac resin

It is an ester complex of long chain hydroxy fatty acids and sesquiterpenic acid.

Lac dye

Lac dye is present in haemolymph and obtained through washing of lac. It is an anthraquinone derivative.

Lac colour

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

Lac hosts

Trees and bushy plants is used for lac cultivation is called as lac-hosts. Lac insects draw nutrients by sucking the phloem sap of host plants, these are the nearest biotic associates of lac insects and stand at the first trophic level eg. *Palas (Butea monosperma)*, *kusum (Schleichera oleosa)* and *ber (Zizyphus mauritiana)* and *Flemingia semialata*

Coupe - Group or set (*Khand*)

Pruning

Pruning is a removing/cutting undesirable shoots of host plants. Pruning of lac hosts is an important operation to provide suitable space for the lac insects to feed and thrive upon them. Appearance of maximum number of shoots of suitable age for lac inoculation depends upon proper pruning. Pruning should be done with sharp instruments such as *dauli* / tree pruner / secateur in such a manner that branches or twigs remain free from splitting or deep scratching.

Inoculation

Inoculation is a tying of broodlac bundles (lac stick with mature female insect) on host twigs for release of young lac larvae (crawlers). The lac crop management begins from inoculation or infestation of host plants with broodlac. Inoculation is of two types *i.e.* Artificial inoculation and self inoculation.

Baisakhi (*Rangeeni* summer crop)

Inoculation of lac insect during Oct.-Nov. and which is harvested in the month of June- July

Katki (*Rangeeni* rainy season crop)

Inoculation of lac insect during June- July and which is harvested in the month of Oct.-Nov.

Aghani (*Kusmi* winter crop)

Inoculation of lac insect during June- July and which is harvested in the month of Jan. - Feb.

Jethwi (*Kusmi* summer crop)

Inoculation of lac insect during Jan. -Feb. and which is harvested in the month of June- July

Broodlac (*Beehan lakh* or *Beej lakh*)

Broodlac means "healthy lac encrustation consisting of gravid females about to produce young ones." The status of broodlac is similar to seeds of agricultural crops.

Phunki

Phunki is a used-up broodlac sticks after complete emergence of lac larvae from female cells

Ari lac

If lac crops are harvested by cutting down the lac bearing twigs a little before the crop maturity (larval emergence), that lac is known as *ari* lac (immature lac). The commercial *baisakhiari* lac is harvested in April from *Palas* and may from *Ber*

Yellow spot

It is a sort of ovisac, a gap created by mother cell within lac cell. This is a method to forecast of larval emergence from matured broodlac

Harvesting

It is a cutting of mature (broodlac) or immature (*ari*) lac crop from the host along with host sticks

Lac sticks (*Lakh Dandi*)

Lac encrustation along with twigs of host trees is called as lac sticks

Sticklac (*Chhili lakh*)

Lac resin obtained, after scraping from sticks is called as sticklac. It is called as scraped lac.

Seedlac (*Chauri or Lakh dana*)

The granulated form of lac resin obtained after crushing and washing of scraped lac is called seedlac. It is a semi-processed form of lac resin free from insect body, bark etc.

Shellac (*Chapra*)

It is the refined commercial form of lac resin, marketed usually in flakes. Besides, the lac resin is also marketed in the form of button lac prepared from seedlac either by manual process or hot filtration.

Button lac

After melting process, lac is dropped on a zinc sheet and allowed to spread out into round discs of about 3" diameter and 1/4" thickness is called button lac.

Garnet lac

It is prepared from inferior seed lac or *kiri* by the solvent extraction process. It is dark in colour and comparatively free from wax.

Bleached lac

It is a refined product obtained by chemical treatment. It is prepared by dissolving shellac or seed lac in Sodium carbonate solution, bleaching the solution with Sodium hypochlorite and precipitating the resin with sulphuric acid. Bleached lac deteriorates quickly and should be used within 2-3 months of manufacture.

De waxed decolorized lac

White lac without wax.

Molemma

It is finely divided dust-like material separated from seed lac contains 70% shellac.

Kiri

It is dirt and refuse inside the cloth bag after recovering the molten mass and it contains 50% shellac.

Passewa

It is the material that is collected from the cloth bag by boiling them after removing *kiri* and this contains 20 % shellac.

Aleuritic acid

Aleuritic acid is the principal acid component of lac resin. It is promising starting material for the synthesis of perfumery components, besides several bio-active components like insect sex pheromone, juvenile hormone etc., and other industrially important products.