AN EXPLORATIVE STUDY ON LAC INSECT, *Laccifer lacca* (Kerr.) IN ORISSA

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(ENTOMOLOGY)

BY

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The 5th September, 2009

CERTIFICATE-I

This is to certify that the thesis entitled "AN EXPLORATIVE STUDY ON LAC INSECT, *Laccifer lacca* (Kerr.) IN ORISSA submitted in partial fulfillment of the requirements for the award for the degree of MASTER OF SCIENCE IN AGRICULTURE (ENTOMOLOGY) to the Orissa University of Agriculture & Technology, Bhubaneswar is a faithful record of *bona fide* research work carried out by SRI ASHOK KUMAR BEHERA under my guidance and supervision. No part of the thesis has been submitted for any other degree or diploma or published in any other form.

It is further certified that the assistance and help availed by him from various sources during the course of investigation have been duly acknowledged.

Satapathy 5/9/09

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Chairman
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CERTIFICATE-II

This is to certify that the thesis entitled "AN EXPLORATIVE STUDY ON LAC INSECT, *Laccifer lacca* (Kerr.) IN ORISSA" submitted by SRI ASHOK KUMAR BEHERA to the Orissa University of Agriculture &Technology Bhubaneswar in partial fulfillment of the requirements for the degree of MASTER OF SCIENCE IN AGRICULTURE (ENTOMOLOGY) has been approved by the student's Advisory committee after an oral examination on the same line in collaboration with an External Examiner.

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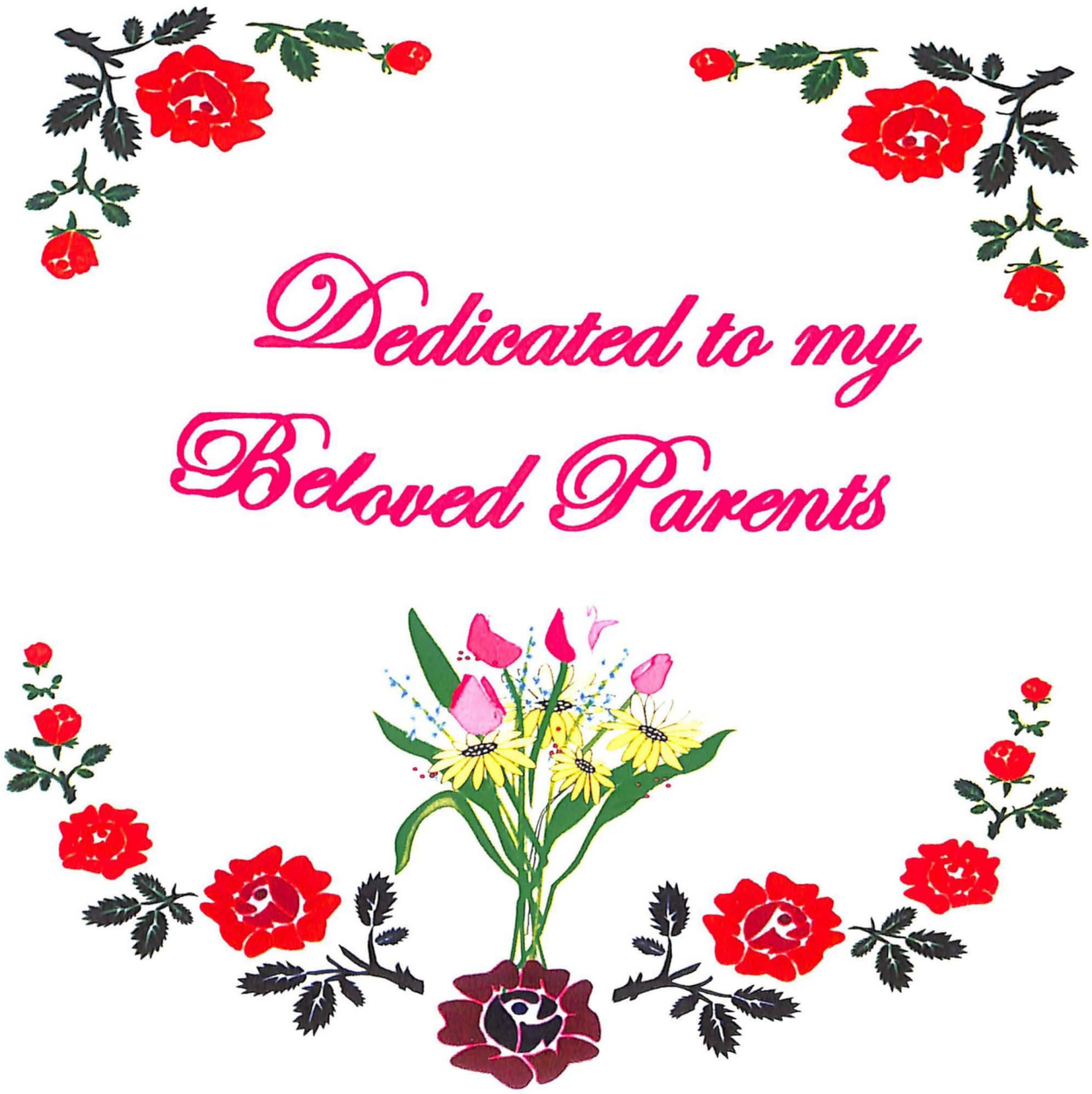
Dedicated to my
Beloved Parents

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ABSTRACT

"An explorative study on the lac insect, *Laccifer lacca* (Kerr.) in Orissa" was undertaken during 2008–09 in the Department of Entomology ,College of Agriculture, OUAT, Bhubaneswar to ascertain the current status of lac cultivation in the state . Lac is presently cultivated in six districts of Orissa viz., Keonjhar, Koraput, Mayurbhanja, Nabarangapur, Sundargarh and Balasore. Lac cultivation previously practiced in undivided Kalahandi and Sambalpur district is no more in voyage. In Nabarangpur district it is being practiced in four blocks viz. Chandahandi, Raighar, Jharigaon and Umarkot . Concerted efforts of the Tribal Co-operative Marketing Development Federation of India Ltd. (TRIFED)has enabled the tribals to adopt improved lac cultivation practices in Sundargarh thereby harvesting about 100-120 kg of lac sticks/tree/season compared to 8.0-20.0 and 10-25 Kg of lac/tree/season harvested by the lac grower of Keonjhar and Mayurbhanj district respectively practicing traditional method. Four host plants viz., Kusum (*Schliechera oleosa*), Palash (*Butea monosperma*) , Ber (*Zizuphus mauritiana*) and Dimbiri (*Ficus hispida.*) are utilized for lac cultivation. Kusum (*S. oleosa*) being the predominant species. *Ficus hispida* as a host plant of lac in Orissa is the first record. *Flemingia semialata* Roxb. ,a quick growing host plant identified for commercial cultivation of Kusumi lac can very well be utilized for lac cultivation in Orissa. The ideal period for collection of brood lac for raising *aghani* and *Jethwi* crop in our state is the month of July and month of February respectively. The lac insect *Laccifer lacca (Kerria lacca)* completed its life cycle successfully at Bhubaneswar on Valia, *Flemingia semialata* and Ber (*Zizuphus mauritiana*) and issued swarm in 145 and 158 days after inoculation respectively while it failed on arhar (*Cajanus cajan).*The first instar nymph are pinkish red in colour and oval in shape measured about 1.06 mm in length leaving aside the antennae and caudal setae and of 0.43 mm in width . The female cells are reddish in colour spherical in shape and measured 0.33cm in dia weighing about 10.7 mg Infestation by lac insect reduced the number and length of the branches in arhar (*Cajanus cajan)* plant. Two important predators viz., the black moth, *Pseudohypatopa (=Holcocera) pulverea* Meyr. and the white moth, *Eublemma amabilis* Moore attacked lac insect in Orissa of which the former is more prevalent. Besides the larva of green lace wing bug feed on the first instar nymphs. Five species of parasitoids, a beetle and the black ant feeding on honey dew are the other fauna associated with the lac insect directly or indirectly.

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Introduction

Chapter -1

Introduction

Indian lac insect, *Laccifar lacca* (Lacciferidae, Hemiptera) is one of the most important productive insects exploited for commercial use. This sucking pest produces an encrustation through secretion of resinous material over its body popularly known as lac, which is the only natural resin of animal origin. Use of lac was known to the human beings since time immemorial. The lac cultivation dates back to Vedic period (1500-500BC) and the Atharva Veda devotes a complete chapter containing vivid description of laksha. In our grate epic Mahabharata there is a mention of construction of "Yatugriha" (house of lac) by Kauravs to ablaze the Pandavas. However, the first authentic descriptive account of lac is found in the report sent in 1596 by a traveler-adventurer, John Huyoghen van Linchoeten to the king of Portugal where-in there is mention about uses of lac in those days. In recent years lac is also utilized widely for multifarious purpose.

The insect is confined mostly to equatorial region i.e. between 40^0 north and south from the equator. The warm humid climate is very congenial for growth and development of the insect and the ecological conditions of India is very favourable for this insect. The lac insect survives on specific trees called as host plants which are grown mostly in forest areas.The nature's blessings have made India to be the chief lac producer in

the world. India accounts for 50-60 per cent of the total world's lac production and foreign exchange of 10-15 crores rupees is earned annually from trading of lac. Over 90 per cent of the lac produce in the country is being exported to foreign countries in the form of shellac, seed lac and other lac products. During 2006-07, India processed 29,800 tons of stick lac and exported 7362 5.8 tones of lac and its value added products of worth Rs. 147.72 crores. In 2007-08 India produced a total of 20640 tones of stick lac , 95 per cent of it being produced by the five states viz. Chhattishgarh, Jharkhand, M.P., West Bengal and Maharastra . Orissa, Uttar Pradesh, Assam, A.P, Gujurat and Bihar are the other minor producers. Orissa, producing 435 tones of lac, ranks 7th as the lac producer in the country. At present lac is cultivated in Keonjhar, Mayurbhanja, Sambalpur, Sundargarh, Nabarangpur, Koraput and Balasore districts of Orissa.

Cultivation of lac, yields the ultimate product of interest i.e. the natural resin named as lac which is basically a forest product of immense economic value. Thus, it act as a lucrative enterprise and a source of subsidiary income for the tribal and economically back ward people of our country. This lac cultivation is a very good source of livelihood for resource poor farmers, tribal and it does not require much agro inputs like fertilizer, pesticide, water etc. Its cultivation is takes up in the exiting plantations with lac hosts like Kusumi, Palash, Ber etc which are very common in forests and sub forest in our states. Further it does not compete with agricultural and horticultural

crops for additional land or farm operations. It acts as a very good source of employment generation. The climatic conditions of our country as well as the state are too congenial for growth & development of this lac insect, *Laccifer lacca*. Besides, the lac ecosystem is a very complex ecosystem with multitrophic web of flora and fauna, representing a highly rich biodiversity supporting our country to be the country of mega biodiversity. So cultivation of lac insects helps in conservation of our biodiversity.

In early days, our state was a major lac producer which has been declined to a very low level due to various reasons. Further, if the lac cultivation is completely abandoned its re-initiation will be very difficult.

During last five decades sizable work has been done on various aspects of scientific lac cultivation in the country particularly at **Indian Institute of Natural Resin and Gums,(IINRG)** Namkam, Ranchi, the National Institute devoted for various aspects of lac research. Now the Institution with a separate division is also playing a pivotal role in Transfer of Technology (TOT) on lac. Besides, the Institution is having a division for Lac production technology dealing with Insect Improvement, Host Improvement, Crop Production and a separate division for Lac processing and product development .However no much research work has been taken up in our state. Lac cultivation in our state practiced mostly in traditional methods in tribal pockets. Information on lac cultivation in the state is also

very scanty. Keeping this in view the present research has been undertaken with the following objectives.

Objectives:

1. To survey the occurrence of lac insect in different agro climatic zones of Orissa
2. To survey for the host plant of the lac insect in the state
3. To study on the occurrence of the natural enemies attacking lac insect in Orissa and
4. To study the biology and behaviour of the lac insect in the laboratory and field conditions in Bhubaneswar.

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CHAPTER-2

Review of literature

Chapter-2

Review of Literature

Lac ,a Nature's gift to mankind, is a product of commerce derived from a specialized group of plant bugs commonly known as lac insects, *Laccifer lacca* (Keer.) ,(Lacciferidae:Hemiptera), which thrives on specific trees called as lac hosts. Lac is a resinous exudation from the body of female scale insect and it is the only natural resin of animal origin .It is a source of three basic materials viz., resin (68%), dye (1%) and Wax (6%) and the rest 25 % being the miscellaneous waste materials. The distribution of this lac insect is restricted mainly to tropical and sub tropical regions,40 ^{0} North and South of Equator (www.icar.org.in/ilri).

2.1 About lac and lac insect-

The history of lac can be traced back to Vedic period(1500-500B.C.) and Vedic people knew that the lac is obtained from numerous insects . They must be knowing about the biological and commercial aspects of lac industry, as laksh griha in that period would need a lot of lac which could only come from a flourishing lac industry. Since ancient times, Greeks and Romans were also familiar with the use of lac. The cultivation of lac insects has a long history in Asia and with some suggestion Lac is cultivated in India since time immemorial (Singh, 2007).

The first scientific account of the lac insect was given by J. Kerr in 1782, which was published in Philosophical Transaction of Royal Society of London (vol. 71, pp.374-382). The first scientific name given to it was *Tachardia lacca* following the name of French Missionary Father 'Tachardia'. It was later changed to *Laccifer lacca* Kerr. The other name given to it is *Kerria lacca*(Kerr.)

The systematic position

Phylum - Arthropoda

Class - Insecta

Order - Hemiptera

Suborder - Homoptera

Super family - Coccoidea

Family - Lacciferidae

Genus - *Laccifer*

Species – *lacca*

There are six genera of lac insects out of which only five secrete lac, and only one, i.e.*Laccifer* secretes true resin which produces the recoverable or commercial lac. The commonest and most widely occurring species of lac insect in India is *Laccifer lacca* (Kerr) which produces the bulk of commercial lac. To produce 1 kg of lac resin, around 300,000 insects loose their life (Singh ,2007)..

According to Sharma et. al.,(2006), 87 species of lac insects falling under nine genera are recorded from the world out of which only 19 species belonging to two genera, namely *Kerria* and *Paratachardina* are found in India There are approximately 41 species in this genus *Kerria* of which Indian lac insect, *Kerria lacca* Kerr. is the most important one. This insect is widely exploited for lac cultivation and can be further distinguished into two strains ***rangeeni*** and ***kusumi*** on the basis of differences in life cycle, host preference and quality of lac produced. Besides , *K. chinensis* in north estern states and *K.sharada* in coastal region of Orissa and West Bengal are also cultivated to certain extent. Lac insects under genus *Kerria* are generally bi-voltine but *K. lacca mysorensis* on *Shorea talura* and *K.sharada* on *Schleichera oleosa* and *Albizia saman* are tri-voltine

Lac is produced mainly in India, Thailand, Indonesia, Myanmar and Chaina. *Butea monosperma* (Palash), *Zizyphus mauritiana* (Ber) and *Schleichera oleosa* (Kusum) are the major commercial lac host trees in India. Mostly it is the tribals in Jharkhand, Chhattisgarh, W.B, Maharastra, M.P. Orissa, Gujurat & Assm that under take the production. Approximately three million people are engaged in production of lac in India. On an average India produces 18 thousand tones of lac per year. It is an export oriented product. Some 80% of the countries total product is exported that earns approximately U.S. $ 16-22 million as foreign exchange annually. It does not require any skill, requires less time than other agricultural operations. The pruning of the host tree, bundling of the brood lac twigs,

tieing of broad lac on trees for infestation, removal of used brood lac stick. (Phunki) from trees harvesting of crops & lac scrapping are the basic operation in lac production. These operations are carried out manually with help of locally available traditional tools, (Prasad et al, 2004).

Our country is the largest producer of lac in the world, accounting for about 50-60% of the total world lac production. At present, production of raw lac in India is approximately 20,000 metric tonnes per year. The major lac-producing states are Jharkhand (57% of the country's production), Chhattisgarh (23%), West Bengal (12%), while Orissa, Gujarat, Maharashtra, Uttar Pradesh, Andhra Pradesh and Assam are minor producers. Over three million tribals inhabiting these states are engaged in lac cultivation. Lac insects and their host plants play an important role in economics of lac growers1. Besides, India fetches approximately Rs 120-130 crores of foreign exchange through export of lac every year. Lac resin being natural, biodegradable and non-toxic, finds applications in food, textiles and pharmaceutical industries in addition to surface-coating, electrical and other fields and provides immense employment opportunities (Sharma et al.,2006)

India produces more than 20000 tons of lac annually. Lac industry in the country provides livelihood to over one million cultivators. Over 150 processing units are there in the country engaging about 5000 workers (www.icar.org.in/ilri).

Since the lac insects thrive and feed on certain species of the tropical trees, it is found distributed South-East Asian countries. It is currently produced in India, Myanmar, Thailand, Malaya, Lao and Yuan province of China. India and Thailand are main areas in the world, while India has prime position in relation to lac production. Lac cultivation is

introduced into Thailand from India. Over 90% of Indian lac produced comes from the states of Bihar, Jharkhand, West Bengal, Madhya Pradesh, Chattisgarh, Eastern Maharashtra and northern Orissa. Some pockets of lac cultivation also exist in Andhra Pradesh, Punjab, Rajasthan, Mysore, Gujarat, and Mirzapur and Sonebhdra districts of Uttar Pradesh. (Singh, 2007)

The first authentic record of occurrence of lac insect in Gujurat was made by Varshney (2000).According to the auther the Lac insect *Kerria Lacca* is widely distributed in India & its neighbouring countries. In Western India its occurrence is however is very scarce. But *Kerria comunis* has been reported from Maharastra, Goa, Karnatak & Kerala .

Mishra & Sushil (2000) reported that *Kerria sharada spp.* is a new trivoltine lac insect species infesting *Schleichera oleosa* from Eastern ghat region of Orissa. It is very close to the species *Kerria albizzae.*

The Indian lac Research Institute (ILRI) establish in 1924 at Namkum, Ranchi recently named as Indian Institute of Natural Resin and Gum is the pioneer Institute contributed immensely in the field of lac research, transfer of technology on lac cultivation and product development related to lac in the country. So far as the lac research is concerned, the Institute has made marvelous achievement in the management of lac insect and important lac host plant for lac cultivation. (www.icar.org.in/ilri). The lac growing areas of India and Orissa (Anon.1958) is depicted in (Fig-1).

2.2 Host plants

The Lac insects thrives on specific trees called as lac hosts. Various lac hosts are exploited for lac cultivation in different lac growing region of the country. Out of more than 400 plants on which lac insects have been observed, only about two dozen are utilized for lac production as commercial lac cultivation on other plants is economically not viable. Moreover, lac host plants exploited for commercial production of lac vary from region to region . Danger looms large on other host plants whose economic importance remains to be realized. The future of various flora and fauna associated with lac is thus intricately linked to the fate of lac cultivation. Fast shrinking area of lac cultivation is a serious threat to biodiversity of the lac insect ecosystem and with abandoning of lac cultivation, unutilized lac hosts are frequently cut for timber and fuel wood, etc.

The major host plant of *Kerria lacca* recorded in India are *Butea monosperma, Schleichera oleosa* and *Zizyphus mauritiana.* Besides the other multipurpose trees recorded as host plant for the insect are *Albizia lucida, Grewia cerulata, Leea crispa, Ougeinia oojeinensis, Shorea talura* and *Z. xylophora.* (Bahuguna and Shiva, 2002).

Pigeon pea crop grown for fuel production, soil conservation and as a food source etc. is alternately used for mass rearing of lac insect, in

China (Zhou Chao Hong et al, 2001). Li zhenghong et. al., 2001 also reported Pigeon pea as an excellent host for lac cultivation in China and is being used for major research studies.

Subarayudu (1997) recorded 53 species of host plant of *Kerria lacca* belonging to 32 genera in Bihar

Shi lei(1999) recorded *Kerria lacca* on ten different host plants viz. *Schleichera oleosa, Litchi chinesis, Koelreuteria paniculata, Flemingia macrophylla, Cajanus cajan, Albizia bracteata, A. lucidior*(*A. Lucida*), *Acacia montana, Zizyphus mauritiana* and *Ficus racemosa.*

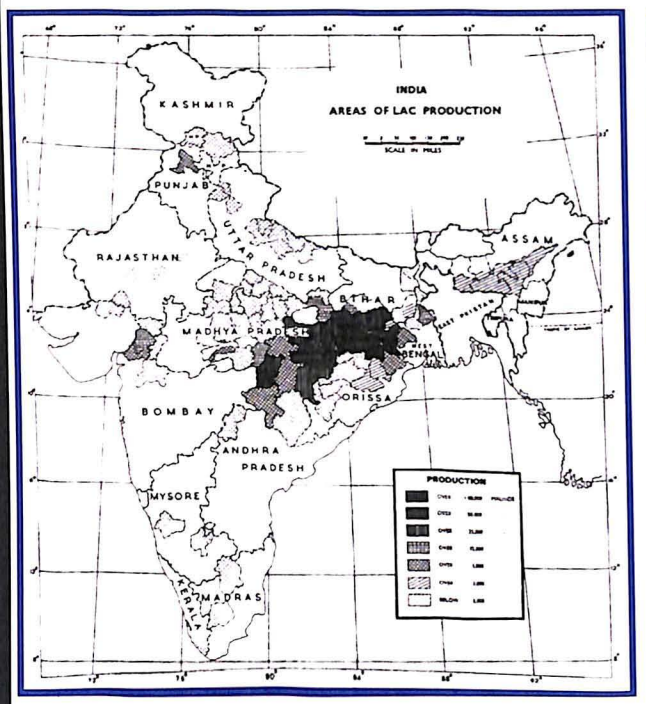
Ramadevi et al, (1997) recorded *Accacia auriculaeformis,* a multipurpose tree raised in Chitradurga as a natural host of *Kerria lacca.* Ramadevi et al, 1998 also recorded *Santalum album.* L. as a host of *Laccifer lacca.*

Sharma ,1997 recorded *Thrvetia peruviana* (peras) Merrilla as a new food plant of *Kerria lacca* at Hisar. Sabharayuba (1999) reported occurance of lac insect on *Peltophorum pierocarpa.* Similarly Madras thorn *Pithecellobium dulce* was reported as a new host of *Kerria lacca* (Kerr) from Ludhiana (Jalaluddin et al, 1999) .Amherstia nobilis a new host plant observed to be infected by lac insect in Kerala (Sudheendrakumar & Varma ,1999).

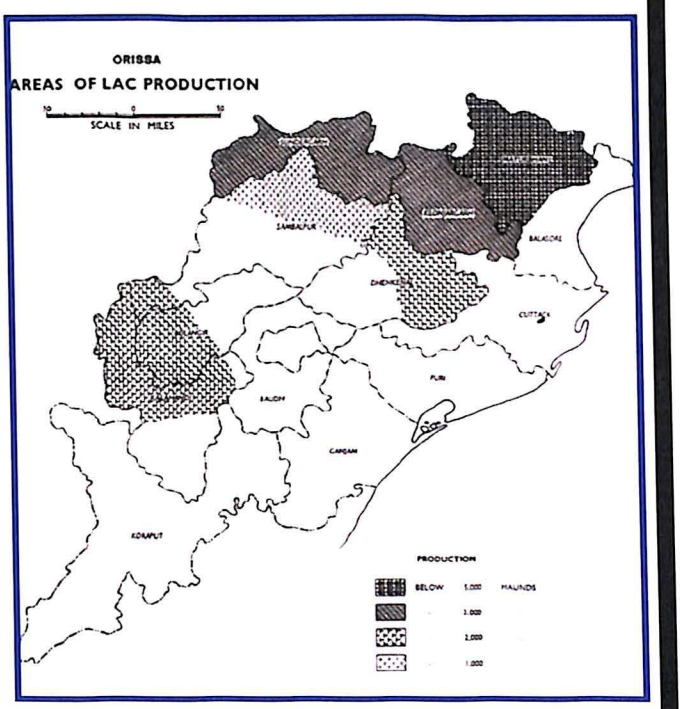
Mishra et al, 1998 studied the performance of different lac insect (*Kerria spp*) stocks collected from different locality in Bihar, Orissa, W.B and M.P. and host plant species are compared with respect to density to settlement & percent initial mortality of nymphs on *Flemingia macrophylla* a promising busy host of lac insect. The mean density of settlement varied between 57 and 175 nymphs per c.m.square. of the shoot surface where as mortality from 12. 94 to 42.8%.

A study on performance of kusumi strain on *Flemingia macrophylla* in the winter season indicated that the insect could successfully survive on *Flemingia macrophylla* (Srivastava et al, 1998). The plants are pruned to 6 inch above to 6 inch above to ground level in Jan-Feb & inoculated on new shoot in July.

Flemingia semialata Roxb. (Leguminosae : Papilionaceae) is a short duration, bushy perennial, erect, fast growing ,input responsive lac host identified for intensive lac cultivation during winter season lac crop of kusumi strain(Aghani).It is grows up to a height of about 3m , fix atmospheric nitrogen and thus enrich soil fertility. It is propagated through seed (more preferred) and stem cuttings. Yield of lac crop grown on this host increases (>50%) from second year on wards.(Yadav et . al., 2005) (Fig-2).



India



Undivided Orissa

Fig. 1. Lac growing areas of India and Orissa (Anon.1958)

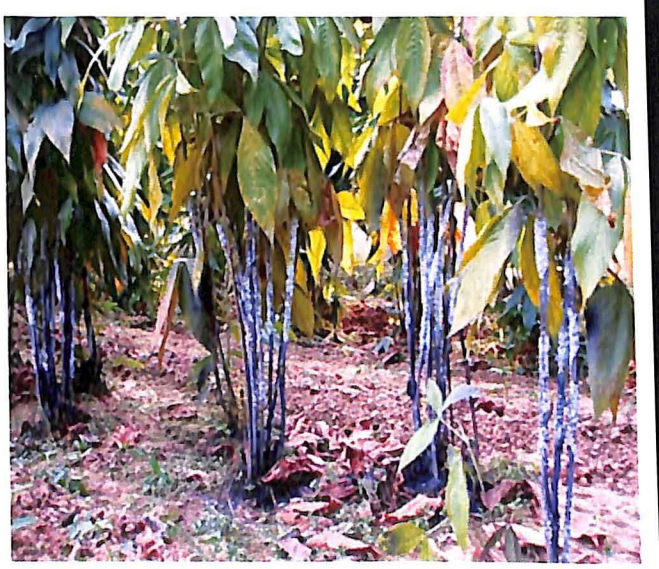


Fig. 2. *Flemingia semialata* Roxb. (Leguminosae) a promising host plant of lac insect identified at IINRG, Namkum, Ranchi.

2.3- Biology and Behaviour

In India, Lac insect is known to have two distinct strains: kusumi and rangeeni. The kusumi strain is grown on kusum or on other host plants using kusumi brood. The rageeni strain thrives on host plants other than kusum. The life cycle of lac insects take about six months, hence, two crops a year can be obtained.

The life cycle of a lac insect (*Laccifer Lacca*) takes about six months and consists of four stages: egg, larva, pupa and adult. The brood lac containing the female lac insect is tied onto fresh new twigs of trees (lac host trees) where they thrive and complete its life cycle under a protective covering which prevent an attack by predators. This secretion forms hard resinous layers which completely cover their bodies leaving small anal and breathing openings. (Singh,2007)

Enumerating the life cycle of the lac insect Singh(2007) highlighted that the female insect is larger than male, measures 4-5 mm in length and has a pyriform body. The head, thorax and abdomen are not clearly distinct. The antennae and legs are in degenerated form, and wings are absent. The Life cycle of lac insect takes about six months and consists of stages: egg, nymph instars, pupa and adult. The lac insects have an ovoviviparous mode of reproduction. Female lays 200-500 ready to hatch eggs, i.e. the embryos are already fully developed in eggs when these are laid. Eggs hatch within a few hours of laying, and a crimson-red first

instar nymph called crawlers come out. The crawler measures 0.6 x .25 mm in size. The emergence of nymph is called swarming, and it may continue for 5 weeks. The nymphs crawl about on branches. On reaching soft succulent twigs, the nymphs settle down close together at rate of 200-300 insects per square inch. At this stage, both male and female nymphs live on the sap of the trees. They insert their suctorial proboscis into plant tissue and suck the sap. After a day or so of settling, the nymphs start secreting resin from the glands distributed under the cuticle throughout the body, except mouth parts, breathing spiracles and anus. The resin secreted is semi-solid which hardens on exposure to air into a protective covering. The nymphs molt thrice inside the cells before reaching maturity. The duration of each instar is dependent on several factors, viz. temperature, humidity and host plant. The female brood cell is larger and globular in shape and remains fixed to the twig. The female retains her mouth parts but fails to develop any wings, eyes or appendages. While developing, it really becomes an immobile organism with little resemblance to an insect. Females become little more than egg producing organisms.The female increases in size to accommodate her growing number of eggs. Lac resin is secreted at a faster rate, and a continuous layer coalesces or grows into one body. After fourteen weeks, the female shrinks in size allowing light to pass into the cell and the space for the eggs. About this time, two yellow spots appear at the rear end of the cell.

The spots enlarge and become orange coloured. When this happens, the female has oviposit a large number of eggs in the space called 'Ovisac'. The ovisac appears orange due to crimson fluid called lac dye. It indicates that the eggs will hatch in a week time. When the eggs hatch, larvae emerge and the whole process begins all over again

Jaiswal(2007) studied the life cycle of Lac insect in detail at IINRG,Ranchi.The life cycle commenced with the first instar larvae called crawlers which are soft,oval shaped body tapering on posterior side of the abdomen.The crawler measured 0.6mm long from head to abdomen and 0.25mm broad at thorax.There was no pronounced demarcation between head ,thorax and abdomen.The head carried a pair of antennae and the last abdominal segment carried a pair of greatly elongated setae.The female insect completed its life cycle in 44 and 69 days after inoculation as Jethwi and aghani crop and survived for another 150 and 90 days respectively recording a total life span of 194 and 159 days respectively.

Bhagat (2007) reported that the living lac insects secret wax filaments throughout the life to check the blockage of pores. Initially the secretion is very fast but at the time nearer to maturity, it slow down. This is also an indication from which one can forecast probable time of emergence.

Chen youQing et al, (2003) made very interesting observation on growth of the host plant of lac insects. According to their observation the longitudinal growth of branches was 5 times faster than the transverse growth. Further the host trees of lac insect grow slowly in the beginning of the insect life history. But grew faster after the insect matures. Younger branches grow faster than the older ones. Lac insect has higher mortality during the larval stage and the total mortality was 90%.

A study carried out by Chen youQing et al, (2004) on characteristics of lac foraging behaviour of *Kerria lacca* and its preference to host branch indicated that *K. lacca* hardly hosted on branches over two years old and the distribution of lac insect on branches had no relation with orientation. The diameter of hosted branches range from 0.47 - 1.60 c.m. on erect branches *K lacca* was distributed round the branch but on most decline branches *K.lacca* only settle on the shaded parts.

The biology of the strain of the lac insect introduced from Nepal to Yuanjaing of Yunnan province of China was studied by He Ju et al,(2003). The insect completed its life cycle successfully twice in a year and based on the other habits this strain could be identified as Rangeeni of *Kerria lacca.* Individual of this strain could produce 19 mg/lac and 600-1000 eggs. The colour of lac was light yellow and it 's quality was better than the lac produced by lac insect sp. of China. *Kerria chinensis* . *Butea monosperma* was recorded as the best host followed by *Acacia glauca.*

Mishra et al, (1999) reported that the growth & development of lac insect is affected by the physiological state of the plant.

2.4- Natural Enemies

Sharma et al, 2001 reported that three new fungi belonging to the family Eurotiaceae / Aspergilaceae viz. *Asperzilous awamori, A. terricola* & *Penicillium citrinum* infecting Indian Lac *Kerria Lacca.*

Studies on predatory activity of *C. carnia,* the most widely used beneficial predator in India indicated that lac insect not a preferred host for the predator as it failed to completed its life cycle on lac insect under laboratory condition. (Sushil et al, 2002).

Sharma & Ramani (2001) recorded 28.13% & 32.18% incidence of parasitism Kusumi & Ranganee strain of female *K. lacca* in the rainy season. Paratisation although had no effect on the size of lac cells but the quantity of resin production decline by 17.92% and 17.44% and fecundity decreased by 32.55 and 34.71% in Kusumi & Ranginee strain respectively.

Sharma et .al.,(2000) for the first time reported the occurrence of *Bracon bravicornis* as the larval parasite of *Eublemma amabilis* Moore, a major predator of lac insect *Kerria lacca,* Kerr.

Sushila et al, (1999) reported 5 hymenopterous egg parasitoid of *Pseudohypatopa pulverea* viz,. *Tricogramma braziliensis, Trichogramma chilonis, T. pretiosum,Trichogrammatoidea bactrae* and *Telenomus remus..*

Sushil et. al, 2000 reported five hymenopterous egg parasitoids namely *Trichogramma brasiliense, T. chilonis, T. pretiosum, Trichogramma*

toidia bactrae and *Telenomus ramous* on *Eublemma amabilis* among which *T. brasiliense* was the predominant one parasitising 43.7% of the *E. amabilis*.

Bhattacharya et al, 1996 during their extensive Survey in Bihar in the rainy season of 1995 recorded *Poecilomyces sp.* for the first time as an entomogenus fungi infecting larvae of *Eublemma amabilis* with recorded mortality of 5-10 per cent of the larvae.

Battacharya et al, 1998 could successfully reared *Psedohypatopa pulverea* on artificial substrate namely cerelac and threptin biscuits under laboratory condition.

Bhattacharya et al, 1998 recorded 24.07 & 90.99 per cent mortality of 1-3 day old eggs of *Eublemma amabilis* through exposure to U.V. light for a period of 5 and 25 minutes respectively.

Sharma, and Ramani (1997) studied the life cycle of two strains of Indian lac insect *Kerria lacca* namely Ranginee & Kusumi on fruits of pumpkin , *Cucurbita muschata.* Although the duration of life cycle and extent of resin secretion reduced than the normal but the strains could complete their life cycle satisfactory providing variable progeny with out much effect on fertility.

Subbarayudu & Maheswar (1998) studied on the parasites of lac insects through collection of random samples from the field at weekly interval commencing from four week of inoculation.

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CHAPTER-3

Materials and Methods

Lac grower of village Bardepta of Keonjhar District.

Lac crawlers in their advanced stage after settling on Kusum tree

Field visit to Bardepta of Keonjhar District

Table 1. List of KVKs requested for providing information relating to lac cultivation in their respective districts.

S.No.	Name of the K.V.K.	Place	District
1.	Krishi Vigyan Kendra, Angul	Panchomohala	Angul
2.	Krishi Vigyan Kendra, Baragah	Gambharipali	Baragarh
3.	Krishi Vigyan Kendra, Bhadrak	Ranital	Bhadrak
4.	Krishi Vigyan Kendra, Boudh	Paljhar	Boudh
5.	Krishi Vigyan Kendra, Dhenkanal	Mahisapat	Dhenkanal
6.	Krishi Vigyan Kendra, Deogarh	Purunagad	Deogarh
7.	Krishi Vigyan Kendra, Gajapati	R. Udayagiri	Gajapati
8.	Krishi Vigyan Kendra, Ganjam	Benekunda	Gunjam
9.	Krishi Vigyan Kendra, Jagatsinghpur	Dist. Agril. Officer Campus	Jagatsinghpur
10.	Krishi Vigyan Kendra, Jajpur	Barachana	Jajpur
11.	Krishi Vigyan Kendra, Jharsuguda	OSAP, 2nd Batallian	Jharsuguda
12.	Krishi Vigyan Kendra, Kalahandi	Bhawanipatna	Kalahandi
13.	Krishi Vigyan Kendra, Kandhamal	G. Udayagiri	Kandhamal
14.	Krishi Vigyan Kendra, Keonjhar	Judia Farm	Keonjhar
15.	Krishi Vigyan Kendra, Kendrapara	Jajanga	Kendrapara
16.	Krishi Vigyan Kendra, Koreaput	Semiliguda	Koraput
17.	Krishi Vigyan Kendra, Mayurbhanj	Shyamakhunta	Mayurbhanj
18.	Krishi Vigyan Kendra, Malkangiri	Dist. Agril. Officer Campus	Malkangiri
19.	Krishi Vigyan Kendra, Nabarangpur	Umerkote	Nabarangpur

20.	Krishi Vigyan Kendra, Nayagarh	Panipoila	Nayagarh
21.	Krishi Vigyan Kendra, Nuapada	Nuapada	Nuapada
22.	Krishi Vigyan Kendra, Puri	Block Colony, Kakatpur	Puri
23.	Krishi Vigyan Kendra, Rayagada	Gunupur	Rayagada
24.	Krishi Vigyan Kendra, Sambalpur	RRTTS Campus, Chiplima	Sambalpur
25.	Krishi Vigyan Kendra, Sonepur	Badajhinki, Bolangir Road	Sonepur
26.	Krishi Vigyan Kendra, Jharsuguda	Kirei	Jharsuguda

3.1.2 Collection of available literature from Internet

Scanning of available literature

Information from secondary sources like M.S.SWAMINATHAN RESEARCH FOUNDATION, Honda Information Center 3rd Cross Street, Taramani institutional Area, CHENNAI-600113, were collected, besides referring the available journal's, books and magazines.

Accessing information through internet from pertinent web sites :

The web sites such as www.google.com., www.icar.org.in/ilri were also visited and useful information were collected to support the present investigations.

3.1.3. Physical survey

The following few selected villages were visited to ascertain the status and constraints of lac cultivation in context with the prevailing situations;

Date	Place	Districts
22.8.2008	Bardebta	Keonjhar
27.9.2009	Jhansanpur ,Telcoi	Keonjhar
10.10.2008	Sunashahi	Mayurbhanj

	,Gaurichandrapur Keshpada ,Block Kaptipada	
11.2.2009	Keshpada Jadagarh Block - Kaptipada	Mayurbhanj

During the course of visit interaction with farmer's of the above villages, undertaking lac cultivation was made. Information on lac cultivation and host plants exploited for lac cultivation were collected through personal interaction with the farmers.

Indian Lac Research Institute, (I.L.R.I.), presently renamed as Indian Institute of Natural Resin and Gum (IINRG), Namkum, Ranchi ,the pioneer institute devoted for lac research and extension was also visited to gather the latest information relating to lac cultivation.

Laboratory and field studies were also made to generate preliminary information on the lac insects. The brood sticks collected from different area from time to time were keenly observed for record of natural enemies if any and of the brood sticks were characterised.

3.2 Laboratory studies

3.2.1 Brood sticks :- To know various attributes associated with brood stick, such sticks collected from different areas were subjected to the following observations.

3.2 The length of the brood sticks were measured and recorded separately.

3.3 The diameter of the brood sticks with and without lac encrustation were recorded by help of a slide calipers (Fig.3) after calibrating the slide calipers.

3.4 The weight of the brood sticks, scrap lac (stick lac) were taken by the digital balance and these were recorded separately.

3.2.2. Study of natural enemies:

In order to record the occurrence of different predators and parasites, the brood sticks were placed inside the plastic jars, big enough to accommodate the brood lacs. The lead of the jar is remove and after placing 8-10 brood sticks in each jar. The mouth is covered with a transparent minutely perforated polythene bag in a ballooning position (Fig. 4). The basal portion of the jars were kept dark by covering them with thick black cloth so as to induced upward movement of the predators and parasites emerging from the brood sticks. The parasites or predators emerging from the sticks were collected in specimen tubes and were subjected to the morphological studies. The brood sticks were kept in such condition till the issue of swarm.

3.2.3. First instar nymph:

Soon after issue of the swarm, about 100 freshly emerged nymphs were collected randomly by help of a camel hair brush and kept in 70 % alcohol for further study. The morphological features were studied under a Stereoscopic binocular microscope. The length and breadth of the nymphs were taken using a standardized ocular micro meter (1 ocular division = 0.4 mm).

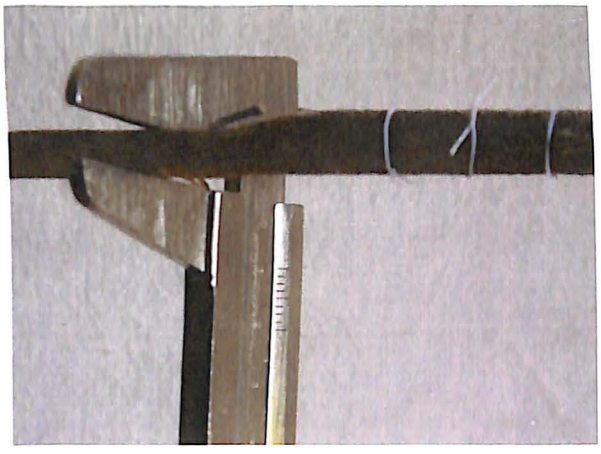

Fig. 3. : Mesurement of twig thickness by slide calipers

Fig. 4. : Method adopted for collecting natural enemies of lac insect and parasites from brood lac stick

3.2.4 Female cell :

During the course of investigation random sample of the mature female cells of lac insects with encrustation on host plant *Flemingia semialata* were collected. The isolated cells were dislodged by help of a scalpel and subjected to morphological study on the stereoscopic micro scope and the measurement were taken by placing them on graph papers and observing the division through a 10 x hand lens(Fig.5). The weight of the corresponding lac cell was taken by help of a highly sensitive (Sensitivity - 0.001 gm) ocular electronic digital balance (Fig. 6).

3.3.1. Field studies:

Attempts were made to study the biology of lac insects on few selected plants of *Flemingia semialata,* and arhar plants grown in the experimental plot(Fig. 7) and (Fig.9) of the Department of Entomology, O.U.A.T., Bhubaneswar. A plant of Ber grown on the border was also utilized for the study. The arhar plants were raised from local seeds and pruned plants after the first season crop were utilized. Brood lac sticks collected from Keshpada of Kaptipada block of Mayurbhanja districts and brood stick of I.I.N.R.G., Ranchi were describe the methods inoculated in the host plants both in scientific method and as the conventional practice adapted by the tribals (Fig.8). Due to inadequate host plants in some plants brood lacs are kept for a day during which sufficient number of crawlers could settle on the entire stem of the host plants. Subsequently such brood lacs were removed and

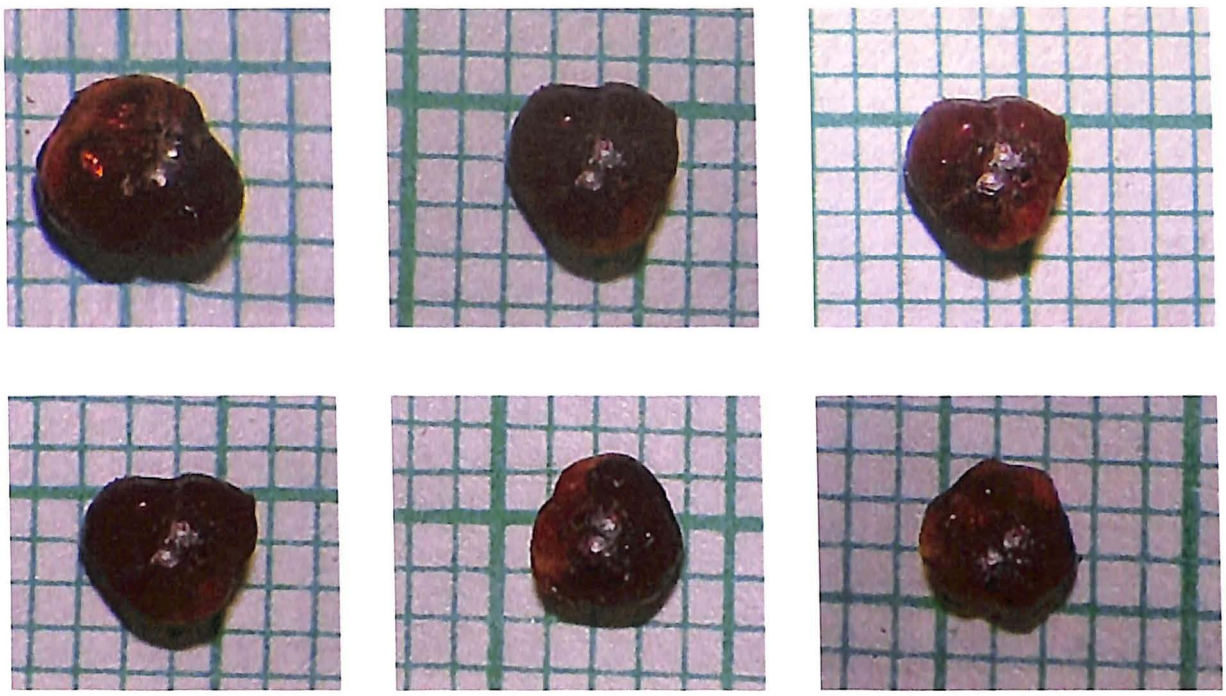

Fig.5. : Measurement of female lac cells

Fig.6. : Acculab electronic balance used for measurement of lac cell. (A female lac cell weighing 0.014 g)

Fig. 7. Inoculation of brood lac on arhar plant at experimental plot of Entomology division, OUAT

A. Scientific Method
(Brood lac in net cloth bag)

B. Traditional Method
(Naked brood lac)

Fig. 8. Method of tieing brood lac on host plant

utilized for inoculation on other host plants till the completion of the swarming. Observations were recorded daily till a fortnight of inoculation and subsequently at biweekly interval till the maturity of the crop.

In order to record the extend of survival of the lac insect on arhar, 7 sample plants were selected and tagged by coloured threads(Fig. 10) on upper portion and lower portion of the plant to demarcate specific unit area and total number of dead and live insects in the marked area were counted from which estimate of survival was recorded at 45 and 65 days after inoculation.

To know the effect of lac infestation on *Cajanus cajan* ,10 sample plants from each level of infestation i.e. heavy, medium and no infestation(healthy) were selected randomly. The numbers of healthy branches were counted and lengths of branches were measured in all the sample plants.

v) Statistical analysis

The data collected from different sets of experiments were subjected to analysis adapting appropriate statistical tools like arithmetic mean, standard deviation and co-relation co-efficient. The data were analyzed following procedures as suggested by Gomez and Gomez (1976) and then they were utilized for deriving necessary inference.

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Fig. 9. : Tieing of brood lac stick on arhar plants

Fig. 10. : Tagging of arhar plant for counting lac cells/unit area in field

CHAPTER-4

Result and Discussion

Chapter -4

Results and Discussion

The information gathered through questionnaire and personal contact with different persons during the course of survey are presented below with critical analysis and there were discussed with appropriate literatures collected from various sources.

4.1. Present status of lac cultivation in Orissa

4.1.1 Survey

4.1.1.1 Information gathered through questionnaire

Table 2. List of Krishi Vigyan Kendras responded to the questionnaire

Sl. No.	Name of the K.V.K.	Place and District	Response on whether Lac cultivation	
			Practiced previously	Practiced Presently
1.	K.V.K., Baragarh	Gambharipali, Baragarh	No	No
2.	K.V.K., Dhenkanal	Mahisapat, Dhenkanal	No	No
3.	K.V.K., Deogarh	Purunagad, Deogarh	No	No
4.	K.V.K., Jharsuguda	Kirei, Jharsuguda	No	No
5.	K.V.K., Kalahandi	Bhawanipatna, Kalahandi	Yes	No
6.	K.V.K., Mayurbhanj	Shyamakhunta, Mayurbhanj	Yes	Yes
7.	K.V.K., Nabarangpur	Umerkote, Nabarangpur	Yes	Yes
8.	K.V.K., Sundargarh	Kirei, Sundargarh	Yes	Yes

Out of the 26 Krishi Vigyan Kendras.'s requested for providing preliminary information's about past and present status of lac cultivation in their respective districts only eight K.V.K's (Table -2)responded. The response

indicates that the lac cultivation was practiced previously in Kalahandi, but discontinued presently. However, in the district of Mayurbhanj, Nabarangpur and Sundargarh lac cultivation was practiced previously and the same with little modification is being continuing till date.

A very informative response was obtained from the then Programme Coordinator of K.V.K., Nabarangpur. Lac cultivation was done previously in the districts and presently it is being practiced in four blocks viz. Chandahandi, Raighar, Jharigaon and Umarkot out of 10 blocks of the district. In Chandahandi block it is cultivated in the village viz. Fatiki, Karadunguri, Rajkot and Boitipada. Previously lac cultivation was encouraged by the kings and at that time bangles and like products were prepared by the inhabitants of *Shankhri Sahi* of Nabarangpur districts headquarters. After independence the cottage industry was in the average of extinction as market consumption inside was abysmally low. However, due to concerted efforts of the scientists and technical persons of the IINRG, Namkum, Ranchi visiting to the lac growing villages of the districts and giving pertinent guidance from time to time to the farmers the lac cultivation is regaining its popularity. Presently the domestic demand as well as demand of external agencies has increased. The farmers presently harvesting 52-110 kg of stick lac per annum depending upon the number of tree they owned. Further it is worth mentioning that the lac species *Kerria lacca* (Kerr.), strain kusumi is cultivated on the host plant Kusum. *Schleichera oleosa* in the district and it can also be cultivated successfully on *Ficus glomerata.*

Similarly in the district of Mayurbhanj lac was cultivated since long by the tribals and the practice is also continuing till date. The lac cultivation is further promoted by the staff of extension wing of Indian Institute of Natural Resin and Gum, Namkum, Ranchi, either directly or indirectly. Farmers of village Keshpada of Gaurichandrapur, G.P. and Sharad in Kaptipada block of Mayurbhanj district cultivated lac, *Laccifer lacca*, strain kusumi on kusum plant (*Schleichera oleosa*).

undargarh

In Sundargarh district , lac is also cultivated above a century ago .But after intervention of Tribal Co operative Marketing and Procurement Federation of India Ltd (TRIFED) lac is cultivated in commercial basis since last three years in village Elga of block Kutra and near by villages. Over 100 farmers of village Elga are engaged in lac cultivation in small groups . *Schleichera oleosa* is the only host exploited for the purpose. They use 10 kgs of brood lac per tree and harvest about 100-120 kg of lac/tree/season. Marketing of the lac harvested is facilitated by the TRIFED and NGOs operating in their village .The prevailing sale price of scrap lac is Rs. 80/- to Rs.100/- per Kg. and that of brood lac is Rs.120/- per Kg. A lac farmer of the village normally earns about Rs. 8000/- to Rs.9000/-from a *Kusum* tree. Sri Gobind Khus (Village Elga, P.O. Agora, Via. Kutra, Dist. Sundargarh) a successful and progressive lac grower of the districts has ventured for scientific lac cultivation.

4.1.1.2 Information gathered through scanning of literatures:

Scanning of available literatures revealed that lac is cultivated in 7 districts of Orissa namely Keonjhar, Mayurbhanj, Sambalpur, Sundargarh, Nabarangpur, Koraput and Balasore.

According to Singh(2007), India, Myanmar, Thailand, Malaya, Lao and Yuan province of China. India and Thailand are main areas in the world where lac is cultivated while India has prime position in relation to lac production. Over 90 % of Indian lac comes from the states of Bihar, Madhya Pradesh, West Bengal, Maharastra and northern Orissa but Sharma et al. (2006) stated that Jharkhand is the chief lac producing state of India followed by Chattishgarh and West Bengal whereas Orissa, Gujurat, Assam, Punjab and Uttar Pradesh contributed significantly to lac production in early days now their share is almost negligible but cultivation of lac has been abandoned in these state and many species of lac insect reported from these places have become endangered. According to these workers Orissa stands as a minor producer.

The latest literature (Pal et.al.,2008) indicates that lac is cultivated in six districts of Orissa viz. Balasore, Keonjhar, Koraput, Mayurbhanj, Nabarangpur and Sundargarh of which during the present study, existence of lac cultivation practice in Keonjhar, Mayurbhanj, Nabarangpur and Sundargarh is being confirmed through survey and Balasore and Koraput through personal contact.

Cultivation of lac in undivided Sambalpur district was mentioned by Mukhopadhyay and Muthana (1962) in Lac Monograph. Being a bigger one, this district is divided into four districts viz., Sambalpur ,Jharsuguda, Bargarh and Deogarh. Programme Co-ordinators of three K.V.K.s informed that neither previously nor at present the lac is cultivated in their districts. Therefore, further survey is needed to confirm the status of lac cultivation in the divided Sambalpur district. Further the mixed response received during this study regarding lac cultivation in Kandhamal, Boudh and Nayagarh needs to be verified.

4.1.2. Lac cultivation in Keonjhar and Mayurbhanj districts

The preliminary information collected through direct interaction with the farmers of Keonjhar and Mayurbhanj are presented below.

4.1.2.1 Keonjhar

Eight farmers of village Jansanpur of block Telkoi, district Keonjhar (Table-3) associated with lac cultivation were personally interviewed. It is learnt from discussion that lac cultivation in their village was done since long. As far as their knowledge is concerned lac cultivation was practiced since 50-100 years ago in their village. Kusum (*Schleichera oleosa*) is the only host plant utilized in the village for the purpose.

Further it is ascertained from them that they harvest 8-20 kg of lac per tree per season. The lac produced by them is marketed in the village it self which is

purchased by the middle man. Sometimes it is sold to the society. The sale price of lac stick in the village varied from Rs.50/- to Rs.80/-

The lac cultivation practiced by the farmers was mostly through traditional method without any technical or financial support from any Government or private agency. Further, the naturally developed *Kusum* trees in the locality are shared by the farmers. Non availability of sufficient host plant to the credit of individual farmer share was a constraint in the lac production. Support from Government like arranging facilities for vocational training of the farmers; financial support to develop host plants in the locality and providing facilities for scientific lac cultivation were the prime needs posed by the framers for improving lac cultivation in the village in addition to supply of good quality brood lac.

Table- 3 Current status of lac cultivation in Keonjhar

Host plants exploited - Kusum
Village surveyed –Jansanpur , Telcoi

Sl. No	Name	Occupation	Lac cultivated in the village since	Lac stick yield (kg/tree / Season)	Cost of lac stick (Rs./kg)	Marketing of lac	Help sought from Govt.
1	Sri Rasunia Nayak	Farming	50 years	10	50	In village	Need financial support for raising host plants & also need training
2	Sri Sukura Nayak	Farming	50 years	20	50	In village	Need financial support for raising host plants & also need training
3	Sri Dinabandhu Dehuri	Farming	80 years	15	50	In village but earlier sold to society	Need financial support for raising host plants & also need training
4	Sri Badri Nayak	Farming	80 years	14	50	In village but earlier sold to society	Need financial support for raising host plants & also need training
5	Sri Bakori Dehuri	Farming	80 years	15	80	In village but earlier sold to society	Need financial support for raising host plants & also need training
6	Sri Pathi Nayak	Farming	80 years	20	80	In village but earlier sold to society	Need financial support for raising host plants & also need training
7	Sri Rusi Dehuri	Farming	80 years	13	80	In village but earlier sold to society	Proper care of natural enemies and supply of quality brood lac
8	Sri Baklu Nayak	Farming	100 years	8	80	In village but earlier sold to society	Proper care of natural enemies and supply of quality brood lac

4.1.2.2 Mayurbhanj

Similarly 10 farmers of village SuriaSahi, Keshapada, Gaurichandrapur of block Kaptipada, District of Mayurbhanj were interviewed. During the interaction the information collected from them (Table - 4) revealed that four species of host plants were used by them namely *Kusum, Ber , Palas* and *Dimbiri* predominant being the *Kusumi* tree. Farmer of the Kaptipada block harvested 10-25 kg of lac stick/tree/season and the interviewed farmers harvested 40-100 kg of lac stick depending upon the number of tree shared by them.

In Kaptipada, the cultivation practice of lac adopted by the farmers was also traditional as it learnt from their ancestors. The farmer's were not able to trace exactly/apparently from when lac cultivation was started in the area. All were in opinion that it is practiced in their locality since long. The harvesting of lac was done in a disorganized manner however most of them kept about $1/10^{th}$ of their total lac stick collection for use as brood lac.

The lacs produced in their locality were sold to the whole saler who lift their stock from their door step as lac stick at a cost of Rs.50/- per kg of lac stick. Farmers were aware of the higher price of stick lac which is produced by scarping out the lac encrustation from the lac stick, but normally avoided to produce and market stick lac as the process involve is quite labour intensive.

The concerned farmers expressed that support from Government or any other agency involve in promotion of lac cultivation would definitely improve the status of lac production in their area. They aspired for technical support through training for educating them for better lac cultivation practice.

Table- 4 Current status of lac cultivation in Mayurbhanj

Sl. No	Name of the farmer	Village/ Block	Host plants used	Lac stick yield kg / tree /season	Yield/ trees/ season (Kg.)	Sale price of Lac/ Kg	HRD	Need
1	Sri Matai Teya	Sunasahi Keshapada, Kaptipada	Kusum, Ber, Palas, Dimbiri	60	15	50	Govt.	-
2	Sri Ramachandra Singh	Gourichandrapur, Keshpada	Kusum, Ber, Palas, Dimbiri	80	20	50	-	Training
3	Sri Dama Singh	Gourichandrapur, Keshpada	Kusum, Ber, Palas, Dimbiri	70	17.5	50	-	Training
4	Smt. Monika Singh	Keshpada, Kaptipada	Kusum, Ber, Palas, Dimbiri	80	20	50	-	Training
5	Smt. Shanti Tiu	Keshpada, Kaptipada	Kusum, Ber, Palas, Dimbiri	80	20	50	-	Training
6	Sri Ghanashyam Singh	Keshpada, Kaptipada	Kusum, Ber, Palas, Dimbiri	70	17.5	50	-	Training
7	Sri Jayapal Singh	Keshpada, Kaptipada	Kusum, Ber, Palas, Dimbiri	40	10	50	-	Training
8	Sri Sunaram Singh	Keshpada, Kaptipada	Kusum, Ber, Palas, Dimbiri	100	25	50	-	Training
9	Sri Pravat Rout	Keshpada, Kaptipada	Kusum, Ber, Palas, Dimbiri	60	15	50	Govt. training	Training
10	Sri Rabindra Rout	Keshpada, Kaptipada	Kusum, Ber, Palas, Dimbiri	80	20	50	Govt. training	Training

Farmers view

* Each of the above farmers shared 4 trees for their lac production
  Harvest-10-25kg/ tree of Kusum
  Harvest from plants in a disorganized manner
  Number of harvesting / Year Two (2)
  Sale wholesale take the produce at door step- without scrapping
  Farmers know about scrap lac but avoided to do so due to labor intensive nature of the operation
  They keep about 1/10 of the total collection for use as broad lac

4.2. Host Plants :

Information gathered during survey on host plants used for lac cultivation in Orissa is presented in Table -5 .It is revealed that Kusum (*Schliechera oleosa*) was the predominant host utilized for lac cultivation in all the six districts namely Balasore, Keonjhar, Koraput, Mayurbhanj, Nabarangpur and Sundargahr followed by Palas (*Butea monosperma*) and Ber (*Zyzuphus mauritiana*). In Koraput only Kusum plant is used by the tribals for lac cultivation. In Mayurbhanja, the leading district of the state on lac production, Dimbiri (*Ficus hispida.*) an additional host utilized for lac cultivation in addition to Kusum, Palash and Ber.

Although the lac insect is reported to have more than 400 host plants ,only about two dozen are utilized as hosts for commercial lac production others are not economically viable (Sharma et al. 2006, Singh, 2007). The same authors however have reported that the host plants exploited for commercial lac production vary from region to region and in Orissa only *Schleichera oleosa* (Kusum) and *Z. mauritiana* (Ber) are exploited for the purpose which is in accordance to the observations made in this present investigation. Mukhopadhyay and Muthana (1962) categorized the lac host as common or major hosts, occasional hosts and rare hosts. Under common hosts they listed 14 species of host plant of which Palas, Kusum and Ber were the common hosts of all India importance.

Different species of *Ficus* are known to serve as minor host plant for lac insects (Roonwal et al, 1958). *Ficus hispida* is a small to moderate size quick

growing tree having opposite leaves and distributed commonly in many parts of India and Burma usually in shady places. Roonwal et al. (1958) reported that lac is grown on *Ficus hispida* in Shan states and Burma. Palas is a common host plant reported earlier was also used by the farmers of Orissa but *Ficus hispida,*(Dimbri) as a host plant of lac in Orissa is the first record.

Table -5 Host plants exploited for lac cultivation in Orissa

Name of the district	Name of the village	Name of the host plant	Scientific name	Family
Balasore	Haldipada, Jaleswar, Nilagiri	Kusum, Palas, Ber	*Schleichera oleosa*(Lour.)Oken *Butea monosperma*(Lam.)Taub. *Zizyphus mauritiana* Lamk.	Sapindaceae Leguminaceae Rhamnaceae
Keonjhar	Bardepta, Telkoi	Kusum, Palas, Ber	*Schleichera oleosa*(Lour.)Oken *Butea monosperma*(Lam.)Taub. *Zizyphus mauritiana* Lamk	Sapindaceae Leguminaceae Rhamnaceae
Koraput	Ramgiri	Kusum	*Schleichera oleosa*	
Mayurbhanja	Kaptipada, Sharad, Keshpada, Hadagarh	Kusum, Palas, Ber, Dimbiri	*Schleichera oleosa*(Lour.)Oken *Butea monosperma*(Lam.)Taub. *Zizyphus mauritiana* Lamk *Ficus hispida* Linn.	Sapindaceae Leguminaceae Rhamnaceae Urticaceae
Nabarangpur	Chandahandi, Raighar	Kusum, Ber	*Schleichera oleosa* *Zizyphus mauritiana*	Sapindaceae Rhamnaceae
Sundargarh	Khandadhar, Rajgangpur	Kusum, Palas	*Schleichera oleosa* *Butea monosperma*	Sapindaceae Leguminaceae

4.3 Studies on lac insect

The lac insect, *Laccifer lacca* (=*Kerria lacca*) (Lacciferidae, Order Hemiptera) is a very typical sucking insect possessing many interesting features. Due to its hiding nature under the resinous encrustation produced by it self, it is relatively difficult to study about the insect properly. An attempt was still made to study

about the insect under the agro climatic conditions of Bhubaneswar, district Khurda where no record of evidence about lac cultivation is available. This study was conducted in the experimental field of Department of Entomology, College of Agriculture, O.U.A.T., Bhubaneswar on Arhar (*Cajanus cajan*) , Ber (*Zizyphus mauritiana*) and few plants of a new host *Flemingia semialata* .

In order to raise the Aghani crop, altogether 16 brood sticks were collected from Kaptipada on 19th October, 2008 and inoculated on Arhar, Ber and Pumpkin. However, brood sticks even after a month of inoculation failed to issue the swarm. This is most probably due to the delay in collection of the brood sticks. Normally in Kaptipada swarming of lac insect under self inoculation completes by end of July. The information collected earlier during exploration that the normal crawling time is August-September and sometimes it extends was conclusively misleading month of July is the ideal time for brood lac collection for Aghani crop. Thus, month of July is the ideal time for brood lac collection for raising *aghani* crop in our state. Subsequently, again the brood lac sticks (Fig. 11-A) were collected from the same location of Kaptipada block on 10th February, 2009. Incidentally the brood lac stick produced at Indian Institute of Natural Resin & Gum, (IINRG), Namkum, Ranchi was also distributed to the beneficiary. Altogether twenty three brood lac sticks on Kusum from the crops raised at Kaptipada and four brood lac sticks on ber produced at (IINRG), Ranchi was procured.

Fig. 11. (a) : Brood lac sticks collected from Keshapada, Mayurbhanj.

Fig.11a. (b) : Flemingia fully covered waxy filaments.

4.3.1 Descriptions on Brood lac :

During the course of survey only four brood lac sticks of IINRG, Ranchi could be collected in addition to the brood sticks collected from lac growing districts of Orissa. There was distinct visual difference in the brood sticks .The attributes of the brood sticks collected from Ranchi and Local are presented separately.

It was observed that the brood sticks on the host plant ber procured from Ranchi were very healthy, thick with uniform encrustation, where as the brood sticks collected from local were showing haphazard encrustation. The length of the brood sticks of former source varied from 12.4 to 32.0 cm with mean of 18.9 cm (Table 6) where as the corresponding figure for local brood stick were 7.0-16.0 cm with a mean of 12.64 (Table 7) Similarly the thickness of the twig on which lac insects completed their life cycle was 0.9 to 1.57 cm (Av. 1.14 cm) for Ranchi sticks while it was 0.5-1.0 cms (Av. 0.69 cms) for the local ones. The thickness of encrustation in the brood stick collected from Ranchi varied from 1.26-2.06 cm with a mean of 1.82 cm whereas in local it was 0.38 to 0.97cms (Av. 0.70 cm).

As far as the length is concern stick length of both the samples collected from Ranchi and local area were almost of same size but one brood stock out of 4 collected from Ranchi was up to 32 cm long. The length of brood sticks used local region ranged from 7.0 - 16.0 cm with an average of 12.64 cm.

Table- 6 Attributes of Brood Lac sticks procured from IINRG, Ranchi

		Date of collection-10.02.2009,					
		Place of collection - Ranchi					
		Host plant- Ber. Zizyphus mauritiana					
Sl.no.	Length (cm)	Dia(cm)			Weight(gm)		
		with lac	without lac	Difference	with lac	only stick	scrap lac
1	16.50	2.39	1.13	1.26	33.38	10.25	23.13
2	14.70	3.00	0.94	2.06	18.53	5.29	13.24
3	12.40	2.95	0.92	2.03	18.14	5.28	12.86
4	32.00	3.50	1.57	1.93	169.18	46.76	122.42
Mean	**18.90**	**2.96**	**1.14**	**1.82**	**59.81**	**16.90**	**42.91**
$SD_{\pm}$	**8.89**	**0.45**	**0.30**	**0.37**	**73.25**	**20.40**	**53.21**

Table . 7 Attributes of Broad lac sticks procured from Mayurbhanj

Date of collection-18.10.2008							
Place of collection - Keshpada							
Host plant- Kusum, *Schleichera oleosa*							
	Dia(cm)				Weight(gm)		
Sl.no.	**length (cm)**	**with lac**	**without lac**	**Difference**	**with lac**	**only stick**	**Scrap lac**
1	15.00	1.43	0.55	0.88	24.99	4.73	20.26
2	13.60	1.27	0.73	0.54	31.75	7.85	23.90
3	12.00	1.39	0.73	0.66	13.99	4.75	9.24
4	14.00	1.64	0.72	0.92	27.73	5.84	21.89
5	8.50	1.60	0.76	0.84	19.96	4.16	15.80
6	14.00	1.32	0.95	0.37	22.14	7.05	15.09
7	11.40	1.58	1.00	0.58	17.47	4.77	12.70
8	13.90	1.38	0.76	0.62	15.28	4.03	11.25
9	14.80	1.68	0.80	0.88	27.66	6.58	21.08
10	15.00	1.22	0.70	0.52	21.47	4.22	17.25
11	11.70	1.45	0.54	0.91	17.88	2.71	15.17
12	12.00	1.40	0.62	0.78	13.37	4.10	9.27
13	14.00	1.43	0.81	0.62	21.24	5.26	15.98
14	7.00	1.03	0.54	0.49	9.09	2.60	6.49
15	11.40	1.30	0.65	0.65	26.97	5.13	21.84
16	15.00	1.45	0.64	0.81	21.53	4.19	17.34
17	16.00	1.13	0.55	0.58	13.70	4.03	9.67
18	12.60	1.70	0.73	0.97	19.53	4.00	15.53
19	9.00	1.61	0.66	0.95	16.26	4.25	12.01
20	11.00	0.90	0.52	0.38	7.48	2.51	4.97
21	14.00	1.42	0.70	0.72	15.62	3.44	12.18
22	11.40	1.38	0.74	0.64	12.80	4.80	8.00
23	13.50	1.44	0.66	0.78	20.85	3.59	17.26
Mean	**12.64**	**1.40**	**0.70**	**0.70**	**19.08**	**4.55**	**14.53**
SD ±	**2.275**	**0.199**	**0.122**	**0.178**	**6.163**	**1.331**	**5.236**

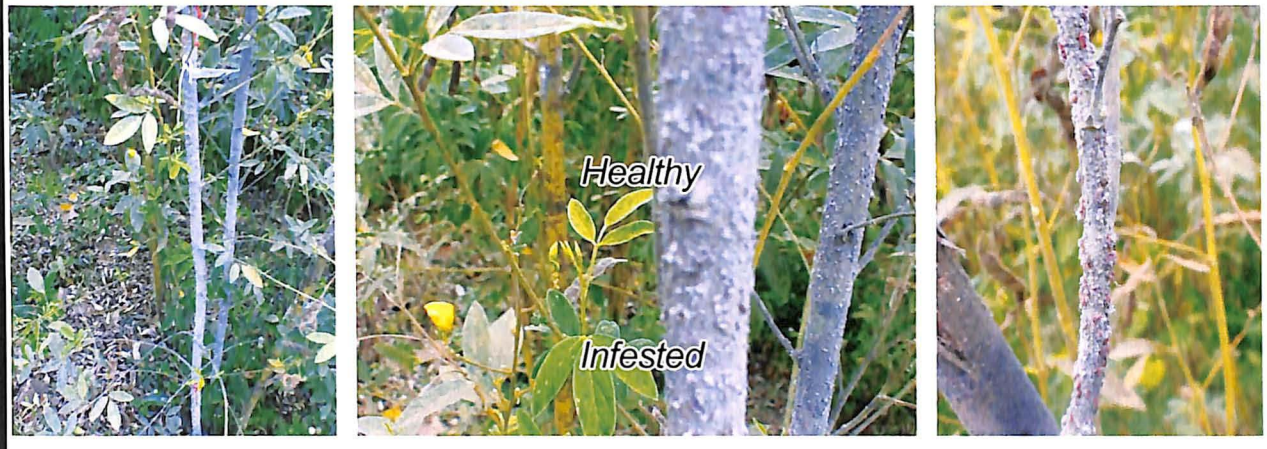
As regards to the diameter is concerned the diameter with lac of brood stick collected from Ranchi varied from 2.39 to 3.5 cm with mean of 2.96 cm while without lac it was 0.92 to 1.57 cm with mean of 1.14 cm. From this it is estimated that there was deposition of resinous material of thickness 0.6 to 1 cm over the twig. About 12.86 to 122.4 gms of stick lac could be recovered from such phunki lac sticks. The diameter of local brood sticks with lac ranged from 0.9 to 1.70 cm with an average of 1.40 cm whereas without lac it ranged between 0.52 to 1.00 cm with an average of 0.7 cm. The thickness of encrustation over twig varied from 0.19 to 0.46 with an average of 0.35 cm. About 4.36 to 22.38 gm with mean of 13.1 gm stick lac could be recovered from Phunki lac of the locally collected sample.

4.3.2 Biology :

Preliminary biology of the lac insect *Laccifer lacca* was studied under the agroclimatic conditions of Bhubaneswar on three host plants namely Bhalia (*Flemingia semialata*), Arhar (*Cajanus cajan*) and Ber (*Zizyphus. mauritiana*). Due to insufficient brood lac as well as host plants in depth study could not be undertaken. However the result obtained and some salient observations made are furnished below supplemented with pertinent tables and growth of lac insects on different host is illustrated in Fig-12.

The Jethwi crop of Kusumi strain of *Laccifer lacca* was initiated in the first fortnight of February, 2009 on the aforementioned three host plants through inoculation on the plant in the field soon after observing the issue of swarm in the brood stick collected from Keshpada on 10.2.2009. It is observed that issue of swarm of first instars nymph of the insect was more in the morning hour compared to afternoon hours. The crawlers took one day for settling on the host

GROWTH OF LAC INSECTS ON *Flemingia semialata ON* 60 DAI (16.4.09)



GROWTH OF LAC INSECTS ON Cajanus cajan ON 60 DAI (16.4.09)

GROWTH OF LAC INSECTS ON Zizyphus mauritiana ON 60 DAI (16.4.09)

FIG. 12. GROWTH OF LAC INSECTS ON DIFFENT HOST PLANTS

(Fig -13). Further it is observed that crawlers on both Arhar and *Flemingia* hosts preferred to congregate close to the basal region than the apical portion. It is also interesting to mention here that in the morning hour the crawlers remind uniformly distributed all around shoots of both the host plants. Nevertheless, due to heavy and bright sun shine majority of nymph shifted and settle on the opposite direction of the bright sunshine on host plants grown isolatedly. The nymphs continued to remain in the same position till the crop is matured. Swarming from the brood stick continued for 5-10 days (Table 8).

It was observed that the first instar nymphs were pinkish red in colour and oval in shape with both the ends tapering more being towards the posterior end. The body division was quite indistinct and it was observed that the nymphs posses a pair of long antennae and two long caudal filaments. The first instar nymph measured 0.96 to 1.16 mm with an average of 1.06 mm in length leaving aside the antennae and caudal setae and 0.36 to 0.48 mm brood with an average of 0.43 mm at the broadest thoracic portion of the body (Table. 9) . Further, it was observed that the nymphs were about 2.48 times longer than their width.

Mukhopadhay and Muthana (1962) and Jaiswal (2007) however indicated the size of the first instar nymphs to be of 0.6 mm long from head to abdomen (without antennae and caudal setae) and 0.25 mm brood at thorax. Exact citation was also made by Singh(2007).However ,the size recorded during the present study was relatively more which may be attributed to varied situations of lac ecosystem of Kaptipada,Orissa .

Fig. 13. : First instar nymph (crawlers) of *Laccifer lacca*

Fig. 14. : Ant forageing on lac infested arhar plant

Table 8 ***Biological attributes of lac insect on different host plants***

Sl. No.	Host plants	Date of Inoculation	Days taken for settling of crawlers	Days taken for issue of swarm	Remark
1	*Flemingia semialata*	11.2.09	1	-	Placed for 1 day
2	*Flemingia semialata*	11.2.09	1	-	Placed for 1 day
3	*Flemingia semialata*	12.2.09	1	5	Placed till completion of swarming
4	*Flemingia semialata*	12.2.09	1	5	Placed till completion of swarming
5	*Cajanus cajan*	11.2.09	1	-	Placed for 1 day
6	*Cajanus cajan*	11.2.09	1	-	Placed for 1 day
7	*Cajanus cajan*	12.2.09	1	-	Placed for 1 day
8	*Cajanus cajan*	12.2.09	1	-	Placed for 1 day
9	*Cajanus cajan*	13.2.09	1	7	Placed till completion of swarming
10	*Zizyphus mauritiana*	13.2.09	1	10	Placed till completion of swarming
			1	5-10 days	

Table 9. Morphometrical features of first instar Nymphs of Lac insect

Sl. No.	Length in mm	Width in mm	L/W Ratio
1	0.96	0.36	2.67
2	1.04	0.48	2.17
3	1.08	0.48	2.25
4	1.00	0.40	2.50
5	1.08	0.48	2.25
6	0.96	0.44	2.18
7	1.04	0.48	2.17
8	1.00	0.40	2.50
9	1.04	0.44	2.36
10	0.96	0.48	2.00
11	1.04	0.40	2.60
12	1.12	0.36	3.11
13	1.12	0.44	2.55
14	1.00	0.40	2.50
15	0.96	0.36	2.67
16	1.08	0.44	2.45
17	1.16	0.44	2.64
18	1.08	0.44	2.45
19	1.04	0.40	2.60
20	1.16	0.40	2.90
21	1.12	0.40	2.80
22	1.16	0.48	2.42
23	1.16	0.48	2.42
24	1.08	0.44	2.45
25	1.04	0.44	2.36
Mean	**1.06**	**0.43**	**2.48**
SD±	**0.066**	**0.040**	**0.247**

Table 10. Growth and development of lac insect on different host plants.

Sl. No.	Host plant	Date of Inoculation	Days taken for wax filament secretion	Days taken to over the nymphs entirely with wax filaments	Gap between initiation and total coverage of nymphs with white filaments	Days to secretion of maximum filament
1	*Flemingia semialata*	11.2.09	4	11	7	28
2	*Flemingia semialata*	11.2.09	3	11	8	29
3	*Flemingia semialata*	12.2.09	2	10	8	28
4	*Flemingia semialata*	12.2.09	2	10	8	28
5	*Cajanus cajan*	11.2.09	3	11	8	29
6	*Cajanus cajan*	11.2.09	3	12	9	30
7	*Cajanus cajan*	12.2.09	3	11	8	28
8	*Cajanus cajan*	12.2.09	3	11	8	29
9	*Cajanus cajan*	13.2.09	3	11	8	29
10	*Zizyphus mauritiana*	13.2.09	3	10	7	27
	Range		2-4	10-11	7-9	28-30

Table 11. Performance of lac insect on different host plants

Sl. No.	Host plant	Date of Inoculation	Days taken for Formation of distinct female cell	Date of	Days taken from Initiation of self inoculation	Remark
1	*Flemingia semialata*	11.2.09	34	6.7.09	145	Successfully completed L.C
2	*Flemingia semialata*	11.2.09	34	13.7.09	151	Successfully completed L.C
3	*Flemingia semialata*	12.2.09	35	13.7.09	156	Successfully completed L.C
4	*Flemingia semialata*	12.2.09	34	15.7.09	152	Successfully completed L.C
5	*Cajanus cajan*	11.2.09	-	-	-	Failed to survive
6	*Cajanus cajan*	11.2.09	-	-	-	Failed to survive
7	*Cajanus cajan*	12.2.09	-	-	-	Failed to survive
8	*Cajanus cajan*	12.2.09	-	-	-	Failed to survive
9	*Cajanus cajan*	13.2.09	-	-	-	Failed to survive
10	*Zizyphus mauritiana*	13.2.09	35	22.7.09	158	Successfully completed L.C

LC – Life cycle

The other salient observations on growth and development of the lac insects are presented in Table 10. It is revealed that within two to four days of inoculation the crawlers of the insects started secreting of waxy filaments, which continued until the completion of life cycle. Within 10 to 11 days irrespective of host plants, the nymphs were totally covered with waxy white filaments(Fig.11-B) and after 28 to 30 days of inoculations maximum filamentous secretion was noticed. Ten to 11 days after inoculation the nymphs were so covered with wax filaments that it was not possible to mark further growth and development. However towards the flag end of the crop the waxy secretion was very low and the female cells were distinctly visible. The female cells possessed three distinct pores which are covered with little filament. Bhagat (2007) reported that the living lac insects secret wax filaments throughout the life to check the blockage of pores. Initially the secretion is very fast but at the time nearer to maturity, it slow down. This is also an indication from which one can forecast probable time of emergence. Further the visual observation indicates the growth of waxy filament was comparatively lower in Arhar, *Cajanus cajan* compared to *Flemingia semialata* and *Zizyphus mauritiana*.This variation may be attributed to the suitability of the host. Arhar is a less preferred host compared to the other two.

Observation on survival of lac insects on the three different test hosts (Table 11) revealed that the insect could complete its life cycle successfully on *Flemingia semialata* and *Zizyphus mauritiana* where as it failed to complete its life cycle on *Cajanus cajan*. On *F. semialata* the distinct female cell were noticed 34 to

35 days after inoculation whereas on *Z. mauritiana* it took 35 days. On *F. semialata* self inoculation was observed at 145 to 156 days after inoculation whereas on *Z. mauritiana* self inoculation was observed at 158 days after inoculation indicating that the total life span of female insect is about 145 to 158 days. Jaiswal (2007) reported that the total life span of female insects in Jethwi (Summer) crop of Kusumi strain is 159 days and days taken to reach adult hood on the same crop in case of female is about 71 days. During the present investigation although the detailed stages of the insect could not be studied but it could be confirm that the lac insect under Bhubaneswar conditions could complete its life span and issued swarm in about 145 to 158 days which corroborates with the finding of the above worker. Although arhar has been reported as an alternate host for the lac insect (Zhou Chao Hong et al, 2001 ,Li zhenghong et. al., 2001 and Shi lei,1999) In the present investigation insects failed to survive which may be attributed to unfavorable ecological conditions like lack of irrigation extremely high temperature, age of the host plant and unsuitability of the variety.

Female cells

The lac cells of the female insects which were found isolated were spherical in shape with distinct pores with filamentous waxy threads secreted by the insects . In addition to these two branchial pore the anal tubercle was also distinctly visible . The female measured 0.33cm in dia weighing about 7.0 to15.0 mg with an average of 10.7mg (Table-12).It is estimated that about one lakh (97722) female cells will produce about 1kg of *lac* .Singh (2007) reported that the female insect is

larger than male, measuring 4-5 mm in length and has a pyriform body. The head, thorax and abdomen are not clearly marked and around 300,000 insects loose their life to produce one kg of lac resin. During the present investigation the female cells obtained were smaller in size (3.0- 3.5 mm) compared to the size of female cells reported by the author . Further ,it is estimated that about one lakh (97722) of only female cells will produce about 1kg of lac as against the reported figure of 300000 insects in general which may not include only female cells .

Table -12 Descriptive features of the female lac cells

Sl. No.	Dia (cm)	Weight (mg)	W/D ratio	No of cells required to produce 1 kg lac
1	0.35	13.00	37.14	76923
2	0.30	8.00	26.67	125000
3	0.30	7.00	23.33	142857
4	0.32	9.00	28.13	111111
5	0.35	11.00	31.43	90909
6	0.35	12.00	34.29	83333
7	0.30	9.00	30.00	111111
8	0.30	9.00	30.00	111111
9	0.30	8.00	26.67	125000
10	0.38	15.00	39.47	66666
11	0.36	14.00	38.89	71428
12	0.35	11.00	31.43	90909
13	0.30	8.00	26.67	125000
14	0.35	12.00	34.29	83333
15	0.30	10.00	33.33	100000
16	0.35	13.00	37.14	76923
17	0.34	12.00	35.29	83333
18	0.30	8.00	26.67	125000
19	0.33	11.00	33.33	90909
20	0.32	10.00	31.25	100000
21	0.34	11.00	32.35	90909
22	0.30	8.00	26.67	125000
23	0.34	11.00	32.35	90909
24	0.30	9.00	30.00	111111
25	0.30	7.00	23.33	142857
26	0.36	14.00	38.89	71428
27	0.37	13.00	35.14	76923
28	0.35	12.00	34.29	83333
29	0.37	14.00	37.84	71428
30	0.35	13.00	37.14	76923
Mean	**0.331**	**10.73**	**32.114**	**97722**
SD ±	**0.026**	**2.31**	**4.640**	**22245**

~~4.3.3~~ 4.3.3 Survival of lac insect on arhar

The lac insects was inoculated in 23 arhar plants but in non of the plant the insects could complete its life cycle although the inoculated plants exhibited varied level (heavy moderate and low) of infestation by the lac insects. The impact of the host plants on survival of lac insects after 45 days of inoculation (Table -13) revealed that only 12.9-46.0 per cent(Av.34.7%) of the insects survived on arhar which further declined to 7.2 to 8.2 per cent (Table 14) at 65 days of inoculation . Further the rate of survival was comparatively more on the host plants in the lower portion of the plant (8.2%) whereas on upper portion the survival rate was only 7.2 % . By 90 days after inoculation almost all the insect were found dead on the host plants.

Table 13 Extent of survival of lac insects on *Cajanus cajan* at 45 days after inoculation

Sample plants	Dead	Live	Total	Survival (%)
3	304	45	349	12.9
4	427	167	594	27.2
5	320	287	607	47.3
20	240	83	323	25.7
21	364	295	659	44.8
1	258	165	423	39.0
8	204	174	378	46.0
Mean	**302.4**	**173.71**	**476.1**	**34.7**
SD ±	**76.57**	**93.50**	**170.07**	**13.03**

Table 14 -Extent of survival of lac insects on *Cajanus cajan* at 65 days after inoculation

	Upper portion of the plant				**Lower portion of the plant**			
Sample plants	Dead	Live	Total	Survival (%)	Dead	Alive	Total	Survival (%)
3	129	15	144	10.4	137	7	144	4.9
4	172	14	186	7.5	347	36	383	9.4
5	385	44	429	10.3	412	57	469	12.2
20	46	4	50	8.0	293	9	302	3.0
21	157	3	160	1.9	218	16	234	6.8
1	363	22	385	5.7	436	87	523	16.6
8	191	13	204	6.4	327	15	342	4.4
Total								
Mean	**206.1**	**16.4**	**222.6**	**7.2**	**310.0**	**32.4**	**342.4**	**8.2**
SD ±	**123.82**	**13.81**	**137.63**	**2.93**	**105.37**	**29.89**	**135.26**	**4.80**

The effect of varied level of lac infestation on *Cajanus cajan* after 90 days of inoculation indicated that , there was a pronounced adverse effect of infestation by lac insects on growth and development of the arhar plant. The mean number of healthy branches on the host plants having heavy, low and no infestation were 8.2, 9.5 and 15.3 respectively(Table 15). Similarly the effect of lac insect infestation on length of branch indicated that in heavy, low and no infestation the mean length were 87.7, 106.6, and 137.0 cm respectively. In general it has been clearly perceived that being a sucking insect feeding by it

results in adverse growth of the host plant for which in scientific method of lac cultivation coupe system of cultivation is adopted to provided to adequate rest to the host plant for better lac production and quantum of brood stick for inoculation has also been standardized . However no such work on arhar plant has been done elsewhere to compare the finding.

Table 15 Effect of Lac insect infestation on *Cajanus cajan* at 90 days after inoculation

Sl.No	Level of infestation	Number of branches			Length of branches (cms)		
		n	Mean (no.)	SD ±	n	Mean (no.)	SD ±
1	Heavy	10	8.2	1.62	10	87.7	13.58
2	Low	10	9.5	1.58	10	106.6	7.73
3	No infestation (Healthy)	10	15.3	1.89	10	137	19.19

3.4 Natural Enemies of lac Insects

During the course of investigation four natural enemies(Table 16) were recorded on lac. In addition five different types of parasites associated with brood lac sticks were also collected during the course of investigation. Black ant (Fig.14) feeding on honey dew were also recorded which were more prevalent at the early stage of the infestation.

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Among the natural enemies recorded, the black moth *Pseudohypatopa (=Holcocera) pulverea* was predominant one followed by the white moth *Eublemma amabilis* Moore Besides the larva of green lace wing bug feeding on the first instar crawlers was noticed. A black beetle (Fig. 18-A) although recovered from the brood lac stick its exact nature of damage has sot been traced. It is interesting to note that the black

Table 16. Natural enemies of lac insects

Sl. No	Common Name	Scientific Name	Family	Order
1.	Big White moth	*Eublemma amabilis* Moore	Noctuidae	Lepidoptera
2.	Small black moth	*Pseudohypatopa (=Holcocera)pulverea* Meyr.	Blastobasidae	Lepidoptera
3.	Lace wing bug	*Chrysopa* sp.	Chrysopidae	Neuroptera
4.	Beetle	-	-	Coleoptera

moths also continue to emerge from the preserved scrapped lac in the laboratory which was prepared from the brood lac sticks collected on 10.2.2009. The white moth emergence continued upto 18.2.09 (9 days) while emergence of black moth continued up to 25.4.09 (67 days) from the same stock . Bhattacharya (2007) recorded occurrence of 14 insects predators as important insect predators of the lac insects. of which *Eublemma amabilis and Pseudohypatopa* are of the major concern. He also reported that two neuropterans as the most important predator

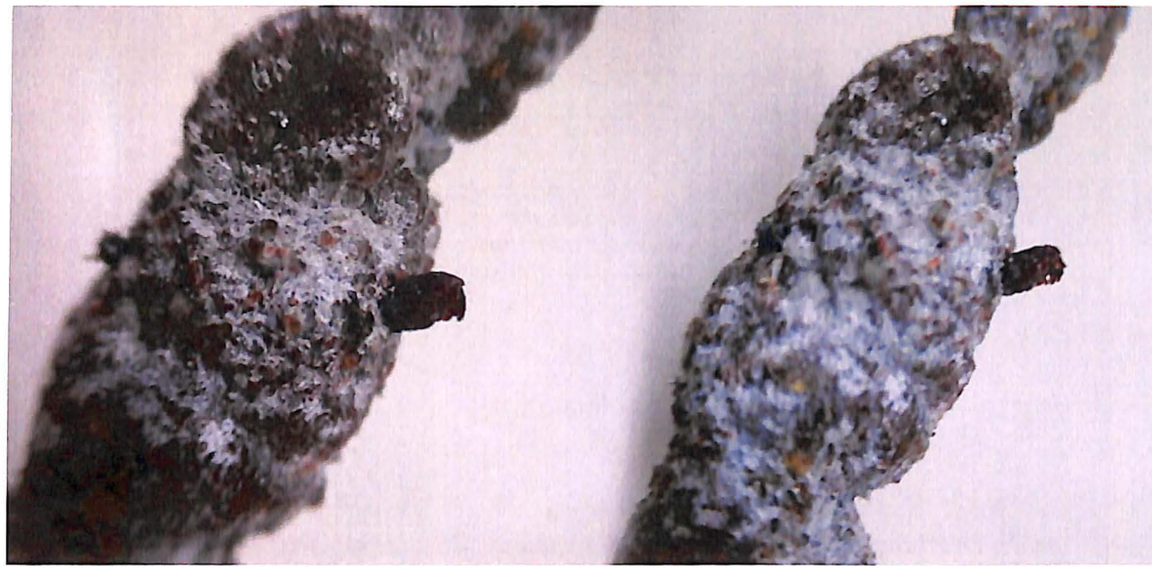
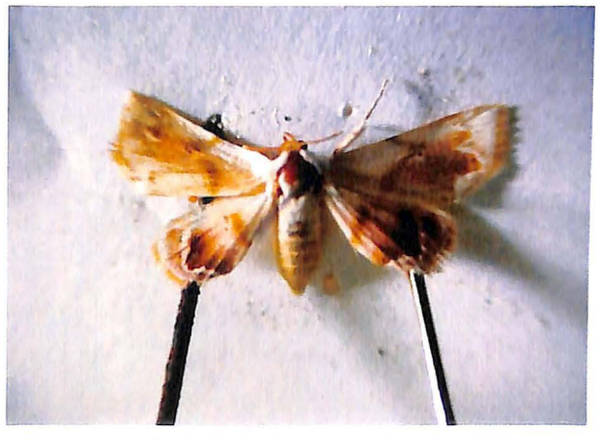


Fig. 15. : Half emerged pupal case of *E. amabilis* on brood stick

a. Ventral view b. Dorsal view



c. Adult with stretched wing

Fig. 16. : Adult moth of *E.amabilis*

a. Larvae

b. Adult moths

c. Adult moths with stretched wing

Fig. 17. : Predatory black moth *P.pulverea*, of lac consect

Table 17. Morphometrics of Adult moths of *E. amabilis* & *P. pulverea.*

Sl. No.	*E. amabilis*		*P. pulverea*	
	Body length (mm)	Length across spread wing (mm)	Body length (mm)	Length across spread wing (mm)
1	8	17.9	7.5	16
2	9	18	6	13
3	8.7	18	8	17
4	8.5	17.5	6.5	15
5	9.5	20.5	6.8	14.5
6	8.6	17.8	6.9	16.2
Mean	**8.72**	**18.28**	**6.95**	**15.28**

Table 18 No. of natural enemies emerged for broad lac

Sl. No.	Natural enemies	February						5.3.09	6.4.09	15.4.09	25.4.09
		14th	15th	16th	17th	18th					
1	White moth	1	-	2	1	2	Brood stick	Scarp	-	-	-
2	Black moth	1	2	4	-	2	used for	Lac	2	2	1
3	Beetle	1	-	-	-	-	innoculation	prepared	-	-	-
4	Parasites	14	8	22	23	2	on Arhar		-	-	-

In addition, during the course of investigations five species of parasites (Fig.18-b) were collected from the brood lac sticks. However, their exact host whether it is the parasitoid of the lac insect or its lepidopterous predators could not be confirmed. Excepting very minute one the braconids and other three parasitoids collected were much bigger than the first instar nymph of the lac insects. Presumably they are the parasitoids of the *Eublemma amabilis and Pseudohypatopa (=Holcocera) pulverea* , thus being beneficial one in the lac ecosystem. Sushila *et al* (1999 & 2000) reported 5 hymenopterus parasitoid attacking the predator of lac insect.

The specimens were send to Dr. T. Rajendran, Professor, Kerala Agriculture University, but it could not reach him due to postal dislocation.

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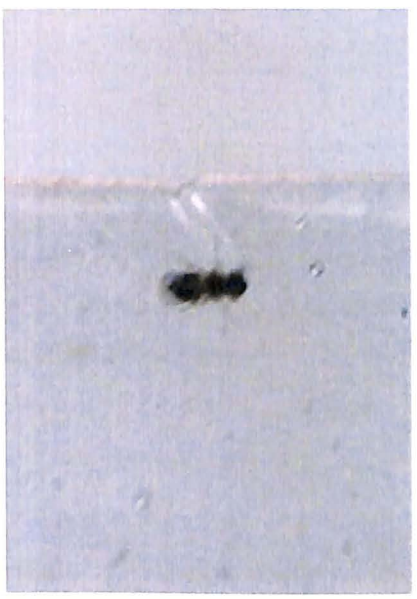
a. Black betle recovred form brood lac stick

b. Parasites emerged from brood lac, collected from Keshpada.

Fig. 18. : Natural enemies recovered from brood lac sticks

a. Black betle recovred form brood lac stick



b. Parasites emerged from brood lac, collected from Keshpada.

Fig. 18. : Natural enemies recovered from brood lac sticks

CHAPTER-5

Summary and Conclusion

Chapter -5

Summary and Conclusion

Lac ,the only natural resin of animal origin is secreted by a specialized group of insects called Lac insects. There are 19 species of lac insects found in India among which *Laccifer lacca* (=*Kerria lacca*) , Laciferidae: Hemiptera is the species most widely exploited for commercial lac production. At present our country is the largest producer of lac accounting for 50-60 per cent of total world's lac production. In early days, our state Orissa was a major lac producer which has been eroded to a very low level due to various reasons. Further, if the lac cultivation is completely abandoned its re-initiation is very difficult. Therefore, this piece of work entitled **"An explorative study on the lac insect, *Laccifer lacca* (Kerr.) in Orissa."** was undertaken during May,2008 to July,2009 with the objectives to survey the occurrence of lac insects in different agro climatic zones of Orissa ; survey the host plants of the lac insect in the state; study the activities of the natural enemies attacking lac insect in Orissa and to study the biology and behaviour of the lac insect in the laboratory and field conditions of Bhubaneswar. The salient findings of the present investigation are enumerated as follows.

1. The lac insect ,*Laccifer lacca* (=*Kerria lacca*) Lacciferidae:Hemiptera is presently cultivated in five tribal dominated inland districts of Orissa viz., Keonjhar, Koraput, Mayurbhanja, Nabarangapur, Sundargarh and in the

coastal district ,Balasore. Lac cultivation previously practiced in undivided Kalahandi and Sambalpur district is no more in voyage.

2. In Nabarangpur district out of 10 blocks ,lac cultivation is being practiced in four viz. Chandahandi, Raighar, Jharigaon and Umarkot blocks . In Chandahandi block it is cultivated in the village Fatiki, Karadunguri, Rajkot and Boitipada.

3. Concerted effort of the Government organization i.e., Tribal Co operative Marketing and Procurement Federation of India Ltd. (TRIFED)has enabled the tribals of village Elga of block Kutra and near by villages in Sundargarh district to go for improved lac cultivation. Using 10 kgs of brood lac per tree they harvest about 100-120 kg of lac sticks/tree/season, and sale the scrap lac at Rs. 80/- to Rs.100/- per Kg. and that of brood lac at Rs.120/- per Kg.

4. The lac grower of Keonjhar and Mayurbhanj adopting traditional method harvested only 8.0-20.0 and 10-25 Kg of lac/tree/season respectively while following the improve method, the farmers of Sundergarh harvested 100-120 Kg of lac/tree/season . Thus, scientific method of lac cultivation is highly remunerative. Government support can give a boost to lac production in the state.

5. In Orissa four host plants, Kusum (*Schliechera oleosa*) Palash (*Butea monosperma*) and Ber (*Zizuphus mauritiana*). Dimbiri (*Ficus hispida.*) are

utilized for lac cultivation .Among these hosts ,Kusum (*Schliechera oleosa*) is predominantly exploited in all the six lac growing districts of the state while Dimbri, *Ficus hispida* in addition to other hosts is used only in Mayurbhanj district. Besides , *Ficus glomerata* can also be utilized for successful lac cultivation in Nabarangpur. Dimbri, *Ficus hispida* as a host plant of lac in Orissa may be the first record.

6. The Valia, *Flemingia semialata* Roxb. ,a quick growing plant of family Leguminosae is identified as a suitable host for commercial cultivation of Kusumi lac by IINRG can very well be utilized for lac cultivation in Orissa. This plant can revolutionise the lac cultivation in the state as well as in the country if properly utilized.

7. The ideal period for collection of brood lac for raising *aghani* and *Jethwi* crop in our state is the month of July and February respectively.

8. The lac insect in conventional method of lac cultivation in the state preferred to settle and infest the twigs of 0.52 to 1.00 cm thick. The brood sticks of own crop utilized by the farmers for further inoculation are usually invigourous which accounts for low production of lac in this method. The brood sticks of about 12.64 cm. are normally used for fresh inoculation.

9. The lac insect *Laccifer lacca(Kerria lacca)* completed its life cycle successfully at Bhubaneswar on Valia, *Flemingia semialata* and Ber

(*Zizuphus mauritiana*) and issued swarm in 145 and 158 days after inoculation respectively while it failed on arhar (*Cajanus cajan).*

10. It is observed that the rate of issue of swarm of first instars nymph of the lac insect was more in the morning hour compared to afternoon hours and the insect preferred to settle on lower(Shaded portion) of the twigs. Further the nymphs preferred to settle towards the base of the plant rather than apical portion.

11. The first instar nymphs are pinkish red in colour and oval in shape with both the ends tapering more being towards the posterior end. Such nymph measured about 1.06 mm in length leaving aside the antennae and caudal setae and of 0.43 mm broad at thoracic portion of the body .The nymphs were about 2.48 times longer than their width. The female cells are reddish in colour spherical in shape and measured 0.33cm in dia weighing about 10.7 mg .

12. Infestation by lac insect reduced the number and length of the branches in arhar (*Cajanus cajan)* plant.

13. Two important predators viz., the black moth *Pseudohypatopa (=Holcocera) pulverea* Meyr. and the white moth *Eublemma amabilis* Moore attacked lac insect in Orissa of which the former one is more prevalent. Besides the larva of green lace wing bug feed on the first instar nymphs. About five species of parasitoids, a beetle and the black ant feeding on

honey dew are the other fauna associated with the lac insect directly or indirectly.

Conclusively , the lac , *Laccifer lacca* (=*Kerria lacca*) , Lacciferidae: Hemiptera is an insect of industrial importance having wide scope for cultivation in Orissa on the host plants like Kusum and Ber. The agro climatic conditions are very conducive too for the insect. Properly planned plantation of *Flemingia semialata,* management of the predators and support from Government agency will further improve the status and production of Lac in the state.

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