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Studies on lac host plant occurrence in different Agro-climatic zones of Madhya Pradesh

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Abstract
In the present study intensive surveys were undertaken in eleven Agro-Climatic Zones of Madhya Pradesh during the years 2014-15 to 2019-20 by Lac Co-operating Centre, State Forest Research Institute, Jabalpur (Madhya Pradesh) to find the natural occurrence of lac host plants and potential host plant sites to exploration of lac culture and *in-situ* conservation of hosts. It is revealed that 30 diverse lac host plant species occurrence was reported with 307 natural sites of host occurrence and 154 potential sites of host plants. The maximum number of potential sites with occurrence frequency 119 (77.29%) was reported in Palas (*Butea monosperma*) host followed by 30 (19.49%) of Kusum (*Schleichera oleosa*), 3(1.94%) of Ber (*Ziziphus mauritiana*) and 1(0.64%) of Ghont (*Ziziphus xylopyra*) species. In the context of occupied areas of host as per Agro-climatic zone, Seoni district under Kymore plateau and Satpura Hill occupied maximum 36(23.38%) sites of patches followed by Balaghat 37(22.73%) under Chhattisgarh Plain, Chhindwara 3(1.94%) of Satpura Hills zone, Shahdol 11 (3.24%) and Anuppur 3(1.94%) of Northern Hill region of Chhattisgarh. In the state commercial cultivation of lac is being done on Palas (*Butea monosperma*), Kusum (*Schleichera oleosa*) and Ber (*Ziziphus mauritiana* Lam.) host plants through traditional methods, farmers of this state are cultivating *rangeeni strain* on Palas (*Butea monosperma*) and Ber (*Ziziphus mauritiana* Lam.) host and *Kusumi strain* on Kusum (*Schleichera oleosa*) host, except for more potential sites not under cultivation but having good natural resources of host availability. The efforts should be made to expand lac cultivation on new identified sites to enhance livelihood to rural communities.

Keywords: lac host plants, occurrence, *butea monosperma*, *zizyphus mauritiana*, *ficus bengalensis* linn, *ficus racemosa* linn, agro-climatic zones

Introduction
Globally India and Thailand are main lac producing countries and India is producing about 80% of lac in the world contributing (Ramani, 2002) [17] and it continues to maintain its leadership in lac export despite the fluctuations in production. In India over 90% lac produced comes from the states of Jharkhand, Chhattisgarh, Madhya Pradesh, West Bengal, Maharashtra and Odisha. Jharkhand state is pre-dominated with lac host plants Palash, Kusum and Ber existing in forest and forest fringe villages which favours lac insect rearing in the state by the farmers. Lac insects are plant sap feeders (Sharma *et al.*, 2006) [21], Singh *et al.*, 2009) [24] therefore thrive well only on certain plant species known as lac hosts. More than 400 lac hosts have been observed throughout the world (Kapur, 1962) [11], (Varshney and Teotia, 1968) [27],(Varshney 1985) [26] and (Sharma *et al.*, 1997) [22].

Palash, Ber and Kusum are the most common hosts for commercial lac production in India (Roonwal, 1962) [18], Pal, 2009) [15] and (Mohanta *et al.*, 2012) [14], which are found in states of Jharkhand, Chhattisgarh, Madhya Pradesh, West Bengal, Maharashtra, besides a few others (Pal *et al.*, 2010) [16]. The various lac host plants in China are *Dalbergia sp.*, *Dalbergia obtusifolia*, *Ficus altissima* and *F. racemosa* (Chen *et al.*, 2010) [1] while *Z. mauritiana*, *Samanea saman*, *B. monosperma*, *Acacia nilotica* and *A. catechu* are the major lac host plants in Bangladesh (Ferdousee *et al.*, 2010) [2]. Lac insects thrive on twigs of certain plant species and get settled upon it, suck the plant sap and grow. The lac insect starts growing and also secretes resin from their bodies. The plants preferred for feeding and development are called host plants. Although lac insect is natural pest on host plant, these insects enjoy the privileged position not being treated as pest.

The major host plants of *K. lacca* include *palas, kusum, ber, Ficus spp.*, red gram (*Cajanus Cajan*) and *Flemingia semialata* (Sharma and Ramani, 2010) [20], Ghosh *et al.*, 2014, 2017) [4 &5]. Rangeeni and Kusami are two strains of commercial importance which produce two crops in a year. The two strains are found growing well on the known natural host *viz.*, Kusami on Kusum (*Schleichera oleosa*) and also on a few other trees but not on palas (*Butea monosperma*), whereas *Rangeeni* strain on palas and also on a few other trees but not on Kusum (Jaiswal and Bhattacharya, 2007) [7]. Madhya Pradesh is third largest lac producer and accounts for about 15% lac in our country.

Lac insects also infesting economically important plants *viz.*, Litchi (*Litchi chinensis),* Mango *(Mangifera indica),* Sandal (*Santalum album), etc.* are the direct target of pest management leading to erosion of the bio-diversity of lac insect and associated fauna and flora (Sharma *et.al.* 2010) [20]. Madhya Pradesh is ideal and has favourable climatic conditions for the existence of natural hosts of lac insect in the region. This region provides home for the natural survival of lac strain on its host plants which are abundantly grown in the forest area as well as in personal holding of farmers. The lac insect thrives naturally on these hosts and was

available in abundance on its natural host plants years back. But with advancement in Agriculture, indiscriminate deforestation and rapid industrialization, the natural existing host trees are depleting. Moreover, there is lack of awareness among local people about the existence of lac genetic resources on these host trees and they ignorantly destroy their natural habitat. It has this heritage has been associated with economy of tribal and poor people, providing them regular income in absence of other cash crops. To overcome the situation we need to record these hosts tree for creating awareness among farmers and to identify the potential sites of more host plant for cultivation the conservation of prevailing genetic resources of lac insect hosts plants.

Material & Methods

Survey of the lac host plant occurrence and potential areas of host plant in Madhya Pradesh was conducted by the Lac Co-operating Centre established at State Forest Research Institute, Jabalpur under Network project on '*Conservation of lac insect genetic resources'* funded by ICAR-Indian Institute of Natural Gum and Resin, Ranchi. Host plants potential areas were surveyed in 51 districts of Madhya Pradesh.

Prior to undertaking the survey work contact was made with local authorities. The districts many have some information about lac host plant potential areas. Thereafter, each forest range office in each block in various districts was visited to get information some sites were identified about lac insect and their host plant potential areas.

Information was also taken from traders and farmers in blocks. With this information some sites were identified in the state under undertaken from 2014-15 to 2019-20 in Madhya Pradesh under network project.

Host plant species were identified and GPS reading taken, source/habitat, frequency, plant material, population, sampling, habit, plant characteristics, insect/pest infection, disease symptoms, soil colour, soil type, land aspect, slope, topography, occurrence of lac insect, and plant utilization were noted as given in prescribed preformed. For the identification of lac host plant species, the 'Flora of Jabalpur' by Mathew Oommachan and Shrivastava, 1960) [13] and the 'Flora of Madhya Pradesh' by (Roy *et.al.*, 1992) [19]. The plant specimens were also collected and their identification was verified with the standard specimen kept in the herbarium of Lac Insect Museum, Lac Cooperating Centre, SFRI, Jabalpur. Names of the host species and number of individual species in each unit are recorded and percentage frequency and relative frequency calculated by the formula as given below

$$\text{Frequency} = \frac{\text{Number of the plots that contain the species}}{\text{Total number of plot used}} \times 100$$

$$\text{Relative frequency} = \frac{\text{Frequency of the species}}{\text{Total frequency of the all species}} \times 100$$

Results and Discussion

Intensive survey was conducted to lac host plant species occurrence and potential areas of host plant sites of lac host plant in 11 Agro-Climatic Zones of Madhya Pradesh. The present study was done in 2014-15 to 2019-20. In the state 319 blocks of 51 districts were surveyed and natural lac host occurrence were reported in 126 blocks. While in the survey, 154 sites were spotted where patches of host plant are present adequately. These sites marked as potential sites for lac cultivation as well as *in-situ* conservation of lac insects. These species were found occurring naturally in farmer's field, revenue lands, and forest lands. All technical information of the potential lac host sites of survey were documented in prescribed in passport data sheets. Lac host plant species diversity status In the survey total 30 diverse lac host plant species were documented as given in Table 1. Among these host species Palas (*Butea monosperma* (Lam.) Taub., Ber (*Ziziphus mauritiana* Lam.) and Kusum (*Schleichera oleosa*) are major host species and are beining use for commercial lac cultivation. Pipal (*Ficus religiosa*), Bargad (*Ficus benghalensis*), Gular (*Ficus racemosa* L.) and Ghont (*Ziziphus xylopyra*) host trees are not in commercial cultivation but it has been observed in few site, live lac insect conserved naturally on these host plants. The similar work are also in conformity with the previous findings by Swami, *et al.* 2017 [25] in other region and it's reported that Palas (*Butea monosperma* L.) Ber (*Zizyphus mauritiana* L. and *Zizipus jujube* L.), Pipal (*Ficus religosia* L.), Siris (*Albizzia lebbek* Denth), Custard apple (*Annona squamosa* L.), Khair (*Acacia catechu*), Arhar (*Cajanus cajan* L.) Gular (*Ficus racemosa* L.) Babool (*Acacia arabica*), Amaltas (*Cassia fistula* L.) and Bargad (*Ficus bengalensis* L.) were found as frequently prevailing major lac insect host plants in various regions of Rajasthan, Gujarat and Haryana states with varying densities. These findings also are in conformity with the findings of Singh and Chatterjee (1994) [23] and Kumar *et al.*, (2007) [7] reported *Butea monosperma*, *Zizyphus mauritiana*, and *Ficus religosia* as the major lac hosts. Similarly Jaiswal *et al.* (2003) [9] also reported that in lac growing states of Jharkhand, West Bengal and Orissa the maximum number of lac farmers utilized Ber trees followed by Palas (72%) and Kusum (57%) for the lac production which suggest them as major host of lac insect.

Table 1: List of total observed host plants with potential sites of species in Madhya Pradesh

S. No.	Host plant observed	Scientific name	Family
1.	Palas	*Butea monosperma* (Lam.) Taub.	Fabaceae
2.	Kusum	*Schleichera oleosa* (Lour.) Oken.	Sapindaceae
3.	Ber	*Ziziphus mauritiana* Lam.	Rhamnaceae
4.	Pipal	*Ficus religiosa*	Moraceae
5.	Bargad	*Ficus benghalensis*	Moraceae
6.	Gular	*Ficus racemosa* L.	Moraceae
7.	Akashmoni	*Acacia auriculiformis*	Fabaceae
8.	Bhalia	*Flemingia macrophyla*	Fabaceae
9.	Semialata	*Flemingia semialata*	Fabaceae
10.	Sitaphal	*Annona squamosa*	Annonaceae

11.	Babul	*Acacia nilotica*	Fabaceae
12.	Arhar	*Cajanus cajan*	Fabaceae
13.	Kher	*Acacia catechu*	Fabaceae
14.	Pakur	*Ficus rumphii*	Moraceae
15.	Wild banyan tree	*Ficus citrifloia*	Moraceae
16.	Jangle Jalebi	*Pithecellobium dulce*	Leguminaceae
17.	Ghont	*Ziziphus xylopyra* (Retz.) Wild.	Rhamnaceae
18.	Rain tree	*Albizia saman*	Fabaceae
19.	Kala siris	*Albizia lebbeck* (L.)Benth.	Fabaceae
20.	Safed siris	*Albizia procera*	Fabaceae
21.	Bija	*Pterocarpus marsupium*	Fabaceae
22.	Sandan	*Ougeinia oojeinensis*	Fabaceae
23.	Teak	*Tectona grandis*	Lamiaceea
24.	Tendu	*Diospyros melanoxylon*	Ebenaceae
25.	Galphoollo	*Flemingia strobilifera* (L.)	Fabaceae
26.	Chandan	*Santalum album* L.	Santalaceae
27.	Mango	*Mangifera indica*	Anacardiaceae
28.	Kassod	*Cassia siamea* Lam.	Fabaceae
29.	Churna	*Ziziphus rugosa*	Rhamnaceae
30.	Gudshakra	*Grawia sp.*	Tiliaceae

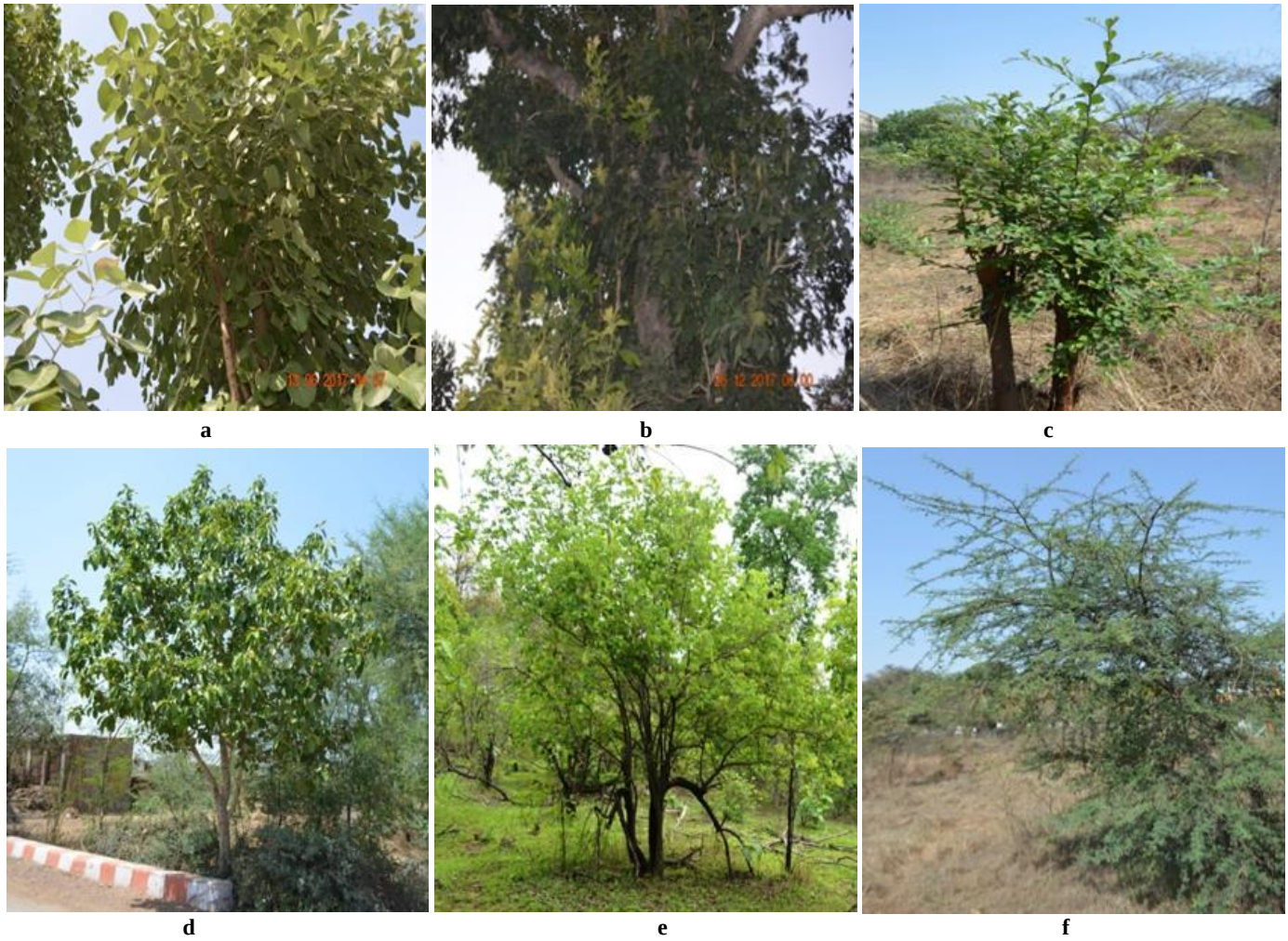

Fig 1: Depicting most occurring lac host plant species in Madhya Pradesh; (a). Palas (*Butea monosperma*), (b). Kusum (*Schleichera oleosa*), (c). Ber (*Zizipus mauritiana*), (d). Pipal (*Ficus religiosa*), (e). Babul (*Acacia niotica*), (f).*Ziziphus xylopyra* (Ghont)

Occurrence of lac host plant species and potential areas

These potential sites of host plants with their occurrence frequency (%) of host plants in agro-climatic zones wise are detailed in Table 3. The study revealed the that maximum number, 119 (77.29%) patches of Palas (*Butea monosperma*) were marked followed by 30 (19.19%) of Kusum (*Schleichera oleosa*), 12 (7.76%) Ber (*Ziziphus mauritiana*) and 1(0.64%) in Ghont (*Ziziphus xyloyra*). The similar work are in conformity

with the findings of Singh and Singh and Chatterjee (1994) [22] and Kumar *et al.* (2007) [12] who reported *Butea monosperma*, Zizyphus *mauritiana*, and *Ficus religosia* as the major lac hosts. Similarly, Jaiswal *et al.* (2003) [9] also reported that in lac growing states of Jharkhand, West Bengal and Orissa the maximum number of lac farmers (845) utilized ber trees followed by palas (72%) and Kusum (57%) for the lac production which suggest them as major host of lac insect. The pooled survey results of natural occurrence status and host plant potential sites are presented Agro-Climatic Zone wise (Table 2 & 3). The pooled survey results are discussed here as per agro-climatic region;

Chhattisgarh Plain: In this zone eight blocks of Balaghat (*viz.*, Balaghat, Lalbarra, Waraseoni, Katangi, Paraswara, Kirnapur, Khairlanji, and Lanjhi) were studied. These blocks are have potential in view of large natural occurrence of lac host palas, survey revealed that there are 35 (22.73%) potential sites of host *Butea monosperma* L. (Palas) plant marked followed by 2 (1.29%) sites of *Schleichera oleosa* (Kusum). (Kumar, 2007)[12] Observed that palas is one of the best host for *rangeeni* lac insect strain production which complete its life cycle twice in a year. This host species naturally occurs in natural forest, uncultivated land and road sides even in cultivated land. The work is also in conformity with previous workers (Vershney, *et. al.* 1968, Ghosal, 2012, Swami, *et. al.* 2017 and Jaiswal *et. al.* 2013) [26], [3] [24], [10].

Northern hill zone of Chhattisgarh: This is one of the leading zones of palas tree occurrence, singly this zone contributes for 28(28.57%) relative frequency of host plant occurrence, followed by Chhattisgarh plain (24.03%) in areas under cultivation of lac, hence these areas offer good opportunity for farmers for using palas trees for lac cultivation.

Five districts were surveyed where potential sites of *Butea monosperma* L. (Palas) were observed. In Mandla district, 16.23% relative host plant frequency was observed, among these 25(14.94%) sites covered by *Butea monosperma* L. (Palas) followed by 1(0.64%) *Schleichera oleosa* (Kusum) and 1(0.64%) *Ziziphus mauritiana* (Ber) occurrence observed. In Dindori district (4.54%) relative frequency of host plant was observed in 3 blocks, 5(3.24%) potential sites of *Schleichera oleosa* (Kusum) and 2(1.29%) sites covered by *Butea monosperma* L. (Palas). In Shahdol district only single species *Butea monosperma* L. (Palas) occurrence were observed in 5(3.24%) different blocks with 3.24% relative frequency. Anuppur district is one of richest area in the context of palas and ber occurrence, many farmers are doing cultivation for longer period and making their livelihood better, 4(2.59%) potential sites of host plants were identified in this district, where palas accounted 3 (5.55%) sites for potential sites for lac and 1(0.64%) of Ber (*Ziziphus mauritiana*). In Umaria 3(1.94%) sites of *Butea monosperma* L. (palas) were found.

Kymore plateau and Satpura hill: This zone rich in palas patch potential sites, this zone contributed 43(27.92%) relative frequency of host plant *viz.*, Palas, Ber, Kuusm, Ghont occurrence.

In the survey of Jabalpur 2(1.29%) sites was of palas host plant were reported, in Katni district Palas 1(0.64%) and 1(0.64%) noted. In Seoni district 34(22.08%) potential sites of palas were reported and this site singly contributed 16 % of the total lac production of the country, Seoni district of the state being largest contributor of 41.6 per cent (Kumar, 2013). District panna is also having good potential of host with 3(1.94%). In Rewa there is host plant occurrence found randomly but no potential site for commercial cultivation of lac.

Vindhyan Plateau: Sagar, Damoh, Bhopal, Raisen, Sehore and Vidisha districts were surveyed but did not find any potential sites of host except Raisen district, 8 blocks under this district was surveyed and 1(0.64%) site of Kusum patch having good potential to cultivate kusumi lac were found.

Central Narmada valley: Good potential in Kusum (*Schleichera oleosa*) host plant occurrence, under this zone Narsinghpur, Hoshangabad and Harda districts were surveyed and 6 sites (3.89%) in Narsinghpur and 10 (6.49 %.) in Hoshanghabad were found with high occurrence. Kusum was found scattered in forest and farmer's field. Kusum plant is very promising host plant of Kusmi strain lac insect *Kerria lacca*. Kusmi strain lac insect completes their life cycle twice in a year (both are of six months) and produces best quality of lac of the world, it can be propagated through seed and by air layering (Kumar, 2013) [12].

Gird Zone: In this zone, 34 blocks of 7 districts were surveyed but no significant potential pockets were found, however Palas, Barged, Pipal were reported randomly in scattered manner.

Bundelkhand zone: In this zone 18 blocks of 3 districts *viz.*, Datia, Chatterpur and Tikamgarh were surveyed, but no significant potential pockets were found, except a site of Tikamgarh where palas patch was identified. However Palas, Pipal were reported randomly in revenue land and farmer's field. Malwa Plateau region: Malwa Plateau regions known for good soil fertility and agriculture production but for lac cultivation there is lack of potential host plant sites, except 1(0.64%) site of palas at Indore region. The intensive survey work was carried out in 53 blocks of 10 districts in Malwa plateau regions but there is random presence of host plant like Palas, Pipal, Ber and Barged.

Satpura hills: Chhindwara and Betul districts were studied 18(7.14%) relative abundance was noticed. In Chhindwara, 11 blocks were observed and 3(1.94%) potential sites of Kusum (*Schleichera oleosa*) host plant and 7 blocks were surveyed in Betul district 4(2.59%) potential sites of Palas were reported.

Nimar valley: 25 blocks of 4 districts like Khandwa, Khargone, Badwani, and Burhanpur were surveyed, but no potential sites were observed. However Palas and Pipal host were observed in few areas but with insignificant population that cannot be explored for commercial lac production.

Jhabua hill: In this zone 6 blocks of Jhabua and 3 blocks of Alirajpur district were surveyed but no potential site of host plants were found, except presence of Pipal and Gular hosts.

The similar work is also in conformity with previous workers (Swami, *et. al.* 2017) [24] and (Jaiswal *et. al.* 2013) [10].

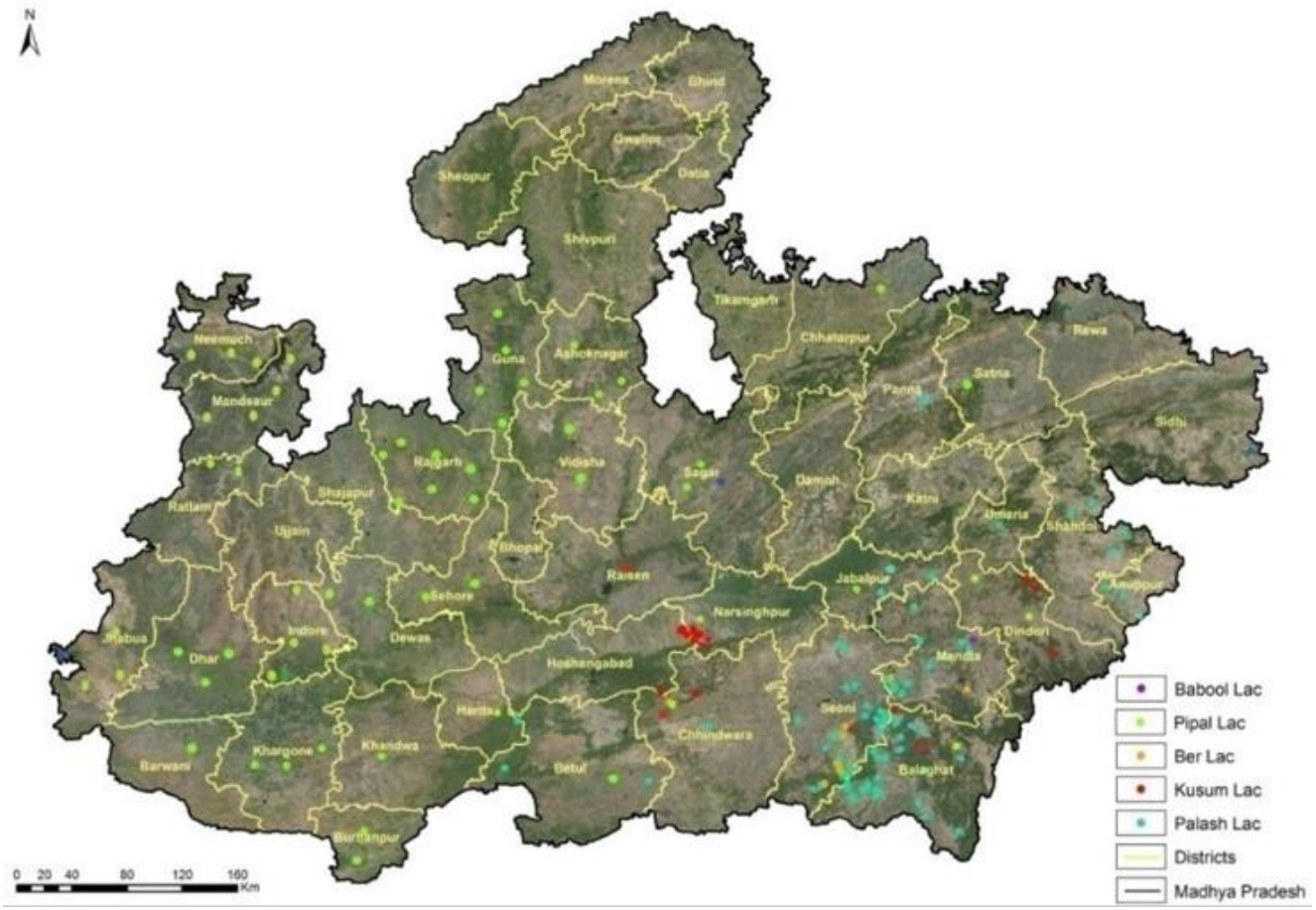

Fig 2: Depicting occurrence of lac host plant in Madhya Pradesh

Table 2: Occurrence of Lac host plant species Agro-climatic zone wise in Madhya Pradesh

Agro-climatic zone	Districts	Surveyed blocks	Host plant observed
Chhattisgarh Plain (I)	Balaghat	Lalbarra,Waraseoni, Katangi, Paraswara, Kirnapur, Khairlanji, Balaghat, Lanjhi	Butea monosperma (Lam.) Taub, Schleichera oleosa (Lour.) Oken, Ziziphus mauritiana Lam., Diospyros melanoxylon, Annona squamosa, Acacia catechu, Albizia lebbeck (L.) Benth, Albizia lebbeck (L.) Benth. Ficus religiosa Ficus benghalensis
Northern hill zone of Chhattisgarh (II)	Mandla	Mandla, Niwas, Narayanganj, Bijadandi, Nainpur, Ghughri, Mohgaon, Bichhiya, Bijadandi, Mawai, Ghughri,	Butea monosperma (Lam.) Taub. Schleichera oleosa (Lour.) Oken, Ziziphus mauritiana Lam., Sitapha, Ficus racemosa L., Tectona grandis, Acacia nilotica, Ficus religiosa, Diospyros melanoxylon, Annona squamosa, Ficus benghalensis
	Dindori	Bajag, Dindori, Shahpura, Shahpur, Amarpur, Karanjia, Mehadwani, Samnapur	Schleichera oleosa (Lour.) Oken., Ficus religiosa, Ziziphus mauritiana, Butea monosperma, Ghont Lam.
	Shahdol	Jaitpur, Gohparu, Jaisinghnagar, Burhar, Beohari, Sohagpur	Butea monosperma (Lam.) Taub, Schleichera oleosa (Lour.) Oken.,Ficus religisa, Ficus bengalansis
	Anuppur	Jaithari, Anuppur, Kotma, Pusparajgarh	Butea monosperma (Lam.) Taub., Ziziphus mauritiana Lam., Ficus religiosa
	Umaria	Pali, Umaria, Nowrozabad, Karkeli	Butea monosperma (Lam.) Taub., Ficus religiosa
Kymore plateau and Satpura Hill (III)	Jabalpur	Jabalpur, Kundam, Barela	Butea monosperma (Lam.) Taub, Schleichera oleosa (Lour.) Oken., Ziziphus mauritiana Lam., Ficus religiosa Ficus benghalensis, Diospyros melanoxylon, Acacia nilotica, Ficus recemosa
	Katni	Katni, Rethi, Badwara, Bahoriband, Vijayraghavgarh, Dhimarkheda	Butea monosperma (Lam.) Taub., Ziziphus mauritiana Lam., Ficus benghalensis, Ficus religiosa, Dispyrous malaxylon
	Seoni	Barghat, Kurai, Seoni, Keolari, Lakanadon, Dhanora, Chhapara	Butea monosperma (Lam.) Taub, Schleichera oleosa (Lour.) Oken, Ziziphus mauritiana Lam., Schleichera oleosa (Lour.) Oken., Acacia auriculiformis, Diospyros melanoxylon, Annona squamosa, Dispyrous malaxylon
	Rewa	Rewa, Govindgarh, Gangeo, Jawa, Sirmour, Naigarhi, Hanumana, Mauganj	Butea monosperma (Lam.) Taub, Ficus religiosa, Ficus benghalensis, Acacia nilotica, Ziziphus mauritiana Lam., Albizia procera, Albizia lebbeck (L.)Benth.

	Panna	Devendranagar, Ajaigarh, Gunore, Pawai, Sahanagar	Butea monosperma (Lam.) Taub, Schleichera oleosa (Lour.) Oken., Ziziphus mauritiana Lam.
	Sidhi	Rampur, Sidhi, Kusmi, Majhauli	Butea monosperma (Lam.) Taub, Ficus benghalensis, Ficus religiosa, Albizia procera, Albizia lebbeck (L.) Benth., Ficus racemosa L., Ziziphus mauritiana Lam.,
Vindhyan plateau (IV)	Sagar	Sihora, Sagar, Rahatgarh, Garhakota, Banda, Bina, Deori, Malthone, Jaisinghnagar, Kesli, Khurai, Shahgarh	Butea monosperma (Lam.) Taub., Albizia saman, Ficus religiosa, Ficus benghalensis, Albizia lebbek
	Damoh	Singrampur, Jaora, Damoh, Batiyagarh, Hatta, Patera, Patharia, Tendukheda	Ziziphus xylopyra (Retz.) Wild., Butea monosperma (Lam.) Taub.Ficus Religiosa
	Bhopal	Phanda, Berasia	Butea monosperma (Lam.) Taub., Albizia saman, Ficus religiosa, Acacia nilotica,
	Raisen	Dehgaon, Badi, Begamganj, Obedullaganj, Sanchi, Silwani, Udaipura, Raisen	Butea monosperma (Lam.) Taub., Schleichera oleosa (Lour.) Oken., Ziziphus xylopyra (Retz.) Wild.
	Sehore	Sehore, Asta, Budhni, Nasrullaganj, Ichhawar	Butea monosperma (Lam.) Taub., Ficus religiosa, Albizia saman, Ficus benghalensis
	Vidisha	Vidisha, Sirnonj, Basoda, Gyaraspur, Kurwai, Lateri, Nateran	Ficus religiosa, Fiicus Bengalansis, Butea monosperma
Central Narmada valley (V)	Narshinghpur	Gadarwara, Chichli, Chawarpatha, Kareli, Narsinghpur, Saikheda	Schleichera oleosa (Lour.) Oken., Ziziphus mauritiana Lam., Butea monosperma (Lam.) Taub., Ficus religiosa, Diospyros melanoxylon, Ziziphus xylopyra (Retz.) Wild.
	Hoshangabad	Pipariya, Bankhedi, Babai, Pipariya, Babai, Seonimalwa, Sohagpur	Schleichera oleosa (Lour.) Oken., Butea monosperma (Lam.) Taub., Acacia catechu, Ziziphus mauritiana Lam., Pithecellobium dulce, Annona squamosa, Ficus religiosa, Ficus benghalensis
	Harda	Timarni	Ficus religiosa, Butea monosperma (Lam.) Taub., Acacia catechu
Gird Zone (VI)	Gwalior	Gwalior, Bhitarwar, Dabra, Ghatigaon	Ziziphus mauritiana Lam., Acacia catechu, Ficus religiosa, Ficus rumphii, Ficus racemosa L.
	Guna	Guna, Rathihai, Kumbhraj, Binaganj, Maksudanganj	Ficus religiosa, Ziziphus mauritiana Lam., Acacia catechu
	Ashoknagar	Mungwani, Sadora, Ashoknagar, Chanderi	Ficus religiosa, Ficus Bengalansis, Butea monosperma
	Morena	Ambah, Porsa, Kolaras, Paharagarh	Ziziphus mauritiana Lam., Acacia catechu, Ficus religiosa, Ficus rumphii
	Shivpuri	Shivpuri, Kolaras, Pohri, Shivpuri, Badarwas, Karera, Khaniyadhana	Ficus religiosa, Ficus benghalensis, Butea monosperma (Lam.) Taub. Ziziphus mauritiana
	Sheopur	Karahal, Sheopur, Vijaypur	Butea monosperma (Lam.) Taub., Ficus religiosa,
	Bhind	Ater, Lahar, Mehgaon, Raun, Gohad	Ziziphus mauritiana Lam., Acacia catechu, Ficus religiosa, Ficus rumphii, Ficus religiosa
Bundelkhand zone (VII)	Datia	Bhander, Datia, Seondha	Butea monosperma (Lam.) Taub., Ficus religiosa, Zizyphus mauritiana, Acacia nilotica
	Chhatarpur	Lavkushnagar, Bada Malhera, Bijawar, Buxwaha, Chhatarpur,Gaurihar, Nowgaon, Rajnagar	Butea monosperma (Lam.) Taub., Ziziphus mauritiana Lam., Zizyphus mauritiana, Acacia nilotica
	Tikamgarh	Teonthar, Baldevgarh, Tikamgarh, Jatara, Prathvipur,Niwari, Palera	Butea monosperma (Lam.) Taub.Ficus religiosa, Ficus Bengalansis, Zizyphus mauritiana, Acacia nilotica
Satpura Plateau (VIII)	Chhindwara	Chhindwara, Tamia, Jamai, Jumnardev, Panduna, Parasia, Sausar, Bichua, Amarwara, Harai, Damua	Schleichera oleosa (Lour.) Oken, Butea monosperma (Lam.) Taub., Ziziphus mauritiana Lam., Ficus religiosa, Ficus benghalensis, Ziziphus xylopyra (Retz.) Wild., Annona squamosa, Acacia auriculiformis
	Betul	Shahpur, Amla, Ather, Ghoradongri, Bhimpur, Prabhat Patan, Betul	Butea monosperma (Lam.) Taub., Schleichera oleosa (Lour.) Oken., Ziziphus mauritiana Lam., Ficus religiosa
Malwa Plateau (IX)	Indore	Hatod, Mhow, Indore and Sanwer	Ficus religiosa, Butea monosperma (Lam.) Taub, Ficus bengalansis
	Ujjain	Ghatia, Mahdipur, Tarana, Khachrod, Badnagar	Butea monosperma (Lam.) Taub, Ficus religiosa, Albizia saman, Albizia lebbeck (L.)Benth.
	Neemuch	Manasa, Neemuch, Rampura	Ficus religiosa, Zizyphus maritiana
	Dhar	Rajgarh, Sardarpur, Badnawar, Bagh, Dharmpuri, Gandhwani, Kuksi, Manawar, Nalchha, Nisarpur,Tirla, Umarban	Ficuss religiosa, Butea monosperma (Lam.) Taub.
	Mandsaur	Bhanpur, Mandsaur, Shamgarh, Dalonda, Malhargarh	Ficus religiosa, Butea monosperma (Lam.) Taub., Ficus benghalensis, Ziziphus mauritiana Lam., Acacia catechu, Acacia nilotica
	Dewas	Sonkakch, Shipra, Bagli, Kannod, Khategaon, Tonkhurd	Butea monosperma (Lam.) Taub., Ficus religiosa, Albizia saman, Ficus benghalensis
	Ratlam	Jaora, Bajna, Alot, Piplonda, Ratlam	Ficus religiosa, Ziziphus mauritiana Lam., Acacia nilotica
	Rajgarh	Sarangpur, Khilchipur, Jirapur, Pachore, Narsimhgarh, Rajgarh	Ficus religiosa, Ziziphus mauritiana Lam., Acacia catechu

	Agar-Malwa	Agar, Badod, Nalkheda, Sunser	Ficus religiosa, Acacia nilotica, Acacia catechu, Zizyphus mauritiana
	Shajapur	Shajapur,Sujalpur,Kalapipal,	Ficus religiosa, Acacia catechu, Zizyphus mauritiana
Nimar Valley (X)	Khandwa	Bhikangaon Khandwa, Baladi, Chhegaon, Makhan, Harsud, Pandana, Punasa	Butea monosperma (Lam.) Taub., Ficus religiosa
	Khargone	Segaon, Bhikangaon, Barwaha, Bhagwanpura, Goganwa, Kasrawad, Maheshwar, Ziranya	Butea monosperma (Lam.) Taub., Ficus religiosa
	Badwani	Barwani, Niwali, Pansemal, Pati, Sendhwa, Thikri	Ficus religiosa, Butea monosperma (Lam.) Taub.
	Bhuranpur	Bhuranpur, Nepanagar	
Jhabua Hill (XI)	Jhabua	Jhabua, Meghnagar, Petlawad, Ranapur, Thandla, Rama	Ficus religiosa, Butea monosperma
	Alirajpur	Alirajpur, Bharva, Jobat	Ficus religiosa, Albizia lebbek, Butea monosperma, Annona squamosa

Table 3: Agro-climatic zone wise host plant occurrence in Madhya Pradesh

Agro-climatic zone	District	Surveyed blocks (Nos.)	Host plants Observed	Potential sites of host plants (Nos.)	Frequency of host plant occurrence (%)	Total potential sites of host plants (Nos.)	Relative Frequency (%)
Chhattisgarh plains (I)	1. Balaghat	8	Palas	35	22.73	37	24.03
			Kusum	2	1.299		
		8		37	24.02	37	24.03
Northern hills zones of Chhattisgarh (II)	1. Mandla	11	Palas	23	14.94	25	16.23
			Ber	1	0.649		
			Kusum	1	0.649		
	2. Dindori	8	Kusum	5	3.247	7	4.545
			Palas	2	1.299		
	3. Shahdol	6	Palas	5	3.247	5	3.247
	4.Anuppur	4	Palas	3	1.948	4	2.597
			Ber	1	0.649		
	5. Umaria	4	Palas	3	1.948	3	1.948
		28		44	28.57	44	28.56
Kymore plateau of Satpura hills (III)	1.Jabalpur	3	Palas	2	1.299	2	1.299
			Pipal				
	2. Katni	7	Palas	1	0.649	2	1.299
			Ghont	1	0.649		
	3. Seoni	7	Palas	34	22.08	36	23.38
			Ber	1	0.649		
			Kusum	1	0.649		
	4. Panna	5	Palas	3	1.948	3	1.948
		34		43	27.92	43	26.62
Vindhyan Plateau (IV)	1.Sagar	8	Pipal				
	2.Raisen	8	Kusum	1	0.649	1	0.649
		32		1	0.64	1	0.64
Central Narmada velley (V)	1.Narsinghpur	6	Kusum	6	3.896	6	
	2.Hoshangabad	8	Kusum	10	6.494	10	6.494
	3.Herda	1	Pipal	1	0.649	1	0.649
		15		17	11.03	17	7.14
Malwa Plateau (XIII)	1.Indore	4	Palas	1		1	0.649
		53		1		1	0.64
Satpura hills (IX)	1.Chhindwara	11	Palas	3	1.948	7	4.545
			Kusum	4	2.597		
	2.Betul	7	Palas	4	2.597	4	2.597
		18		11	7.14	11	7.14

Conclusion

It is concluded that natural flora part of central and western plateau of agro-ecological region are significant importance as these state are habitat of important lac host trees on which the lac insects thrive naturally and the preliminary study revealed thirty diverse species of host trees preferred by the lac insects in this state. Palas (*Butea monosperma*), Kusum (*Schleichera oleosa*), Ber (*Ziziphus mauritiana*) and *Ficus* species are the most occurring host species, which are found abundantly in Eastern and Central parts of state. Palas (*Butea monosperma*) major host found abundantly in Chhattisgarh plains, Northern Hills of Chhattisgarh and Kymore Plateau and Satpura Hills whereas Kusum (*Schleichera oleosa*) found in Central Narmada Valley and Satpura Hills zone of state. Ber (*Ziziphus mauritiana*) also

found abundantly in Seoni and Balaghat districts. *Ficus species* reported throughout the state, where few sites reported with live lac insect conserved naturally. In view of abundant availability of naturally grown lac host plants, lac cultivation has good scope in the region and this biodiversity could be better utilized for the natural conservation of lac insects. Efforts should also be made for the local conservation of local hosts and strains of lac insects available by creating awareness and popularizing the lac cultivation in the region.

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