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Incidence of insect pests during storage of lac under different structure

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Abstract
Pseudohypatopa (Holcocera) pulverea Meyr (Lepidoptera; Blastobasidae) and *Eublemma amabilis* Moore (Lepidoptera; Noctuidae) were the only two insect pests found in stored lac samples collected from nine different categories of lac traders and storage structures from Barghat block, Seoni district during 2015-2016.The mean larval population of *P. pulverea* and *E. amabilis* per 50 g stored lac samples was found highest 2.30 and 2.37 in month of November 2015, respectively. The larval population of *P. pulverea*and *E. amabilis* are absent in month of September 2015, January and February 2016. Mean monthly population (Larvae + Pupae) of *P. pulverea* and *E. amabilis* were recorded in August 2015 to February 2016 from the (50) g stored lac samples. *P. pulverea* was absent in samples of stored lac collected during the month of September 2015, January and February 2016 in all storage structures. The mean (larval + pupal) population of *P. pulverea* was highest (7.67) in month of November 2015 followed by December 2015 (7.33), October 2015 (7.33) and August 2015 (6.00) in Pucca storage structures. *E. amabilis* was not found in the stored lac collected during the month of September 2015, January and February 2016. However the mean (larval + pupal) population of *E. amabilis* was highest (7.31) in the month of December 2015 followed by November 2015 (7.00), August 2015 (7.00) and October 2015 (6.67) in Pucca storage structures.

Keywords: *Pseudohypatopa pulverea, Eublemma amabilis,* lac traders, Storage structure

1. Introduction
Lac is cultivated as a cash crop in different countries of south, southeast and east Asian countries including India, China (Ramani *et al*., 2007) [18]. It is only the resinous compound of animal origin with great economic importance due to its safety for human use, renewable and ecosystem friendly source of different chemicals (Ranjan *et al*., 2011) [19]. It is secreted by phytophagous scale insect *Kerrialacca* Kerr belonging to the family Tachardiidae (Kerriidae) andorder Hemiptera (Ahmad *et al*., 2012) [1]. Common lac host trees especially *Buteamonosperma*, *Zizyphus mauritiana* and *Schleicheraoleosa* are usually found on undulating landscape in rainfed area (Ogle *et al*., 2006) [13]. Lac insects are reported to have 400 host plant species in the world (Sharma *et al*., 1997) [21], while in India there are 113 species (Roonwal *et al*., 1958) [20]. *K. lacca* is a scale insect belonging to order Hemiptera, Sub order- Homoptera, Super family- Coccoiddae, Family -Laciferridae. *K. lacca* are exploited for their product of commerce viz. resin, dye, and wax. Cultivation of lac not only provides livelihood to millions of lac growers, but also helps in conserving vast stretches of forest and bio-diversity associated with lac insect complex. Lac ecosystem is complex multi - trophic web of flora and fauna. Twenty two species of lac predators, 30 species of primary and 45 species of secondary parasites, beside several fungal pathogens, represent a rich bio-diversity of this ecosystem. Moreover, this natural lac complex also maintains a variety of other tree flora, micro-fauna and soil micro-organisms. Several of the insect of the fauna associated with lac insect are species - specific (exclusive to the ecosystem) and hence, loss of even one species of lac insect poses a danger losing many other related species (Sharma *et al*., 2006). There are two strains of lac insect viz., *Rangeeni* and *Kusmi*. Each strain is specific to particular host trees, having different life cycle and produces different body extracts but morphologically is too similar to be separated into different species. *Rangeeni*strain is specific to *B. monosperma* and *Z. mauritania*, and the *Kusmi* strain is specific to *S. oleosa*. The lac produced by the *kusmi*strain is of higher quality (Dwivedi, 1993) [5].
India is the largest producer of Lac in the world, followed by Thailand, Indonesia, China, Vietnam and Burma (Ogle *et al.*, 2006) [13]. India has a share of 62 per cent of the world production of 44,000 m tons. India export lac and its products worth Rs 15,262 lakh

(Ogle *et al.*, 2006) [13]. Lac is produced mostly by tribal, in the states of Jharkhand, West Bengal, Chhattisgarh, Madhya Pradesh, Orissa, Maharashtra and part of Uttar Pradesh, Andhra Pradesh, Gujarat and NEH region (Pal *et al.*, 2010) [15]. On an average around 28 per cent of total agriculture income is contributed by lac cultivation and more than 80 per cent of lac produced in India is exported (Chamberlin, 1923 [3]; Prasad *et al.*, 2004 [16]; Pal *et al.*, 2010 [15]; Ramani*et al.*, 2010) [17].The annual lac production of the country varied from 18000 tons (Prasad et al, 2004) [16], 23,229 tons (Pal *et al.*, 2007) [14] and 21,935 tons (Pal *et al.*, 2010) [15]. On the basis of survey in the markets of different lac producing districts and states, the estimated national production of lac during 2013-14 was approximately 21,008 tons (Yogi *et al.*, 2014) [23].

Madhya Pradesh is traditionally a Lac production centre of the country since late 19th century and early 20th century (Ogle *et al.*, 2006) [13]. In MP, Jabalpur division is the major producer of lac. Balaghat and Seoni districts in Jabalpur division are the largest producer of lac in the state. Anuppur district is the largest producer and seller of brood lac in MP. In MP, (Jaiswal *et al.*, 2008) [10] observed that Seoni district contributed maximum in the lac production (41.6 %) followed by Balaghat (30.6 %), Hosangabad (8.4 %) and Mandla (7.0 %).

Biotic and abiotic stress are the two factors responsible for yield reduction of lac crop. Predators and parasitoids are the biotic stress factors, while weather factors create abiotic stress. *Eublemmaamabilis* Moore (Lepidoptera; Noctuidae), *Psuedohypatopa pulverea*Meyr (Lepidoptera; Blastobesidae) and *Chrysopalacciperda*Kimmins and *Chrysopamadestes* Banks (Chrysopidae; Neuroptera) are the major predators *(*Sharma *et al.*, 2006) [21]. Predators cause around 35 to 40 per cent loss to lac production (Glover, 1937 [6]; Jaiswal*et al.*, 2008 [10]) while 5 to 10 per cent damage by parasitoids (Varshney, 1976) [22]. The predator *Pseudohypatopapulverea*are destructive predator of lac insects and found in all lac growing areas of the country. It feeds on the live and dead lac insects and is found in large numbers in stored lac and so it is responsible for the qualitative and quantitative deterioration of stored lac. Larval stages feed on the lac larvae and spin a loose web. A single larval predator is capable of destroying 45-60 mature lac cells (Chattopadhyay, 2011) [4]. Lac suffers losses both during the production and storage. There are numerous studies on the production losses of lac in the field. Unfortunately this export commodity reaches the port or origin of export after a process of storage and trading. Storage loss of lac is not seriously studied earlier in spite of the fact that India is the largest producer and exporter of lac in the world. Therefore the present investigation was carried to see the incidences of pest during storage of lac.

2. Materials and Methods

The present research was conductedin different categories of lac traders of Barghat block, Seoni district, M.P, from July 2015 to February 2016, as well as in the laboratory of Department of Entomology JNKVV, Jabalpur M.P. The study was planned under Split plot design, with 3 replications (lac samples/factor) and 3 main factor (Storage conditions) and 3 sub factors (lac traders). The details are the mentioned in (Table 1).

The observations were recorded from stored lac in laboratory in weekly during Aug.2015-Feb.2016 for the study. The observations were recorded the following parameter as given below-

Table 1: Details of the Experiment

Commodity		Stored Lac samples
Design		Split Plot Design
Total no. of Lac traders		09
No. of main factors (storage conditions)		03
No. of sub factors (lac traders)/ main factors		03
No. of replication		03
Stored Lac samples/factor/replication		50 g
Total no. of samples		27 / Month (Seven months)
Duration of the study		August 2015 to February 2016
Treatment details		
S. No.	**Main factor (storage conditions)**	**Sub factor(Lac traders)**
1.	Pucca storage structures (S_1)	Big trader (T_1)
		Medium trader (T_2)
		Small trader (T_3)
2.	Semi-pucca storage structures (S_2)	Big trader
		Medium trader
		Small trader
3.	Kuchcha storage structures (S_3)	Big trader
		Medium trader
		Small trader

Insect emergence from stored lac in laboratory-

a. Total initial counting of storage insect including larva and pupa/ sample/replication.
b. Total adult counting /sample/replication

2.1 Statistical Analysis

The experiment was laid in a split plot design with different storage structures as the maintreatment and different categories of lac traders as the sub-treatments. Statistical analysis was performed to test the population fluctuation of storage pest of lac under different storage condition with different treatment and sub-treatments. Analysis of variance was performed to determine the different lac traders and their interactions. The data recorded on different observations were tabulated and analyzed statistically by using the techniques of analysis of variance (ANOVA) as suggested by Gomez and Gomez (1984) [7].

3. Results and Discussions

3.1. Incidence of insect pests during lac storage

*Pseudohypatopa (Holcocera) pulverea*Meyr (Lepidoptera; Blastobasidae) and*Eublemmaamabilis* Moore (Lepidoptera; Noctuidae) were the only two insect pests found in stored lac samples collected from nine different categories of lac traders and storage structures from Barghat block, Seoni district during 2015-2016.Glover (1937) [6] reported the two predators*E. amabilis* and *P. pulverea*as the key pests of Lac crop causing a loss of around 30 to 40 per cent. Mishra and Gupta (1934) [11] reported that the presence of large number of *P. pulverea*under stored condition. Similarly Imms and Chatterjee (1915) [8] reported that the presence of *E. amabilis* during the initial stage of the lac storage and later absent under storage condition. Bhattacharya and Yogi (2015) [2] reported that *P. pulverea* completes five generation is about 381 days, similarly the life cycle of *E. amabilis*is completed six generation in a year. The duration of the generation are about 37, 45, 42, 125, 80, 40 days respectively.

In the present findings the mean larval population of *P. pulverea* and *E. amabilis* per 50 g stored lac samples was

found highest 2.30 and 2.37 in month of November 2015, respectively. High population of *P. pulverea* and *E. amabilis* in storage may be due to the fresh raw lac reaching the godown after the harvest in October and the lac growers directly sell raw lac to the small lac traders and some times to the medium traders and big traders. In fresh stored lac the population of insect pests of lac are high specially the *P. pulverea*and *E. amabilis.* This explains the peak population in November 2015.

Jaiswal*et al.* (1997) [9] reported that the presence of *A. tachardiae*and large number of *Prestomerus sulci* even after eight months of storage is due to the facts that their host, the larvae of *P. pulverea* are available in large number. Similarly, Mukhopadhyay and Muthana (1962) [12] reported that the predator *P. pulverea*is considered very important as it inflicts damage to the standing lac crop and is simultaneously responsible for the qualitative and quantitative deterioration of the stored lac. Similarly, Jaiswal*et al.* (1997) [9] reported that the lac insect predator, *P. pulverea*; parasitoid *Aprostocetus (Tetrastichus) purpureus* and *Eupelmustachardie;* predator's parasitoids, *Prestomerus sulci* and to small extend *Apantelestachardie* were found even after eight months of storage of lac. Similarly Chattopadhyay (2011) [4] reported that the predator *P. pulverea*are destructive predator of lac insects and found in all lac growing areas of the country. It feeds on the live and dead lac insects and is found in large numbers in stored lac and so it is responsible for the qualitative and quantitative deterioration of stored lac

In present studies we observed the mean larval population of *P. pulverea*and *E. amabilis* from August 2015 to February 2016. In which larval population of *P. pulverea*and *E. amabilis* are absent in month of September 2015, January and February 2016. This may be due to sale of all the fresh lac due to market demand, where the insect may have been removed along with the lac stock.

Table 2: Incidence of insect pests during lac storage

Observation period	Mean monthly larval population/50 g stored lac samples							
	P. pulverea				*E. amabilis*			
	R1	R2	R3	Overall mean	R1	R2	R3	Overall mean
August 2015	2.56	2	1.67	2.08	2.22	2	1.89	2.04
September 2015	0	0	0	0.00	0	0	0	0.00
October 2015	2.47	2.11	1.33	1.97	2	1.78	1.89	1.89
November 2015	2.78	2	2.11	2.30	2.78	2.33	2	2.37
December 2015	2.67	2.11	1.89	2.22	2.11	2.22	1.89	2.07
January 2016	0	0	0	0.00	0	0	0	0.00
February 2016	0	0	0	0.00	0	0	0	0.00

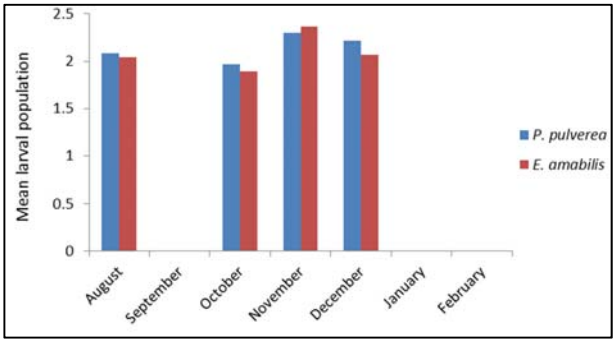

Fig 1: Incidence of storage pests of lac

3.2. Population fluctuation of storage pests under different storage conditions of lac

3.2.1. Population fluctuation of mean monthly population of storage pests of lac (larvae + pupae) in different storage structures

Mean monthly population (Larvae + Pupae) of *P. pulverea* and *E. amabilis* were recorded in August 2015 to February 2016 from the (50) g stored lac samples. *P. pulverea* was absent in samples of stored lac collected during the month of September 2015, January and February 2016 in all storage structures (Table 3).

a. *P. pulverea*

The mean (larval + pupal) population of *P. pulverea* was highest (7.67) in month of November 2015 followed by December 2015 (7.33), October 2015 (7.33) and August 2015 (6.00) in Pucca storage structures. In Semi-pucca storage structures, the mean (larval + pupal) population of *P. pulverea* was highest (9.33) in month of December 2015 followed by November 2015 (9.00), October 2015 (8.67) and August 2015 (7.67). The mean (larval + pupal) population of *P. pulverea* was highest (16.33) in month of December 2015 followed by November 2015 (14.67), October 2015 (12.00) and August 2015 (11.00) in Kuchcha storage structures.

b. *E. amabilis*

E. amabilis was not found in the stored lac collected during the month of September 2015, January and February 2016. However the mean (larval + pupal) population of *E. amabilis* was highest (7.31) in the month of December 2015 followed by November 2015 (7.00), August 2015 (7.00) and October 2015 (6.67) in Pucca storage structures. In Semi-pucca storage structures it was highest (9.33) in the month of August 2015 followed by October 2015 (9.00), December 2015 (9.00) and November 2015 (8.33). In Kuchcha storage structures it was highest (15.33) in the month of November 2015 followed by December (13.00), August (11.00) and October (10.33).

Table 3: Mean monthly population fluctuation of storage pests of lac (Larvae + Pupae) in different storage structures

Observation periods	Mean monthly population of storage pests of lac (Larvae + pupae) / 50 g stored lac samples					
	P. pulverea			*E. amabilis*		
	Pucca (S_1)	Semi-pucca (S_2)	Kuchcha (S_3)	Pucca (S_1)	Semi-pucca (S_2)	Kuchcha (S_3)
August 2015	6	7.67	11	7	9.33	11
September 2015	0	0	0	0	0	0
October 2015	7.33	8.67	12	6.67	9.00	10.33
November 2015	7.67	9.00	14.67	7.00	8.33	15.33
December 2015	7.33	9.33	16.33	7.31	9.00	13
January 2016	0	0	0	0	0	0
February 2016	0	0	0	0	0	0

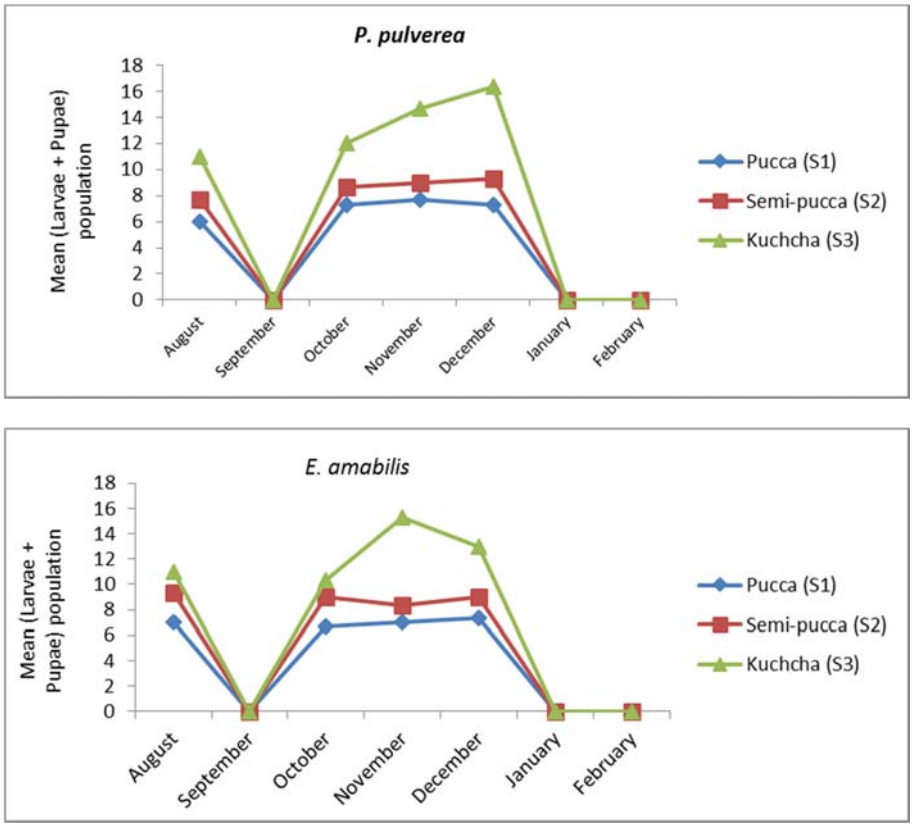

Fig 2: Population fluctuation of (larval + pupal) of *P. pulverea* and *E. amabilis* in different storage structures

3.2.2. Adult emergence of storage pests of lac from stored lac samples

The adult emergence (%) of *P. pulverea* was highest (81.99) in month of October 2015 followed by November 2015 (78.73), August 2015 (78.10) and December 2015 (72.67). The adult emergence (%) of *E. amabilis* was highest (80.78) in the month of August 2015 followed by October 2015 (79.51), November 2015 (79.41) and December 2015 (75.07). There was no emergence of adults of these pests from lac samples collected in the months of September 2015 and January, February 2016 due to no larvae and pupae recorded. (Table 4)

Table 4: Percent adult emergence of storage pests of lac from the stored lac samples

Observation period	Mean no. of *P. pulverea* (larvae + pupae)	Mean no. of *P. pulverea* Adult emerged	Adult emergence of *P. pulverea* (%)	Mean no. of *E. amabilis* (larvae + pupae)	Mean no. of *E. amabilis* Adult emerged	Adult emergence of *E. amabilis* (%)
Aug. 2015	2.74	2.14	78.10	3.07	2.48	80.78
Sept. 2015	0	0	0	0	0	0
Oct. 2015	3.11	2.55	81.99	2.88	2.29	79.51
Nov. 2015	3.48	2.74	78.73	3.4	2.7	79.41
Dec. 2015	3.66	2.66	72.67	3.25	2.44	75.07
Jan. 2016	0	0	0	0	0	0
Feb.2016	0	0	0	0	0	0

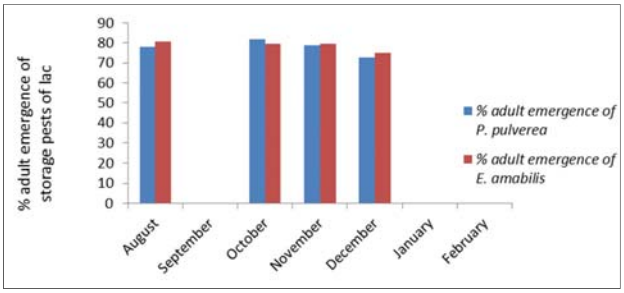

Fig. 3: Percent adult emergence of *P. pulverea* and *E. amabilis* from the stored lac samples

4. Conclusion

It is concluded that the *Pseudohypatopa (Holcocera) pulverea* Meyr (Lepidoptera; Blastobasidae) and *Eublemma amabilis* Moore (Lepidoptera; Noctuidae) were the only two insect pests found in stored lac samples. The mean larval population of *P. pulverea* and *E. amabilis* per 50 g stored lac samples was found highest 2.30 and 2.37 in month of November 2015, respectively and larval population of *P. pulverea*and *E. amabilis* are absent in month of September 2015, January and February 2016.

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