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Study on abundance of lac associated fauna in Seoni and Balaghat districts of Madhya Pradesh

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Abstract
The present study was carried out for the assessment of the abundance of various insect associated with lac insect in seoni and balaghat district of madhya pradesh during 2020-2021. During the study 12 species of fauna were reported with *Kerria lacca* kerr, 3, predators, 4 parasitoids and 5 hyper parasitoids belonging to 10 families. The study revealed that *E. amabilis* and *P. pulverea* are the major predator and *T. Tachardiae* and *P. clavicornis* found are the most destructive parasitoids of lac insects. In Seoni district maximum abundance was of *T. tachardiae* (43.12%) followed by *P. clavicornis* (23.9%), *E. amabilis* (18.70%), *P. pulverea* (8.31%) whereas in Balaghat district similarly maximum abundance was of similarly T. tachardiae (74.8%) followed by *P. clavicornis* (9.22%), *E. amabilis* (7.32%) and *P. pulverea* (6.18%). Results revealed that the number of predators and parasitoids was higher in Balaghat district as compared to Seoni district and the maximum number of lac associated fauna were found in Lohmara, Katangi (484) and Budbuda, Waraseoni (350) in Balaghat district. The study concludes that the abundance of predators, parasitoids and hyper parasitoids varied considerably in different lac growing sites of Seoni and Balaghat districts. Predator *E. amabilis* and *P. pulveria*, parasitoids *T. tachardie* and *P.clavicornis* are abundantly found in most of the lac cultivation sites whereas hyper parasitoids *Brocon greeni, P. sulci and Brachymeria tachardiae* occurred in less frequency in different lac growing sites of Seoni and Balaghat district of Madhya Pradesh.

Keywords: *Kerria lacca*, lac associated fauna, predator, parasitoids, hyper parasitoids

Introduction
Lac is a natural resinous compound secreted by an insect, *Kerria lacca*, thrives on tender twigs of specific host trees viz., palas (*Butea monosperma*), ber (*Ziziphus mauritiana*), kusum (*Schleichera oleosa*) and Ficus spp. etc. India is the largest producer of lac in the world [1] Indian states engaged in lac production are Jhharkhand, Chhatisgarh, Madhya Pradesh, West Bengal and Maharashtra contributing around 95 percent of national lac production [2] *Kerria lacca*, the most important and widely exploited insect for lac cultivation in India which is cultivated for its products, namely resin, dye and wax which find application in diverse area such as food, pharmaceutical, cosmetics, paints, varnishes etc [3]. Indian lac insect has been grouped into two strains based on its life cycle pattern viz, kusmi and rangeeni. Kusmi completes two life cycles per year each having six month duration namely aghani (winter season crop) and jethvi (summer season crop). Similarly, rangeeni strain completes two unequal life cycle per year namely katki (rainy season crop-four months) and baisakhi (summer season crop-8 months) [4]

Lac culture is a cash crop of importance and provides valuable income to resource constrained growers inhabiting tribal-dominated forest and sub-forest regions of Eastern India. Cultivation of lac not only provides livelihood to millions of lac growers, but also helps in conserving vast stretches of forest and biodiversity associated with lac insect complex. Lac ecosystem in complex multi-trophic web of flora and fauna. Twenty-two species of lac insect predators, 30 species of primary parasites, 45 species of secondary parasites [5] and several fungal pathogens of lac insects as well as lac hosts besides several other fungal pathogens represent a rich biodiversity of lac ecosystem (Sharma *et al*., 2006)

The lac insect during its life cycle spends only few hours of active mobility and thereafter spends a complete sedentary life and hence they are prone to be attacked by many insect predators and parasitoids, causing substantial damage to the lac crop qualitatively and quantitatively [6] Associated fauna cause upto 50% loss to the lac crop production in one season. Lac predator *Eublemma amabilis* and *P. pulverea* cause an average of 35-40%

damage to lac crop while Parasitoids or primary parasites damage 5-10% lac production, secondary parasitoids or hyper parasitoids act as a bio control agent in controlling the damage done by immoral insects., their natural population constitutes only about 4-10% of the total fauna associated with lac insect [7].

Madhya Pradesh is the third largest producer in the country. Seoni and Balaghat districts are the major lac producing districts of the state. Seoni is leading in lac production, approximately 900 tons are annually produced followed by Balaghat which contributes 741 tons share both districts contribute about 73% of the lac production of the state [8]. Lac associated fauna affects lac production substantially. So it is necessary to identify lac associated fauna including predator, parasitoids and hyper parasitoids of lac insects and take precautions for management of lac associated fauna. Keeping this in view the present study on incidence of lac associated fauna was conducted in these two important production Seoni and Balaghat districts.

Materials and Methods

To document the lac associated fauna of lac insect one meter samples of stick lac were collected from Malara, Janamkhari in Seoni district and Parsatola, Lohmara, and Budbuda in Balaghat district. The method used by Jaiswal *et al.*, 1998 [9] adopted for the study. The study was carried out in State Forest Research Institute, Jabalpur from October 2020 to January 2021. One meter stick of Rangeeni lac was collected from Palas trees and kept inside the 60 mesh nylon net bags and wet cotton swab (water) put at both the ends of lac bearing twigs to maintain the turbidity of samples and for maintaining the lac insect. The mouth of net bags was tied and kept under room temperature for proper aeration. Fauna that emerged were collected and separated based on their identification under the microscope based on morphological characters of the predators, parasites and hyper parasitoids with the help of lac insect practical manual of Mohansundaram *et. al.*, 2016 [10]. The following mathematical analysis was made for estimating the species and abundance of lac associated fauna

$$\text{Related density (RD\%)} = \frac{\text{Number of individuals of one species}}{\text{Total number of Individual of all species}} \times 100$$

Result and Discussion

Lac associated fauna

During the present investigation 12 species were found associated with lac insect (Table 1). These were 3 predators *Eublemma amabilis, P. pulverea, Chryosopa sp* 4 parasitoids *A. purpureus, Tachardiaphgus tachardiae,P. clavicornis,* E. tachardiae, and 5 hyperparasitoids *E. claripennis, B. tachardiae, Apanteles sp., B. greeni Ashmead***,** *P. sulci* from *kerria lacca* which were found attacking culture in samples taken from different lac growing areas of Seoni and Balaghat districts. Of these 9 belonged to Hymenoptera, 2 from Lepidoptera and 1 from Neuroptera. The analysis revealed that 16.67% genera belonged to Encyrtidae and Braconidae each and 8.33 percent each to Noctuidae, Blastobasidae, Chrysopidae, Eulophidae, Eupelmidae, Elasmidae, Chalcidae, and Ichneumonidae. The data on lac associated insect fauna emerging out from brood lac samples are given in Table.1

Table 1: Analysis of fauna associated with lac insect collected from Seoni and Balaghat districts of Madhya Pradesh

S. No	Associated fauna name	Order	Family	Genera
	Predator			
1	*E amabilis*	Lepidoptera	Noctuidae	1 (8.33%)
2	*P. pulverea*	Lepidoptera	Blastobasidae	1 (8.33%)
3	*Cryosopa spp*	Neuroptera	Chrysopidae	1 (8.33%)
	Parasitoids			
1	*A. purpureus*	Hymenoptera	Eulophidae	1 (8.33)
2	*Tachardiaphgus tachardiae*	Hymenoptera	Encyrtidae	2 (16.67%)
3	*P. clavicornis*	Hymenoptera	Encytidae	
4	E. tachardiae	Hymenoptera	Eupelmidae	1 (8.33%)
	Hyperparasitoids			
1	*E. claripennis*	Hymenoptera	Elasmidae	1 (8.33%)
3	*B. tachardiae*	Hymenoptera	Chalcidae	1 (8.33%)
4	*Apanteles sp.*	Hymenoptera	Braconidae	2 (16.67%)
5	*B. greeni Ashmead*	Hymenoptera	Braconidae	
6	*P. sulci*	Hymenoptera	Ichneumonidae	1 (8.33%)

Ea:*Eublemma amabilis*, Pp:*Pseudohypatopa pulverea*, C: *Cryosopa* sp, Ap: *Aprostocetus purpureus*, Et: *Eupelmus tachardiae*, Pc: *Parechthrodryinus clavicornis*, Tt: *Tachardiaephagus tachardiae*, A: Apantles Spp, Bg: Bracon Greeni, Bt: *Brachymeria tachardiae*, Ec: *Elasmus claripennis*, Ps: *Pristomerus sulci*

Numerical abundance of lac associated fauna in lac growing sites of Seoni and Balaghat

Out of samples of lac encrustation collected from 6 different lac growing sites of Seoni and Balaghat district. *Eublemma amabilis* Moore was found maximum in Janamkhari (33) followed by Parsatola (32), Budbuda (31), Mundraikala (22), Malara (17), Lohmara (14). Similarly *Pseudohypatopa pulveria* Meyr was abundantly found in Parsatola (49) followed by Janamkhari (25), Budbuda (11), Lohmara (05), Malara (03) and Mundrai (3) and predator Chryosopa spp was the minimum occurring predator which was mainly found in Budbuda (03) followed by Lohmara and Parasatola (01) each.

Among the parasitoids of lac insect *T. tachardiae* was found in the highest number i.e, 406 in Lohmara followed by Budbuda (288), Janamkhari (102), Parsatola(93), Mundrai (34) and Malara (34). Similarly *P. clavicornis* was observed as the second most destructive parasitoids which abundantly occurred in Janamkhari (72) followed by Lohmara (49), Parsatola (42), Mundrai (13), Malara (7) and Budbuda (06). Other parasitoids appearing during the study but in limited number like *Eupelmum tachardae* found in Lohmara (6), Mundrai (4), Budbuda (03) and Malara (02). Similarly *Aprostocetus purpureus* occurred in Janamkhari and Malara (03) each and Lohmara (01).

Among the beneficial insect or hyper parasitoids of lac insects were seen in very limited numbers. Maximum hyper parasitoids *P. sulci* were observed in Budbuda (4) followed by Janamkhari. Similarly, *Brocon greeni* found in Mundarai (02) followed by Janamkhari and Budbuda and Parsatola in only 1 found. *B. Tachardiae* occurred in Mundrai, Malara and Budbuda in each 2 found. *Elasmus claripennis* also found in Lohmara (2) and Malara (01), whereas Apentles species occurred only in Malara and Budbuda (in each 1).Data collected on the abundance of fauna associated with lac insects in the seoni and Balaghat district is given in Table 2 and Fig 1 and 2.

Table 2. Numerical abundance of fauna associated with lac insect in Seoni and Balaghat Districts of Madhya Pradesh

S. No	Location	Predators (1 meter lac stick)			Primary Parasitoids (1 meter lac stick)				Hyper parasitoids (1 meter lac stick)					Mean value
		E. a	P. p	C.sp	A.p.	E.t.	P.c.	T.t	A.sp	B.g.	B.t.	E.c.	P. s.	
Seoni														
1	Mundrai kala	22 (5.71)	3 (0.78)	-	-	4 (1.04)	13 (3.38)	34 (8.83)	-	2 (0.52)	2 (0.52)	-	-	80
2	Malara (Barghat)	17 (4.42)	04 (1.04)	-	3 (0.78)	2 (0.52)	07 (1.82)	30 (7.79)	1 (0.26)	-	2 (0.52)	1	-	67
3	Janamkhari (Barghat)	33 (8.57)	25 (6.49)	-	3 (0.78)	-	72 (18.7)	102 (26.5)	-	1 (0.26)	-	-	2 (0.52)	238
		72 (18.7)	32 (8.31)	-	6 (1.56)	6 (1.56)	92 (23.9)	166 (43.1)	1 (0.26)	3 (0.78)	4 (1.04)	1 (0.26)	2 (0.52)	385
Balaghat														
4	Budbuda (Waraseoni)	31 (2.95)	11 (1.05)	3 (0.29)	-	3 (0.29)	6 (0.57)	288 (27.4)	1 (0.1)	1 (0.19)	2 (0.19)	-	4 (0.38)	350
5	Lohmara (Katangi)	14 (1.33)	5 (0.48)	1 (0.1)	1 (0.1)	6 (0.57)	49 (4.66)	406 (38.6)	-	-	-	2 (0.19)	-	484
6	Parsatola (Lalburra)	32 3.04)	49 (4.66)	1 (0.1)	-	-	42 (3.99)	93 (8.84)	-	1 (0.1)	-	-	-	218
		77 (7.32)	65 (6.18)	5 (0.48)	1 (0.1)	9 (0.86)	97 (9.22)	787 (74.8)	1 (0.1)	2 (0.19)	2 (0.19)	2 (0.19)	4 (0.38)	1052

Ea:*Eublemma amabilis*, Pp:*Pseudohypatopa pulverea*, C: *Cryosopa* sp, Ap: *Aprostocetus purpureus*, Et: *Eupelmus tachardiae*, Pc: *Parechthrodryinus clavicornis*, Tt: *Tachardiaephagus tachardiae*, A: Apantles Spp, Bg: *Bracon Greeni*, Bt: *Brachymeria tachardiae*, Ec: *Elasmus claripennis*, Ps: *Pristomerus sulci*

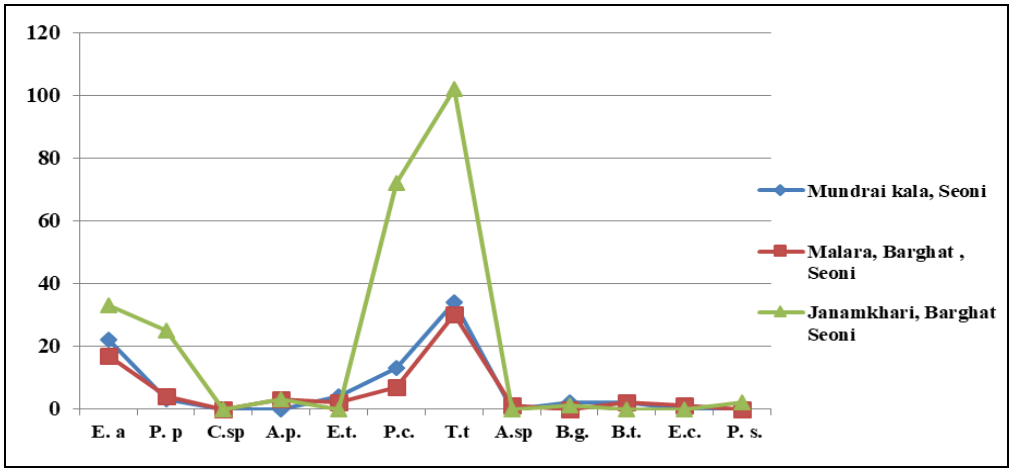

Fig 1: Lac associated fauna in different sites of Seoni district

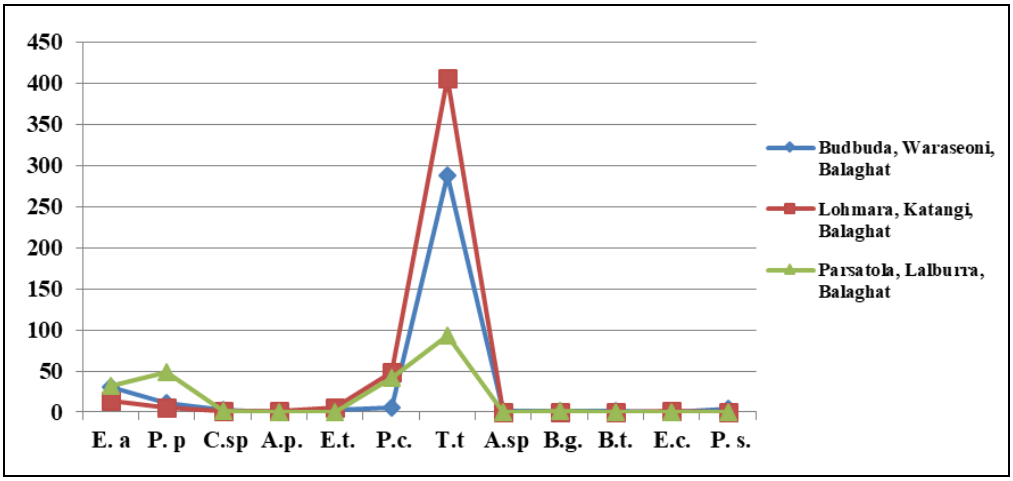

Fig 2: Lac associated fauna in different sites of Balaghat district

Distribution of lac associated fauna in Seoni district

Data pertaining to fauna associated with lac insect during October-December 2021 (Table 1) collected from 3 different lac growing sites of Balaghat district were analyzed for the relative abundance of each insect population (Table 3). Based on pooled data of three lac growing sites it was observed that predator *E. amabilis* Moore was the most abundant predator as compared to *P. pulverea* (8.31 %) with mean relative density of 18.70% percent among all associated fauna. Among all parasitoids of lac insect, *Tachardiaephagus tachardiae* was the most prevalent parasitoid in terms of its numerical abundance among all the associated fauna with mean relative density of 43.12 per cent followed by *Parechthrodryinus clavicornis* (23.9%), *Eupelmus Tachardiae* (1.56%), *Aprostocetus purpureus* (1.55%). *Brachymeria tachardiae* was the most abundant hyper parasitoid among the hyper parasitoids with mean per cent value of 1.04 percent followed by *Brocon greeni* (0.78), *Pristomerus sulci* (0.52%) and minimum abundance of *Elasmus claripennis* and Apantles Spp both are 0.26% respectively.

Distribution of lac associated fauna in Balaghat district

Data pertaining to fauna associated with lac insects during October-November 2020 (Table 2) collected from 3 different lac growing sites of the Seoni district were analyzed for the relative abundance of each insect population (Table 3). On the basis of pooled data of three lac growing sites it was observed that predator *Eublemma amabilis* (7.32%) were the most dominant predator compared to *Pseudohypatopa pulverea* (6.18%) and chyosopa (0.48%). Among all parasitoid of lac insect, *Tachardaephagus tachardae* was the most prevalent parasitoids in terms of its numerical abundance with a mean abundance of 74.8 % followed by *Parechthrodryinus Clavicornis* (9.22%), *Eupemus tachardae* (0.70%) and *Aprostocetus purpureus* (0.07%). *Pristomerus sulci* was found the most abundant hyper parasitoids in all hyperparasitoids with a mean percent value of 0.38% followed by *Brocon greeni* (0.25%), *Brachymeria tachardiae* (0.19%, *Elasmus claripennis* (0.14%) and *Apantles* sp. (0.09%). Thus *Tachardaephagus tachardae* was numerically the most abundant among all the associated fauna. Distribution of lac associated fauna in Seoni and Balaghat districts showing in Figs 3 and 4.

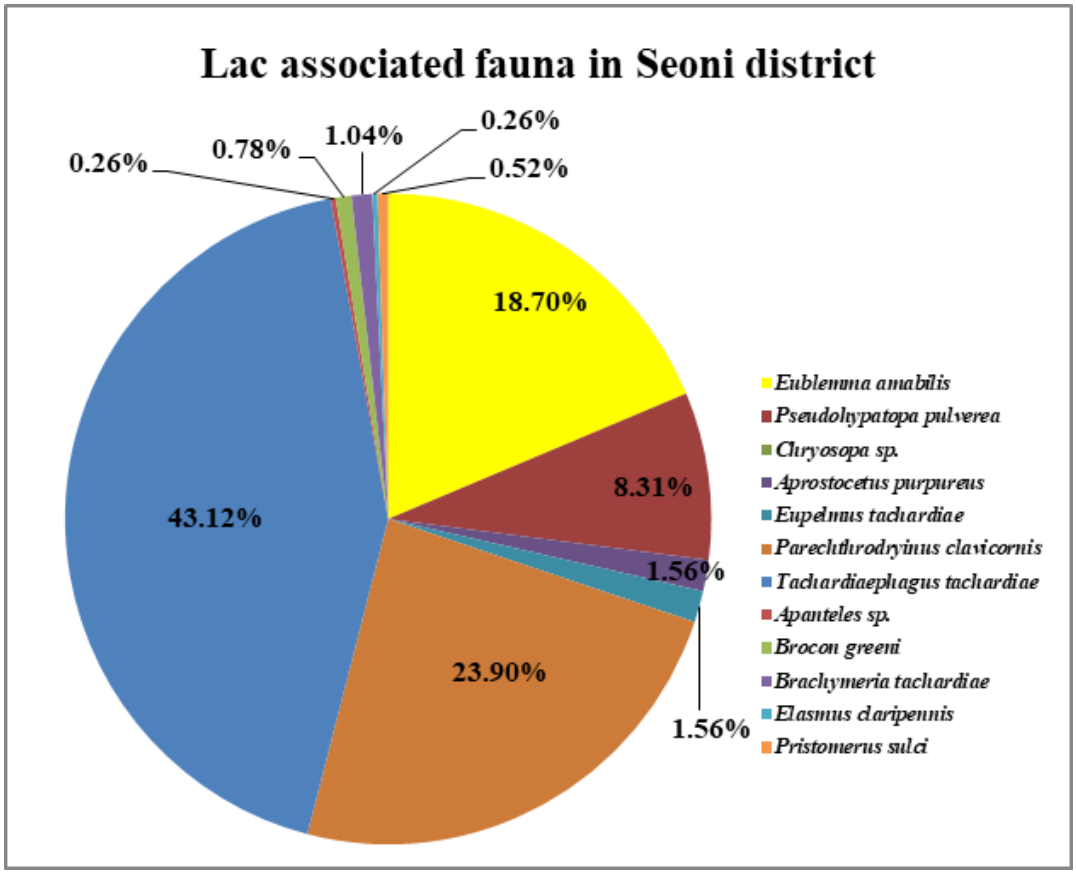

Fig 3: Lac associated fauna in Seoni district

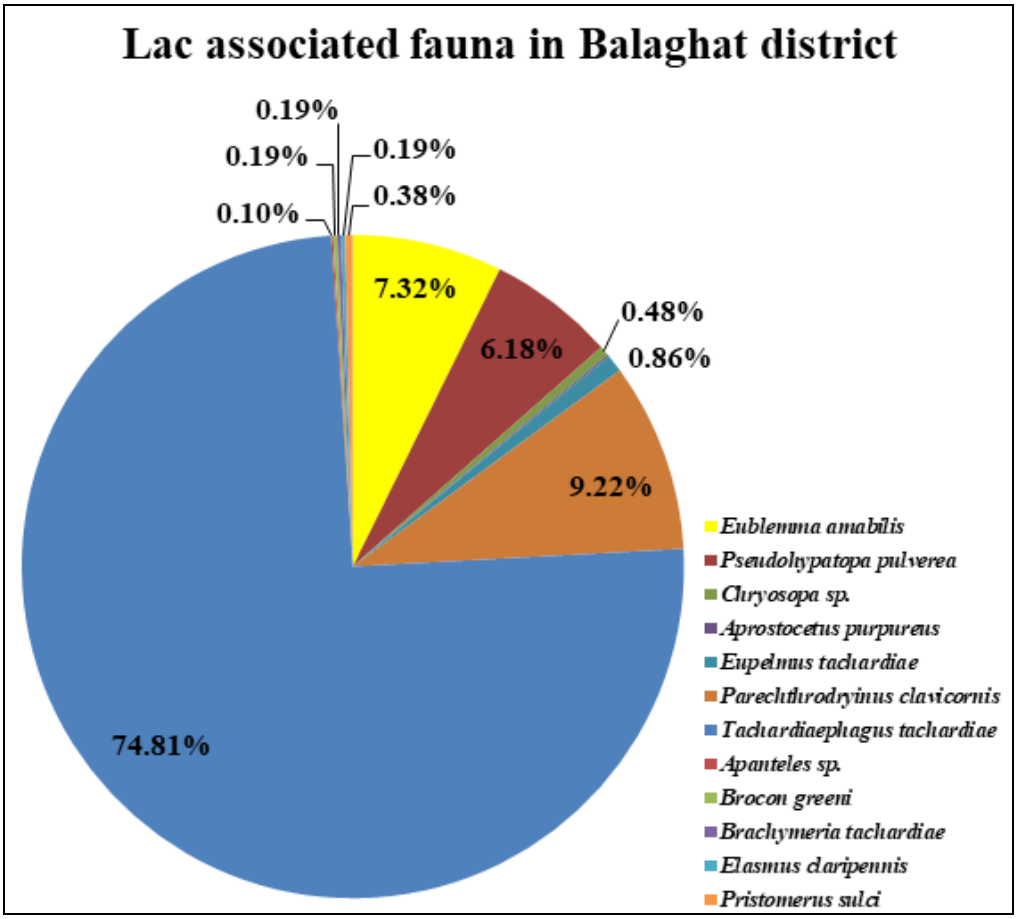

Fig 4: Lac associated fauna in Balaghat district

Among the predator *E. amabilis* were recored as most prevalent in all predators followed by *P. pulverea* and *Chryosopa* spp., Glover, 1937 [11]; Mishra, 2002 [12]; Jaiswal *et al*., 2008 [13]; Singh *et al*., 2009 [14] reported that Two lepidopteran predators *Eublemma ambilis* and *Pseudohypatopa pulverea* cause 30-40 per cent damage to lac crop. Narayanan (1962) [15] also reported *E. amabilis* as a monophagous predator of lac insects, causing damage to the tune of 20 to 25 per cent to lac crop. Malhotra and Katiyar (1975) [16] too reported *E. amabilis* and *P. pulverea* as major pests normally causing 30 to 35 per cent damage to lac crop.

Among the parasitoids *T. tachardiae* was the most prevalent parasitoids and followed by *P. Clavicornis* and *E.tachardae*. In the case of hyper parasitoids *Brocon greeni* , *Brachymeria tachardiae and Pristomerus sulci* are the major hyper parasitoids in Seoni and Balaghat districts. The study revealed that number of predators and parasitoids is higher in Balaghat district as compared to Seoni district and a maximum number of lac associated fauna were found in Lohmara, Katangi (484) and Budbuda, Waraseoni (350) of Balaghat district.

The present study is more or less similar to Meena *et al*., (2018) [17] who reported that during the investigation 11 species of fauna associated with *Kerria lacca* from 8 families under 3 were recorded representing predator species *E. amabilis, P. pulverea, C zastrowi*; primary parasitoids *T. tachardiae, A. purpureus, T. clavicornis, E. dewitzi and* hyper-parasitoids *A. fakhrulhajiae, E. tachardiae, B. greeni, B. Tachardiae* in western plains of India.

According to Uike (2015) [18] The *E. amabilis* and *P. pulverea* were recorded as key predators and *Chryosopa sp*. was recorded as a minor predator, among the parasitoids *T. tachardiae* was recorded as a major status in Kanker district of Chhattisgarh, and season incidence of predator and parasitoids viz. *E. amabilis, P. pulverea, Chyosopa sp., T. tachardiae, E. tachardiae* and *A. purpureus* in Gariaband district of Chhatisgarh. Similarly observations were made in this study.

Present findings conform with Mohansundaram *et al*.,(2018) [19] who also reported that variation in lac associated fauna is related to different lac host plants for both Rangeeni and kusmi strain. Lac associated fauna viz. *T. Tachardiae, A.purpureus, P. clavicornis, E. amabilis, P. pulverea* and hyperparasitoids *B. greeni, B. tachardiae and Elasmus clavipennis* was observed in Katki, Baisakhi, Jethavi and Agahni crop of different host plant viz. palas, ber, kusum, semialata and redgram

Conclusion

Twelve species associated with lac insect 3 predators, 4 parasitoids and 5 hyper parasitoids belonging to 10 families and 04 orders were observed from Seoni and Balaghat districts of Madhya Pradesh. Predator *Eublemma amabilis* and *Pseudohypatopa pulveria*, parasitoids *Tachardiephagus tachardie* and *P.clavicornis* are abundantly found in most of the lac cultivation sites of Madhya Pradesh whereas hyper parasitoids *Brocon greeni, P. sulci and Brachymeria tachardiae* occurred in less frequency in different lac growing sites of Seoni and Balaghat district of Madhya Pradesh. The species richness differed in different lac ecosystems.

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