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Species Composition, Relative Abundance and Diversity of Ants Associated with Lac Insect in Assam

Rituraj Saikia[1]*, Purnima Das[1], Lakshmi Kanta Hazarika[2], Athar Nishat Islam[3], Surajit Kalita[1] and Priyanka Saikia[1]

[1]Department of Entomology, AAU, Jorhat, Assam, India
[2]Assam Women's University, Jorhat, Assam, India
[3]Department of Agricultural Meteorology, AAU, Jorhat, India

**Corresponding author:*

A B S T R A C T

The present investigation highlighted the facultative mutualistic association of six ant species, *viz. Camponotus parius* Emery, *Meranoplus bicolor* Guerin-Meneville, *Paratrechina longicornis* Latreille, *Monomorium dichroum* Forel, *Technomyrmex albipes* Smith and *Oecophylla smaragdina* Fabricius (Hymenoptera: Formicidae) belonging to three sub-families (Formicinae, Myrmicinae and Dolichoderinae) with lac insect (*Kerria lacca* Kerr) on host plants, *Flemingia semialata.* Out of these, *Technomyrmex albipes* was the most abundant and dominated species which constituted 76.66 percent (394.8 no. of individual/15cm lac encrustation) followed by *Paratrechina longicornis* which contributed 12 percent (61.8 no. of individuals/15cm) of the total ant community throughout the crop season of lac insect. Highest numbers of ant population (101.5 no. of ants/15cm) was recorded at 81 days after inoculation *i.e.* at initial post fertilization stage. Highest numbers of ant species (5) was also recorded at initial post fertilization stage *i.e.* 81 days and 95 days after inoculation. Shannon-Wiener diversity Index for ant was recorded Highest (0.87) at 81 days after inoculation and lowest was recorded at maturity stage of lac insect (0.41). However, the Pielou's evenness index showed the highest value of 1.21 at 67 days after inoculation and lowest was recorded at maturity stage of lac crop (0.14).

Keywords

Ant, Lac insect, Trophobiont, Diversity, Abundance

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Introduction

Ants are the most abundant, widely distributed social ubiquitous insects from the Arctic Circle to the Equator (Brian, 1978) but, they are most abundant in the tropical and subtropical ecosystem. The known living ants involve 16 subfamilies, 296 genera and 15000 species, around 10000 of which are described (Bolton, 1994). Most of the species play an important role within the terrestrial ecosystems as they have numerous interactions with different plant species such as seed dispersers, leaf and seed predators, and in some cases, as pollinators (Bingham, 1903; Vazquez,1998). The effects of ants on the biotic communities include a variety of possible interactions which may include

predation (Kajak *et al.,* 1972; Karhu, 1998), herbivory (Albert *et al.,* 2005; Rodriguez, 2008), intraguild interference (Moja-Larano and Wise, 2007; Sanders and Platner, 2007), mutualistic interactions (Stadler and Dixon, 2005) and ecosystem engineering (Dauber *et al.,* 2008). Ant is one of the dominant taxon in the lac insect ecosystem, where, facultative mutualistic association is seen between the two groups. The tiny scale insect act as trophobiont as their product, honey dew is taken as food by the ant and in return they protect the sap suckers from their natural enemies. Therefore, ant attendance in the lac ecosystem is very crucial for quality and quantity lac production. The species of ant associated with lac insects in Assam is not documented till now and hence, present investigation was undertaken to find out the ant species associated with lac insects. Another attempt was also made to study their relative abundance as well as diversity with different developmental stages of the lac insect.

Materials and Methods

The study was conducted at lac park, AAU, Jorhat, which is maintained for genetic conservation of lac insects. The winter crop of kusumi strain of lac insect was inoculated on 3rd July, 2017 on host *Flemingia semialata* and observations were started 25 days after inoculation and it was continued at fortnightly interval till harvesting of the crop. Ten plants of *F. semialata* were selected randomly and on each plant, fifteen centre meter lac encrustation was measured to record the ant species and their population abundance. Samplings were done during the evening time by visual count method as ants were found to be congregated on lac encrustation. Different ant species found to be associated with lac encrustation were counted, unidentified specimens collected, preserved separately at 90% alcohol and sent to Department of Forest Entomology, Kerala Forest Research Institute, Thrissur, Kerala for identification. Photographic documentations of the identified specimens were studied using Leica image analyzer. The diversity was calculated by using "Shannon Wiener diversity Index (1949) and evenness was calculated by Pielou's evenness index (1975).

Results and Discussion

Species composition and richness of ants

The current study revealed association of six ant species belonging to the subfamily Formicinae, Myrmicinae and Dolichoderinae with the lac insect ecosystem (Table 1). Formicinae was the dominant subfamily representing three species (*Camponotus parius* Emery, *Paratrechina longicornis* Latreille and *Oecophylla smaragdina* Fabricius) followed by Myrmicinae which comprised of two species (*Meranoplus bicolor* Guerin- Meneville, *Monomorium dichroum* Forel) and a single species of Dolichoderinae (*Technomyrmex albipes* Smith) (Fig. 1. A-F). Carroll and Janzewn (1973) and Holldobler and Wilson (1990) also reported these three subfamilies as commonest attendant ant of trophobionts. Similar observation was also made by Kurmi *et al.,* (2015) from Madhya Pradesh where they recorded association of seven ant species with kusumi lac ecosystem. Sharma *et al.,* (2010) also reported association of 17 ant species with lac insect. Highest number of ant species (5) was encountered during 81 and 95 days after inoculation, *i.e.* at initial post fertilization stage of lac insects (Table 2).

Population abundance of ant species

Out of the six species, *Technomyrmex albipes* was the most abundant and dominated species encountered throughout the life cycle of lac insects. Data collected through visual count

method revealed a mean total of 515 no. of individual/15cm lac encrustation throughout the sampling period and out of these, *Technomyrmex albipes* constituted 76.66 percent (394.8 no. of individual/15cm lac encrustation) followed by *Paratrechina longicornis* 12 percent (61.8 no. of individual/15cm lac encrustation) of the total population. Ant population was initially low which gradually increased, reached highest (101.5 no. of individuals) at 81 days after inoculation followed by a subsequent declining trend. Two species, *viz.*, *Technomyrmex albipes* and *Paratrechina longicornis* were encountered throughout the crop periods of lac insect. Regarding the life stages of lac insect, it was evident from the Table 2 that ant population was much higher during the initial post fertilization stage as compared to the other stages.

Diversity and evenness of ants

Diversity index was calculated by Shannon-Wiener diversity Index and it revealed highest diversity of ant at 81 days after inoculation (0.87) and the lowest was recorded at maturity stage of lac insect (0.41) (Table 3). Diversity was more or less similar from 39 days to 109 days. However, the Pielou's evenness index showed the highest evenness of ant at 67 days after inoculation (1.21) and lowest was recorded at maturity stage of lac crop (0.14).

Several factors such as species of tending ants (Addicott, 1979; Bristow, 1984; Gibernau and Dejean, 2001; Itioka & Inoue, 1996), the aggregation size of the honeydew-producing insects (Breton and Addicott, 1992; Cushman and Whitham, 1989), temperature (Bannerman and Roitberg, 2014), the developmental stage of the honeydew-producing insects (Cushman and Whitham, 1989; Eastwood, 2004) as well as competition among honeydew-producing insect aggregations for the services of ant mutualists (Cushman and Whitham, 1989; Cushman, 1991) determine the mutualistic association between ants and lac insects. During the initial stage, both the sexes of lac insects produce a little honeydew, but after mating all males die and only females produce honeydew, but in large quantities. This honeydew can be found on the body of lac insects or on the surface of leaves and branches, and even on the ground (Chen *et al.*, 2017) which are being consumed as a source of energy by the attendant ants.

Table.1 Ant species, their mean population count and relative abundance

Serial No.	Ant Species	Common Name	Sub-Family	Mean population	Relative abundance
A	*Camponotus parius* Emery	Carpenter Ant	Formicinae	12.1	2.35
B	*Meranoplus bicolor* Guerin- Meneville	Silky Shield Ant	Myrmicinae	43.3	8.31
C	*Paratrechina longicornis* Latreille	Crazy Ant	Formicinae	61.8	12
D	*Monomorium dichroum* Forel	Yellow Legged Ant	Myrmicinae	1.6	0.31
E	*Technomyrmex albipes* Smith	White Footed Ant	Dolichoderinae	394.8	76.66
F	*Oecophylla smaragdina* Fabricius	Weaver Ant/ Orange Gaster	Formicinae	1.4	0.27
			Total	**515**	

Table.2 Relative abundance of ant during different stages of lac crop

Date of Observation	Life stages	Species observed	Mean population	Total	Relative abundance
25	Initial settlement stage	*Technomyrmex albipes*	7.2	8.8	81.8
		Meranoplus bicolor	0.8		9.1
		Paratrechina longicornis	0.8		9.1
39	Sex differentiation stage	*Technomyrmex albipes*	13	17.4	74.7
		Meranoplus bicolor	2.6		14.9
		Camponotus parius	0.6		3.4
		Paratrechina longicornis	1.2		6.9
53	Physiological maturity stage	*Technomyrmex albipes*	35.2	48.3	72.9
		Meranoplus bicolor	6.7		13.9
		Camponotus parius	0.6		1.2
		Paratrechina longicornis	5.8		12.0
67	Initial post fertilization stage	*Technomyrmex albipes*	50.4	69.3	72.7
		Meranoplus bicolor	8.3		12.0
		Camponotus parius	2.6		3.8
		Paratrechina longicornis	8		11.5
81		*Technomyrmex albipes*	74.5	101.5	73.4
		Meranoplus bicolor	8.7		8.6
		Camponotus parius	2.5		2.5
		Paratrechina longicornis	14.2		14.0
		Monomorium dichorum	1.6		1.6
95		*Technomyrmex albipes*	72.7	95.6	76.0
		Meranoplus bicolor	6.2		6.5
		Camponotus parius	2.8		2.9
		Oecophylla smaragdina	1.4		1.5
		Paratrechina longicornis	12.5		13.1
109		*Technomyrmex albipes*	47.7	60.7	78.6
		Meranoplus bicolor	3.6		5.9
		Camponotus parius	1.2		2.0
		Paratrechina longicornis	8.2		13.5
123		*Technomyrmex albipes*	40.2	48.7	82.5
		Meranoplus bicolor	3		6.2
		Camponotus parius	0.8		1.6
		Paratrechina	4.7		9.7

		longicornis			
137	Late post fertilization stage	*Technomyrmex albipes*	26	32.4	80.2
		Meranoplus bicolor	2.8		8.6
		Camponotus parius	0.8		2.5
		Paratrechina longicornis	2.8		8.6
151		*Technomyrmex albipes*	22.5	25.5	88.2
		Meranoplus bicolor	0.6		2.4
		Camponotus parius	0.2		0.8
		Paratrechina longicornis	2.2		8.6
165		*Technomyrmex albipes*	3.2	3.8	84.2
		Paratrechina longicornis	0.6		15.8
179		*Technomyrmex albipes*	1	1.6	62.5
		Paratrechina longicornis	0.6		37.5
193	Maturity stage	*Technomyrmex albipes*	1.2	1.4	85.7
		Paratrechina longicornis	0.2		14.3

Table.3 Diversity and evenness index of ant communities at different stages of lac crop

Time of observation (Days after inoculation)	Diversity index	Evenness index
25	-0.60	-0.65
39	-0.80	-0.76
53	-0.81	-1.05
67	-0.86	-1.21
81	-0.87	-1.00
95	-0.82	-0.93
109	-0.70	-0.96
123	-0.62	-0.81
137	-0.69	-0.80
151	-0.45	-0.48
165	-0.44	-0.58
179	-0.66	-0.31
193	-0.41	-0.14

Fig.1 (A-F): Ant species associated with lac insect at lac park, AAU

A. *Camponotus parius* Emery

B. *Meranoplus bicolor* Guerin-Meneville

C. *Paratrechina longicornis* Latreille

D. *Monomorium dichorum* Forel

E. *Technomyrmex albipes* Smith

F. *Oecophylla smaragdina* Fabricius

During present investigation, the highest mean individual count (81days after inoculation) of ants, highest species richness (81 and 95 days after inoculation), highest diversity index (81 days after inoculation) and highest evenness index (67days after inoculation) *i.e.* at initial post fertilization stage might be due to increase in honeydew secretion by the lac insect. The male emergence of lac insect was started 45 days after inoculation which continued for 12 days. Therefore higher secretion of honeydew after mating might be the major cause of the observed differences.

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