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SPECIES RICHNESS OF ARBOREAL ANT ASSEMBLAGES (HYMENOPTERA, FORMICIDAE) AND FREQUENCY OF *Oecophylla smaragdina* (Fabricius) OCCURRENCE IN A WET ZONE CASHEW (*Anacardium occidentale* L.) FIELD IN SRI LANKA

R. K. S. DIAS* AND A. P. S. PERERA

Department of Zoology and Environmental Management, University of Kelaniya, Sri Lanka

ABSTRACT

Ant assemblages on cashew trees in the wet zone of Sri Lanka were recorded throughout three phenological phases from March to June in 2015. Baited trapping and hand collection recorded fourteen ant species in five subfamilies and species richness observed on each occasion ranged from 7 to 11. Absence of serious cashew pests was noticeable in the current phenological cycle. *Oecophylla smaragdina* (Fabricius) was the only species recorded on all trees. Number of *O. smaragdina* nests observed on the same cashew trees in the two plots was recorded from April to June in 2015 and nests of the species were observed only on large and medium-sized trees. The materials carried by *O. smaragdina* workers on cashew tree branches were also collected, preserved in 70% ethanol and identified as far as possible using a Low Power Stereo-microscope and various plant and animal materials carried by workers confirmed that the species is an omnivore and a generalist predator. In the current study absence of serious damages caused by the cashew insect pests even without any insecticide application might be due to the presence of ant assemblages on cashew trees.

Keywords: Cashew arboreal ants, *Oecophylla*, species diversity, obligate ants, facultative ants, ant sampling methods

INTRODUCTION

Many ants (Hymenoptera, Formicidae) are generalist predators and have the potential to control herbivore abundance, reducing the plant damage while increasing plant growth,

* Corresponding author Email: rksdias@kln.ac.lk

reproduction and yield (Majer 1972, Leston 1973, Schmitz *et al*. 2000, Symondson *et al*. 2002, Van Mele 2008) in agro-ecosystems (Way & Khoo 1992, Peng & Christian 2004, 2005, Peng *et al*. 1995, 1997, 1999, 2014). Cashew, *Anacardium occidentale* L., a tree crop native to coastal Brazil, grown in many other countries including Sri Lanka (Cashew Corporation of Sri Lanka 2010) has high economic value as a fruit, nut and oil globally (Blomhoff *et al*. 2006, FAO 2013). In Sri Lanka, a substantial contribution to national income hails from the cashew industry in large-scale plantations in dry and the arid zones of the country while small-scale cashew fields also exist in the wet zone (Rickson & Rickson 1998, Cashew Corporation of Sri Lanka 2010). The Red Weaver Ant, *Oecophylla smaragdina* (Fabricius), was reported as a natural enemy of the cashew pest, *Helopeltis antonii* Sign., in an arid-zone cashew field in Sri Lanka (Wijetunge *et al*. 2003). However very little is known about the ant assemblages that forage on the cashew trees (Rickson & Rickson 1998) in the wet zone of the country, especially throughout flowering and nut initiation, fruit and nut maturing and the vegetative phases of cashew, in the absence of any insecticide application.

The present paper reports here on the species richness of ant assemblages and frequency of occurrence of ant species that were associated with wet-zone cashew trees in the absence of insecticide application from March (flowering and nut initiation) to June (vegetative phase) in 2015. Also, qualitative observations on the damage symptoms and the common pests, the nest occurrence of *O. smaragdina* on cashew trees and the food materials carried by its workers were recorded.

METHODOLOGY

Description of cashew field

The survey on arboreal ants was conducted in a 1.2 ha field consisting of 28 *A. occidentale* trees of traditional and recent varieties, of varying size, located at Delgoda, Udupila (GPS Coordinates: 07°00.395' N and 0.80°00.96' E) in Gampaha District in the wet zone of Sri Lanka.

Field and laboratory methods

Ant assemblages associated with three phenological phases of cashew were surveyed on small (S1, S2) medium-sized (M1, M2) and large (L1, L2) trees (Tables 1 and 2) in each of the two selected plots on each visit, from March to June in 2015. Seven to 15 plastic bottles, containing a small amount of dry crushed anchovies and 3 ml of 70% ethanol, were

set 25 cm apart at different heights on the branches of small to large trees as baited traps. All traps were collected after three hours and the workers in each bottle were sorted and preserved in the bottles filled with 70% ethanol with appropriate labels, in the laboratory. In addition, worker ants seen on the main trunk and four major branches of each tree (Table 2) were collected using a paint brush or a pair of forceps for a five-minute period and preserved in the bottles containing 70% ethanol. Worker ants were identified to the possible taxonomic levels using a Low-Power Stereo-microscope at suitable magnifications and the existing taxonomic keys and morphological descriptions of ants (Bingham 1903, Bolton 1994, Dias 2014).

Qualitative observations on the presence of any cashew pests were recorded by observing sweep net samples taken from reachable heights of each tree. Fallen cashew apples in the fruit and nut initiation phase were also checked for any damage symptoms. Information on the occurrence of serious cashew pests was also collected from the cashew field owner.

In addition, number of nests or nest units of *O. smaragdina* on the same cashew trees in the two plots were recorded from April to June in 2015. The materials carried by *O. smaragdina* workers crawling on the cashew tree branches were collected, preserved in 70% ethanol and identified as far as possible using a Low Power Stereo-microscope.

Table 1: Size, height and diameter of selected trees in the cashew field

Plot	Size		Height (m)	Diameter (cm)
1	Large	(T_1)	12.2	96.0
	Medium	(M_1)	8.2	70.0
	Small	(S_1)	2.5	18.0
2	Large	(L_2)	12.0	90.0
	Medium	(M_2)	8.0	62.0
	Small	(S_2)	2.4	16.0

Table 2: Details of sampling from each tree (T: large; M: Medium; S: Small) in each plot during each phenological phase F: Flowering and nut initiation phase, FN: Fruit and nut maturing phase and V: Vegetative phase

Date of sampling in 2015	Phenological stage	No. of samples											
		Plot 01						Plot 02					
		Baited trapping			Hand collection			Baited trapping			Hand collection		
		T_1	M_1	S_1	T_1	M_1	S_1	T_2	M_2	S_2	T_2	M_2	S_2
7th March	F	15	9	7	9	9	5	15	9	7	9	9	5
21st March	F	15	9	7	9	9	5	15	9	7	9	9	5
4th April	FN	15	9	7	9	9	5	15	9	7	9	9	5
25th April	FN	15	9	7	9	9	5	15	9	7	9	9	5
16th May	V	15	9	7	9	9	5	15	9	7	9	9	5
6th June	V	15	9	7	9	9	5	15	9	7	9	9	5

Table 3: Species richness and species composition of ant assemblage and percentage frequency of occurrence of each ant species observed on each phenological phase of cashew trees during the study period

		Flowering and nut initiation stage		Fruit and nut maturation stage		Vegetative stage			
Subfamily	Species	07/ 03	21/ 03	04/ 04	25/ 04	16/ 05	06/06	Frequency of occurrence % **(out of 36 trees on 6 visits)**	Frequency of Occurrence % **(out of 12 plots)**
Dolichoderinae	1. *Technomyrmex albipes* (Smith F.)	+	+	+	+	+	+	91.6	100
Formicinae	2. *Anoplolepis gracilipes* (Smith F.)	+	+	+	+	+	+	66.7	100
	3. *Camponotus irritans* (Smith F.)	-	+	+	-	-	-	5.6	16.7
	4. *Camponotus* sp.	+	+	+	+	+	+	61.1	100
	5. *Oecophylla smaragdina* (Fabricius)	+	+	+	+	+	+	100	100
Myrmicinae	6. *Cataulacus taprobanae* Smith F.	+	+	+	+	+	+	16.7	50
	7. *Crematogaster biroi* Mayr	-	-	-	+	-	-	2.7	8.3
	8. *Crematogaster rothneyi* Forel	-	-	+	+	+	-	8.3	25
	9. *Meranoplus bicolor* (Guerin-Meneville)	+	+	+	+	+	+	33.3	50
	10. *Pheidole* sp. 1	-	-	+	-	-	-	2.7	8.3
	11. *Pheidole* sp. 2	-	-	-	+	-	-	2.7	8.3
Ponerinae	12. *Diacamma rugosum* Forel	-	+	-	-	+	-	5.6	16.7
	13. *Odontomachus simillimus* Smith F.	-	-	-	+	+	-	13.9	16.7
Pseudomyrmecinae	14. *Tetraponera allaborans* (Walker)	+	+	+	+	+	+	36.1	50
	Species richness	7	9	10	11	10	7		

RESULTS

Ant assemblages and *O. smaragdina*

Table 3 presents the ant assemblages in five subfamilies that were observed on the cashew trees from March to June in 2015. Species richness of ants observed on the cashew trees ranged from 7 to 11 while 14 species were recorded during the period (Table 3). Significant differences were not evident among the species richness values (Chi Square Test; $p>0.05$) recorded on the six visits. *O. smaragdina* and *Technomyrmex albipes* Smith F. were recorded from both plots on all occasions but the former was the only species observed on all trees (100%). Other species (Table 3) occurred at lower frequencies.

Very few unidentified bugs (hemipterans) and beetles (coleopterans) were recorded from sweep net samples. Several cashew apples had damage symptoms. Serious damage caused by insect pests was never observed by the cashew field owner.

Occurrence of *Oecophylla* nests

T_1 and M_1 in Plot 01 (6, 5 and 3 nests**,** respectively) only had *O. smaragdina* nests on three occasions and T_1 (3 nests) only had the nests on the fourth occasion. Frequency of occurrence values for the nests out of six trees were 2/6, 2/6, 2/6 and 1/6 on each occasion.

Types of material collected from *O. smaragdina* workers

Plant and animal materials, pieces of cashew flowers and leaves, other ants (e.g. *Cataulacus* sp., *Camponotus* sp., *Odontomachu simillimus* and *Diacamma rugosum*), body parts of thrips, hemipterans, beetles, weevils, spiders and the larvae of lepidopterans and weevils were observed among the materials carried by the *O. smaragdina* workers.

DISCUSSION

Arboreal ant assemblages throughout three phenological stages of cashew trees in the wet zone were reported for the first time in Sri Lanka. The presence of 14 ant species including *O. smaragdina* provided an insight into the importance of their presence on cashew trees with regard to the absence of major insect pests during the phenological cycle because damage symptoms were not reported in the cashew field (personal observation, second author; personal communication, cashew field owner). According to Offenberg *et al*. (2004) interspecific pheromones of the ants may have repelled the cashew pests.

Rickson & Rickson (1998) reported 8–11 species of ants including *A. gracilipes*, *C. taprobanae*, *O. smaragdina*, *T. albipes*, and unknown species of *Camponotus* and *Crematogaster* from the wet-zone cashew trees in Sri Lanka and those species were also recorded during the present survey. Ants in Ghana cashew fields included *Pheidole megacephala*, two *Crematogaster* species, *O. longinoda* and a species of *Cataulacus* and *Camponotus* on both young and mature trees (Dwomoh *et al*. 2008), and these genera were recorded during the current survey also.

Past studies have shown (Rickson & Rickson 1998) that ants were attracted to food sources, extrafloral nectaries located on both upper and lower leaf surfaces, the inflorescence axis and base of flowers and young fruits, and there was no evidence of herbivory on cashew trees. The importance of *O. smaragdina*, the most frequent species observed in the present survey, for the control of *Helopeltis* in an arid-zone cashew field in Sri Lanka was highlighted recently (Wijethunga *et al*. 2003).

Among the standard sampling methods used for arboreal insects, (such as insecticide spraying on trees, trapping, beating tray method and hand collection), two methods that did not cause untimely flower or nut dropping or repel pollinators (which ultimately could have reduced the cashew harvest) i.e. only baited trapping and hand collection, were used during the present survey. Nest building on wet-zone cashew trees by *O. smaragdina* was observed during this study, as previously observed in the wet (Rickson & Rickson 1998) and arid zone (Withanage *et al*. 2003) of Sri Lanka and in Australia (Peng *et al*. 1997) and Vietnam (Barzman *et al*. 1996). Although the nests of *O. smaragdina* were not observed on the cashew trees in the Plot 2, workers from any nest could forage on the same tree or neighbouring trees in the cashew field (Rickson & Rickson 1998). Height and maturity of the cashew trees may be an important factor in nest building by the species although we did not aim to determine the importance of the two factors during this survey; in a previous study the nests were observed only on 7-8, 10-12 and 25 year old trees and not found on 1-2 and 4 year old trees (Rickson & Rickson 1998).

The species can be categorized as an omnivore and a generalist predator when foraging on cashew trees in the wet zone of Sri Lanka, as previously noted for the species (Crozier *et al*. 2010), and workers occurred on all trees on all six occasions. Other opportunistic ant species observed during the survey can also be considered omnivores, scavengers or generalist predators, as recorded in West African cashew fields (Dwomoh *et al*. 2008). Nests of *T. allaborans* were encountered on the small branches of several trees,

indicating that cashew is a host tree of the species. The cashew tree should thus be added to the list of host trees of *T. allaborans* (Ward 2001). Also, the roles played by each ant species observed on the trees should be investigated further. Species richness and species assemblage observed on three phenological phases were slightly different, perhaps due to the fluctuations in the extra-floral nectaries on the cashew trees (Rickson & Rickson 1998).

Negative effects of ants such as decreased fruit set of cashew due to the viable pollen damage (Bhattacharya 2004) and an inhibitory effect of *Oecophylla* on flower-visiting pollinators on rambutan in Sumatra (Tsuji *et al*. 2004) have been reported and such aspects of cashew in Sri Lanka should be investigated in the future.

CONCLUSIONS

Fourteen species in five subfamilies of ants including *Oecophylla smaragdina* with 100 % frequency of occurrence were recorded throughout flowering and nut initiation phase, fruit and nut maturing phase and vegetative phase of cashew trees in the wet zone of Sri Lanka. The omnivorous predator, *O. smaragdina*, nested on large and medium sized cashew trees and also foraged on neighbouring trees.

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