ANT SPECIES DIVERSITY AND COMPOSITION AT MLINGANO MANGO ORCHARD IN TANZANIA

[1]Christopher L. Materu, [2]Seguni Z. Kombo and [3]Linus Masumbuko

[1,2,3]P O Box 6226, Mikocheni Agricultural Research Institute Tanzania
*chrismateru@yahoo.com[1]; zseguni52@yahoo.com[2,] linusmasumbuko@yahoo.ie[2]

ABSTRACT: Ants are major decomposers and they are sensitive to any human influence in our environment. Presence or absence of ants in cropland habitat is resulted from alteration of forest habitat into cropland. Ant's species diversity in mango orchard was considered as an important biodiversity indicator due to alteration of the primary forest into cropland habitat. Ants were sampled from mango trees searching species of ants from tree bases to 2M high. Dental rolls with 10% sugar as attractant bait were also used to attract ground preference of ant species. Attractant bait was placed on a tree base for 30 minutes and thereafter inspected for data collection. This study has revealed that ant species composition in mango orchard varies according to cropping system. Dominance of species was *Crematogaster* followed by *Pheidole megacephala* and the least was *Oecopyhlla longinoda* ants. Comparison of species composition revealed that there were significant differences. Species with low representative individuals were considered as extinct or rare species. The intended study was carried out at Mlingano mango orchard with the aim to determine the ant's species diversity and composition. The results from this work will help in developing sustainable biodiversity conservation programmes as well as for future research.
Key words: ants, AWA African weaver ant, species richness, diversity mango orchard

INTRODUCTION

Ants are widely distributed in tropical areas characterized with different land use [1]. They are considered as a useful tool for monitoring biodiversity changes. Habitat transformation reduces available food resources or changes the microclimate or structure of the habitat [2]. Ant's species composition has numerous advantages that make them suitable for various biodiversity monitoring studies.

Furthermore, ants play a major role of decomposers, nutrient cycling, seed dispersal, pollination and compete with other ants species [3, 4]. Ants are major arthropod predators that regulate many insect populations [5, 6, 7]. Ants have been employed as biological control to manage potential coconut bug *Pseudotheraptus wayi* (Coreidae) in coconut growing areas [8, 9].

Many studies showed ants are used as indicators of environmental changes [10, 11]. Distribution of ants is determined by seasonal changes in temperature as well as rainfall patterns [12, 13].

Other factors related to ants distribution includes vegetation type and habitat disturbance [14, 3]. Human activity *ie* opening of the forest habitat for various land use as evaluated in cocoa, banana and coffee showed that ant species diversity were seriously affected [15, 16]. Despite of the importance of ants little effort has been taken to asses' species richness and composition in mango orchards in Tanzania.

MATERIALS AND METHODS
Study Ste
The district covers an area of 1,497.96Km^2 characterized with different ground cover. The study area lies between 5° 17′and 38° 79′. Slashing was common farmers practices carried out to manage weeds in the selected mango orchard. Ants were sampled from 170 trees monoculture mango orchard planted at spacing of 9m x9m aged 8years.

Rainfall and Temperature
The district has bimodal rainfall pattern the long rain season commence from March to June and the short rain season is available between October and December. The district receives an average rainfall of about 1,400mm/year and temperatures ranges from 20°C to 32°C. Criteria of the site selection were large area under mango growing were expected to provide good data than the small mango orchard area.

Ants Sampling
Ants were sampled from mango trees searching ants from tree bases to 2M high. One hundred and seventy dental rolls with 10% sugar as attractant bait were used to attract ground and arboreal preference ant species. Attractant bait was placed on transect line at an interval of 9M and left for 30minutes and thereafter was inspected for data collection. Seven transects were marked to collect datasets on ants species composition. Furthermore, visual searching from leaf litter and collection of ants using a fine brush and preserved in insect vials with 70% alcohol for further laboratory identification.

Weaver Ants Sampling
Weaver ants abundance were enumerated directly by counting leaf nests per tree and individuals foraging on tree branches [17]. One hundred and fifty mango trees were selected randomly per site for AWA abundance assessment as follows:-
   (i)   Number of nests per tree
   (ii) Number of main tree branches foraged with AWA
   Trees occupied with AWA
   (i)   Number of tree branches foraged with AWA/ Number of main tree branches foraged with AWA x 100
   (ii) Percentage tree colonization with AWA were calculated from tree colonized with AWA per field site

Species Richness
Species richness (S), total number of species recorded at a given site during a sampling period total ant abundance (Ntot), total number of individual ants collected per tree during a sampling period; Shannon's index of diversity (H′), it was estimated as H′ $= -\sigma$ (p$_i$ ln p$_i$), where p$_i$ is the proportion of individuals of the *i*th species (pi = ni / Ntot; ni: number of individuals of the *i*th species; Ntot: total number of individuals of all species) recorded during the period of study.

Species Evenness
Species evenness index (J′), the relative distribution of individuals with which each species is represent is represented in sample was calculated as J′= H′/ H $_{max}$ (the value of J varies between 0 (a single species dominates) and 1 (all species are equally abundant), and H$_{max}$ is the maximum possible value of H′, and is equivalent to lnS— thus E = H′ lnS [18].

Ants identification
Collected ants were identified using a key developed by Bolton [19]. Only soldiers were used during identification of different species collected during the study period. Ants were identified to the genera level.

Data analysis
The collected information were subjected to one way ANOVA ("GraphPad Software, InStat guide to choosing and interpreting statistical tests, 1998, Graph Pad Software, Inc., San Diego California USA, www.graphpad.com") and mean separation were carried out using Tukey kramer method at P=0.05. Where possible the data set were transformed to normalize the data before analysis.
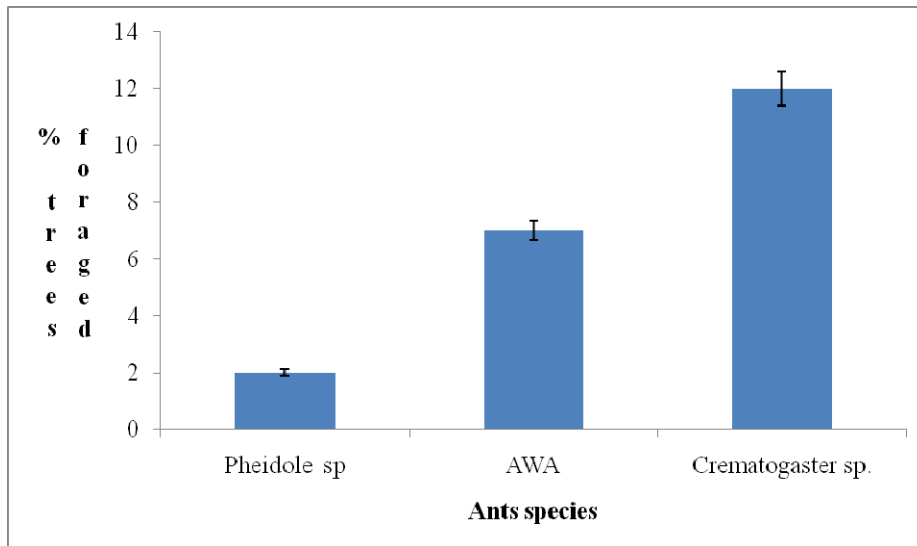
RESULTS

Ants Species Richness

During flowering season in 2013 the most species-richness genera sampled from the mango orchard were *Crematogaster* followed by *Pheidole*, and the least was weaver ants. *Crematogaster* and weaver ants were mostly arboreal ants while *Pheidole* was the most abundant ground dwelling ant (Figure 1). After one year re-sampling was carried out and the result revealed that more than 60% of mango trees were foraged by *Crematogaster* followed by *pheidole* 10%. (Figure 2).

Mean of ant species composition sampled from the mango orchard for two flowering season were extremely significance One –way Analysis of variance revealed that the p value is 0.0001 considered extremely significant (Table 1).

Table 1: Tukey Krammer Ant Species Multiple Comparison

Comparison	Mean differences	Q	P value	Significance
AWA vs *Crematogaster*	-13.93	13.10	P<0.0001	***
AWA vs *Pheidole*	-2.73	2.57	p>0.05	Ns

Figure 1: Ants species sampled from Mlingano mango orchard during flowering stage 2013
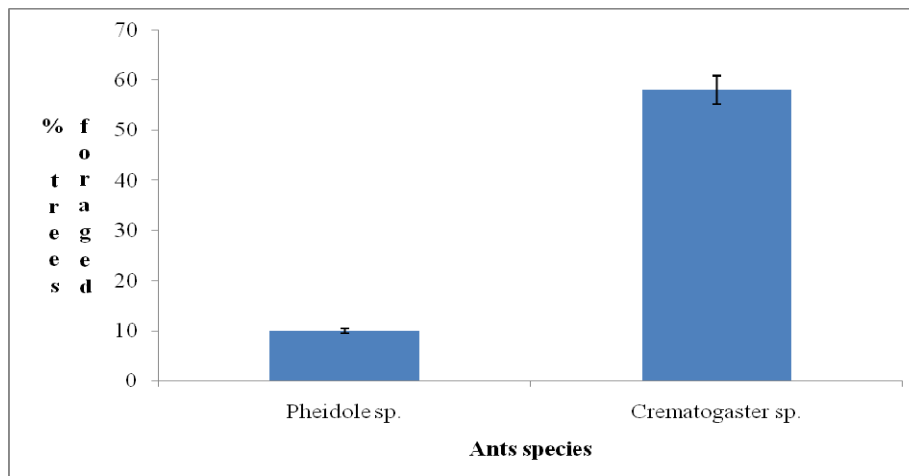
Figure 2: Ants species sampled from Mlingano mango orchard during flowering stage 2014

Species Richness

The most abundant species richness recoded was *Crematogaster*, followed by *Pheidole* and the least was AWA. The differences in numbers were statistically significant ($P < 0.05$). Only two species were recorded during 2014 flowering stage (Figure 2).

Ant Species Diversity and Evenness

Ant species diversity and evenness recorded during 2013 was high compared to 2014 during flowering season (Table 2)

Table 2: Ant species diversity and evenness during 2013 and 2014 mango flowering season

Species diversity	2013	Species diversity 2014
Species diversity (H′),	0.38	0.19
Species evenness (J′ ′= H′/ H $_{max}$)	0.34	0.27

RESULT DISCUSSION

Ants Species Richness and composition

Ants species abundance sampled during flowering season in 2013 the most species-richness genera sampled from the mango orchard were *Crematogaster* represented with 284 individuals, followed by *Pheidole*, 132 and the least was weaver ants represent 45 individuals. In 2014 *Crematogaster* represent 1,840 and *Pheidole* were represented with 361 individuals respectively.

Number of ant species sampled from Mlingano mango orchard was under estimated in contrast to studies carried out in Malaysia [20]. No weaver ants were sampled during the second year probably competition with other arboreal ants. Weaver and *Crematogaster* were arboreal nesters while *Pheidole* was the most abundant ground dwelling ant. Studies carried out in smallholder coconut and mango growing areas in Tanzania showed that weaver ants has ability to drive off range of pests [21, 22]. However, extinction of weaver ant in mango orchard depends on type of cropping systems, food availability and suitable nesting sites in agreement with other findings Khoo and Chung [23].

During the second sampling period more than 50% of the mango orchard trees were occupied by dominant ant *Crematogaster* thus lessens the foraging ability of weaver ants Figure 2.in contrast with Khoo and Chung [23].

CONCLUSION

Mono cropping of mango as practiced at Mlingano should be discouraged as the ecological complexity is not good enough to allow coexistence of ant species. Species richness, diversity and evenness were dominated by *Crematogaster* followed by *Pheidole* and the least was AWA. A difference on ant species abundance and composition in mango orchard is an evident indicator of high disturbance and poor cropping system.

ACKNOWLEDGEMENTS

REFERENCES

[1] Fisher, B. L. Biogeography in: Lach, C. L. Parr and K. L. Abbott (edds). Ant ecology. Oxford University, New York, USA, 2010. PP 18-37.

[2]   Andersen A.N; Hoffmann, D. B Mülle, J. W and Griffiths D.A. Using ants as bioindicators in land management: simplifying assessment of ant community responses. Journal of Applied Ecology 2002. Vol 39:8-17

[3] Andersen, A. N and Majer, J. D. The structure and biogeography of rainforest and communities in the Kimberley region of north-western Australia. In N. L. McKenzie R. B. Johnson and P. J Kendrick (eds). Kimberley rainforest of Australia. Survey Beatty and Sons Sydney. 1991. Pp 333-346.

[4] Gomez, J. M and Zamora, R. Pollination by ants consequences of the quantitative effects on mutualistic system. *Oecologia* 1992. 91: 410-418

[5]   Jeanne RL. A latitudinal gradient in rates of ant predation. Ecology. 1979. 60:1211–1224.

[6]   Novotny V, Basset Y, Auga J, Boen W, Dal C, Drozd P, Kasbal M, Isua B, Kutil R, Anumbor M, Molem K. Predation risk for herbivorous insects on tropical vegetation: A search for enemy-free space and time. Australian Journal of Ecology. 1999. 24:477–483.

[7]   Cerdá X, Dejean A. Predation by ants on arthropods and other animals. In: Polidori C, editor. *Predation in the Hymenoptera: An Evolutionary Perspective*. Trans World Research Network; 2011. pp. 39–78.

[8]   Van Mele P. A historical review of research on the weaver ant *Oecophylla* in biological control. Agricultural and Forest Entomology. 2008. 10:13–22.

[9]   Seguni Z.S.K. Way, M. J and Van Mele, P. The effect of ground vegetation management on competition between the ants Oeco*phylla longinoda* and *Pheidole megacephala* and implications for conservation of biological control. Crop protection 2011. 30: 713-717.

[10]   Whitford, W. G. Seasonal and diurnal activity patterns in ant communities in a vegetation transition region of southeastern New Mexico (Hymenoptera: Formicidae). Sociobiology. 1999. 34: 477-491.

[11]   Wang C., Strazanac, j and Butter L. Abundance, diversity and activity of ants (Hymenoptera: Formicidae) in oak-dominated mixed Appalachian forests treated with microbial insecticides. Enviromental Entomology 2000. 20: 579-586.

[12]   Lindsey, P. A and Skinner, J. D. Ant composition and activity patterns as determined by pitfall trapping and other methods in three habitats in the semi –arid and Karoo. Journal of Arid Enviroments 2001. 48: 551-568.

[13]   El keroumi, A, Naamani, K, Soumamane, H. and Dahbi A.. Seasonal dynamics of ant community structure in the Moroccan forest. Journal of insect Science. 2012. 94: 172-181.

[14]   Picket S. T. A. and White, P.S The ecology of natural disturbance and patch dynamics. Academic Press. New York 1985.

[15]   Perfecto I, Vandermeer J. Microclimatic changes and the indirect loss of ant diversity in a tropical agroecosystem. Oecologia. 1996. 108:577–582.

[17]   Peng, R. K. and Christian K. Effective control of Jarvis fruit fly, *Batrocera jarvisi* (Diptera: Tephritidae), by waver ants Oecopyhlla smaragdina (Hymenoptera: Formicidae), in mango orchards in the Northern Territory of Australia. International Journal of Pest Management, 2006. 52: 275-282.

[18]   Zar, J. H. *Biostatistical analysis* 4th Ed. Prentice-Hall, Inc Englewood cliffs New Jersey. USA. 1999.

[19]   Bolton B. Distribution of (Hymenoptera: Formicidae) Ants Diversity in Pohara Forest Area of Amravati Region, Maharashtra State, India 1994.

[20]   Tho, Y. P. "The termite problem in plantation forestry in Penisular Malaysia", Malaysian Forester, 1974. 37: 278-283.

[21]   Seguni, Z.S.K. Biology and control of *Pheidole megacephala* (Hymenoptera: Formicidae, Myrmicinae) especially in relation to use of *Oecophylla longinoda* (Formicidae, Formininae) for biological control of *Pseudotheraptus wayi* (Herteroptera: Coreidae) in Tanzanian coconut cropping systems. University of London 1997. pp 246.

[22]   Materu C.L; Zuberi K. S and Ngereza A. Assessment of *Oecophylla longinoda* (Hymenoptera: Formicidae) in the Control of Mango Seed Weevil *(Sternochetus mangiferae)* in Mkuranga District Tanzania. International Journal of Biology, Agriculture and Healthcare 2013.Vol. 4(8) 2224-3208.

[23]   Khoo, K.C. and Chung, G.F. Use of the black cocoa ant to control Mirid damage in cocoa. Planter, 1989. 65, 370–383.