A Case Study of Arboreal Termite (Insecta: Isoptera) Tree Selection at Fincas Las Piedras, Madre de Dios, Peru

Declan Cronin

Corresponding emails: dmcronin26@gmail.com & info@sustainableamazon.org

Abstract

Knowledge associated with the processes responsible for termite tree selection for gallery sites remains limited. While tree diameter and chemical properties seem to be important factors influencing tree choice, results of previous studies are not coherent, which is the reason why more research is required. In this study, I predicted termites would select trees based on their size, condition, and chemical defenses associated with the tree. Here I show that termite tree selection is dependent on diameter at breast height (DBH), chemical defense of the tree and the condition of the tree. The research concludes that termites are aware of resource quality and appear not to choose locations randomly but are selective of location.

Introduction

Termites are fascinating social insects that have a large abundance within the tropical rain forest. These insects remain a very important component in the decomposition cycle of biomass on the forest floor (Kircher, 2017). In the tropics, termite nests are not only found in the form of termite mounds on the ground, but also in the form of galleries on trees. Even though these termite galleries are commonly found in tropical forests, it is not clear to this point how termites choose the tree their nest is occupying. Little information is known about the factors dictating the use of trees by termites. Several factors may limit the use of trees by termites. One of these might be latex, a chemical found in a large variety of trees in neotropical forests. Latex is a white, milky substance used by trees as a chemical defense and contains terpenes known to deter termites from invading trees (Sguizzatto de Araújo et al., 2010). Next, the size of a tree could be an important factor that determines termite preference due to potentially more resources available. Larger trees would be able to provide more food for termites in the form of leaf litter and dead bark. Furthermore, trees with a large circumference have more surface area, which enables termites to create larger nests. Tree condition is another important factor to consider when attempting to understand why termites chose the tree their nest is occupying. The presence of termite galleries might be more likely on dead trees than on living trees. Only very few studies exist that investigate the factors that influence termite gallery location choice (Gonçalves et al., 2005, Sguizzatto de Araújo et al., 2010). These studies found that tree circumference affects the presence of termite galleries with thicker trees having more termite galleries (Gonçalves et al., 2005). Coherent with that, a field study conducted by DeSouza et al. (2009), found the speed at which termites occupy cellulosic baits is dependent upon the size of the bait. An additional lab experiment has shown termites will investigate the size

of baits and will choose to consume the largest bait (Evans et al., 2005). They also found a higher incidence of galleries on dead trees rather than living trees (Sguizzatto de Araújo et al., 2010). However, Gonçalves et al. (2005), concluded in their study that termites are not selective and choose trees randomly. Lastly, the presence of latex and the taxonomic family did not affect the presence of galleries on trees (Sguizzatto de Araújo et al., 2010).

Only limited knowledge exists about the choice of trees by termites for their nest sites and studies have been restricted to the locations of Rio Doce State Park, Brazil and the municipality of Conceicao da Barra, State of Espirito Santo, Brazil. Additional research exploring these factors in other locations is required due to contradictory results from different studies. Therefore, I conducted a study investigating the variables that influence termite gallery location choice at Finca Las Piedras. The hypothesis that was tested: termite galleries are more likely to be on large, living trees that do not have latex present.

The structure and methods of this study are similar to the study done by Sguizzatto de Araújo et al. (2010), in order to see if the results can be replicated in a different region.

Methods

The location of the study was at Finca Las Piedras, Madre de Dios Region, Peru (S 12°13.570', W 069°06.850'; altitude 257m above sea level). To conduct this study, eight transects were established in the forested part of the property using QGIS. All trees on the transect, as well as, five meters on each side of the transect were sampled. These transects covered 24,100 m^2 of the Finca Las Piedras 54-hectare property. Trees that had a circumference less than 15 cm were excluded in the study. CBH was measured using a measuring tape and height was estimated. The presence of latex is easily obtained and was determined by cutting a small amount into the tree. Cut sizes were 1-2 cm long and the depth was dependent on tree type but was deep enough to penetrate the bark. The amount of resources was estimated by tree size (circumference at breast height, CBH at 136 cm and height) and tree condition: alive, stressed and dead. In this study, a tree was considered stressed when 20% or more of the crown or trunk is damaged. Resources in this study were defined as food and shelter for termites. Termites in the galleries were sampled and identified in order to see if the type of species could have an effect on location.

All data was analyzed using R, using generalized linear models. Different models were used and evaluated to determine which was more powerful in analysis. The hypothesis: termite galleries are more likely to be on large, living trees that do not have latex present, was tested using a model whose binary response was the presence and absence of termite galleries. The independent variables within the model were: tree condition (alive, stressed and dead), estimated tree height (meters) and diameter at breast height (DBH, centimeters). Interaction variables were created using DBH and latex, as well as DBH and condition. Neither had statistical significance, therefore were excluded from the final model. Not significant variables, in this case only height, were removed from the model and both models were compared using Akaike's information criterion (AIC). The model excluding height was selected for interpretation as it had a lower AIC score and was determined to be a better fit for the study.

Results

A total of 836 trees were sampled. Out of 836, 630 were alive (75.35%), 114 were considered stressed (13.63%) and 92 were determined dead (11.00%). Termite galleries were observed in 274 trees (32.77%). Termites sampled from galleries are part of the Termitidae family and the genus *Nasutitermes*. This was the only genus detected in galleries within the study area. The galleries were large, dark-colored and basketball-shaped which is typical of the genus. Latex was present in 291 trees (34.80%). The mean with standard deviation of DBH in the study was 75.24 cm ± 76.32 cm. The mean with standard deviation of height of trees in the study area was 11.49 m ± 6.55 m.

The generalized linear model showed that presence of latex was highly significant and did affect the presence of galleries in the trees ($z=3.89$, $P<0.001$). Diameter at breast height (DBH) was statistically significant and termite galleries were more likely to observed with increasing diameter in trees ($z=2.78$, $P=0.005$). The presence of termite galleries was also affected by tree condition. Termite galleries were more likely to be observed in dead trees rather than stressed or living trees ($z=2.94$, $P=0.003$). Trees that were alive and considered to be stressed were not statistically significant in the study.

Discussion

Here, I examined which factors affect in which trees termites place their galleries. Termite galleries were found in trees with a larger diameter rather than smaller. Besides that, tree condition was a determinant of tree exploitation by termites. Termites preferred dead trees rather than trees that were alive or stressed. The presence of latex did deter termites from exploiting trees. Therefore, my results suggest that termites appear to be selective of trees as opposed to random selection.

While knowledge is limited about the exploitation of trees by termites there is evidence to support termites are selective of location rather than random. Evidence in this study did not support the results of Gonaçlves et al. (2005), which inferred that termites selected trees randomly. However, results were coherent with Sguizzatto de Araújo et al. (2010), implicating that termites preferred dead trees as opposed to living or stressed trees. In this study, DBH was a significant factor determining the presence of termite galleries. A study conducted by DeSouza et al. (2009), found the speed at which termites occupy cellulosic baits is dependent upon the size of the bait. Gonaçlves et al. (2005), had similar results showing that termites were more likely to be found on trees with increasing size. Another lab experiment has shown termites will investigate the size of baits and will choose to consume the largest bait (Evans et al., 2005). Termites use acoustic vibration signals to determine which bait is larger. The same process could be used in nature when selecting trees to exploit. An additional explanation of this may be that there are more resources available for feeding and gallery sites.

Contrary to results produced by Sguizzatto de Araújo et al. (2010), my results support latex as a deterrent to termites exploiting trees for gallery sites. This evidence was coherent with previous studies performed that showed termites did avoid chemical defenses in trees and plants (Smythe & Carter 1970; Behr et al. 1972). These studies were conducted in a laboratory setting rather than a field study as this one. Even though these are obvious differences it could still be valid for the field.

The results presented may provide better insight on the process of tree

selection by termites. Evidence supported the quantity of resources was a significant factor in exploitation, as well as, condition and the presence of latex. It is reasonable to conclude that termites are aware of resource quality and appear not to choose locations randomly but are selective of location. However, more research is necessary as results are still not fully clearly and different patterns emerge from different studies.

Acknowledgments

I would like to thank Barbara Hendus for the advice, guidance, and expertise throughout the entire project especially during the process of data analysis. Without Barbara's help this project would have been significantly more difficult to complete. Barbara's unending support does not go unnoticed. I would also like to thank the rest of the staff at Finca Las Piedras for providing mentorship during my time here.

Works Cited

Behr, E.A., Behr, C.T. & Wilson, L.T. (1972). Influence of Wood Hardness on Feeding by the Eastern subterranean termite, *Reticulitermes flavipes* (Isoptera: Rhinotermitidae). *Annals of the Entomological Society of America* 65, 457-460.

DeSouza O., Araújo, A.P.A & Reis Jr., R. (2009). Trophic Controls Delaying Foraging by Termites: Reasons for the Ground Being Brown? *Bulletin of Entomological research* 99, 603-609.

Evans, T.A., Lai, J.C.S., Toledano, L., McDowall, Rakotonarivo, S. & Lenz, M. (2005). Termites Assess Wood Size by Using Vibration Signals. *Proceedings of the National Academic Science* 102, 3732-3737.

Kricher, John C. (2017). *The New Neotropical Companion*. Princeton University Press, 2017. 2nd ed., 91-93.

Martius, C., Amelung, W. & Vinicius Bastos Garcia, M. (2000). The Amazonian Forest Termite(Isoptera: Termitidae) (*Constrictotermes cavifrons*) Feeds on Microepiphytes. *Sociobiology* 35, 379-382.

Smythe, R.V. & Carter, F.L. (1970). Feeding responses to sound wood by *Coptotermes formosanus, Reticulitermes flavipes*, and *R. virginicus* (Isoptera: Rhinotermitidae). *Annals of the Entomological Society of America* 63, 841-847.

Squizzatto de Araújo, F., Albano Araújo, A.P., Marcelo da Silva Junior, W., Augusto Alves Meira Neto, J.& DeSouza, O. (2010). Bottom-Up Effects on Selection of Trees by Termites (Insecta: Isoptera). *Sociobiology* 55, 725-733.

Telles Gonçalves, T., DeSouza, O., Reis Jr., R. & Pontes Ribeiro, S. (2005). Effect of Tree Size and Growth Form on the Presence and Activity of Arboreal Termites (Insecta: Isoptera) in the Atlantic Rain Forest. *Sociobiology* 46, 1-1