Micro-landscape context effects on the dispersal of coffee berry borer (*Hypothenemus hampei*) in Costa Rica

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Introduction

The coffee berry borer (CBB) *Hypothenemus hampei* (Ferr.) has been detected in the Costa Rican landscape since 2000 from whence it has rapidly expanded its territory, colonizing new coffee farms. Although the males of the species have atrophied wings and are flightless, females have the ability to fly, and particularly do so when seeking new coffee berries to colonize after harvest. Distances covered by CBB are known to be large enough to reach proximate pest free areas (Baker, 1984); however, the number of individuals able to fly great distances across non-coffee land uses is probably low. As a consequence, CBB dispersal is believed to be facilitated by the connectivity between coffee plantations, but may be hampered by fragmented landscapes when alternate land uses are found between coffee patches.

The aim of this study was to understand the effect of landscape context on the short distance dispersal (≤140m) of CBB in the Turrialba canton. Turrialba is a low altitude coffee region of Costa Rica under Caribbean influence, favorable to CBB development.

Materials and Methods

We conducted a six-month study during the flight period of the CBB (January to July 2009), in six locations of the Turrialba region (Figure 1). Each location consisted of one isolated coffee plantation bordered by two of the following three possible land uses: (1) forest, (2) sugar cane and (3) pasture. Each of the land uses combinations (forest-pasture, pasture-sugar cane, forest-sugar cane, Figure 2) was repeated twice.

Due to the isolation of the studied coffee plantations, we assumed that these were the only sources of CBB in each location. CBB movements from the coffee plantations to the other land uses were studied by using Brocap® traps (Figure 2) baited with a 3:1 mixture of methanol and ethanol (Dufour *et al*., 2005, 2008).

Figure 2. Coffee-forest-sugar cane combination in one of the six locations of the study. Four Brocap® traps can be seen in the coffee field

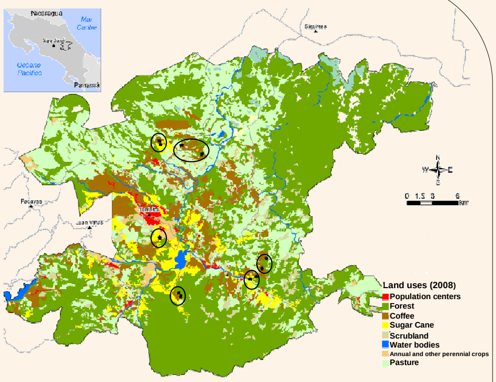

Figure 1. Location of the six study coffee plantations (ovals) and the groups of three transects with Brocap® traps (stars) extending into the two adjacent land uses,Turrialba, Costa Rica

Figure 3. Simplified representation of the distribution of the BROCAP® traps along six transects in a coffee-forest-sugar cane combination. Other studied land uses combinations were coffee-forest-pasture and coffee-sugar cane-pasture

At each location, we established six transects, with traps placed each 10 m, starting 30 m within the coffee plantation and continuing 140 m into each of the two adjacent land uses (three transects per land use separated by 30-40 m each) (Figures 2 and 3). The captured CBB were collected and counted every ±12 days. We analized data from a total of 120 days of trapping.

Our primary response variable was the number of females captured per day. We used the median data from the three transects in order to normalize the data's distribution.

We used a generalized linear mixed model to analyze the data, where the adjacent land use and the distance of the Brocap trap® to the coffee plantation were considered as fixed factors and the collecting date as random factor. We also included altitude as a covariable.

Results

We captured 96.5% of the individuals within the coffee plots and only 3.5% in the adjacent land uses. The majority of the individuals captured outside the coffee plots (30.2%) was found directly on the edge between the two land uses. However, some individuals (2.9%) were found up to 140 m from the coffee edge beyond which we had no traps (Figure 4). Despite this low frequency of dispersal events outside of coffee, we found significant differences in the permeability of the three adjacent land uses. The forest generated the greatest friction to CBB movement: the number of CBB captured in forests was only 12 % and 19 % of the number of CBB captured in sugar cane and pasture respectively (Figure 5).

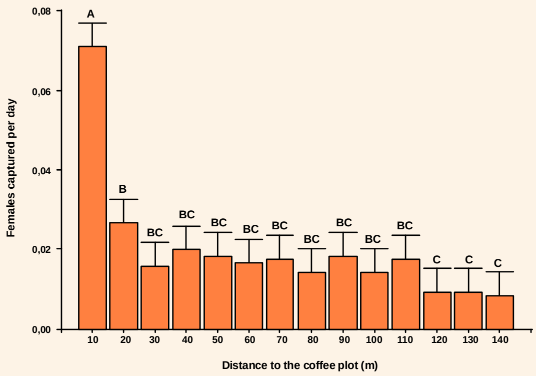

Figure 4. Number of coffee berry borers captured per day with Brocap® traps during a 120-day period as a function of the distance to the coffee plot (mean of the medians data from three transects)

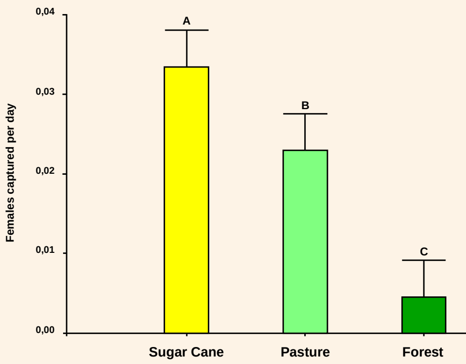

Figure 5. Number of coffee berry borers captured per day with Brocap® traps during a 120-day period in different land uses up to 140 m from a coffee plot (mean of the medians data from three transects)

Discussion and Conclusion

Although occasional CBB individuals were captured 140 m from coffee edges, our results show that CBB does not regularly disperse outside of coffee. This finding suggests that breaking connectivity between coffee plantations may help to reduce CBB dispersal particularly when low permeability land uses such as forests are placed between coffee plots (compared to sugar cane and pasture which have greater permeability). These results are especially important in the Turrialba region where CBB flights are not so abundant due to the year-round presence of coffee fruits for CBB infestation. Because of this, we recommend that the study be repeated in other regions with synchronized flowering.

References

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