DISTRIBUTION OF CICADA NYMPHS IN PRIMARY AND SECONDARY LOWLAND TROPICAL RAINFORESTS

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Abstract. Cicada (Cicadidae) nymphs leave behind their casts on the ground, often attached to leaves in the forest understory. A non-random distribution of nymphal casts indicates cicada host plant preference. In this study, the distribution and abundance of cicada nymphal casts was measured in the primary and secondary forest at Corcovado National Park, Costa Rica. Nymphal casts were more abundant in the secondary forest than the primary forest. Nymphal casts occurred in regularly distributed clumps or patches in second growth forest. In the primary forest, nymphal casts were randomly distributed. The greater abundance and patchy local distribution of nymphal casts in the secondary forest may be due to the greater abundance there of balsa trees (*Ochroma lagopus*). Nymphal cast abundance was highest under balsa trees, indicating that nymphs, as with adult cicadas, may prefer balsa.

Key Words: balsa , habitat distribution, nymphal casts

INTRODUCTION

Cicadas (Homoptera: Cicadae) are large bodied arboreal insects that inhabit temperate and tropical forests. Cicadas are well-known in the United States for their thirteen and seventeen year life cycles, but in Costa Rica, cicadas have an annual life cycle (Young 1983). In the lowland tropical rainforest, many species of cicadas have several overlapping generations of nymphs. Cicadas suck sap from plants, thus potentially having a great impact on plant growth and survival. In addition, when cicada abundance is high, they may damage trees.

According to Young (1983), cicadas deposit white eggs on branches of palm fronds in the understory. The nymphs drop to the ground and burrow into the soil. Upon hatching, the nymphs leave behind their casts on the ground or often attached on the underside of leaves. These nymphal casts are often more common underneath some tree species than others. It has been suggested that the location of these nymphal casts may indicate feeding preferences of nymphs (Young 1983).

In this experiment, I tested whether nymphal casts were patchily distributed under certain trees, which would indicate feeding preferences for those trees. I hypothesized that (1) nymphal casts would be patchily distributed if they had feeding preferences for a particular species of trees. If not, their distribution should be random. I compared the distribution of nymphal casts in primary and secondary lowland tropical forest.

METHODS

On 3-5 February 1997, I sampled the spatial distribution of cicada nymphal casts in Corcovado National Park, Costa Rica. I sampled two long transects, one in the primary forest and one in the secondary forest. The primary forest transect was located approximately 500 m from Sirena Biological Station on the north end of Los Espavales trail, running 2 m to the side and parallel to the trail for approximately 111 m on one side and 96 m on the opposite side of the trail (50 quadrats). The secondary forest transect was similarly placed along the Pavo trail, starting approximately 150 m from Sirena Biological Station on the Los Patos (Pavo) trail, taking quadrats for approximately 131 m on one side , 101 m on the opposite side (44 quadrats). On each transect , 2 x 2 m quadrats were located every 5 m. Within quadrats, I searched all leaves less than 4 m above the ground for nymphal casts. I counted the number of nymphal casts, noting but not recording differences in size. Scot Zens identified the dominant trees which were above the quadrats I sampled.

To determine if the nymphal casts were randomly distributed, I performed two types of tests for two scales of dispersion on both the primary and secondary forest samples. For distribution within quadrats, I calculated an index of dispersion [$I = \sum(ni-n)2/(m-1)n$], where m= number of quadrats, ni=number of points in quadrat I, and n= mean number of points per quadrat, for both the primary and the secondary forest (Schulze et al 1997). This index of dispersion was used to assess if the distribution of cicadas within quadrats was clumped (I>1), randomly distributed (I=1), or evenly distributed (I<1). A randomization test was used to determine if nymphal casts were randomly distributed between quadrats. This test determined if the observed mean distance between neighbors was different from a large number of simulated random distributions of quadrats containing cicadas. Observed mean neighbor distances smaller than the simulated random mean neighbor distances indicate clumped cicada patches while greater observed mean neighbor distances than the simulated distances indicate an even distribution of cicada patches.

RESULTS

The secondary forest had a greater abundance of nymphal casts than the primary forest (one-way ANOVA, F= 10.63, df= 9, P= 0.002). The primary forest had a mean of 1.22 nymphal casts per quadrat (S.E.= 0.46), while the secondary forest had a mean of 3.36 nymphal casts per quadrat (S.E.=0.46).

In addition, the number of nymphal casts is related to the presence of balsa trees (G=5.97, df= 2, P=0.05). More patches with balsa than without balsa have a high number of nymphal casts (Table 1). A list of overstory tree taxa found above the primary and secondary forest patches sampled is given in Table 2.

Next, I looked at the distribution of nymphal casts, at the scale of quadrats (Fig. 1). Nymphal casts at this scale were randomly distributed in the primary forest (dispersion index=4.09, df= 43, P=1.000, critical chi-square value= 59.30). In contrast, nymphal casts in the secondary forest were clumped (dispersion index= 62.8, P= 0.05, df=49, critical chi-square value=62.09).

Table 1: Frequency of nymphal cast categorized by presence or absence of overstory balsa (*Ochroma lagopus*)

Category (# casts)	Balsa absent	Balsa presentt	Total Quadrats
1 (0 casts)	29	8	37
2 (1-3)	31	14	45
3 (≥4)	6	8	14
Total	66	30	96

Table 1: Trees in the overstory above quadrats sampled for cicadas in primary and secondary forest. Number of particular genera and species within families, where known, are given in parenthesis.

Taxa	Primary Forest Abundance	Secondary Forest Abundance
Anacardiaceae: Anacardium sp (5,0) Spondius mombim (3,7)	8	7
Anoncaceae	6	0
Apocynaceae	0	3
Aracaceae: Astrocanon standly-anum (4,0) Chrysophila gulugara (2,0)	6	0
Bombacaceae: Ochroma lagopus (1, 27)	1	27
Burseraceae	1	0
Euphorbiaceae	2	0
Fabaceae	4	0
Lauraceae: Acae sp. (0, 3) Octaea sp. (1,0)	1	3
Meliaceae: Carapa guanensis (0,6)	1	6
Moraceae: Castilla sp (7,1) Cecropia sp (3,1) Ficus sp (2,0)	12	2
Myristicaceae	1	0
Myrsinaceae	1	0
Passifloraceae	2	1
Rutaceae: Xanthoxylem sp(0,1)	0	4
Sapotaceae	1	0
Tiliaceae: Goethalcia sp (1,0) Luchua sp (0,1)	1	1

The mean distance between quadrats containing nymphal casts in the primary forest was 29.5 m, while the mean distance between quadrats with nymphal casts in the secondary forest was 35.1 m. Using a randomization test, I found that the quadrats containing nymphal casts were randomly distributed in the primary forest (df= 43, P= 0.44) and evenly distributed in the secondary forest (df= 49, P= 0.04). A computer-generated random distribution of mean neighbor distances and the actual mean distance between nymphal casts in the primary and secondary forest is shown in Fig. 2.

Discussion

Preference by cicada for balsa appears to be strong. In the secondary forest, nymphal casts are clumped at the scale of quadrats, but these patches were regularly distributed. The larger scale regular distribution appears to match the regular distribution of balsa, the dominant emergent in the secondary forest. The nymphal casts may be clumped at the smaller scale because adults may have preferences for where they lay their eggs; for example, leaves of the same species may be more suitable than others. The females lay eggs in the understory, so the clumped distribution of nymphal casts within quadrats may reflect the distribution of preferred understory trees for egg deposition.

There was probably a smaller number of nymphal casts in the primary forest because the primary forest had fewer balsa trees, and the nymphs seem to prefer balsa sap. In addition, the primary forest distribution of nymphal casts might appear more random on a large scale, because of the fewer preferred balsa trees in the primary forest. In the primary forest, cicadas may be clumped where there are no highly preferred host species. This may result in more randomly distributed suitable egg laying substrates than in secondary forests.

Further studies should investigate other preferred food sources of nymphs to determine if small scale patchiness is, in fact, due to preferred egg deposition sites. By examining size and other characteristics of nymphal casts, it should be possible to differentiate between species. Food or substrate attachment preferences of specific cicada species may help us further understand the basis for the spatial distribution of cicadas and their nymphs.

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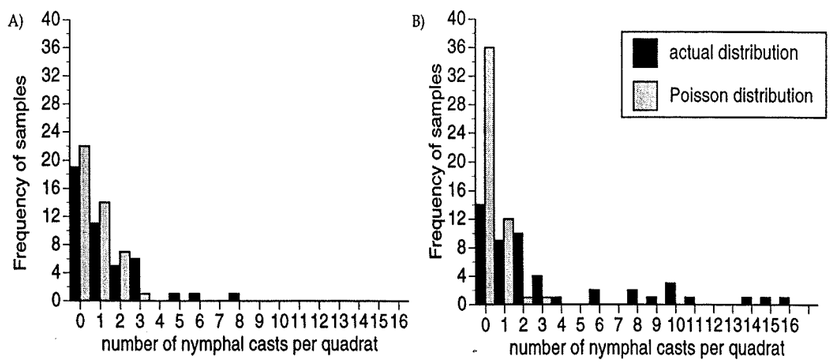

FIG. 1. The frequency distribution of nymphal casts in a 2m x 2m quadrat (black) and a Poisson distribution (stipled) in (A) primary forest and (B) secondary forest. Nymphal casts are clumped in the secondary forest i.e., do not fit the Poisson distribution- (see text).

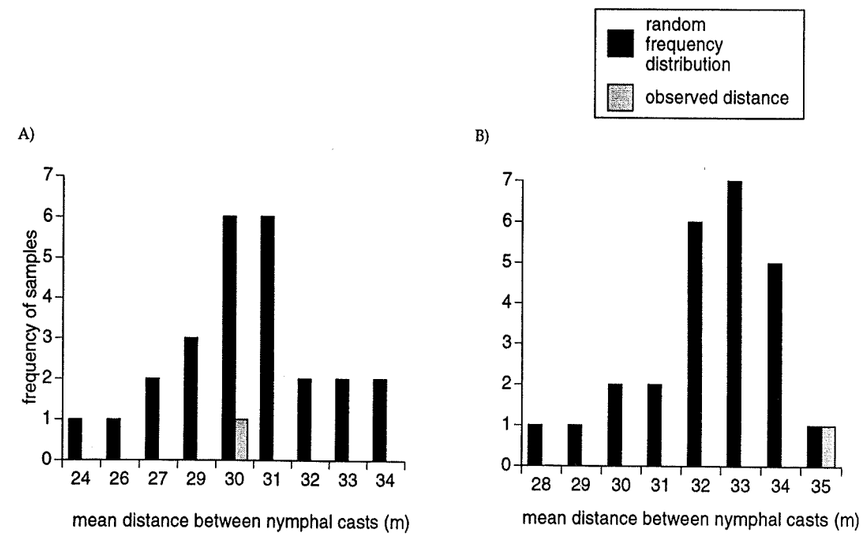

FIG. 2. A random distribution of distance (m) between nymphal casts (black) and the actual mean distance (stipled) in the (A) primary forest and (B) secondary forest. Nymphal casts are evenly distributed in the secondary forest (randomization test)- see text.