Mud: An Insect Hotspot

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Introduction

We observed a small section of forest trail at La Selva to be an insect hotspot. Specifically, a very localized section of the trail was intensively visited by a large number of individuals and species of Hymenoptera, especially a trigonid bee (Melipona sp.), to collect mud. We censused the insects visiting this spot, attempted to characterize their behavior and interactions, and performed an experimental manipulation to test the importance of: 1) disturbance, 2) site and 3) mud in producing this hotspot. Disturbance produced a short-term decrease in activity, while both site and mud types significantly increased visitation rate and length of stay.

Methods

The hotspot (approximately one meter by two meters) was on a bare, muddy section of the East Boundary trail, between a forest edge and an open light gap. The ground was level, and not perceptibly different from neighboring sections of the trail in muddiness, slope or soil type. Insects were visiting the site to collect mud.

On 4 July, 1981, we set up two 0.5 by 0.5 meter quadrats within the hotspot, and made observational censuses of all insects visiting the two sites during one minute intervals, every fifteen minutes from 0730 to 0930, then after experimental manipulation, from 1000 to 1130. In addition, from 0800 to 0930, and from 1000 to 1130, we observed individual insects in each plot, and recorded the following data for each visit: the species of insect, the length of stay on the mud in the plot, whether mud was gathered or not, the presence of other insects in the quadrat, and interactions with other species, defined as the approach of one insect causing the flight of the approached insect. We marked approximately twenty insects with paint in order to recognize individuals.

To experimentally test the effects of disturbance, site, and mud on the visitation rate in creating the hotspot, two additional quadrats were set up approximately three meters down the trail, at the edge of the light gap, in a slightly lower, wetter section of the trail. Each of the plots was subdivided into equal halves, and the following manipulations were performed. At each site, one subsection was left as a control. In another subsection, the mud layer (5 cm) was dug up and replaced as a sham-control. In the two remaining subsections, the mud layers were removed and reciprocally transplanted with the other site. All subsections were then compressed to the trail level by boot compaction. An additional subquadrat was created on the edge of the original quadrats as an additional control, because we noticed many insects going to the edge of the original control, but not entering, apparently becuase of the compaction disturbance.

Results

During the observations, six species of Hymenoptera were observed, but two species, a meliponid bee (Melipona sp.), and a vespid wasp (genus unknown) accounted for 80% of all observations. All data reported here are for the predominant Melipona species only. An average of 4.4 Meliponas were observed in the two hotspot plots during the one minute censuses, but by eliminating the censuses immediately after the experimental manipulations, the average increases to 5.3 (Fig. 1).

Individual observations show that many of the visits were of very short duration, and no mud taking was observed during these short visits. These short, non-mud taking visits increased from 28% of the visits before the experimental disturbance to 70% of the visits post-disturbance (Figs. 2 and 3).

The effect of disturbance is also demonstrated in the experimental plots, where visitation length between the untouched controls and the sham-controls is almost significant (Mann-Whitney $U = 33.5$, $0.05 < p < 0.10$).

The effect of mud on visitation rate is significant in one of the two transplants ($U = 23$, $p < 0.01$), but not significant in the other. The visitation rate also dropped significantly between the control, the original, and the newly created control, from the transplants ($U = 61.5$, $p < 0.01$; $U = 14.5$, $p < 0.05$).

The site effect was significant in visitation duration ($U = 61.5$, $p < 0.01$) and the number of visits during the censuses (22 in the hotspot quadrat, 1 in the new quadrats). Twelve insects visited the foreign soil in the hotspots, while only one insect visited the hotspot soil in the new site.

Discussion

The hotspot phenomenon appears to depend largely on site factors, probably most importantly the location in a light gap and the amount of water. This is apparent in the large site differences tested for above. The highly localized nature of the hotspot does not appear to be explained by these factors, however, as these same conditions existed for several meters on either side of the hotspot. It is also significant that the hotspots remained stationary throughout the day, and did not move with temporal factors of light and/or heat.

Disturbance caused a great decrease in the number of visits, the duration of visits, and mud taking. The effect seems temporary, however, and did not cause a large shift, or disappearance of the hotspot phenomenon.

Other hypotheses could be entertained to explain the phenomenon, including its proximity to insect nests. The number of species visiting the site, and their extreme concentration, however, seems to refute this hypothesis.

Most surprising of the results is the significance of the mud in the duration of visits and mud-taking by the bees. This mud factor may explain the highly localized hotspot within a more generally appropriate site.

Future work should investigate the chemical nature of the mud, which may be distinct to the site, possibly due to root exudates. Also interesting to investigate would be the role of "memory" in insects in returning to the spot: whether or not the same insects return to the site, and how new individuals find the site.

Addendum

The same site was observed during two days, approximately six weeks after this study (17 and 18 August). The hotspot persisted; Meliponas and vespids were visiting exactly the same site in high concentrations, while not visiting other areas further down the path, including the site of the previous mud transplants.

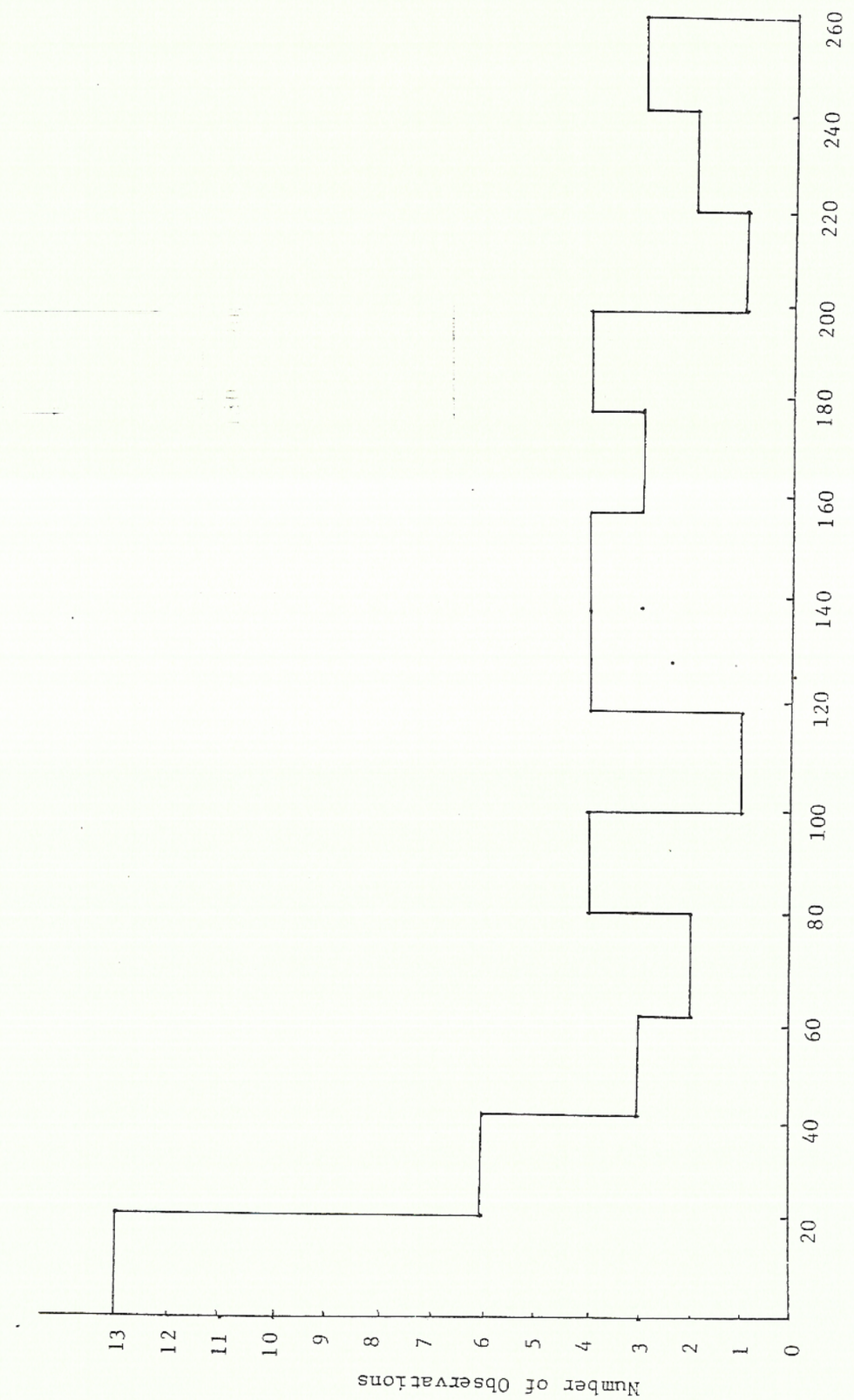

Fig. 2. Histogram of the length of bee visits to the experimental plots before experimental manipulations.

Fig. 3. Histogram of the length of bee visits to the experimental plots after manipulations.

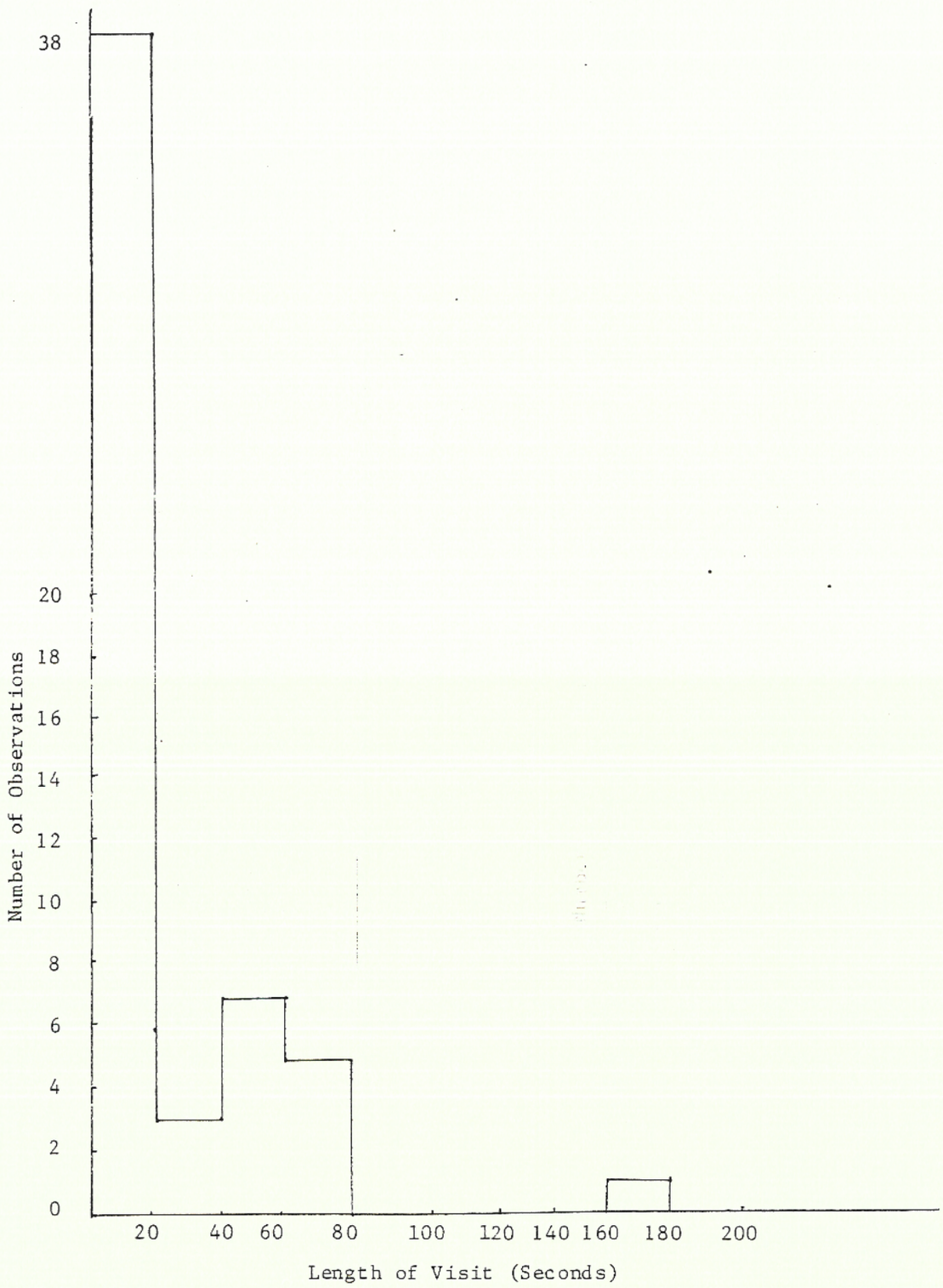

Fig. 1. The number of bees visiting the experimental plots during one minute censuses. The arrow indicates the time of experimental manipulation of the plots.