Composition of Scavengers in the Canopy and Understory

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ABSTRACT

The degradation of dead organic matter by scavengers is an important step in the circulation of nutrients in all ecosystems. In tropical rainforest ecosystems, the canopy and understory are two very different environments and thus would be expected to contain differing levels of scavenger species abundance, diversity, and composition. Four uniform traps were used to collect specimens for this experiment. The experiment focused on examining differences that arise between different bait types, times of day, and forest canopy vs. understory. Significant results were found when comparing overall abundance and time of day, diversity and type of bait, and ant and fly composition and forest level.

Key words: scavengers, canopy, decomposition, understory, community ecology

INTRODUCTION

Scavengers play an integral part in all ecosystems through the degradation of dead organic material and circulation of nutrients throughout the community. In tropical rainforest ecosystems, scavengers play an even more important role by vertically transporting nutrients between the canopy and the understory, two very different habitats within the ecosystem. Our study looks at the differences in diversity, composition, and abundance of scavengers in the canopy and in the understory at Maliau Basin, Borneo. Due to the greater amount of dead material in the understory in comparison to the canopy, we hypothesized that species abundance in the canopy should be lower than that in the understory; however, since the canopy habitat differs from the understory habitat in that it consists of complex systems of branches and leaves of varying morphologies and sizes as well as being raised a good distance above the ground, there should be a certain degree of specialization in its residents, leading to a second hypothesis that species diversity should be higher in the canopy than in the understory. Due to considerable ecological differences between the canopy and understory, we additionally made the more general hypothesis that organismal composition between the two habitats should be different. Secondary hypotheses involving the additional factors of time of day of collection and type of bait used to attract scavengers include expectations that more and more diverse scavengers will be attracted to the traps during the day compared to during the night, since temperatures are higher and the decay rates greater as well as greater scent travel distance; and that there should be little difference in abundance and diversity of scavengers across the two different bait types (fruit and meat), as we found no evidence to suggest that such differences existed. Achieving greater knowledge of the scavengers, a much-overlooked group of organisms that are nevertheless essential to proper nutrient cycling within the rainforest ecosystem, will better enable biologists (researchers and conservationists alike) to model the ecological changes that may occur following both natural disturbances such as typhoons and El Niño events and human disturbances such as logging, whether or not it is done selectively or sustainably.

MATERIALS AND METHODS

To collect specimens for this experiment, four identical traps were constructed using cardstock, adhesive tape, and plastic bags. Three plastic bags were taped together using duct tape to form the body of the trap. The ends of the traps were then sealed and fitted with a paper funnel on the bottom and a sealed plastic cup with fruit or meat bait on the top. Small holes were cut into the bottom of the cup in order to facilitate the circulation of air and the spreading of the smell of the bait. The traps were then spread out over two trees, with two traps placed in the canopy and two ~1m above the forest floor. Each trap was filled with rotting meat for one 24-hour period and with fruit for the other, with each tree having one type of bait for both levels. The traps were checked twice a day, once at 7:00am and again at 6:00pm. In order to collect the specimens, the traps were uniformly filled with knockout gas and then the bottom unsealed. To avoid repelling insects by the scent of the knockout gas, all of the traps were aired for several minutes after fumigation. To ensure that all of the collections would be uniform, the traps were also sprayed and aired before the first collection. All of the collected specimens were brought back to the lab for identification down to order level. Subsequent statistical analyses were conducted using R software, version 2.7.0.

RESULTS

Table 1. Abundance and Diversity of Insect Scavengers Collected in Traps at Maliau Basin, Borneo

Trap Name	Time	Level	Bait Type	Abundance	Diversity
Catapult	Day	Understory	Meat	37	0.81
Catapult	Day	Understory	Fruit	17	0.36
Catapult	Night	Understory	Meat	12	0.56
Catapult	Night	Understory	Fruit	5	0.5
MinSheng	Day	Canopy	Meat	30	0.64
MinSheng	Day	Canopy	Fruit	22	0.3
MinSheng	Night	Canopy	Meat	2	0.69
MinSheng	Night	Canopy	Fruit	5	0
Santiago	Day	Understory	Meat	10	0.35
Santiago	Day	Understory	Fruit	2	0
Santiago	Night	Understory	Meat	4	1.04
Santiago	Night	Understory	Fruit	2	0.69
Shirley	Day	Canopy	Meat	27	0.52
Shirley	Day	Canopy	Fruit	55	0.82
Shirley	Night	Canopy	Meat	3	0.64
Shirley	Night	Canopy	Fruit	3	0

ANOVA and GLM comparing diversity and bait type gave a p-value of 0.03.
ANOVA and GLM comparing abundance and time of day gave a p-value of 0.004.
ANOVA and GLM comparing percent abundances of ants between canopy and understory gave a p-value of 0.02.
Wilcoxon's rank sum test comparing abundances of ants between canopy and understory gave a p-value of 0.04.
ANOVA and GLM comparing abundances of flies between canopy and understory gave a p-value of 0.1.
Wilcoxon's rank sum test comparing abundances of flies between canopy and understory gave a p-value of 0.03.
ANOVA and GLM comparing percent abundances in the understory between ants and flies gave a

p-value of 0.05.
ANOVA and GLM comparing percent abundances in the canopy between ants and flies gave a p-value of 0.004.

DISCUSSION

Our results did not show significant support for our primary hypotheses that scavenger abundance would be greater in the understory but that diversity would be greater in the canopy, leading us to conclude that between the forest canopy and understory there are no significant differences between species diversity, or abundance. With our available resources it was difficult to statistically assess compositional differences between canopy and understory, but we did notice that ants (Order Hymenoptera) seemed to be more abundant in the canopy while flies (Order Diptera) were more abundant in the understory, which given the biology of these two orders – ants being observed more often on the ground and flies in the air – is rather surprising. This observation was supported by ANOVA tests, Wilcoxon's rank sum tests, and generalized linear models, calculated using percent abundances (since our data showed considerable variability in the raw numbers) and all with p-values less than or equal to 0.05. This finding may be explained by the fact that personal observations of ants and flies are (nearly) always made in the understory. Because flies are primarily scavengers while ants have many other food sources, flies may predominantly occur in the understory (statistically significant by a Wilcoxon's rank sum test using percent abundances with p-value = 0.03) where the forest's dead matter accumulates, outcompeting ants there; but in the canopy, where less dead matter is found, ants are the predominant scavengers. We have looked mainly at ants and flies in our data as they form the vast majority of insects caught in our traps.

Regarding our secondary hypotheses that diversity and abundance would be greater during the day than night and that diversity and abundance would be about equal between the meat bait and the fruit bait, results were mixed. For bait types, ANOVA showed a p-value of 0.03 comparing diversity and bait type, indicating a significant difference between diversities across the bait types when we had predicted none; and a second ANOVA showed a non-significant p-value of 0.8 comparing abundance and bait type, indicating no significant difference in abundances between meat and fruit baits, as we had predicted. For time of day, ANOVA showed a non-significant p-value of 0.8 comparing diversity and time of day, indicating no significant difference in diversity between day and night when we had predicted a greater diversity during the day; and a second ANOVA showed a p-value of 0.004 comparing abundance and time of day, indicating significant differences in abundances between day and night, with day having the greater abundances, as we had predicted. The unexpected finding that scavenger diversity differed between meat and fruit bait may be explained by the difference in availability of meat and fruit in the forest, as well as the increased competition in the case of fruit since both scavengers and various fruit-specialist dispersers are competing for the same fruit resources; while the unexpected finding that there was no difference in diversity between day and night may be explained by the partitioning of scavengers into primarily diurnal and primarily nocturnal species.

It must be noted, however, that our identification of insect specimens caught in our traps necessarily ignores all those individuals who were, for any reason, unable to find their way inside the trap, as well as all those who were, for any reason, able to find their way back out again. Due to the method of collection from the traps we have also excluded microscopic insects. Much information may have been lost due to our identification of the insect specimens to order only, as we did notice, for example, that more than one species of ant (Order Hymenoptera) was found in the traps, but did not have sufficient resources to identify them to species level. It was also impossible for us to control for weather due to time limitations on our data collection period, and we observed that, for example, rainfall generally occurred in the early evening while we were at the research location, such that the rain generally fell in the nighttime period of our experiment. However, we have maintained consistent sampling practices across all traps set as much as possible, and in such a way hope to minimize the amount of bias introduced through our methodology.

As the amount of degraded tropical rainforest, partially logged forest, and other forms of disturbed forest increases in Southeast Asia, the understanding of scavenger communities and thus nutrient cycling in the vertical rainforest system becomes ever more critical. Canopy scavengers often reinvest nutrients in the understory through deposition of their fecal matter and their own decomposition; if a decrease in canopy density in our studied system were to occur, it may result in fewer canopy scavengers and subsequently reduce nutrients that are available to the understory, which will be important in determining the species composition of the understory in the gaps that are thus formed, as well as affecting the forest's regeneration capacity following disturbances. Many scavengers are also involved in pollination events, such that any change in density of canopy or understory will likely affect scavengers, which in turn affects overall community composition in both habitats.

Further studies could be conducted not only to expand this same project by collecting using better-constructed traps, more traps, a longer period of data collection (to better control for factors such as weather conditions), and identification of specimens to species level. Another interesting study would be to construct a phylogeny of the species observed to look at not only the ecology but also the evolutionary implications of vertical stratification in habitats on speciation events.

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Yes, we will change this before we submit our final version.

LITERATURE CITED

(no relevant literature found in the summer 2008 course library)