ABUNDANCES OF TWO DUNG BEETLE SUBFAMILIES (SCARABAEINAE AND APHODIINAE) IN FORESTED VS. OPEN TROPICAL HABITATS

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Abstract. Mammal dung is a nutrient-rich resource that is patchily distributed in time and space in lowland rainforests of Costa Rica. Two subfamilies of scarab beetles which have specialized at utilizing this resource are the Scarabaeinae and Aphodiinae. Scarabaeinae generally form balls of dung which they roll away from the source pile, while Aphodiinae dig tunnels under the dung pile in which they deposit small dung balls. Based on these different foraging methods, we predicted (1) that more ball rollers (Scarabaeinae) would be found in the forest than in open fields, because the dense growth of grasses in the open field would limit the mobility of a ball roller and (2) that burrowers (Aphodiinae) would be found in equal abundance in forest and open field sites, as they do not need to move the dung from the source. As predicted, we found a greater abundance of Scarabaeinae beetles at the forest sites than the open field sites, but no significant difference in the abundances of Aphodiinae beetles between the forest and the open field sites. Thus physical conditions of a habitat (e.g. amount of leaf litters, density of plant growth) may limit the specific behavior of a species, which may influence dung beetle

INTRODUCTION

One potentially important input of nutrients into lowland rain forests is mammal dung. Many specialist insects are associated with this nutrient-rich resource, utilizing it as food or for laying eggs. In the Atlantic lowlands of Costa Rica, there are two primary sub-families of dung beetles (Coleoptera: Sacarabaeidae) that forage on dung: Aphodiinae and Scarabaeinae (Arthropods of La Selva, ALAS). Aphodiinae are small beetles (2-10 mm) that burrow through dung piles to form balls of dung in tunnels underneath the source pile. Scarabaeinae, generally larger beetles (10-30 mm), form balls of dung which they roll away from the pile to deposit in a tunnel far from the original deposition site (White 1983).

Variation in dung use by these specialists has been observed across Costa Rica. For example, Janzen (1983) observed horse dung sitting untouched by beetles in pastures outside Corcovado National Park, Costa Rica, while a similar pile only tens of meters away within the rain forest nearly disappeared overnight. One possible explanation for this observation entails potential differences in the abundances of dung beetles between habitat types (field vs. forest). Perhaps these differences are so great that the deposition site of a dung pile affects which, if any, dung beetles will find it.

We hypothesized that more Scarabaeinae dung beetles would be found at dung in closed canopy forests than open fields; whereas Aphodiinae dung beetles would be found at a similar abundance in both closed canopy forests and open fields. We based this prediction upon the assumption that the dense grass coverage of open fields would limit ball-rolling, thereby limiting the number of ball-rollers (Scarabaeinae). Aphodiinae, which simply burrow underneath the dung piles and do not roll dung balls away from the source, would not have the same difficulty in dung transport as the Scarabaeinae. Therefore, its abundance would be similar between forests and fields.

METHODS

Our study was conducted 15-17 February 1997 at Estación Biológica La Selva, Costa Rica. We selected six sites along Sendero Tres Rios (STR). Three of the selected sites were in closed canopy forests, located at the trailmarkers 2350 m, 2450 m and 2550 m. Three of the selected sites were in open fields, located at the trailmarkers 5000 m, 5100 m and 5200 m. On 15 February, we installed five pitfall traps at each site and baited each trap with approximately 20 ml of cow dung. The traps were placed approximately 10 m from the STR along an 8 m line (one trap every 2 m) running perpendicular to the trail. Cow dung was collected from pastures near Puerto Viejo. To ensure the dung was not contaminated with fly larvae or beetles, only recently deposited dung was collected.

We collected all the beetles in the traps on 17 February and identified them with the help of comparative material in the ALAS arthropod collection. All of the beetles collected were identified as belonging to either the Scarabaeinae or Aphodiinae.

RESULTS

A total of 47 Scarabaeinae beetles were collected, 41 in the closed forest and 6 in the open field. We found three species of Scarabaeinae (See Table 1), the most abundant species being *Dichotomius carolinus*. Of the total 70 Aphodiinae beetles collected, 31 were collected in the closed forest and 39 in the open field. Due to the small size of these beetles, we were able to identify only one Aphodiinae to species *(Uroxys macrocularis)*.

We found that there was a higher abundance of Scarabaeinae in forest habitats compared to open habitats ($t=3.55$, $df=29$, $P=0.001$). However, there was no significant difference in the abundance of Aphodiinae between forest and open habitats ($t=0.778$, $df=29$, $P=0.443$) (See Fig. 1).

DISCUSSION

Scarabaeinae were more abundant in the forest habitat. This finding runs contrary to those found by Sherman (1993), in which scarabs were not found at any forest interior dung samples. Sherman's study used human feces as bait, while we used cow dung. It is possible that we found Scarabaeinae in forest habitats because of their preference for certain types of herbivore dung. For example, *Dichotomius carolinus*, our most abundant Scarabaeinae, forms a mass of dung into a ball and rolls it away from the source to an appropriate site. A female lays eggs on the ball and digs an underground chamber where she buries them (White 1993). This harvesting strategy is actually facilitated by the fibers found in herbivore dung. These undigested fibers create a more stable dung ball which is less likely to break apart while being rolled (Janzen 1983).

Two other factors which may have contributed to the relatively low abundance of Scarabaeinae in the open field sites as compared to the forest sites both relate to the high density of grass in the open field. First, this dense growth could interfere with the harvesting method of Scarabaeinae, making ball-rolling nearly impossible. Secondly, Scarabaeinae have large bodies which may make it more difficult for them to move within the dense grass thickets of the field. Both of these factors may restrict Scarabaeinae beetles to the forest, which has a more open ground layer.

We found that Aphodiinae were found in both open field and closed forest habitats. The reason for this may be because these beetles have a foraging method that is not specific to the ground conditions. Most adults of this subfamily tunnel into a dung pile, then continue burrowing into the ground to deposit their eggs. Thus, they are not as affected by either dung composition or surrounding habitat conditions.

Our results suggest that the different harvesting behaviors and relative abundances of Scarabaeinae and Aphodiinae beetles may affect their distribution of dung across the landscape. This may have important implications for how nutrients are cycled in these systems. Scarabaeinae move dung balls, a resource high in nutrients, away from the source pile, thereby, spatially distributing nutrients. Potentially, this suggests that the nutrients contained in these dung piles are more widely distributed in the forest habitat where Scarabaeinae are abundant, as compared to the field habitat where few Scarabaeinae beetles occurred.

Further studies could examine the possible preferential differences between dung beetles among the dung of different feeder types (carnivore, herbivore,

Table 1: Numbers of Scarabaeidae collected in dung-baited pitfall traps (n=30)

Subfamily Scarabaeidae	Open Field	Closed Forest
Coprophyanaeus telamon	0	2
Dichotomius satanus	3	3
Dichotomius carolinus	3	36
Total	6	41
Subfamily Aphodiinae		
Uroxys macrocularis	0	3
Other Aphodiinae	39	28
Total	39	31

or omnivore). In general, herbivore dung contains a large amount of fibrous material. These fibers facilitate the ball rolling process (Janzen 1983). It is possible that the high proportion of *D. carolinus* occurred because they have a preference for cow (herbivore) dung. If other dung were to be used, other beetle species may predominate.

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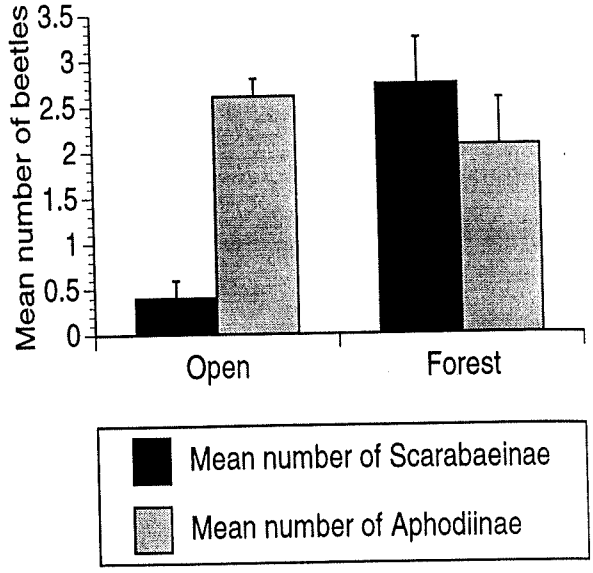

FIG. 1. The mean number of Scarabaeinae and Aphodiinae beetles found in pitfall traps (n=30) in open field and closed forest habitats.