



THE EFFECT OF ANTS ON DIFFERENT STAGES OF THE SEED DISPERSAL CYCLE OF THE RUDERAL *RICINUS COMMUNIS* (EUPHORBIACEAE)

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INTRODUCTION

Seed dispersal is important for the colonization of new habitats, which can be low stressful but highly disturbed. Plants growing in these conditions were named ruderals by Grime (1979). *Ricinus communis* was originated in Africa and introduced in all continents, nowadays occurring worldwide as a ruderal species. In Brazil, Martins *et al.* (2006) have shown that *R. communis* seeds are primarily dispersed by autochory and present secondary dispersal by ants, which are attracted to the seed's elaiosome. Seed dispersal by ants is often regarded as directed dispersal, which results in high seed deposition in micro-habitats that are better for seed survival and seedling establishment (Wenny, 2001). Ants usually carry seeds into their nest, eat their pulp or elaiosome, and discard the seeds often in viable condition in pile mounds (Beattie, 1985). Moreover, seeds deposited near ant nests usually show higher germination success and seedling growth due to the higher concentration of organic matter and nutrients in the soil (Horvitz, 1981) and the ants foraging behavior, which may render protection for seeds and seedlings against herbivores (Passos & Oliveira, 2004).

Nevertheless, confirming and quantifying the effects of seed dispersal to further steps in the seed dispersal cycle has been challenging, especially for directed seed dispersal. This study was designed to cover the processes from post-dispersed seeds to established juvenile plants of a typical ant-dispersed, ruderal species. Our main objective was to determine whether *R. communis* benefits from directed dispersal by ants to maintain its populations.

OBJECTIVES

(1) Are there differences in seed, seedling and juvenile densities between the pile mound and its

vicinities? (2) Does seed fate differ between seeds in the pile mound and seeds in its vicinities, and is it density-dependent? (3) Are ant nest soils nutrient-enriched? (4) Do the number of germinated seeds and the juvenile vigor measurements differ between the pile mound and its vicinities? (5) Do seedlings growing in pile mounds gain differential protection from ants against herbivores?

MATERIAL AND METHODS

Fieldwork was undertaken in Campinas, Southeast Brazil (22°54' S, 47°03' W). The experiments were performed on fallow grounds, which we considered as an open area with no considerable shady sites located in urban scenarios. We counted the number of *R. communis* seeds with and without elaiosome, seedlings and juveniles in plots (0.5 m x 0.5 m) placed in ant nest pile mounds and at a 5 m distance (control plots; n = 30 pairs). Differences were analyzed with Wilcoxon tests. Then, we examined the fate of post-dispersed seeds in pile mounds and in control plots by counting along a six week period the number of removed seeds, which were originally placed at five densities (n = 30 pairs). For each observation, we made a simple linear regression between the number of non-removed seeds and the seed density. Then, we made a simple linear regression between the two sets of regression coefficients and the observations along time. We also collected soil from pile mounds and control plots for chemical analysis and to carry out a germination experiment. The number of *R. communis* seeds germinated in both types of soil was compared with a paired t test (n = 10 pairs). After the germinated seeds had progressed to juveniles, we performed 18 vigor measurements. Differences were analyzed with paired t tests or Wilcoxon tests. Lastly, we glued live termite workers on leaves of *R. communis* seedlings growing in pile mounds and in control plots to evaluate whether they can gain protection by ants.

We used chi-square test to compare the number of termites attacked.

RESULTS AND DISCUSSION

There were more seeds without elaiosome ($P = 0.003$), seedlings ($P = 0.034$) and juveniles ($P < 0.001$) in pile mounds, which is in accordance with other studies (e.g. Passos & Oliveira, 2004). Seeds with elaiosome were equally distributed ($P = 0.347$), which may be an outcome of the primary seed dispersal mechanism of *R. communis*.

The removal of post-dispersed seeds did not differ between pile mounds and control plots ($P = 0.902$). Therefore, seeds neither gain protection from ants against post-dispersal predators nor do they become unavailable for further removal by other dispersal vectors. The removal presented a small increase along time and was disproportionately inversely density-dependent. The causes of this pattern are not clear and deserve further investigation.

Pile mound soils were not nutrient-enriched, which is in agreement with some authors (e.g. Horvitz & Schemske, 1986). We found no differences in the number of germinated seeds ($P = 0.299$) and juvenile vigor measurements ($P > 0.05$) between pile mounds and control plots, indicating that there are no advantages related to a richer environment for seeds and seedlings in pile mounds.

Ants did not provide differential protection for seedlings in pile mounds against herbivores ($P > 0.999$), which is contrary to many findings in literature (e.g. Passos & Oliveira 2004). The non-differential patrol of ants may be due to the presence of extra-floral nectaries on leaf petioles and nerves of *R. communis*.

CONCLUSION

Seed dispersal of *R. communis* by ants had a marked effect on the distribution pattern of the seeds, seedlings and juveniles. However, there were no additional advantages for the seeds, seedlings and juveniles in the pile mounds: neither did they gain protection by ants nor they were provided with a nutrient-enriched environment. In spite of the suggestion that seed dispersal by ants affects recruitment in many species, we found no evidence to support this hypothesis for *R. communis*, which, therefore, does not benefit from directed dispersal by ants to maintain its populations in the study sites. (V. F. Martins was

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