SYAGRUS ROMANZOFFIANA (PALMAE) SEED PREDATION BY INSECTS IN FOREST FRAGMENTS: COMPARISONS BETWEEN INTERIOR AND EDGE

Caio Castro Freire

Melissa Bars Closel; Flavio Nunes Ramos

Departamento de Ciências Biológicas e da Terra, Universidade Federal de Alfenas-UNIFAL - MG, Gabriel Monteiro da Silva, 714, Alfenas, MG, Brasil. CEP 37130 - 000. Tel: 35 3291 - 1477, E - mail: **cdcfreire@gmail.com**

INTRODUCTION

The reduction of natural forests to small and isolated fragments caused by anthropogenic interference is one of the mean causes of biodiversity loss in tropical forests and one of the biggest threats to tree populations. Besides the direct forest area reduction and habitat loss that can cause extinctions, reduction of species richness and modification in the organization of trophic communities, one of the consequences of forest fragmentation is the edge creation. This new environment might expose the forest to atypical conditions that can modify or extinguish necessary abiotic and biotic conditions to survival of animals, seeds and seedlings, and drastically affect phenomena such as territorial behavior and feeding habits of various animal species, pollination, and seed predation (Laurance *et al.*, , 2002).

Seed dispersal and predation interactions in the tropics are likely to be affected by forest fragmentation because many plant species are subject to animal dispersal and/or predation, and habitat disturbance tends to reduce or eliminate these vectors. The trophic rank hypothesis, based on the species–area relationship, suggests that increased susceptibility to habitat fragmentation should be found at higher trophic levels. Thus, it is expected perhaps, that seed predators should be more affected by habitat fragmentation. Others factors as seed density, seed size and fruit handling by vertebrate seed dispersers, can also affect directly or indirectly the seed predation.

Seed predation is one of the most important factors determining seed survival, and consequently an important process of inter - specific interaction in regulation of the structure and composition of the plant community (Schupp 1990). Seed and seedling predation is intense for many tree species and many of them lose a substantial proportion of their seed production to predators. The seeds of most economically important species are significantly damaged by insects, which are the main biotic agents responsible for seed deterioration, principally by affecting germination capacity.

Palm trees, very common in Atlantic forest regions, produce fruits throughout most of the year, and are therefore important food source at fruit scarcity periods. Studies indicate that palms have great importance for the diet of several animals, and their fruits are consumed by a large variety of vertebrates. Despite their diversity and importance for the fauna, studies about Atlantic forest palms are scarce, and palms can be suffering drastically the fragmentation effects (Wright & Duber 2001). The endosperm of palm seeds has high nutritional value, which increases the chances of predation.

OBJECTIVES

The aim of this paper is to compare the *Syagrus romanzoffiana* seed predation by insects of semi - deciduous Atlantic forest fragments in southeastern Brazil. The specific objectives are: (i) to compare the seed predation rates between the edge and the interior (ii) to compare the species composition found in both habitats (edge and interior) (iii) to analyze if the density, size or weight of the fruits influence the predation rates. We expected to find lower predation rates and less typical forest species in the edge, probably because of a depression in the abundance, diversity and species richness of seed predators, which are mainly specialized insects that respond to the environmental fluctuations resulting from fragmentation (Chacoff *et al.*, , 2004). Moreover, we expected that the larger fruits and those found in high densities had higher probability of predation, because the seed predators may choose abundant food sources and that offer a better cost - benefit balance (Brewer 2001).

MATERIAL AND METHODS

The study was carried out in three fragments of semi - deciduous Atlantic forest (fragment I - 65 ha; fragment II-52 ha; fragment III - 14 ha) within a radius of 30km around the city of Alfenas (21º 25' 45" S e 45º 56' 50" W) situated in the south of the State of Minas Gerais, southeastern Brazil. The climate is classified as Cwa according to Köeppen, and mean annual precipitation ranging from 1400 to 1700 mm.

Syagrus romanzoffiana is the most common palm species in semi - deciduous Atlantic forest and its fruits have approximately 2.5 cm of diameter and 1.6 ± 0.3 g of mass, with soft exocarp and solid endocarp. This palm produces fruit throughout the year, but the peak fruiting period occurs mainly between February and August.

Ten palms (at least 50m away from one another) were randomly selected and marked on each fragment, five in the forest edge (between 0 and 10 m from the matrix) and five in the interior forest (in the center of the fragment). All fragments were visited monthly during the fruiting period, and all the recently - fallen fruits under each adult palm were collected, measured, weighed, and visually examined for the quantification of eggs and emergence holes of adult insects. Then twenty fruits from each collected sample (each palm on each collecting day) were opened for the quantification of larvae, and ten were stored in plastic pots for further identification of adults that emerge. Predation was defined as the presence of larvae or emergence holes (= endosperm consumed), and predation rates represent the percentage of seeds predated.

The relationship between predation rates and density, size or weight of the fruits was analyzed by Multiple Linear Regression, and the Anova Hierarchy was utilized to compare the predation rates between edge and interior, after arcsine data transformation.

RESULTS AND DISCUSSION

From a total of 1586 fruits found at the edge and 1195 in the interior, 3.0(±7.9)% and 1.7(±4.9)% respectively showed damage caused by insects. There were no difference on predation rates between palms located at the edge and in the interior ($F_{1,4} = 0.15$; $p = 0.71$). The number of fruits collected under each palm ranged between 12 and 150. The length, width, and weight of fruits were on average 2.6 (±0.3) cm; 1.8 (±0.3) cm and 4.4 (±1.6) g respectively. The predation rate ($R^2 = 0.27$; $p = 0.83$) and the percentage of fruits with eggs ($R^2 = 0.29$; $p = 0.21$) were not influenced by any of the variables considered (density, size and weight of the fruits). The presence of egg(s), larva or emergence hole were mutually exclusive, 45 fruits presented egg(s) (up to eight eggs), 29 showed only one larva, and 36 presented only one emergence hole. From some personal observations, it was clear that only those with partial pulp removal exhibited egg(s). The fruits are still stored because the time of larval development is extremely variable and can last several months. Thus, the species composition was not obtained yet.

The predation rates did not differ statistically between edge and interior, and did not influence by density, size or weight of the fruits. Four hypotheses were considered to explain these results. The first hypothesis suggests that the results could be consequence of predators scarcity likely related to size and disturbance historical of the fragments studied. Most studies about palms (Pizo *et al.,* , 2006; Salm 2006; Ramos *et al.,* , 2001) showed seed predation rates by insects higher than 15%; some recorded rates higher than 60%. But all these studies were performed in fragments larger than 400 ha, while the largest fragment of the present study has 65 ha. Therefore, the ratio perimeter/area very high in smaller fragments can increase the permeability conditions imposed by the edge, there is an extrapolation of the conditions of the edge to the interior of the forest.

Several studies show a decrease in the seed predation by insects in forest fragments (Chacoff *et al.,* , 2004; Cascante *et al.,* , 2002; Wright & Duber 2001), they suggest that the intensity of this interaction is depressed in small fragments. Predation of eggs by ants, parasitoids, and typical edge effects as high temperature and lower humidity are causal factors of mortality for insect seed predators.

The second hypothesis regards as a limiting factor to seed predation the absence of fruit pulp removal, maybe as a result of low activity of vertebrate seed dispersers that can also be affected by forest fragmentation. Studies have reported the influence of fruit handling by vertebrates on invertebrate seed predation. Silvius & Fragoso (2002), studying *Attalea maripa* seed predation, observed that the partial fruit pulp removal increases the susceptibility of the seeds to bruchid beetle attack. Many studies with high predation rates recorded (Pizo *et al.,* , 2006; Salm 2006; Silvius & Fragoso 2002), previously removed the fruit pulp to maximize the oviposition probability.

The third hypothesis suggests that the predation rates found in the present study could present a temporal variation (Allmen *et al.,* , 2004), being low only during certain periods. This variation may demonstrate differences between edge and interior not evidenced yet.

Finally, the results can be different if the pre - dispersal predation is also analyzed (next stage of the present study). Although the scarcity of studies related, some authors (Chacoff *et al.,* , 2004; Cascante et. al 2002) have demonstrate the forest fragmentation effects on the pre - dispersal predation. They suggest that this interaction is affected in small fragments, mainly by the edge effect on the community of the predator insect. Silva *et al.,* , (2007), studying the *Syagrus romanzoffiana* seed predation, found fruits predated only by curculionid beetles with morphological characteristics similar to *Revena rubiginosa*, and noted that the oviposition occurred in pre - dispersal period. Alves - Costa & Knogge (2005) described the larval development of *Revena rubiginosa* in seeds of *Syagrus romanzoffiana*; they showed that: (i) the eggs are deposited directly inside the seeds (not in the fruits surface like does the bruchids), (ii) that the oviposition occurs therefore during the fruit development while the endocarp is still soft and may be penetrated by the females rostrum, and (iii) that only one larva survives and develops per fruit.

Besides the hypotheses that had been considered, the absence of relationship between predation rates and density, size and weight of the fruits can be associated to low number of fruits predated and low egg infestation.

CONCLUSION

Although differences had not been detected in the predation rates between edge and interior, the predation process in the fragments studied may be suffering strong influence of the forest fragmentation as the hypotheses mentioned suggest.

It is important to remind that the plants reproductive success is affected by several factors (not only seed predation). Also, genetic variability of plants and seeds wasn't analyzed, neither pollinators activity, nor seed dispersal and germination rates. So the investigation of these hypotheses, as well as, these others preponderant factors to plants reproductive success, may contribute well to elucidate some effects of the forest fragmentation.

(A special thanks to research group ECOFRAG (Ecology of fragments at south of Minas Gerais, Brazil) of Universidade Federal de Alfenas-UNIFAL, and to FAPEMIG (process 340/07) for supporting the project.)

REFERENCES

Allmen, C.V., Morellato, P.C., Pizo, M.A. 2004. Seed predation under high seed condition: the palm *Euterpe edulis* in the Brazilian Atlantic Forest. **Journal of Tropical Ecology** 20: 471 - 474.

Alves - Costa, C.P. & Knogge, C., 2005. Larval competition in weevils *Revena rubiginosa* (Coleoptera: Curculionidae) preying on seeds of the palm *Syagrus romanzoffiana* (Arecaceae). **Naturwissenschaften** 92: 265 - 268.

Brewer, S.W., 2001. Predation and dispersal of large and small seeds of a tropical palm. **Oikos** 92: 245–255.

Cascante, A., Quesada, M., Lobo, J.A., Fuchs, E.J., 2002. Effects of dry tropical forest fragmentation on the reproductive success and genetic structure of the tree, *Samanea saman*. **Conservation Biology** 16: 137–147.

Chacoff, N.P., Morales, J.M., Vaquera, M.P., 2004. Efectos de la fragmentación sobre la aborción y depredación de semillas en El Chaco Serrano. **Biotropica** 34: 107–117.

Laurance, W.F., Lovejoy, T.E., Vasconcelos, H.L., Bruna, E.M., Didham, R.K., Stouffer, P.C., Gascon, C., Bierregaard Jr., R.O., Laurance, S.G., Sampaio, E., 2002. Ecosystem decay of Amazonian forest fragments: a 22 - year investigation. **Conservation Biology** 16: 605–618.

Pizo, M.A., Von Allmen, C., Morellato, L.P.C., 2006. Seed size variation in the palm *Euterpe edulis* and the effects of seed predators on germination and seedling survival. **Acta Oecologica** 29: 311-315.

Ramos, F.A., Martins, I., Farias, J.M., Silva, I.C.S., Costa, D.C., Miranda, A.P., 2001. Ovoposition and predation by *Speciomerus revoili* (Coleoptera, Bruchidae) on seeds of *Acrocomia aculeate* (Arecaceae) in Brasília, DF, Brazil. **Brazilian Journal of Biology** 61: 449-454.

Salm, R., 2006. Invertebrate and vertebrate seed predation in the Amazonian palm *Attalea maripa*. **Biotropica** 38: 558–560.

Schupp, E.W., 1990. Annual variation in seedfall, post-dispersal predation, and recruitment of a neotropical tree. **Ecology** 71: 504 - 515.

Silva, F.R., Begnini, R.M., Scherer, K.Z., Lopes, B.C., Castellani, T.T., 2007. Predação de sementes de *Syagrus romanzoffiana* (Cham.) Glassman (Arecaceae) por insetos na ilha de Santa Catarina, SC. **Revista Brasileira de Biociências** 5: 681-683.

Silvius, K.M. & Fragoso, J.M.V., 2002. Pulp handling by vertebrate seed dispersers increases palm seed predation by bruchid beetles in the northern Amazon. **Journal of Ecology** 90: 1024-1032.

Wright, S.J. & Duber, H.C., 2001. Poachers and forest fragmentation alter seed dispersal, seed survival, and seedling recruitment in the palm *Attalea butyraceae*, with implications for tropical tree diversity. **Biotropica** 33: 583 - 595.