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Predation of young palms (*Atalea phalterata*) by feral pigs in the Brazilian Pantanal

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Introduction

Feral pigs (*Sus scrofa*) are one of the most successful invasive mammalian species in the world (Lowe *et al*. 2000). Many studies document the negative ecological and socio-economic consequences of feral pig invasions (Wolf and Conover 2003) and for this reason, most of the literature on feral pigs discusses methods of control and eradication (Choquenot *et al*. 1996, Cruz *et al*. 2005). Feral pigs were introduced to the Pantanal more than 200 years ago and can now be found throughout the floodplain (Mourão et al. 2002). The ecological impact of this species in the Pantanal is still not well understood. It has been shown that they may act as reservoirs for disease (Freitas *et al*. 2004; Herrera *et al*. 2005; Herrera *et al*. 2008; Paes *et al*. 2008) predate eggs of ground nesting birds (Desbiez *et al*. 2009) and reptiles (Campos 1993) and disturb large areas of pasture (Desbiez 2007). Feral pigs are also the main hunting target of local people in the Pantanal thereby diluting the hunting pressure on native species (Desbiez 2007). Feral pigs may also act as potential seed dispersers (Desbiez 2007, Donatti *et al*. 2007) Along with tapirs (*Tapirus terrestris*), cows (*Bos taurus*), and rheas (*Rhea americana*) feral pigs are one the few species capable of ingesting whole seeds of the *Attalea phalerata* palm and dispersing them far away from the parent tree (Desbiez *et al*. 2009). Furthermore, they are the second main consumers of this fruit (Desbiez 2007). *A. phalerata* seeds were encountered in 56% of 94 fecal samples of feral pigs collected during a study on feral pigs diet (Desbiez *et al*. 2009). We have also observed that feral pigs predate young *A. phalerata* palms during the dry season.

A. phalerata palms occur in high density aggregations scattered around the landscape and are locally referred to as "acurizal". These aggregations have been considered as one of the most prominent structural components of the Pantanal ecosystem (Prance and Schaller 1982, Pott and Pott 1994). *A. phalerata* palms may be considered as a key resource as they provide abundant fruit during a time of the year when fruit production is at it's lowest and is consumed by a wide range of species (Desbiez 2007). Furthermore this palm is an important source of browse and shelter to both fauna and livestock (Santos *et al* 2002). The aim of this study was to describe and evaluate the importance of feral pig predation and consumption of young *A. phalerata*, and speculate on the impact of *A. phalerata* recruitment.

Methods

Research took place on traditionally managed ranches in the central region of the Brazilian Pantanal at the Embrapa Pantanal Nhumirim ranch and 6 neighboring ranches covering an area of >200 km^2 (18º 59' South; 56º 39' West). Traditionally managed ranches are mostly comprised of native vegetation, cattle range freely within large grazing areas, and human densities and impact are very low.

Fecal samples of feral pigs were collected opportunistically at any time in the field between August 2002 and September 2003. Following fresh trails or groups of animals, fecal samples were collected soon after they had been deposited and before they were scattered by dung beetles. Fecal samples that were not associated with recognizable tracks or direct animal observations were excluded from the analyses. A total of 94 fecal samples were collected; 64 during the dry season (April –September) and 30 during the wet season (October- March). Micro-histological analysis was then used to identify the roots and stems from *A. phalerata* in the fecal samples following methods developed by Sparks and Malecheck (1968) including modifications from Scott and Dahl (1980).

During the dry season in August 2003, the number of *A. phalerata* plants dug up by feral pigs and the structure of the acurizal were evaluated while walking transects through two acurizals. One acurizal where predation (based on number of holes dug by feral pigs to uproot the plants) was high and another where predation was mild, were evaluated. The growth stage of *A. phalerata* plants was divided into the following growth stage categories:

Category 1: germinating plants with one or two leaves that are closed
Category 2: more than two leaves but they are still closed
Category 3: 3 to 4 leaves that are open and waist high
Category 4: open leaves above the waist up to the shoulder
Category 5: more than 4 open leaves higher than shoulder
Category 6: between class 5 and mature *Attalea phalerata* tree.
Category 7: mature tree that gives fruits

Results

Fibers from the roots and stems of the *A. phalerata* were encountered in 40.6% (N=26) of the fecal samples collected during the dry season and in 10% (N=3) of the fecal samples collected during the wet season.

In the acurizal with mild predation by feral pigs, 420 m^2 were surveyed and 26 holes made by feral pigs to uproot *A. phalerata* were found. In the acurizal with high predation by feral pigs, 490m^2 were surveyed and 63 holes were found. Plant categories 4 to 7, belonging to the more mature stages, appeared in similar numbers between the two areas while the other categories corresponding to initial growth stages (1-4) were lower in the areas highly predated by feral pigs (Figure 1). Observations showed that feral pigs could dig up an *A. phalerata* palm within minutes and holes could be up to 50cm deep (Figure 2).

Discussion

The negative impact of feral pigs on plant recruitment has been reported in several studies throughout their distribution (Wolf and Conover 2003). Feral pigs alter plant communities through their rooting

activities (Aplet *et al*. 1991, Finlayson *et al*. 1997, Mayer *et al*. 2000, Drake 2001, Cushman *et al.* 2004) or even more directly by predating on seedling and young plants (de Nevers and Goatcher 1990, Mayer *et al*. 2000, Drake 2001). Even their nest constructing behavior has been shown to cause substantial local damage to shrubs and saplings (Ickes *et al*. 2005). Feral pigs uproot young plants and chew at the base of the stem and roots. The excavation and uprooting of young *Attalea phalerata* palms is spectacular and a herd of feral pigs can rapidly dig up large areas and destroy many plants.

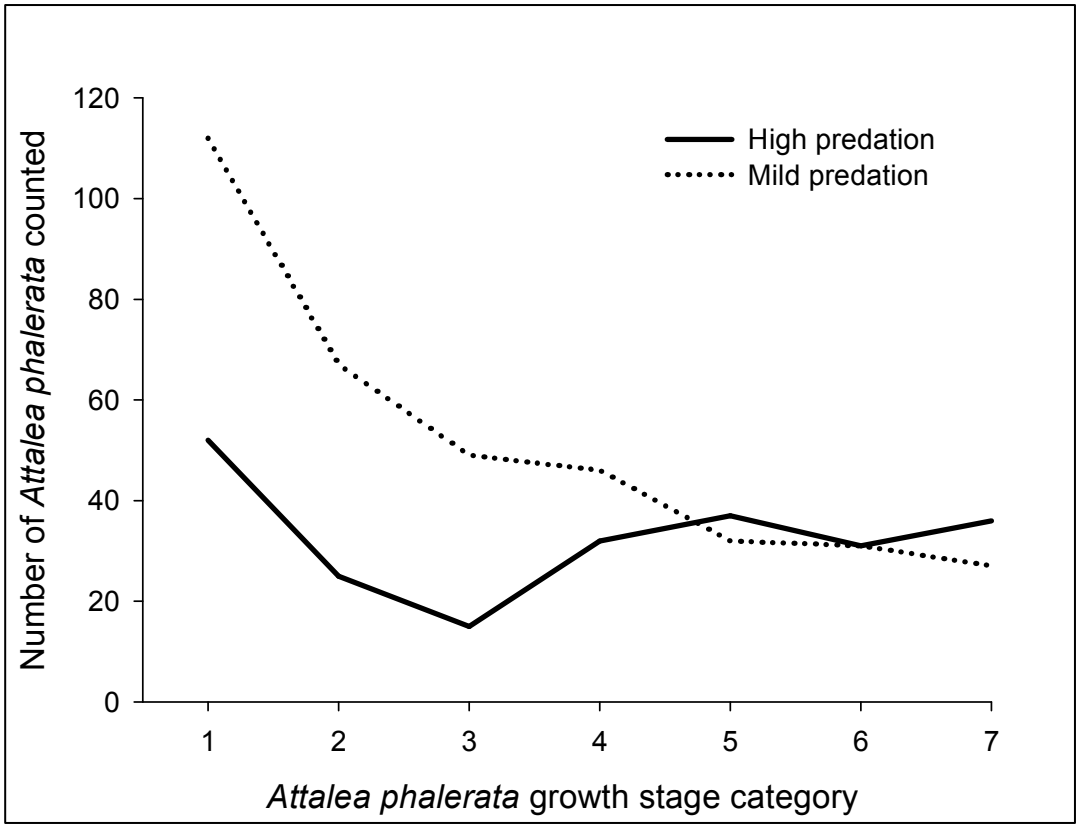

Figure 1. Number of *Attalea phalerata* plants at different growth stage in areas under high and mild feral pig predation in August 2003 (dry season) in the Embrapa Pantanal Nhumirim ranch (Category 1: germinating plants with one or two leaves that are closed; Category 2: more than two leaves but they are still closed; Category 3: 3 to 4 leaves that are open and waist high; Category 4: Open leaves above the waist up to the shoulder; Category 5: More than 4 open leaves higher than shoulder; Category 6: Between class 5 and mature *A. phalerata* tree; Category 7: Mature tree that gives fruits)

Palms of *A. phalerata* at initial growth phases are an important resource for feral pigs during the dry season. In another study, Desbiez *et al*. (2009) analyzed the frequency of items encountered in fecal samples of feral pigs. Percentages of leaves, fibers and invertebrates were similar between both seasons. However there was a marked difference in the percentage of fruits and roots found in the samples. During the wet season over 55% of the diet were fruits, while fruits made up only 13% of their diet during the dry season. Roots made up only 5% of the diet during the wet season and over 40% in the dry season. Roots are an important resource for feral pigs during periods of low fruit availability (dry season) and a high percentage of the roots ingested were young *A. phalerata* palms.

Figure 2. Predated category 3 *Attalea phalerata* palm, August 2003 (dry season).

Some studies suggest a positive effect of feral pig rooting. Lacki and Lancia (1986) examined the effect of rooting on tree growth. They found that beech responded to feral pig rooting with increased height growth, which they speculate resulted from enhanced nutrient mobilization in soils disturbed by pigs. Other studies find no impact. A study by Groot Bruinderink and Hazebroek (1996) in the Netherlands examined the effects of rooting by wild boar on soil chemistry and forest regeneration in various habitats. They did not find a significant impact from wild boars. However, in the acurizals the rooting behavior is not random and is directly linked to predation of young palms. The overall effect is loss of young plants.

Other factors may be affecting *A. phalerata* recruitment in acurizals. In the Pantanal, cattle trampling was found to affect the recruitment of young manduvi (*Sterculia apetala*) (Johnson *et al*. 1997) and in a similar way most certainly impact *A. phalerata* recruitment in acurizals. When it is windy or colder, cattle sleep in acurizals and trample young plants. Traditionally, pasture in the Pantanal is frequently burned (Rodrigues *et al*. 2002). These fires may propagate themselves in forested areas. Although older *A. phalerata* trees are resistant to fire (Pott and Pott 1994) young plants might be killed.

The preliminary data presented here does not enable us to measure the long lasting impact of young *A. phalerata* palm predation by feral pigs. Number of mature trees was similar between highly predated and mildly predated areas. In another study (Keuroghlian & Eaton, in press), predation of *A. phalerata* seedlings was found to promote the maintenance of acurizais by reducing competition between the young plants. This study needs to be repeated in several areas and feral pig predation of plants needs to be monitored. The use of exclosure plots could be used to evaluate the impact of cattle trampling and feral pig rooting in acurizals. This study shows that young *A. phalerata* plams roots and stems are an important part of feral pig diet particularly during the dry season when fruit availability is low. It predicts that predation may have a long lasting impact on *A. phalerata* recruitment.

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