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Short Communication

Ecological aspects of *Langsdorffia hypogaea* (Balanophoraceae) parasitism in the Pantanal wetlands

Carlos Rodrigo Lehn[1], Suzana Maria Salis[2*] and Patrícia Póvoa Mattos[3]

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ABSTRACT

Most studies on holoparasitic plants have focused on taxonomic or systematic issues. The objective of this study was to examine the ecological aspects of parasitism of *Langsdorffia hypogaea* (Balanophoraceae) in the Pantanal wetlands. Individuals of *L. hypogaea* were dug out by hand and the host trees were identified. Eighty-eight percent of host trees exhibited zoochory dispersal syndrome. *Protium heptaphyllum* and *Cordiera sessilis* represented 50% of the sampled trees. Both species are evergreen and are preferentially shade-tolerant species growing under the canopy of other trees. Fecal sample of collared peccaries (*Pecari tajacu*) had seeds from both the host tree (*Protium* sp.) and the parasite *L. hypogaea*. We therefore propose the hypothesis that *P. tajacu* play a role as a seed disperser and may affect root parasitism.

Keywords: host specificity, Pantanal, parasite, root, savanna

Most studies on holoparasitic plants have focused on taxonomic or systematic issues aspects, while only a few have examined the ecology of these species, e.g., Ecroyd (1996) and Holzapfel *et al.* (2001). Bellot & Renner (2013), who conducted a study on the pollination and reproductive traits of parasitic angiosperms, reported that most of the families that support parasites are pollinated predominantly by insects and by some vertebrates, and that they are dispersed mainly by birds and mammals. However, we are still far from understanding the ecological and evolutionary interactions among hosts, parasites, their pollinators and dispersers, even of the most extensively studied species, because ecological data have been slow to accumulate. The present study aims to identify the biological characteristics of the savanna tree species parasitized by *Langsdorffia hypogaea* Mart. in Brazil's Pantanal wetlands, and to discuss the relationship of this holoparasite with its host trees.

Langsdorffia hypogaea (Balanophoraceae) is a pantropical root parasite that uses angiosperm trees as hosts (Hansen 1980). In Brazil, *L. hypogaea* occurs in forests, savannas and savanna woodlands, and usually flowers during the dry season in central-western savannas of the Pantanal wetland region (Pott & Pott 1994).

The study was conducted at the Nhumirim Experimental Farm (18º59' S and 56º38' W), located in the sub-region of Nhecolândia in the Pantanal wetlands of the state of Mato Grosso do Sul, Brazil. The regional vegetation comprises 59.6% of natural pasture, 2.1% of savannas or "cerrado" (tortuous tree canopy, with underlying shrubs and ground-level vegetation), 28.9% of "cerradão" (upper layer of trees of usual "cerrado" species, up to about 13 m tall and producing a broken canopy, with sparser ground-level vegetation, according to Ratter *et al*. 1973), and 9.4% of permanent or temporary ponds (Embrapa 1997). The climate is markedly seasonal (tropical/megathermal), with rainfall prevailing between October and April, with an annual average of 1180.8 mm (Soriano & Alves 2005). The annual average maximum temperature varies from 28°C to 30°C and the absolute maximum temperature may reach 35°C in winter and 43°C in summer (Soriano & Alves 2005).

The sampling procedure was carried out from April to June 2007 in areas of "cerrado" and "cerradão". The holoparasite was sampled in these vegetation types on a natural

[1] Instituto Federal de Educação, Ciência e Tecnologia Farroupilha, Campus Panambi, Erechim, 860, 98280-000, Panambi, RS, Brazil
[2] Embrapa Pantanal, P.O. Box 109, 79320-900, Corumbá, MS, Brazil
[3] Embrapa Florestas, P.O. Box 319, 83411-000, Colombo, PR, Brazil
[*] Corresponding author: suzana.salis@embrapa.br

reserve without cattle grazing, and involved searching for inflorescences of the holoparasite by walking along three 250 m long contour lines (D500, D1500 and F500). These lines are part of a 5 x 5 km sampling grid, containing 30 lines spaced at 1 km intervals, according to Magnusson *et al.* (2005) (Fig. 1).

The inflorescences of *Langsdorffia hypogaea* were dug out carefully by hand to reach the root of the host tree. Then, the distance between the parasitized roots and the trunk of host trees was measured. The diameter and depth of the parasitized root were also recorded. The rhizome of *L. hypogaea* presents several ramifications, making it difficult to quantify the number of parasites per individual host (Fig. 2A).

The host trees were classified according to their leaf phenology (deciduous, semideciduous or evergreen), shade-tolerance (heliophyte or sciophyte), dispersal syndromes (anemochory, zoochory or autochory), and period of fruiting, based on information available in the literature (Lorenzi 1992; 1998; Pott & Pott 1994, Jardim & Batalha 2009) and on field observations.

Twenty-four *Langsdorffia hypogaea* host trees were found along the three sampled contour lines, in 12 host species (Tab. 1). Vouchers of *L. hypogaea* from previous collections at the study site are deposited at the CPAP herbarium (A. Pott 1922, 18/VI/2985; A. Pott 2931, 10/VI/1987; A. Pott 8034, 18/V/1998; V.J. Pott 1407, 03/VII/1990).

The parasitized roots were located at an average depth of 16.4 ± 3.9 cm, ranging from 6 cm (in *Aspidosperma tomentosum* Mart.) to 24 cm (in *Cordiera sessilis* Kuntze). On average, the inflorescences were observed about 2.4 m away from the host trunk. In general, parasitized roots presented small diameters, measuring on average 1.60 ± 1.40 cm, ranging between 0.3 and 5.1 cm. In two cases, individuals of *L. hypogaea* were found attached directly to the main root, in the crown area, parasitizing *Byrsonima coccolobifolia* Kunth and *Simarouba versicolor* A.St.-Hil. (Fig. 2B).

The point where the holoparasite attached to the host was the most developed portion of the vegetative body of the sampled *L. hypogaea*, with a diameter ranging from 2.2 to 3 cm. Hsiao *et al.* (1994) also observed an increase in this diameter in *L. hypogaea* occurring by sparse and diffuse divisions in the matrix parenchyma of the pith and inner layers of the cortex and, by a more rapid rate of division, in the parenchyma cells. According to these authors, one hypothesis for tuber growth is that the host tissues of the composite bundles are actually “roots,” which means

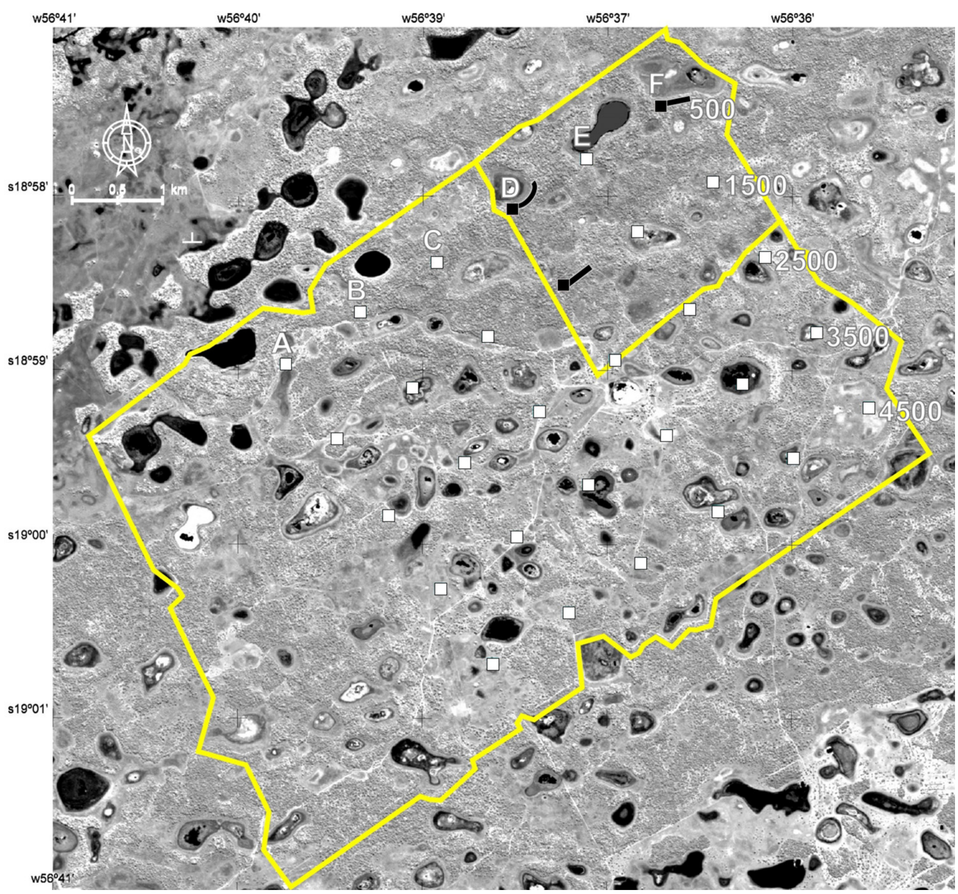

Figure 1. Satellite image of Nhumirim Experimental Farm (inside the yellow border), showing details of sampling grid (in white) and the reserve area (small area demarcated with a yellow line). The holoparasite sampling are identified by black line and squares. Please see the PDF version for color reference.

Table 1. Tree species parasitized by *Langsdorffia hypogaea* Mart. (Balanophoraceae) in "cerrado" and "cerradão" on Nhumirim farm in Brazil's Pantanal wetlands.

Family and species	Biological characteristics*	Fructification of zoochorous tree species*	Number of parasitized trees
Apocynaceae			
Aspidosperma tomentosum Mart.	semideciduous[2], heliophyte[2], anemochorous[4]	-	1
Hancornia speciosa Gomes	semideciduous[1], heliophyte[1], zoochorous[5]	October to April[3]	1
Bignoniaceae			
Handroanthus ochraceus (Cham.) Mattos	deciduous[1], heliophyte[1], anemochorous[4]	-	1
Burseraceae			
Protium heptaphyllum Marchand	evergreen[3], sciophyte, zoochorous	October to January[3]	7
Cactaceae			
Cereus hildmannianus K. Schum.	heliophyte, zoochorous	-	1
Dilleniaceae			
Curatella americana L.	evergreen, heliophyte[1], zoochorous[3]	October to November[3]	2
Fabaceae			
Bowdichia virgilioides Kunth	deciduous[1], heliophyte[1], anemochorous[4]	-	1
Malpighiaceae			
Byrsonima coccolobifolia Kunth	deciduous[2], heliophyte[2], zoochorous[4]	October to March (April)[3]	1
Melastomataceae			
Mouriri elliptica Mart.	evergreen, heliophyte, zoochorous[4]	December to March, immature fruits all year long[3]	2
Myrtaceae			
Psidium guineense Sw.	deciduous, heliophyte, zoochorous	December to March, immature fruits all year long[3]	1
Rubiaceae			
Cordiera sessilis Kuntze	evergreen[3], sciophyte to heliophyte[2], zoochorous	December to February[3]	5
Simaroubaceae			
Simarouba versicolor A. St.-Hil.#	semideciduous[2], heliophyte[2], zoochorous	November to December[3]	1
Total			24

* Biological characteristics were found in Lorenzi (1992)[1], Lorenzi (1998)[2], Pott & Pott (1994)[3], and Jardim & Batalha (2009)[4].
# Tree sampled outside of the contour lines in the Nhumirim Farm natural reserve.

that they are basically modified host lateral roots growing intrusively through the parasite tissues of the tuber.

The lack of host specialization in Balanophoraceae was noted by Nickrent (2002), who suggested that this family generally occurs in tropical regions because forests have high potential host diversity. In this case, a generalist strategy would offer evolutionary advantages. Nevertheless, we identified most common host trees of *Langsdorffia hypogaea* associated with evergreen species (70%), although most species of savanna vegetation present a different phenological strategy (44% of deciduous species and 16% semideciduous, Pirani *et al.* 2009), suggesting a role played by leaf phenology.

Half of the sampled roots parasitized were represented by two evergreen species: *Protium heptaphyllum* Marchand (seven host trees) and *Cordiera sessilis* (five host trees), which among the most frequent species along the sampled contour lines (DRM Neves unpubl. res.). However, the holoparasite was not observed in other frequent species such as *Astronium fraxinifolium* Schott, *Magonia pubescens* A.St.-Hil. and *Tabebuia aurea* (Silva Manso) Benth. & Hook.f. ex S.Moore (DRM Neves unpubl. res.). Upon comparing the dispersal syndrome of parasitized and non-parasitized (or less parasitized) tree species, we found that most parasitized species are zoochorous (88%) while non-parasitized species are anemochorous. The high parasitism of *P. heptaphyllum* and *C. sessilis* could be related to the feeding behavior of their seed dispersers. Desbiez *et al.* (2009) examined the diet of collared peccaries - *Pecari tajacu* (Linnaeus 1758) - in the Pantanal and observed the presence of *Langsdorffia hypogaea* in 21% of the fecal samples. In an earlier study, Desbiez (2007) observed the presence of fruits of *Protium* sp. in 12.5% of the fecal samples. Simmen *et al.* (2003) observed lemurs in Madagascar (*Lemur catta* and *Eulemur fulvus*) eating mature fruits and seeds of another parasitic

Figure 2. *Langsdorffia hypogaea* Mart. parasitizing *Simarouba versicolor*. A. St.-Hil., in the fine roots (A) and the crown area of the main root (B). The black arrow identifies the holoparasite and the white arrow, the host tree.

plant (*Hydnora esculenta* Jum. & H. Perrier). We therefore, propose the hypothesis that the collared peccary could be acting as disperser of *L. hypogaea*, favoring its establishment on available zoochorous host trees because they presumably eat the fruits of both, host and holoparasite. In the study area, *L. hypogaea* flowers and fruits during the dry season, from April to August, and most of the zoochory host species identified in this study produce fruits at the beginning of the rainy season, before the flowering and fruiting of *L. hypogaea*. Collared peccaries may eat fruits of *L. hypogaea* beneath the crown of some potential host trees, and therefore, may disperse seeds from the holoparasite near other fruit trees.

We propose that the disperser syndrome and shady conditions facilitate parasitism by *L. hypogaea*. However, further investigations involving ecology and biology of both plant and possible dispersers are required to confirm this hypothesis.

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