

Seed dispersal of *Attalea phalerata* (Palmae) by Crested caracaras (*Caracara plancus*) in the Pantanal and a review of frugivory by raptors

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ABSTRACT: We observed Crested caracaras (*Caracara plancus*) consuming and dispersing fruits of the palm *Attalea phalerata* at Pantanal, Brazil. We reviewed the literature of seed dispersal by raptors and suggest that raptors may affect seed dispersal by three different paths: secondary seed dispersal by preying on frugivorous birds, primary seed dispersal of ornithocoric fruits and primary seed dispersal of large, lipid-rich fruits. The latter path may be an important long-distance seed dispersal mechanism for large seeds.

KEY WORDS: birds of prey, megafauna fruits, *Polyborus*, Pantanal, raptors, secondary seed dispersal, frugivory

Raptors are not the typical image of a frugivore bird and their role in seed dispersal have been neglected in reviews of the importance of birds for plants (Snow 1981, Fleming 1991). However, raptors can be important secondary seed dispersers when they feed on frugivore preys or primary dispersers when they deliberately consume fruits (Engel 2000, Shanahan *et al.* 2001, Nogales *et al.* 2002). Available information on raptor seed dispersal is scanty and based mainly on anecdotal records. Here we report the seed dispersal of the “bacuri” palm *Attalea phalerata* (Palmae) by Crested caracaras *Caracara plancus* (Falconidae) in the Pantanal of Brazil and review the evidences of seed dispersal by raptors around the world.

Crested caracaras are generalist falconids that are known to feeding on a variety of food items, including carrion, small vertebrates such as lizards, frogs and rodents, insects, eggs and fruits (Sick 1997). Although widespread in Pantanal and other natural (or human-generated) open fields, few published studies focus on the ecology of this species. On July and November 2003, we regularly observed interactions of Crested caracaras and *A. phalerata* fruits. *Attalea phalerata* produces large-sized fruits, rich in lipids (da Silva *et al.* 1994), that are dispersed by a small coterie of animals, including two introduced species (cattle, and feral pigs), and rheas, tapirs, and rodents (agoutis and *Clyomys* spp.) (M. Galetti unpublished data). Rodents are mainly seed predators but also disperse *Attalea* seeds at short distance, while tapirs, cattle and feral pigs can be long distance seed dispersers (Fragoso *et al.* 2003). Hyacinth macaws are the main seed predator and also carry *Attalea* nuts and may occasionally disperse its seeds (Guedes and Harper 1995). Of the recorded *Caracara-Attalea* interactions, in two occasions we observed the cacaracas taking off with one *Attalea* fruit in its beak (Figure 1) and perching in trees more than 200 m away. Caracaras eat only the pulp of the fruit, leaving the nut intact.

We also compiled the evidence of frugivory and seed dispersal by four families of birds of prey (Accipitridae,



Figure 1. *Caracara plancus* dispersing seeds of *Attalea phalerata* (Palmae) at Fazenda Rio Negro, Pantanal, Brazil.

Cathartidae, Falconidae, and Pandionidae) using the ISI-Web of Science (isi3.isiknowledge.com), the Raptor Information System (ris.wr.usgs.gov), and different books about natural history of birds (see Table 1). We recorded evidence of frugivory in 13 taxa of birds of prey (three families, Table 1). The records on frugivory by raptors are scarce, but sampled data indicate three paths in which birds of prey may disperse seeds.

First, raptors may act as secondary seed dispersers by consuming primary seed dispersers and seed predators and discarding intact seeds at the perch or regurgitating pellets with seeds (Hall 1987, Dean and Milton 1988, Engel 2000, Pearson and Ortega 2001, Shanahan *et al.* 2001). The strongest evidence of the ecological importance of this kind of dispersal is restricted to a single kite species (*Falco tinnunculus*) and non-falconiform predatory birds in ocean islands (Nogales *et al.* 1998, 2002), but there is evidence of its occurrence for introduced predatory mammals, such as

Table 1. Evidence of frugivory by birds of prey (Cathartidae, Accipitridae, Falconidae).

Order	Family	Species	Fruits recorded ¹	Distribution ²	Reference
Ciconiformes	Cathartidae	<i>Cathartes aura</i>	<i>Acrocomia</i> (P)*, <i>Elaeis</i> (P)*, <i>Juniperus</i> (C), grapes	NA	Hiraldo et al. 1991, Sick 1997
		<i>Coragyps atratus</i>	“fruit”	NA	Buskirk & Lechner 1978
Falconiformes	Accipitridae	<i>Buteogallus urubitinga</i>	<i>Spondias</i> (A)*	NA	Del Hoyo et al. 1995, Sick 1997
		<i>Elanoides forficatus</i>	<i>Byrsonima</i> (Ma), <i>Castilla</i> (Mo), <i>Cupania</i> (S), <i>Matayba</i> (S), <i>Sapium</i> (E), “fruits” (S and Mo)	NA	Buskirk & Lechner 1978, Lemke 1979, Del Hoyo et al. 1995, Sick 1997, Chaves 2000, Gerhardt et al. 2004, Meyer et al. 2004,
		<i>Gypohierax angolensis</i>	<i>Elaeis</i> (P)*, <i>Raphia</i> (P)*, <i>Phoenix</i> (P)*	AFR	Brown & Amadon 1968, Brown et al. 1982, Del Hoyo et al. 1995
		<i>Milvus migrans</i>	<i>Elaeis</i> (P)*	Palaearctic	Brown et al. 1982, Del Hoyo et al. 1995
		<i>Polyboroides typus</i>	<i>Elaeis</i> (P)*	AFR	Brown & Amadon 1968, Brown et al. 1982, Del Hoyo et al. 1995
	Falconidae	<i>Caracara plancus</i>	<i>Attalea</i> (P)*, <i>Elaeis</i> (P)*, <i>Cocos</i> (P)*, “beans” (L), “peanuts” (L),	NA	Del Hoyo et al. 1995, Sick (1997), This work
		<i>Daptrius ater</i>	<i>Elaeis</i> (P)*, <i>Desmoncus</i> (P), <i>Mauritia</i> (P)*, “unidentified seeds”	NA	Schubart et al. 1965, Brown & Amadon 1968, Thiollay 1991, Del Hoyo et al. 1995, Sick 1997
		<i>Daptrius americanus</i>	<i>Poraqueiba</i> (I), “fruits” (Ma and P), “unidentified fruits”	NA	Schubart et al. 1965, Thiollay 1991, Del Hoyo et al. 1995, Sick 1997
		<i>Falco rufigularis</i>	“small green fruit” +	NA	P. Madrigal, pers. comm.
		<i>Milvago chimachima</i>	<i>Elaeis</i> (P)*, <i>Byrsonima</i> (Ma)	NA	Schubart et al. 1965, Del Hoyo et al. 1995, Sick 1997
	<i>Micrastur ruficollis</i>	<i>Blomia</i> (S)	NA	Thorstrom 1996	

¹(A) Anacardiaceae, (C) Cupressaceae, (E) Euphorbiaceae, (I) Icacinaceae, (L) Leguminosae, (Ma) Malpighiaceae, (Mo) Moraceae, (P) Palmae, (S) Sapindaceae, * large fruits (> 3 cm of length), + not confirmed, ²AFR Africa, NA Neotropical America

feral cats (Nogales *et al.* 1996) and for several continental predatory birds (review in Dean & Milton 1988). This path of seed dispersal is more likely to affect seedling recruitment in simple ecological systems, such as islands, in which frugivores consume few plant species and are consumed by few predators in a regular basis (Nogales *et al.* 2002). However, based on the quantity of preys - especially seed-eating rodents- consumed by predatory birds, Dean & Milton (1988) suggest that the amounts of seeds that are secondarily dispersed by predatory birds are not negligible. Differently from other kinds of secondary seed dispersal, such as short distance, scatterhoarding by rodents, secondary dispersal by raptors is likely to enhance considerably seed dispersal distances (Nogales *et al.* 2002). Further work is needed to clarify the role of the secondary dispersal by birds of prey in continental habitats.

Second, raptors may act as primary seed dispersers of ornithocoric fruits. There is evidence of kites that actively

consume small berries and seeds with fleshy arils. The few reports of this kind of seed dispersal by raptors occur in insectivorous species such as *Elanoides forficatus* (by far, the raptor species in which the frugivory was best recorded) and vertebrate predators such as *Micrastur ruficollis* (Table 1). Raptors capture the fruits on trees, as in *E. fortificatus*, or fallen fruits, such as in *M. ruficollis*. Based on the scarcity of natural history data for several forest-dwelling species, it is possible that more species of kites and hawks eventually consume fruits, acting as non-specialized frugivores and, occasionally, dispersing seeds.

Third, raptors may primarily disperse large-seeded fruits. The consumption of large fruits, especially palm fruits, is apparently widespread among the Neotropical Falconidae with a generalist diet that includes carrion, small vertebrates and insects, but also in wasp-specialist species (*Daptrius ater*) (Table 1). Sick (1997) recorded Crested caracaras consuming fruits of *Elaeis oleifera*, but he did not provide any estimative

of the potential role as seed dispersers. Moreover, opportunistic raptors from other families, such as *Cathartes aura* (Cathartidae), and *Gypohierax angolensis* (Accipitridae) also consume large fruits, including palms (Table 1).

All large fruits recorded here (*Acrocomia*, *Attalea*, *Elaeis*, *Phoenix*, *Raphia*, *Mauritia*, and *Spondias*) have pulps rich in lipids (Carciofi 2002, da Silva *et al.* 1994). The exploitation of lipid-rich fruits by carnivorous is a pattern also recorded by carnivorous arthropods, such as Ponerinae ants and harvestmen, in which lipid-rich fruits are used because they are chemically analogous to animal prey (Machado and Pizo 2000, Pizo and Oliveira 2001). We suggest that a similar explanation may be used to fruit consumption by generalist or insect-specialized raptors.

The interactions of large fruits with large, generalist birds of prey possible have consequences for seed dispersal of these plants. Most of large fruits cited in Table 1 fit to "megafauna seed dispersal syndrome", that is, their putative seed dispersers are large mammals (Janzen and Martin 1982, P. R. Guimarães *et al.* unpublished data). All megafauna are now extinct in South America, except for tapirs, and these large-seeded plants are now dispersed by a small coterie of species, mainly by short-distance scatterhoarding rodents such as agoutis and *Clyomys* (M. Galetti and C. Donatti unpublished data). Thus, occasional dispersal by Crested caracaras and other generalist raptors may provide important events of long-distance seed dispersal.

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