

## FRUITING PHENOLOGY AND FRUGIVORY ON THE PALM *EUTERPE EDULIS* IN A LOWLAND ATLANTIC FOREST OF BRAZIL

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**Abstract.** The palm *Euterpe edulis* (Palmae) is one of the main sources of palm-heart in Brazil. Although economically important, the ecology of *E. edulis* is poorly known. Fruiting phenology and frugivory on *E. edulis* was studied in a pristine lowland Atlantic forest in Brazil from April 1994 to March 1996. *Euterpe edulis* produced ripe fruits from April to September, during the peak of overall fruitfall in the area. The peak of ripe fruit production occurred in July during the drier season. Fruits of *E. edulis* are rich in carbohydrates and were eaten by 14 bird species, mainly thrushes (*Turdus* spp. and *Platyicbha flavipes*) and large avian frugivores such as toucans, guans, and cotingas, and also one mammal species. Seed dispersal effectiveness differed for each bird species. The diet overlap among the fruit-eating birds was low because they consumed the fruits at different times during the ripening period. Resident birds, such as toucans and cotingas, consumed the fruits early in the fruiting season, while migratory thrushes used *Euterpe* fruits in the middle or late fruiting season. The long fruiting season of *E. edulis*, the large assemblage of frugivores associated with its fruits, and its abundance in the Atlantic forest makes this palm an important food resource for Atlantic forest frugivores. This emphasizes the urgency of finding new approaches to its conservation and sustainable management. Accepted 26 July 1999.

**Key words:** *Astrocaryum*, Atlantic forest, *Euterpe*, frugivory, fruit production, *Geonoma*, palm ecology, phenology, seed dispersal.

### INTRODUCTION

Neotropical forests hold one of the richest palm diversities of the world with an estimated 66 genera and 550 species (Uhl & Dransfield 1987, Henderson *et al.* 1995). In the Atlantic forest, along 4000 km of the coast of Brazil, reaching Argentina (Misiones) and Paraguay, 10 genera and 40 species of palms occurs, of which many are endemic (Henderson *et al.* 1995).

The “palmito juçara” (*Euterpe edulis* Mart.) is the commonest palm of the Atlantic forest and was the main source of palm-hearts in Brazil until the late 1970s (Hodge 1965, Galetti & Fernandez 1998). Palm-heart, “palmito” or “coeur de palmier,” is the edible terminal buds of certain palms, especially in the genera *Euterpe* and *Bactris*. These tender parts of the palms are eaten raw, thinly sliced in salads, on soups, or even on top of pizzas (Montagne & Lang 1998). *Euterpe edulis* is considered to have one of the best-tasting palm-hearts among palms. The over-

harvesting of *E. edulis* strongly depleted the natural stands and the palm-heart industry has moved to the Amazon estuaries to exploit the “açai” *Euterpe oleracea*, which nowadays is the main source of palm-hearts (Galetti & Fernandez 1998).

Although the palmito (*E. edulis*) is still abundant in a few protected areas, ecological studies of the species are rare (see Matos & Watkinson 1998, Carvalho *et al.* 1999) and most are based on silvicultural aspects (Bovi *et al.* 1991, Carvalho 1994) or previous essays on palm management (Ribeiro *et al.* 1994).

Palm fruits are an important food source for frugivorous vertebrates in Neotropical forests, and they are often mentioned as “keystone” species (Terborgh 1986a,b; Peres 1994, but see Galetti & Aleixo 1998). Keystone plant species support the frugivore vertebrate community in periods of extreme fruit scarcity (Terborgh 1986a,b).

This paper presents information on fruiting phenology and frugivory of the palmito *Euterpe edulis* in a lowland Atlantic forest in southeastern Brazil. The

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main aims of this study were to investigate the phenology of *E. edulis*, to compare its fruit production with those of two others sympatric palm species, to assess the feeding assemblage that consumes their fruits, discussing the importance of *E. edulis* as a food source to Atlantic forest frugivores.

## STUDY SITE AND METHODS

This study was carried out at Parque Estadual Intervales, a 410 km<sup>2</sup> area of pristine Atlantic forest in São Paulo State, southeastern Brazil. The field base, Base Saibadela, is located in a lowland forest at 70 m a.s.l., near Sete Barras city (24° 14' S, 48° 04' W; see Galetti 1996, Aleixo & Galetti 1997).

The climate at Base Saibadela is tropical rainy according to the Köppen (1948) system, with substantial rain occurring every month. The total rainfall was 4244 mm and 3958 mm in 1994 and 1995 respectively (Fig. 1). The climate is slightly seasonal, with a wet and warm period from October to April and a drier and colder period from May to September.

The Base Saibadela is covered by primary forests dominated by Myrtaceae, Rubiaceae, Lauraceae and Rutaceae (Almeida-Scabbia 1996). *Euterpe edulis* is a middle-understorey palm that can reach up to 20 m in height with a maximum diameter at breast height (DBH) of 18 cm. The fruits are black-purple drupes 1 cm in diameter, rich in carbohydrates (6% lipids, 31% water, 6% protein and 21.5% carbohydrates) (Galetti 1996). The palmito fruit is among the ten most nutritive fruits in terms of energy produced per

100 g of pulp (c. 150 kcal) of more than 50 fleshy-fruited species analysed by Galetti (1996) at Saibadela. Each infructescence produces between 54 and more than 1500 ripe fruits per season. Palm-heart harvesting had apparently never taken place in the study area before our study (but see Galetti & Chivers 1995) and the density of *E. edulis* can reach up to 500 adult palms/ha (Ribeiro *et al.* 1994).

The availability of fruits on palms was assessed by counting the ripe fruits of 41 tagged *Euterpe edulis* Mart., four *Astrocaryum aculeatissimum* (Schott.) Burret and nine *Geonoma elegans* Mart. palm trees every month, from April 1994 to March 1996. The fruiting phenology of the palms was observed monthly during the entire study period. Fruits were considered unripe from the beginning of their development until achieving their full size but still green-colored; fruits were characterized as ripe when they changed their color to dark purple.

Up to 233 bird species were recorded in the Base Saibadela area, including several large endangered frugivores such as the Black fronted Piping-guan (*Pipile jacutinga*, Cracidae), the Cinnamon-vented Piha (*Lipaugus lanioides*), the Black-headed Berryeater (*Carpornis melanocephalus*, Cotingidae), and the Blue-bellied Parrot (*Triclarina malachitacea*, Psittacidae) (Aleixo & Galetti 1997). The frugivore assemblage that consumes the fruits of *E. edulis* was studied while walking along eight transects of 1 km length. We recorded a feeding bout every time we observed an animal or a flock eating a fruit (Galetti 1996). This method was chosen, instead of watching focal trees, because *E. edulis* is highly abundant in the area, and

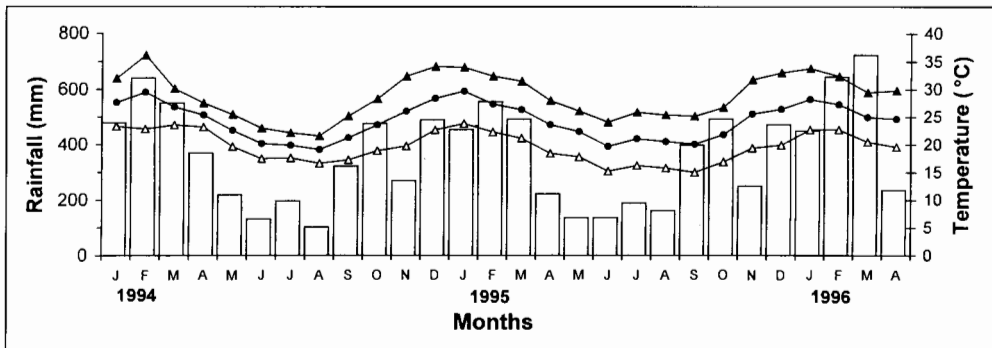


FIG. 1. Climate at Base Saibadela, Parque Estadual Intervales, São Paulo, Brazil. The bars are rainfall and the lines are maximum (filled triangles), mean (filled circles) and minimum temperature (open triangles).

TABLE 1. Importance of *Euterpe edulis* fruits in the diet of frugivores at Parque Interales (a = seeds found in feeding roots, b = seeds found in the faeces, c = reported by local people, d = seeds eaten by captive animals, o = occasionally eat unripe fruits, \* = observed eating in other areas, see references).

Species	Number of feeding bouts recorded in the entire diet	% of <i>Euterpe</i> fruits in the diet of each species and feeding bouts
Birds		
Cracidae		
<i>Penelope obscura</i>	28	17.8 (5)
<i>Pipile jacutinga</i>	35	8.6 (3)
Ramphastidae		
<i>Bailloni bailloni</i>	6	0
<i>Selenidera maculirostris</i>	103	17.5 (18)
<i>Ramphastos dicolorus</i>	7	43 (3)
<i>Ramphastos vitellinus</i>	40	17.5 (7)
Psittacidae		
<i>Brotogeris tirica</i>	23	8.7 (2)
<i>Pyrrhura frontalis</i>	19	15 (3)
<i>Triclaria malachitacea</i>	14	15.4 (2)
Cotingidae		
<i>Carpornis cuculatus</i>	0	0*
<i>Carpornis melanocephalus</i>	26	7.7 (2)
<i>Lipaugus lanioides</i>	2	0*
<i>Procnias nudicollis</i>	12	41 (5)
<i>Pyroderus scutatus</i>	24	25 (6)
Trogonidae		
<i>Trogon viridis</i>	46	13 (6)
Turdidae		
<i>Turdus albicollis</i>	100	8 (8)
<i>Turdus rufiventris</i>	4	*
<i>Platycichla flavipes</i>	96	29.6 (28)
Momotidae		
<i>Barythegus ruficapilus</i>	1	(1)
Tyrannidae		
<i>Pitangus sulphuratus</i>	2	*
<i>Megarhynchus pitanga</i>	1	*
Mammals		
Chiroptera		
<i>Artibeus lituratus</i>		a
Primates		
<i>Cebus apella</i>		o
Canidae		
<i>Cerdocyon thous</i>		b
Rodentia		
<i>Sciurus ingrami</i>	15	27 (4)
<i>Dasyprocta leporina</i>		c
<i>Agouti paca</i>		c
<i>Proechymis iheringii</i>		d
Perissodactyla		
<i>Tapirus terrestris</i>		b
Artiodactyla		
<i>Tajacu tajacu</i>		c
<i>Tajacu pecari</i>		c
<i>Mazama americana</i>		c

Four species observed at Base Saibadela eating *Euterpe* fruits (*Trichlaria malachitacea*, *Pitangus sulphuratus*, *Megarhynchus pitangua*, both Tyrannidae, and *Carpornis melanocephalus*) were not recorded in the highlands by Laps (1996). On the other hand, we did not record five other species observed by Laps (1996) (*Bailloni bailloni*, Ramphastidae, *Myiodynastes maculatus*, *Tityra cayana*, both Tyrannidae, *Celeus flavescens*, Picidae, and *Orthogonys chloricterus*, Thraupidae). All these species may occur at Base Saibadela as well. Except for *Carpornis melanocephalus*, which is restricted to the lowlands of the Atlantic forest, we predict that in non-defaunated areas of the forest the feeding assemblage that could consume *Euterpe* fruits could reach 25 bird species and about 15 mammals (including rodents and bats).

In forest fragments and secondary forests, however, *E. edulis* is dispersed by a much smaller assemblage, because large frugivores such as guans, trogons and toucans are usually absent (Aleixo & Vielliard 1995). Matos & Watkinson (1998) observed only five bird species feeding on *E. edulis* in a small (250 ha) forest fragment, while Zimmermann (1993) noted eight species swallowing *E. edulis* fruits

in a secondary forest in the south of Brazil. The consequences of this reduced feeding assemblage is not known but due to the generalized feeding assemblage that disperses *E. edulis* fruits, it seems that seed dispersal is not the main threat for this palm in such areas.

Bats can probably disperse *Euterpe* seeds but only in periods of extreme fruit scarcity (Mantovani 1998). Fallen fruits can also be dispersed by ungulates, such as tapir (Rodrigues *et al.* 1994), or carnivores such as the crab-eating fox *Dusycion thous* (M. Galetti, unpubl. data), but their role as effective seed dispersers remains unknown.

Although *Euterpe* fruits were consumed by many frugivores, the seed dispersal effectiveness (*sensu* Schupp 1993), not accessed in this study, must be investigated. Schupp (1993) considers disperser effectiveness as the contribution of a disperser to the future reproduction of a plant. Effectiveness consists of a qualitative and a quantitative component, where the number of seeds eaten per visit, the quality of the treatment given by the frugivore to the seeds, and the quantity and quality of seed deposition are the important factors determining if the frugivore is a "good" or "bad" seed disperser (Schupp 1993).

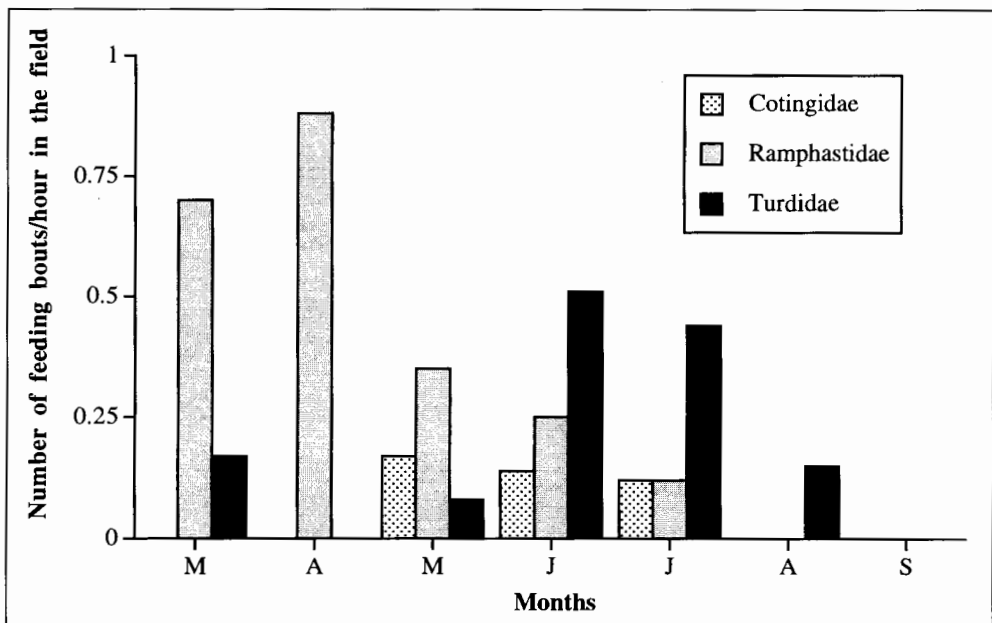


FIG. 4. Frequency of feeding bouts of the main fruit-eating birds that consume *Euterpe edulis* at Saibadela.

The main frugivores observed feeding on *E. edulis* fruits (in terms of feeding bouts) during this study are apparently poor seed dispersers. Toucanets (*Selenidera*), toucans (*Ramphastos*) and thrushes (*Platycichla* and *Turdus*) usually stay up to one hour eating and regurgitating *Euterpe* seeds below the parent plant. Large cotingas (*Pyroderus scutatus*, *Carpornis* spp., and *Procnias nudicollis*) and cracids (*Pipile* and *Penelope*), however, make only brief visits to *E. edulis*, eating few fruits per bout and flying away. The high consumption of green fruits by toucans and cotingas, however, does not classify them as bad seed dispersers since unripe greenish fruits can still germinate (Mantovani 1998).

The low overlap in *Euterpe* fruit consumption by birds may reduce the competition among these species. Toucans and cotingas are resident birds in the area and they usually monitor the ripeness of the preferred fruiting trees within their home ranges (Galetti 1996), while *Platycichla flavipes* is an altitudinal migrant that reaches the lowlands of Serra do Mar in June and July (Aleixo 1997). *Platycichla flavipes* is highly aggressive and monopolizes *Euterpe* fruiting trees, displacing even large cotingas (*Procnias nudicollis* and *Pyroderus scutatus*) and toucans (*Ramphastos*).

The sequential consumption of fruits by different bird families during the fruiting season was also observed in *Casearia corymbosa* (Flacourtiaceae) in Costa Rica (Howe 1977). In both cases, resident birds visited and consumed the fruits in the beginning of the ripening period, then migratory birds in the middle or at the end of the fruiting season. Galetti *et al.* (in press) noted that resident toucans monitor the main fruit sources within their home ranges, and they are usually the first frugivores to exploit abundant resources, such as *Euterpe* fruits.

*Euterpe edulis* fruits are specially important for birds in the highlands of the Serra do Mar because they are ripe in the winter when the abundance of fleshy fruits is lower (Laps 1996). In the lowlands, however, palmito bears fruits (as during our study period) when several berries are ripe (mainly Myrtaceae), but their importance as food energy cannot be ignored (Galetti 1996, Galetti & Aleixo 1998, Morellato *et al.*, in press). The long *E. edulis* fruiting season, the large assemblage of frugivores associated with its fruits, and its high frequency of occurrence in the Atlantic forest makes this palm fruit an im-

portant food resource for Atlantic forest frugivores and underlines the urgency of finding methods for its conservation and sustainable management (see Galetti & Fernandez 1998).

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