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Seed Predation by a Curculionid Beetle on the Dioecious Palm Chamaedorea tepejilote

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ABSTRACT

Seed predation by a curculionid beetle (unidentified yet) on the fruits of the dioecious palm *Chamaedorea tepejilote* is reported. Pre-dispersal and post-absission predation, and the removal of seeds from the soil were studied. More than 60% of the seeds on the maternal plant were damaged by predation before dispersion and very few seeds were damaged after the fruits fall on the soil. Levels of damage were correlated with the density of fruits on the plants. Fallen fruits were removed by small mammals in one night. The demographic consequences of seed predation in *C. tepejilote* and possible mechanisms of plants defense against seed predators are discussed.

RESUMEN

Se reporta la depredacion de semillas de los frutos de la palma dioica *Chamaedorea tepejilote* por un curculiónido (aun no identificado). Se estudió la depredación pre-dispersión y post-absision, asi como la remoción de frutos en el suelo. Más del 60% de los frutos en el suelo fueron depredados antes de la dispersión y muy pocos frutos fueron depredados después de que cayeron al suelo. Los niveles de depredación estuvieron correlacionados con la densidad de frutos en las plantas. Los frutos en el suelo fueron removidos por mamíferos pequeños en una noche. Se discute las consecuencias demográficas de la depredación de semillas en *C. tepejilote* y sus posibles mecanismos de defensa.

Seed predation is one of the main factors influencing the mortality of plants (for a review see Janzen 1971) and many studies on tropical plant species have been reported (Janzen 1975; Moore 1978*a*, *b*; Silander 1978; De Steven 1981, among others). The influence of seed predation on the determination of the structure and diversity of tropical communities has been also evaluated (Hubbell 1980). However, very few studies have reported the effects of seed predation on the population dynamics of tropical plants (Sarukhan 1980, Piñero and Sarukhan 1982).

In 1981, a long-term project on the population biology of the dioecious palm *Chamaedorea tepejilote* Liebm. was initiated, and until now the demography (Oyama 1987, unpublished), resource allocation (Oyama and Dirzo 1988), herbivory (Oyama 1984, Oyama and Dirzo, unpublished), and artificial defoliation (Oyama 1987, Oyama and Mendoza, unpublished) have been reported. In this paper, I present the results of the levels of predation suffered by the seeds of *C. tepejilote* by a curculionid insect (unidentified yet) in a Mexican lowland rain forest.

Materials and Methods

Study Site. This study was conducted at the 700 ha reserve "Estacion de Biologia Tropical Los Tuxtlas" owned and operated by the Instituto de Biologia of Universidad Nacional Autonoma de Mexico. This reserve is located at 95°04′–95°09′W and 18°34′–18°36′N in the state of Veracruz. The forest of Los Tuxtlas is classified as Tropical Rain Forest with trees reaching heights up to 35 m. Elevations range from

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150–700 m. Mean annual rainfall is approximately 4,500 mm and mean daily temperature is 24° 132C. The palm flora of Los Tuxtlas is described in Ibarra-Manriquez (1988) and Ibarra-Manriquez and Sinaca-Colin (1987).

Chamaedorea tepejilote Liebm. in Mart. is one of the most common palms in the understory of the forest at Los Tuxtlas (Oyama 1984, Bongers et al. 1988). The tallest individuals reach up to 5.0 m in height. The ripe fruits are black (green when immature), ovoid, 10–15 mm large and 6–8.5 mm wide; with thin exocarp, mucilaginous mesocarp and endocarp with fiber and thin membrane. The seeds are yellow-brown, 9–11 mm large and 5–6.5 mm wide (Aguilar-Amar 1986). Each fruit has only one seed. Taxonomical description of *C. tepejilote* is provided by Ibarra-Manriquez (1988).

Flowering is from September to March. The fruiting peak is concentrated in July–August. The fruits remain on the maternal palm for a long time (sometimes more than one year). The seed predator is a larva (Curculionidae as yet unidentified) that parasitizes the fruits before ripening. When this occurs a black dot is observed in the green immature fruits. In a preliminary study, I collected more than 500 fruits from 16 infructescences of 8 palms, and in more than 95% of the fruits with a black dot, a weevil larva was observed. The presence of a dot was therefore used to indicate weevil predation, thereby avoiding the harvesting of fruits. Further germination experiments with damaged seeds were not carried out because the seeds were completely destroyed.

The seeds of *C. tepejilote* have been observed in the mouth-pocket of a heteromyid mouse, *Heteromys desmarentianus*. This mouse eats seeds of more than 20 species at Los Tuxtlas but the seeds of *C. tepejilote* are among the five more common ones used by the mouse. From 1–4 seeds per pocket have been observed but most of them were fragmented suggesting a post-dispersal predation (V. Sanchez-Cordero, pers. comm.). Otherwise, infructescences of *C. tepejilote* are visited by some species of birds (D. Van Dorp, pers. comm.).

Methods

Pre-Dispersal Predation. Thirty-seven palms comprising 105 infructescences and 2,084 fruits were observed from August through October, 1985. The degree of ripening and the presence or absence of a curculionid larvae (noting the black dot) were recorded every month. The number of abortive fruits were also recorded as identified by the abnormal morphology of the fruits. The differences between two consecutive measurements were considered as "fruits removed". These 37 palms were used to compare the density of fruits with the intensity of seed predation.

Post-Absission Predation. Seventeen reproductive palms along a 100 m transect were chosen and a 1 m diameter basket was placed at the base of each palm, just below the infructescences, to catch all the fallen fruits. The fruits in the baskets were classified as ripe, unripe, damaged by predation, undamaged and aborted. Because the fruit-seed damaged by the weevil was easily recognized, only fruits with a different type of damage were considered as showing post-absission predation.

Removal of Seeds from the Soil. Thirty sets of 20 undamaged ripe fruits were placed randomly on one 600 m^2 (30 m × 20 m) permanent plot. Ten sets were covered with a mesh of 0.5 cm^2; another 10 with a mesh of 2.0 cm^2 and the rest without any mesh. This experiment was designed to measure rates of predation or dispersal on the soil.

Results

Pre-Dispersal Predation. The weevil larva was the only seed predator. At the beginning of this study, 1,283 of 2,084 fruits (61.56%) were damaged by weevil-

Table 1. Pre-dispersal seed predation on Chamaedorea tepejilote. *Total number of seeds sampled = 2,084 in 37 palms. The number in parentheses represents the proportion of fruits (seeds) in relation to the total fruits sampled.*

	August			September			October		
	UN	RI	Total	UN	RI	Total	UN	RI	Total
Damaged seeds	1,219 (58.19)	64 (3.07)	1,283 (61.56)	326 (15.64)	337 (16.17)	663 (31.81)	211 (10.12)	45 (2.16)	256 (12.28)
Undamaged seeds	669 (32.10)	116 (5.57)	785 (37.67)	506 (24.28)	201 (9.64)	707 (33.92)	80 (3.84)	356 (17.08)	436 (20.92)
Aborted seeds	—	16 (0.77)	16 (0.77)	7 (0.34)	149 (7.15)	156 (7.49)	—	222 (10.65)	222 (10.65)
Removed seeds		—			558 (26.78)			1,170 (56.14)	
Total		2,084			2,084			2,084	

predation: 1,219 of unripened fruits and only 64 of ripe fruits. Very few fruits were aborted. In September, the proportion of fruits damaged was only 31.81% (326 of unripe and 337 of ripe fruits) and 558 fruits (26.78%) were removed. I assumed that most of the fruits removed were damaged the month before. The fruits removed and the fruits predated on this month were 58.59% of all the fruits. This value is low compared with the 61.56% recorded in the month before, and could be expressing the error associated with the use of the dot-marker. Also, the rate of predation did not increase suggesting that the attack of the weevil was concentrated in the months before August. In October, only 256 fruits (12.28%) were predated and 1,170 were removed (Table 1).

Post-Absission Predation. In the first month, 192 of 924 fruits (20.7%) were removed from the maternal plants. Ninety-two fruits dropped under the maternal plants and of these, only 26 (2.81% of the total) were damaged by the same pre-dispersal weevil. One hundred fruits were considered dispersed. After the second month, 457 of 924 fruits (50.5%) were removed from the maternal plant and only 34 fruits (3.68%) were damaged, again by the same weevil (Table 2).

Density Dependence. The intensity of

Table 2. Post-absission seed predation on fruits of Chamaedorea tepejilote. *Total number of fruits (seeds) = 924. The number in parentheses represents the proportion of fruits (seeds).*

Month	Number of Seeds	Seeds Predated	Safe Seeds
(a) Fruits (seeds) under the maternal plant			
August–September	92 (9.96)	26 (2.81)	66 (7.14)
September–October	211 (22.84)	34 (3.68)	177 (19.16)
(b) Fruits removed (dispersed)			
August–September	100 (10.82)		
September–October	246 (26.62)		
(c) Fruits (seeds) on the crown			
August–September	732 (79.22)		
September–October	467 (50.54)		

(a) = means fruits collected in the 17 baskets under the maternal plants.

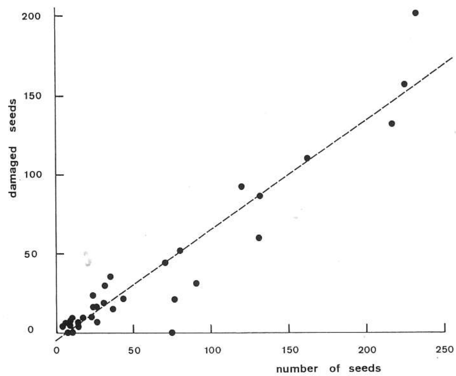
seed predation was correlated with the density of fruits on the palms ($R^2 = 0.90$) Fig. 1.

Dispersion of Seeds. Seeds without mesh were removed in one night but seeds covered with mesh were left for three months. Any sign of parasites or fungus was recorded.

Discussion

More than 60% of the fruits produced by *C. tepejilote* are damaged by larvae of the curculionid insect. This percentage of damage is higher than the values reported for other species (Janzen 1971). Seed predation has been reported for other species at Los Tuxtlas (Cordova 1985, Alvarez-Buylla 1986) and in the case of *Astrocaryum mexicanum* 90% of the seeds are damaged influencing the population dynamics of this species (Sarukhan 1978, Piñero and Sarukhan 1982). In *C. tepejilote,* seed predation constituted the main factor of mortality in the life cycle influencing the intrinsic rate of population growth based on sensitivity analysis (Oyama 1987).

One curculionid species was observed during the study period and probably was a specialist insect that could drill the protected exocarp of *C. tepejilote* fruits. Several mechanisms of defense against seed predation have been reported for plants. Chemical compounds (Rosenthal and Janzen 1979) and "escape" in time and space (Janzen 1978) have been suggested. The data available for *C. tepejilote* suggest in part an "escape" by satiation of predators (see Janzen 1978). Some individual plants of *C. tepejilote* produce enough fruits to satisfy the food requirements of the curculionid insect leaving a number of safe fruits for the establishment and propagation of *C. tepejilote* at Los Tuxtlas. There is not a precise definition of the term "satiation" but if some seeds can escape predation then the efficiency of escape could be evaluated. The simplest case of satiation



1. Correlation between density of fruits (seeds) and the intensity of predation.

of predators occurs when the number of predators is independent of the seed crop produced and the rate of removal by dispersal agents (Janzen 1978). However, in *C. tepejilote* density-independence of seed predation occurred although this palm produced a wide range of fruits per individual (Oyama 1987; unpublished). Seed predators could have played a significant role on the selection of the fruits produced.

The rate of seed predation on the maternal palm and the rapid removal of seeds from the soil, also determine the pattern of spatial distribution of *C. tepejilote* at Los Tuxtlas. Few seeds (compared with the entire seed crop) can germinate and establish, mainly near the parental palm or some meters far away (removed by dispersors), producing the aggregated pattern of spatial distribution of this species (Oyama 1984, Oyama et al., unpublished).

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