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CLEOGONUS WEEVIL SEED PREDATION ON *ANDIRA* CAN BE PREDICTED BY FRUIT PUNCTURES

D. H. Janzen

Department of Biology. University of Pennsylvania, Philadelphia, Pennsylvania 19104

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ABSTRACT

When *Andira inermis* (Leguminosae) fruits are sorted into those with 0, 1, 2–5, and greater than 5 feeding and oviposition punctures by *Cleogonus* weevils, there is 100, 87, 65, and 2 percent seed survival in these four categories, respectively (lowland Guanacaste Province, Costa Rica). These results suggest that the bats that harvest the fruits and disperse the seeds could increase seed survivorship by selecting fruits with 0 to 5 feeding punctures.

The fruits of *Andira inermis,* an evergreen fabaceous legume tree of the lowland deciduous forests of Guanacaste Province, Costa Rica, are picked from the crown by bats and carried to feeding roosts tens of meters from the parent tree (Janzen *et al.* 1976). After the bat eats the fruit pulp off the large single-seeded nut, it drops it and returns to the tree for another fruit. Simultaneously, adults of three species of large black *Cleogonus* weevils are feeding, mating and ovipositing on the mature fruits in the crown of the *Andira* tree (Fig. 1) and on fallen or dropped *Andira* fruits both below and far from the parent. The percent seed mortality due to *Cleogonus* larvae among the seeds below bat feeding roosts is lower than that below the parent tree (e. g., Janzen *et al.* 1976 and unpublished), Moreover, the mortality due to *Cleogonus* below the bat feeding roosts is lower than that encountered in fruits shaken from the crown of the *Andira* tree at the time the bats are picking fruits. This implies that either the bats remove some of the larvae and eggs along with the pulp, before any larvae have entered the nut, or that the bats select fruits that have lower than usual numbers of weevil larvae in them. The former hypothesis has been tested by removing the fruit pulp in a manner simulating fruit pulp removal by the bats, and the results show that fruit pulp removal does lower seed mortality (Janzen 1982). However, selection of uninfested fruits by bats remains a posibility. For this to be a reasonable possibility requires that there be some trait of the fruit correlated with the probability that it contains enough weevil larvae or eggs for one or more of them to make it into the seed. Feeding and oviposition punctures in the fruit are certainly large enough for a bat to perceive and here I test the hypothesis that the probability that an *Andira* seed will be killed by *Cleogonus* larvae is related to the number of punctures in the fruit that contains that seed.

A sample of 424 ripe *Andira* fruits was shaken from a large tree near Cañas, Guanacaste Province, on 1 June 1979. There was a moderate density of *Cleogonus* weevils in the tree crown and on the ground below. The fruits were sorted into two categories: one puncture per fruit (n = 178), and more than 1 puncture per fruit (n = 246). After waiting 30 days for larval development, each fruit and seed was split open and examined. In the first category, 86 percent of the seeds were intact and in the second category, 84 percent of the fruits were intact. These differences are not statistically significant. These results suggest that a bat choosing fruits according to the amount of fruit surface damage would not harvest a disproportionate number of fruits with insufficient larvae or eggs to kill the seeds.

However, at the same time another set of 759 fruits was shaken from a different part of the same tree. This sample was sorted into four categories: no feeding or oviposition punctures (n = 56), one puncture (n = 113), two to five punctures (n = 282), and greater than five holes (n = 308). After 30 days, the fruits with intact seeds were 100, 87, 65 and 2 percent of their respective samples. It is obvious that seed survival in not distributed evenly across the four categories.

It is evident that if the bat selects fruits with five or fewer punctures it is likely to be carrying off many more seeds that will live than if it takes fruits indiscriminately. There are at least three different ways that a bat may harvest fruits with disproportionately low numbers of punctures. First, it may harvest fruits before the weevils get to them by taking them early in the season. Second, it may actively avoid fruits with many punctures. Such avoidance would occur if the bat rejected fruits with scarred, and therefore hard, epidermis, or fruits that are somewhat fermented from microbial activity in the punctures. Third, the bat may take the most exposed fruits (bats harvest *Andira* fruits in flight, flying along the outer margins of the tree crown). These fruits tend to have the lowest number of punctures because the weevils concentrate their activity on fruits in the centers of clusters and nestled in foliage.

In such a system there is the obvious opportunity for evolutionary 'fine tuning' among the following traits: bat perception of 'ripeness', location of the fruits on the tree, details of ripening demography within the crown, fruit susceptibility to rotting once it has been punctured by a weevil, and bat squeamishness about flavor.

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Resumen

Cuando los frutos de *Andira inermis* (Leguminosae) se agrupan en categorías de 0, 1, 2–5, y más de 5 agujeros causados por la alimentación y oviposición de comer y ovipositar por gorgojos *(Cleogonus)*, hay 100, 87, 65, y 2 por ciento de supervivencia de las semillas, respectivamente, en las tierras calientes bajas de la provincia de Guanacaste, Costa Rica. Estos resultados sugieren que los murciélagos que cosechan los frutos y dispersan las semillas pueden aumentar la supervivencia de las semillas, al seleccionar para su consumo frutos con 0 a 5 agujeros de gorgojo.

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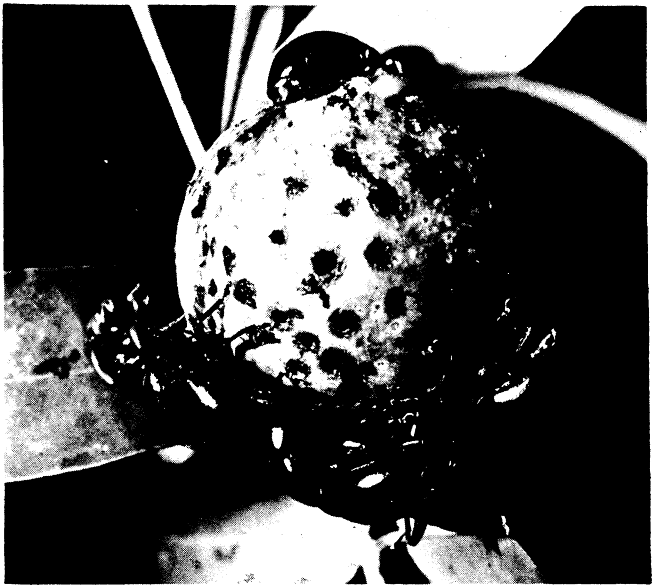

Fig. 1. A heavily punctured mature fruit of *Andira inermis* being fed on by numerous copulating pairs of *Cleogonus* weevils.