Differential Ingestion of Viable vs Nonviable Ficus Seeds by Fruit Bats

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Frugivorous bats are among the most important dispersal agents of many species of figs (*Ficus*), both worldwide (*e.g.,* August 1981, Janzen 1979), and within the Philippines (Utzurrum 1984). Some species of Philippine fruit bats move distances of at least 12 km in a single night (Heideman & Heaney 1989), and thus present the potential for long distance dispersal of fig seeds. In this note, we suggest that the manner of ingestion of *Ficus* seeds by some Philippine members of the fruit bat family Pteropodidae increases the quality of these bats as dispersal agents.

Fig syconia (the "fruits" of a fig), masses of masticated and ejected syconium ("ejecta"), and fecal masses ("splats") were collected from beneath five fruiting *Ficus chrysolepis* trees in submontane primary forest surrounding Lake Balinsasayao in the mountains of southern Negros Island, Philippines (9°22′N, 123°11′E; see Antone 1983, Utzurrum 1984, and Heideman 1989 for site descriptions). The syconia of *F. chrysolepis* are eaten by at least 5 and perhaps as many as 10 of the 14 species of fruit bats known from the site (Heideman & Heaney 1989, Utzurrum, 1984), including the smallest, 18-gram *Haplonycteris fischeri,* and the largest, 1000-gram *Acerodon jubatus.* Figs have a unique pollination system, in which wasps of the family Agaonidae carry pollen to young syconia and also oviposit within certain ovaries (Janzen 1979). One consequence is that a substantial fraction of the seeds within each syconium are killed by wasp larvae (79%, 79%, and 81%; $N = 3$ syconia from one tree with a mean of 404 seeds). Parasitized seeds have conspicuous holes and are easily identified in mature syconia.

Germination tests were conducted on seeds removed from ejecta, splats, and fragments of ripe syconia dropped by bats. Every seed (both holed and intact) was removed from each ejecta, splat, or fragment of syconium dropped by bats the previous night onto clean plastic sheets. Seed samples were placed on damp filter paper in sterile petri dishes in shade and checked weekly for six weeks, after which the cumulative total of germinated and ungerminated seeds was recorded. Ninety-one percent of the seeds from splats germinated, compared with an average of 48 percent of those from ejecta and 57 percent of those from ripe syconia (Table 1). Although sample sizes were very small, these differences were statistically significant (Kruskal-Wallis test; $H = 9.559$, df = 2, $P < 0.01$). A post hoc comparison between seeds from fecal samples and those from ejecta showed significantly greater germination of seeds from feces (contrast value = 36, $N = 6$, $P < 0.01$). The difference in viability was largely due to the absence of holed seeds that have been parasitized from splats. Ejecta and syconia, in contrast, contained abundant holed seeds.

It is possible that the lack of holed seeds in splats could result from differential digestion of damaged seeds. However, the short gut passage times of these bats (20–45 min from feeding to first elimination of seeds in feces for captive *Nyctimene rabori* and *Ptenochirus jagori* fed with ripe *F. chrysolepis* syconia; $N = 3$ and 5, respectively) allows little time for digestion of hard seeds. We suspect that differential digestion, if it occurs, is probably secondary to other causes for the lack of holed seeds in splats.

We suggest instead that the lack of holed seeds in splats is due to differential ingestion of intact seeds. Nearly all intact seeds, including those from splats, had a thin, extremely slippery and sticky gelatinous coating (recently characterized for *Ficus awkeotsang* by Lin *et al.* 1989). Seeds damaged by fig wasps lacked this coating. This slippery coating on these relatively small fig seeds (1–2 mm) would make it difficult for a bat applying gentle suction to a mass of masticated fig to avoid swallowing intact seeds, while those seeds lacking the coating could be rejected with the fiber and damp pulp.

If differential ingestion of intact seeds is frequent, then the dispersal of fig seeds by bats is more efficient than it would be otherwise. The result of differential ingestion of intact, undamaged seeds is an increase in the number of viable seeds in bat splats. Since long-distance seed dispersal by bats occurs primarily through fecal deposition, dispersal is much more effective than it would be if parasitized and otherwise inviable seeds were as frequent in splats as they are in the fig syconium.

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TABLE 1. *Viability of seeds from ripe fruits, ejecta, and fecal splats.* (N = *number of trials; Range = range, in percent, of seeds germinating per trial; Time = mean time, in days, to germination.) Ejecta and splats used in these tests were produced by* Acerodon jubatus, Nyctimene rabori, Ptenochirus jagori, *and* Pteropus vampyrus.

	N	Number of seeds per trial	Percent germination[1]	(Range)	Time (days)
Ripe syconia (fragments)	2	(28–34)	57	(47–68)	29
Ejecta	6	(14–53)	48	(3–87)	31
Fecal splats	6	(101–364)	91	(88–96)	31

[1] Differences among the three categories in proportion germinating significant ($P < 0.01$, $H = 9.559$, df = 2; Kruskal-Wallis test); difference between ejecta and fecal splats in proportion germinating significant ($P < 0.01$, contrast = 36, $N = 6$; Kruskal-Wallis post hoc comparison).

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