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***Ficus ovalis* Seed Predation by an Orange-chinned Parakeet
(*Brotogeris jugularis*) in Costa Rica**

DANIEL H. JANZEN

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

Parrots and parakeets (Psittacidae) are often thought of as frugivorous, and fruits are often listed as the food of parrots observed feeding in the wild (e.g. Forshaw 1978, *Parrots of the World*, London, David and Charles, Newton Abbot). On the other hand, from observing parrots of all sizes feeding in the wild in Central America and in captivity, I have the impression that a parrot is rarely frugivorous and usually preys on the seeds inside the fruit, whether the fruit is immature or mature. I have never encountered an unambiguous case of seed dispersal by parrots. Psittacids that eat figs, however, are often mentioned to me as potential exceptions to this generalization, and the tiny Orange-chinned Parakeet

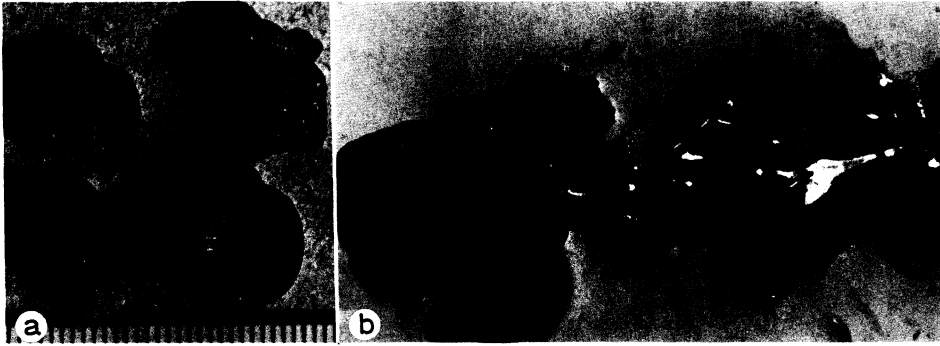


Fig. 1. a. Ripe fruits of *F. ovalis* that have had a piece bitten out of them by *Brotogeris jugularis* before being dropped (scale is in mm). b. Gizzard of an adult male *Brotogeris jugularis* (top, cut open) stuffed with nested seed coat fragments of *F. ovalis*; upper intestine (bottom) split open lengthwise to expose the purée of finely ground seed contents and fruit pulp.

(*Brotogeris jugularis*) is often the example given in Costa Rica. To determine whether *B. jugularis* is primarily a seed predator rather than disperser of fig seeds, I dissected one that had been feeding on figs for a morning. The results described below confirm my initial impression that *B. jugularis* is acting as a predator on fig seeds, even though it also consumes some fruit pulp.

A large tree of *Ficus ovalis* grows near the southwest corner of the historic Casona in Santa Rosa National Park. The Park lies about 25 km south of the town of La Cruz, between the Pan-American Highway and the Pacific ocean, in northwestern Guanacaste Province, Costa Rica (0–350 m elevation). This tree usually produces a large crop of several hundred thousand 9–15-mm diameter pink to red spherical figs in the early rainy season (June–July) and at the end of the rainy season (December–January) (Janzen 1979a, *Biotropica* 11: 48; 1979b, *Biotropica* 11: 127). Many vertebrates eat these figs while the fruits are in the tree crown and after they fall. A flock of 50–100 Orange-chinned Parakeets often arrives about dawn (0530) and feeds and socializes in the tree crown until late morning. For several hours an individual parakeet walks along the branches and branchlets, reaching out with its bill to pick single ripe fruits, usually in the ivory to dark pink color stage. At this stage the occupant fig wasps have left the fruit, but it is still only partly softened. The bird bites a piece out of the fruit that is about one fifth

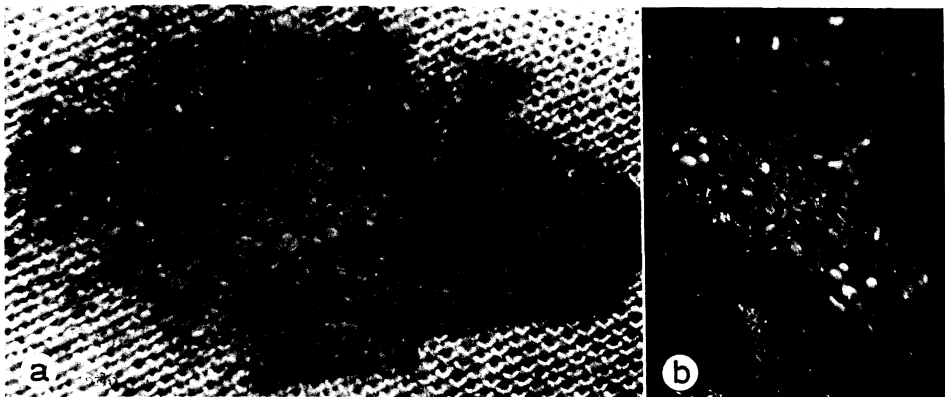


Fig. 2. a. The rare type of fecal splat of *B. jugularis* when feeding on *F. ovalis* fruit pulp and seeds; the feces contains no viable seeds and probably contains the bulk of a bolus of seed coats voided by the gizzard. b. Relatively dry bat feces rich in intact *F. ovalis* seeds, largely undigested fig pulp fiber, and seeds that contained fig wasps (two seeds have conspicuous exit holes).

of the fruit's surface area (Fig. 1a) and then drops the fruit. On occasion it holds the fig in one foot while taking repeated bites. The bird manipulates the piece of fig for only a few seconds and then drops the remains. It appears to be swallowing pieces of the fruit, a behavior that gives rise to the impression that it is swallowing intact seeds.

On 7 January 1980, I shot a male of one of these birds at 1300, after it had been feeding in the tree all morning. The crop contents were massaged out and the bird dissected. The autopsy was completed 30 min after shooting the bird. The crop contained about 6 cc of beige liquid fig fruit pulp thoroughly mixed with numerous apparently intact and viable fig seeds and a few broken large seed fragments. The seeds were hard, roughly spherical, and 1–2 mm in diameter. Each seed and large seed fragment was covered by the clear gelatinous sheath that swells up around seeds of *Ficus ovalis* when they are immersed in water. There were 2,695 seeds and 358 large seed fragments in the crop.

The gizzard contained the seed coats of approximately 1,575 seeds (Fig. 1b). It was completely filled. In addition, it contained 171 apparently intact seeds. Microscopic inspection, however, showed each of these seeds to be cracked. Most seed coats were halves or other large pieces and were tightly nested, as would be a large number of broken bird eggshells haphazardly but tightly packed into a box. There were no conspicuous masses of seed contents or fruit pulp in the gizzard.

The small and large intestine was plumply filled with a very fine-grained, beige-colored purée (Fig. 1b), with a few traces of finely ground seed coats scattered along the intestinal tract. Additionally, there were 16 apparently intact *F. ovalis* seeds in the intestine. Microscopic examination, however, showed all 16 to be cracked. None of them had the gelatinous sheath around them, and none germinated when rinsed and placed on moist toweling for 15 days (intact *F. ovalis* seeds from bat feces germinate in about a week when placed on moist toweling).

Upon re-examination of the seeds in the crop, I found that each of the 2,695 apparently intact seeds was cracked. The parakeet had cracked each with its bill before swallowing it, probably with the tongue and the knife-edge of the lower bill working against the anvil of the buccal side of the upper bill (as do captive *B. jugularis*). I suspect that simply cracking the seed rather than shearing it in half is a faster action than biting it all the way through, both because of a shorter bill movement and because there are then fewer pieces for the parakeet to control. The muscular walls of the gizzard then crushed the cracked seeds against one another (there was no grit in the gizzard). Acting as the grinding surface in the gizzard, the seed coats finely pulverized both the seed contents and the fruit pulp. This purée was then passed on to the intestine.

I watched the *B. jugularis* defecate while in the fig tree and collected their feces on cloth sheets and on leaves. There were two kinds of droppings. The most common were liquid with fine beige particles and contained occasional small fragments of seed coat. The other type was the same but contained a large quantity of seed coat fragments (Fig. 2a). The parakeets apparently retained the seed coats in the gizzard for a digestive bout and then passed them on as a bolus. This bolus probably passed rapidly through the intestinal tract, and its broken seed coat edges had minimum contact with the intestinal mucosa. I found no intact seeds in the parakeet fecal splats on leaf and branch surfaces beneath the tree.

The bat feces below the *F. ovalis* tree were generated by phyllostomatid bats and were quite different from those of *B. jugularis* (Fig. 2b). The bat feces contained intact viable seeds, seeds with wasp exit holes, florets from inside the fig, and fibrous fruit pulp and rind. Intact seeds from the bat feces germinated in moist soil. The bats were clearly consuming whole fruits or large pieces and only very superficially processing the contents. *B. jugularis*, on the other hand, contained nothing but clean fruit pulp and seeds that were once intact. It must therefore have eaten only the pulp that is interior to the fig epidermis and exterior to the outermost layer of seeds. Furthermore, it must have orally examined each seed to determine whether it was intact or had a wasp exit hole or wasp inside. I suspect that after it bit a piece out of the fruit wall, it bit many seeds one at a time. Upon encountering a solid seed (one free of wasp damage), it bit hard enough to crack it and then removed only that seed from the fruit fragment. In the meantime, it also bit tiny pieces of pulp out of the fruit wall.

In a sample of 20 figs taken from the branches where the parakeets were selecting fruit, a minimum of 36% of the seeds had been killed by wasps, and the average was 77% per fig; there was an average of 47.2 good seeds per fig in this sample. Calculating backwards from the 4,815 originally intact seeds in this parakeet, the bird would have to have picked 510 figs that morning. This assumes that the parakeet bit 20% out of each fig, that the fig fruits contained an average of 47.2 good seeds, and that the parakeet made no mistakes. At this rate, a flock of 100 *B. jugularis* would pick 51,000 figs per morning, or 15% of the original crop of about 780,000 figs in the fruit crop in which the parakeet was feeding.

In summary, it appears that to a *Ficus ovalis* fig crop, the Orange-chinned Parakeet is a fruit pulp consumer and a seed predator, but not a seed disperser. The fruit fragments it drops below the parent

tree, however, may be later eaten by a nonvolant seed disperser. *B. jugularis* may therefore not only kill fig seeds but alter the nature of the seed shadow by directing seeds into a different portion of the disperser coterie than would have swallowed them had the ripe figs been left in the crown for arboreal and volant vertebrates to eat.

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