ECOLOGY OF THE GUACHARO (STEATORNIS CARIPENSIS) IN VENEZUELA

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The Guacharo *(Steatornis caripensis)* was first brought to the attention of scientists in Humboldt's (1833) account of his visit to the colony near Caripe, in which he described its unique habit of nesting in caves and the manner in which inhabitants of the area extracted oil from the enormously fat chicks. A more recent study in Trinidad by Snow (1961, 1962) established the Guacharo's equally unique habit of feeding exclusively on fruits of forest trees; even the nestlings are apparently fed on exclusively fruit diet.

Snow also determined the identity of many fruits taken by the Trinidad birds, aided by their habit of swallowing fruits whole and later regurgitating the intact seed after returning to the cave. This habit makes it possible to collect regular samples of the seeds to determine the abundance of different types and to monitor changes in the diet. The purpose of the present study was to relate the use and availability of different fruits over time with the birds' activities, and to recommend conservation measures based on these findings.

Because the birds rely entirely on fruits of forest trees and because human intervention throughout their range is rapidly destroying these forests, conservationists may be justified in expressing concern over the future of the species. Poaching of nestlings continues at many colonies, although its impact in the larger caves, where most nests are not accessible, is unknown. Five of thirteen known colonies in Trinidad have become extinct in recent years and Snow (1962) suggests that humans exterminated them. There is evidence in Venezuela as well that certain colonies have become extinct (De Bellard Pietri, 1957).

It appears that considerably more colonies are known in Venezuela than any other country in the species' range, which includes Colombia, Peru, Ecuador, Bolivia and Guyana (Clements, 1974). De Bellard Pietri (1970) cites thirty caves in Venezuela with colonies and more recent reports have

ncreased the total. In this study we concentrated on the colony first visited by Humboldt, the Cueva del Guacharo near Caripe. Brief visits to other colonies in Venezuela have supplied supplementary information about the status and foraging ecology of the species in this country.

The Cueva del Guacharo contains the largest known colony of Guacharos.[1] Our own estimate is based on the number of nests counted in the cave, with the observation that almost all are occupied by a pair of birds. Our count of approximately 500 nests would indicate an absolute minimum of 1000 birds; however, as many as 90% of the nests may not be visible from the floor of the cave, and there are additional birds who do not appear to occupy nests. Therefore, colony size certainly exceeds our minimum estimate by several thousand.

The cave is located at approximately 1100 meters altitude in rugged mountainous terrain marked by limestone outcroppings. Much of the area is devoted to coffee production, and only selected shade trees remain. On certain upper slopes including the hill above the cave, and along the Rio Negro immediately west of the cave some forested areas remain. Most of the country to the north, south and west for a number of kilometers is devoted to agriculture on is otherwise deforested. Small isolated patches of forest remain in this area, and to the east beginning aproximately 17 km from the cave, there is a more extensive undisturbed forest.

METHODS

Work in the Cueva del Guacharo began in early May 1976 and continued through November, with a second study period during January 1977. One hundred thirty-seven nests were accessible for regular censusing of reproductive activity. These were accessible for regular censusing of reproductive activity. These were grouped in three areas evenly spaced through the 700-meter section of the cave inhabited by the birds. The three groupings (including 28 nests, 48 nests and 61 nests respectively) were regularly censused, usually at least once per week.

Much of the dietary information was obtained through collections of seeds regurgitated within the cave. Each of five seed traps located on the cave floor below nest ledges covered an area of one square meter. Twenty-four hour accumulations of seeds were collected daily from 6 May through

1. This cave was decreed National Monument "Alejandro de Humboldt" in 1949 and the area around it "Parque Nacional del Guácharo" in 1975. The Cueva de El Toro in Falcón State, which also contains a large Guácharo colony, was created a national park in 1969. These two colonies are the only sites in Venezuela currently under protection.

19 June, then twice-weekly collections until 13 september. Thereafter two-day accumulations were collected once each week. The absolute number o seeds in one trap cannot be directly compared to the number in other traps because it is not known how many birds contributed seeds to each trap. However, the relative abundance of different types. To determine the seeds regurgitated by a single pair and their brood five nests were fitted with individual seed traps. These traps were usually examined once per week.

The relative abundance and fruiting activity of food trees in the Caripe area was censused along several paths or roads. Twice-monthly censuses were made of the lauraceous trees in the large valley west of the cave, and several individual trees were censused regularly to determine changes in the availability of fruit.

RESULTS

Over thirty different species of fruits were eaten by the Guacharos in the Cueva del Guacharo. These belong to at least three families of plants, as follows: 14 Lauraceae, 3 Burseraceae, 8 Palmae and 6 unknowns. Most of the species of trees represented by these seeds have not been identified, as the fruits and seeds alone are not diagnostic. Several of the Palmae and Lauraceae, and one of the Burseraceae have been identified to genus on the basis of specimens collected in the Caripe area.

In any given seed collection not all of the 30-odd species were represented. A typical collection from May to mid-September included about ten species, with one or two predominating in number. This diversity in diet dropped gradually to a low of three or four species per collection in late September through January. All traps exhibited similar diversity, and changes in the prominance of individual species of seeds occurred generally throughout the cave. For short periods of time a particular type of seed might be found in greater proportion in one trap than in the others, suggesting that individual birds develop at least short term preferences either for foraging locations or for species of fruit.

Throughout the study one or two species of fruit dominated each seed collection. The species predominating changed as the season progressed with little overlap in time. Figure 1 presents data from a representative collection site. All sites were very similar in the proportion of major seeds, differing primarily in the absolute number of seeds accumulated and in the presence of some of the less common seed types.

During the peak period for egg-laying in early to mid-May, a large buseraceous fruit *Dacryodes* sp. predominated in collections. This species of tree is not abundant in the immediate vicinity of the cave, but is fre-

quent in the forests to the east of Caripe. It may also occur closer to the cave, but in areas outside of those explored during this study. Toward the end of May a species of the palm *Euterpe* briefly replaced *Dacryodes* sp. as the predominant seed in collections, before *Cinnamomum* sp. (Lauraceae) became abundant. This utilization of palm fruits between the fruiting peaks of the non-palm species appeared as a consistent pattern for the Caripe Guacharo colony. Again in mid-July, between the peaks of *Cinnamomum* and *Peresea* sp. (Lauraceae), and after the decline of *Persea* in September the use of *Euterpe* and speciesof the palm genus *Geonoma increased.* ....

The sequence of these fruit species reflects the availability of these fruits in the forest around the cave as well as their use by the birds. Both the *Cinnamomum* sp. and *Persea* sp. were very abundant trees with abundant fruit crops in the coffee plantations surrounding Caripe. Within each species the trees were closely synchronized in fruiting. Contrasting with the single fruiting season common in the Lauraceae and Burseraceae families, palms tend to produce smaller amounts of fruit continuously. For the Caripe colony *Euterpe* spp. and to a lesser extent *Geonoma* spp. provided a continuously available food source that was exploited with particular intensity when the more abundantly-producing lauraceous and burseraceous species were unavailable. From the endof September through January, species of *Euterpe* and *Geonoma* were essentially the only seeds regurgitated in the cave. It is possible that other fruits were eaten during this period and the seeds regurgitated before entering the cave. This situation would apply especially to colonies foraging at great distance from their cave.

From the start of collections in May, there was an increase in the absolute number of seeds regurgitated in the cave (Figure 2). The greatest accumulations of seeds were collected between 1 August and 20 August, after which the volume decreased rapidly to very low levels in mid-September. This decline in seed volume was coincident with the decrease in relative abundance of *Persea* in the diet (Figure 1), and suggests that palms became the primary food source that time. Low volumes of seeds were collected throughout October and November, and were still low in January when the colony was censused for the last time. No lauraceous or burseraceous species of trees were found fruiting in the Caripe area after September.

We began inspecting nest contents on May 10 and reached the total sample size of 137 by 19 June. From earliest inspection it was clear that the breeding season was already in progress, as almost all nests had eggs or very small young. Of 67 chicks for which the hatching dates are most precisely known, 64% hatched between 1 June and 21 June. This sample includes birds nesting in all area of the cave that we studied. Of the 137 nests

studied, 127 nests (92%) had had at least eggs in them by 11 July, the date when we saw the last new egg in one of our nests.

If we assume that the 33-day incubation period found for Trinidad birds holds for the Cueva del Guacharo colony as well, we can count back one month from the peak hatching period to the peak of egg-laying. Since over half of the chicks with known hatch dates appeared between 1 and 21 June, most eggs were probably laid in early- to mid-May.

Fledging normally occurs 100 to 115 days after hatching (Snow, 1962). Using this rate of development, the peak of fledging occurred in earlyto mid-September in the Caripe colony. Throughout the breeding period we found chicks of various ages on the floor of the cave, possibly knocked there by nestmates or adults. Adults do not appear to attend these chicks and they are usually eaten by rats and insects. Near the end of August, however, we found a dramatic increase in the number of chicks on the ground. Many were of fledging age leaving the nest in the normal course of their development; however, many others were not as advanced and did not survive. The number of chicks and fledglings on the ground increased through September, reaching a peak of 59 on the night of September 20. Nearly all of these fell to the ground during the previous day and 48 were probably too young to survive. The total number of live chicks we found on the floor between 15 August and 10 October, the period of greatest losses, was 361. We judged that 197 (54.6%) were under fledging age.

We have no information on pre-fledging losses in previousyears, although guides at the cave told us that the number of birds on the ground was abnormally high. One characteristic of the chicks, owever, suggests an explanation. Almost all chicks and most fledglings on the floor during this period were extremely thin, much under the weight of chicks still in the nest and of the occasional chicks we found on the ground before the middle of August.

Snow (1962) found in the Trinidad colony that normally developing nestlings exceed average adult weight by 50% at 70-80 days of age, and gradually return to adult weight by fledging (ca. 100 days). The chicks we found on the cave floor had lost considerably more weight (average fledgling weight was 69% of adult weight).

These results suggest that the Cueva del Guacharo colony experienced a food shortage at the critical period when most chicks were near to fledging. We have noted previously (Figure 2) that the quantity of seeds brought into the cave began to decrease sharply in the last week of August, which would coincide with the period where chicks are dropping back toward adult weight and the oldest begin to fledge. Adults may normally decrease the amount ofprovisioning of nestlings at this point, but we suspect that

this year an extraordinary decline in food supplied to the young was responsible for so many premature losses of chicks.

DISCUSSION

Results point out the close dependence of the Guacharo breeding cycle one the production of fruit by their major food trees, summarized in Figures 1 and 2. In the nine months covered in this study, theprolonged nesting period coincided with the only period when a superabundance of fruit was available near the cave. Although the birds' reproductive cycle appears timed to exploit maximum production in the forest, many young did not survive this year, especially those hatched late in the season.

Fruits have lower protein and mineral value than insects, which comprise the bulk of the nestling diet in almost all avian species. Thus, Guacharo nestling growth is comparatively very slow and large quantitiesof fruit are necessary to produce a fledgling bird. It may be critical for birds with chicks in the nest to have abundant fruit available within a short distance of the cave.

In addition to these problems, which influence the timing of breeding, a Guacharo colony must have a supply of fruit during the nonbreeding season. Within a reasonable foraging range of the Caripe colony, apparently few lauraceousor burseraceous species fruit between September and February. The remaining food sources are those species of palms which appear to produce fruit at a low steady rate through much of the year.

The switch to dependence on palms may be a general situation for many colonies in Venezuela. During the period January-March, 1977, we visited other colonies in the country. The Cueva del Agua and Cueva del Encanto in Anzoategui state were censused in late February. Colony size wasprobably under 100 birds in the former and about 30 in the latter, but estimates were difficult to make. There was evidence of poaching in both caves. Old seed on the cave floor were similar in diversity and composition to those in the Cueva del Guacharo, and seeds recently deposited included many *Euterpe* spp., *Geonoma* spp. and one lauraceous species. This colony largely confirms the situation studied in Caripe.

Two visits to the Cueva de Coy-Coy de Uria in Falcon are of particular interest in evaluating the importance of palms during the nonbreeding season. This colony was first visited near the end of January. Surprisingly only two birds were present from a colony previously estimated as several hundred (De Bellard Pietri, pers. Comm.). Many unoccupied nests were visible. Seeds on the cave floor were old, dominated by several lauraceous species. *Euterpe* and *Geonoma* were absent although another palm, *Jessenia* sp. was

present. We censused this colony again in early March. At that time we estimated at least fifty birds were present and some fresh seeds of a lauraceous tree were being regurgitated in the cave. No fresh palm seeds could be found. It is possible that the food supply available around this cave located in the isolated San Luis mountains, is insufficient to support a colony of that size throughout the year. At the time of our last visit the colony was beginning to return, exploiting a supply of lauraceous fruits. Presumably the abundance of fruit continues to increase from March into the breeding season. It is not known where these birds go when they leave the cave.

In Snow's (1962) study of the food trees of Guacharos in Trinidad at least one lauraceous species plus the palms *Euterpe langloisii* and *Jessenia oligocarpa* had fruit at all times of the year. Habitat destruction probably accounts for the absence of a consistent and abundant supply of fruits around the cave we examined in Venezuela. In Trinidad as well as Venezuela, birds apparently depend on palm fruits during the non-breeding season, and the scarcity of this food source may explain the migratory habit of the Coy-Coy colony.

Findings suggest that enormous Guacharo colonies may coexist to a certain extent with agricultural activities in the surrounding area. It is a fortuitous coincidence that in the Caripe area, with its extensive coffee plantations, agriculturists selectively spared certain lauraceous trees to shade their plants, for this food source largely supports the bird in the breeding season. The same clearing of the forest has had harmful effects as well. The number of palms remaining near the cave is very low and these are a critical food source during much of the year. In addition, it appears that certain palms *(Euterpe)* are still being destroyed in remaining patches of forest to obtain the edible palm heart. We have visited isolated forest patches where countless palm stems lying on the ground witness the visits of palm hunters.

We would also call attention to the possible importance of the area east of Caripe, beginning past the Village of Yucucual, in which we found the only extensive undisturbed forest in the entire area. We suspect that forest patches elsewhere are entirely inadequate to support a colony of several thousand birds, and that the section to the east may be of critical importance to the Cueva del Guacharo colony.

The Parque Nacional del Guacharo, an area of aproximately 15,000 hectares including the cave hill itself, is a step toward the conservation of the colony. However, this area probably cannot continue to support the colony at its current size if losses of forest, especially palms, continue. The unex-

ploited forest to the east may also be of considerable importance to the Caripe colony, and restriction of deforestation inthis area would be beneficial. Several large colonies of Guacharos are known in the area around Mata de Mango, a settlement east of Yucucual. The certainly depend on the forest of this area for their food. Possibly the most important conservation measure other than forest preservation is to eliminate the destruction of palms by local residents. This kind of protection, the preservation of forests near colonies and the elimination of poaching will ensure a place for the Guacharo in the fauna of Venezuela in the future.

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