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BREEDING BEHAVIOR OF THE ENDANGERED HISPANIOLAN CROSSBILL (*LOXIA MEGAPLAGA*)

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Resumen. – Comportamiento de la reproducción en el amenazado Pico Cruzado de la Hispaniola (*Loxia megaplaga*). – El Pico Cruzado de Ala Blanca de la Hispaniola (*Loxia leucoptera megaplaga*), el cual es considerado aquí como una especie distinta (Pico Cruzado de la Hispaniola, *L. megaplaga*), es endémico de Haití y República Dominicana, donde está restringido a bosques de pinos (*Pinus occidentalis*) en áreas elevadas. Poco es conocido sobre la biología del Pico Cruzado de la Hispaniola, en parte debido a su bajo tamaño poblacional y a sus hábitos errantes, tampoco hay datos similares sobre el pico cruzado de Norteamérica (*L. l. leucoptera*). El nido del Pico Cruzado de la Hispaniola no fue descripto hasta 1975, y hasta ahora no ha sido estudiada la ecología o biología reproductiva de la especie. Investigamos el comportamiento reproductivo del pico cruzado en 2 de 17 nidos los cuales fueron facilmente observables y proveemos el primer dato sobre construcción del nido, descripción de los huevos y pichones, y comportamiento de los padres. La incubación por la hembra duró 13 días y fue interrumpida solo por cortos períodos de descanso de la hembra cerca del nido. El macho trajo comida a la hembra, pero aparte de eso pasó poco tiempo cerca del nido. La hembra también atendió a los pichones mientras que el macho trajo comida a la hembra y a los pichones. La comida comsumida por los pichones consistió principalmente en semillas de pino, pero también incluyó insectos (orden Hemíptera). Adultos del pico cruzado se quedaron en bandadas durante la época de reproducción, y los juveniles se quedaron con los padres por tiempo indeterminado.

Abstract. – The Hispaniolan White-winged Crossbill (*Loxia leucoptera megaplaga*), which is considered here as a full-species (Hispaniolan Crossbill, *L. megaplaga*), is endemic to Haiti and the Dominican Republic where it is restricted to high elevation forests of Hispaniolan pine (*Pinus occidentalis*). Little is known of the biology of the Hispaniolan Crossbill, in part owing to its low population size and wandering habits; there is a paucity of similar data for the North American White-winged Crossbill (*L. l. leucoptera*) as well. A nest was

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not described for the Hispaniolan Crossbill until 1975, and until now there has been no study of the ecology or breeding biology of the species. We investigated the breeding behavior of crossbills at two of 17 nests which were easily observable, and here provide the first published data on nest construction, description of eggs and nestlings, and parental breeding behavior. Incubation by the female lasted 13 days and was interrupted only by short breaks where the bird remained close to the nest. The male brought food to the female but otherwise was seldom seen near the nest. Brooding of nestlings was also by the female, while the male brought food to both the female and the nestlings. Food consumed by the nestlings consisted mostly of pine seeds, but insects (Order Hemiptera) were also included. Adult crossbills remained in flocks throughout the breeding season, and fledglings remained with the parents for an undetermined length of time. *Accepted 25 January 2002.*

Key words: Crossbill, *Loxia*, nest, eggs, breeding behavior, Hispaniola, Dominican Republic.

INTRODUCTION

The endemic Hispaniolan White–winged Crossbill (*Loxia leucoptera megaplaga*; American Ornithologists' Union 1957), has recently been treated as a full-species (Hispaniolan Crossbill, *L. megaplaga*; Benkman 1994, Smith 1997, BirdLife International 2000; terminology which we adopt here). This crossbill is restricted to pine forests of the Dominican Republic and Haiti where it is dependent on pine seeds for food (Benkman 1994). The Hispaniolan Crossbill was first reported to science in 1916, and was known to Wetmore & Swales (1931), but was not reported again by ornithologists until 1970 (see Smith 1997 for a history of this species). The crossbill has been considered an occasional or local wanderer (Wetmore & Swales 1931), and has been recently listed as endangered by the Globally Threatened Species Programme of BirdLife International (BirdLife International 2000) because of the small and declining size of the population and the severe fragmentation of subpopulations. Dod (1978) speculated that the species had declined in numbers as the result of deforestation through timber cutting, but a more recent evaluation cited habitat loss through uncontrolled fires as the principal threat to crossbill populations (Latta *et al.* 2000). Estimates of total population size have ranged from 600 (Benkman 1992) and less than 1000 (Benkman 1994, Smith 1997) to 3375 (Latta *et al.* 2000), but total numbers of crossbills probably fluctuate depending on food availability.

A nest of the Hispaniolan Crossbill was first described by Kepler *et al.* (1975). There are no descriptions of eggs, nestlings, or parental nesting behavior in the literature, but the breeding habitat of this species was recently quantified and described based on the location of 17 nests (Latta *et al.* 2000). Crossbills nested primarily high in Hispaniolan pine trees (*Pinus occidentalis*), but two nests were found in understory shrubs of *Lyonia* sp. (Ericaceae). Nest trees tended to be within groups of similarly–sized trees, but nest trees contained more pine cones than surrounding trees. Results from a multivariate analysis of nesting habitat at the patch level suggested that crossbills favored sites with taller, more densely–spaced pine trees. At the landscape level crossbills favored areas that had higher canopy height, greater canopy cover, and more broadleaf trees in the understory than were generally available across the landscape. The results also suggested that crossbills may respond negatively to fragmentation of the pine forest. The study supported previous findings that expanses of mature pine are required by this species, but also suggested that protection of unfragmented areas with higher rates of canopy closure may be

beneficial.

Because only a single nest had been described for the Hispaniolan Crossbill, and data were lacking on many aspects of breeding biology for even the more common North American White–winged Crossbill, we sought to describe the nest, eggs, nestlings, and parental breeding behavior of the Hispaniolan species in the Sierra de Bahoruco, Dominican Republic.

STUDY SITE AND METHODS

Description of study area. We studied Hispaniolan Crossbills from October 1997 to April 1998 at three sites in the Sierra de Bahoruco, Pedernales Province, Dominican Republic (18°0' N, 71°38' W). These sites, P1 (18.4 ha), P2 (15 ha), and P3 (15 ha), were all in mature pine forest at 1100 m, 1375 m, and 1470 m elevation, respectively, but nesting observations were made only at P1.

Based on climate and other factors, pine forest in the Sierra de Bahoruco can be classified as lower montane moist forest, lower montane wet forest, and montane wet forest (Holdridge 1964). However, the pine forest is relatively homogeneous because fire and soil conditions are most important in determining vegetation at this site (Fisher-Meerow & Judd 1989). A foliage height profile constructed using data from site P1 (Latta & Sondreal 1999) shows a fairly open canopy, a sparse intermediate layer, and a denser mixed–broadleaf understory. Canopy cover averaged 51% (SD = 26.4) with greatest cover in the 6–15 m height categories and a maximum pine height of 23 m. Mean and median pine heights were 17.7 m (SD = 4.9 m) and 19.0 m, respectively. The intermediate layer also consisted solely of pine. Broadleaf trees and shrubs formed a dense ground cover and understory, with broadleaf trees extending to heights of 2.5 m. Young pines were also present in the understory.

Fisher–Meerow & Judd (1989) found 48% of the plant species in these pine forests to be endemic. These sites are dominated by Hispaniolan pine, and the only other common tree is the palm *Coccothrinax scoparia*. A well-developed shrub layer is present, and common broadleaf species include *Cestrum brevifolium*, *Chamaescrista glandulosa*, *Coreopsis buchii*, *Eupatorium illitum*, *Hypericum hypericoides*, *Lyonia truncata*, *L. microcarpa*, *Myrica picardae*, *Senecio picardae*, and *Sophora albopetiolulata*, as well as the succulent *Agave antillana*. The ground is covered by a thick layer of grasses including *Andropogon glomeratus*, *A. urbanianus*, *Schizachyrium gracile*, *Triodia eragrostoides*, *Tripsacum dactyloides*, and *Panicum aciculare*, as well as the sedge *Bulbostylis subaphylla*.

Nest searching and nest observations. Study sites were searched regularly and systematically for crossbill nests, but observations of nesting behavior were made only at two nests in P1 which were located where they could be easily watched without disruption of the nesting regime. Observers sat quietly 15–30 m from the nest site, partially or fully concealed by vegetation or a small nylon blind. Adult birds did not appear to be bothered by the presence of observers and did not flush from the nest until close (< 2 m) contact. Observations were made with 8x or 10x binoculars, or a 25x spotting scope, and notes were recorded by hand or into a small tape recorder.

Nest construction was observed at one nest for a total of five hours between 13 January and 20 January (13 Jan: 1600–1800; 14 Jan: 0900–1000; 20 Jan: 1000–1200), but progress in nest construction was monitored daily until egg–laying. Observations of nests containing eggs or nestlings were made on an irregular basis as time allowed, but we tried to include morning, mid–day, and evening observation periods. In addition, a dawn–to–dark observation was made at one nest

FIG 1. First photograph of nest and eggs of the Hispaniolan Crossbill (*Loxia megaplaga*), 17 m high in Hispaniolan pine tree (*Pinus occidentalis*) in the Sierra de Bahoruco, Dominican Republic. Photograph by D. Mejía.

containing eggs and at another nest containing nestlings. Observations of nests containing eggs were made at two nests for 34.8 h (Nest # 1 – 24 Jan: 1000–1015; 28 Jan: 1345–1550; 30 Jan: 0710–1910; 3 Feb: 1530–1745; 5 Feb: 1515–1745; 6 Feb: 1718–1748. Nest # 2 – 8 Feb: 1655–1730; 9 Feb: 1230–1720; 10 Feb: 1240–1645; 12 Feb: 1115–1625; 15 Feb: 0745–0820). Observations of nests containing chicks were made at two nests for 19.4 h (Nest # 1 – 7 Feb: 1628–1738. Nest # 2 – 23 Feb: 1240–1900; 24 Feb: 0715–1910). Diet analysis was made by examining crop contents of three nestlings who died in the nest.

Behavior of post-fledging juveniles and adults. Observations of post–fledging behavior were made serendipitously on juveniles as they were encountered in the field. Behavior of adults was recorded away from nest sites as well with respect to flocking behavior and behavior towards juveniles.

RESULTS

Nest construction. Only the female crossbill built the nest. In 5.0 h of observation, the female made a mean of 6.5 trips/h (SD = 1.11) to the nest site, with occasional resting periods which ranged from 10 to 20 min when she would perch within 20 m of the male. During nest construction, the female searched for small twigs for the nest on nearby trees and on the forest floor at a distance of about 25 m from the nest site. During this time, the male perched near the nest site itself, apparently guarding the nest or the female. On one occasion (13 Jan), he was seen to evict a Pine Warbler (*Dendroica pinus*) and a Prairie Warbler (*Dendroica discolor*) from the tree containing the nest under construction. The male was frequently heard singing while the female was building the nest, but this singing was invariably very low and quiet. When the female paused in her search for twigs, the male approached her, the two birds 'billed' or 'nibbled' one another, and then the female began begging by shaking and quivering her wings and tail. The male fed her by passing a white food bolus directly to her. This was observed three times in the five hours of observation. Following these courtship activities, the female continued with nest construction, this time taking pine twigs directly from the tree in which the nest was located.

Nest and eggs. Nest construction lasted approximately one week (13–20 January) and eggs were laid by 24 January when the female was found incubating. The nest was an open cup and was initially built entirely of woven small twigs of the Hispaniolan pine with some pine

needles (Fig. 1). It was later lined with green pine needles, and lichens were added to the central portion. Two accessible nests were measured. Inside depth of bowls were 6.5 cm and 4.6 cm; inside diameters were 5.8 cm and 7.0 cm.

Eggs in two nests were smooth and ovate, but were variable in color. In nest # 1, two eggs were laid and these were bone white with small, dark brownish markings at the larger end (Fig. 1). In nest # 2, three eggs were laid. Two eggs had a bone white ground color with dark brown and grey swirling markings at the large end, while the third egg was very pale bluish–white with very few markings. All eggs were similar in size but were not measured.

Incubation. Incubation in one nest lasted 13 days (24 Jan–6 Feb). Only the female incubated the eggs. The female left the nest for brief intervals and only at a short distance. In 34.8 h of observation, the female left the nest 10 times. These breaks lasted a mean 4.9 min (SD = 1.8, range = 2–12 min), while she perched or foraged a mean 5.0 m (SD = 2.6, range = 0.3–20 m) from the nest site. Although breaks were short, they tended to be relatively frequent. In one 12–h observation period, the female incubated a mean 2.6 h (SD = 0.7, range = 2.2–3.1) between breaks.

Frequently the female left the nest just before or after the male passed a food bolus to her (5 of 10 times). It did not appear that the male remained nearby to guard the nest during her brief absences. The male brought food to the incubating female 17 times in 34.8 h of observation. The mean time between feeding bouts was 1.3 h (SD = 1.0 h, range = 0.2–2.2 h). In each case, the male delivered multiple boluses to the female but these were difficult to count accurately.

On the nest, the female passed considerable time restlessly opening and closing the mandibles (often repeatedly so), touching needles in the nest or those hanging close to the nest, and reaching into the nest perhaps to preen belly feathers or slightly reposition the eggs. This was done at least 56 times in the 34.8 h of observation. The female frequently appeared to be regurgitating and masticating the food boluses that were passed by the male, and she could be seen to be working the mandibles and the tongue while chewing this white substance.

In contrast to the nest construction phase when the male seemed to jealously guard the nest site, the male was seldom seen in the vicinity of the nest except when delivering food to the female. On occasion, males could be heard to softly vocalize repeated "*chit–chit, chit–chit*" notes, sometimes from as close as 10 m to the nest and the incubating female, but males did not sing typical songs from perches nearby the nest. The female often responded to these "*chit*" notes with a similar "*chit*" note, but hers was generally softer, higher in pitch, and quieter. On more than one occasion, the female was heard to vocalize as well with a series of two to four "*chits*" in response to a small band of crossbills calling as they overflew the nest site. However, no response from the flock was observed.

The male often arrived and departed from the same direction and appeared to fly some distance as we could not see where he was going nor from where he was arriving. Upon arriving or departing from the nest site with very quiet "*chit*" calls, the female frequently responded with begging behavior by fluttering the wings and tail before and during the feeding. The transfer of food was invariably done quickly and the male did not linger. However, the male may roost near the nest as he was seen to arrive and perch at a distance of 12 m to the nest just before sundown (30 Jan).

Following the nest construction period,

there seemed to be an increased tolerance of the presence of other birds. Numerous birds perched or foraged in the nest tree at distances of 0.3–15 m without being chased by either crossbill parent. These species included Pine Warbler, Palm Warbler (*Dendroica palmarum*), Yellow–throated Warbler (*Dendroica dominicus*), and Black–crowned Palm Tanager (*Phaenicophilus palmarum*), as well as a mixed–species flock of Hispaniolan Pewee (*Contopus hispaniolensis*), Black–and-white Warbler (*Mniotilta varia*), Palm Warbler, Pine Warbler , and Yellow–throated Warbler.

Brooding of nestlings. Upon hatching, chicks are small, naked, and have closed eyes. The bill is pinkish grey, inside of the mouth is red, and the gape is purplish–pink in the center with yellowish–orange swellings distally. By the second day, chicks have grey, fluffy down developing on the tops of their heads, and by the third day they are covered with light grey down.

The nestlings were frequently seen with their crops full and their necks extended twice their normal size. Food in the crop showed white through the skin. An analysis of food found in the crops of two of three chicks which died in the nest (see Mortality of nestlings, below) showed that 80–90% of the contents were pine seeds, but 10–20% were identified as insects parts. All insect parts appeared to belong to a single, unidentified species of Hemiptera.

Brooding of the nestlings was by the female only, but the nestlings were left unattended for significant lengths of time. In 19.4 h of observation, the female brooded a mean 45.4 min (SD = 5.2, range = 6–80 min, n = 9) before taking a break. When off the nest, females returned to the nest after a mean 58.2 min (SD = 6.0, range = 5–138 min, n = 12). Females also did most of the feeding of the nestlings. Of 51 feeding bouts observed, 42 (82.4%) were by the female. The female frequently fed the chicks while sitting on the nest by reaching down and regurgitating boluses for the nestlings, but we were unable to quantify how many boluses were passed to which nestlings. The mean length of time between feeding bouts was 24.0 min (SD = 5.8, range = 2–122 min, n = 40). Females removed fecal sacs by consuming them.

The male crossbill also fed the nestlings as well as the brooding female, and consumed fecal sacs. The male made 9 of 51 (17.6%) feedings to the nestlings, and fed the female five times in 19.4 h of observation. The mean time between bouts of feeding the nestlings was 1.8 h (SD = 1.3, range = 0.1–4.3 h). The mean time between bouts of feeding the female was 2.8 h (SD = 1.5 h, range = 1.8–5.4 h), which is much longer than the mean time between feeding bouts during the egg incubation period (1.3 h, see above) when the female seldom left the nest. The female did not appear to pass food received from the male directly to the nestlings, as only 6 of 42 (14.3%) feeding bouts between the female and the nestlings were made within 30 minutes of the female having been fed by the male.

On occasion the female left the nest site after being fed by the male and he remained near the nest for a few minutes. This is reflected in data showing that the nest was left unguarded a mean of 49.4 min (SD = 5.55, range = 15–136 min, n = 12), in contrast to the mean 58.2 min in which the female was absent from the nest site (see above). The male also did not brood at night, and may have roosted at some distance from the nest during the brooding period, as on at least one occasion he was seen to fly away from the nest at nightfall.

It is possible though that the male is present nearby more than we observed. Evidence of this is seen in the quick response of the male to the sudden appearance of a Merlin (*Falco columbarius*) which perched 15 m high

in a pine tree 10 m from the nest. The male crossbill, which had not been seen in more than 10 min, suddenly flew in, and with a harsh '*chut'* call, swooped at the Merlin, which then left the area. Other, non–predatory birds were tolerated near the nest site as they were during incubation. Birds which were observed within 8 m of the nest during brooding included the Hispaniolan Pewee and the Prairie Warbler.

Mortality of nestlings. Neither of the nests produced fledglings. Nest # 1 which was high in a pine tree was found abandoned two days after chicks hatched. Both the adult male, which was banded, and the adult female, distinguished by unique plumage, built a second nest later in the season in another tree about 25 m distance. The chicks in nest #2, found low in a *Lyconia* bush, survived 10 days (15–25 Feb), but on the morning of 26 Feb they were found cold and dead in the nest with their crops full.

Post-fledging behavior. Juvenile birds appeared to remain with the parents for some time after fledging. An adult male, adult female and a juvenile bird were seen together on 30 Jan, with the juvenile begging and being fed by the female. On 9 Feb a crossbill family of an adult male, adult female, and two juvenile birds were seen to arrive at a small, artificial reservoir near the nesting site and perch in surrounding pine trees. For the next 40 min, the adult male alone would make short, quick sallies low over the water edge without perching. Finally, after numerous sallies, he landed about 0.3 m from the water edge and walked down to drink. Only then did the female and the juvenile birds also approach the water to drink and bathe.

Adult foraging and flocking. Crossbills associated in small flocks throughout the nesting season. Mean flock size was 5.4 individuals (SD = 2.3, range = 1–20, n = 40). These flocks would often be seen early in the day while moving between pine trees and foraging, or in late-afternoon when they would arrive to drink and bathe from the small reservoir. This appeared to be the only regular water source in the area (Klein *et al.* 1998, Latta *et al.* 2000).

DISCUSSION

The data and observations presented here offer our first look at the breeding behavior of the Hispaniolan Crossbill. Although this species is locally common at our study site, elsewhere it is decidedly uncommon to rare (Latta *et al.* 2000, Keith *et al.*, in press). Nomadism and the remoteness of study sites have contributed to limitations on field studies of this and other crossbills. There is still much to be learned of the breeding biology of the Hispaniolan Crossbill, and even of the much more common and accessible White–winged Crossbill in North America (Benkman 1992).

Our observations on development of the pair bond between the male and the female contributes to that observed by Benkman (1992). Benkman noted three behaviors employed in pairing, including song, aerial chases, and bill touching and courtship feeding. Our observations suggest that the "*chit*" notes we describe here also serve in formation and maintenance of the pair bond. These "*chit*" notes appear not to have been previously described. These calls appear to be similar to the single note begging call or "*chit*" notes of juvenile birds described by Groth (1992) and Benkman (1992), but in this case were used by males and females at the nest and in courtship. Benkman (1992) suggests that songs are not given at the nest, but makes no mention of these contact notes. The alarm call which we record here also has not been previously described.

The nests described here are similar in construction to those of the White–winged Crossbill in North America, with principal materials being pine twigs, pine needles and lichens. While we saw less diversity in materials used to line the nests than reported by Austin (1968) and Benkman (1992), this is probably an artifact of a small sample size.

The role of females and males in the breeding season is similar to that described from the North American breeding grounds of the White–winged Crossbill. Females provide much of the work of nest construction, doing all of the incubating, as well as the brooding. Data presented here are the first quantification of rates of feeding and attendance patterns at the nest, but correspond to general patterns suggested by Tufts (1906) and Benkman (1992). The incubation period of the White–winged Crossbill has not been previously verified, although Benkman (1992) assumed it to be 12–14 days based on that of other crossbill species. Our calculation of a 13–day incubation period supports that assumption. The role of the male is primarily in providing some of the food for the female and the nestlings, and some role in protection of the nest site. Newton (1972) and Benkman (1992) noted that males defend an area around the female and the nest tree both before and during egg–laying, as we describe, and also found little evidence of territoriality later in the nesting cycle.

This study confirms the assumption that adult crossbills feed nestlings boluses of whole conifer seed kernals (Benkman 1992), but the proportion of insects in the diet is surprising. Benkman (1992) speculated that the white, viscous material covering the bolus may contain supplemental food, but insects have only been rarely reported in crossbill diet in North America. On Hispaniola, crossbills were never observed to consume insects (Latta *et al.* 2000). However, the probability that all insects were of a single Hemipteran species suggests the possibility that these bugs were coincidentally ingested by the adult crossbills as both the birds and insects fed on the same pine seed. Further analysis of pine cones and insect communities are needed to verify this possibility. The observed repeated opening and closing of the mandibles while masticating the food boluses is similar to that described by Tordoff (1954) for the Red Crossbill (*L. curvirostra*) which he called "stropping" and attributed to a purposeful and intentional attempt to reduce certain parts of the bill by abrasion.

There are no data on mortality of nestlings from any location, and few data on mortality of adults. Potential predators of nestlings and adult birds in the Sierra de Bahoruco include Indian mongoose (*Herpestes auropunctatus*), Hispaniolan boa (*Epicrates striatus*), Merlin (*Falco columbarius*), Barn Owl (*Tyto alba*), Ashy-faced Owl (*Tyto glaucops*), Stygian Owl (*Asio stygius*), and Hispaniolan Palm Crow (*Corvus palmarum*). We assume that chicks from nest # 1 were depredated, as we believed the adults were later found renesting. The death of chicks in nest # 2, however, suggests that the female may have died suddenly the evening or night prior to the deaths of the nestlings, resulting in the nestlings' deaths due to exposure. Nightime lows in late February reached 8ºC (46ºF; SCL, unpub. data) at this site. Alternatively, the female may have abandoned the nest or provided sub-adequate parental care. This is supported by an observation of the female leaving the nest with the male late in the day of 24 Feb (1627 h) despite a moderate rain falling. We would expect, however, that if she had abandoned the nestlings they would not have been found with their crops full.

Like the White–winged Crossbill, the Hispaniolan Crossbill appears to associate in intraspecific flocks throughout the breeding season. These flocks included males, females, and juvenile birds, though it is not known if

these flocks included actively breeding birds as well as non-breeders. Because of the extended breeding season observed in this year (Latta *et al.* 2000) when not all birds were breeding synchronously, we do not know if flock members at our study site represented non-breeding birds, males whose mates were at the nest, or females that had left the nest.

Combined with our previous study of habitat use by Hispaniolan Crossbills (Latta *et al.* 2000), the results of this paper provide a basis for understanding the reproductive behavior and conservation of this endangered endemic. Further studies which look at reproductive success of crossbills in this habitat, and which relate habitat and landscape features to demographics and reproductive success, are warranted.

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