

OBSERVATION OF GEOPHAGY BY HISPANIOLAN CROSSBILL (*LOXIA MEGAPLAGA*) AT AN ABANDONED BAUXITE MINE

STEVEN C. LATTA

The National Aviary, Allegheny Commons West, Pittsburgh, PA 15212; email: steven.latta@aviary.org

Abstract: I report an observation of endangered Hispaniolan Crossbill (*Loxia megaplaga*) feeding on soils near abandoned bauxite mines in the Sierra de Bahoruco, Dominican Republic. Although geophagy has been widely reported from a number of bird taxa, especially Neotropical parrots and boreal carduelines, this is the first report of this behavior from birds in the Caribbean. Based on the known ecology of this crossbill and published reports of local soil characteristics, I suggest testable hypotheses on why soils may be ingested by this species, including the crossbills' need for dietary salts and their need to detoxify the pine seeds which are their main diet items.

Key words: calcium, crossbills, diet, geophagy, Hispaniola, *Loxia megaplaga*, soil, toxicity

Resumen: OBSERVACIÓN DE GEOFAGIA EN *LOXIA MEGAPLAGA* EN UNA MINA DE BAUXITA ABANDONADA. Observé a *Loxia megaplaga*, especie amenazada de La Española, alimentándose de barro cerca de minas de bauxita abandonadas en la Sierra de Bahoruco, República Dominicana. Aunque la geofagia ha sido registrada ampliamente en numerosos taxones de aves, especialmente en loros y carduelínidos boreales, este es el primer registro de esta conducta en el Caribe. Basado en el conocimiento de la ecología de esta especie y en los registros publicados sobre las características de los suelos locales, sugiero una hipótesis comprobable de por qué ingieren barro estas especies que incluye la necesidad de suplementos de sales y de detoxificar las semillas de pino que constituyen el principal artículo de su dieta.

Palabras clave: calcio, dieta, geofagia, La Española, *Loxia megaplaga*, barro, toxicidad

Résumé : OBSERVATION D'UN BEC-CROISÉ D'HISPANIOLA (*LOXIA MEGAPLAGA*) PRÉSENTANT UN COMPORTEMENT DE GÉOPHAGIE DANS UNE MINA DE BAUXITE ABANDONNÉE. Un Bec-croisé d'Hispaniola (*Loxia megaplaga*) a été observé mangeant de la terre à proximité des mines de bauxite de la Sierra de Bahoruco, en République dominicaine. Bien que la géophagie soit bien connue chez de nombreux oiseaux, notamment chez les perroquets néotropicaux et les carduelinés boréaux, il s'agit de la première mention d'un tel comportement concernant des oiseaux de la Caraïbe. Compte tenu de l'écologie de ce Bec-croisé et des données publiées sur les caractéristiques locales du sol, des hypothèses vérifiables sont proposées pour expliquer l'ingestion de terre par cette espèce, incluant la recherche de sels alimentaires et le besoin de détoxification vis-à-vis des graines de pin qui constituent l'élément principal de son régime alimentaire.

Mots clés : Bec-croisé, calcium, géophagie, Hispaniola, *Loxia megaplaga*, régime alimentaire, sol, toxicité

The consumption of soils by birds, technically called geophagy, is widely reported in the literature (Abrahams and Parsons 1996, Diamond *et al.* 1999), particularly from Neotropical parrots (Burger and Gochfeld 2003, Brightsmith and Muñoz-Najar 2004, Valdés-Peña *et al.* 2008). But the phenomenon is also known in temperate zones, especially among boreal cardueline finches including Red Crossbills (*Loxia curvirostra*; Bennetts and Hutto 1985, Adkisson 1996) and White-winged Crossbills (*L. leucoptera*; Benkman 1992). In both of these northern crossbills, the taking of grit from the base of trees and road cuts, and the consumption of salt spread on roads in winter is a well-known phenomenon (Benkman 1992, Adkisson 1996), but these activities have not been well studied or understood.

On 16 February 2007, while co-leading a tour group in the Aceitillar sector of the Sierra de Ba-

horuco National Park (18°07' N, 71°33' W), we ascended the mountains to the pine zone at about 1,100 m elevation. Failing to find Hispaniolan Crossbills (*Loxia megaplaga*), one of our target species, at some of the more regular locales, such as an open water source, we proceeded to walk through adjoining pine forest listening for the tell-tale calls of the species. Finally, while making our way through regenerating pine along an abandoned access road to a bauxite test mine, we came across an apparent family group of an adult male, adult female, and three juveniles. Such groups are commonly seen together following breeding, which generally extends from December to April but may occur year-round (Latta *et al.* 2006). The birds were first heard quietly calling back and forth in mature Hispaniolan pines (*Pinus occidentalis*) of about 15–20 m in height, but the birds slowly descended to

young pines, and finally dropped down to the ground, with the adult male preceding the others. On the bare ground, the crossbills could be seen repeatedly scraping the reddish soil with their beaks, and then apparently ingesting the soil, before scraping more at the ground. Although the ground was liberally covered with dry pine needles, little vegetation grows on these sites, and in patches there are no needles at all, leaving exposed patches of generally hard, red soil.

The Aceitillar sector of Sierra de Bahoruco National Park has been widely disturbed for the extraction of bauxite since the 1960s. Large open pit mines, small test pits, and access roads are now a near-permanent part of the landscape. When several mines were closed, the area was graded and terraced, and plugs of natural vegetation and exotic trees were planted. While the vegetation on the mines has mostly survived for > 25 yr, it remains stagnant and rarely spreads beyond the original plug. The ground remains hard and only permits very slow revegetation, most frequently in the smaller pits where erosion provides new topsoil more amenable to plant growth. Most often this revegetation resembles in structure and species diversity the surrounding forest, which is dominated by Hispaniolan Pine; the only other common tree is the palm *Coccothrinax scoparia*. In some areas, particularly those disturbed by roadcuts, burning, or natural forces, *Trema lamarckiana* may be prominent. A well-developed shrub layer is present, and common broadleaf species include *Cestrum brevifolium*, *Chamaescrista glandulosa*, *Coreopsis buchii*, *Hypericum hypericoides*, *Lyonia truncata*, *L. microcarpa*, *Myrica picardae*, and *Senecio picardae*, as well as the succulent *Agave antillana* (Fisher-Meerow and Judd 1989). The ground is also covered in places by grasses and ferns.

While generally considered detrimental to bird populations, the abandoned bauxite mines may provide access to a unique resource for Hispaniolan Crossbills. In studies from similar bauxitic soils in Jamaica, Greenberg and Wilding (2007) found that the physical properties of both pre- and post-mined soils were mostly clay. But after open pit mining, bauxite lands are reshaped, such that the resulting post-mined soils are significantly higher in underlying limestone rock fragments than the pre-mined soils. The primary constituents of bauxitic soils are aluminum (Al) and iron (Fe) oxides, but these marginally reclaimed lands had significantly higher pH levels than pre-mined soils, as well as higher extractable calcium and CaCO₃ equivalent.

This suggests two explanations for geophagy in crossbills. One possible explanation for the observed consumption of soil is that the crossbills may be obtaining dietary salts. Dawson *et al.* (1965) found experimentally that sodium chloride (NaCl) was not an essential nutrient, and that the ingestion of salt beyond that present in food was not necessary for the maintenance of a sodium balance or the apparent good health of Red Crossbills. They could not exclude, however, the possibility that consuming salt might satisfy a requirement for some co-occurring mineral that they do not obtain in sufficient quantity in their food. For example, Bennetts and Hutto (1985) attributed geophagy by Red Crossbills in Montana to an extra-dietary need for salt ingestion that was satisfied by consumption of calcium carbonate (CaCO₃) leaching from stone walls of a building. It is possible then that Hispaniolan Crossbills are satisfying an extra-dietary need for calcium, aluminum, iron, or some other mineral found in the bauxitic soils.

A second explanation might be the crossbills' need to detoxify their commonly eaten foods. Crossbills feed largely on pine seeds (Benkman 1992), which contain terpenoid components that play a major role in reducing or preventing herbivore attack (Mumm and Hilker 2006), but the seeds are relatively free of toxins and are commonly eaten by many species (Smith and Balda 1979). However, if toxins persist in the seeds, or if other diet items are detrimental to the birds, geophagy may protect them from dietary toxins, as has been shown for some geese (Wink *et al.* 1993) and parrots (Gilardi *et al.* 1999). Recent studies of Amazonian parrots have focused on their consumption of fine soils and clay that act to absorb toxins (Gilardi *et al.* 1999, Brightsmith and Muñoz-Najar 2004). In these species, consumed clay binds readily to alkaloid toxins, but is also thought to provide gastrointestinal cytoprotection and protect the gut from damage by dietary phenolics, alkaloids, and other toxins (Gilardi *et al.* 1999). Farther north, Maroon-fronted Parrots (*Rhynchopsitta terrisi*) of northern Mexico subsist primarily on pine seeds as well as acorns. Valdés-Peña *et al.* (2008) suggested that this parrot consumes clay at licks as a mineral supplement, but also to absorb secondary compounds and to buffer acids. The nature of the clay-based bauxitic soils found in the Bahoruco may be a similar resource for Hispaniolan Crossbills.

Although the biological need for salts remains unanswered, as Bennett and Hutto (1985) have pointed out the behavior nonetheless presents inter-

esting management implications. While current thinking is that Hispaniolan Crossbills are most abundant in the Sierra de Bahoruco due to the size or regularity of the cone crop (Latta *et al.* 2000), or perhaps due to the regular access to otherwise scarce surface water (Klein *et al.* 1998), the occurrence of geophagy may suggest that their need for clay, salts, or some other soil-borne mineral also influences their distribution. Bauxite is not mined elsewhere on the island, and indeed, bauxitic soils are rare elsewhere on Hispaniola. If in fact pre- or post-mining bauxitic soils are unique in providing easily obtained access to CaCO₃ or other scarce resources on the island, then their availability for this endangered species should be managed. Further study should be made on soil properties and how they function in the ecology of this crossbill. It should be noted, too, that these same mines were recently shown to host nesting Golden Swallows (*Tachycineta euchrysea*), another endangered species found only on Hispaniola (Townsend *et al.* 2008). While this may not be a preferred habitat, the bauxitic soils and abandoned mines may not represent a total loss in habitat for these endangered endemics.

ACKNOWLEDGMENTS

I thank Kate Wallace of Tody Tours for inviting me along on her tour. I also thank Tom Fiore, Brad Klein, Danielle Gustafson, Kristine Wallstrom, Dana Gardner, and Michael Chin for their interest and camaraderie on this trip. Craig Benkman kindly commented on a previous draft of this note; Andrew Dobson, Floyd Hayes, and an anonymous reviewer provided helpful comments.

LITERATURE CITED

- ABRAHAMS, P. W., AND J. A. PARSONS. 1996. Geophagy in the tropics: a literature review. *Geographic Journal* 162:63–72.
- ADKISSON, C. S. 1996. Red Crossbill (*Loxia curvirostra*). In *The birds of North America*, no. 256 (A. Poole and F. Gill, eds.). The Academy of Natural Sciences, Philadelphia, PA, and The American Ornithologists' Union, Washington, DC.
- BENKMAN, C. W. 1992. White-winged Crossbill (*Loxia leucoptera*). In *The birds of North America*, no. 27 (A. Poole, P. Stettenheim, and F. Gill, eds.). The Academy of Natural Sciences, Philadelphia, PA, and The American Ornithologists' Union, Washington, DC.
- BENNETTS, R. E., AND R. L. HUTTO. 1985. Attraction of social fringillids to mineral salts: an experimental study. *Journal of Field Ornithology* 56: 187–189.
- BRIGHTSMITH, D. J., AND R. A. MUÑOZ-NAJAR. 2004. Avian geophagy and soil characteristics in Southeastern Peru. *Biotropica* 36:534–543.
- BURGER, J., AND M. GOCHFELD. 2003. Parrot behavior at a Rio Manu (Peru) clay lick: temporal patterns, associations, and antipredator responses. *Acta Ethologica* 6:23–34.
- DAWSON, W. R., V. H. SHOEMAKER, H. B. TORDOFF, AND A. BORUT. 1965. Observations on metabolism of sodium chloride in the Red Crossbill. *Auk* 82:606–623.
- DIAMOND, J., K. D. BISHOP, AND J. D. GILARDI. 1999. Geophagy in New Guinea birds. *Ibis* 141: 181–193.
- FISHER-MEEROW, L. L., AND W. S. JUDD. 1989. A floristic study of five sites along an elevational transect in the Sierra de Baoruco, Prov. Pedernales, Dominican Republic. *Moscosoia* 5:159–185.
- GILARDI, J. D., S. S. DUFFEY, C. A. MUNN, AND L. A. TELL. 1999. Biochemical functions of geophagy in parrots: detoxification of dietary toxins and cytoprotective effects. *Journal of Chemical Ecology* 25:897–922.
- GREENBERG, W. A., AND L. P. WILDING. 2007. Pre- and post-mined bauxite soils of Jamaica: physical and chemical properties. *Soil Science Society of America Journal* 71:181–188.
- KLEIN, N. K., F. H. SHELDON, K. WALLACE, E. CUEVAS, AND S. C. LATTA. 1998. Use of a small water reservoir by locally rare birds in the Dominican Republic. *Pitirre* 11:36.
- LATTA, S. C., M. L. SONDRAL, AND C. R. BROWN. 2000. A hierarchical analysis of nesting and foraging habitat for the conservation of the Hispaniolan White-winged Crossbill (*Loxia leucoptera megaplaga*). *Biological Conservation* 96:139–150.
- LATTA, S. C., C. C. RIMMER, A. R. KEITH, J. W. WILEY, H. A. RAFFAELE, K. P. MCFARLAND, AND E. M. FERNANDEZ. 2006. *Birds of the Dominican Republic and Haiti*. Princeton University Press, Princeton, NJ.
- MUMM, R., AND M. HILKER. 2006. Direct and indirect chemical defence of pine against folivorous insects. *Trends in Plant Science* 11: 351–358.
- SMITH, C. C., AND R. P. BALDA. 1979. Competition between insects, birds and mammals for conifer seeds. *American Zoologist* 19:1065–1083.
- TOWNSEND, J. M., E. GARRIDO, AND D. A. MEJÍA. 2008. Nests and nesting behavior of Golden Swallow (*Tachycineta euchrysea*) in abandoned

- bauxite mines in the Dominican Republic. *Wilson Journal of Ornithology* 120:867–871.
- VALDÉS-PEÑA, R. A., S. G. ORTIZ-MACIEL, S. O. VALDEZ JUAREZ, E. C. ENKERLIN HOEFELICH, AND N. F. R. SNYDER. 2008. Use of clay licks by Maroon-fronted Parrots (*Rhynchopsitta terrisi*) in Northern Mexico. *Wilson Journal of Ornithology* 120:176–180.
- WINK, M., A. HOFER, M. BILFINGER, E. ENGLERT, M. MARTIN, AND D. SCHNEIDER. 1993. Geese and dietary allelochemicals—food palatability and geophagy. *Chemoecology* 4:93–107.