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OBSERVATIONS OF HUMMINGBIRDS INGESTING MINERAL-RICH COMPOUNDS

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Abstract.—Hummingbirds may need to replace electrolytes and minerals lost during daily diuresis and seasonal reproduction. Minerals such as calcium may not be obtained in sufficient quantities from a nectar-rich diet alone. We report observations of female Rufous Hummingbirds (*Selasporus rufus*) ingesting soil in western Oregon and review other known observations of hummingbirds ingesting mineral-rich compounds. We suggest these behaviors are the result of diet deficiencies of specific minerals, particularly calcium for nesting females.

OBSERVACIONES SOBRE ZUMBADORES INGIRIENDO COMPUESTOS ALTOS EN MINERALES

Sinopsis.—Los zumbadores muy bién pudieran necesitar remplazar los electrolitos y minerales que pierden diariamente a través de su sistema excretor o durante la época de reproducción. Es posible que las aves no puedan obtener el calcio que necesitan ingiriendo néctar solamente. Informamos a una hembra de *Selasporus rufus* ingiriendo suelo en la parte oeste de Oregón y además revisamos otras observaciones de zumbadores ingiriendo compuestos ricos en minerales. Se sugiere, que esta conducta es el resultado de una dieta deficiente en algunos minerales, en particular calcio para hembras reproductivas.

Many of the nutrients required by hummingbirds are provided by the nectar that makes up the majority of their specialized diet (Brice and Grau 1989, 1991). However, hummingbirds may require minerals that are found in inadequate amounts in nectar to meet some metabolic needs, and the production of large amounts of urine may result in loss of some minerals that can be obtained in nectar (Calder and Hiebert 1983). Nutrients, particularly proteins, not supplied by nectar-rich diets are often provided by insects (Remsen et al. 1986). However, during or after reproduction females may need additional elements, such as calcium. We report observations of female Rufous Hummingbirds ingesting soil and review observations in the literature of hummingbirds ingesting mineral-rich compounds. We propose that this is a mechanism to supplement the diet or replace those compounds lost as a result of reproduction and diuresis.

One of us (MDA) observed female Rufous Hummingbirds (*Selasphorus rufus*) ingesting soil under two bridges in the Oregon Coast Range. Four of the five observations (22 Apr., 10 May, 1 Jun., and 15 Jun. 1996) were under a bridge (T19S, R11W, Section 33) that spans the Siltcoos River, Lane County, approximately 1.2 km from the Pacific Ocean. A single ob-

servation (24 Apr. 1996) was located under a bridge (T4S, R8W, Section 2) that spans Niagara Creek, Tillamook County. All four observations at the bridge in Lane County were at the same location under the bridge. The soil under each of these bridges is exposed and supports little or no vegetation. We could not classify the soil due to the unknown origin of the soil used during bridge construction and/or deposited during flooding.

On each occasion observations were made in the mid-morning (0900–1000 h PST) 3–5 m from the bird. The behavior was almost identical in each case. The hummingbird briefly (<5 s) hovered approximately 0.5 m above the ground, perched on a rock, and began ingesting the soil by repeatedly flicking its tongue into the soil, and then retracting its tongue. This behavior lasted approximately 5–10 s and was followed by 3–5 s of licking of the bill. This was repeated several times for 1–2 min before the bird flew away. Occasionally, a bird would ingest the soil with the tongue-flicking technique while hovering above the ground, then fly away.

Following each observation, the area where the birds were ingesting soil was inspected. There was no evidence of insects or anything biotic. A soil sample was collected at each location where hummingbirds had been observed ingesting soil and analyses were conducted on potassium, phosphorus, calcium, magnesium, and soluble salts. Both samples had high levels of calcium (Siltcoos: 4480 ppm, Niagara: 8500 ppm) and soluble salts (Siltcoos: 4960 ppm, Niagara: 4736 ppm), and low levels of phosphorus (Siltcoos: 6 ppm, Niagara: 16 ppm; Marx et al. 1996). In addition, the Niagara sample showed high levels of potassium (335 ppm) and magnesium (1020 ppm).

Because of their nectar–rich diet, hummingbirds must daily dispose of large amounts of excess water via combined respiratory and excretory routes (estimated at 56–149% of their body mass; Calder 1979), which in climatic extremes causes electrolyte balance problems. Water balance problems are accentuated in cooler climates where electrolyte losses due to diuresis are greatest (Calder 1979), perhaps forcing birds to supplement their diet. Electrolyte loss through urinations can be significant. Calder and Hiebert (1983) report that in Broad-tailed Hummingbirds (*S. platycercus*) approximately 14% of the body sodium and potassium needs to be replaced each day.

The Oregon Coast is cool and wet throughout the spring with average temperatures in May and June averaging 10.6 and 12.2 C, respectively; precipitation in May and June averages 12.5 and 8.9 cm, respectively. This weather may contribute to conditions for electrolyte loss for Rufous Hummingbirds and low insect populations needed for electrolyte replacement. We suspect the behavior observed augments mineral replacement. Two factors may contribute to the soil ingestion behavior by Rufous Hummingbirds under bridges in western Oregon. First, streams in the Coast Range of Oregon flood periodically and this probably contributes significantly to the amount of minerals in soils under bridges. Second, bridge construction exposes subsurface layers of soils in which minerals like calcium often have higher concentrations than surface layers of the soil

(John Hart, Department of Soil and Crop Science, Oregon State University, pers. comm.).

Calcium is a critical element in avian reproduction (Simkiss 1961). Hummingbirds have greatly reduced medullary bone from which to supply the calcium required during and after egg production. This reduced calcium reservoir combined with diuretic conditions during the breeding season may cause a calcium deficiency in hummingbirds. Previous observations of hummingbirds ingesting mineral-rich compounds include items which are high in calcium (Table 1). Two substances, wood ash and sand or sandy soil, are the most commonly consumed. Wood ash is rich in calcium oxide and calcium carbonate (Wise 1944), while sand can be high in calcium carbonate (Siever 1988). The hypothesis for ingesting calcium supplements in further supported by the strong bias toward females in reported observations (Table 1), although the nesting status for most of the sightings was unknown. Soils under the bridges described in this paper contained high levels of calcium and the observations were made during the breeding season of Rufous Hummingbirds.

Supplementing diets with minerals is not unique to hummingbirds. Other birds have been reported ingesting calcium-rich compounds, including Arctic sandpipers (*Calidris* spp.) eating brown lemming (*Lemmus trimucronatus*) bones (MacLean 1974), Turkeys (*Meleagris gallopavo*) eating snail shells (Beasom and Pattee 1978), nestling Tree Swallows (*Tachycineta bicolor*) and House Wrens (*Troglodytes aedon*) eating mollusk shells (Mayoh and Zach 1986), Boreal Chickadees (*Parus hudsonicus*) eating wood ashes (Ficken 1989), nestling Tree Swallows eating fish bones, crayfish exoskeletons, clam shells, and bird eggshells (St. Louis and Breebaart 1991), Red-cockaded Woodpeckers (*Picoides borealis*) caching bone fragments (Repasky et al. 1991), Common Terns (*Sterna hirundo*) eating mollusk shells (Nisbet 1997), and Pine Siskins (*Carduelis pinus*) eating wood ashes (des Lauriers, pers. obs.). Thus, mineral replacement is probably a common problem in birds, with temperate zone nectar feeders being the extreme case.

There is difficulty determining the importance of mineral supplements in the diet of hummingbirds because little is known about the mineral content of floral nectar. Carroll and Moore (1993) found hummingbirds foraged at artificial feeders containing the highest concentrations of supplemental minerals and suggested that the non-energy nutrients in the feeders affected the birds foraging behavior, although they could not determine which mineral or group of minerals were serving as the attractant.

Even under extreme conditions, hummingbirds meet their daily energy requirements through the consumption of nectar and insects. Non-energy needs, such as calcium for egg production or replacement, appear to be obtained from sources such as soil or wood ash. Future studies might investigate how hummingbirds detect concentrations of minerals such as calcium. In addition, more data regarding the mineral content of floral nectars as well as the role these supplemental diets play in the physiology of these birds are needed.

TABLE 1. Reported observations of hummingbirds ingesting mineral-rich compounds.

Species	Location/Date	Compound	Nesting status	Sex	Source
Anna's (*Calypte anna*)	California/January 1929	Sand	?	Female	Arnold (1930)
	???/???	Sandy soil	?	Female	R. S. Woods in Bent (1940)
	California/1953	Sandy area/Ashes small ants present	?	Females	Legg and Pitelka (1956)
	California/May 1969	Sand	?	Female	Verbeek (1971)
	California/December 1982	Ashes	Yes	Female	des Lauriers (1994)
	California/April 1983	Ashes	Yes	Female	des Lauriers (1994)
	California/February 1992	Ashes	?	Female	des Lauriers (1994)
	California/December 1994	Limy grit from house foundation	?	Female	J. des Lauriers, pers. obs.
	California/April 1995	Soot on a rock	?	Female	K. Huxman, pers. comm.
	California/May–June 1995	Ashes	?	Female	J. Koerner, pers. comm.
	California/???	Ashes	?	Female	K. Wilson, pers. comm.
Allen's (*Selasporus sasin*)	California/June July 1970	Ashes	?	Female or Juvenile	A. S. Leopold, mentioned in Verbeek (1971)
Black-Chinned (*Archilochus alexandri*)	California/June 1938	Sandy soil	Yes	Female	Linsdale, mentioned in Verbeek (1971)
Blue-throated (*Lampornis clemenciae*)	Arizona/July 1978	Ashes	Yes	Female	des Lauriers (1994)
Broad-tailed (*S. platycercus*)	Arizona/July 1978	Ashes	Yes	Female	des Lauriers (1994)
Costa's (*C. costae*)	California/March 1980	Ashes	Yes	Female	des Lauriers (1994)
Lesson's Emerald (*Amazilia fimbriata*)	Surinam/December 1951, January 1952	Sand	?	?	Haverschmidt (1952)
Rufous (*S. rufus*)	California/July 1967	Sand	?	Female or Juvenile	DeBell and Bapista, mentioned in Verbeek (1971)
	Washington/June 1988	Ashes	?	?	A. K. English, pers. comm.
	Oregon/April–June 1996	Soil under bridges	?	Female	This paper
	Oregon/???	Ashes	?	Female	R. and T. Nelson, pers. comm.
	Oregon/???	Ashes	?	?	K. Wilson, pers. comm.

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